# THE STATUS OF ECOLOGY IN THE BRITISH ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

**Stewart Thompson**

A thesis submitted in partial fulfilment of the requirements of Oxford Brookes University for the degree of Doctor of Philosophy

This research programme was carried out in collaboration with English Nature

School of Biological and Molecular Sciences
Oxford Brookes University

November 1994

# Abstract

Environmental impact assessment (EIA) is a process by which the potential environmental impacts of a proposed development are assessed. An assessment of the ecological impacts of a development on ecosystems, habitats and species is required under the 1985 European Directive 85/337/EEC, which is implemented in Britain through the 1988 Town and Country Planning (Assessment of Environmental Effects) Regulations.

The status of ecology within the British EIA process was investigated by analysing 179 environmental statements mostly produced between 1989 and 1992. Criteria relating to ecological survey information, consultation, impact prediction and evaluation, mitigation, and monitoring were used.

Most of the ecological information presented was of such poor quality, or of such limited quantity, that it was not adequate to assess the ecological implications of the proposed schemes. Only 21% of statements devoted more than 10% to ecology. Only 45% were based on new ecological survey information, with only 59% of surveys conducted by an ecologist.

Consultation with a statutory body was reported by 48%. Potential impacts were identified in 92% of statements, but only 9% quantified impacts. Although 78% mentioned mitigation measures, only 23% described them. A major shortcoming was that none gave a commitment to monitor development impacts.

It was concluded that a major reason for these shortcomings is a lack of guidance for developers and ecologists involved in EIA. As a potential solution, survey guidelines incorporating a simple scoring system were produced and tested for woodlands, a habitat type particularly prone to development pressure.

The shortcomings described relate to the individual project approach to EIA. The European Community is discussing environmental impact assessment of policies, plans and programmes, a process known as strategic environmental assessment (SEA). The need for, and feasibility of, SEA was investigated from an ecological point of view for a habitat (lowland heath), a bio-geographic unit (the coastal zone) and an industry (salmon farming). SEA frameworks for each are outlined and the required legislative changes are discussed.

The need for ecologists to involve themselves in EIA initiatives, and to learn lessons from the longer established north American EIA system, is stressed. This will help to enhance the status of ecology within the British EIA process.

## Acknowledgements

Many people gave their valuable time to discuss various aspects of my research; my sincere apologies to anyone I inadvertently miss out!

I would like to thank my supervisors David Thurling and Andrew Lack. Thanks also to Keith Porter and Hazel Long of English Nature, the collaborating institution.

My thanks to colleagues in the School of Biological & Molecular Sciences and School of Planning at Oxford Brookes University, to Carys Jones and Fiona Walsh at the University of Manchester, and to John Foster at the University of Hertfordshire for his comments on the woodland guidelines.

Many conservation and other non-governmental organisations offered their time and advice for which I am eternally grateful. I am indebted to all staff at the RSPB, at the Lodge, Regent Terrace, and in the various regional offices. In particular: Ian Bainbridge, Kevin Bayes, Chris Corrigan, Frank Hamilton, David Minns, David Pritchard, Phil Rothwell, John Taylor, Roger Turner and John Waldon. Special thanks to Robin Wynde for all his help and advice with these and other enquiries down the years. Similar accolades to the WWF, particularly Carol Hatton, Martin Mathers, Gail Murray and Simon Pepper, all of whom have provided insightful comments on this research. Thanks to Jo Burgon at the National Trust for all his time and comments on the coastal issues. David Wilkinson at the Institute of European Environmental Policy offered valuable comments relating to the SEA component. Oliver de Soisson, Marjorie Reid and Graeme McVittie provided information for the woodlands in Oxford and Manchester.

Thanks to John Halliday, Ed Mackie, Jim Mumford and Owen Paisley of Scottish Natural Heritage, and to Jenny Heap and Richard Keymer of English Nature. I specially thank Jo Treweek of the Institute of Terrestrial Ecology, Monks Wood for her enthusiasm for this research and her valuable advice.

I have a great many friends in and around Oxford Brookes University, you have all made this thing bearable. So... Jeremy Biggs, Melanie Breeze, Andrew Bunney, Kay Cocker, Lara Derwent, Bob Eeles, Andy Felton, Dave Goulson, Rob Hammond, Anna Jeary, Susie Lickman, Celia Maier, Sue and Tim Marlow, Anne Miller, Jeff Ollerton, Tim Shreeve, Drew Thomas, Andrea Turner, Mary Webb and Penny Williams ...thanks! Repetition I know, but the help of Anne, Bob, Jeff, Tim, Rob and particularly David and Kay in the final throws of putting this together was greatly appreciated.

This is for my Mam and Dad, Anne and Bill.

## Publications

The following publications contain material originating from my research for this thesis. I was responsible for the ecological input to Therivel *et al.* (1993), responsible for Chapter 4: Coastal zones and Chapter 6: Lowland heath, and co-wrote Chapter 7: Strategic environmental assessment and global futures. See Appendix 4 for further details.

**Therivel, R., Wilson, E., Thompson, S., Heaney, D. & Pritchard, D. (1992).** *Strategic Environmental Assessment.* Earthscan, London.

**Treweek, J.R., Thompson, S., Veitch, N. & Japp, C. (1993).** Ecological assessment of proposed road developments: a review of environmental statements. Journal of Environmental Planning and Management, **36**, 295-307.

CONTENTS

# Chapter 1

# ENVIRONMENTAL IMPACT ASSESSMENT IN BRITAIN

## 1.1 INTRODUCTION

Environmental impact assessment (EIA) is a process by which information about the likely effects of a development on the environment are assessed. The process includes predicting and evaluating an action's impact on the environment, the conclusions to be used as a decision making tool. EIA aims to prevent environmental degradation by giving decision makers better information about the consequences that development actions could have on the environment. EIA cannot, of itself, prevent environmental degradation. The findings of the EIA are summarized in a report, the environmental statement. This report is then taken into account by the Local Planning Authority in forming their judgement as to whether or not the development should go ahead (Department of the Environment/Welsh Office, 1989).

There is concern about the general quality of environmental statements (ESs) (Lee & Colley, 1990; Lee & Brown, 1992; Lee & Dancey, 1993), with ecologists expressing specific concern over the inadequacy of the ecological content of the ESs produced so far (Mathers, 1993, Treweek, 1992, Wynde, 1990, *pers comms*). Many developments are proposed which have potential impacts upon the ecology of a site, often in sensitive areas where any damage incurred is irreversible. The ecological components of the ESs produced for some of these developments have been of such poor quality that in some instances the non-statutory conservation bodies have threatened legal action in the European law courts (see Chapter 8).

Although ecology has a major contribution to make to the planning system, planners generally have little knowledge of the subject and see only a limited scope for its application. As a result, the major stumbling block to the integration of ecology and planning has been the lack of perceived relevance (Selman, 1981). My discussions with the statutory and non-statutory bodies indicate that there is a reluctance of some ecologists to become involved in the environmental impact assessment (EIA) process. Historically ecologists have only been consulted over proposed developments late in the decision making process, and then only over specific issues with no question of including their

expertise to make the process of planning decision making a holistic mechanism. This may explain their lack of participation in the EIA process.

The EIA concept was first developed in the United States, and the National Environmental Policy Act (NEPA) 1969 was the first of many national decisions to enact legislation which allows certain developments to go ahead only with knowledge of their environmental consequences (see Chapter 2). In July 1985, after nearly a decade of deliberation, the European Community (EC) adopted Council Directive 85/337/EEC making environmental assessments mandatory for certain categories of projects (Wathern, 1988) (see Appendix 1 for details). The Directive has been implemented in all EC member states by amending existing laws or passing new ones. For example, the Netherlands have introduced EIA by amending the General Environmental Protection Act (Therivel *et al.*, 1992) while Spain has introduced EIA by separate legislation. In the UK, Directive 85/337 was implemented through the Town and Country Planning (Assessment of Environmental Effects) Regulations, 1988.

Article 3 and Annex III (3) of Directive 85/337/EEC clearly state that the direct and indirect effects of a project should be considered as part of the environmental assessment (EA), including effects on "human beings, fauna, flora, soil, water, air, climate, any interactions between the foregoing, material assets and the cultural heritage". Annex III (4) then states that a description of the likely significant effects should include "direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects" (Council of the European Communities, 1985). If ecology is defined as "the scientific study of the interrelations between living organisms and their environment, including both the physical and biotic factors" (Walker, 1988) then the wording of the Directive equates to a clearly stated requirement to study the ecological implications of any development scheme (Treweek *et al.*, 1993). The wording of the Directive is, however, vague as to what is actually required from ecologists involved in the EIA process, with little guidance provided for them in an area which for the majority is a new discipline.

## 1.2 THE ROLE OF ECOLOGY IN EIA

Ecology, and more specifically ecological evaluation, has an increasing role to play in decision making regarding the acceptability of proposed developments (Booth, 1984;

Bradshaw, 1984; Daniels, 1988; Wathern, 1988). The current EIA Directive clearly identifies the need to consider the potential impacts of the proposed development upon the flora and fauna of the site as part of the overall assessment process, and it is this consideration which is the basis of my research.

I propose the following three aims for the ecological component of EIA.

(i) To assess the conservation value of species and communities within the area of impact for the proposed development.

(ii) To predict the likely impacts of that development on the species and communities present.

(iii) To propose mitigation measures which will reduce or remove the predicted impacts.

A major problem associated with the role of ecology in planning in general, and environmental impact assessment in particular, appears to be a lack of dialogue and understanding between planners and ecologists (Clark *et al.*, 1981; Treweek, 1993, *pers comm*). Planners often fail to recognise that ecology is a science requiring the allocation of time and resources for the collection and analysis of information, usually from baseline surveys, which will then allow predictions regarding potential impacts to be made. Obviously, the smaller the amount of time and resources made available then the poorer the data collection and subsequent impact prediction. Ecologists have responded to these problems in a predictable manner. Many simply refuse to make judgements based upon insufficient or incomplete data sets. However, as Selman (1982) notes, EIA does not merely comprise a limited collection of predictions but forms an integrated process of baseline survey, impact identification, forecasting, assessment and monitoring, with the ecologist playing a distinctive role at each stage.

The ecological component of EIA has three basic elements; baseline survey, impact assessment based on the survey information and impact prediction. The following provides a brief summary of the key considerations for each element.

## 1.3 BASELINE SURVEY

Baseline surveys identify a set of environmental conditions against which change can be measured and they are an integral part of the EIA process. Before the baseline survey can be performed it is necessary to define the scope of the process. The scoping exercise entails the identification of those impacts which are considered to be significant and the removal of those which are not. The scope of the ecological component of the EIA, i.e. what is actually considered by the consultant ecologist, is usually decided by a desk study which allows for the preliminary assessment of the proposed development site. Included in this assessment will be the identification of the area impacted upon and an initial indication of the ecological sensitivity of the site.

Deciding the extent of this area can prove difficult because it is heavily influenced by the nature of the development. For example, some developments will have the potential to impact outside the immediate confines of the site. This may occur in a number of ways, such as changing hydrological regimes, polluting waterways or noise generation. It is therefore important to recognise that the extent of the impact area may change as information is acquired during the EIA process.

Determining the ecological sensitivity of the proposed site may be somewhat easier in that the scoping exercise will provide information concerning any habitats and species present which are of national or international importance (assuming the ecologist involved has the expertise to interpret the information). These should act as effective constraints on any adverse development proposal.

The scoping exercise should lead to an outline of the baseline survey requirements for the habitats and species at the proposed site, indicating the optimum time to conduct the survey and which methodologies and field techniques to employ. Ideally, the scoping exercise will also indicate the level of precision which the surveys should achieve, emphasising the need for quantitative data wherever possible.

Baseline surveys form the mainstay of ecological impact assessment and therefore ecologists should be consulted over the development at the earliest stages of planning and not brought in when decisions have already been made. The area of potential impact of the proposed development should be determined, because this dictates the area to be

surveyed. Usually this is difficult as many of the impacts are indirect and often little is known about the flora and fauna of an area, with good knowledge existing for only a small number of resident animal populations or higher plants. A further problem is that much of the ecological interest of a potential development site may be linked to its physical characteristics and any ecological survey must account for this. This can be demonstrated in coastal ecosystems which are largely a product of the wide range of wave activity and tidal regimes, the highly variable geology of the coast, and the large range of topographical features exhibited. I suggest that some of the problems encountered in relation to site ecology, and its relationship with physical characteristics, can be overcome by conducting surveys in parallel. For example, coastal habitats, communities and species would benefit from consideration in relation to tidal movement and the geology of the site, which themselves should be considered as part of the EIA process.

## 1.4 SITE SURVEYS

The study area surveyed should include as many habitat types and component taxonomic groups as possible. These site surveys are an integral part of ecological assessment because they determine both the presence of important habitats, communities and species, and they quantify the parameters against which potential ecological impacts are assessed (Treweek *et al.*, 1993). New surveys should be conducted wherever necessary. Although fieldwork for some habitats, communities and species is difficult, and suitable survey methodologies may not have been developed, this is no reason for not undertaking new fieldwork; in fact I suggest the reverse is true. Ecologists should develop survey methodologies which will provide information of a standard which allows informed predictions to be made. These must be developed in the light of the geographical, seasonal and financial constraints with which any ecologist conducting a survey must contend.

Once the fieldwork has been concluded it is important to present the information in such a manner so as to make it useful to decision-makers without undermining the ecological rationale. Lists of species present at the time of survey are of little use on their own because an indication of the presence or absence of a particular species contributes little to the prediction or the assessment of ecological impacts. Abundance or frequency measures should be used to indicate the status of the species' populations (Treweek *et al.*, 1993). Ideally, repeat surveys of the development site should be carried out as part of the EIA,

although if the species or habitat initially surveyed are extreme rarities then repeat surveys are of little value. Ecosystems (in general) are dynamic with a high degree of seasonality. Whilst some faunal groups will be found all year round, fish, bird populations and most invertebrates for example, change in relation to their breeding and overwintering strategy. Consequently, habitats must be considered as important ecological units all year round and any survey which only provides a snapshot in time is undesirable.

## 1.5 IMPACT PREDICTION

Fundamental to the EIA process are predictions concerning the magnitude and extent of the likely impacts of the proposed development. Each type of development has its own peculiar problems. Impact prediction requires that the likely impacts of a development be identified to enable predictions to be made concerning their effects. Ideally, these predictions will be based upon quantitative studies which will provide scientific rigour. Ecological impact prediction is difficult in that the baseline information required is often inadequate or unavailable. However, whilst inadequate information or a lack of understanding of the ecosystem may prevent prediction of the outcomes of changes in a complex community structure, it may still be possible to state that a given species requires a certain set of environmental variables present in order to maintain a viable population, and that a given area with these variables present will support a particular size of population. Conversely, it may be possible to make predictions concerning extinction probabilities. It follows that any proposal which alters the balance of these variables or the area in which they operate will have an impact upon that species. Thus, based on the ecologist's judgement, an EIA can give an indication of the ecological consequences of the development.

A number of methods of impact prediction exist which include the use of predictive models (Starfield & Bleloch, 1986; North & Jeffers, 1991), matrices and checklists (Leopold, 1971; Clark *et al.*, 1981, Glasson *et al.*, 1994; Wathern, 1988), cartographic overlays and Geographic Information Systems (GIS) (Hendrix *et al.*, 1988; Eversham *et al.*, 1992; Treweek & Veitch, 1994) or flowcharts (Sorensen, 1971). All of these predictive methods are useful but are not without their problems. Predictive modelling is expensive and time consuming, heavily reliant upon accurate data sets which often do not exist, and models need to be validated by extensive "ground-truthing" exercises. Using

computer modelling to make ecological predictions is difficult because each development site is different and therefore often it is not possible to extrapolate from one set of outcomes to a similar site. Checklists and matrices only identify and cross-reference project features, often giving no indication of the size or significance of the impact predicted. Flowcharts merely serve to indicate the highly complex nature of the ecosystem affected, the majority identifying direct impacts, but giving no indication of secondary or cumulative impacts.

## 1.6 MITIGATION

Mitigative measures are those which will remove, reduce or reverse an adverse environmental impact. Ecologists involved in the EIA process should have appropriate mitigation measures as one of their main objectives. They should provide detailed prescriptions for the proposed measures, indicate how they would actually be put in place, and propose how they might be modified if unforeseen post-project ecological impacts manifest themselves. This point is particularly relevant for developments, such as barrage schemes or power stations, which potentially affect the coastal zone because of their (often) large scale, the dynamic nature of the habitats they affect, and a lack of monitoring. The need for mitigation measures is often identified post-project and is reliant upon appropriate monitoring procedures present. These procedures will identify and measure the impacts of the development in question, indicating activities which are causing environmental degradation and are in need of remedial action. Currently there are no legal requirements for developers to put in place monitoring programmes post-project.

## 1.7 RESEARCH AIMS

In 1990, when my research started, there were approximately 1000 British environmental statements (ESs). These had been produced for a range of developments, many of which did not fall within the requirements of the Directive's schedules (see Appendix 1) and therefore did not require an EIA. Information about the types of developments involved was obtained from the *Journal of Planning and Environmental Law* which lists all ESs received by the Department of the Environment, Scottish Office and Welsh Office. This journal publishes a description of the project type, details of the local authority to whom it

was sent, and the decision reached by the planning department. These ESs should have considered the effects of the proposed developments upon the flora and fauna in keeping with the wording of the Directive and the guidelines issued by the Department of the Environment (1989), whether they were included under the Directive's schedules or not. My research was undertaken with the following aims:

1 To determine the extent to which British environmental statements contain the ecological information required under current EC legislation.

2 To examine the ecological component of EIAs undertaken in Britain and to highlight those elements of ecological assessment which are adequate and those which are in need of improvement.

3 To identify any vulnerable habitat types which are particularly prone to development pressure.

4 To produce guidelines for use by ecologists assessing habitats particularly vulnerable to development pressure.

5 To examine the suitability and effectiveness of the current individual project approach to EIA and if necessary to suggest an alternative.

# Chapter 2

# THE NORTH AMERICAN APPROACH TO ENVIRONMENTAL IMPACT ASSESSMENT

## 2.1 INTRODUCTION

Compared with the rest of the world North America has a long history of EIA which has been a formal requirement (for some projects) of the American planning system since 1969 and of the Canadian system since 1974. Because of their long history of EIA in general, and their heavy commitment to the provision of a national ecological monitoring programme in particular (Stevens, 1994), there may be lessons to be learned in the light of their experience. In this chapter I will review the treatment given to ecology in North America in the context of the various planning policy mechanisms, notably the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ). I also review some of the more recent attempts to provide information which will assist in predicting the potential impacts upon the ecology of proposed development sites in North America

## 2.2 THE NATIONAL ENVIRONMENTAL POLICY ACT AND THE COUNCIL ON ENVIRONMENTAL QUALITY

The US National Environmental Policy Act (NEPA) of 1969 was the first legislation to require the preparation of EIAs, and the first time that explicit consideration was given to environmental issues within a planning framework. One of the Act's official purposes was to utilise collected information to provide "detailed statements of impacts, alternatives, and other matters related to all major Federal actions significantly affecting the quality of the human environment" (US Govt., 1970).

The enactment of the NEPA has resulted in the preparation of over 10,000 EIAs (Bear, 1990). Van Winkle *et al.* noted as early as 1976 that "a demand has been created for a substantial number of ecologists to collect and analyze data, to write environmental reports and environmental impact statements, and to participate in adjudicatory proceedings as

expert witnesses". Consequently, the American experience of EIA has become an important model on which Britain could base its own ecological impact analysis process.

The NEPA contained three elements. The first was a declaration of national environmental policy which was intended to guide the actions of all Federal agencies (Andrews *et al.*, 1977). The second was criteria to which regulatory agencies must adhere to ensure the policy's implementation. The final part of the act established the Council on Environmental Quality (CEQ) to advise the President on environmental matters and to oversee implementation of the Act (Andrews *et al.*, 1977).

The NEPA was intended to be implemented as a whole and not as separate parts. However, much of the act was lacking in terms of procedural provision but one of the few elements which could be put into place immediately was the requirement for "detailed statements" or "environmental impact statements" for each major action having significant effects (US Govt., 1970). This resulted in the NEPA being augmented by an Executive order which authorised the CEQ to issue guidelines for the preparation and use of environmental impact statements and directed all agencies to "ensure the fullest practicable provision of timely public information and understanding...in order to obtain the views of all interested parties" (Andrews *et al.*, 1977).

In North America the Federal agencies, including the CEQ, focused their attentions on complying with this one element of the NEPA. The CEQ issued guidelines for the "preparation and use of environmental impact statements" (US Council on Environmental Quality, 1970) but not for the implementation of the NEPA as a whole. It was not until several years later that the revised CEQ guidelines indicated that the preparation of EISs was just one element of the whole NEPA. EISs, and the guidelines and procedures, have thus taken on a life of their own somewhat independent of the law as a whole (Andrews *et al.*, 1977).

The CEQ guidelines can therefore be taken as providing a basic framework for the process of EIA in north America. There were problems in that too much emphasis was placed upon procedures for preparation of the EISs and on the administrative details, particularly in the earlier years of implementation (Andrews *et al.*, 1977). However, the guidelines did result in a number of positive steps towards the production of good environmental impact assessment procedures. These can be summarised as:

- Draft environmental impact statements as a device to permit review of impact statements by State and local agencies before the statement is finalised.

- An EIS to be prepared for any project which generates controversy, regardless of whether the agency believes that its effects will be significant.

- The creation of a 90 day comment period before action.

- Guidelines produced which outline the contents of an EIS. These include a description of the proposed action, a statement of its purposes, and a description of the environment affected. They also require discussion of the relationship of the proposed action to land-use plans, policies and controls for the affected area. In the case of final statements they required agencies to include responsible opposing views not discussed in the draft statement, and the agency's response to the issues raised. Further (1973) guidelines also discussed in greater detail the categories of impacts that should be considered, the kinds of actions and alternatives that should be developed, and the relationships between the EIS requirements and other provisions of the law.

  (Adapted from Andrews *et al.*, 1977)

The NEPA and the resulting CEQ guidelines have had a large influence on the way in which the EIA process has been integrated into international planning legislation. Wathern (1988) illustrated this when he noted that "a host of industrialised countries have implemented EIA procedures since the NEPA. Canada, Australia, the Netherlands and Japan, for example, adopted legislation in 1973, 1974, 1981, and 1984 respectively, while in July 1985 the European Community (EC) finally adopted a directive making environmental assessments mandatory for certain categories of projects, after nearly a decade of deliberation".

Wathern (1988) emphasised the timing of the NEPA as being important because it "emerged at a point when there was a growing environmental constituency prepared to ensure that its provisions, unlike previous attempts to reform the federal decision making process, would be assiduously applied to federal agencies". This willingness to enforce the provisions of the NEPA was instrumental in the production of advice and guidelines for

the preparation of adequate EISs, because many environmental groups used the threat of litigation as a spur for their production (see Wathern, 1988 for examples). Despite the advice and guidance available, litigation by environmental organisations is commonplace in north America. Before 1984 there had been 1602 NEPA related lawsuits which represented almost 10% of those projects for which an EIS had been prepared (Wathern, 1988). Canter (1984) reported that in the same time period almost 40% of the law suits filed were from environmental groups. A similar situation exists today in that many organisations and interested parties are using litigation to reject NEPA documents on the grounds of inadequate impact analysis (Therivel *et al.*, 1992). It appears that those agencies which segment large projects or ignore closely connected projects, i.e. they do not view developments strategically (see Chapter 4), are particularly prone to these challenges.

Against this background the rest of this chapter will concern itself with an appraisal of the importance of ecology within the north American planning system.

## 2.3 ECOLOGY WITHIN THE NORTH AMERICAN PLANNING SYSTEM

North American EIA literature often concerns itself with the treatment given to ecological considerations within its planning system (Andrews *et al.*, 1977, Brink, 1978; Cooper, 1976; Cooper & Zedler, 1980; Eberhardt, 1976; Norton & Walker, 1982). For over two decades American authors have presented frameworks and models which look at the role of ecology in impact assessment, and the contribution of ecology to environmental impact prediction and decision making (Auerbach, 1978, Barnthouse & van Winkle, 1980; Beanlands & Duinker, 1983; Buffington *et al.*, 1980; Hinkley, 1980; Holland, 1990; Kepner & Fox, 1991; Leibowitz *et al.*, 1991). The main theme running through these frameworks is the provision of a means of defining the environmental impact of a development project. One of the main differences between the various frameworks is the biological level of organisation at which they are aimed; some discuss impacts on ecosystems (Auerbach, 1978), some on populations (Fritz *et al.*, 1980), and some attempt to evaluate impacts on endangered or threatened species (Baysinger, 1980).

The most thorough treatment given to the status of ecology within a planning framework and the prescription of solutions to the problems encountered is the work of Beanlands and Duinker (1983). These authors undertook a two year study on the problems of ecological

components of impact statements in Canada, and developed an ecological framework for EIA in Canada. Their study included a critical review of 30 EISs, a systematic review of the scientific literature and a series of 10 workshops. These workshops brought together EIA practitioners from a variety of fields in an attempt to identify the scientific weaknesses of EIA, and focused on ways of improving the ecological content of assessment studies (Beanlands & Duinker, 1984).

An important question to address in any country is the role of ecology within the EIA framework. Beanlands and Duinker (1984) indicated that the political machinery of the country was geared to processing EISs as smoothly as possible and that the proponents' concern for scientific integrity is limited to the extent to obtaining project go-ahead. These elements are compounded by several perceived problems including:

- the lack of agreement on the objectives of EIA;
- inappropriately short time frames;
- politically motivated decisions;
- the poor definition of roles in undertaking and reviewing EIA studies;
- the adversarial nature of the EIA forum;
- the inflexibility of government EIA procedures; and
- the lack of information transfer between the research community and those who administer, conduct and review EIAs.

(Beanlands & Duinker, 1984).

Beanlands and Duinker (1984) concluded that major changes were needed if a substantial upgrading of the scientific quality of EIA is to be achieved. These changes come under two headings - the scientific and practical aspects and the administrative and institutional aspects (Beanlands & Duinker, 1983). Under these headings they state the need for:

- *A common standard.* This would clarify the composition of an acceptable ecological basis for impact assessment. This would reduce the confusion and different expectations which surround the topic. Agreement on the basic considerations in terms of design, execution and review of assessment studies would be a major achievement.

- *Early agreement.* Because of the time limitations imposed on EIA it is important that those involved in their production and review discuss as early as possible the basic approach to be adopted. This may mean that studies would proceed after reviewing the scientific and ecological rationale with the technical advisors of the agency administering the assessment procedures. This would enable the final review process to focus on the importance of the impacts rather than on the acceptability of the supporting studies.

- *Continuity of study.* The importance of continued study beyond the production of an ES must be recognised by all participants in EIA. Without this the rationale for baseline studies and impact predictions becomes tenuous and the ability to upgrade prediction and assessment skills is reduced.

- *Information transfer.* To improve the scientific basis of EIA the assessment community must be aware of the most recent concepts, techniques and approaches developed by the practitioners and the research community. This can only be achieved if all of those involved are made aware of current advances in approaches and methods via information transfer.

(Adapted from Beanlands & Duinker, 1983).

## 2.4 QUANTITATIVE ECOLOGICAL ASSESSMENT

Eberhardt (1976 & 1976a) outlined several important issues in a review of environmental impact assessment conducted from the point of view of quantitative ecology. Many of these issues manifest themselves in the current British approach to EIA. He suggests that environmental impact studies are characterised by a number of problems, including:

- too wide an initial choice of species;
- inadequate statistical analyses;
- reports limited to, at best, one year's work;
- absence of true replication; and
- inadequate sample sizes.

(Eberhardt, 1976a)

Eberhardt (1976a) suggests two possible approaches to impact assessment. The first is to list all of the presumed relevant features, rate their importance, and judge the likely impact of the proposed activity on each feature. The second is to employ the use of computer models and simulations. Both of these approaches have their problems. First, in drawing up what are effectively matrices it is necessary to be able to identify relevant features, which for some habitats or communities is not easy. Second, it is necessary to rank these features in terms of their importance, again not an easy process. Third, it is necessary to be able to make predictions regarding the impact of the development on the identified features. This leads to further problems of objectivity versus subjectivity.

Matthews (1975) defined objective judgements as those which involve facts which are observable or verifiable, and which do not depend upon personal reflections, feelings or prejudices. He defined subjective judgements as those which are made on the basis of values, feelings, and beliefs and these may vary widely from person to person. It is inevitable that both forms of judgement will manifest themselves when lists or matrices are being constructed. The subjective judgements will cause the most concern as what is considered to be important by one person(s) will be unimportant to another. Careful consideration is therefore required when drawing up these lists and matrices because a balanced appraisal of the potential impacts are necessary if they are to be taken seriously by decision makers.

The second approach is to use computer models and simulations. Eberhardt (1976a) indicated that using models and simulations poses problems in that few of the results are

published in an accessible form. The chief concerns are a lack of knowledge of structural details in ecological systems, the almost non-existent attention to sampling and estimation problems, and the tendency to assume that these models are useful as predictive devices (Eberhardt, 1976a).

Duinker (1987) advocated forecasting of quantitative environmental impacts. He claimed that it is better to forecast environmental impacts quantitatively and risk being wrong, than to forecast them qualitatively and render them untestable. The rationale behind this is that decision makers are more likely to pay attention to, and use, environmental impact forecasts when they are stated quantitatively and are measurable (this does assume, however, that decision makers are used to quantitative information and are capable of assessing it). Also, decision makers and impact analysts cannot learn much about the system for which decisions are being made unless they can detect error, and the detection of error is much easier for quantified forecasts than for qualitative forecasts.

Thomas & Eberhardt (1976) suggested that there are problems in attempting to establish population effects quantitatively and that anything other than the most obvious of judgements cannot be wholly defended. This would appear to be a negative way in which to view quantitative ecology. A more positive approach would be to employ the use of a network (similar to that outlined for the Environmental Monitoring and Assessment Program (EMAP) - see 2.5) which would accumulate ecological data and subject it to levels of analysis which would allow for reliable impact prediction. This is an ambitious undertaking, especially if the current problem of providing information which is both easily accessible and easy to use is to be addressed.

## 2.5 ECOLOGICAL IMPACT MITIGATION

In the United States the identification and evaluation of mitigation measures for adverse biological impacts of proposed projects is often the focal point for opposition and debate on projects (Canter *et al.*, 1991). This has resulted in several approaches to both identifying and evaluating potential mitigation measures. The identification approaches include the review of utilised measures for similar projects, computer based literature and information searches, and the use of computer generated checklists of potential measures. Evaluation approaches include pre-project qualitative evaluation based on case studies, pre-

project quantitative evaluation using structured habitat based methods and post environmental statement monitoring (Canter *et al.*, 1991).

The habitat based methodologies of North America which have been developed to evaluate the ecological impacts, and the effectiveness of proposed mitigation measures, are relevant to my research. Much of the work in this area has been undertaken by the US Fish and Wildlife Service (USFWS), the most notable being the Habitat Evaluation Procedures (USFWS, 1980) and the Habitat Suitability Index Models (Schamberger *et al.*, 1982). Canter *et al.* (1991) looked at the use of these habitat based methodologies and reported that at the time of their research there were models for evaluating the habitat requirements of about 150 species (birds, mammals and reptiles), with more being developed.

The habitat evaluation procedures are used to document the quality and quantity of available habitat for both aquatic and terrestrial animal species (USFWS, 1980) and employ the habitat suitability index (Schamberger *et al.*, 1982). The index uses criteria to assign a value to the habitat in question in relation to its probable utilisation by the species being evaluated. Once this has been achieved the index score is multiplied by the area of available habitat to obtain the Habitat Units (HUs). HUs are calculated for the habitat with and without the presence of the proposed development. The HUs are instrumental in the development of mitigation plans because they can be used to detect avoidable losses of suitable habitat for the species being evaluated. They can also be used to give an indication of those areas which, given the correct management regime, would increase the HUs available to the species in question.

Biological impact mitigation is one of the requirements under the NEPA and subsequently has been developed by the Council on Environmental Quality. Agencies within the US are required to prepare records of decisions (RODs) on projects having EISs. The RODs must state what the decision was and identify all alternatives which were considered to be environmentally preferable (Council on Environmental Quality, 1978). In addition, there are laws on specific aspects of environmental quality, such as water and air quality, and natural resources protection. Included in these laws are policies and implementation requirements for biological impact mitigation measures (Canter *et al.*, 1991).

## 2.6 ECOLOGICAL MONITORING

In north America hundreds of millions of dollars are spent annually on environmental monitoring (Messer *et al.*, 1991) and there is extensive literature on the monitoring of ecological impacts (e.g: Baker, 1976; Canter & Fairchild, 1986; Conover, 1987; Cowell, 1978; Gray, 1980; Holland, 1990; Kepner *et al.*, 1991; Monk *et al.*, 1979; Messer *et al.*, 1986; Messer *et al.*, 1991; Stevens, 1994).

Several examples of monitoring were reported by Bisset and Tomlinson (1988); they cited schemes undertaken in the US, and illustrated some of the problems encountered within these programmes. These authors emphasised the problems of analysing the effects of a development and comparing them with the pre-operational predictions made in the ES. Canter *et al.*, (1991) suggested that post-project monitoring would allow for an evaluation of the actual effectiveness of both planned and previously implemented mitigation measures. They stated that systematic evaluations of proposed mitigation measures (presumably in the light of past experience for projects of a similar nature) are becoming increasingly important as their costs are often high.

Of particular relevance are the studies initiated by the US Regulatory Commission to determine some of the impacts of operational nuclear power plants (Bisset & Tomlinson, 1988). They are of interest because one of their major aims was a commitment to monitor the aquatic ecological impacts brought about by the building and operation of the power stations. In the ESs produced the consultants predicted that there would be effects on all biotic groups, but that they would be minimal and unimportant (Bisset & Tomlinson, 1988). This type of statement is one which appears regularly in British EISs but which cannot be substantiated because monitoring programmes are not, in the main, put in place. The value of monitoring to certain development proponents is illustrated by Bisset and Tomlinson (1988) who reported that for the power station monitoring programme there was no evidence of any significant effects upon the biota.

In 1988 the EPA Science Advisory Board recommended that a programme be implemented within the EPA to establish an integrated, cooperative ecological monitoring programme involving participation by Federal, State and private entities (US EPA, 1988). The impetus for this EPA research was lack of access in north America to monitoring data which would assist in establishing key research and assessment areas and would help to assess the

success or failure of environmental policy instruments. Messer *et al.* (1991) stated that the lack of an integrated approach to monitoring indicators of ecological conditions presents two problems. First, it cannot be determined whether the frequency and extent of the problems are increasing on a regional scale and second, it cannot be determined whether such patterns are warning indicators of long-term changes. They indicated the need to establish baseline conditions against which future changes can be documented.

Against this background the US government has initiated the Environmental Monitoring and Assessment Program (EMAP) with the main aim of filling this critical data gap. Once fully implemented, EMAP will be able to assist policy and decision makers because it will provide ecological information about a range of problem areas via a series of integrated monitoring networks. These networks will aim to:

- estimate current status, extent, changes, and trends in indicators of the Nation's ecological resources on a regional basis with known confidence;

- monitor indicators of pollutant exposure and habitat condition, and seek correlative relationships between human induced stresses and ecological conditions that identify possible causes of adverse effects; and

- provide periodic statistical summaries and interpretive reports on ecological status and trends to the EPA Administrator and the public.

(Messer *et al.*, 1991).

The EMAP is both a large and ambitious project. The scope of the programme is to cover all of the Nation's ecological resources with all estimates of status, trend and change to have a sound statistical basis. This will reduce levels of uncertainty as confidence levels will be calculated (Stevens, 1994). In order to meet these stringent requirements the EMAP has an organisational structure which charges specific responsibility for the following; inland and aquatic systems (surface-waters and wetlands), terrestrial systems (forests, agro-ecosystems and arid ecosystems) and near coastal systems (Great Lakes, near-coastal waters and estuaries) to resource groups (Stevens, 1994). At the time of writing the EMAP, which aims to provide current information on the condition of the nation's environment and to identify any changes in that environment, has been applied to

several specific ecosystem types as pilot studies (see Holland, 1990; Kepner & Fox, 1991; Leibowitz *et al.*, 1991; Palmer *et al.*, 1991).

Once the ecological impacts of development have been monitored the data generated must put to good use. Bissett and Tomlinson (1988) suggest that impact monitoring provides an "early warning" device which alerts those managing the project or the environment to possible harmful impacts before the full potential is realised. This alone should be justification for monitoring a development site for potential impacts.

## 2.7 CONCLUSIONS

This analysis of the north American experience of EIA has highlighted the problem of provision of reliable information which can be used to make predictions regarding development impacts upon habitats and their dependent species. I suggest that the habitat based methodologies employed in north America should be adopted by British ecologists. One such application which is currently receiving much interest in Britain is the use of Geographic Information Systems (GIS). These employ modelling functions to predict the possible impacts of a development upon the ecology of the receiving site. A successful example of the use of a GIS is the location and delimitation of the extent of wetlands and the identification of suitable indicators of wetland condition (Leibowitz *et al.*, 1991). I hope that British ecologists will explore the use of GIS and expand their use to include modelling capabilities which draw upon the experiences of the north American habitat based methodologies.

Existing information about the use of various mitigation methods and their success rates should be the starting point for the identification of potential mitigation measures against negative ecological impacts. In north America there are accessible databases which deal directly with the identification of ecological mitigation measures. An important one is the Endangered Species Information System (ESIS) which provides information on nationally listed threatened or endangered plants and animals (US Fish and Wildlife Service, 1988). 1988 records on 435 species were available on the ESIS including mitigation related information. This includes reasons for a species' present status, actions recommended for its recovery and information concerning its habitat requirements (Canter *et al.*, 1991).

Canter *et al.* (1991) suggest that use of the ESIS would enable the systematic identification of potential mitigation measures for threatened or endangered plant or animal species in a project study area. In other words there is the potential for ecological amelioration which moves from the individual species approach to a habitat or possibly a bio-geographic unit.

Ecological monitoring is an important element of environmental assessment because it shows that there has been an impact, and that the impact is often attributable to the activities of the development and not to some other factor. It also makes it possible to gauge the size of the impact, and it provides valuable information with which we can address future development proposals of a similar nature. There are lessons to be learned from the north American experience of ecological monitoring which will be valuable if a system of monitoring is to be instigated in Britain. The EMAP is a very ambitious and expensive project and yet if a framework had been in place from the outset of EIA under the NEPA many of the problems the north American governments are currently aiming to address would possibly either not exist or would be small and easy to deal with.

The north Americans have questioned both the scientific and technical quality of the environmental statements produced, and the relevance of the document to the needs of the decision makers. It should therefore be a primary consideration of all ecologists involved in the EIA process to draw upon the north American experiences so as not to replicate the weaknesses of their system and to emulate its strengths.

# Chapter 3

# AN ANALYSIS OF THE ECOLOGICAL CONTENT OF BRITISH ENVIRONMENTAL STATEMENTS

## 3.1 INTRODUCTION

An assessment of ecological impacts relating to the viability, sensitivity and value of ecosystems, habitats and species, which might be affected by a development proposal, is required as part of the overall assessment specified under Article III (3) of EC Directive 85/337 (CEC, 1985). Article III (3) states that the direct and indirect effects of a project should be considered as part of the environmental assessment (EA), including effects on "human beings, fauna, flora, soil, water, air, climate, any interactions between the foregoing, material assets and the cultural heritage". Annex III (4) then states that the description of the likely significant effects should include "direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects".

## 3.2 METHODOLOGY

A primary aim of my research was to determine the quality of the ecological components of British ESs. This was done by reading in detail 179 ESs produced for a cross-section of the development types for which EAs have been carried out under current legislation. Wherever possible the most recent examples of ESs were used in order to gauge contemporary approaches to ecological assessment for purposes of EA. Difficulties were experienced in obtaining ESs produced in 1992 which resulted in the bulk of the review being based upon those reports produced in the period 1989 to 1991.

The aim was to determine whether or not each ES contained the ecological information required under the current legislation, and to establish the extent to which the environmental impact assessment (EIA) process ensures the effective assessment of potential ecological consequences of development. Review criteria were derived based on existing guidance on EA and the required content of ESs (DoE/Welsh office 1989). These allowed comparison of the treatment given to ecology within the various development

types examined, and identification of those parts of the EA process which result in poor ecological assessment.

### 3.2.1 Number and type of environmental statements reviewed

Table 3.1 shows the numbers of ESs reviewed for each development type. Several categories include a number of very specific development types. For example, mineral extraction includes the winning of sand and gravel, limestone, clay, granite, deep mined coal, peat and semi-precious minerals such as barytes.

**Table 3.1** Number of environmental statements reviewed for different development types

| Development type | Number | % |
|---|---|---|
| Power transmission | 3 | 2 |
| Leisure | 6 | 3 |
| Port and harbour | 5 | 3 |
| Power stations | 25 | 14 |
| Mixed developments | 29 | 16 |
| Agricultural | 5 | 3 |
| Wind farms | 5 | 3 |
| Waste treatment | 8 | 5 |
| Mineral extraction | 18 | 10 |
| Landfill | 12 | 7 |
| Pipelines | 8 | 5 |
| Opencast mines | 15 | 8 |
| Roads | 26 | 15 |
| Miscellaneous | 14 | 8 |
| **TOTAL** | **179** | 100 |

Wherever possible I attempted to review 10% of the total number of ESs produced for each development type. To facilitate this, a database was established in conjunction with the Institute of Terrestrial Ecology (ITE) Monkswood which enabled me to look at the distribution, on a county basis, of project types for which an ES had been produced. At the time of my review (1990 - 1993) approximately 1100 ESs had been produced, of which 179 were acquired for review.

### 3.2.2 Analysis of the environmental statements

Each statement reviewed was subjected to the same review criteria (see Appendix 2 for an example of a completed review). The review criteria were grouped into the following categories:

***Details of the ES*** This category provided general information about the development proposal itself. Included within this category were details of the type of development (e.g. power station, wind farm), the annexe of the Directive under which the development type was listed, any regulations which might affect it, and the planning authority to which it was submitted.

***Description/characterisation of site/area affected*** These details were necessary to understand the ecological value of the area likely to be affected. Application of these criteria involved describing the site in general (size, topographical form and current land-use), and recording major habitat types and designated areas likely to be affected.

***Description/characterisation of the development*** These criteria provided information concerning the nature of the development proposal because these were necessary for making predictions regarding potential impacts. I recorded details of the size and type of operations involved when the development is complete, the duration of operation, information regarding potential impacts and at which stage of construction and/or operation they would occur, alternatives (processes and sites), and reasons why the particular site had been chosen.

***Information provided necessary to predict ecological impacts*** These criteria require an indication of any direct and indirect predicted ecological impact, timescales for these impacts, quantification of ecological impacts and a consideration of their complexity/interactive nature.

***Ecological evaluation/assessment*** These criteria provided information about the levels and type of baseline ecological assessment obtained during the EA process. Considered were the types and sources of baseline data, and designated habitats and species potentially affected (including levels of geographic importance - local, regional, national or international).

*Ecological mitigation measures proposed* These were stated or implied proposals to ameliorate the impacts of the proposed development and how they related to specific ecological impacts. The criteria used ascertained the types and levels of prescription for the proposals, including an indication of their success and proposed further modifications should the original proposals prove unsuccessful.

*Survey methods* The levels and types of survey employed were recorded. Included under this category were information about consultants, literature reviews, baseline and new surveys conducted, the time of year at which surveys were conducted and for how long, the type of result obtained (descriptive or quantitative), and acknowledgement of any survey limitations.

*Presentation of ecological information* In order to understand the ecological implications of a proposed development it is important that all relevant information is presented in a form which is clear and concise. The criteria used for this gave an indication of the type and levels of ecological information provided (maps, surveys), where the source documents might be obtained, and who was responsible for the production of the ecological information presented.

## 3.3 RESULTS AND DISCUSSION

### 3.3.1 Size or length of proposed development

There was a wide range of sizes amongst the proposed developments with no one category dominating (Table 3.2). This table does not include the dimensions or lengths for linear developments, e.g. roads, which were sometimes not stated or were difficult to calculate.

There are two reasons for establishing the actual size or length of a proposed development. First, for some types of development, such as salmon farms, roads and afforestation proposals, it is the size of that development which triggers the need for an EA. Second, the size of the scheme will often determine the overall ecological impact because the larger the scheme the greater the probability that a wide range of habitat types and their dependent species will be affected. In order to predict the areas of wildlife habitat which are likely to be affected it is necessary to know the total area of the proposed scheme. ESs which fail to state this are not complying with the legislative stipulations of the EA process

which requires a clear statement of the ecological implications of any proposed scheme. Despite the importance of this criterion, it was not possible to discover the area for all of the developments for which an ES had been produced.

**Table 3.2** Size distribution of proposed non-linear developments

| Size in ha | Number | % |
|---|---|---|
| <10 | 16 | 11 |
| 10-49 | 34 | 24 |
| 50-99 | 19 | 14 |
| 100-199 | 22 | 16 |
| 200-500 | 14 | 10 |
| Not stated | 35 | 25 |
| **TOTAL** | **140** | 100 |

There were three main reasons why it was not possible to determine development area. First, 22% (39) of the ESs reviewed were for linear developments, namely roads, power transmission lines and pipelines. For these developments it was the length of the proposed scheme which was stated and not the actual area to be occupied by the development. This in itself might be misleading because many of the linear developments require large areas of land during the construction phase, with elevated levels of constructional disturbance compared with those when the development is in operation. Of the 140 EIAs reviewed for non-linear developments, thirty five (25%) did not give the size of the development site (see Table 3.2).

Second, a common theme which I found throughout my review was that the Schedule I developments provided ESs in which the ecological component of the report appeared relatively substantial compared with those ESs produced for Schedule II and non-scheduled developments. These were not always the largest development proposals in terms of area covered, and the ecology was adequately discussed because of the nature of the development (often in an ecologically sensitive area) and its legislative requirements. Third, although in general the largest development proposals had the largest ESs in terms of document length, and also the longest ecology sections, this was by no means always true. Several long ESs paid little or no attention to ecology, whilst some very short ones

concerned themselves almost solely with ecology. Again, the nature of the development will have been a key factor here, as would the time and money allocated to the study by the development proponents.

### 3.3.2 Percentage of the environmental statement as ecology

Because many of the ESs reviewed were of variable length, I decided to look at the percentage of the report in terms of number of pages concerned with ecology (see Table 3.3). Ecology was only considered in its strictest sense in that any discussion under the heading "landscape architecture" or the like was not counted, but text referring to nature conservation was (although some ecologists feel the need to distinguish between ecology and nature conservation). One hundred and forty one ESs (79%) had <10% of the report given over to ecology, whilst sixteen (9%) had no ecological content. This illustrates that Directive 85/337 is not being adhered to in that the requirements of Article III (3) are not being met.

### 3.3.3 Ecological survey information

Habitats, their flora and fauna, and any physical site factors must be surveyed to determine a proposed development site's ecological importance prior to predicting impacts from development. The ESs were therefore reviewed to determine ecological survey methods which had been employed, and the time of year when the surveys were undertaken. Those development types for which surveys did not take place, were also identified, and reasons for this were sought.

The review of the 179 ESs revealed some interesting information regarding the levels and types of surveys/fieldwork undertaken in the preparation of the ecology sections. The results differ from those of Spellerberg & Minshull (1992) who, in their examination of 45 reports, found that 84% had included data gathered from original fieldwork. In my review I found only 81 (45%) of the reports had undertaken a new ecological survey. One possible reason for this difference may be that the ecological section of the ES does not always indicate that original field surveys had taken place, despite this being the case. Discussion by Spellerberg & Minshull (1992) with the project proponents or the consultants responsible for the production of the ES revealed that, in some, original fieldwork had taken place but mention of it had been omitted from the final document. Because my review sample was much larger it was not possible to ascertain whether a similar situation existed, although it is likely.

**Table 3.3** Percentage of environmental statement, in terms of numbers of pages, devoted to ecology

| Percentage of environmental statement devoted to ecology | Statements | |
|---|---|---|
| | Number | % |
| 0 | 16 | 9 |
| 0.1 - 4.9 | 77 | 43 |
| 5.0 - 9.9 | 48 | 27 |
| 10.0 - 14.9 | 22 | 12 |
| 15.0 - 19.9 | 4 | 2 |
| 20.0 - 24.9 | 7 | 4 |
| 25.0 - 29.9 | 0 | 0 |
| 30.0 - 49.9 | 4 | 2 |
| > 49.9 | 1 | 1 |
| **TOTAL** | **179** | 100 |

As with the work of Spellerberg & Minshull (1992), my research showed that of those reports for which an element of fieldwork had been undertaken, the majority concentrated on vegetation. Higher plant surveys were undertaken for 71 (40%) of the 179 ESs reviewed. Less emphasis was placed on faunal surveys, with only 35 (20%) reporting a bird survey, 9 (5%) a mammal survey and 7 (4%) an amphibian survey. The term survey is used loosely because the ecological sections often indicated that for the fauna no more than casual observations were made, often whilst undertaking the vegetation survey. Less than 10% of the surveys were quantitative. Those ESs for which the ecological survey findings were quantified were for those developments which had specific implications for a particular taxonomic group, such as ditch drainage (dragonflies) or marine aggregate winning (birds, molluscs and fish). In these cases numbers of individuals and of species present, and in a few isolated instances the survey technique(s), were given. Six ESs did give a quantitative account of many of the plant and animal groups found/expected and the potential impacts upon them, but these were a small minority.

There are at least three reasons for the heavy emphasis on vegetation surveys. First, it is possible to conduct vegetation surveys quickly, because plants are static and therefore easy to locate. Birds and mammals, on the other hand, are often highly mobile and are difficult

to locate, the surveyor relying upon an ability to identify their presence by other means (e.g. calls, footprints and analysis of faecal material). Second, there is a great deal more knowledge concerning vegetation survey methodology and how to interpret the results than for faunal surveys. The presentation of the results of vegetation surveys are more directly related to the needs of EIA (as perceived by decision makers, e.g. maps of distribution which are easy to produce for static plant populations as compared with more mobile birds and mammals). Third, there are many more ecologists competent to perform higher plant surveys than for other taxonomic groups. This, I suggest, is due to there being very few plant species in relative to other taxonomic groups, (e.g. terrestrial and aquatic invertebrates). As a result, a specialist may be needed to survey and identify each of the invertebrate groups compared to one individual for vegetation surveys.

Choice of methodology in terms of applicability to the site and any limitations in the techniques employed are topics which must be considered when formulating survey programmes. None of the ESs discussed the suitability and limitations of the survey methods used or gave an indication of confidence in the findings of the fieldwork. Also, few ESs stated the objectives of the survey. This information need not appear in the submitted ES but I recommend that it be made available as a supplementary report for scrutiny if required by those determining the application and advising on it.

My review highlighted many disappointing aspects of ecological surveys carried out for EIA purposes. Of the 81 surveys carried out, only 59% were carried out by an ecologist or other competent person. Competent persons were considered to be representatives of statutory bodies and non-governmental organisations/voluntary groups in which they are employed in an ecological capacity. I do not class landscape architects as ecologists.

The time of year during which an ecological survey is undertaken is crucial and 63 of the 81 (78%) with surveys mentioned their timing, but only 37 (41%) were carried out between April and September. This I consider to be the time of year which for most species will provide an accurate picture of the flora and fauna of the site. For some groups, such as migratory wildfowl and waders, it is appropriate to survey for their presence during the autumn and winter periods. Reasons for poor survey timing may be that it was inconvenient to the development proponent to have conducted their survey between April and September, although the majority should be aware of the necessity to survey within this period.

The length of time given over to the fieldwork was not stated in the majority of ESs. In those where it was stated the time scale was of the order of 1-7 days. This I consider unsatisfactory. Clearly there is a lack of knowledge amongst developers regarding the time (and resources) which are required in order to undertake the ecological component of an EIA. Until this fundamental problem is addressed, the ecological section of ESs for proposed development sites will continue to be inadequate.

### 3.3.4 Conservation status of habitats and species assessed

A serious deficiency in the majority of ESs was a failure to classify species and habitats mentioned as locally, regionally, nationally or internationally important. Only 31 (17%) ESs stated that the species/habitat potentially affected were of local importance, 27 (15%) were of regional importance, 43 (24%) of national importance and 10 (6%) of international importance. The relatively high figure for species/habitats of national importance reflects the high number of SSSIs either directly affected or within the immediate vicinity of proposed developments. In this situation, information taken direct from the SSSI citation, and presented either in the text of the report or as an appendix, indicated the conservation status of the habitat(s) or species in question.

The number of ESs noting protected species and habitats is likely to be an underestimate of the true situation, given that ecological surveys were poorly conducted, may well have taken place at an inappropriate time of year for the area to be surveyed, or simply did not occur. Thus, protected species are vulnerable to development impacts, and designations may not give them, and the habitats on which they depend, adequate protection. Both of these are areas of concern and are in need of revision under the existing EA regulations if EIA is to achieve effective conservation of Britain's wildlife.

### 3.3.5 Consultation

Consultation with statutory (English Nature (EN), Scottish National Heritage (SNH) and Countryside Council for Wales (CCW) and non-statutory bodies (e.g. Royal Society for the Protection of Birds (RSPB) was very variable in both type and quality (Table 3.4). In no instance was I able to ascertain the extent of the consultation. Fifty nine (33%) ESs did not state whether consultation had taken place or not.

**Table 3.4** Number of environmental statements claiming consultation with different categories of organisation

| Organisation | Number | % |
|---|---|---|
| Statutory (EN, SNH, CCW) | 86 | 48 |
| County museums | 10 | 6 |
| Countryside Commission | 29 | 16 |
| RSPB | 28 | 16 |
| Local wildlife trust | 63 | 35 |
| Special interest groups | 33 | 18 |
| NRA/RPB | 41 | 23 |
| Other | 3 | 2 |
| None stated | 59 | 33 |

Eighty six (48%) of the reports stated that the statutory country agency (English Nature, Scottish Natural Heritage or Countryside Council for Wales) had been consulted over the proposal, a surprisingly low figure considering that these are the official government spokesmen on nature conservation issues. This should result in them being consulted over all development proposals. I suggest that this is not happening for two reasons. First, there are financial constraints resulting in too few staff being given responsibility for EA, and second there is a communication breakdown in that many developers do not invite the comments from the country agencies when formulating the framework for the EIA for the proposed development. I suggest that this low level of consultation between development proponents and the statutory bodies is a fundamental flaw in the EIA process and one which needs urgently addressing. While this lack of consultation remains, the EC Directive (85/337/EEC) is effectively being contravened.

The various water authorities appeared to be adequately consulted, considering that only a small proportion of the proposed developments would directly affect watercourses. However, I consider the 23% consultation figure unsatisfactory because at least 84 (47%) of the proposed developments (open cast mining, roads, agricultural, mineral extraction, waste treatment and landfill sites) had potential impacts upon watercourses.

The non-statutory bodies (RSPB, British Trust for Ornithology, Council for the Preservation of Rural England, local wildlife trusts and other special interest groups) were not often consulted (Table 3.4). These interested parties should be consulted for three reasons. First, contact with these groups can save time by both focusing fieldwork attention on the right areas and saving on duplication of any previous surveys. Second, these bodies have long-standing expertise which should be utilised which would permit the time saved in using their expertise to be used on another area for which existing information is not available. Third, their expertise can be employed to confirm any fieldwork data as being not representative or atypical for that site at that time of year. This will then enhance the accuracy of predictions which are made about the effects of the development on the ecology of the site.

Perhaps of greatest concern are the number of development proposals which appear not to have undertaken any form of ecological or nature conservation consultation. Fifty nine (33%) of the ESs reviewed gave no indication that consultation had taken place. Again I suggest that this is unsatisfactory because development proposals are being put forward without proper consideration being given to the flora and fauna of the site. This is contrary to the EA Directive. For some proposals relevant consultation may have taken place, but this was not recorded in the statement. This could be to the detriment of the development proponent because those involved in the decision making process regarding planning applications, if working to the letter of the Directive, should refuse the application on these grounds. I have no evidence that this actually occurs.

### 3.3.6 Potential impacts upon designated sites

The DoE/Welsh Office (1989) guidelines state that information should be provided which relates to "all relevant statutory designations". Many ESs did mention proximity to designated sites (Table 3.5). Also, for certain development types, e.g. road schemes and afforestation proposals, the proximity to designated sites is one of the indicative criteria which necessitate the undertaking of an EA. It is therefore not surprising that a high number of designated sites were described in the statements reviewed. The majority of the designations mentioned were designed to maintain the integrity of Britain's most important wildlife and landscape areas. I therefore considered it important to ascertain the numbers and types of designation affected by proposed developments, both directly and indirectly. I suggest that for a development to pose an indirect impact to a designated area then that area must fall within 2 km of the boundary of the proposed development.

**Table 3.5** Numbers and types of designated areas which could be affected by developments covered by the 179 environmental statements analyzed (Note: Some developments potentially affected two or more areas with the same designation)

| Designated area | Number directly affected | Number indirectly affected |
|---|---|---|
| National Nature Reserve | 1 | 3 |
| Ramsar Site | 2 | 2 |
| Special Protection Area | 2 | 3 |
| SSSI | 30 | 160 |
| RSPB Reserve | 0 | 2 |
| Local Authority | 9 | 6 |
| Local Wildlife Trust | 20 | 7 |
| National Park | 2 | 0 |
| AONB | 16 | 2 |
| AGLV | 11 | 3 |
| Heritage Coastline | 4 | 0 |
| Tree Preservation Order | 9 | 0 |

SSSIs are the statutory means of protecting Britain's most important wildlife sites. My research has highlighted SSSIs as being affected by seventy seven (43%) of the 179 ESs reviewed. Of these, 30 (17%) appeared to be subject to possible direct effects and 47 (26%) to possible indirect effects. I suggest these figures are unacceptable because the SSSI designation is designed to protect Britain's wildlife, and any development with potential impacts upon one should be rigorously assessed with the designation viewed as a barrier to development. This rigorous assessment is not taking place as indicated by the large number of designated areas forming part of proposed development sites.

My results indicate that certain types of development may have a larger potential impact upon SSSIs than others. These include pipelines, roads, power transmission and opencast coal operations. There are two probable reasons for this. First, three of the four development types are linear. Linear developments tend to cover long distances, and therefore have the potential to affect directly or indirectly a much higher number of designated areas. This is illustrated by one power transmission line which, according to the ES, passed in the vicinity of 34 SSSIs. Second, the nature of these developments and

the public's perception of them, dictates a degree of segregation/separation from human activity, pipelines and open cast operations in particular. These are often areas with wildlife and landscape designations. This is an important point because it demonstrates the different and often conflicting interests in EIA, in this case ecological and socio-economic.

In every instance where a proposed development site had some form of designation on it then the ecology was given reasonable treatment. If none was present then little was said about the site, despite the proposals being very similar. This was particularly evident when reviewing the reports for the road schemes. Some habitats are considered to be of much more ecological value than others and this seems right to me, but sweeping statements to the effect that, for example, arable and improved grasslands are of no ecological interest, are often untrue. These broad rules of thumb should be discouraged.

### 3.3.7 Habitats lost or affected by proposed developments

Where possible a description of the habitat types occurring within the proposed development site was obtained from each ES. This allowed me to gain an overall indication of which habitat types were most threatened by development, and which habitats are likely to be affected by a particular type of development (Table 3.6). The four main categories of wildlife habitat potentially affected by the development proposals were woodland, grassland, wetland and coastal. A fifth miscellaneous category was comprised of all the habitat types stated as being potentially affected which can not easily be assigned to one of the above four categories, e.g. wet heath, limestone outcrops, derelict quarries and railway embankments.

In the majority of the ESs reviewed some reference was made to the habitat types which made up the development site. The level of description was very variable, ranging from one line statements to in-depth descriptions of the habitat(s). Where rare or declining habitats, such as grazing marsh or hay meadows, were likely to be affected, the report generally argued that the impacts would not be significant, and/or that attempts would be made to keep the level of land take and disturbance to a minimum. This raises the questions of defining "significant" and the general absence of alternative development sites throughout the reports.

**Table 3.6** Number of developments potentially affecting different habitat types

| Habitat type | Number of developments |
|---|---|
| Woodland | |
| broadleaved | 69 |
| coniferous | 11 |
| mixed | 8 |
| ancient semi-natural | 19 |
| scrub | 49 |
| hedgerows | 68 |
| individual trees | 27 |
| Grassland | |
| agricultural | 33 |
| pasture | 21 |
| improved/short-term leys | 11 |
| semi-improved/unimproved/rough | 51 |
| chalk | 4 |
| wet | 20 |
| Watercourses/wetlands | |
| rivers | 16 |
| streams | 8 |
| ditches | 19 |
| waterbodies | 54 |
| Coastal | |
| saltmarsh/intertidal | 12 |
| estuary | 9 |
| Miscellaneous, e.g. wet heath, limestone pavement | 30 |

A problem when reviewing the statements was that habitat types were not described or assessed consistently. Despite this I managed to group the habitats into similar types, e.g. woodland described as "mainly native species with some conifers" I classified as mixed woodland, similarly "intensive grassland" and "agricultural leys" I classified as improved/short term leys.

Of the four broad habitat classifications, woodlands are potentially affected by a high number of development proposals. Overall, 88 out of the 179 (49%) ESs reviewed indicated that they would have a impact upon woodland of some description (this figure does not include those developments which affect scrub, hedges and individual trees). Of the statements in which potential impacts on woodlands would occur, 69 (64%) referred to broadleaved woodland of which 19 (18%) were ancient semi-natural woodlands. Mixed and coniferous woodlands appeared much less likely to be affected by proposed developments, being mentioned in only 8 and 11 (8% and 10%) statements respectively.

These potential impacts upon woodlands are cause for concern because it is those woodlands which are generally considered to be of the highest ecological value, i.e. broadleaved woodland, and in particular ancient semi-natural woodland, which are under the greatest threat. Given their importance as areas of high landscape appeal and as wildlife sites, possible damage or removal of these woodlands should be given serious consideration by those involved in the planning decision making process.

Within the woodland classification I also include hedgerows, scrub and individual trees. These three habitats were stated as being potentially affected by 68 (38%), 49 (27%) and 27 (16%) development proposals respectively. Again, these potential losses should be given serious consideration because all three provide valuable habitat for British wildlife and are important components of the landscape. Hedgerow loss has been singled out as being of particular concern because much has been removed due to agricultural change. It has been estimated that 225,000 km were removed between 1946 and 1974, 86% of this loss being attributed to agricultural operations (NCC, 1984). Despite recent grant initiatives to reinstate tracts of hedgerow, it appears from my review that potential developments are placing unacceptable pressure upon this valuable habitat type, and any development which potentially removes hedgerow should be given serious consideration.

Scrub was commonly referred to in statements, with 49 (27%) developments potentially damaging or removing this type of vegetation. Although not usually considered to be of any landscape value, scrub is often an important habitat for birds and invertebrates and can provide a significant amount of vegetation cover in otherwise urban environments. However, no ES acknowledged this, and without exception it was stated that it is of little or no wildlife interest and its removal will therefore be of little ecological consequence.

Of the 179 ESs reviewed, 140 (78%) had potential impacts upon grassland habitats. Within this broad category I obtained descriptions of the management techniques employed by the current owner (wherever possible) because this gives an indication of their wildlife value. Within the grassland category the large number of developments potentially affecting certain "types" was of concern. Of particular concern were the 51 (29%) developments potentially affecting semi-improved/unimproved/rough grasslands, all habitats which have experienced declines and which are likely to have high wildlife value (NCC, 1984). Similar concern must be voiced over the 20 (11%) wet grasslands. Wet grassland, defined as managed grassland below 200 m subject to periodic flooding (Buisson & Williams, 1991) is a particularly important habitat for Red Data Book birds, e.g. Bewick's swan (*Cygnus columbianus*), Black-tailed godwit (*Limosa limosa*) and Garganey (*Anas querquedula*) (Batten *et al.*, 1990).

The watercourses and wetlands category encompasses all types of waterways mentioned in the ESs reviewed. Waterbodies, the largest type encountered, is effectively a "miscellaneous" one which includes marshes, bogs, disused gravel pits, ponds and canals. My review indicated that developments would have a potential impact upon 54 (30%) of these waterbodies. Also of note are the waterways, i.e. rivers, streams and ditches, which had 16 (9%), 8 (5%) and 19 (11%) potential developments impacting upon them respectively.

Two main coastal habitat types, saltmarsh/intertidal and estuary, emerged as threatened (Table 3.6). Although estuaries possess intertidal zones they were kept distinct from the saltmarsh category because 12 developments (7%) stated that their potential impact would be confined to saltmarsh/intertidal habitats, whilst 9 (5%) were for development which specifically cited estuaries as being one of the habitat types affected. The estuaries category proved to be of particular interest to myself as many of the developments proposed had large-scale implications for the habitat, all of which constitute scarce/threatened wildlife areas in Britain. The review findings under this category led me to investigate the potential application of a new method of environmental assessment, strategic environmental assessment (SEA), for developments affecting the coastal zone (Chapter 7).

Among the miscellaneous other habitat types affected, 30 (17%) developments were found to have potential impacts. For many of these the area they represented was small and quite

often they were the product of some previous industrial activity, e.g. quarrying, railway embankments and sand and gravel extraction. There were exceptions to this, and these habitats represented some of Britain's most fragile wildlife areas, e.g. wet heaths, lichen heaths and limestone pavements.

### 3.3.8 Existing land-use

To comply with the DoE/Welsh Office (1989) guidelines the ES should describe the site and its environment. I tried to discover the existing land-use because this would indicate if there were any which were prone to development proposals or conversely if there were any which seemed to have a presumption against development. In keeping with the DoE/Welsh Office guidelines, the majority of ESs reviewed did include a reference to the land-use type within the proposed development area. Difficulty was experienced with some reports because they did not make it clear whether the land-use types mentioned were to be directly affected by the development, or whether they were described in a manner which gave an general overview of the areas of interest. Table 3.7 therefore only comprises those developments where a definite indication of the existing land-use was stated in the ES.

My review indicated that the majority of proposed developments appeared to affect areas where the land-use was predominantly agricultural with 114 (64%) developments in this category (Table 3.7). The number of schemes which appeared to affect urban/industrial and suburban/residential areas were much fewer with only 55 (31%) and 5 (3%) developments referred to respectively. Waste/derelict areas were also much less represented with 28 (16%) ESs stating they would be potentially affected. The final category considered in this element of the review was nature conservation as a land-use. Fifty two (29%) of the ESs reviewed were considered to have nature conservation as a major component of the existing land-use. The majority of these sites were those which had a woodland present, although some proposed schemes had substantial areas of wetland/waterbodies present.

**Table 3.7** Number of proposed developments, based on 179 environmental statements, likely to affect different types of existing land-use

| Existing land-use | Number of developments |
|---|---|
| Waste/derelict | 28 |
| Urban/industrial | 55 |
| Suburban/residential | 5 |
| Agriculture | 114 |
| Nature conservation | 52 |

### 3.3.9 Ecological impacts of the proposed developments

Directive 85/337 states that "a description of the likely significant effects, direct and indirect, on the environment of the development, explained by reference to its possible impacts on a number of environmental factors" is to be specified. Included in these environmental factors are the flora and fauna. In order to discover whether this requirement of the Directive was being met the ESs were examined to establish the number and range of potential ecological impacts posed by developments.

Potential ecological impacts of proposed schemes were either omitted or stated as not occurring in 12 (8%) of the ESs reviewed, with 167 (92%) identifying some form of ecological impact (Table 3.8). The largest category of impact identified was habitat loss with 117 (65%) schemes indicating that this could potentially occur. Also figuring highly as potential ecological impacts were pollution, constructional disturbance, and operational disturbance with 44 (25%), 31 (17%) and 25 (14%) schemes indicating their likelihood respectively. One type of potential impact rarely considered was habitat fragmentation which was mentioned in only 7 (4%) of the ESs reviewed. This is of concern because the nature and size of many of the developments reviewed had the potential to cause large - scale fragmentation by both acting as barriers to species movements and by reducing the amount of habitat available to resident species. Despite this fragmentation potential this topic was rarely considered, the majority of ESs making references only to more direct potential impacts on the flora and fauna (Table 3.8).

**Table 3.8** Potential ecological impacts of proposed developments

| Potential impact | Number of developments |
|---|---|
| Habitat loss | 117 |
| Habitat fragmentation | 7 |
| Constructional disturbance | 31 |
| Operational disturbance | 25 |
| Pollution | 44 |
| No ecological impact stated | 12 |

The overall quality of the information on the likely ecological impacts of proposed schemes was poor in the majority of ESs reviewed. Only 19 (11%) of the ESs considered the potential complex, cumulative and interactive adverse effects which the developments could cause. Although the majority of the ESs referred to some form of potential ecological impact, few impacts were described in detail. Only 16 (9%) statements quantified the impacts predicted, and only 5 (3%) attached a timescale to the duration of the impact predicted. None of the ESs mentioned the indirect impacts of the development proposal receiving planning permission. Many of the developments proposed would require some form of access, usually a road. For large scale developments this would involve the extraction of large amounts of road-building materials, often from outside the immediate geographic location of the proposed development. A recent example of this is the current situation on Harris and Lingarby in the western isles of Scotland where offshore "super quarries" are extracting building materials to meet the demands of the new road building programme on the mainland, the majority of which is taking place in the south east of England. The people of Harris and Lingarby rely upon the area which is quarried for a source of income from fishing and the whole of the west coast of Scotland is commonly regarded as an area of high ecological value because it contains nationally important areas for a number of bird species, and holds a high population of the European otter (*Lutra lutra*).

### 3.3.10 Mitigation

Most (78%) of the reports mentioned mitigative measures. Of the 139 which mentioned mitigation only 90 (64%) described the management measures needed to achieve mitigation

with only 32 (23%) making reference to management prescriptions. Only 7 (5%) predicted the likely success of the mitigation measure proposed, basing the prediction on similar schemes which had been studied.

Forty percent of development proposals reviewed included planting schemes, and a further 41% stated landscaping (which included tree planting) as a mitigative measure. Planting schemes can be very beneficial to development sites if they are correctly planned, taking site details into account and employing native trees suitable for the surrounding habitat. Ninety eight percent of the schemes did not fit any of these criteria, making only vague recommendations to address the cosmetic problems of the development. The main requirement appeared to be to provide as much green cover as necessary to minimise the potential visual impacts as quickly as possible. Little if any thought was given to the long - term impacts of these proposed schemes on the ecology of the surrounding area. Only two schemes proposed detailed planting prescriptions, including the relevant aftercare, which was solely comprised of native species and was stated as having nature conservation as the primary objective (Table 3.9).

Sixty (34%) of the ESs mentioned restoration to the former habitat(s) or creation of a new one(s) once the development was complete. A range of habitat types appeared in the review (see Table 3.9), some of which would be easy to create in something resembling the original form, but some almost impossible. Thirteen (7%) of the ESs proposed mitigation measures in response to a specific potential impact, and none recommended modifications to mitigative measures in the light of unforeseen post-project impacts.

Historically, British natural and semi-natural habitats have been reduced and fragmented by development activities. However, only 4% of the ESs specifically mention that habitat fragmentation will take place. Despite this low figure a number of development proposals aim to restore or recreate new habitats in order to compensate for these losses (Table 3.9). Such proposals, often unbeknown to developers, can be problematic. The term "re-creation" implies that the original habitat composition is known and its functioning understood, something which is never wholly true, and for most is far from true. It is therefore important that developers are made aware that the reassembly of an original habitat is not usually within the scope of current expertise. Also, there is no evidence that, once a habitat is removed and then replaced at a later date, all the component species will return.

**Table 3.9** Number of environmental statements, out of 179 analyzed, which proposed mitigation measures against potential adverse ecological impacts

| Mitigation measure proposed | Number of statements |
|---|---|
| Landscaping | 57 |
| Amenity tree planting | 56 |
| Habitat replacement | |
| trees | 28 |
| meadows/species rich grassland | 5 |
| heathland | 1 |
| wetland | 3 |
| Habitat creation/recreation | |
| trees | 60 |
| meadows/species rich grassland | 28 |
| heathland | 8 |
| wetland | 23 |
| ponds | 17 |
| Relocation/translocation of species/individuals | 17 |
| Miscellaneous, e.g. species introduction | 63 |

### 3.3.11 Monitoring

Monitoring should be a key component of any development proposal because the success of mitigative measures can be gauged and post-development problems identified and rectified. None of the ESs included a commitment to monitor the impacts of the proposed development, but 8 (5%) suggested monitoring as a possibility for the future. I suggest that the main reason why monitoring is often not considered is that it is expensive to undertake and the findings of monitoring schemes may highlight areas which will cost the developer money to rectify. There is also the problem of public perception of developments. If monitoring shows them to be environmentally damaging, the public will become concerned, and will often strongly oppose development of a similar nature in a similar location. Obviously this is not in the best interests of the developer.

Ecological monitoring is essential for effective EIA because the EIA process is based upon predictions which must be tested if prediction accuracy is to be improved. The recent

introduction of mandatory EIA in Britain means that prediction expertise is sparse. Feedback from developments through monitoring should help to prevent future ecological damage through inaccurate predictions. There has been a failure on the part of all those concerned in the EIA process to publicise the benefits of monitoring. As a result, it is likely that monitoring will either not be undertaken or will be inadequate. I believe that the only effective solution is through legislation which makes a monitoring plan compulsory before consent is given to those developments for which an EIA is undertaken. Monitoring will also operate as a check in that it is a means of ensuring that what a developer says will be done is done.

## 3.4 CONCLUSIONS

The results of my review demonstrate that there are a number of shortcomings in the current assessment of potential ecological impacts arising from those developments for which an ES has been produced. A major objective of my research was to determine whether or not the ESs which have been produced comply with the requirements of the EC Directive (85/337) which clearly states a formal need to consider the flora and fauna of proposed development sites. My findings indicate that most ESs do not meet with the requirements of the Directive in terms of ecological assessment.

In most ESs ecological data were absent or deficient, and inadequate as a basis for reliable predictions of development impacts on the natural environment. This poor provision of data is attributable to the inadequacy, or absence, of ecological surveys. The survey information which was provided concerned itself with broad habitat descriptions, with little information about the presence of species and their distributions. Further, where species information was present, too few reports placed that information in any context, i.e. the species or populations were not discussed in terms of local, regional, national or international status or rarity.

For many of the development proposals, the ability to assess the potential ecological impacts would have been assisted by quality baseline data. My findings indicate that this fundamental problem must be addressed if ecological impact prediction is to be effective (see strategic environmental assessment of lowland heath - Chapter 6). The provision of baseline data will be especially important if there is to be a move away from the individual

project approach to ecological environmental assessment, which is clearly not working, to one which considers cumulative impacts of related projects. Currently developers are not required by law to monitor post-development and therefore, at least in the short-term, the situation regarding baseline information is likely to remain unchanged.

Predicting the ecological impacts of proposed developments is arguably the most important omission under the current EA process, particularly considering that it is a requirement under the EA Directive. It is therefore not surprising that the majority of the mitigative measures were not related to any specific ecological impact and that there were few indications of their likely success. The majority of measures proposed were aesthetic and would not mitigate any real ecological damage such as species/habitat loss, pollution related problems, changes in vegetation patterns and disruption to breeding patterns.

It appears that there are inconsistencies in ecological assessment methodologies and that the procedures adopted to date limit the ability to predict the impacts of a potential development on the ecology of a site. The ecological information presented in the majority of the statements reviewed was of such poor quality or of such limited quantity that it was not possible to use it to assess the ecological implications of the proposed schemes. I suggest that many of the problems identified within the current EA process can be attributed to ecological considerations being incorporated into development proposals after, rather than before, site selection, and to the small amounts of time and resources allocated to ecological assessment in general.

Several reports were reasonably well prepared and appeared to have adequately considered most of the major components of the development site in terms of consultation and survey, but these were the exception rather than the rule. EIA is a predictive tool, yet few reports attempted to predict the impacts to the ecology of the proposed development site and its immediate surroundings. Partly this is due to the degree of difficulty associated with predicting impacts to habitats and species, which in turn can be linked to ecologists requiring unrealistically long survey periods and wishing to acquire large data sets. These are simply not available to those ecologists involved in the EIA process and they must learn to adapt their approach to accommodate this. Adding to the problem is a lack of available advice and guidance to ecologists involved in the EA process.

# Chapter 4

# GUIDELINES FOR THE ECOLOGICAL ASSESSMENT OF WOODLANDS SUBJECT TO DEVELOPMENT PROPOSALS

## 4.1 INTRODUCTION

My review of environmental statements revealed that certain habitat types are particularly prone to potential development pressure. Of particular concern is the large number of proposed developments likely to have an impact upon woodlands (see Chapter 3). I therefore decided to use woodlands as a pilot habitat for which to develop ecological assessment guidelines. The aims of the guidelines are to assist ecologists when making value judgements about the ecology of woodlands, and to help ecologists to demonstrate simply to development proponents the ecological value of any woodland under threat from a development.

The problem is how to decide upon the nature conservation value of a woodland and the overall ecological value of the site in question. Ecologists involved in the assessment of a woodland which forms part of a development proposal, and/or which is included in an environmental statement, have many questions to answer. Here I include topics such as contribution to the overall intrinsic value of the landscape, as well as the more predictable questions surrounding size, species diversity and structural diversity. These guidelines aim to provide ecologists with useful baseline information from which they can begin to consider the next stage of ecological assessment and to answer questions which assist in the appraisal of woodlands potentially affected by development.

Woodland assessment is based upon the need to establish the contribution of the woodland to the overall ecology of the development site. This process is fraught with pitfalls in that any appraisal will be limited by the knowledge and experience of the assessor. Despite this, most ecologists are in general agreement as to what constitutes a "good" woodland and this will be reflected in the guidelines.

When assessing a woodland, a comprehensive species list should be drawn up as part of the baseline study. Generally a wood is more valuable to nature conservation if it contains a large number of species (Peterken, 1981). Normally the rarer (both locally and

nationally) species render the site more valuable than one which has few or no rare species present. This presents a problem in that the observer must be familiar with all woodland species and be able to classify them in terms of their rarity. A further problem when producing guidelines for any kind of habitat is that of regionality. What is common in one area may be rare or absent from another. If all regional differences are to be covered then an exhaustive set of criteria is needed.

Emphasis was placed on the ability of the ecologist to identify woodland/plantation types, to comment upon stand structure and silvicultural management, to discuss the importance of size and the attendant problems of fragmentation, and to place the wood in context relative to its surroundings in the wider countryside. In most cases this information will be available from already documented sources such as local authority woodland officers, Forestry Commission site maps (pertaining to grant applications) or from the Site of Special Scientific Interest (SSSI), National Nature Reserve (NNR) and ancient semi-natural woodland (ASNW) registers of the country agencies, English Nature (EN), Scottish National Heritage (SNH) and the Countryside Council for Wales (CCW)). This approach was chosen as the basis for the guidelines for two reasons. First, because of the readily available documentation coupled to the background levels of expertise field ecologists possess, I assume that stand structure and management will be easy to ascertain, even to an ecologist specialising in another discipline. Second, there are a number of associations between stand structure, the management used to achieve that structure and species richness (Bayes & Henderson, 1988; Harding & Rose, 1988; Kirby, 1988; Smith, 1987; Stowe, 1987; Warren & Fuller, 1990; Warren & Key, 1991; Warren & Thomas, 1992).

Subsidiary habitats which contribute to the level of ecological diversity in woodlands are to be found in the guidelines under that heading. With the exception of rocky outcrops, quarries and geomorphological features, all of these habitats need to be subjected to periodic management if they are to retain their value to nature conservation. This should be noted by those involved in the preparation of an ES when they make recommendations concerning any work within the wood, and for any subsequent monitoring.

These guidelines attempt to provide a quantitative method of woodland assessment in terms of ecological value. This in turn should allow the significance of any potentially damaging operations to be identified at an early stage in the planning process and the ES produced to be worded accordingly. However, there are many problems which ecologists face in

quantitatively assessing any habitat, and woodlands are no exception, but these problems are outside the scope of these guidelines.

## 4.2 ECOLOGICAL CRITERIA EMPLOYED

The statutory conservation bodies have long been involved in habitat appraisal. Ratcliffe's (1977) criteria are those which are referred to in all the ESs reviewed which specifically mention habitat appraisal. These were adapted by Peterken (1981) with respect to woodland. My discussions with practising woodland managers suggest that in every case there are isolated situations under which the validity of these criteria can be questioned, e.g. some isolated woodlands have more ecological interest than those which are contiguous with other semi-natural habitats, and many woodland managers take issue with the naturalness criterion, referring to the fact that few, if any, British woodlands are unmanaged. Despite the criticisms, these criteria provide the basis for my own guidelines because discussions with woodland managers also suggested that they are generally good evaluation criteria which have practical applications, and are easy to interpret to the non-ecologist (McVittie, 1993, *pers. comm.*). They can be categorised as follows:

*Size.* Where woods are isolated habitat islands, their importance generally increases with size of area. Many woods are undesirably small in their total area. Woods with large trees are better than those with only small trees.

*Diversity.* Variety is better than uniformity. Sites with more species are better than those with few, provided that similar types of woodland are being compared. Sites with a range of woodland types are better than those with only one.

*Naturalness.* Woodlands which have been least modified in structure and composition by man are the most valuable.

*Rarity.* Woods are more valuable if rare species or communities are present.

*Fragility.* Fragile ecosystems and species have high value. Fragility is both intrinsic (e.g. from successional change or vulnerability of small populations) or extrinsic (i.e. probability of deleterious change by human actions). It can also be a combination, e.g. a population

fragmented into small groups by human action. Ancient woods are more valuable than recent woods.

*Typicalness.* Given that one objective is to maintain examples of all woodland types, good examples of commonplace types are as important as examples of rare types.

*Recorded history.* Woods which have been used for an important piece of research or which possess a good historical record are thereby made more important.

*Position in an ecological/geographical unit.* A wood which is contiguous with other semi-natural habitats is more valuable than one which is not.

*Potential value.* A wood whose value has diminished due to past management, but not irreversibly, has a potential value greater than present value.

*Intrinsic appeal.* This applies to species, not habitats. Species which appeal to the greater number of people are more important, e.g. birds and conspicuous flowers.

(Peterken, 1981)

These criteria will obviously show a degree of overlap. As Peterken (1981) noted they mostly reinforce each other, as in the case of size and diversity. Some are complementary - rarity and typicalness, whilst others are potentially in conflict - diversity and naturalness. What should be borne in mind is that they do not contribute equally in terms of their conservation value, neither are they mutually exclusive; a valuable site will score highly under many of the above.

## 4.3 WOODLAND SURVEY TECHNIQUES

In conjunction with the criteria produced by Peterken (1981), I consider the approach to woodland survey and assessment of its nature conservation value of Goodfellow and Peterken (1981) to be valuable because much practical, yet key, survey guidance is provided. Their approach to woodland survey has four main elements:

(i) Having accepted that ancient semi-natural woods are the most important, each wood is classified as (a) ancient or recent and (b) plantation or semi-natural, using mainly maps and aerial photographs. Only the woods with at least some ancient semi-natural woodland need to be considered further if survey resources are limited.

(ii) Field survey each wood, recording chosen features as objectively as possible.

(iii) Rank all surveyed woods into one or more league tables on the basis of the species recorded.

(iv) Select a limited number of woods, being those which, for various reasons, are the most important for nature conservation.

When appraising a woodland it is important to identify those areas which are of particular ecological importance. This is a dual purpose task because it not only makes it possible to pinpoint specific areas for which a sensitive approach is required (from a development point of view), but also, if a strong enough case can be put forward, may result in the whole area being designated as unsuitable for development.

The most important areas in a woodland have often already been identified if it has been subjected to a management plan, in particular one which considered areas with potential for commercial forestry. This emphasises the need for an in-depth literature review and the need for good consultation in the production of site documentation. There are however problems in that many woodlands are just good examples of a particular type and have no areas which can really be deemed important. Unfortunately, this is a consequence of any grading. It still leaves the question "Are woodlands of this type particularly vulnerable to development?".

Once a woodland has been assessed it is important to look at the ways in which the needs of nature conservation can be integrated with those of woodland management in general. The best method of doing this is by producing a management plan. Nature conservation can be adequately provided for within a management regime, with only small sacrifices made to timber production and recreation/amenity. In order to achieve this, any management plan must be forward looking and contain as many elements of silvicultural

management as can be made applicable to that woodland. Only then will nature conservation be truly integrated, at the same time keeping any losses to a minimum.

Peterken (1977) listed strategic principles for the integration of nature conservation with other objectives of management in British woodlands. Amongst other things he suggested that these could be used as a substitute for on-the-spot ecological advice when this is not available, and for that reason the principles he listed have been reproduced here with a view to providing guidelines for present and future woodland management plans.

*Site grading.* Distinguish between (a) woodland areas of high conservation value and (b) other woodland areas.

*Management priorities.* Afford special treatment to special sites and special areas.

*Clearance.* Minimise clearance. Necessary clearance should avoid sites and areas of high conservation value.

*Afforestation.* Accept afforestation, except on sites of high nature conservation value, but not so much that non-woodland habitats are reduced to small islands.

*Change.* Minimise rates of change within woods.

*Stand maturity.* Encourage maturity by maintaining long rotations. If this is not possible, retain a scatter of old trees after restocking.

*Native species.* Encourage native tree species and use non-native species only where necessary.

*Diversity.* Encourage diversity of (a) structure, (b) tree and shrub species and (c) habitat in so far as this is compatible with other principles.

*Regeneration.* Encourage restocking by natural regeneration or coppice growth.

*Rare species.* Take special measures where they are necessary to maintain populations of rare and local species.

*Records.* Retain records of management.

*Natural woodland.* Manage a proportion of woods on non-intervention lines in order to restore natural woodland in so far as this is possible.

*Traditional management.* Maintain or restore traditional management where this is possible and appropriate.

*"Modern" management.* Where traditional management is not possible or appropriate, introduce alternative systems of management which retain or enhance the conservation value of special sites and areas.

## 4.4 GUIDELINES FOR WOODLAND ASSESSMENT

Taking into account the points I have just made, and those made by others I have cited, I have produced the following guidelines which can be taken into a woodland, or part of a woodland, and used to determine its ecological value by scoring key components. The aim of these guidelines has been to keep the method of scoring as simple as possible, whilst attaching the most value to those elements of woodlands and woodland management which render them valuable to nature conservation. Forest management has been emphasised because this will determine the current and future value to nature conservation of British woodlands, and upon stand type as this can be a useful indicator of ecological diversity.

Once the overall score for the woodland has been obtained it must be compared with a table of scores which gives an indication of the ecological/nature conservation value of that woodland. Further information is then provided regarding recommendations for the level and type of development which is acceptable. Several components of woodland need to be considered when producing guidelines and associated scores because they have a large bearing on the overall ecological value of the woodland. They can be considered as follows.

**Component 1: Size**

For any review of a woodland it is important to look at its size. Generally, the larger a woodland the greater its ecological value because it will contain more species and larger

populations, will be structurally more diverse and will have a higher incidence of subsidiary habitats. Because of previous land-use changes, particularly agricultural, many woodlands remain only as fragments and are often undesirably small (Peterken, 1981). In those situations where woods are isolated habitat islands, their importance generally increases with size. Any development which proposes to reduce the area of most woodland types should be carefully scrutinised because of their generally high value to nature conservation.

The concept of species having minimum area requirements, especially for breeding, is common in the literature (Freemark & Merriam, 1986; Hinsley *et al.*, 1994; Opdam *et al.*, 1985; Robertson *et al.*, 1994; Saunders *et al.*, 1991; Wilcove *et al.*, 1986). These authors have demonstrated a clear linear relationship between the size of a woodland and the number of woodland species present, this I use as the basis for my scoring system. Ecologists employing this scoring system should be aware that there are a number of other factors to consider in relation to the taxa in question. For example, certain species have short dispersal distances, e.g. nuthatches *(Sitta europaea)* which are absent from woodland of 100 ha or more, suggesting that the wood is too isolated from potential source populations which might otherwise colonise (Hinsley *et al.*, 1994).

A further point to consider is the management practices employed. Appropriate management of small woodlands can provide adequate conditions for many species, although there are some species, e.g. the purple emperor butterfly *(Apatura iris)*, which appear to prefer large woodlands or well wooded areas (Robertson *et al.*, 1994). In those small woodlands where appropriate management exists one might expect to find the woodland associated species but in small numbers. These key points suggest that the scoring system should not be viewed in isolation.

Table 4.1 provides guidance as to how the size of a woodland should be scored by a consultant ecologists involved in the evaluation process of a development potentially impacting upon a woodland.

**Table 4.1** Scores to be allocated for woodlands of different sizes

| Size (ha) | Score |
|---|---|
| <1 | 1 |
| 1-5 | 2 |
| 6-10 | 4 |
| 11-20 | 6 |
| 21-50 | 10 |
| 51-100 | 12 |
| >100 | 15 |

**Component 2: Stand structure or woodland type**

The way in which a woodland or forest has been managed, and the way in which it is being managed, are important factors influencing its ecological value. It is commonly acknowledged that certain types of woodland management are recommended for enhancement of their value to certain taxonomic groups, particularly birds (Bayes & Henderson, 1988; Bibby *et al.*, 1985;, Smith, 1988; Stowe, 1987) and butterflies (Robertson *et al.*, 1994) It is also recognised by woodland managers that in order to maximise the ecological value of a woodland there should be both structural and species diversity of all the woodland components (trees, shrubs and herbs) (McVittie, 1993, *pers. comm.*). It therefore follows that a naturally regenerating broadleaved woodland has a higher ecological value than a broadleaved plantation woodland.

Stand structure or woodland type and silvicultural management are important interacting factors. Management of a wood dictates the stand structural diversity which in turn influences the number and types of ecological niches. It should also be remembered that management may also greatly reduce the mature element of a wood and its unmanaged character. Lack of management generally leads to a uniform structure in the short to medium term, with structural diversity returning only after a very long period of non-intervention (Peterken, 1981).

There are several issues for the ecologist involved in the appraisal process to identify. They centre around the ability to place the wood in question into a particular category, and to identify and comment upon the management to which it has been subjected. An ability

to do this is important because many species are known to have specific stand type and silvicultural preferences, e.g. butterflies and warblers prefer to inhabit young coppice. Table 4.2 provides a scoring system for various woodland types. The scores are linked to the ecological values of the woodland types and to the woodland management operations to which they are subjected.

The following criteria form the basis of the scoring:

- Native species have a higher conservation value than non-native species (Kennedy & Southwood, 1984; Southwood, 1961). Native species are those which normally would be expected to be past natural components of woodland on the site under consideration (Peterken, 1981) and which have the highest conservation value because wildlife has become adapted to the habitat they provide.

- Age structure of woodland is important because the more structurally diverse a woodland the greater the diversity of species it can support. This is reflected in the scoring system in that plantation systems result in uniform age structure, and therefore score low, whilst ancient semi-natural woodlands and naturally colonising native species woodlands score high. Natural regeneration (colonisation) is to be encouraged as a means of maintaining existing woodlands in a state of high structural diversity and of providing new ones, because it increases the ecological value of the woodland.

- Monoculture, whether in native species or alien species form, results in woodland which is of low ecological value compared with mixed species woodlands. Non-native species are particularly undesirable because they have a very limited dependent invertebrate fauna (Southwood, 1961), although some of the longer established species have become established features of British woodlands. These species have valuable contributions to make to nature conservation in that they form an important component of semi-natural communities, e.g. Horse chestnut (*Aesculus hippocastanum*) (Peterken, 1981).

**Table 4.2** Scores to be allocated for different types of forest/woodland and their associated management

| Forest/woodland management type | Score |
|---|---|
| Plantation (even aged) | |
| native conifers | 5 |
| non-native conifers | 1 |
| broadleaves | 5 |
| mixed | 3 |
| Shelterwood | 6 |
| Selection felling | 6 |
| Neglected coppice | 5 |
| Managed coppice | 6 |
| Managed coppice with standards | 6 |
| Natural regeneration | |
| native conifers | 8 |
| non-native conifers | 3 |
| broadleaves | 8 |
| mixed | 4 |
| Plantation (uneven age) | |
| native conifers | 8 |
| non-native conifers | 3 |
| broadleaves | 6 |
| mixed | 4 |
| Wood pasture - pollarded | 7 |

**Component 3: Stand age and species composition**

Stand age and species composition are important because they dictate the thinning regime employed by the woodland manager. Thinning is undertaken to reduce the tree density and gives an intermediate economic return on the owner's investment because the timber removed can be sold. Modern planting practice is to initially plant at high density to induce dense shade, which reduces competition from scrub and other weed species, and to produce straight timber. Thinning allows the remaining trees to grow to their maximum

potential in terms of height and girth. Generally, the first thinning operation takes place twenty years after planting for coniferous species and at after approximately forty years for native broadleaves. The scores provided in Table 4.3 reflect these standard forestry operations for broadleaves and conifers.

**Table 4.3** Scores to be allocated for different categories/types of woodland

| Category/type of woodland | Score |
|---|---|
| Recent (<40 yrs) native broadleaved plantation | 6 |
| Recent (<40 yrs) plantation mixed woodland | |
| 15-24% native species | 2 |
| 25-49% native species | 4 |
| 50-74% native species | 5 |
| Recent (<20 yrs) non-native coniferous plantation | 1 |
| Recent (<20 yrs) native coniferous plantation | 8 |
| Coniferised (non-native) semi-natural | 6 |
| Ancient semi-natural | 15 |
| Secondary (40-150 yrs) by colonisation | |
| broadleaved | 8 |
| mixed | 6 |
| native coniferous | 12 |
| non-native coniferous | 2 |

Many authors have discussed the importance of ancient semi-natural woodlands (Ball & Stevens, 1981; Peterken, 1977; Peterken, 1981; Rackham, 1980). Such woodlands are worthy of special attention in any development proposal with the potential to have an impact on them. They are ecologically important because of the structural diversity within all their components - the tree and shrub layers, ground flora and soil profile (Peterken, 1981). Ancient semi-natural woodland has become highly fragmented in its distribution due to human activities and every attempt should be made to conserve the remaining British examples. This is given the highest score in the guidelines (see Table 4.3)

**Component 4: Immediate surroundings**

It is important to consider a woodland not as a separate entity, but as a part of the wider countryside. This is because the immediate surroundings of any habitat will either deplete or enhance its ecological value through positive and negative ecological impacts. For

example, immediate surroundings may be important to a wood in that they provide feeding areas for some of the recognised woodland species. Certain adjacent habitats and land uses will provide a favourable transition over the whole of the area in question, e.g. scrub or rough grassland at the periphery of the wood, whilst others will provide abrupt halts to all but the most generalist of woodland inhabitants, e.g. urban fringe or improved grassland. Table 4.4 indicates habitat types/land uses most likely to be encountered within a radius of 1 km of a woodland proposed as part of a development. The distance chosen, i.e. 1 km, is purely arbitrary; ecologists might argue that the many impacts associated with the developments currently affecting woodland (see Chapter 3) will have impacts over a much greater distance than 1 km. As a result, further discussion with ecologists involved in environmental impact assessment may be required to reach a consensus on this point.

**Table 4.4** Scores to be allocated to different types of habitat and land use within 1 km of the edge of a woodland

| Immediate (within 1 km) habitat or land use | Score |
|---|---|
| Woodland | |
| secondary - by natural colonisation | 6 |
| non-native conifer plantation | 1 |
| native conifer plantation | 5 |
| mixed plantation | 4 |
| ancient semi-natural | 10 |
| scrub | 4 |
| Arable | 2 |
| Urban | 1 |
| Disused/derelict | 2 |
| Grassland | |
| improved | 1 |
| unimproved | 4 |
| Moorland | |
| upland | 4 |
| lowland | 6 |

**Component 5: Nature conservation and landscape designations**

Designations represent official recognition that the woodland in question is considered to be of some value, either for ecological or landscape reasons. Designations are recognised by decision makers as indicative of special site conditions and are therefore important in

the environmental assessment process. These conservation and landscape designations also indicate the level of importance, i.e. locally, regionally, nationally or internationally important. Although not an "official" designation, ancient semi-natural woodland is included in Table 4.5 because it is the subject of a site register compiled by the Institute of Terrestrial Ecology (Bunce, 1969), which indicates the distribution, size and type of this woodland classification throughout Britain. Table 4.5 will enable the consultant ecologist to score the ecological value of a woodland in relation to its designation. Where a woodland has more than one designation, e.g. it is a Site of Special Scientific Interest and a National Nature Reserve, only the highest score is allocated.

**Table 4.5** Scores to be allocated for woodland which includes one or more designated areas

| Designation | Score |
|---|---|
| National Nature Reserve / Forest Nature Reserve | 10 |
| Ancient semi-natural woodland | 10 |
| Any international designation | 12 |
| Site of Special Scientific Interest | 8 |
| Area of Outstanding Natural Beauty | 5 |
| Local, e.g any local authority designation | 2 |

**Component 6: Subsidiary features**

Subsidiary features, such as those listed in Table 4.6, are important in any habitat because they increase spatial diversity and hence the potential species diversity. They are therefore important components of any habitat, and any development which proposes to remove them, or the active management required to maintain them, should come under scrutiny. It is important to note that a woodland may possess many of the features listed, and as a result, the overall score under this category may well be high.

Once the scores for each category of criteria have been determined they are summed to obtain the total score for the woodland in question. This overall score can then be used by the consultant ecologist to help gain an understanding of the ecological value of the woodland. I suggest that the score obtained is not considered in isolation, but is used to complement other ecological evaluation criteria which may be used, e.g. indicator species

in ancient woodland (Peterken, 1981; Rackham, 1980). Using this scoring system the consultant ecologist can quickly obtain a useful indication of the value of the woodland to nature conservation, and then report this in the ecological section of the environmental statement produced. Ultimately, the fate of both the woodland and the development are decided by the contents of this report. Using this scoring system, woodlands will fall into one of the following categories.

**Table 4.6** Scores to be allocated for subsidiary features within woodland

| Feature | Score |
|---|---|
| Water bodies | |
| ponds | 2 |
| bogs/mires | 2 |
| streams | 2 |
| Rock faces/quarries | 2 |
| Glades/rides | 2 |
| Artifacts, e.g. ancient wood bank | 2 |
| Geomorphological feature, e.g. glacial drainage system or pingo | 2 |

**Category A.** (Overall score > 79). These woodlands will be the best examples in terms of both species composition and size, of native woodlands in Britain. Because of this, and their consequent importance, any proposed development on the site should be opposed.

**Category B.** (Overall score 50 - 79). These woodlands will have many key attributes (highlighted in the guidelines) which should be maintained. They will invariably be good quality (in terms of structural and species composition) secondary woodland which has been subjected to a management regime which benefits the ecology of the woodland. Woodlands of this description may have limited scope for sensitive development, although the sensible solution would be to look for alternative sites.

**Category C.** (Overall score 20 - 49). Woodlands falling into this category will have several key attributes (highlighted in the guidelines) which should be maintained. Woodlands within this category will be very variable. It may be that the high score is made up largely from one section of the guidelines, or conversely it may be that they

achieve modest scores for several criteria. Woodlands of this description affected by a development proposal will ideally have their most important features preserved within the development proposal by sensitive planning of the overall development and appropriate mitigation measures.

**Category D.** (Overall score < 20). These woodlands will have few, if any, key attributes. Invariably they will be small woods/plantations, often of non-native species, which have been subjected to an ecologically unsympathetic management regime. It will be difficult to justify protection for woodland of this description when subject to potential adverse impact from a proposed development.

## 4.5 EVALUATION OF GUIDELINES AND SCORING SYSTEM

In order to test the usefulness of the guidelines and scoring system proposed I applied them to 17 woods which I know well in and around Oxford and Manchester. I did this in consultation with either the local woodland officer or a member of the local wildlife trust responsible for the woodland's management. Although the purpose of the guidelines is to provide a quick yet informative appraisal of a wood, which requires no prior knowledge, familiarity was important in this instance because it enabled me to identify any unsatisfactory criteria. These woodlands were, with one exception, broadleaved. This bias toward broadleaves was not ideal, but time limitations and problems of access prevented application of the guidelines to conifer plantations. Of the 17 woodlands to which the guidelines were applied, one came out in category A, five in category B, nine in category C, and two in category D (Table 4.7).

I was surprised that only one woodland achieved a category A score, particularly as the wood in question has a large plantation conifer component. However, it also has both secondary broadleaved and managed coppice elements, both of which score highly under my assessment guidelines. The four factors which contributed to the wood's very high score were its large size, its designation as ancient semi-natural, its close proximity to another ancient semi-natural woodland and its designation as a Forest Nature Reserve.

**Table 4.7** Total scores obtained by 17 woodlands assessed using proposed guidelines (M = Manchester region, O = Oxford region)

| Name of wood | Score | Category |
|---|---|---|
| Chinnor Hill (O) | 51 | B |
| Steventon Copse (O) | 35 | C |
| Ardley Wood (O) | 60 | B |
| Gorse Covert (M) | 16 | D |
| Hough End Clough (M) | 21 | C |
| Sharston Spinney (M) | 11 | D |
| Hazlitts Wood (M) | 24 | C |
| Gibb Lane Wood (M) | 47 | C |
| Bailey's Wood (M) | 41 | C |
| Well Wood (M) | 59 | B |
| Oakley Hill Beech Wood (O) | 41 | C |
| Sandford Brake (O) | 54 | B |
| Magdalen Wood West (O) | 40 | C |
| Blackley Forest (M) | 36 | C |
| Brasenose Wood (O) | 73 | B |
| Shabbington Wood (O) | 88 | A |
| Botany Bay Wood (M) | 41 | C |

The five category B woodlands were fairly small, the largest being less than 20 ha. Generally they achieved high scores because they were either ancient semi-natural or they had stand types and associated management which score highly under my guidelines (coppice, regenerating broadleaves, planted uneven age broadleaves etc.) and they also contained a number of subsidiary features. All five of the woodlands were designated Sites of Special Scientific Interest which also scores highly.

The nine category C woodlands were mostly either medium size woodlands (five were in the 5 - 19 ha range) with plantation status or a low scoring management regime, or small (three in the 1 - 4 ha size range) with those features, stand types and management regimes which are reasonably valuable for nature conservation and score accordingly. The larger

woodlands tended to have low scoring designations, e.g. local authority site, or none at all, whilst the smaller ones tended to have ancient semi-natural status or a similar high scoring designation.

Both the category D woodlands were small (1 - 4 ha), even aged plantations without designations. Their small size meant that they had no subsidiary features, four categories which can greatly influence the overall score obtained under the guidelines.

## 4.6 DISCUSSION

These guidelines are intended for use by consultant ecologists when considering areas of woodland identified following the use of more general ecological surveys for which guidelines, such as those being prepared by English Nature and the Institute of Environmental Assessment, should soon be available. My guidelines assume that the ecologist has adequate knowledge of ecological principles as they apply to woodlands, and that he or she has access to the information which is available on the distribution and abundance of woodlands and their dependent species.

Ideally the guidelines will be used to ensure that any woodland likely to be affected by a development is properly assessed before the development application is determined. They should be particularly useful when used to evaluate an area of woodland which might be termed semi-natural, because these are the areas of greatest value to nature conservation. Although semi-natural habitats have been modified to some extent by human activity, they continue to support communities of native plants and animals, similar in structure to natural communities.

There are problems with producing guidelines based on a scoring system which is used to provide an overall measure of ecological value for a habitat type. Some ecologists consider scoring systems such as mine to be of limited use because it is difficult to assign a score to some attributes (Kirby, 1988). This is particularly evident when attempting to score the Nature Conservation Review Criteria (Ratcliffe, 1977) where criteria such as fragility and recorded history are exceedingly difficult to score (Peterken, 1981). A further criticism which could be made is that there are elements of a woodland to be quantified which effectively make up the non-ecology component, i.e. the recreation, amenity and

educational value of the woodland. These three elements should also be considered when considering a potential development which may erode or remove their function. However, further discussion of this topic is outside the scope of my research.

The scores obtained when I tested the guidelines highlight several key points. First, the larger a wood then the higher the score. The reasons for this are that the larger an area the greater the scope for it to contain a diversity of tree species, stand types and management regimes, some of which will score highly because they increase the ecological value of the woodland. Second, those woodlands with landscape and conservation designations on them tend to score highly. This is easily explained in that the woods not only score highly due to the presence of the designation, but also because the wood was (usually) designated because of the management and planting regime(s) employed. These score highly because they are sympathetic to the needs of nature conservation. Finally, a subjective observation is that the woodlands in Manchester tended to score lower than their Oxford counterparts. There are a number of possible reasons for this, apart from unrepresentative samples. One possible reason is that the ecological value of the Manchester woodlands is indeed inferior to that of the Oxfordshire ones. However, I do not think this is the case. I suggest that the main reason for the differences in scores is linked to the Manchester woodlands not possessing designations which adequately reflect their ecological value. The reasons for this situation are political and outside the scope of my research.

Peterken (1981) stated that "quantitative methodology is in its infancy and nice points can be argued *ad nauseam* ". The results of my research indicate that woodlands in general, and semi-natural woodlands in particular, are the subject of many development proposals with the potential to erode or remove their ecological value. Therefore I consider it desirable to make available to decision makers a means of determining the overall value of such habitats to nature conservation. Criticism has been levelled at this approach, but perhaps the best way to conclude this chapter is to consider the words of Peterken (1981) who states that "in areas where semi-natural woodlands remain, there is such a large measure of agreement about which sites are best, and such pressure to damage their conservation value, that practical conservation measures cannot wait on the fine tuning of assessment methodology". I agree with this, but only to an extent. I believe that the problem is one of a lack of a method which alerts decision makers, not ecologists, to the importance of a habitat, such that adequate attention is given to likely development impacts. These guidelines go some way to providing such a method.

# Chapter 5

# STRATEGIC ENVIRONMENTAL ASSESSMENT - AN ALTERNATIVE TO PROJECT BASED ENVIRONMENTAL IMPACT ASSESSMENT

## 5.1 INTRODUCTION

Strategic environmental assessment (SEA) is the formalised, systematic and comprehensive process of evaluating impacts of policies, plans and programmes (PPPs), and using the findings in publicly accountable decision making (Therivel *et al.*, 1992). In 1992, SEA in some form was called for under the Agenda 21 follow-up to the 1992 United Nations Conference on Environment and Development (Quarrie, 1992), and from the United Nations' Economic Commission for Europe, where a task force concluded that:

"A well-prepared and timely assessment of policies, plans and programmes can anticipate and highlight potential environmental problems, prevent delays, assist in long-term planning and prevent or simplify litigation."
(UNECE, 1992)

The EU Fifth Environmental Action Programme *Towards Sustainability* (COM (92) 23) also suggested that the development of SEA is fundamental to the success of the incorporation of sustainability objectives into PPPs. Although well intended, the incorporation of sustainability objectives into the environmental assessment of PPPs has caused problems surrounding the objectives themselves. Currently, SEA, where practised, tends to consider non-environmental objectives, such as job creation or increased food production, and then proposes a policy which will achieve those aims in the least environmentally harmful manner. This approach contrasts markedly with the view of English Nature (1992) who propose that PPPs be environment-led with the concepts of carrying capacity and critical natural capital determining the objectives of policy. PPPs are therefore important to the ecologist involved in the planning process because they can have a large-scale bearing upon developmental pressures on habitats and their dependent species.

The concept of SEA is generally receiving much interest in the European Union. In mid-1991, the EC's Directorate-General XI produced a proposed Directive on SEA (Commission of the European Communities (CEC), 1991) amidst criticism about the

limitations of the current system of project environmental assessment. However, the Directive is still under development and is yet to be agreed by the Commission. In the light of this, and having already identified the poor treatment given to the ecological component of project environmental assessment (see Chapter 3), I looked at the SEA concept, and analyzed its applicability to the ecological aspects of environmental impact assessment.

## 5.2 THE NEED FOR ECOLOGICAL SEA

Broadly speaking, the aim of environmental assessment is to improve the planning decision-making process by providing information about the context and environmental repercussions of proposed development projects.

The existing system of project environmental assessment has some major deficiencies namely:

- it reacts to development proposals rather anticipating them;
- it does not adequately consider the cumulative impacts of more than one project of similar nature;
- alternatives are addressed only in a limited manner;
- mitigation measures are limited and are often inappropriate; and
- the timescale for project EA is determined by other factors such as financial constraints which result in a limited time in which to collect baseline data and analyze it. (Therivel *et al.*, 1992)

All of the objectives of SEA which I propose are related to removing these limitations which may constrain ecologists in their approach to environmental assessment and reduce the quality of the ecological component of the environmental statements to which they contribute. I suggest that ecological SEA should be underpinned by a system which:

- ensures full consideration of alternative policy options which bestow the highest degree of protection to habitats and dependent species;

- ensures that cumulative, indirect or secondary impacts of development activities are considered, especially in relation to those habitats and bio-geographic units subject to multiple development activities;

- avoids replication of impact assessment at the project level; and

- ensures that environmental principles, such as sustainability and the precautionary principle, are integrated into those policy proposals which potentially could have adverse impacts on habitats and their dependent species.

The implementation of ecological SEA is fraught with difficulties, some of which have been encountered in the environmental assessment of individual projects. These I suggest include problems related to:

- the large number of potential developments affecting certain habitat types, and the large area the developments cover;

- the large area of the habitat under consideration for development;

- local and regional differences in terms of ecological "value" within the habitat in question;

- the high levels of analytical complexity required to account for all these factors;

- lack of information about the existing habitat in question and its projected future condition;

- lack of exact information about future development proposals affecting the habitat (nature, scale, location);

- lack of precision of impact prediction; and

- the tendency for decisions regarding these PPPs to be made in an incremental and unclearly formulated fashion.

There are many issues to be addressed when considering the adoption of SEA. The EC Directive on the Assessment of the Effects of Certain Private and Public Projects (85/337/EEC) (Commission of the European Communities, 1985) took about ten years to be agreed, despite the previous existence of many other systems of environmental assessment. From the onset in 1991 of EU proposals concerning SEA a similar period of time might be expected to elapse before the Directive becomes legislation, especially bearing in mind the more complicated procedures involved compared with the individual project approach. Further, there are few existing SEA systems on which to base a UK system (Therivel *et al*, 1992).

## 5.3 EXISTING SYSTEMS OF SEA

Currently there are few SEA systems, or near equivalents, either in operation or recently proposed. The best examples of SEA systems which I have been able to identify are those operated in California and the Netherlands, the latter being particularly appropriate as the Netherlands is an EU Member State. The following is a brief synopsis of these two systems and any other systems which might be viewed as a move away from the individual project approach to environmental impact assessment.

### 5.3.1 United States

In the United States, the regulatory basis for SEA began with the US National Environmental Policy Act, 1969. This sets out a national environmental policy and, as a means of achieving this policy, requires that all federal agencies prepare a "detailed statement" on the environmental impacts of "every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment" (US Government, 1970). However, over the years the procedural details for preparing these statements have attracted more attention than the Act's other provisions, and the EIA process has tended to focus on individual projects rather than PPPs (Therivel *et al*, 1992).

During the late 1980s and early 1990s there was a revived interest in SEA related topics.

A series of court cases concerning the need and scope for cumulative impact analysis seems to be going beyond the narrow rulings of the late 1970s and into a new era in which such issues as global warming, loss of species diversity and ozone depletion are gaining in importance (Herson and Bogdan, 1991). A number of recent rulings in the US have found against certain developments on the grounds of inadequate cumulative impact analysis.

The Council on Environmental Quality has determined that SEA is necessary when actions are:

- interconnected because they automatically trigger another activity or because they are sub-components of a larger activity;

- cumulative, namely if they will have a significant impact if considered together. Cumulative actions can be divided into actions which are cumulative within a given region, and those which are connected by a type of action, i.e. sectoral; and

- similar to other proposed or reasonably foreseeable actions

(Wagner, 1991).

Between 1979 and 1987 about 320 full SEAs, known as "programmatic environmental impact statements" (PEISs), were prepared in the US for federally linked PPPs. These covered a wide range of issues. Several had an ecological theme, such as an analysis by the US Forest Service of the impact of five alternative types of forest management practices designed to protect the endangered and declining population of red-cockaded woodpeckers (Wagner, 1991).

California appears to have the best developed and most fully operational system of SEA in the world. The California Environmental Quality Act (California Office of Planning and Research, 1986) requires environmental assessments to be prepared for PPPs as well as for individual projects, and 342 were prepared between January 1988 and July 1990 (Bass, 1990). The CEQA requires public agencies to prepare SEAs for any series of linked actions, including those projects which are related:

- geographically;

- as logical parts in the chain of contemplated actions;

- in connection with issuance of rules, regulations, plans, and other criteria to govern the conduct of a continuing programme; or

- as individual activities carried out under the same authorising statutory or regulatory authority, and having generally similar environmental effects which can be mitigated in similar ways.

(California Office of Planning and Research, 1986).

The requirements of the SEA appear to make provision for a substantial ecological input because there must be an evaluation of the action's impacts, including direct, indirect, long-term, short-term, unavoidable, cumulative and growth-inducing effects. Also required are a description of the alternatives to the proposed action, including alternative sites, which would reduce or avoid the significant impacts, and a statement indicating the reasons why some possible environmental impacts were determined not to be significant, and therefore not evaluated.

### 5.3.2 European Union member states

During the early formulation of Directive 85 337/EEC the assessment of PPPs was considered but was later removed. There are diverse existing SEA systems ranging from the Netherlands' mandatory formal system to the various forms of less thorough and less official environmental evaluation (Therivel *et al.*, 1992). With the Commission of the European Communities currently involved in discussion regarding SEA for Member States' PPPs, with a Directive as the means of instituting the idea, it is important for ecologists to understand the intentions of SEA so that they can maximise their input into it.

In the Netherlands there has been a formal system of SEA for sectoral plans for waste management, drinking water supply, energy and electricity supply, and some land-use plans since 1987 (Therivel *et al.*, 1992). The legislation requires that SEAs analyze a wide range of impacts and their significance. The findings of the SEA are then reviewed by a special commission on EIA. In May 1989 the environmental strategy for the Netherlands for the next decade was set out in the National Environmental Policy Plan (Ministry of Housing, Physical Planning and Environment, 1989). For a number of PPPs a "section on the

environment" must be prepared. This is a written presentation of the repercussions of the action(s) on the environment. It provides ecologists with an ideal opportunity to predict the impacts of a policy, plan or programme on a habitat and/or species, and to recommend steps to be taken to remove the threat.

### 5.3.3 The UK

The UK has no formal system of SEA. The closest equivalent to an informal SEA system is the Department of the Environment's guide *Policy Appraisal and the Environment* (HMSO, 1991) and the same department's planning policy guidance note on Development Plans and Regional Planning Guidance (PPG 12) (Department of the Environment, 1992). Both of these documents have been criticised in that they carefully avoid directly linking the concepts of sustainable development and SEA, and they only provide a step up from the current system of project environmental assessment (Therivel, *et al.*, 1992).

A number of partial attempts at SEA have been made, such as The Fylde Coastal Water Improvements study, which had the objective of determining what works were needed to achieve the EC bathing standards along a length of the Fylde Coast. In this study the effectiveness and the environmental impacts of a number of sewage treatment options were appraised, and a final best option put forward (CPRE, 1991). A similar operation was undertaken voluntarily by Thames Water in 1988 when an SEA on the Lower Colne Flood Defence Scheme, sixty projects in total, was carried out (CPRE, 1991). This approach was warmly welcomed by the CPRE which stated that for the scheme "while any one project may or may not have had a significant effect on the environment, taken together the programme as a whole would have. An EA on the whole scheme was therefore essential" (CPRE, 1991).

## 5.4 PROBLEMS WITH IMPLEMENTATION OF SEA

It is noticeable that SEAs prepared to date have been for plans and programmes, rather than for policies. The Netherlands' proposals for policy SEAs are still in their early stages and are concerned with the problems and issues of policy SEA rather than proposals for SEA implementation (Therivel *et al.*, 1992).

There are problems when considering the adoption of SEA, which may have repercussions for ecologists. For example, it may be necessary to determine which PPPs require SEA. This can be done by either listing or defining them. The draft EC Directive on SEA proposes a list of PPPs which will require SEA. This has the advantages of being definitive and not open to interpretation, but problematic in that PPPs which have a significant environmental impact may be omitted. The definition approach has the advantage that it has the potential to be more comprehensive, but the disadvantage that determination of those PPPs requiring SEA may be more difficult. In the US, projects requiring EIA are decided by a definition, arrived at through a series of law suits. I suggest that it is likely that the UK will adopt the list approach to SEA as has been done for project EIA.

The impacts which could be considered in an SEA can be divided into three types:

- *Traditional impacts* which are normally covered by most project EAs, e.g. hydrological, geological and pollution impacts.

- *Sustainable-related impacts* which specifically consider resources which are threatened by irreversible, cumulative or secondary impacts, e.g significant habitats and species and unique natural features.

- *Policy-related impacts* which are affected by, and affect, other policies, e.g. road building policy and its implications for the extractive industry.
  (Therivel *et al.*, 1992)

Of the existing SEA systems only the Netherlands' uses sustainability-related issues in its methodology for screening government policy areas (Therivel *et al.*, 1992). The draft EU Directive list of impacts to be considered in an SEA is similar to the existing project list under Directive 85/337/EEC. Other systems do not involve a formal list. SEA methodology in general is in its infancy and ecologists would do well to recognise this and have a voice in the formulation of guidelines for SEA. With this in mind, I will now discuss ways in which ecological SEA could be applied in the context of a habitat (lowland heath), a bio-geographic zone (coastal zone) and an industry (fish farming).

# Chapter 6

# THE APPLICATION OF STRATEGIC ENVIRONMENTAL ASSESSMENT TO LOWLAND HEATH

## 6.1 INTRODUCTION

The limitations of project environmental assessment and the potential benefits of strategic environmental assessment (SEA) have been outlined. There is potential for applying SEA to those developments which are related by virtue of the habitat type on which they will impinge. Here I apply this to lowland heath.

I chose lowland heath as a habitat type to which the SEA approach might be applied for three reasons. First, it was assumed that, being a special habitat in terms of rarity, and one for which a great deal of research has been undertaken (Armstrong, 1973; Auld *et al.*, 1992; Cadbury, 1989; Farrell, 1983; Gimmingham, 1972; Harrison, 1981; Moore, 1962; Webb & Haskins, 1980; Webb & Hopkins, 1984), there would be an up to date, easily accessible, data source which could be used to formulate ideas. Second, this habitat type has a history of development linked problems which have resulted in large-scale losses which might have been avoided if a strategic approach to development consent had been employed. Third, depending upon central government policy, there are a number of development proposals with implications for lowland heath, namely the large road and house building programmes. With these points in mind, a major component of this research involved discussion with a wide range of organisations and interested parties about the desirability and feasibility of SEA to lowland heath.

## 6.2 THE IMPORTANCE OF LOWLAND HEATH

Lowland heath is defined by the RSPB as *Calluna vulgaris* dominated vegetation occurring at altitudes of less than 300 m above ordnance datum. I prefer to define lowland heath in terms of its vegetation/substrate association, i.e. *Calluna* and *Erica* species found on sand and gravel. To many people lowland heaths are visually attractive and they are also of considerable value as wildlife habitats. Their flora and fauna have developed together to give rise to a unique community. Lowland heaths are of particular interest because they

represent a type of vegetation dominated by the heather and pea families, and they are the stronghold of a number of nationally scarce plants and animals, e.g. sand lizard (*Lacerta agilis*), natterjack toad (*Bufo calamita*), smooth snake (*Coronella austriaca*), Dartford warbler (*Sylvia undata*), woodlark (*Lullula arborea*), stone curlew (*Burhinus oedicnemus*), marsh gentian (*Gentiana pneumonanthe*), wild gladiolus (*Gladiolus illyricus*), yellow centaury (*Cicendia filiformis*) scarce Ischnura damselfly (*Ischnura pumilio*), small red damselfly (*Ceriagrion tenellum*) and Silver-studded Blue butterfly (*Plebejus argus*).

There are three types of heathland in the UK: maritime, upland and lowland. Each occurs under different climatic conditions and supports different plant and animal communities. As distinctive habitats, each is important, but lowland heathland can be regarded as particularly important, both nationally and internationally, because 40% of the world's heathland is found in the UK (Davies, 1989). Lowland heath can be found across most of southern England, with similar communities occurring in parts of west Wales, the Midlands, Cumbria and Scotland (Webb, 1986). Discussion of the importance of lowland heaths in these regions is outside the scope of this study, and is given adequate treatment in a number of the references cited above.

## 6.3 DECLINE OF LOWLAND HEATH IN BRITAIN

The reduction in area of lowland heath has taken place at an alarming rate. The reasons for this are many, but an important factor has been the encroachment of development. Between 1830 and 1980 a 78% loss (103,800 ha) of lowland heath occurred, and the habitat was reduced in area by 40% between 1950 and 1984 (NCC, 1984). Lowland heath was once found in large tracts in Berkshire, Dorset, Hampshire, Suffolk, Surrey, and Sussex (Webb, 1986). However, changes in land use, especially in the last 20 years, have resulted in large-scale reduction of these areas. A similar situation exists in Europe, to an even greater extent in some areas, and as a result, British lowland heath has come to assume international status as a rapidly diminishing habitat and landscape type. The decline of this habitat type in western Europe led the Council of Europe in 1977 to issue Resolution (77)5 which urges Member States with heathland to recognise its uniqueness and cultural value and to formulate policies to protect remaining areas. This is to take place particularly in those areas where heathland is disappearing and is no longer managed in a traditional way. In order to implement such a resolution successfully, or to provide a

framework for SEA of the habitat, it is necessary to understand both past and present threats to the habitat.

## 6.4 THREATS TO LOWLAND HEATH

Historically there have been many forms of threat to lowland heaths. Much of the traditional use of the habitat, i.e. grazing, has been abandoned and replaced by a number of other land uses which has both reduced the total cover of lowland heath and increased the degree of fragmentation. Afforestation and the conversion of heathland to farmland in particular have resulted in a direct loss of the habitat, and in some areas, notably the Bournemouth/Poole conurbation, urban development has also resulted in severe losses (Therivel *et al.*, 1992). The following is a brief synopsis of the threats to lowland heath. It is important to note that their relative importance varies with the location of the heathland and the nature of the development.

### 6.4.1 Afforestation

Although now no longer a direct threat, large sale afforestation of lowland heath has taken place in the past, mainly involving the planting of alien conifers, although some schemes have planted broadleaves, as in the case of the New Forest. A great many heathland systems (such as Windsor Forest on the borders of Surrey and Berkshire) have been lost to conifer plantations (Webb, 1986). Once these plantations establish then the situation is made worse because any remaining heath adjacent to the plantation may be colonised by seedlings of the parent conifers. My observations suggest that this encroachment is often unchecked, possibly because the timber is of economic value, whereas heathland is regarded as having no economic value. Today it is this self-seeding of conifers which forms one of the greatest threats to remaining heathland sites.

### 6.4.2 Agriculture

Lowland heath is not now directly threatened by loss to agriculture except in the most isolated of situations. However, there is a risk that nutrient enrichment of heathlands from fertilizer run-off is occurring. This is unsatisfactory because it speeds the rate of encroachment of scrub. Other agricultural practices, such as the spraying of insecticides and herbicides, may prove deleterious because spray drift from agricultural land adjacent to

heath may occur. Particularly vulnerable are the fragmented islands of heathland surrounded by farmland and forestry.

### 6.4.3 Urban development

Lowland heaths increasingly suffer from the encroachment of urban development, and many losses have occurred despite protective mechanisms such as Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNRs), Local Nature Reserves (LNRs) and Green Belt designation. For instance, developments which fall within the planning process, and are often regarded as being of national importance, receive planning permission despite their impact on heathland. An example of this is national government policy for road construction and improvement schemes. Much lowland heathland has been nibbled away or fragmented through the lack of strategic assessment of road networks (Therivel *et al.*, 1992). This includes the severance of Chobham Common by the M3, Esher Common by the A3, and the quartering of Wilsey Common by the A3-M25 interchange, adding to the destruction of lowland heathland in Surrey (NCC/SCC,1988). Further problems are being experienced on those areas of lowland heath which have existing planning permission under the Interim Development Orders (IDOs) put in place before any of the previously stated protective mechanisms were imposed. An example of this is the SSSI at Upton Heath in Dorset which has an IDO covering 50 ha of the heath (Pearce, 1993).

### 6.4.4 Other types of development

The energy sector provides similar examples of developments causing potential problems to lowland heath, such as the routing of pipelines and overhead transmission lines. These are generally regarded as being essential to the national interest, however, they may be directed through lowland heathland, often as a result of a lack of alternative land availability in highly built up urban areas. Demand for nationally important scarce resources also threatens lowland heath. For example, the very scarce ball clay found only under the Dorset heath at Purbeck will result in heathland destruction if extracted (Waldon, 1992, *pers comm.*).

Changes in housing policy at both central and local government level have resulted in areas of heathland being sold off for development. The provision of housing development results in direct loss of the heath and indirect loss due to degradation at the periphery of the development site where heathland vegetation is present. This can often be quite

extensive due to increased use by the home owners adjacent to the site. Despite concern from a number of conservation bodies, and a general understanding of the rarity and fragility of heathland, the problem of lowland heath degradation and removal still remains with the regular appearance of development proposals.

### 6.4.5 Neglect and lack of management

Most heathland in lowland Britain owes its origin to human activity in Neolithic and Bronze-age times (Cadbury, 1989), and similar management is required if the heathland is to maintain its wildlife value. There are examples of positive management practices in most counties. For example, Hampshire County Council has published a document on heathland with the purpose of drawing attention to the extent of heathland and its value to the people of Hampshire (Hampshire County Council, 1989). This document recognises that the heathland area in Hampshire is shrinking. Similar publications are "A Strategy for Surrey Heathlands", published jointly by the NCC and Surrey County Council (NCC/SCC, 1988), "Action for Staffordshire Heathlands" (Drewett, 1991), and a "Survey of the Lowland Heathland of Staffordshire and the West Midlands County" (NCC West Midlands/Staffordshire County Council, 1985). The factor which restricts heathland management is the high cost associated with the labour intensive nature of heathland conservation. The former NCC specialist on lowland heath, Lynne Farrell, estimated in 1991 that around 50% of lowland heath SSSIs are in need of management (Farrell, 1992, *pers comm.*).

## 6.5 CONSIDERATIONS IN THE FORMULATION OF SEA PROCEDURES FOR LOWLAND HEATH

Lowland heath is an ecologically important but rapidly diminishing habitat. There is a need for developers and planning authorities to view it in its entirety and not as individual tracts in different counties. A co-ordinated approach based on SEA would allow information regarding heathland to be brought together and used to safeguard the remaining heathland sites, both in the main heathland rich areas and the fragmented outliers.

Lowland heath is utilised in a variety of ways now that the traditional management has virtually disappeared. It is important that those individuals and organisations primarily concerned with the management and use of heathland are identified as a first step to

removing the threats listed above. Those most responsible for the management and/or use of lowland heath are:

- the Ministry of Defence which owns large areas of heath, particularly in Hampshire and Surrey;
- the Forestry Commission which in 1989 began a review of its conservation policies for the Dorset Heath;
- the extractive and waste disposal industries (particularly sand and gravel and British Gas);
- local authorities; and
- national and local conservation bodies;

## 6.6 CURRENT POLICIES RELATING TO LOWLAND HEATH

In the post-war years there has been more official recognition of the importance of lowland heath than previously. In this section I discuss international and national policies relevant to lowland heath.

### 6.6.1 International policies

In 1977, the Committee of Ministers of the Council of Europe adopted resolution 77(5) on the Conservation and Management of Heathlands which urged member states that still have heathland to recognise the uniqueness and cultural value of this habitat, and to formulate policies to protect the remaining areas. It recommended that the governments of the Council of Europe should:

> "Contribute to the establishment of the European network of biogenetic reserves... by proposing typical, unique, rare or endangered sites or entities belonging to the heathland ecosystem in the various biogeographical areas it covers"

For regions where heathland is disappearing, or where it occupies only residual areas, the resolution suggested that Member States:

- "Protect the last fragments [of heathlands] either by incorporating them in the national network of nature reserves or by seeking to ensure that, in the course of physical planning, they are not subject to undue destructive measures";

- "Apply to such protected areas conservation and management measures to prevent spontaneous afforestation or deterioration through ageing, uncontrolled fires, soil erosion, eutrophication, excessive grazing and public access".

In 1979, the Convention of the Conservation of European Wildlife and Natural Habitats (the Berne Convention), to which the UK government is a signatory, was drawn up by the Council of Europe. This convention seeks to conserve wild flora and fauna in their natural habitats. It gives protection, *inter alia*, to certain species that are strongly associated with lowland heathland in western Europe: the sand lizard, the smooth snake, hobby, nightjar, woodlark and Dartford warbler.

Also in 1979, the EC Directive on the Conservation of Wild Birds (79/409/EC) placed an obligation on member states to take special measures to conserve the habitat of birds listed in Annex 1 (lowland heath associated birds listed are nightjar, woodlark and hobby) and to designate the most suitable areas as Special Protection Areas (SPAs). It is envisaged that SPA designation will be useful in that it will give added protection to lowland heath areas. For example, English Nature Southern region aim to designate the Surrey/Bucks./Hants. heaths as SPAs (Long, 1993, *pers comm.*).

### 6.6.2 British government policies

The Wildlife and Countryside Act of 1981, as amended in 1985, gave the NCC (now English Nature (EN), Scottish National Heritage (SNH), and the Countryside Council for Wales (CCW)) powers to notify land which, in their opinion, is of special interest by reason of any flora, fauna, geological or physiographical features, as Sites of Special Scientific Interest (SSSI), thus affording it some protection. This has proved an important piece of legislation for lowland heath because much of this habitat has been designated as SSSI.

SSSIs are notified under Section 28 of the Act which confers on them a statement of scientific value, but does not carry prohibitive powers. EN, SNH, or CCW then provide the landholder with a list of Potentially Damaging Operations (PDOs), and the landowner must inform them of intent to undertake any PDOs on the site. They then have 4 months to respond. Under Section 15 of the Countryside Act 1968, management agreements can be reached between the landholder and the NCC for refusal to permit a PDO on the land, however, this effectively compensates the landowner for not doing something (Rowell, 1991). The following safeguards were added on 2 January 1992 by DoE Circular 1/92.

- Planning permission will be required for all use of land in SSSI's for war games, motor sports or clay pigeon shoots.

- Local planning authorities will be required to consult with EN or CCW before deciding on planning applications in areas adjacent to SSSIs.

These additional safeguard measures are welcome for the conservation of heathlands. Time will tell how successful they are. However, SSSI legislation is flawed in that it relies upon the goodwill of landowners to respect the special interest of the site in order to safeguard it. A further problem is that the criteria which determine whether a site is an area of special interest are too rigid, thus preventing large-scale protection on all but the most contentious and high profile areas. Pearce (1993) summed up the role of the SSSI system as "a largely passive role for conservation, restricted to activities on the site itself and to preventing new developments. The system cannot control outsiders, or insist on better than existing land management. It does not supersede old planning consents, and lacks a means of preventing parliamentary bills, or the determination of central government from pushing through development projects".

## 6.7 PROBLEMS IN APPLYING SEA TO LOWLAND HEATH

If SEA, rather than project based EA, is to be applied to those developments potentially impacting on lowland heath then there are a number of important issues to be considered. The following is a synopsis of these issues.

### 6.7.1 Databases and maps of lowland heath

There is no central database on lowland heathland. At present it is difficult to obtain information on the distribution of lowland heath, other than on a sub-regional level, because most information is collated on a county basis.

Some information is held by various environmental non-governmental organisations but there appears to be no central data source. For example, the Royal Society for Nature Conservation has no national policy on heathland, and although some county wildlife trusts have good information at the county level, the quality of the information is not consistent. Consequently, acquiring information on a national basis for heathland is both difficult and time consuming. However, a fundamental aspect of SEA is the need to consider the potential impact of a policy, plan or programme at a regional, and preferably, national level. In terms of applying SEA to an endangered habitat, the provision of a centralised database containing standardised information is essential. The need for national data was recognised by many of the organisations I contacted, but many assumed that "someone else" was in possession of such data.

I contacted five major conservation organisations (RSPB, World Wide Fund for Nature UK, Institute of Terrestrial Ecology, National Trust, Council for the Preservation of Rural England and English Nature) but failed to discover a map detailing the distribution of British lowland heath. Information is available for counties which have large amounts of heathland, but not for those with small amounts of heathland. Furthermore, the quality of information appears to vary, e.g. Bedfordshire, which has a small area of lowland heath provided me with good 1:10,000 heathland boundary maps, whereas the Devon Wildlife Trust provided only a very basic map of lowland heathland in the county on a 10 $km^2$ grid basis. They suggested contacting English Nature or the RSPB. Cornwall Wildlife Trust are mapping the county from aerial photographs. They are also able to provide good 1:10,000 Ordnance Survey maps of lowland heathland, but are unable to provide a summary map for the whole county.

English Nature is collating this information using the Phase 1 survey method for habitat classification, but there are gaps. For example, Kent County Council is aware that there is some lowland heathland in the county, designated as a Local Nature Reserve, but they have not yet undertaken the Phase 1 habitat survey, and are unsure of the extent of the heathland. I was told by that county council that lowland heathland is not identified specifically in their Structure Plan.

My discussions with the various conservation organisations revealed disagreement regarding the definition of lowland heath. The RSPB, as previously stated, roughly define lowland heath as *Calluna* dominated vegetation occurring at altitudes of less than 300 m above ordnance datum. This definition is problematic in that tracts of the "Flow Country" in the north of Scotland would fall within that description, and this area cannot be considered lowland heath. I would define lowland heath in terms of the vegetation/substrate association, i.e. *Calluna* and *Erica* species found on sand and gravel. This definition would not provide a total solution because it would not include the "wet heaths"

**6.7.2 Environmental assessment of projects affecting lowland heath**

I examined 250 environmental statements to determine how many were directly concerned with lowland heath. Ten (4%) were for developments predicted to directly affect this habitat. Of these ten, five sites were designated as either part or whole SSSI. Interestingly, all of the development proposals which affected SSSIs were for either road/rail or energy developments, i.e. those for which there are government policy statements regarding their need. This provides further evidence that designation does not guarantee site protection. The low number of developments affecting lowland heath may reflect the success of the conservation organisations in opposing developments on this habitat type, or the general perception by developers that heathlands are "no-go" areas.

The statements examined were of poor quality considering that they concerned such an important habitat type. Several failed to provide the most basic of details, such as the size of the area to be developed. None gave any detailed ecological information regarding the habitat requirements of the heathland species possibly under threat or mentioned the need for the identification of key species sites. The international importance of the habitat type, and legislative obligations to conserve it, were not mentioned.

### 6.7.3 Considerations when applying SEA to lowland heath

The presence of designations on lowland heath proved to be a problem when I was exploring the possibility of applying SEA to lowland heath. Over 90% of the heathland is designated as SSSI and is therefore subject to a level of protection, but what of the remaining areas, especially the outlying fragments? There are areas of heath which have limited floristic and faunistic interest and have therefore remained undesignated; these I was able to locate from discussions with county wildlife trusts. Their lack of wildlife value may be due to reasons such as bad management, being outside the range of the classic heath species and being too small to support a viable population of the classic heath species. Despite these deficiencies they are still lowland heaths with the potential to regain their wildlife value. Areas of heath which fit some or all of these descriptions may well benefit from the recent EC Habitats Directive (Council of the European Communities, 1992) in that it is the habitat which is being considered and not its component species. However, at the time of writing there are no proposals for UK implementation of this Directive.

Several schemes have been proposed affecting sites which are potential candidates for various designations, e.g. the Lyndhurst by-pass, which runs through the New Forest, is a proposed Special Protection Area. It appears to be much easier to protect those areas already designated than those for which designation is proposed. Given the long periods of time which elapse before site designation is achieved, particularly for the European/International ones, it may be that the application of SEA to a habitat type is an essential, though very difficult to implement, requirement of the planning system.

Ownership of heathland may cause problems when considering SEA of lowland heath. The Ministry of Defence, as an owner of substantial amounts of heathland, extensively consults the statutory and non-statutory bodies However, it is in a period of flux and might substantially increase or decrease its use of the heathland it owns, or possibly sell some. Both of these possibilities could have severe implications for the well-being of large tracts of heathland. It is desirable that any plan or policy put forward by central government should take into account its effects upon the whole of a habitat type, rather than consider only localised impacts.

If the SEA concept were applied to all potentially damaging development programmes then there would be no need for the habitat based approach. As this is unlikely to occur, it is

important to pursue further the SEA concept. There is a need to assess all development programmes in terms of how they fit in with habitat specific policies. These need to be formulated, a process which should take advantage of any forthcoming legislation which moves away from the individual project approach to EA (SEA, 1991, & Habitats Directive, 1992). Any proposed development programme affecting a habitat type must take into account the effects of other proposed and existing programmes via an interactive SEA framework such as the one I propose (see 6.5.4). Ideally, programmes should aim for zero ecological impact.

A more general problem is that of public perception of the threats to a habitat. Most of Britain's lowland heath is concentrated in the south and southeast of England, with only small outlying fragments occurring elsewhere. There are few direct threats to this heathland, especially in the southwest. The conservation bodies, backed by local authority policy statements in their structure plans, have been successful in opposing the majority of developments likely to affect heathlands. This might give the impression that most heathland is well protected, but the outlying fragments of lowland heath are poorly managed and researched, and therefore possibly under threat. Future developments may well look to these small outlying fragments as potential sites because of the apparent lack of interest in, and concern about, them. It would be desirable to aim for expansion of these outlying fragments. Again this points to the need to review the British lowland heath as a whole.

## 6.8 CONCLUSIONS AND RECOMMENDATIONS

The first step in a comprehensive British lowland heath management programme would be to identify all areas of lowland heath because presently no such information exists. The identification process could involve the following steps.

- Agree on a definition of lowland heath which is both simple to use and which, if adhered to, will not underestimate the amount of lowland heath.

- Use this definition to determine the areas of lowland heath by utilising all existing information sources held (EN, Joint Nature Conservation Committee, Institute of Terrestrial Ecology, RSPB, local wildlife trusts and local authorities).

- Alert local authorities to the importance of any lowland heath that they have in their county, and propose specific policies for their protection within the structure plan.

- Map all of these areas, initially onto 1:10,000 Ordnance Survey maps, and then onto a more sophisticated system such as a Geographic Information System (GIS). These systems utilise computer programmes to collect, store, manipulate and analyze spatially referenced digital data (Treweek & Veitch, 1994). By overlaying different sets of data, such as heathland areas and a proposed road, it is possible to identify and analyze potential interactions.

- Establish a periodic monitoring programme to review and update the mapping information.

This will document the extent of all lowland heath remaining in Britain, allowing guidelines to be drawn up regarding future management as well as aiding monitoring of its effectiveness of any SEA. The GIS will help with predictions of development proposal impacts on heathland. Many local authorities are either already in possession of a GIS or are considering using such a system. This means that they will be able to utilise any centrally held habitat information source.

In parallel with the establishment of this information source, a national heathland umbrella group could be established. This would comprise all the organisations with an interest in lowland heath e.g. RSPB, World Wide Fund for Nature, county wildlife trusts etc.. It would

- establish a commonly agreed definition of lowland heath;

- set objectives for the management of lowland heath;

- provide advice and draw up guidelines for managing the heathland resource;

- identify areas of former heath by consulting historical mapped information (via a GIS system) which are suitable for restoration;

- co-ordinate any specialist advice available; and

- ensure that the umbrella group's objectives are met regarding the resource.

This will facilitate the determination of the importance of heathland at the regional level, and allow a national overview of the habitat. Major objectives would be the conservation of all areas of lowland heath and the expansion/linking up of areas, especially the fragmented "islands. These broad based objectives would be achieved by

- a moratorium on all development likely to directly affect heathland, including agriculture, drainage schemes, road building, forestry and urban growth;

- the development and application of guidelines for activities which have detrimental effects on heathland, such as the use of fertilisers and pesticides on adjacent agricultural land;

- a compensation system for the landowners affected by the above;

- strengthening of the SSSI regulations to prevent any form of detrimental development activity, not merely presenting developers with a situation which can be overridden; and

- identification of those areas of lowland heath not designated as SSSI. Some of these are still very important sites and may not have received designation for a number of reasons, such as lack of English Nature funding/manpower or limited floristic or faunistic value compared with other heaths. These outliers provide the baseline resources for the restoration/expansion of heath in lowland England, and should be afforded primary protection.

Overall, SEA related to any habitat should consider the following actions.

- Establishment of the range, both existing and potential, of the habitat.

- Establishment of the global, national, regional and local importance of the habitat.

- Identification of the interest groups for this habitat, and formation of an umbrella group to advise and co-ordinate activities which affect the habitat.

- Establishment of the objectives of a management strategy based on scarcity and importance of the habitat, both nationally and regionally.

- Illustration of the significance/importance of the habitat, especially to the public.

- Use of the management strategy to enhance sectoral and regional SEAs.

- Monitor the effectiveness of the above and update as required.

Problems are likely when applying SEA to sectors where habitats and habitat management are constraints. One of these stems from public perception of a habitat such as heathland. Often a proposed development is not seen as problematic because of a lack of appreciation of the ecological value of the habitat.

I conclude that it is very difficult to apply the SEA concept to a habitat. It would be better to apply SEA to the impacting developments, either sectorially or by region. The receiving environment should be protected through the use of management plans which act as constraints and provide objectives for SEAs of sectors and regions.

# Chapter 7

# THE APPLICATION OF STRATEGIC ENVIRONMENTAL ASSESSMENT TO COASTAL ZONES

## 7.1. INTRODUCTION

The UK has more than 15,000 km of coastline, 48 counties border the coast and there are approximately one-third of a million $km^2$ of territorial waters (Gubbay,1990). English Nature (1992) define the coastal zone as land (and inland water) subject to direct marine influences, together with the foreshore and inshore waters extending seawards to three nautical miles. The coastal zone is important to nature conservation; 7,800 $km^2$ of land and intertidal water have been notified as Sites of Special Scientific Interest (NCC,1991). The coastal zone is subject to a lot of pressure from both economic and amenity points of view. Because of this, I suggest that there is a need to view the coast as a whole and to implement a system of national strategic planning for the coastal zone. This will allow the adoption of an integrated management approach which recognises the complex nature of the resource, its dependent species and human needs.

For many years there has been growing concern for coastal areas, both ecologists and conservationists having noted the deterioration of this varied habitat, much of it directly linked to development pressure. Rothwell (1991) noted that twenty years previously the Countryside Commission reviewed the topic of coastal development and preservation and that many of the problems which they identified still remained, and in a good many instances were worse.

The Countryside Commission made a number of recommendations in their 1970 review (Countryside Commission, 1970). These included a call for a national coastal strategy and local development of coastal zone management plans, both of which have been ignored. These recommendations were repeated in a subsequent piece of research (Gubbay, 1990) undertaken for the Marine Conservation Society and the World Wide Fund for Nature UK (WWF). This work suggested that a national perspective was important to allow strategic planning. The only part of the recommendations to be acted upon has been the concept of Heritage Coastline, a non-statutory designation. Reports from both Government and the non-governmental organisations (RSPB, 1991; Davidson *et al.*, 1990; Rothwell & Housden,

1990) show that coastal management practices are poor and there is a need for co-ordination and guidelines. The only response from government has been the promise of a Planning Policy Guidance Note which is at the draft stage at the time of writing. For the foreseeable future, development seems destined to go ahead in piecemeal fashion without any checks. The main problem is the Department of the Environments's unwillingness to bring together conflicting and overlapping interests. Local authorities are powerless to control activities on their coastlines and require strategic guidance as to their position and approach to coastal development (Therivel *et al.*, 1992).

## 7.2. THE ECOLOGICAL IMPORTANCE OF THE BRITISH COASTLINE

The British coastline is particularly special because of its location; temperate, Lusitanian and Arctic species can all be found along it. The types of habitats associated with the coast are many (saltmarsh, intertidal flats, sand dunes, vegetated shingle, saline lagoons and maritime cliff grasslands) (English Nature, 1992). Each of these habitats has its own characteristic assemblage of plants. Forty-eight nationally rare and sixty-five nationally scarce plants are found in the coastal zone (English Nature, 1992). These habitats provide refuges for rare animal species such as the avocet (*Recurvirostra avocetta*), roseate tern (*Sterna dougallii*) and natterjack toad (*Bufo calamita*), and for nationally/internationally important populations of waders and wildfowl, such as dark-bellied brent goose (*Branta bernicla*), barnacle goose (*Branta leucopsis*), sanderling (*Calidris alba*) and turnstone (*Arenaria interpres*). The importance of these areas to birds in particular cannot be over emphasised. British seabird colonies are of global importance. Of the 261 Internationally Important Bird Areas (IBA's) present in the UK, twenty-eight qualify because they hold over 1% of the world population total of that seabird species, and 61 IBA sites qualify because they hold over 1% of the EC population total for that species (RSPB, 1991).

Concern over the coastal zones has been increasing over the last decade. Several incidents have been the focus of recent controversy, namely land claim on the Ribble and the Wash estuaries, the Felixstowe dock and Cardiff Bay barrage developments (Therivel *et al.*, 1992), and the possible implications of sea level rises as a result of global warming. From my discussions with the interested parties (National Trust, WWF, RSPB and Marine Conservation Society) concerning coastal development schemes I have concluded that too

many other forms of coastal development, for which no cumulative impact predictions have been made, are being proposed

### 7.2.1 Estuaries

British estuaries are important because they are an internationally important habitat type (English Nature, 1992; Gubbay, 1990; Rothwell & Housden, 1990). Britain has more estuarine habitat than anywhere else in Europe (Davidson *et al.*, 1991). Estuaries are among the most biologically productive ecosystems in the world. Their intertidal mudflats harbour a variety of invertebrate species, often in very large numbers (Rothwell & Housden, 1990). They are an abundant habitat type in Britain because of the large tidal ranges, warm seas, mild winters and the heavily indented shoreline, all of which provide ideal conditions for the formation of estuaries (Rothwell & Housden, 1990). In both European and world terms, British estuaries are important areas for a number of species of birds which gather in large numbers to exploit the food resource provided. Gubbay (1990) put forward a strong economic argument against estuarine development when she stated that "many commercially exploited fish stocks use UK estuaries as nurseries (plaice and sole particularly) and these areas substantially contribute to the North Sea being the most profitable sea in the world".

British estuaries form vital links between the breeding and overwintering grounds of migratory waders and wildfowl. Of the 155 recognised estuary sites in the UK, 68 qualify for designation as Ramsar sites under the Ramsar Convention (HMSO, 1971), or as Special Protection Areas (SPAs) under the EC Directive on the Conservation of Wild Birds (EC, 1979). These designations place stringent obligations upon the signatories to protect these important wild bird sites.

Because of the importance of estuaries to wading birds and wildfowl much research has been undertaken to determine actual numbers and percentages of populations using the habitat ( Allport *et al.*, 1986; Goss-Custard & Moser, 1988; Mitchell *et al.*, 1988; Moser, 1988; Owen *et al.*, 1986; Prater, 1981). In January 1989 a peak total of one and a half million wading birds were recorded as using estuaries to feed and roost. This accounts for 40% of the total population in the whole of north-west Europe (Salmon *et al.*, 1989). The same authors also stated that 43 UK estuaries each hold over 10,000 wading birds in winter.

Estuaries are important for a number of individual species. For example, 63% of north-west Europe's knot (*Calidris canutus*) spend the winter on UK estuaries, and the Wash alone supports 25% of the knot population which breeds in Greenland and Canada (Rothwell & Houseden, 1990). Mitchell *et al.* (1988) reported that knot were in substantial decline on the Dee estuary, whilst Rothwell and Housden (1990) reported that the bird's average wintering population was 27% lower than 25 years previously. Conversely, the grey plover (*Pluvialis squatarola*) is exhibiting a long-term increase in its winter numbers. In 1988 overwintering numbers were three times those of the early 1970s, and numbers had stabilised in some southern estuaries indicating that they were "full" (Moser, 1988). The shelduck (*Tadorna tadorna*) has increased steadily since the 1960s, but this change hides spectacular changes within the UK (Rothwell & Housden, 1990). Populations in Scotland appear to have fallen by up to 40%, but those of the Dee and Mersey have generally increased (Owen *et al.*, 1986).

### 7.2.2 Habitat loss

Estuarine habitat loss has been widespread both in Britain and worldwide. For example, in France 40% of the coastal wetlands of Brittany were lost between 1968 and 1988 and in the USA 54% of all wetlands have been destroyed since colonial times (Maltby, 1988). In Britain about 32,000 ha of fenland on the Wash have been claimed for agriculture since Roman times (Doody & Barnett, 1987).

Habitat loss has been implicated in the steep decline of the dunlin, *Calidris alpina* (Rothwell and Housden, 1990). In this instance the loss has been attributed to the spread of *Spartina* which has caused the birds' feeding areas to dry out and therefore a consequent loss of invertebrates. This decline has not been noted elsewhere in Europe where inter-tidal land has not been lost (Goss-Custard & Moser, 1988). This has been exacerbated by built developments affecting the upper shore and consequent loss of mudflat. Similar losses are occurring in coastal regions in the south-east of England which have the added problems of natural subsidence and the possibility of rising sea-levels, both of which reduce the extent of inter-tidal land (RSPB, 1991).

## 7.3 THREATS TO COASTAL ZONES

There are many threats to coastal zones, and particularly estuaries. A recent survey carried out by the RSPB (Rothwell & Housden, 1990) concluded that, of the 123 estuaries surveyed (80% of the UK total), 80 were under some degree of threat, with 30 in imminent danger of permanent damage. The range of threats was large but recreational pressures, marinas, pollution, land claim and barrage schemes were identified as causing large-scale problems. Some of the impacts are irreversible and seriously reduce the amount of inter-tidal habitat. There have been many large-scale losses of inter-tidal areas in the past, notably the reduction of the Tees estuary by around 90% in the last 100 years (Rothwell & Housden, 1990). The 82% loss of mudflat in the estuary led to serious declines in populations of redshank (*Tringa totanus*), curlew (*Numenius arquata*), bar-tailed godwit (*Limosa lapponica*) and knot (*Calidris canutus*) (Prater, 1981). Many types of estuary development are small and scattered in comparison with those above, but they still have the overall effect of causing habitat fragmentation and large cumulative habitat losses.

The ecological consequences of estuarine development can be large. Any significant loss or alteration to the estuarine habitat means that the diversity and biomass of the invertebrates present will decrease. Food chain effects of these food sources will affect both wading birds and fish.

The problems the British intertidal areas are experiencing are exacerbated by the number of government departments, statutory bodies and agencies which have responsibilities in coastal areas. When the other interested parties, i.e. virtually every conservation organisation and representatives of the recreation and amenity users of coastal areas, are added to this list then the scope for confusion and duplication over the objectives for wise use of the resource becomes apparent. Designations appear to be ineffective in safeguarding sites because many estuaries recognised as internationally important wildlife sites are still being subjected to development pressures, e.g. the Felixstowe Dock and Railway Act (1988) destroyed part of the Orwell estuary, a SSSI and candidate SPA/Ramsar site, and the Cardiff Bay Development Corporation's proposal to permanently flood the Bay will also destroy a SSSI which is a candidate SPA/Ramsar site (WWF, 1992). This points to a the need for a radical change in the way in which coastlines are managed. A national strategic planning framework would result in an overall management plan for the coast and would do away with the current piecemeal way of dealing with

development proposals. A possible way forward would be for the Department of the Environment to be the co-ordinator for coastline management. It would then be asked to look at existing systems of integrated coastal zone management, such as the Californian system (California Office of Planning and Research, 1986), and, if appropriate, use them as models for a British approach. Ideally a new government department responsible for coastal issues should be established (Rothwell & Housden, 1990).

### 7.3.1 Barrage schemes

There are a many types of potential developments which have varying degrees of ecological impact. Perhaps the most controversial are the barrage schemes. By 1990, 22 estuarine sites had been the subject of preliminary investigation for barrage construction (Rothwell & Housden, 1990). Barrages fall into two basic categories; permeable and impermeable. Impermeable barrages are those which are intended for recreational purposes to produce static water on which to conduct water sports or to provide aesthetically pleasing views for waterside developments (Therivel *et al.*, 1992). Little is known about this type of barrage and their likely impact, yet proposals are under consideration for the Taff/Ely estuary and also for the Truro River (Rothwell & Housden, 1990).

Better known are the permeable barrages used to generate tidal power, especially the Mersey and Severn proposals. On the Severn, £5 million has already been allocated for advanced studies for a proposed 17 km barrage linking South Glamorgan to Somerset, whilst a £400,000 research project on the Mersey is under way (Cadbury, 1987). Both research projects can be interpreted as clear indications of the government's commitment to this form of power generation. Altogether there are nine sites currently under review for tidal barrage schemes.

The different types of barrage produce different types of impacts. The impermeable barrage schemes remove all tidal movement, keeping water at the high-tide level. This effectively removes all the intertidal feeding areas which were once present. The permeable barrage schemes still leave an inter-tidal regime, but in a much reduced or modified form. This adversely affects the estuarine ecosystem in the following ways:

- The feeding area is greatly reduced and so the site cannot support the numbers of bird and fish it did before the barrage was constructed.

- With a lowered high water level there is encroachment of terrestrial vegetation and consequently a reduced estuarine feeding area.

- Many schemes involve holding the water for time periods longer than that of the normal tidal regime, i.e. the tide is not allowed to recede naturally. This means that water is covering the intertidal areas for long periods and therefore reduces available feeding time and area.

- The upper reaches of saltmarshes are not reached by the sea. This lack of flushing can cause pollution problems and does not fetch any of the seeds produced by the saltmarsh vegetation into the feeding zone of the birds and fish.

- There are substantial changes in the rates of erosion and sedimentation which take place.

- Problems occur with altered salt levels because incoming river water will not be allowed direct access to the main body of the sea and will result in a substantial lowering of salinity.

(Adapted from Rothwell & Housden, 1990).

Conservation organisations, e.g. RSPB and WWF, have put forward several arguments against employing tidal power barrages (RSPB, 1991; Rothwell & Housden, 1990; WWF, 1992). They argue that the conservation value of the areas affected cannot be overstated and that they constitute a natural asset of worldwide importance. Some argue that even if all the proposed schemes went ahead they would still only produce around 10% of the UK's total energy requirement, whilst estimates indicate that energy conservation measures, if employed fully, could result in savings of 40-57% (Rothwell & Housden, 1990). Barrage schemes are very expensive and the cost of them would have to be met by the taxpayer because estimates indicate that they are a poor investment and unlikely to attract private sector funding (Stoney, 1989). A simpler solution to the current energy problems is a strong commitment to energy conservation measures which may well assist in saving some, if not all, of these important wildlife sites.

### 7.3.2 Industrial expansion

Historically, coastal areas in general, and estuaries in particular, have been associated with heavy industry. This has resulted in about one third of all British intertidal estuarine habitat and about half the saltmarsh area being claimed since Roman times (Thornton & Kite, 1990). Traditionally, industry has centred itself in these areas for a number of reasons, one of them being access to a free method of disposing of waste products by simply discharging them into the sea or river. Today, levels of industrial discharge are under tighter control than they were 20 years ago, but many water bodies still bear the scars of years of uncontrolled discharge; the Mersey, Tees, Thames and Taff rivers with substantial estuarine areas, are still heavily polluted (Therivel *et al.*, 1992). Several pollution incidents have occurred along prime estuary sites. In the late 1970s hundreds of birds were killed in the Mersey after having ingested organic lead from one of the petrochemical works lining the estuary. Also, the Mersey and Southampton Water have been subjected to oil spills (Rothwell & Housden, 1990).

It is likely that industrial expansion on all major estuaries will continue. Recently there have been substantial losses of estuarine habitat, despite site designations and the EIA regulations which should serve to protect these sites. The losses at Lappel Bank on the Medway and at Felixstowe docks on the Orwell are indications of a worrying trend for British estuaries. Land claim of one form or another is a problem, whether it be for industrial expansion or to waste disposal. The Nature Conservancy Council found in 1989 that at least 50 UK estuaries were subject to at least one proposal involving land claim (Davidson *et al.*, 1990).

### 7.3.3 Recreation pressures

Recreation pressures are increasing on estuaries as more people with increased leisure time are becoming interested in water based pursuits. Activities such as small vessel sailing (yachts, dinghies), windsurfing and jet-skiing, are all increasing (Sidaway, 1991). These activities threaten wildlife because of the disturbance they cause. Birds are particularly affected by disturbance because they are heavily reliant upon undisturbed feeding. If they are to survive the cold weather during which they are present at these sites in their greatest numbers, it is vital that the birds remain undisturbed.

Of particular concern are marina developments. The increased ownership of small sailing vessels has resulted in more demand for marina facilities. There are 154 marinas in

estuaries around the UK, with a further 78 proposed (Davidson *et al*, 1990). The problem is worst along stretches of coast in the south and south- east of England where these facilities are concentrated. This form of recreation is increasing rapidly, and although it is difficult to forecast accurately, it seems likely that demand will increase by 40-50% by the year 2000 (Sidaway, 1991). With this sort of increase it must be asked where the new facilities are to be situated and to what extent the existing ones can be allowed to expand, if at all.

### 7.3.4 Coastal defence works

In December 1991 a review of flood and coastal defence was undertaken by the Ministry of Agriculture Fisheries and Food (MAFF) to look strategically at the environmental and conservation aspects. In this review the minister announced government intention to develop a national strategy for flood and coastal defence which would be based on the best scientific understanding available and would rely heavily upon positive liaison with conservation bodies and operating authorities (MAFF, 1991).

Coastal defence has in the recent past received increased attention because of the possible implications of sea level rises, and because there has been increased flooding and breaching of existing coastal protection works, especially during the winter of 1990. Government policy on possible sea level rise climatic change has been to outline a strategy which will:

- refurbish defences to reduce existing risk;
- continue research into river and coastal processes;
- monitor trends in climate, sea level, waves, beaches and saline intrusions;
- utilise current predictions of sea level in a review of existing standards; and
- keep policy and "best practice" under review as understanding of sea level trends, surges and weather patterns develops.

(MAFF, 1991a)

Within this document it is stated that "the review will take a strategic view of the general aims and operation of policy to see whether anything more is needed to ensure that the concerns of flora, fauna, landscape, wildlife and birds are being properly taken into account".

Coastal defence works have a major impact upon the flora and fauna in the vicinity and although guidance exists (Department of the Environment *et al.*, 1982) on fulfilling statutory duties there is still a long way to go before it can be considered satisfactory. The guidance was produced prior to the current EIA regulations and today new schemes are sometimes subject to these, possibly resulting in better consideration of the ecological implications of the scheme than previously. However, it is difficult to ascertain the impacts of a coastal development on its seaward side and so this element does not figure in any of the ESs reviewed. I recommend that for coastal developments the landward and seaward components should be considered together so that the total impact of the development is assessed.

Central government ultimately funds flood defence and coast protection. Grant aid gives priority to those schemes which protect property and people, not flora and fauna. Identification of areas in need of protection from an ecological point of view, yet still in areas which fit the people and property element, are a high priority. This will then allow multi-benefit grant packages to be put in place. Currently, to qualify for grant aid, schemes must be technically sound, economically viable and environmentally sympathetic (MAFF, 1991). From an ecological point of view this is a weak statement and in need of change. On a more positive note, there has been a move towards grant aid for preliminary investigations of coastal protection and flood defence which include feasibility studies. However, whether ecological feasibility of the proposed schemes is included is debatable.

A major problem linked to coastal defence is that of land "claim". The grant schemes which allow the claiming of intertidal areas and coastal grazing marsh for agricultural and development purposes are still in place. This has resulted in extensive losses, especially on the south and east coast of England where the largest tracts were once found. Further problems stem from fragmentation of the marsh habitat, which occurs behind sea walls, because of drainage operations to minimise winter floods and lower summer water levels (RSPB,1991). There is "management" of low lying coastal agricultural land, linked to coastal defence, which has a large potential for ecological damage, e.g. the use of hard

defence walls which totally exclude the area behind the sea wall from inundation, lock up cliff sediments and increase beach loss due to increased hydraulic performance of the sea walls (English Nature, 1992). Without statutory obligations to nature conservation for all concerned with coastline development and management, the threat to coastline ecology will remain strong. To rectify this I recommend that all British government agencies and any other bodies proposing policies and programmes which potentially affect the coastline have statutory duties to flora and fauna.

Currently, the MAFF is responsible for sea and coastal defence, and as a result has protected coastline with large agricultural areas. I suggest that the remaining coastal habitats would benefit if the lead role on development related decisions was passed to the Department of the Environment which is already responsible for many matters relating to coastal areas. These include environmental and nature conservation issues, steering of the National Rivers Authority (NRA) and funding the work which goes on at coastal sites via local authority finances. Ideally, this switch would be backed up by greater powers and autonomy given to the NRA to oversee planning for the coastal regions in a strategic manner (Therivel *et al.*, 1992).

In Britain there are a number of former agricultural sites which have high conservation status. This is because accidental, or in some cases deliberate, breaching of the sea defences has resulted in the formation of important wildlife habitats such as coastal lagoons, grazing marsh and intertidal areas. In contrast, there are some coastal areas of high ecological value which are currently threatened by unseasonal flooding or by tidal inundation of freshwater based ecosystems. Areas such as the Norfolk and Suffolk Broads have long been recognised by ecologists for their important freshwater flora and fauna and are in need of protection from saltwater inundation, particularly if the predictions surrounding sea level rises (linked to global warming) prove correct.

Much of the research work on sea level rise is based on predictive modelling. Many different suggestions have been put forward regarding the extent and impacts of any sea level rise. Whatever the extent, sea level rises will result in the loss of both intertidal area and shoreline, both extensively used by a diverse flora and fauna. Wintering waders and wildfowl are particularly threatened. Work by the RSPB (1989) suggested that up to 26 Red Data Book species were threatened by rising sea levels. I believe that the only reliable way to protect these species is through policies and programmes which recognise

the ecological value of the coastal zone and employ defence techniques which will maintain that ecological value.

### 7.3.5 Fish farming

Fish farming is a relatively new industry compared with the more traditional industries based in coastal areas. It provides an ideal example of a development type which should be assessed strategically. Because of the potentially large scale ecological problems the industry may cause, it will be considered separately (see Chapter 8).

## 7.4 ENVIRONMENTAL ASSESSMENT OF PROJECTS AFFECTING COASTAL ZONES

Of the 253 ESs looked at by Therivel *et al.* (1992), 35 related to proposed coastal developments. The development types involved were energy (46%), leisure (14%), infrastructure (11%), flood defence (11%), treatment works (11%), heavy industry (3%) and fish farming (3%). It is likely that there will be future increases in the numbers of some of these types of development, but decreases in the numbers of others. Flood defence works are likely to increase due to increasing concern over rising sea levels, but power stations in coastal locations may well decrease if there is a move away from nuclear power to combined cycle gas turbines.

All the ESs reviewed by Therivel *et al.* considered projects in isolation and failed to consider cumulative impacts on the coastline in question. Examination of the geographic location of the proposed developments illustrated the potential problems associated with cumulative impacts. For example, the Dee estuary is now the subject of proposals for a power station, a coal tip development, a road, a river crossing and a flood defence project. This is in spite of the estuary being designated a Ramsar site, Special Protection Area, Site of Special Scientific Interest, Local Nature Reserve and an RSPB reserve. In addition, the Dee estuary can be regarded as part of the coastal complex encompassing the Mersey, the Ribble and Morecambe Bay. Other ESs reviewed were for proposed developments on these locations. A similar picture emerged for the Severn and the Tees.

This review of ESs highlighted three issues. First, ESs should consider the cumulative impacts of proposed developments. The EC Directive on EA requires this, yet there was

no evidence that this was being done. Second, the designations designed to prevent damaging development activities are proving ineffective. Third, strategic environmental assessment would help to ensure that the ecology of this bio-geographical unit is protected.

## 7.5 PROBLEMS OF APPLYING SEA TO COASTAL ZONES

The evidence I have presented indicates the need for a radical change in British coastline management. I suggest that a national strategic planning framework would result in a national management plan for the coast and would greatly reduce the current piecemeal determination of development proposals. In order to produce such a framework certain problems need to be solved.

Before SEA can be applied to coastlines the coastal zone must be defined. At present there is no such definition. The Planning Policy Guidance note on coastal zone protection and planning (HMSO, 1992) defines the coastal zone as "the area extending seawards and landwards from the coastline, where land and marine influences interact". This I consider inadequate because it does not indicate where the coastal zone begins and ends, thus providing developers with a means of challenging local authorities, at planning enquiry, on their interpretation. I suggest that a recognised zone must be agreed which limits the types of development on both the landward and seaward side of the coast. The next priority is the establishment of "no-go" areas designated because of their ecological importance and/or fragility. A report from the Marine Conservation Society to the World Wide Fund for Nature (Gubbay, 1990) suggested that the seaward boundary should correspond with the 12 nautical mile limit of UK territorial waters. This has much to commend it. Inland boundaries are much harder to define because of their administrative boundaries. The Heritage Coast designation uses topography and land-use as major determining factors. This might be extended to include those ecosystems, such as saltmarsh, which are associated with the landward side of coastal zones.

The various uses of the coastal zone must be more clearly defined, possibly by the Department of the Environment. For instance, sea lochs are not only used to produce salmon and shellfish, but are also used for activities such as recreation and tourism, while providing quality habitat for a diversity of flora an fauna. Estuaries are subjected to an even greater diversity of activities. A major aim of SEA should be to identify all users of

the coastline, including the flora and fauna. A regional management plan, which accords to a national coastal management framework, can then be agreed amongst all parties involved so that a balance between their diverse interests can be reached. This sounds simple but in reality may be a time consuming exercise, as in the case of the Dee estuary management plan which took the four District Councils and two County Councils involved ten years to agree. This was achieved only after a lead authority had been appointed (Therivel *et al.*, 1992). The Dee estuary example provides a useful indication of the need for a centrally co-ordinated body to steer the formulation of a strategic environmental assessment framework for the coastal zone.

## 7.6 RECOMMENDATIONS AND CONCLUSIONS

I recommend the following short-term and long-term actions for achieving strategic assessment of coastlines. The short-term actions are concerned with limiting or removing environmental and ecological damage from coast based development immediately, and the long-term actions are concerned with establishing permanent SEA and coastline management.

For the short-term I recommend the following:

- Local authorities should require that environmental statements for proposed developments on coastlines and estuaries consider cumulative and secondary impacts. Attention should be paid to biota in both the landward and the seaward parts of the coastal zone. The impact of development proposals upon these should be considered together not separately.

- Central government should bring under planning control those developments which can have serious ecological impacts, such as marine aggregate extraction, additions to existing coastal defences and agriculture, and which currently are outside the scope of the planning system. ESs should be required for all such developments.

Jurisdiction for these developments should be handed over to the local authority rather than to the Department of the Environment or the Crown Estates Commission.

- Central government should strengthen designations to give them greater weight in decision making. At present they are largely ineffective as a means of protecting wildlife in areas subject to development.

- Local authorities should consider limiting, through their structure plans, those coast based developments which affect key habitat types. Similarly they should consider a phased ban on all development within such areas.

- Central government should adhere to the recommendations of the North Sea Ministers Conference (1990) which advocated the precautionary principle for policies and activities affecting the marine environment. This approach recognises that knowledge about the biology and ecology of marine systems is limited. Ecologists should make accessible information regarding coastal systems and research should be directed at the consequences of current development activities.

For the long-term implementation of SEA I recommend the following:

- Directorate General XI should include a commitment to SEA in all European Directives, present and future, which have a bearing on coastlines.

- Development of a precise, mutually agreed, definition of the coastal zone. Based on this definition research should be carried out to provide an increased understanding of the carrying capacity of coastal zones. A major objective of SEA for coastal zone would be to maintain, and not exceed, its carrying capacity.

- SEA of the coastal zone should consider all stretches of coastline and not just those which are already protected (to some extent) by designations. This will remove the possibility of development focusing on undesignated coastal areas.

- A national agency, possibly the Department of the Environment, should foster links between the British coastal zones SEA programme and local authorities' coastal

management plans. The Planning Policy Guidance note on coastal zone protection and planning calls for co-operation from local authorities over coastal planning issues but gives no indication of how this co-operation is to take place or of central government's role in it. A clearly defined framework for this co-operation, and the funding to achieve it, should be administered by central government.

Reports from both government (House of Commons Select Committee, 1992) and non-government organisations (RSPB, 1992; WWF, 1992; Scottish Wildlife & Countryside Link, 1993) confirm that coastal management practices are poor and that there is a need for co-ordination of the interested parties and for guidelines for achieving integration of interests. The coastal zone is an outstanding habitat type in Britain and SEA provides a means of providing checks on development activities with the potential to damage valuable wildlife sites. Adoption of SEA will lead to the cessation of piecemeal development and will provide a focus for conflicting and overlapping interests in the coastal zone.

# Chapter 8

# THE SCOTTISH ATLANTIC SALMON FARMING INDUSTRY AS A POTENTIAL CANDIDATE FOR STRATEGIC ENVIRONMENTAL ASSESSMENT

## 8.1 INTRODUCTION

The term "fish farming" includes a variety of fin fish and shellfish growing operations. There is particular concern about the potential environmental impacts of caged farming of Atlantic salmon (*Salmo salar* L.) which is concentrated almost entirely in Scottish coastal waters (Scottish Wildlife & Countryside Link, 1990; Warner & Domaniewski, 1993). The issues surrounding this form of fish farming, and its potential as a candidate for SEA, are the basis of the final part of my research.

Marine fish farming is a relatively new UK industry. From small beginnings around 25 years ago it has undergone a rapid expansion and is now considered to be a major rural industry (Therivel *et al.*, 1992). Atlantic salmon farming has outstripped other forms of aquaculture in Scotland in terms of rate, distribution and overall scale (Scottish Wildlife & Countryside Link, 1988). In world terms the Scottish salmon farming industry output is large. In 1991 the total output was 40,593 tonnes, 18.2% of the world output (Food and Agriculture Organisation, 1993). A recent consultative draft from the Scottish Office Environment Department reported that there are 327 leases for salmon fish farms in Scotland, most of which are situated on inshore sea lochs (Scottish Office Environment Department, 1991). The Western and Northern Isles of Scotland produce 38% of the Scottish total of farmed fish and shellfish (Scottish Wildlife & Countryside Link, 1990). The remainder of the production comes from the west coast of the mainland and the Inner Isles.

A major problem for both salmon and shellfish farmers is that of suitable site availability. The requirement of the fish farm industry for sheltered, easily accessible sea lochs, coupled with the industry's large growth, has resulted in the use of all the readily available and least contentious sites. This has constrained the growth of the industry. Scandinavian salmon producers are now looking at the possibility of farming in more exposed deep-water locations, which has the potential to remove many of the environmental impacts

associated with the industry (Mathers, 1993, *pers. comm.*). This does not necessarily mean that all of the problems currently associated with inshore farming will disappear; perhaps for some they will merely be shifted further out to sea.

The expansion in fish farming in Scotland during the last 25 years has resulted in a number of environmental problems (Scottish Wildlife & Countryside Link, 1988; Warner & Domaniewski, 1993). The coastal areas which contain the majority of salmon and shellfish farms constitute the UK's most varied and cleanest tidal coastlines. Little is known about the biology and ecology of marine systems compared with terrestrial systems, and consequently there is a need to adhere to the recommendations of the North Sea Ministers Conference (1990) which advocated a "precautionary principle" for policies and activities affecting the marine environment (Therivel *et al.*, 1992). My discussions with those organisations with an interest in Atlantic salmon farming (RSPB, Marine Conservation Society, World Wide Fund for Nature) highlighted the possibility that fish farming is threatening the environmental quality of inshore sea lochs and jeopardising viable populations of characteristic wild species. Government departments responsible have not provided any guidelines, safeguards or financial assistance to mitigate the industry's potentially damaging activities.

Scottish Wildlife and Countryside Link, in their report "Marine fish farming in Scotland" (Scottish Wildlife & Countryside Link, 1988), assessed the impact of marine fish farming on the environment. They identified the need for improvements in co-ordination of the different arms of government policy, planning within the context of national guidelines, and regulation of fish farm practices based on research, monitoring and advice. Two years later they reviewed the industry and concluded that little had changed in the control framework despite the continued rise in scale and extent of the salmon and shellfish industries (Scottish Wildlife & Countryside Link, 1990). A concern expressed in both documents was the government's reluctance to establish a clear and responsible approach to the protection of the marine environment, putting fish farming and other development types into proper context.

## 8.2 ENVIRONMENTAL IMPACTS OF ATLANTIC SALMON FARMING

Salmon farms have proliferated on the Scottish coast, with output from the industry increasing approximately ten-fold between 1984 and 1991 (Food and Agriculture Organisation, 1993). As a result, almost all mainland sea loch systems are affected by the industry (Scottish Wildlife & Countryside Link, 1990). Environmental impacts are therefore potentially widespread, as indicated in Figure 8.1 which illustrates the distribution of the 327 salmon farm leases granted in Scotland (excluding the Northern Isles) by 1989.

Scottish sea lochs are ecosystems of special importance because they are undisturbed and unpolluted. The Crown Estates Commission recognised this in 1989 when it published a list of locations where environmental considerations, and/or the potential for conflict with existing fish farms or other interests, imposed severe constraints on new development. These locations were termed "Very Sensitive Areas" and there are currently 44 of these (Scottish Office Environment Department, 1991). Despite this positive move by the Crown Estates Commission, the situation is not ideal because the designation does not totally exclude fish farm developments from these areas. The Scottish Office Environment Department stated that there would be a presumption against new fish farms in Very Sensitive Areas, but that this would not preclude the establishment of new sites to facilitate new husbandry where it could be shown that this would make a positive contribution to environmental quality. They also stated that applications for new salmon farms, or significant modifications at existing sites, in Very Sensitive Areas would require formal environmental statements (Scottish Office Environment Department, 1991).

Similarly, NCC Scotland (now Scottish Natural Heritage) have identified 29 "Marine Consultation Areas" which they consider deserve particular distinction because of the quality and sensitivity of their marine environment. Many of these are sea lochs, and the industry argues that within many there is the potential for fin fish farm development. There are several actual or potential environmental impacts associated with the use of sea lochs.

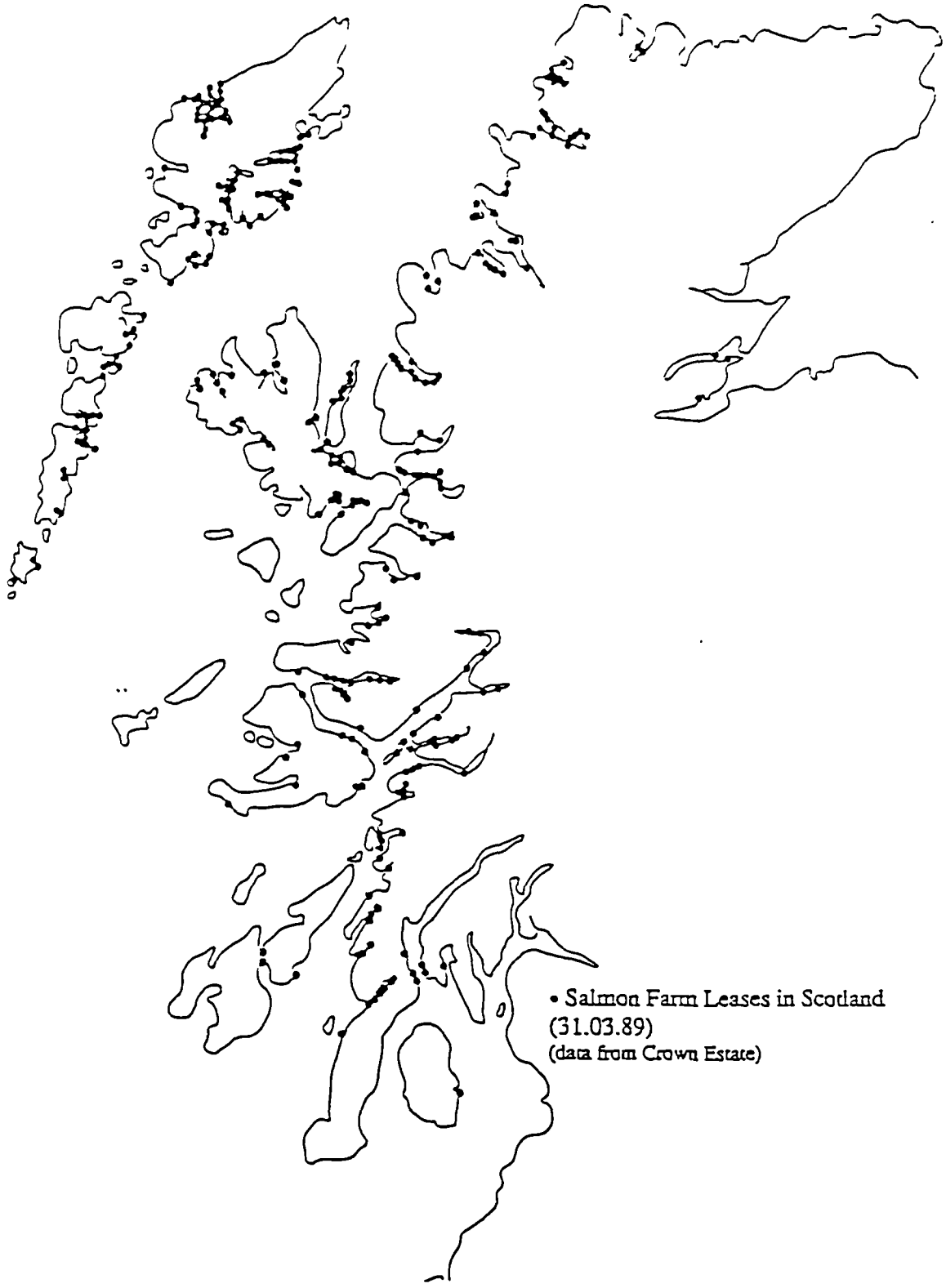


Figure 8.1 Distribution of salmon farm leases in Scotland (excluding the Northern Isles) in 1989. Reproduced, with permission, from *A Review of Marine Salmon Farming in Scotland*, Scottish Wildlife & Countryside Link, 1990.

### 8.2.1 Pollution

Although there are many types of pollution associated with fish farming, they can be linked to two main causes: poor husbandry, which leads to an over-reliance upon chemical means to control the resulting diseases, and over feeding which ultimately results in an accumulation of solid and soluble wastes immediately in and around the area of the cage in which the fish are contained.

Organic carbon, nitrogen and phosphorus compounds in faecal material and uneaten food constitute major forms of pollution from marine fish farming (Ackefors & Enell, 1990). Waste material has both soluble and solid components (Scottish Wildlife & Countryside Link, 1988) and its composition reflects both the composition and the digestibility of the diet (Gowen *et al.*, 1987). The amount of food uneaten by farmed fish varies from 5% to 20% (NCC,1989) and can make a significant contribution to sediment loading directly below cages. Studies by Penczak *et al.* (1982) showed that the production of 1 kg of marketable rainbow trout (*Onchorynchus mykiss*) enriched the lake system with 0.75 kg of carbon, 0.023 kg of phosphorus and 0.1 kg of nitrogen. Other compounds in fish farm waste which have a potential impact on the marine environment are antibiotics, pigments and vitamins (Gowen *et al.*, 1987).

Solid waste pollution from the presence of salmon in cages has been assessed by a number of researchers (Earll *et al.*, 1984; Brown *et al.*, 1987; Gowen & Bradbury, 1987; Gowen *et al.*, 1987). Solid waste largely consists of faecal material and uneaten food particles. Brown *et al.* (1987) estimated that the organic carbon loadings on the sea-bed under salmon cages amounted to 2-7 kg $m^{-2}$ $yr^{-1}$, and that, depending upon the nature of the localised water movement, the pollution effects can extend up to 40 m from the edge of the cage site. It must be stressed that the calculation of solid waste accumulating under salmon cages appears to be very variable because it is dependent upon a number of factors. These include type of feed, feeding method, quantity of food, digestibility of the food itself and other environmental and physiological factors, the effects of which are largely undetermined (NCC, 1988).

Salmon cages tend to be situated in sheltered positions because this simplifies the daily operation of the fish farm (access to cages for feeding, maintenance of anti-predator nets, livestock observation). In these sheltered settings there is often little water movement ("flushing") and as a result uneaten food and fish faeces accumulate directly under the

cages. The organic carbon loading which occurs under the cages results in an increase in biological activity which increases oxygen demand. A point is reached where oxygen levels do not match demand and anoxic conditions begin to develop in the sediment. This then results in the by-products of anaerobic metabolism (methane, hydrogen sulphide, and ammonia) diffusing into the water column (Gowen *et al.*, 1987). These by-products reduce the quality of the water in general, but of particular importance is the production of hydrogen sulphide which is poisonous to both the farmed salmon and to any other fauna using that immediate area of the sea loch. However, recent estimates suggest that bubbles of hydrogen sulphide emanating from the sediments are completely oxidised over a 30 m water column (NCC, 1988) and any problems linked to hydrogen sulphide production must be viewed as localised.

Water quality changes can have significant effects on the composition of the benthic flora and fauna. These effects are poorly understood and largely undetermined (NCC, 1988). Brown *et al.* (1987) found an azoic zone directly below salmon farm cages which was dominated by the polychaetes *Capitella capitata* and *Scolelepsis fulignosa*, and also up to 8m from the site with a gradual return to normal conditions 25 m from the cages. In the most severe cases the white bacterium *Beggiatoa*, characteristic of anaerobic conditions, forms colonies in and around the cages, providing a good visual indicator of low oxygen concentrations in the underlying sediments (Scottish Wildlife & Countryside Link, 1988).

Soluble wastes from caged salmon are a source of pollution about which little is known. Salmon farms give rise to an increase in nitrates, phosphates and nitrogenous waste products in the proximity of the cages (Scottish Wildlife & Countryside Link, 1988). Both nitrogen and phosphorus are required in phytoplankton metabolism and both are essential minerals for the normal growth and metabolism of salmon. Caged salmon diets, and the resulting waste, therefore contain two factors normally limiting to marine phytoplankton productivity. The consequences of this are the stimulation of algal blooms resulting in disease problems for marine life. Examples of this are the algal bloom which occurred along the coasts of Denmark, Norway and Sweden in 1988, resulting in losses of over $10 million to the Norwegian fish industry, and the two major outbreaks of paralytic shellfish poisoning in the UK in 1990 (Scottish Wildlife & Countryside Link, 1990).

Antibiotics are increasingly implicated as pollutants in sea loch systems due to the increase in disease within the fish farming industry which is treated with antibiotics. Furunculosis, bacterial kidney disease and pancreatic disease were reported to be causing particularly severe and persistent problems in the fish throughout 1990, the result being large stock losses and site abandonment (Scottish Wildlife & Countryside Link, 1990). Increases in types of disease and levels of outbreak are paralleled by increases in the amounts of antibiotics used to treat them. The concerns surrounding the high levels of antibiotic use include effects on the benthic fauna, resistance in the salmon pathogens they are supposedly controlling, and the uptake of the drugs by wild stocks (NCC, 1988). These are all areas which need further research because there will be a continued reliance upon antibiotics in the foreseeable future.

Salmon "lice", *Lepeophtheirus salmonis* and *Caligus elongatus*, are a major problem on fin fish farms. They are controlled using the organophosphate insecticide 'Aquagard SLT', active ingredient dichlorvos (2,2 dichlorovinyl dimethyl phosphate (DDVP)). It is administered as a bath treatment which involves enclosing the salmon cage in a tarpaulin "bag" or a weighted skirt which is hung around the cage to at least twice the depth of the cage. 'Aquagard' is then added to the water which is oxygenated throughout the operation for a period of 30-60 minutes, after which the tarpaulin is removed (Spencer, 1992).

It is difficult to calculate the correct application rate because the effectiveness of the active ingredient is temperature dependent. The prescribed treatment is 1 ppm dichlorvos for up to one hour, although there are variations in application rates (Ross & Horsmann, 1988). These differences in application rates are linked to seasonal and geographic variations in sea water temperature, which are allowed for by the prescribing veterinary surgeon. Spencer (1992) reported that in Ireland this has resulted in the application rate often being doubled in winter, but Scottish fish farm workers told me that they use a higher dose for a shorter period of time.

'Nuvan 500 EC' (the old name for 'Aquagard') was shown by Egidius & Moster (1987) to be poisonous to marine crustaceans. They simulated in the laboratory conditions similar to those in a fish farm treated with 'Nuvan'. Their results showed that death of three species of crustaceans (*Cancer pagurus*, *Carcinus maenas* and *Homarus gammarus*) and one bivalve mollusc (*Mytilus edulis*) occurred within 24 h at a concentration of 0.1 ppm. Although Spencer (1992) claimed that is no evidence of a major impact of dichlorvos

usage on the composition and abundance of the rocky shore invertebrate community adjacent to fish farms, there is evidence of sub-lethal effects on some components of the shore community (Robertson *et al.*, 1991). The continued use of 'Aquagard' therefore gives cause for concern.

Dichlorvos is on the UK government's "Red List of Dangerous Substances". It is also on the North Sea States Priority Hazardous Substances List which is a list of chemicals for which the signatories want a 50% reduction of inputs by 1995, as compared with 1985 levels (Therivel *et al.*, 1992). Scottish Wildlife and Countryside Link (1990), however, stated that unless an alternative is found, inputs of the chemical from salmon farming alone will possibly increase by 700% in the period outlined in the North Sea States Priority Hazardous Substance List, i.e. the decrease in levels they are calling for will not be achieved.

Government and the industry itself are responding to the problems posed by dichlorvos-based treatments in that standards have been proposed (Department of the Environment, 1991) and research into alternative non-chemical methods of control, is taking place (Bjordal, 1991). However, at the moment there is no replacement for 'Aquagard', despite increasing opposition to its continued use. The development of an acceptable alternative is therefore a priority.

Food additives are employed in salmon farming in order to give the fish their characteristic pink flesh. The pigments used are canthaxanthin and astaxanthin, both of which occur naturally as part of the fish's diet, although the canthaxanthin used in foodstuffs is synthetic. UK feed manufacturers would prefer to use astaxanthin because it occurs commonly in the marine environment, but British legislation prevents this. However, Norwegian fish farms use it so it still reaches consumers throughout the EEC (Scottish Wildlife & Countryside Link, 1988).

In 1989 the Food Advisory Committee recommended that canthaxanthin should be prohibited from direct use in human food, yet the Feeding Stuffs Regulations 1988 (under EC Directive 70/524) allow for both pigments to be used up to a content of 100 mg per kg in salmonids over the age of 6 months. Despite indications from the Food Advisory Committee that using the pigment is hazardous to humans, there has been nothing published about ecological impacts. The situation regarding the continued use of the

pigment is uncertain, but I think it likely that it will be used less, with astaxanthin eventually taking its place.

### 8.2.2 Impacts of escaped farmed salmon on wild salmon populations

Farmed salmon threaten their wild counterparts in that they are subjecting them to increased levels of parasite infestation. The infestations of "sea lice" seen on salmonid and other fish are ectoparasitic caligid copepods which occur naturally in seawater. In the N.E Atlantic the two species to which the term usually refers are the previously stated *L. salmoni* and *C. elongatus* (Spencer, 1992). Concern has been expressed about the increased number of farmed salmon with heavy levels of infestation which reach the wild either by escaping from their cages or by farmers releasing their diseased or unwanted stock into the sea loch systems (Scottish Wildlife & Countryside Link, 1990). Sattaur (1989) reported that, of all the salmon caught by the Norwegian fishing industry, 20% had escaped from fish farms. In 1987, one escape alone resulted in 90,000 salmon entering a Scottish sea loch system (Maitland, 1987).

Cage reared stock will breed with wild stock (Lura & Saegrov, 1991; Youngson *et al.*, 1993) and this has the potential to interfere with the genetic integrity of the latter (Maitland, 1987). Caged stock are the result of selective breeding to give fish which perform well under captive conditions rather than in the wild. A minimum of 74 genetically distinct salmon populations have been identified in the British isles (Thorpe & Mitchell, 1981) and therefore any potential breeding between wild stock and caged stock is cause for concern.

This has implications for the wild salmon. Although biologists have no means of measuring "wildness" some suspect that traits which contribute to wildness are weakened with each generation of farmed fish (Sattaur, 1989). Cage bred salmon have the greatest potential to cause problems in those areas which have small populations of wild fish. Research on the reproductive success of a related American species, the steelhead trout (*Onchorhynchus mykiss*), showed that the effect of cage bred adults spawning in the wild is to produce fewer smolts, and therefore fewer adults returning to their natal home than would occur from an all wild spawning (Reisenbichler & McIntyre, 1977). It is reasonable to assume that a similar situation could arise in Britain. This is challenged by the fish farmers themselves but the NCC (1988) advised caution if future loss of genetic diversity, and even whole wild stocks, is to be avoided.

### 8.2.3 Impacts on other wildlife populations

A further problem is linked to the feeding of farmed fish. Currently the industry relies very heavily upon high protein feeds and these are often in the form of other fish (Therivel *et al.*, 1992). Stocks of certain fish, notably capelin (*Mallotus villosus*), sprat (*Sprattus sprattus*) and sand-eels (*Ammodytes* spp.) are under pressure from over-fishing to provide feed stuffs for domestic livestock. These species are some of the main dietary components of birds such as guillemot (*Uria aalge*) and puffin (*Fratercula arctica)*, and for wild salmon. Mills (1989) estimated that the Scottish fish farm industry would have consumed 184,000 tonnes of sand eels and sprats by the end of 1990. Even if there is a large reduction in the catch of these particular species, alternative food will probably still be in the form of other fish species. Scottish Wildlife and Countryside Link (1990) stated that it is wrong to present salmon farming as a realistic long-term substitute for over-fished wild stocks of salmon, or any other fish. On the contrary, salmon farming is responsible for over-fishing of fish species not previously subjected to such pressures and hence aggravates the problems of wild fish stock depletion.

### 8.2.4 Side effects of control of fish stock predators

Birds and mammals which naturally predate fish are attracted to fish farms as a source of food. A number of these are piscivorous birds (Carss, 1993, 1994), the species most commonly mentioned being heron (*Ardea cinerea*), cormorant (*Phalacrocorax carbo*) and shag (*Phalacrocorax aristotelis*), and mammals (Ross, 1988), including the otter (*Lutra lutra*), mink (*Mustela vison*), common seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*).

Predator control around salmon farms has been the subject of a survey by the Marine Conservation Society (Ross, 1988). From a questionnaire followed by a site visit, it was found that 80% of fish farms claimed damage from seals, 50% from herons, cormorants and shags, 20% from mink and 10% from otters. If these claims are accurate then stock protection is poor and more effective means of predator control must be sought.

There are several methods of controlling predators on fish farms. The most common method is the use of protective netting, both above the cage and underwater. The effectiveness of nets depends upon the selection of an appropriate net type, its deployment to suit the features of the site (water current, exposure, cage design and layout, husbandry practices), and proper net maintenance (Scottish Wildlife & Countryside Link, 1988).

Scaring is also used for predator control and devices may be visual, acoustic or biological deterrents. Visual deterrents include scarecrows, flags, flashing lights, model airplanes and helicopters, and glass and metal reflectors (Draulans, 1987). Chasing (by boat) is another form of visual scaring which is reported to be a very effective at deterring predators (Scottish Wildlife & Countryside Link, 1988). There is a range of acoustic devices including gas cannons, recorded distress and warning calls, and exploding crackers. Draulans (1987) reported that most authors found acoustic devices to be effective for only one or two days, exceptionally up to four weeks, but sometimes less than a few hours. An acoustic seal scarer has been developed, although Scottish Wildlife and Countryside Link (1988) reported that its success was variable.

Shooting is a common form of predator control. Ross (1988) reported that 64% of the respondents to her questionnaire claimed to shoot seals (both grey and common), shags, cormorants and herons. Scottish Wildlife and Countryside Link (1988) stated that shooting is ineffective and in some instances contravenes the Wildlife & Countryside Act of 1981. They also warned that the removal of individual birds and mammals merely leads to re-occupation of the area by nearby individuals; that the principal predators are widespread in their distribution and highly mobile; and that shooting does not resolve the primary cause of predator presence, namely available access to an abundant food source.

Trapping of fish farm predators is not widespread, although it does occur in localised situations. Mink (*M. vison*) can be trapped legally and this presents a problem in that there is often confusion over the identity of mink and otter, resulting in otters being trapped despite being a fully protected species (Scottish Wildlife & Countryside Link, 1988). Scottish otters form one of the most important populations in Europe (Green & Green, 1987) and are common in those areas in which fish farms are situated (personal observation), so any trapping programme (for mink or otherwise) could have serious implications for otter numbers. I have also observed illegal gin traps being used to trap fish farm predators which could include otters.

The fish farming industry has responded to the need for predator control with codes of practice (Scottish Salmon Growers Association, 1990). These are good in theory but are not working because, as my own observations at fish farms suggest, persecution of piscivorous birds and mammals, many of which are fully protected, continues at unacceptable levels.

### 8.2.5 Landscape impacts

I have observed that fish farms are often proposed for, or situated in, scenic areas which attract tourism. The Scottish Wild Land Group has been critical of the impact of fish farms along the western seaboard of Scotland claiming that their presence detracts from the visual appreciation of the landscape (Scottish Wild Land Group, 1988). Tourism is of major economic importance in Scotland. The Scottish Tourist Board estimated that in 1988 tourism was worth £1,500 million annually and supported 100,000 jobs, far more than fish farming (Scottish Wildlife & Countryside Link, 1988). The scenic appeal of the areas which attract tourists, and the revenue they generate, need to be considered before consent is given for the siting of fish farms.

## 8.3 REGULATORY CONTROL OF SALMON FISH FARMING

Much of the discussion by conservation organisations about the environmental impacts of salmon farming is linked to the role of the Crown Estates Commission. It owns approximately 55% of the UK coastline and almost all of the adjacent seabed. In Scotland it is landlord over virtually all the seabed and about half of the foreshore (NCC, 1991), and has been given the role of a quasi-planning authority in controlling the development of the marine fish farming industry (RSPB, 1991). This is because it grants leases for the attachment of any mooring or erection of any structure, including fish cages and rafts, on Crown property (NCC, 1991).

In 1988, a review by the Scottish Office of the Crown Estates Commission's consultation procedures resulted in the formation of an advisory committee for it. Its purpose was to consider any case thought by the relevant statutory bodies to be contentious and to introduce an independent element to the decision making process (Scottish Wildlife & Countryside Link, 1990). Many conservation bodies, e.g. RSPB, WWF and the Marine Conservation Society, were unhappy with this committee because of its reluctance to formulate any procedures and because it was still only prepared to look at the industry on an individual case basis with no question of policy or strategic planning as part of its remit.

In 1988 the Environmental Assessment (Salmon Farming in Marine Waters) Regulations (under EC Directive 85/337 - see Appendix 1) placed new obligations on the Crown

Estates Commission to subject fish farms to EIA procedures under certain circumstances. This appears not to have happened because there are 327 salmon fish farming sites in Scotland (Figure 8.1) but only one has been the subject of an EIA. The planning application for which an EIA was undertaken was not well received, the standard of the EIA being sufficiently poor to warrant a formal complaint by the Marine Conservation Society to the European Commission (Scottish Wildlife & Countryside Link, 1990). Even the Crown Estates Commission admitted the EIA's failings but nevertheless granted a seabed lease by reducing the size of the fish farm below that stipulated (by them) as requiring an impact assessment (Friends of the Earth, 1991).

In 1989 the Crown Estates Commission published "Marine Fish Farming in Scotland - Development Strategy and Guidelines". Concern about this document was voiced by several conservation bodies including Scottish Wildlife and Countryside Link, because it appeared to allow the industry to develop without any real guidance about the possible environmental impacts of fish farming (Scottish Wildlife & Countryside Link, 1990). The guidelines were considered unsatisfactory because they did not take into account a number of factors such as technological advances in both equipment and disease treatment. Also, only mainland fish farms were dealt with, and therefore the islands, with their more specific requirements regarding site choice etc. were not considered.

The consultation procedures for proposed fish farm developments, in keeping with environmental consultation in general, leave much to be desired. Currently, when the Crown Estates Commission receives an application it invites comments from interested parties. All applications are advertised, but only locally, and copies sent to relevant organisations. Comments must then be submitted within 28 days of appearance of the advertisement (Scottish Office Environment Department, 1991). This is too short a time within which to respond, and an informed reply is only possible when an interested party already has detailed knowledge of the site in question. The Crown Estates Commission liaises closely with the planning authorities to ensure that the onshore and offshore impacts of the fish farm are considered. It takes into account the advice of the planning authorities regarding the acceptability of the proposal, and then appraises the proposal and gives a decision regarding its acceptability, usually within 4 months (Scottish Office Environment Department, 1991). This is too short a time period considering, for instance, the amount of time required to designate an area as an SSSI which may be several years.

Scottish Wildlife and Countryside Link (1988) stated that there were several shortcomings in the EIA system which could be linked to the following factors.

- The Crown Estates Commission as the self appointed "competent authority". This is inappropriate considering their financial interest in granting a lease.

- The Crown Estates Commission's setting of thresholds, for triggering EIA, at levels of production such that the measure is very rarely implemented.

- The Crown Estates Commission's failure to provide adequate guidance to developers to ensure that the statutory requirements for EIA are met.

- Limitations in the legislation, at both UK and EC levels, limiting EIA to the consideration of salmon farming only, and of individual projects only.

Despite all of the criticisms outlined above it is likely that control of fish farming leases will remain with the Crown Estates Commission, at least in the short-term. I believe that any improvements to the existing system will only be achieved by providing a framework which encourages a strategy based on good consultation. This will ensure that the Crown Estates Commission is made aware of the ecological value of those sites proposed for fish farms, and is also made aware of the cumulative impacts of the industry on marine ecosystems.

## 8.4 FISH FARMING AS A CANDIDATE FOR SEA

Scottish Wildlife and Countryside Link's 1990 discussion paper illustrated, with a selection of case studies, the need for coastal zone management in Scotland. In it they cited marine fish farming as illustrative of the many problems which result from the current arrangements for planning and administration of activities within the coastal zone. On the basis of the evidence I have presented, and in the light of discussions with the RSPB and the World Wide Fund for Nature, I will now examine the desirability of applying strategic environmental assessment (SEA) to fish farming.

Non-governmental organisations (NGOs), particularly the Council for the Protection of Rural England (CPRE), Friends of the Earth (FoE) and the RSPB, have been vociferous in calling for more stringent controls of the salmon farming industry and correct application of EC Directive 85/337/EEC to the salmon farming industry. In 1991 Friends of the Earth accused the government of "flouting the EC rules on environmental assessment of salmon farming" and "giving competent authority status to the body which is neither competent to decide the significance of its activities nor independent of the activities it is charged with controlling". Despite their emotive nature, these statements appear to be factually correct.

A key reason why the Scottish marine fish farming industry should adopt the principle of strategic planning is the multiple use of the ecosystem involved. SEA would protect the coastline and sea loch systems by a series of policies closely linked to their sustainable use. Scottish Wildlife and Countryside Link (1990) stated that " the total absence of a conservation strategy for coastal ecosystems, and the lack of a neutral authority, remain as major flaws in any claim by the government to be pursuing an environmentally responsible policy in fish farming" and that "precautionary safeguards on development should be designed to protect ecosystems of known or suspected vulnerability, and should be introduced without delay, to remain in place until superseded by protective measures based on adequate research".

There has been much criticism (Scottish Wildlife & Countryside Link, 1988 & 1990; Council for the Preservation of Rural England, 1991; Friends of the Earth, 1991) of the types and levels of control upon the industry. Many suggestions have been made but at present the only real constraints are the technical limitations and market forces which currently affect fish farming. The Crown Estates Commission has long been criticised for its role as official arbiter of public interest whilst being a major financial benefactor of fish farm leases (Scottish Wildlife & Countryside Link, 1990). There are no signs that this situation is changing despite this issue being a major topic of discussion between the conservation bodies and government departments. The Scottish Office should step in and pass on the regulation of fish farming to a more competent authority. This would ideally involve removing fish farming development control from the Crown Estates Commission and giving it to the local authorities. The Scottish Office Environment Department should make itself responsible for the industry and ensure that a balance between the environmental, social and economic needs of fish farming is achieved. Local authorities would need to become the "competent" authority (under the EA regulations) for all fish

farm applications, contentious or otherwise, and have a lead role in the regulating of all those aspects currently viewed as unsatisfactory (pollution, site choice, chemical use, predator control etc.) (Scottish Countryside and Wildlife Link, 1990). The basis for the regulation of these problem areas would again be a strategic framework.

The Crown Estates Commission would have a major role to play in promoting a strategic approach to the salmon farm industry. An SEA framework would include the provision of information and subsequent guidelines (stating criteria used) which would inform fish farm applicants about the problems currently facing the industry and their consequences for the environment. This would be based on a move away from the existing situation, which views each application on individual merit, to one which places the fish farm within an overall strategy. This strategy would take into account, and try to resolve, conflicts between users of the sea loch system. Conflicts arise because there are a number of interested parties competing for sea loch use, some of which are overlooked under the existing system. This appears to be particularly true for the ecological and nature conservation components which are continually eroded in favour of fish farm developments.

## 8.5 AN SEA FRAMEWORK FOR THE SALMON FARMING INDUSTRY

Ultimately, an SEA framework for the fin fish farming industry must be based upon their being an overall strategic approach for the coast and the marine environment as a whole. The framework would provide more than the current amount of planning guidance for fish farm applications and remove the current *ad hoc* way in which fish farm planning applications are considered. The eventual framework, and the associated guidelines, must be forward looking. In the past, guidelines were drawn up after the main expansion period of Atlantic salmon farming (Scottish Salmon Growers Association, 1990; Scottish Office Environment Department, 1991), i.e. after the major impacts had taken place. Any future expansion of salmon farming, or any other fin fish species, must have adequate guidelines in place before that expansion takes place.

The framework must have at its core a process of consultation which allows for discussion between all of the interested parties. Ideally this consultation process would:

- allow the interested parties access to all levels of decision making;

- make provision for ecologists to advise upon the desirability of fish farm applications, based on their expertise and on the guidelines which state the overall strategy of the industry; and

- provide a mechanism which allows for appeal, by both the developer making the application and any objectors, against the decision of the Crown Estates Commission. This would allow the ecology of the site to be given adequate consideration, because any subsequent changes resulting from the appeal process would have to be agreed by all the consultees.

Many of the proposals regarding SEA of the fin fish farming industry require an overall SEA framework. Ideally the latter would have at its centre a national environmental plan. Within this plan, core elements fundamental to the overall running of the system would have to be established. These core elements would be based upon a clear indication of governmental policy objectives. In the case of fish farming these would possibly include the establishment of a national strategy for fish farming. This would:

- require the establishment of a lead agency with sole responsible for all developments affecting the marine environment, including fin fish farming. This lead agency, via the SEA framework, would provide a more integrated approach to the use of the marine environment than at present.

- remove the current powers given to the Crown Estates Commission and transfer them to the local authorities. I envisage that the Scottish Office Environment Department would be responsible for the overall operations of the industry. The local authorities and other interested parties would then be able to work with the Scottish Office Environment Department to include fish farming policies in structure plans. This would in turn result in cross-boundary consultation between all those local authorities dealing with fish farm applications, thus ensuring that the cumulative impacts of fish farming are considered.

- review the existing environmental assessment regulations as they apply to the fin fish farm industry. The remit of the regulations must be broadened to include all

forms of fish farming and not just salmon farming. This is particularly important because my discussions with the interested parties have highlighted the possibility of the farming of new species such as halibut and sole (Paisley, 1993, *pers. comm.*). I expect the farming of any new species to bring with it new environmental impacts which must be prevented or overcome if the environment is not to suffer and the industry is to benefit. The farming of Atlantic salmon has caused many problems for the marine environment, and any new fin fish species proposed as a candidate for farming would benefit from a strategic approach because this would prevent similar problems re-occurring.

- be based on research into carrying capacities of sea loch systems in terms of the number and size of fin fish farms they might sustain. An attempt must be made to assess the carrying capacity of the whole of the Scottish coastline (including the islands), based upon the establishment of acceptable levels for all those substances and practices currently causing environmental problems. Emphasis must be placed on the use of benign alternatives rather than a lowering of application rates or levels of unacceptable practice.

- insist upon a more rigorous approach to environmental reporting regarding the fish farming industry's impacts. This would be achieved by mandatory reporting of practices. All chemical substances, artificial colorants etc. used by the industry must have duplicate invoices sent by the issuing person/firm to the local authority concerned. Then the local authorities, in conjunction with the Scottish Office Environment Department, will begin to monitor the impact of fish farm husbandry upon the marine environment.

- provide a system of habitat zoning and ranking, along the lines of that once proposed by the former NCC. This would be devised following discussion with the statutory bodies and all the interested parties, and would ultimately result in a national sea loch database indicating those areas with a presumption against new fish farms, a presumption against further fish farms, and areas where regulated fish farming might take place. These areas would be determined based upon existing knowledge about ecology of the sea loch systems. For those systems where no such knowledge exists, the precautionary principle must be exercised, with an emphasis on research into those systems.

## 8.6 REQUIREMENTS FOR EFFECTIVE STRATEGIC ENVIRONMENTAL ASSESSMENT IMPLEMENTATION

Before SEA for fin fish farms can be effectively implemented a number of problems must be addressed. The identification of the physical or regional limits of the area which is to be subject to SEA is a problem not specific to fish farming or the coastal zone; it is a fundamental problem in the application of SEA to any industry, habitat or bio-geographic zone. I suggest that full co-operation from all those concerned with the industry, habitat or bio-geographic zone in question will help to define the limits of SEA application.

The success of SEA is heavily dependent upon the availability of environmental information which is easily accessible and of a nature and scale that is appropriate to the area being studied. Currently this type of information is not available for the fish farming industry. A possible solution (proposed in the SEA framework) would be the provision of the sea loch database which would centralise information concerning a whole range of ecological and related issues.

A reference point is necessary for the prediction and monitoring of environmental impacts which may occur in the marine environment. A long-term objective of SEA of the industry must be to ensure that no further degradation of the marine environment occurs because of fish farming activities. In order to arrive at this reference point two things must be done. First, the baseline situation regarding all of the industry's current impacts must be identified. Second, further research into the environmental impacts of fish farming must be undertaken because currently little is known, especially about cumulative impacts. Increased levels of consultation, provided for in the SEA framework, will stimulate this research, which will ultimately assist the authorities concerned to achieve their long-term goals.

There are some theoretical constraints upon development of the salmon farming industry, yet many of the factors which the Scottish Office Environment Department discuss in their 1991 draft guidelines have not led to rejections of fish farm applications. These factors include potential impacts on water quality, coastal ecology and visual amenity, the existence of necessary infrastructure, and the potential for adverse interactions with existing fish farms (Scottish Office Environment Department, 1991). My discussions with the conservation bodies suggest that consideration of these factors would be warmly welcomed, but only if they are given adequate treatment. It would be particularly desirable to

consider the cumulative effects of these factors. The current draft guidelines state that the "environmental and infrastructural capacity constraints mean that the acceptability of individual development proposals cannot be determined in isolation. The cumulative effects of development require to be considered" (Scottish Office Environment Department, 1991). I hope that the framework for SEA of the fin fish farming industry which I have outlined will make it possible to consider the industry holistically and to determine its true cumulative impacts.

Following discussions with the interested parties, I have concluded that the next environmental problem likely to be caused by the industry will result from a change in husbandry involving what might be called rotational fish farming. Many existing sites have become fouled due to the presence of fish cages and a potential remedy will be to move the farm to a new site. On the face of it this appears acceptable but in practice the problems I have previously outlined are likely to be transferred from one site to the next. Provision for this can be made within a SEA framework which advocates consultation, research and monitoring, and above all a precautionary principle, until there is evidence that this rotational method of fish farming will be environmentally acceptable.

Ultimately, strategic guidance from central government regarding the policies, plans and programmes which affect all users of the marine environment must be given if further ecological damage is to be prevented. However, following discussions with the practitioners I must conclude that there is still a long way to go before this becomes reality.

# Chapter 9

# CONCLUSIONS

Environmental impact assessment aims to prevent environmental degradation by giving decision makers information about the predicted adverse effects that a development project could have on the environment. This information is provided in an environmental statement which should cover the full range of physical and social impacts. For effective decision making there must be adequate, accurate and appropriate information. This is particularly true where the ecology of a proposed development site is concerned because ecological damage is usually not easily or fully reversible.

My extensive review of British environmental statements showed that the ecological component of the EIA process is unsatisfactory. The main reasons for this appear to be a lack of relevant experience amongst professional ecologists more used to academic research, a lack of guidance for those undertaking environmental assessments, and a failure of developers and planners to understand the complexity of ecosystems and the time required for undertaking an EIA. The poor status of ecological considerations relative to economic ones may also be an important factor. My review of the treatment of ecology within the north American planning system revealed interesting information and techniques which would possibly remove some of these problems.

My review of environmental statements indicated a number of deficiencies. The survey fieldwork components of the ESs were often poor. A major criticism is that planning approval is often sought for developments without an ecological survey being conducted. Those ESs which reported a survey were often of poor quality overall. Few stated their objectives or indicated the methodologies used, e.g. which types of survey were conducted and why they were chosen, i.e. why they were appropriate to the particular taxa surveyed. Methodological limitations were often due to the time of year when surveys were/had to be undertaken, the survey techniques employed and problems of studying certain taxa. Too many of the ESs for which an ecological survey was conducted presented the findings as a list without any form of interpretation regarding numbers, abundance and the level of importance which might be attached to their presence, or their vulnerability to potential impacts from development.

Where surveys were conducted there was a strong bias toward the higher plants, possibly because they are easier to survey than many other groups of plants and animals, suitable field techniques are better documented, and expertise in higher plant identification is more readily available. Faunal surveys featured much less frequently, and invariably these were bird surveys which usually reported only on presence and sometimes on abundance. Mammal "surveys" were usually anecdotal sightings or based on the presence of footprints, the exception being badger surveys which were usually the findings of previous work conducted by the local badger group. Invertebrate surveys were mentioned in only a small minority of ESs.

Central to the concept of EIA is the need to predict the likely impacts of the development on the ecology of the site. Few of the ESs made predictions, except in the very broadest sense, e.g." the development will result in habitat loss". In the majority of cases no indication was given as to the extent of the loss, for how long, i.e. temporary or permanent, and which particular species would be affected. Although many aspects of EIA are politically determined, impact prediction relies upon scientific understanding which is where ecologists are in a position to influence the EIA process. Many appear to be reluctant to do this, perhaps because prediction is usually difficult and seen to be dependent on long-term studies involving the production of large data sets. Unfortunately, the current approach to development usually does not allow adequate time for ecological work, therefore ecologists must develop new techniques to overcome this problem. The woodland guidelines I have produced attempt to overcome some of these problems and I suggest that they be used in conjunction with the broader guidelines being developed by the Institute of Environmental Assessment.

Discussions with both my colleagues and other practising ecologists highlighted a further problem linked to impact prediction, that of probability. Most stated that they would not be prepared to commit themselves to a detailed prediction, and that they would not be happy to work with anything less than the statistically recognised levels of acceptance, e.g. 95% confidence limits. Many of the ESs reviewed substantiated this in that they stated that habitat loss was likely, rather than stating that a given area of a specific habitat type would be lost, along with an indication of the effects on dependent species and their numbers.

A serious deficiency in the implementation of EIA is the tendency for development proposals to be well advanced before impact assessment begins. This means that those involved, including ecologists, often have to react to a firm proposal rather than being consulted at an early stage when modification of the proposal, or selection of an alternative site in a less sensitive location, is possible. This problem may be attributed to a lack of awareness on the part of developers that EIA should be undertaken as an integral part of development planning from day one. It can also be attributed to developers' vested interests in ignoring EIA for as long as possible, and the fact that an ES is often seen as a passport to planning approval rather than an integral part of development design.

Even if individual assessments are conducted satisfactorily they may not provide a full picture of likely impacts if no account is taken of spatial and temporal cumulative impacts. This is a criticism of the whole EIA process which is targeted not only at individual projects but also at components of projects meaning that decision makers may be unaware of, or choose to ignore, the true total environmental impacts. A good example of this is the current road building programme where consent is given for numerous small bypasses which together effectively constitute a major trunk road system.

These problems all point to a need for the EIA process to commence at an early stage and preferably in a strategic way which embraces policies, plans and programmes rather than just individual projects. The European Commission has pursued an active environmental policy for many years. As long ago as 1975 it began to commission research on environmental assessment, and it drew up a preliminary draft Directive on EA in 1978. Originally it was intended that this system would apply to plans as well as projects (Wathern, 1988); however, by the time the Directive (85/337/EEC) was approved, its application had been restricted to two lists of projects (see Appendix 1).

A proposal for a draft Directive on SEA was prepared by Directorate General XI (DG XI) and released in March 1991, but has not yet been approved by the Commission. The proposal is reportedly being opposed by a number of the more powerful Member States, including Germany, France and the UK. This has resulted in DG XI altering the draft substantially, but at the time of writing the contents of the new draft are unavailable. There appear to be three main reasons as to why the new Directive has not been issued: the Commissioners cannot agree what is to be in the new proposal, the proposed legislation

was not forecast for this year's work schedule, and the EU would have difficulty applying SEA to its own policies, plans and programmes.

The main benefit of the proposed Directive is its legislative force. Once it is approved, Member States will be required to carry out its procedures. The proposed Directive would require the environment to be formally considered when the objectives and contents of policies, plans and programmes are formulated; this is a positive move in that it provides a framework for considering environmental impacts in decision making. Of particular note is the formal consideration of issues which are at present not considered within project EA, particularly the question of alternatives to policies, plans and programmes and to monitoring arrangements.

The proposed Directive is not ideal in that it makes no mention of such basic principles as irreversibility, uncertainty, or the precautionary principle. Sustainable development is addressed in the introduction to the proposed Directive thus "Sustainable development depends upon sound management of natural resources and on the preservation of the equilibrium of the different ecosystems," but it is not listed as an objective of SEA.

I have discussed SEA as a step up from project environmental assessment; basically a higher tier which would cover a greater number of projects more comprehensively and thus afford greater environmental benefits. If a sustainability-led approach to SEA is adopted then the result will be a much more protective system of impact analysis.

The concept of sustainability is inextricably bound up with the idea of carrying capacities in that to ensure sustainability the carrying capacity must not be exceeded. In order to do this, the current state of the resource and its uses must be monitored, predictions must be made concerning the future state of the resource and its uses, alternatives must be considered, and mitigative measures must be taken if the uses exceed, or threaten to exceed, the carrying capacity.

Despite its sudden growth in popularity, sustainability is neither well understood nor generally viewed as an acceptable objective. What is broadly accepted as an objective is that of sustainable development as defined by the Brundtland Commission (1987), i.e. "development which meets the needs of the present without compromising the ability of future generations to achieve their needs and aspirations".

The sustainability concept provides ecologists (and others) with a particular set of problems. Very little is known about sustainable development, carrying capacity and their links. Carrying capacity is linked to definitions of area, time, resource availability and renewability, and the use of alternatives. This has the net result of viewing carrying capacities from a regional or, in the case of the ecologist, habitat approach. The reality is that regions and habitats are not closed entities, one is affected by others. Knowledge of ecosystems in terms of component interaction, and the effects of outside influences is limited. A final problem lies with the definition of a carrying capacity, which relies heavily upon inherent value judgements and on the use of non-biological standards to measure the severity of an impact.

I have examined the potential for the application of strategic environmental assessment (SEA) to a habitat (lowland heath), a bio-geographic unit (coastline) and an industry (salmon farming), and proposed frameworks for such applications of SEA. This has led me to the following conclusions:

1. SEA requires institutions to consider the consequences of a range of actions early in the planning process, to choose the most appropriate action on ecological as well as socio-economic grounds, and to minimise any remaining environmental impacts.

2. Effective SEA depends on relevant and adequate environmental data on which to base predictions, with a commitment from institutions to co-operate in the standardised collection of that data.

3. SEA is likely to promote equity and public participation because it requires open planning decisions to be made in a rational and open manner.

4. SEA methodology is in its infancy and is not well developed. The framework I have proposed has no monetary valuation included, and this may be necessary before the methodology is given any credibility. Unfortunately, attaching monetary values to habitats and species is a controversial concept which few ecologists have addressed. SEA methodologies will need to cope with high levels of uncertainty due to imprecise data and limited time periods for data collection, which will cause concern to both those involved in their formulation and those required to implement them.

5. SEA is particularly difficult for a habitat, possibly because habitats are often not contained within one political administrative boundary, and there is a tendency for ecological considerations to be bolted on to the decision making process. SEA for bio-geographic units and specific industries is potentially easier because they already have in place regulatory controls and consultative frameworks to address issues linked to multiple use and the problems which arise from it. Further research is, however, required if SEA for these is to be achieved.

SEA will appear within the political arena in the future, the question is in what form and with what amount of power to prevent or ameliorate the environmental impacts of policies, plans and programmes. In October 1994 the European Commission, under the auspice of DGXI, called for tenders for the provision of training modules in environmental impact studies and assessments and in strategic environmental assessment. All relevant staff in all relevant Directorates will be required to complete these training modules. This appears to be a firm commitment to changing the current project based approach to EIA, ideally in the form of a new SEA Directive.

With the above in mind I propose (in conjunction with my co-authors, Therivel *et al.*, 1992) the following "ideal" system of SEA which has seven main points. These points have differing degrees of feasibility, time scale and importance. They are not mutually exclusive.

1. Central government should initiate preparation of a UK system of SEA based on carrying capacity. Targets to be reached should be indicated.

2. Central government should commission studies into carrying capacity in the context of a commitment to sustainable development.

3. SEA should be required as a formal procedure for all those programme areas where government is policy maker, project financier or decision maker.

4. Central government should clarify the objectives of government PPPs at all levels as baseline information for SEA.

5. Central government should adopt the environmental imperative, and give statutory force to it in the powers and duties of ministers and state agencies.

6. Central government should give absolute protection to designated nature conservation and landscape areas.

7. Studies should be commissioned to ascertain non-substitutable natural capital (habitats and their dependent species with limited population sizes and distributions which if lost due to development activity are predicted not to return).

(Therivel *et al.*, 1992)

The Directive format proposed in 1991 was modelled on project EA (85/337/EEC) and ecologists will need to make sure that the problems with one system are not passed on to another, which is a strong possibility. It is therefore important that DG XI amend any new draft of the proposed Directive.

Further research is necessary before SEA becomes reality, as indicated by the number of problems outlined above. In particular, the future roles of the Environmental Protection Agency and the Department of the Environment are in need of address. Both of the agencies should commission research to provide guidance for more widespread application of SEA at both national and European levels. Research is needed to understand the precautionary principle (as outlined in Policy Appraisal and the Environment (Department of the Environment, 1991)), carrying capacities, environmental sustainability and the relationships of these to irreversible loss of natural capital.

SEA will require expertise which agencies currently do not possess and it must be the aim of ecologists to make sure that they have a voice in the process. The ideal would be an outside (government) agency responsible for providing environmental information of all kinds. The UK government is opposed to the formation of any such agency but hopefully one will be formed under the auspices of the proposed Directive. This will only happen if the environmental lobby has a whole range of experts, including ecologists, calling for its formation.

# References


Ackefors, H. & Enell, M. (1990). Discharge of nutrients from a Swedish fish farming to adjacent sea areas. Ambio, **19**, 28-35.

Allport, G., O'Brien, M. & Cadbury, C.J. (1986). Survey of redshank and other breeding birds on saltmarshes in Britain. Unpublished RSPB report. RSPB Sandy.

Andrews, R.N.L., Cromwell, P., Enk, G.A., Farnworth, E.G., Hibbs, J.R. & Sharp, V.L. (1977). Substantive Guidance for Environmental Impact Assessment: An Exploratory Study. The Institute of Ecology. Washington, D.C.

Armstrong, P.H. (1973). Changes in the land use of the Suffolk sandlings: a study in the disintegration of an ecosystem. Geography, **58**, 1-8.

Auerbach, S.I. (1978). Current Perceptions and Applicability of Ecosystem Analysis to Impact Assessment. Ohio Journal of Science, **78**, 163-174.

Auld, M., Davies, S, & Pickess, B. (1992). Restoration of lowland heaths in Dorset. RSPB Conservation Review, **6**, 68-73.

Avery, M. & Haines-Young, R.H. (1990). Population estimates for the dunlin *Calidris alpina* derived from remotely sensed satellite imagery of the Flow Country of northern Scotland. Nature, **344**, 860-862.

Baker, J.M. (1976). Biological monitoring: principles, methods and difficulties. *In* Marine ecology and oil pollution. (Ed. Baker, J.M). 41-53. J.Wiley & Sons Inc. New York.

Ball, D.F & Stevens, P.A. (1981). The role of 'ancient' woodlands in conserving 'undisturbed' soils in Britain. Biological Conservation, **19**, 163-176.

Barnthouse, L.W. & VanWinkle, W. (1980). Modelling Tools for Ecological Impact Evaluation. *In* Strategies for Ecological Effects Assessment at DOE Energy Activity Sites (Sanders *et al.*) 271-313. Environmental Science Division. Oak Ridge National Laboratory. Tennessee. Publication No. 1639.

Bass, R. (1990). California's Experience with Environmental Impact Reports. Project Appraisal, 220-224.

Batten, L.A., Bibby, C.J., Clement, P., Elliott, G.D. & Porter, R.F. (1990). Red Data birds in Britain. T & A.D Poyser. London.

Bayes, K. & Henderson, A. (1988). Nightingales and coppiced woodland. RSPB Conservation Review, **2**, 47-50.

Baysinger, E.B. (1980). Evaluating Impacts upon Endangered or Threatened Species. *In* Symposium proceedings of Biological Evaluation of Environmental Impacts. 123 - 128. Council on Environmental Quality and Fish and Wildlife Service, US Dept. of the Interior, Washington, D.C.

Beanlands, G.E. & Duinker, P.N (1984). An Ecological Framework for Environmental Impact Assessment. Journal of Environmental Management, **18**, 267-277.

Beanlands, G.E. & Duinker, P.N. (1983). An Ecological Framework for Environmental Impact Assessment in Canada. Institute for Resource & Environmental Studies, Dalhousie University, Halifax, Nova Scotia.

Bear, D. (1990). EIA in the USA after Twenty Years of NEPA. EIA Newsletter, **4**, EIA Centre, University of Manchester.

Bibby, C.J., Phillips, B.N. & Seddon, A.J.E. (1985). Birds of restocked conifer plantations in Wales. Journal of Applied Ecology, **22**, 619-633.

Bisset, R. & Tomlinson, P. (1988). Monitoring and auditing of impacts. *In* Environmental Impact Assessment: Theory and Practice. (Ed. Wathern, P.). Unwin Hyman. London.

Bjordal, A. (1991). Wrasse as cleaner fish for farmed salmon. Progress in underwater science, **16**, 17-28.

Booth, A.G. (1984). The planning component. *In* Planning and Ecology (Eds. Roberts, R.D & Roberts, T.M.). Chapman & Hall. London.

Bradshaw, A.D. (1984). The ecological component. *In* Planning and Ecology (Eds. Roberts, R.D. Roberts, T.M). Chapman & Hall. London.

Brink, C.H. (1978). Preparing and reviewing environmental statements and related documents. Wildlife Society Bulletin, **6**, 246-248.

Brown, J.R., Gowen, R.J & McLusky, D.S. (1987). The effect of salmon farming on the benthos of a Scottish sea loch. Journal of Experimental Marine Biology and Ecology, **109**, 39-51.

Buffington, J.D, Sharma, R.K & McFadden, J.T. (1980). Assessment of Ecological Damage: Consensus. *In* Symposium Proceedings of Biological Evaluation of Environmental Impacts, 25-32. Council on Environmental Quality & Fish & Wildlife Service, US Dept. of Interior, Washington, DC.

Buisson, R. & Williams, G. (1991). RSPB action for lowland wet grasslands. RSPB Conservation Review, **5**, Sandy. Bedfordshire.

Bunce, R.G.H. (1969). Classification of British woodlands. ITE. Merlewood.

Cadbury, C.J. (1987). UK estuaries under threat. RSPB Conservation Review, **1**, 41-46.

Cadbury, C.J. (1989). What future for lowland heaths in southern Britain? RSPB Conservation Review, **3**, 61-67.

California Office of Planning and Research (1986). The California Environmental Quality Act. Sacramento. CA.

Canter, L.W. (1984). Environmental impact studies in the United States. *In* Perspectives in environmental impact assessment. (Eds.Clark, B.D, Gilad, A., Bisset, R. & Tomlinson, P.).

Canter, L.W, Robertson, J.M & Westcott, R.M. (1991). Identification and evaluation of biological mitigation measures. Journal of environmental management, **33**, 35-50.

Carss, D.N. (1993). Grey heron, *Ardea cinerea* L., predation at cage farms in Argyll, western Scotland. Aquaculture and Fisheries Management, **24**, 29-45.

Carrs, D.N. (1994). Killing of piscivorous birds at Scottish fin fish farms,1984-1987. Biological Conservation, **68**, 181-188.

Clark, B.B., Chapman, K., Bisset, R., Wathern, P. & Barrett, M. (Eds) (1981). A manual for the assessment of major development proposals. HMSO. London.

COM(92)23 (1992). Towards Sustainability: A European Community Programme of Policy and Action in Relation to the Environment and Sustainable Development. Brussels.

Conover, S.A.M. (1987). Environmental effects monitoring and environment Canada: A synthesis of the findings of four workshops. *In* Audit and evaluation in environmental assessment and management: Canadian and International experience, Volume II. (Ed. Sadler). 408-434. Beauregard Press Ltd. Canada.

Convention on the Conservation of European Wildlife and Natural Habitats (1979). Berne.

Cooper, W.E. (1976). Ecological effects. *In* Proceedings of the workshop on the biological significance of environmental impacts. (Eds. Sharma, R.K., Buffington, J.D. & McFadden, J.T.). 73-87. U.S. Nuclear Regulatory Commission, Washington, D.C.

Cooper, C.F & Zedler, P.H. (1980). Ecological assessment for regional development. Journal of Environmental Management, **10**, 285-296.

Commission of the European Communities (1979). Directive on the Conservation of Wild Birds (79 409/EEC). Official Journal of the European Communities. Brussels.

Commission of the European Communities (1985). Directive on the Assessment of the Effects of Certain Private and Public Projects (85 337/EEC). Official Journal of the European Communities. 175. Brussels.

Commission of the European Communities (1991). Draft Proposal for Directive on the Environmental Assessment of Policies, Plans and Programmes. XI/194 90-EN-REV.4. Brussels.

Commission of the European Communities (1992). Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92 43/EEC). Official Journal of the European Communities. Brussels

Council for the Protection of Rural England (1991). The Environmental Assessment Directive - Five Years On. CPRE. London.

Council of Europe (1977). Conservation and Management of Heathlands. Committee of Ministers Resolution 77(5). Strasbourg.

Countryside Commission (1970). The coastal heritage. A conservation policy for coasts of high quality scenery. Countryside Commission. Cheltenham.

Cowell, E.B. (1978). Ecological monitoring as a management tool. Ocean Management, **4**, 273-285.

Daniels, R.E. (1988). The role of ecology in planning: Some misconceptions. Landscape and Urban planning, **15**, 291-300.

Davidson, N.C, d'A Loffoley, D., Doody, J.P, Way, L.S, Gordon, J., Key, R., Drake, C.M., Pienkowski, M.W., Mitchell, R. & Duff, K.L. (1990). Nature conservation and estuaries in Great Britain. NCC. Peterborough.

Davies, G.H. (1989). Heathland - England's Own Disaster Area. Birds, 30-35, RSPB. Sandy.

Department of the Environment, Ministry of Agriculture, Fisheries and Food & Welsh Office Agriculture Department (1982). Land drainage and Conservation: Guidance Notes on Procedures for Water Authorities, Internal Drainage Boards, Nature Conservancy Council and Countryside Commission. HMSO.

Department of the Environment/Welsh Office (1989). Environmental Assessment: a guide to the procedures. HMSO.

Department of the Environment (1991). National Environmental Quality Standards for Dangerous Substances in Water: Joint Consultation Paper. DoE. London.

Department of the Environment (1991a). Policy Appraisal and the Environment. HMSO.

Department of the Environment (1992). Planning Controls Over Sites of Special Scientific Interest. Joint DoE/Welsh Office Circular.

Devon County Council (1992). Exe Estuary Management Plan. Devon County Council.

Doody, P. & Barnett, B. (Eds) (1987). The Wash and its environment. Research and Survey in Nature Conservation, **7**, NCC. Peterborough.

Draulans, D. (1987). The effectiveness of attempts to reduce predation by fish eating birds: A review. Biological Conservation, **41**, 219-232.

Drewett, J. (1991). Action for Staffordshire Heathlands. Conference Proceedings. RSPB Staffordshire Wildlife Trust.

Duinker, P.N. (1987). Forecasting environmental impacts: Better quantitative and wrong than qualitative and untestable! *In* Audit and evaluation in environmental assessment and management: Canadian and international experience, Volume II (Ed. Sadler) 399-407. Beauregard Press Ltd. Canada.

Earll, R., James, G., Lumb, C. & Pagett, R. (1984). A report on the effects of fish farming on the marine environment of the Western Isles. Report to NCC. Marine Biological Consultants.

Eberhardt, L.L. (1976). Quantitative ecology and impact assessment. Journal of Environmental Management, **4**, 27-70.

Eberhardt, L.L. (1976a). Some quantitative issues in ecological impact evaluation. *In* Proceedings of the workshop on the biological significance of environmental impacts. (Eds Sharma, R.K., Buffington, J.D. & McFadden, J.T.). U.S Nuclear Regulatory Commission, Washington, D.C.

Egidius, E. & Moster, B. (1987). Effect of Neguvon and Nuvan treatment on crabs(*Cancer pagurus, Carcinus maenas*), lobster (*Homarus gammarus*) and blue mussel (*Mytilus edulis*). Aquaculture, **60**, 165-168.

English Nature (1992). Memorandum by English Nature to House of Commons Environment Committee: Inquiry into coastal zone protection and planning. English nature. Peterborough.

Eversham, B.C., Harding, P.T., Loder, N., Arnold, H.R. & Fenton, R.W. (1992). Faunal inventories of sites for cartography and nature conservation. *In*: 8th International Colloquium of the European Invertebrate Survey. 9 - 10 September, 1991. (Eds van Goethem P.G & van Goethem, J.L). L'instituit Royal des Sciences Naturelles de Belgique. Brussels.

Farrell, L. (1983). The current state and objectives of management of British heaths. *In* Heathland Management in Amenity Areas (Ed. Daniels, J.L.). Countryside Commission. Cheltenham.

Food and Agriculture Organisation (1993). Fisheries circular No. 815. Aquaculture production 1985-1991 (Review 5). FAO. Rome.

Forestry Commission (1991). Dorset Forests and Heathlands Project. Forestry Commission. Edinburgh.

Friends of the Earth (1991). UK flouting EC rules on environmental assessments of salmon farming and forestry. FoE Scotland press release 9.9.91.

Freemark, K.E. & Merriam, H.G. (1986). Importance of area and habitat heterogeneity to bird assemblages in temperate forest fragments. Biological Conservation, **36**, 115-141.

Fritz, E.S., Rago, P.J. & Muraka, I.P. (1980). Strategy for Assessing Impacts of Power Plants on Fish and Shellfish Populations. National Power Plant Team, Biological Services Programme, US Fish and Wildlife Service, FWS OBS-80 34.

Gimmingham, C.H. (1972). Ecology of Heathlands. Chapman & Hall. London.

Glasson, J., Therivel, R. & Chadwick, A. (1994). An Introduction to Environmental Impact Assessment. UCL Press. London.

Goss-Custard, J.D. & Moser, M.E. (1988). Rates of change of numbers of dunlin (*Calidris alpina*), wintering in British estuaries in relation to the spread of (*Spartina anglica*). Journal of Applied Ecology, **25**, 95-109.

Gowen, R.J. & Bradbury, N.B. (1987). The ecological impact of salmonid farming in coastal waters: A review. Oceanographic Marine Biology Annual Review, **25**, 563-575.

Gowen, R.J., McLusky, D., Bradbury, N. & Brown, J. (1987). The interaction between fish farming and the marine environment. Unpublished report. University of Stirling.

Gray, J.S. (1980). Why do ecological monitoring? Marine Pollution Bulletin, **11**, 62-65.

Green, J. & Green, R. (1987). Otter survey of Scotland 1984-85. The Vincent Wildlife Trust. London.

Gubbay, S. (1990). A Future for the Coast:Proposals for a UK Coastal Zone Management Plan. Marine Conservation Society.

Hampshire County Council (1989). The Future of Hampshire's Heathland. Hampshire Books.

Harrison, C.M. (1981). Recovery of lowland grassland and heathland in southern England from disturbance by seasonal trampling. Biological Conservation, **19**, 119-130.

Herson, A.I & Bogdan, K.M. (1991). Cumulative Impact Analysis under NEPA. The Environmental Professional, **13**, 100-106.

Hendrix, W.G., Fabos, J.G & Price, J.E. (1988). An ecological approach to landscape planning using geographical information system technology. Landscape and Urban Planning, **15**, 211-225.

Hinkley, A.D. (1980). Guidelines for Ecological Evaluation. *In* Symposium Proceedings of Biological Evaluation of Environmental Impacts. Council on Environmental Quality & Fish & Wildlife Service, US Dept. of Interior, Washington, DC.

Hinsley, S.A., Bellamy, P.E., Newton, I. & Sparks, T.H. (1994). Factors influencing the presence of individual breeding bird species in woodland fragments. ITE. Monkswood.

HMSO (1971). International Convention on Wetlands of International Importance, especially as wildfowl habitat. Ramsar. HMSO. Cmnd 6465. London.

HMSO (1992). Coastal Zone Protection and Planning: Second Report. House of Commons Environment Select Committee. Paper 17-1. HMSO. London.

Holland, A.F. (1990). Near coastal program plan for 1990: Estuaries. EPA 600 4-90 033. Narragansett, Rhode Island: US Environmental Protection Agency, Environmental Research Laboratory, Office of Research and Development.

Kennedy, C.E.J. & Southwood, T.R.E. (1984). The number of species of insects associated with British trees: A re-analysis. Journal of Animal Ecology, **53**, 455-478.

Kepner, W.G. & Fox, C.A. (Eds) (1991). Environmental Monitoring and Assessment Program. Arid Ecosystems Strategic Monitoring Plan. EPA-600/4-92/018. Washington D.C: US Environmental Protection Agency.

Kirby, K. (1988). The Role of Nature Conservation in Environmental Assessment. English Nature. Peterborough.

Lee, N. & Colley, R. (1990). Reviewing the quality of environmental statements. Occasional paper 24. Department of Planning and Landscape. Manchester University.

Lee, N. & Brown, D. (1992). Quality control in environmental assessment. Project Appraisal, **7**, 41-45.

Lee, N. & Dancey, R. (1993). The quality of environmental impacts statements in Ireland and the United Kingdom: A comparative analysis. Project Appraisal, **8**, 31-36.

Leibowitz, N.C., Squires, L. & Baker, J.P. (1991). Environmental Monitoring and Assessment Program. Research plan for monitoring wetland ecosystems. EPA 600/3-91/010. Washington D.C.: Environmental Protection Agency.

Leopold, L.B. (Ed.) (1971). A procedure for evaluating environmental impact assessment. US Geological Survey. Washington DC.

Lura, H. & Saegrov, H. (1991). Documentation of successful spawning of escaped farmed female Atlantic salmon, *Salmo salar*, in Norwegian rivers. Aquaculture, **98**, 151-159.

MAFF (1991). John Gummer holds Flood and Coastal Defence Environmental Review. MAFF Press Release. 433 91.

MAFF (1991a). Periodic Review of Flood and Coastal Defence Policy: Background Paper. MAFF Flood Defence Division.

Maitland, P. (1987). The Impact of Farmed Salmon on the Genetics of Wild Stocks. NCC. Peterborough.

Maltby, E. (1988). Wetland resources and future prospects - an international perspective. *In*: Increasing our wetland resources (Eds. Zelzany & Feierabend). National Wildlife Federation. Washington D.C.

Matthews, W.H. (1975). Objective and subjective judgements in environmental impact analysis. Environmental Conservation, **2**, 121-131.

Messer, J.J., Linthurst, R.A. & Overton, W.S. (1991). An EPA program for monitoring ecological status and trends. Environmental Monitoring and Assessment, **17**, 67-78.

Messer, J.J., Ariss, C.W., Baker, J.R, Drouse, S.K, Eshleman, K.N., Kaufman, P.R., Linthurst, R.A., Omernik, J.M, Overton, W.S., Sale, M.J., Schonbrod, R.D., Stambaugh, S.M. & Tuschall, J.R. (1986). National surface water survey: national stream survey. Phase 1 - Pilot survey. EPA 600 4-86 026. Washington D.C.: US Environmental Protection Agency.

Monk, D.C, Girton, C. & Tapper, K. (1979). Biological monitoring of the effects of oil refinery effluent in rivers. *In* Proceedings of Ecological damage assessment conference. 199-214. Society of Petroleum Industry Biologists. California.

Mills, S. (1989). Salmon farming's unsavoury side: sterner controls are needed to protect the environment from fish farms. New Scientist. 29.4.89. 58-60.

Ministry of Housing, Physical Planning and Environment (1989). National Environmental Policy Plan - To Choose or To Lose. The Hague. Netherlands.

Mitchell, J.R., Moser, M.E & Kirby, J.S. (1988). Declines in mid-winter counts of waders roosting in the Dee estuary. Bird Study, **35**, 191 - 198.

Moore, N. (1962). The heaths of Dorset and their conservation. Journal of Ecology, **50**, 369 - 391.

Moser, M.E. (1988). Limits to the numbers of grey plover wintering on British estuaries: an analysis of long term population trends. Journal of Applied Ecology, **25**, 473 - 485.

National Environmental Policy Act (1969). 42 U.S.C. 4321 - 4347.

Nature Conservancy Council (1984). Nature Conservation in Great Britain. NCC. Peterborough.

Nature Conservancy Council West Midlands/Staffordshire County Council (1985). A Survey of the Lowland Heathlands of Staffordshire and the West Midlands County. NCC/SCC.

Nature Conservancy Council (1988). Fishfarming and the safeguard of the natural marine environment of Scotland. NCC. Peterborough.

Nature Conservancy Council/Surrey County Council (1988). A Strategy for Surrey Heathland. Surrey County Council Commercial Services.

Nature Conservancy Council (1989). Nature Conservation and Estuaries in Great Britain. NCC. Peterborough.

Nature Conservancy Council (1991). Atlas of nature conservation sites in Great Britain sensitive to coastal oil pollution. NCC. Peterborough.

Norton, G.A. & Walker, B.H. (1982). Applied ecology: towards a positive approach. I. the context of applied ecology. Journal of Environmental Management, **14**, 309-324.

North, P.M. & Jeffers, J.N.R. (1991). Modelling: a basis for management or an illusion? *In*: The scientific management of temperate communities for conservation (Eds. Spellerberg, I.F., Goldsmith, F.B. & Morris, M.G). Blackwell Scientific Publications.

Opdam, P., Rijsdijk, G. & Hustings, F. (1985). Bird communities in small woods in an agricultural landscape: effects of area and isolation. Biological Conservation, **34**, 333-352.

Overton, W.S, Stevens, D.L. & White, D. (1990). Design report for EMAP, Environmental Monitoring and Assessment Program. EPA/600/3-91 053. Washington, D.C.: US Environmental Protection Agency.

Owen, M., Atkinson-Willes, G.L. & Salmon D.G. (1986). Wildfowl in Great Britain. Cambridge University Press.

Palmer, C.J., Ritters, K.H., Strickland, T. Cassell, D.L., Byers, G.E., Papp, M.L. & Liff, C.I. (1991). Monitoring and research strategies for forests - Environmental Monitoring and Assessment Program (EMAP). EPA/600 4-91. Washington, D.C.: US Environmental Protection Agency.

Pearce, F. (1993). Road to ruin for Britain's wildlife. New Scientist. 35-38.

Penczak, T., Galicka, W., Molinski, E., Kusto, E. & Zalewski, M. (1982). The enrichment of a mesotrophic lake by carbon, phosphorous and nitrogen from the cage aquaculture of rainbow trout (*Salmo gairdneri*). Journal of Applied Ecology, **19**, 371 - 393.

Peterken, G.F. (1977). Habitat conservation priorities in British and European woodlands. Biological Conservation, **11**, 223 - 236.

Peterken, G.F. (1981). Woodland conservation and management. Chapman & Hall. London.

Prater, A.J. (1981). Estuary birds in Britain and Ireland. T & A.D Poyser. London.

Quarrie, J. (Ed.) (1992). Earth Summit '92: The United Nations Conference on Environment and Development, Rio de Janeiro, 1992. Regency press Corporation. London.

Rackham, O. (1980). Ancient Woodland. Arnold. London.

Ratcliffe, D.A. (Ed.) (1977). A Nature Conservation Review. Cambridge University Press. Cambridge.

Reisenbichler, R.R & McIntyre, J.D. (1977). Genetic differences in growth and survival of juvenile hatchery and wild steelhead trout (*S. gairdneri*). Journal of the Fisheries Research Board of Canada, **34**, 123-128.

Robertson, N.A., Muirson, D.J., Moore, D.C. & McHenry, J.G. (1991). Studies on invertebrate assemblages associated with seaweeds on rocky shores adjacent to salmon farm cages in Scottish sea lochs. Scottish Fisheries Working Paper No. 17/91. Scottish Office Agriculture and Fisheries Department. Aberdeen.

Robertson, P.A., Clarke, S.A. & Warren, M.S. (1994). Woodland management and butterfly diversity. *In*: Ecology and conservation of butterflies (Ed. Pullin, A.S.). Chapman and Hall. London.

Ross, A. (1988). Controlling nature's predators on fish farms. Marine Conservation Society. Ross-on-Wye.

Ross, A. & Horsmann, P.V. (1988). The use of Nuvan 500 EC in the salmon farming industry. Marine Conservation Society. Ross-on-Wye

Rothwell, P.I. & Housden, S.D. (1990). Turning the Tide: a future for estuaries. RSPB. Sandy

Rothwell, P. (1991). Sea of Troubles? Ecos, **2**, 1.

Rowell, T.A. (1991). SSSIs: A Health Check. A review of the Statutory Protection Afforded to SSSIs in Great Britain. Wildlife Link. London.

RSPB (1989). The Impact of Sea Level Rise on Red Data Birds. RSPB Internal Review. Sandy.

RSPB (1991). Coastal Zone Planning:Evidence to the House of Commons Select Committee on the Environment. RSPB. Sandy.

Salmon, D.G, Prys-Jones, R.P & Kirby, J.S. (1989). Wildfowl and wader counts 1988 - 1989. The Wildfowl and Wetlands Trust Slimbridge.

Sattaur, O. (1989). The threat of the well-bred salmon. New Scientist. 29.4.89. 54-58.

Saunders, D.A., Hobbs, R.J & Margules, C.R. (1991). Biological consequences of ecosytem fragmentation: A review. Conservation Biology, **5**, 18 - 32.

Schamberger, M., Farmer, A.H. & Terrell, J.W. (1982). Habitat suitability index models: Introduction. FWS/OBS-82/10. U.S Fish and Wildlife Service.

Scottish Office Environment Department (1991). Guidance on the Location of Marine Fishfarms : Consultative Draft. SOEND. Edinburgh.

Scottish Salmon Growers Association (1990). Salmon Farming and Predatory Wildlife - A Code of Practice. SSGA.

Scottish Wildlife & Countryside Link (1988). Marine Fishfarming in Scotland : A Discussion Paper. SWCL. Perth.

Scottish Wildlife & Countryside Link (1990). Marine Salmon Farming in Scotland : A Review. SWCL. Perth.

Scottish wildlife & Countryside Link (1993). All at sea? coastal zone mangement - the case for Scotland. SWCL. Perth.

Scottish Wild Land Group (1988). Review of the landscape effects of fish farming. Unpublished Report.

Selman, P.H. (1981). Ecology and planning: an introductory study. George Godwin Ltd. London.

Selman, P. H. (1982). The role of the ecologist in EIA. Ecos, **3**, 13-15.

Sidaway, R. (1991). A Review of Marina Developments in Southern England. RSPB/WWF Joint Report.

Smith, K.W. (1987). Ecology of the great spotted woodpecker. RSPB Conservation Review, **1**, 74-78.

Smith, K.W. (1988). Breeding bird communities of commercially managed broadleaved plantations. RSPB Conservation Review, **2** , 43-47.

Sorensen, J.C. (1971). A framework for identification and control of resource degradation and conflict in the multiple use of the coastal zone. Department of Landscape Architecture. University of California. Berkley.

Southwood, T.R.E. (1961). The number of species of insect associated with various trees. Journal of Animal ecology, **30**, 1-8.

Spellerberg, I.F. & Minshull, A. (1990). An Investigation into the Nature and Use of Ecology in Environmental Impact Assessments. Unpublished report to the British Ecological Society.

Spencer, R.J. (1992). The future for sea lice control in cultured salmonids: A review. SWCL. Perth.

Starfield, A.M. & Bleloch, A.L. (1986). Building models for conservation and wildlife management. Macmillan. London.

Stevens, D.L. (1994). Implementation of National Monitoring Program. Journal of Environmental Management, **42**, 1-29.

Stoney, P. (1989). The Mersey Barrage:Panacea or Hot Air? Merseyside Economic and Business Prospect 4 (2).

Stowe, T.J. (1987). The management of sessile oakwoods for pied flycatchers. RSPB Conservation Review, **1**, 78-83.

Therivel, R., Wilson, E., Thompson, S., Heaney, D & Pritchard D. (1992). Strategic environmental assessment. Earthscan. London.

Thomas, J.M. & Eberhardt, L.L. (1976). Ecological impact assessment. *In* Proceedings of conference on computer support of environmental science and analysis. 181-197. U.S Energy and Development Administration, Washington, D.C.

Thornton, D. & Kite, D.J. (1990). Changes in the extent of the Thames estuary grazing marshes. NCC. Peterborough.

Thorpe, J.E. & Mitchell, K.A. (1981). Stocks of Atlantic salmon (*Salmo salar*) in Britain and Ireland - Discreteness and current management. Canadian Journal of Fisheries and Aquatic Sciences, **38**, 1576-1590.

Treweek, J.R., Thompson, S., Veitch, N. & Japp, C. (1993) Ecological Assessment of Proposed Road Developments: A Review of Environmental Statements. Journal of Environmental Planning and Management. **36**. (3). pp 295 - 307.

Treweek, J.R., Manchester, S.J., Hankard, P., Osborn, D., Mountford, O., Eversham, B.C., Arnold, H., Veitch, N. & Fuller, R. (1993a). The development of a comparative environment index. ITE Monks Wood. Huntingdon.

Treweek, J.R. & Veitch, N. (1994). Use of GIS and remotely sensed data for ecological assessment of proposed new road schemes. Journal of Biogeography, in press.

United States Council on Environmental Quality (1970). Regulations for Implementing the Provisions of the National Environmental Policy Act. 40 CFR, 1500 - 1508.

United Nations Economic Commission for Europe (1992). Environmental Series 5: Application of Environmental Impact Assessment Principles to Policies, Plans and Programmes. UNECE. New York.

US Government (1970). National Environmental Policy Act of 1969 (NEPA). P.L. 91 -190. 83 Stat. 852. (1.1.70)

US Fish and Wildlife Service (1980). Habitat Evaluation Procedures (HEP). ESM 102. Washington D.C.

US Fish and Wildlife Service (1988). Endangered Species Information System. Washington D.C.

# SOME PARTS EXCLUDED UNDER INSTRUCTION FROM THE UNIVERSITY

US Environmental Protection Agency (1988). Future risk strategies for the 1990's. SAB-EC-88-048. US EPA. Washington D.C.

Van Winkle, W., Christensen, S.W. & Mattice, J.S. (1976). Two Roles of Ecologists in Defining and Determining the Acceptability of Environmental Impacts. International Journal of Environmental Studies, **9**, 247-254.

Wagner, D. (1991), UVP fur Politiken, Programme und Planungen in den USA. Unpublished Report to UVP.

Walker, B.H & Norton, G.A. (1982). Applied Ecology: Towards a Positive Approach. II Applied Ecological Analysis. Journal of Environmental Management, **14**, 325-342.

Walker, P.M.B. (Ed.) (1988). Chambers Science and Technology Dictionary. Chambers. Cambridge.

Warren, M.S. & Fuller, R.J. (1990). Woodland rides and glades: Their management for wildlife. NCC. Peterborough.

Warren, M.S & Key, R.S. (1991). Woodlands: past, present, and potential for insects. *In* The conservation of insects and their habitats (Eds. Collins, N.M & Thomas, J.A.). Academic Press. London.

Warren, M.S. & Thomas, J.A. (1992). Butterfly responses to coppicing. *In* The ecological effects of coppicing (Ed. Buckley, G.P.). Chapman & Hall. London.

Wathern, P.(1988). An Introductory Guide to EIA. *In* Environmental Impact Assessment: Theory and Practice. (Ed. Wathern, P.). Unwin Hyman. London.

Webb, N.R. & Haskins, L.E. (1980). An ecological survey of heathland in the Poole Basin, Dorset, England in 1978. Biological Conservation, **17**, 281-296.

Webb, N.R. & Hopkins, P.J. (1984). Invertebrate diversity on fragmented *Calluna* heathland. Journal of Applied Ecology, **21**, 921 - 933.

Webb, N. (1986). Heathlands - A Natural History of Britain's Lowland Heaths. New Naturalist. Collins

Wilcove, D.S, McLellan, C.H. & Dobson, A.P. (1986). Habitat fragmentaion in the temperate zone. *In*: Conservation Biology. The Science of Scarcity and Diversity (Ed. Soule, M.E.). Sinauer. Massachusetts.

World Wide Fund for Nature (1992). Written evidence submitted to the House of Commons Select committee on the Environment on Coastal Protection and Planning. WWF. Surrey.

Youngson, A.F., Webb, J.H., Thompson, C.E, & Knox, D. (1993). Spawning of escaped farmed atlantic salmon (*Salmo salar*): Hybridization of females with brown trout (*Salmo trutta*). Canadian Journal of Fish Aquatic Science, **50**, 1986-1993.

# Appendix 1

# PROJECTS TO WHICH THE TOWN AND COUNTRY PLANNING (ASSESSMENT OF ENVIRONMENTAL EFFECTS) REGULATIONS 1988 APPLY

**Schedule 1 projects**

The following types of development ('Schedule 1 projects') require environmental assessment in every case:

(1) The carrying out of building or other operations, or the change of use of buildings or other land (where a material change) to provide any of the following

1 A crude-oil refinery (excluding an undertaking manufacturing only lubricants from crude oil) or an installation for the gasification and liquefaction of 500 tonnes or more of coal or bituminous shale per day.

2 A thermal power station or other combustion installation with a heat output of 300 megawatts or more, other than a nuclear power station or other nuclear reactor.

3 An installation designed solely for the permanent storage or final disposal of radioactive waste.

4 An integrated works for the initial melting of cast-iron and steel.

5 An installation for the extraction of asbestos or for the processing and transformation of asbestos or products containing asbestos:

(a) where the installation produces asbestos-cement products, with an annual production of more than 20,000 tonnes of finished products; or

(b) where the installation produces friction material, with an annual production of more than 50 tonnes of finished products; or

(c) in other cases, where the installation will utilise more than 200 tonnes of asbestos per year.

6 An integrated chemical installation, that is to say, an industrial installation or group of installations where two or more linked chemical or physical processes are employed for the manufacture of olefins from petroleum products, or of sulphuric acid, nitric acid, hydrofluoric acid, chlorine or fluorine.

7 A special road; a line for long-distance railway traffic; or an aerodrome with a basic runway length of 2,100 m or more.

8 A trading port, an inland waterway which permits the passage of vessels of over 1,350 tonnes or a port for inland waterway traffic capable of handling such vessels.

9 A waste-disposal installation for the incineration or chemical treatment of special waste.

(2) The carrying out of operations whereby land is filled with special waste, or the change of use of land (where a material change) to use for the deposit of such waste.

**Schedule 2 projects**

The following types of development ('Schedule 2 projects') require environmental assessment if they are likely to have significant effects on the environment by virtue of factors such as their nature, size or location:

*1. Agriculture*

(a) water-management for agriculture
(b) poultry-rearing
(c) pig-rearing
(d) a salmon hatchery
(e) an installation for the rearing of salmon
(f) the reclamation of land from the sea

*2. Extractive industry*

(a) extracting peat
(b) deep drilling, including in particular
  (i) geothermal drilling
  (ii) drilling for the storage of nuclear waste material
  (iii) drilling for water supplies but excluding drilling to investigate the stability of the soil
(c) extracting minerals (other than metalliferous and energy-producing minerals) such as marble, sand, gravel, shale, salt, phosphates and potash
(d) extracting coal or lignite by underground or open-cast mining
(e) extracting petroleum
(f) extracting natural gas
(g) extracting ores
(h) extracting bituminous shale
(i) extracting minerals (other than metalliferous and energy-producing mineral) by open-cast mining
(j) a surface industrial installation for the extraction of coal, petroleum, natural gas or ores or bituminous shale
(k) a coke oven (dry distillation of coal)
(l) an installation for the manufacture of cement

3. *Energy industry*

(a) a non-nuclear thermal power station, not being an installation falling within Schedule 1, or an installation for the production of electricity, steam and hot water
(b) an industrial installation for carrying gas, steam or hot water; or the transmission of electrical energy by overhead cables
(c) the surface storage of natural gas
(d) the underground storage of combustible gases
(e) the surface storage of fossil fuels
(f) the industrial briquetting of coal or lignite
(g) an installation for the production or enrichment of nuclear fuels
(h) a installation for the reprocessing of irradiated nuclear fuels
(i) an installation for the collection or processing of radioactive waste, not being an installation falling within Schedule 1
(j) an installation for hydroelectric energy production

4. *Processing of metals*

(a) an ironworks or steelworks including a foundry, forge, drawing plant or rolling mill (not being a works falling within Schedule 1)
(b) an installation for the production (including smelting, refining, drawing and rolling) of non-ferrous metals, other than precious metals
(c) the pressing, drawing or stamping of large castings
(d) the surface treatment and coating of metals
(e) boilermaking or manufacturing reservoirs, tanks and other sheet-metal containers
(f) manufacturing or assembling motor vehicles or manufacturing motor-vehicle engines
(g) a shipyard
(h) an installation for the construction or repair of aircraft
(i) the manufacture of railway equipment
(j) swaging by explosives
(k) an installation for the roasting or sintering of metallic ores

5. *Glass making*

the manufacture of glass

6. *Chemical industry*

(a) the treatment of intermediate products and production of chemicals, other than development falling within Schedule 1
(b) the production of pesticides or pharmaceutical products, paints or varnishes, elastomers or peroxides
(c) the storage of petroleum or petrochemical or chemical products

7. *Food industry*

(a) the manufacture of vegetable or animal oils or fats
(b) the packing or canning of animal or vegetable products
(c) the manufacture of dairy products
(d) brewing or malting
(e) confectionery or syrup manufacture
(f) an installation for the slaughter of animals
(g) an industrial starch manufacturing installation
(h) a fish-meal or fish-oil factory
(i) a sugar factory

8. *Textile, leather, wood and paper industries*

(a) a wool scouring, degreasing and bleaching factory
(b) the manufacture of fibre board, particle board or plywood
(c) the manufacture of pulp, paper or board
(d) a fibre-dyeing factory
(e) a cellulose-processing and production installation
(f) a tannery or a leather dressing factory

9. *Rubber industry*

the manufacture and treatment of elastomer-based products

10. *Infrastructure products*

(a) an industrial estate development project
(b) an urban development project
(c) a ski-lift or cable-car
(d) the construction of a road, or a harbour, including a fishing harbour, or an aerodrome, not being development falling within Schedule 1
(e) canalization or flood-relief works
(f) a dam or other installation designed to hold water or store it on a long-term basis
(g) a tramway, elevated or underground railway, suspended line or similar line, exclusively or mainly for passenger transport
(h) an oil or gas pipeline installation
(i) a long-distance aqueduct
(j) a yacht marina

11. *Other projects*

(a) a holiday village or hotel complex
(b) a permanent racing or test track for cars or motor cycles
(c) an installation for the disposal of controlled waste or waste from mines and quarries, not being an installation falling within Schedule 1
(d) a waste water treatment plant
(e) a site for depositing sludge
(f) the storage of scrap iron

(g) a test bench for engines, turbines or reactors
(h) the manufacture of artificial mineral fibres
(i) the manufacture, packing, loading or placing in cartridges of gunpowder or other explosives
(j) a knackers' yard

12. *The modification of a development which has been carried out, where that development is within a description mentioned in Schedule 1.*

13. *Development within a description mentioned in Schedule 1, where it is exclusively or mainly for the development and testing of new methods or products and will not be permitted for longer than one year.*

## Appendix 2

## EXAMPLE OF COMPLETED RECORD SHEET USED IN REVIEW OF ENVIRONMENTAL STATEMENTS

| DETAILS OF ENVIRONMENTAL STATEMENT | |
|---|---|
| CATEGORY OF DEVELOPMENT | Port & harbour |
| ANNEX OF DIRECTIVE | II |
| PROJECT | Proposed re-development of Folkestone Harbour |
| DEVELOPER | Sea Containers Property Services Ltd |
| PLANNING AUTHORITY | Not stated |
| DATE | 1989 |
| REGULATIONS | Town & Country (Env. Ass. Effects) Regs 1988<br>Harbour Works (Env. Ass. Effects) Regs. 1988 & 1989 |
| APPROVAL STATUS | Not known |

| DESCRIPTION/CHARACTERISATION OF SITE/AREA AFFECTED | |
|---|---|
| LOCATION | South eastern corner of Folkestone town |
| GRID REFERENCE | Not stated |
| SIZE | 10.8 ha |
| TOPOGRAPHY | Not stated |
| LAND-USE | 5.0 ha open water<br>5.0 ha urban<br>0.8 ha harbour pier |
| MAJOR HABITAT TYPES | Rocky headland |
| DESIGNATED AREAS | Folkestone Warren SSSI<br>Heritage coastline |
| POSITION/IMPORTANCE OF SITE | Site bounded by sea to south and east.<br>Northern boundary: quayside areas |

| DESCRIPTION/CHARACTERISATION OF DEVELOPMENT | |
|---|---|
| IS THE DEVELOPMENT DESCRIBED? | Harbour village - residential and commercial property + boat moorings and leisure facilities |
| IS THE SIZE OF THE DEVELOPMENT DEFINED? | New basin of 0.7 ha, new land area of 1.3 ha, 200 berths for leisure craft, 500 residential dwellings |
| IS THE PROPOSED TIMESCALE STATED? | Phased construction over 8 years |
| ARE THE MAIN CATEGORIES OF POTENTIAL IMPACT OUTLINED? | Yes (broadly) - construction of lock, waterproofing basin walls |
| IS A DISTINCTION MADE BETWEEN OPERATIONAL & CONSTRUCTIONAL IMPACTS? | No |
| IS DEVELOPMENT DESCRIBED SO THAT POTENTIAL ECOLOGICAL IMPACTS CAN BE IDENTIFIED? | No |
| ALTERNATIVE SITES CONSIDERED? | No |
| ALTERNATIVE PROCESSES/METHODS CONSIDERED? | No |
| CHOICE OF SITE FULLY EXPLAINED? | No |
| NEED FOR DEVELOPMENT ASSESSED? | No |

| INFORMATION NECESSARY TO PREDICT/EXPLAIN IMPACTS | |
|---|---|
| ARE POTENTIAL ECOLOGICAL IMPACTS IDENTIFIED/DESCRIBED? | Yes |
| ARE DIRECT IMPACTS IDENTIFIED? | Loss of 0.6 ha of open water.<br>Water level change will affect habitat - loss of intertidal mudflats and sandflats in inner and outer harbour.<br>Lower water quality in harbour due to reduced flushing.<br>Destruction of algae by sealing permeable harbour walls. |

| | |
|---|---|
| ARE INDIRECT IMPACTS IDENTIFIED? | Changes in salinity.<br>Changes in erosion/deposition patterns in ecologically sensitive intertidal and subtidal areas.<br>Disturbance to roost sites (purple sandpipers) |
| ARE TIMESCALES GIVEN FOR IMPACTS? | No |
| INFORMATION PROVIDED TO QUANTIFY IMPACTS? | No |
| IMPACTS QUANTIFIED | None |
| COMPLEX/INTERACTIVE EFFECTS CONSIDERED? | No |

| ECOLOGICAL EVALUATION/ASSESSMENT | |
|---|---|
| BASELINE DATA AVAILABLE FOR SITE OR ANY HABITATS SPECIES PRESENT | Birds |
| DESIGNATED HABITATS LISTED | Rocky shore |
| PROTECTED SPECIES LISTED | Purple sandpiper |
| HABITATS SPECIES CONSIDERED IN TERMS OF LOCAL, REGIONAL, NATIONAL OR INTERNATIONAL IMPORTANCE? | Yes (most important site in UK wintering Mediterranean gulls |
| FOLLOW-UP MONITORING RECOMMENDED? | No |

| MITIGATION MEASURES/PROPOSALS | |
|---|---|
| ARE ECOLOGICAL MITIGATION MEASURES SUGGESTED? | Yes |
| DO THE PROPOSED MEASURES RELATE TO SPECIFIC IMPACTS? | No |
| MAIN TYPES OF MITIGATION MEASURES PROPOSED | Surface water run-off via petrol interceptors.<br>Sealed bunds round fuel stores to prevent spills. |
| DETAILED PRESCRIPTIONS GIVEN FOR ABOVE? | No |
| LIKELY SUCCESS INDICATED? | No |

| | |
|---|---|
| INDICATION OF HOW PROPOSED MITIGATION MEASURES MIGHT BE MODIFIED SHOULD THEY PROVE UNSUCCESSFUL? | No |

| SURVEY METHODS/SOURCES OF BACKGROUND INFORMATION USED | |
|---|---|
| CONSULTATIONS? | Yes - RSPB, BTO, NCC |
| RELEVANT LITERATURE? | Yes |
| RESULTS OF PREVIOUS SURVEY? | Yes - channel tunnel |
| NEW SURVEYS CARRIED OUT? | Birds & invertebrates |
| TIME OF YEAR CARRIED OUT? | August & September for invertebrates |
| DURATION/INTENSITY OF STUDY | Not known |
| TYPE OF RESULT? | Descriptive |
| LIMITATIONS ACKNOWLEDGED? | Much fuller use of literature and advice than usual. |

| PRESENTATION OF ECOLOGICAL INFORMATION | |
|---|---|
| PROPORTION OF ES DEVOTED TO ECOLOGICAL CONSIDERATIONS? | 17 pages - 20% of ES |
| MAPS INCLUDED, e.g. OF MAJOR HABITAT TYPES? | No |
| CLARITY OF MAPS | Not applicable |
| ECOLOGICAL TERMS FULLY EXPLAINED? | No |
| ARE RESULTS OF ECOLOGICAL SURVEY INCLUDED IN ES? | Yes |
| IF NOT, ARE SOURCE DOCUMENTS FULLY REFERENCED OBTAINABLE? | Not applicable |
| IS AUTHOR/ECOLOGICAL CONSULTANT NAMED? | Yes |
| IS A NON-TECHNICAL SUMMARY PROVIDED? | Yes - included in main ES |
| DOES THIS MAKE ANY REFERENCE TO ECOLOGICAL CONSIDERATIONS? | Yes |

## Appendix 3

# ENVIRONMENTAL STATEMENTS REVIEWED GROUPED BY TYPE OF DEVELOPMENT

### WASTE TREATMENT (8)

1. Roundhill sewage treatment, Stourbridge
2. Haywards heath clinical waste, the Weald
3. Knostrop clinical waste incinerator, Leeds
4. Knostrop effluent treatment, Leeds
5. Fylde sewage treatment, Lancs
6. Mansfield sewage treatment, Notts
7. Calder valley sewage treatment, Yorks
8. Portsea island waste incineration, Hants

### OPENCAST (15)

9. Broughton Lodge, Cumbria
10. Eldon deep, Durham
11. Rye hill, Durham
12. Brynhenllys, Brecknock
13. Symon, Shropshire
14. Colliersdean, Northumberland
15. Bleak House, Staffs
16. Lounge Remainder, Leics
17. Helid, Rhymney
18. Sutherland, Staffs
19. Berryhill, Staffs
20. Nadins, Derbys
21. Chapmans Well, Durham
22. Arkwright, Derbys
23. Airds Green, Strathclyde

### PORT & HARBOUR (5)

24. Folkestone harbour
25. Isle of Grain, Medway
26. Hyle harbour, Cornwall
27. Liquified gas terminal, Isle of Grain, Medway
28. Peterhead Bay

### LEISURE (6)

29. Ring Haw, Northampton
30. Chester-le-Street riverside scheme, Durham

31. Blackpool football club Confernce centre
32. Sampford Courtenay golf club
33. Gateway project, Glos
34. Cotswold water park, Glos

## POWER TRANSMISSION (3)

35. Chase terrace, Cannock
36. Strathaven - Harker
37. Isle of Grain, Medway

## ROADS (26)

38. A650 Airedale
39. A249 Kent
40. Woodstock bypass
41. A658 Harrogate - Knaresborough
42. M20 improvement, Junctions 5 - 8
43. A406 Bounds Lane - Gren Lae
44. A406 east London river crossing
45. A13 Wennington to mar dyke
46. A39 Wadebridge bypass
47. A23 London - Brighton bypass
48. A49 Onibury to Stokesay
49. A27 Folkestone - Honiton, Crossbush bypass
50. A27 Folkestone - Honiton, Brighton bypass
51. A13 Heathway - Wennington
52. A629 Skipton - Kildwick
53. A249 Iwade bypass
54. Melrose bypass to A68
55. Folkestone - Honiton, A259 Brooklands diversion
56. Kelso bypass & New bridge
57. A249 Stockbury to Sheerness
58. A30 Okehampton - Launceston
59. A45 Rushden & Higham Ferrers Dualling
60. A130 bypass, A12 - A132
61. A2070 Stockbridge - South Ashford
62. A46 Leicester western bypass
63. A61 Ripon bypass

## WIND FARMS (5)

64. Climping
65. Deli, Cornwall
66. Crimp, Cornwall
67. Goonhilly Downs, Cornwall
68. Ovenden Moor, Halifax

AGRICULTURE (5)

69. Turkey farm, Spalding
70. Pinchbeck Abbatoir, Spalding
71. Plowlands pig unit, Humberside
72. Upper triley farm, Abergavenny
73. Lamlash Bay fish farm, Arran

MINERAL EXTRACTION TOTAL (18)

74. Chantry farm, Essex
75. Cumnock peat extraction
76. Coalburn moss, Lanark
77. Whatley quarry, Somerset
78. Darlton quarry, Derbys
79. Scotton, N. Yorks
80. Kensworth quarry, Beds
81. Croft quarry, Leics
82. Boghead farm, Banff
83. Covenbrook Hall, Essex
84. Cil-Lonydd, Newbridge
85. Ringstead grange, Northampton
86. Aberduna quarry, Clywd
87. Frating Hall
88. Pasture house, Peterborough
89. Springfield farm, Bucks
90. Cottingham quarry, Northants
91. Duntanlich, Tayside

PIPELINES (8)

92. Bacton gas, Norfolk
93. Stanlow to Eastham
94. Easington to Immingham
95. Teeseide pipelines project
96. Amoco CATS, Teeside
97. Grangemouth to Stanlow
98. Connahs's Quay, Ayr
99. Theddlethorpe to Killingholme

LANDFILL (12)

100. Dimmer landfill
101. Gypsum disposal, N.Yorks
102. Lount, Leics
103. East taphouse, Cornwall
104. Cornwall extension
105. Risley, Cheshire
106. Ufex raffinate, Cumbria
107. Southerham grey pits, Lewes

108. Silent valley, Gwent
109. Hogoak, Berks
110. Thrislington quarry, Co. Durham
111. Salt way, Droitwich

## POWER STATIONS (25)

112. Staythorpe C
113. N.Yorks power project
114. Fawley B
115. South Denes, Great Yarmouth
116. Sizewell C
117. Barking Reach, CCGT
118. Ince B
119. West Burton B
120. Killingholme CCGT
121. Combined heat and Power, Teeside
122. Newport WDF fired station
123. Didcot B
124. Cortaulds Acetate, Derbys
125. Wylfa B
126. Trafford power station, Lancs
127. Connahs quay CCGT, Clywd
128. Killingholme A
129. Rye house, Herts
130. Drax power, N.Yorks
131. Bilsthorpe power, Newark
132. Sutton bridge, Lincs
133. Grovehurst power, Kent
134. Longannet, Dunfermline
135. Angle bay energy project
136. Biston Moss

## MIXED DEVLOPMENTS (29)

137. River springs, Cambs
138. Priory park, Surrey
139. Waterloo Cross, business park
140. Great Common farm, Cambs
141. Junction 27 employment park, Tiverton
142. Armthorpe Industrial park, S.Yorks
143. Six Hills new village, Leics
144. Brockworth business park, Glos
145. Kings Hill commercial development, Kent
146. Kings Cross business park
147. Foston airfield business park
148. Creswell business park, Stafford
149. Blythe Valley business park
150. Peterborough southern township
151. Snow Hill, Wakefield
152. Brackmills, Northants

153. Ashford Great Park, Kent
154. Lords Wood Plantation, Southampton
155. White City Centre, Fulham
156. Waltham Park, Herts
157. Chertsey revitalisation, Brixton
158. Heron Quays, Tower Hamlets
159. Langlands, E. Kilbride
160. Bilsthorpe 2000, Notts
161. Enfield Island, Herts
162. Kennet development, Cambs
163. Belham Hill, Cambs
164. Lowfields, Leeds
165. Northampton new town

## MISCELLANEOUS (14)

166. Distribution depot, Kent
167. Narrow gauge railway, Shropshire
168. Sheffield & rotherham City Airport
169. Landing strip, Ewins
170. Jubilee Line extension
171. Sea Wall, Hants
172. Railway Engineering works, Desford
173. Firework factory, Blaenau
174. NRA gauging station, Whatstandwell
175. Devenport nuclear submarine facilities
176. Harwell laboratory, Oxon
177. Kemsley Mill, Kent
178. River Usk barrage, Newport
179. Netherley pumping station, Kincardine