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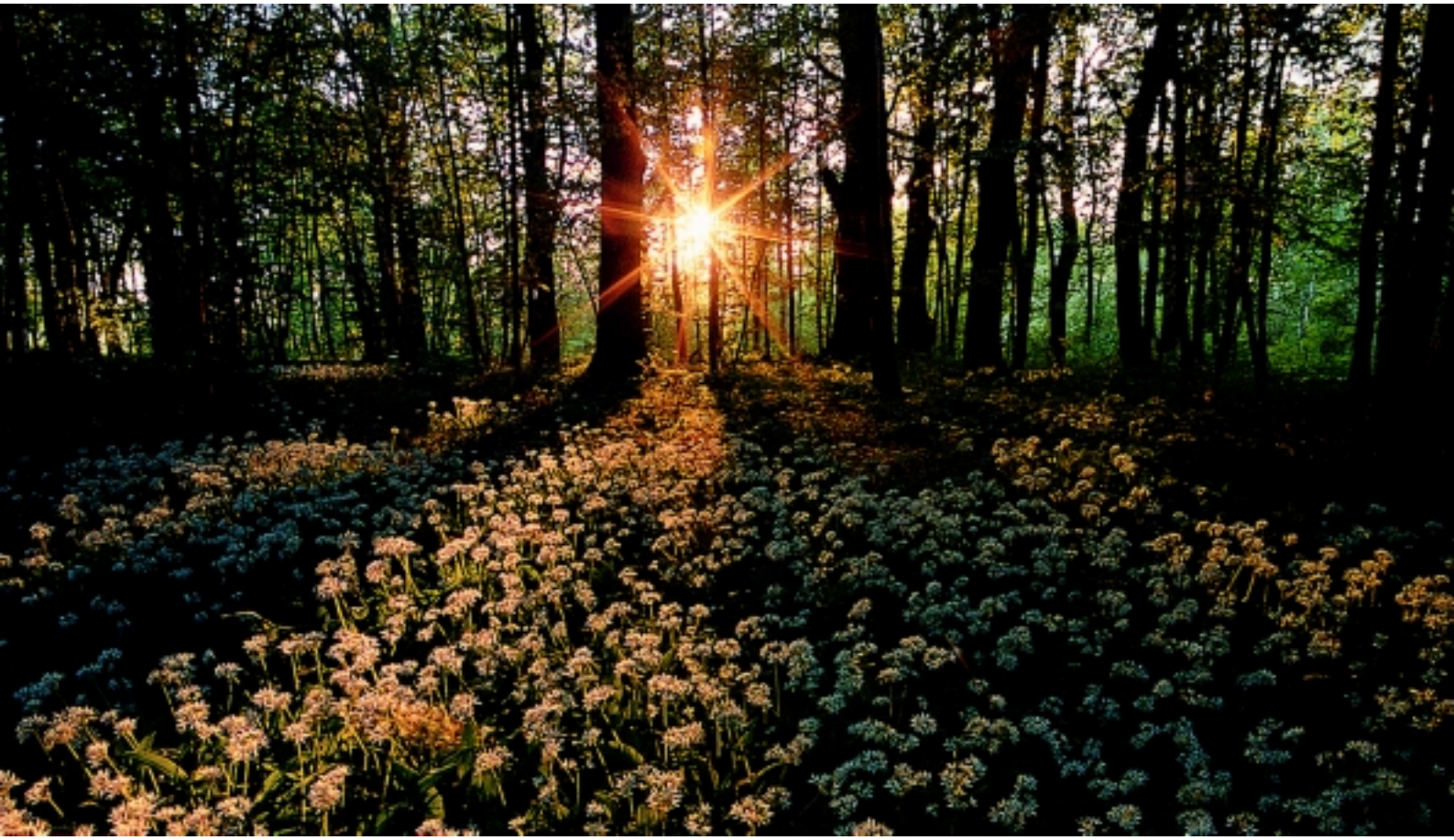

Accounting for biodiversity:

a natural inventory of the Elan Valley Nature Reserve

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The Association of Chartered Certified Accountants

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Contents

Executive summary

Environmental concern occupies centre stage as we enter the new Millennium. Environmental accounting reflects this environmental concern. So far, however, most environmental accounting studies have been descriptive or purely theoretical. There is a need to try to operationalise environmental accounting. Building a practical framework is the concern of this particular research report.

The three main objectives of the research report are:

1. to outline a potential environmental reporting paradigm

2. to show the feasability of the paradigm when applied by a major UK company

   and

3. to encourage discussion and experimentation by companies in the environmental reporting domain.

The research applies a method of recording and valuing habitats, flora, and fauna to the Elan Valley Nature Reserve, owned by UK company, Hyder plc. The research shows that it is feasible to show corporate stewardship of natural assets. The model presents:

- the types of habitat, their critical status and ecological grading

- the number of critical species

- the total number of species

  and

- different valuation methods.

The model used is shown to be feasible and now needs to be field tested on other organisations.

1. Introduction

In the 1990s, environmental accounting, mirroring environmental concern, has flourished. In the main, however, environmental accounting has focused on building a theoretical framework (see, for example, Gray 1992) or on conducting empirical studies that seek to describe and explain environmental accounting in terms of corporate or organisational characteristics (see, for example, Harte and Owen, 1992; Deegan and Gordon, 1996). These studies provide a good framework within which environmental accounting can be located and understood. They do not, however, attempt to provide an operational and practical framework for environmental accounting.

This monograph seeks to develop the debate and provides one possible environmental reporting paradigm. This environmental reporting model is not meant to be exclusive or exhaustive, denying other models. The focus of the proposed model is centred around the concept of a natural inventory. Organisations are encouraged to test and adopt the proposed model which is applied to the Elan Valley Nature Reserve, owned by a large UK listed company, Hyder plc (a utility company specialising in water and electricity).

The main objectives of this paper are:

1. to outline a potential environmental reporting paradigm

2. to show the feasibility of the paradigm when applied by a major UK company

   and

3. to encourage discussion and experimentation by companies in the environmental reporting domain.

The remainder of the monograph is structured as follows. Chapter 2 outlines the motivation for the proposed model and sets out its main components (i.e., hierarchical reporting of habitats, flora and fauna). The following two chapters then apply the model to the Elan Valley Estate owned by Hyder plc. Chapter 3 explains the nature of the estate and the main methodology used in the study, while chapter 4 demonstrates the results of applying the model. Finally, chapter 5 concludes the report and calls for further research.

2. The natural inventory model

2.1 Motivation

This model corrects a common failing of the traditional organisational reporting model which is that environmental factors which do not have a market price are traditionally excluded from corporate reporting. Consider two organisations, A and B. Organisation A may be a good citizen. It establishes expensive pollution controls, protects the land it owns and the wildlife that inhabits it. Organisation B, by contrast, is less altruistic. Not only does it not invest in pollution control, but it neglects its wildlife assets. In pure monetary terms, however, organisation A may be penalised. Its expenditure on pollution controls and on good stewardship activities may reduce its cashflow and, perhaps, even its profit and stock market valuation.

This model starts with the basic premise that this is wrong. Not only should an organisation act as an environmental good citizen, but it should report this good citizenship to its stakeholders. The underlying premise of this model is that organisations are accountable, not only to their stakeholders, but also to society at large, for their stewardship of the environment. More specifically, this monograph argues that organisations are stewards/trustees of natural assets, i.e., habitats, flora and fauna. Importantly, stewardship is distinctly different from ownership. Organisations thus do not, therefore, have the right automatically to use or dispose of natural assets in any way they think fit. There are wider societal concerns.

This monograph focuses on natural assets. This does not imply that this should be the only environmental aspect that is reported. However, these wildlife assets constitute a separate and distinctive environmental sub-system. This sub-system is dynamic and interactive. It is also of crucial importance as it marks a repository for global biodiversity. Habitat and species loss cause a loss of global biodiversity.

2.2 Model development overview

There are three recognisable, but distinguishable, components of any comprehensive natural assets wildlife system: wildlife habitats (land or water), flora and fauna. These three components are intertwined in complex interconnected ecosystems. These ecosystems interact with each other and with human systems such as the economic environment.

Each of these three components can broadly be partitioned into critical and non-critical natural capital. Critical capital is irreplacable. This could comprise rare heathland, and endangered and rare animal or plant species. If critical capital is lost, the planet's biodiversity is diminished. There are thus enhanced imperatives to maintain critical capital. Non-critical capital represents, by default, the remainder of the planet's natural assets.

Natural capital can also be designated as managed or self-sustaining. Managed capital is,

for example, forestry, agricultural and/or wildlife parks. In these instances, human kind intervenes either for commercial purposes or more rarely for conservation/recreational purposes. In the developed word, self-sustaining natural capital is very much of a rarity. Most critical capital is in protected landscapes, for example, in the UK's, Sites of Special Scientific Interest (SSSIs).

The natural capital is capable of being measured and recorded. However, the measurement and recording is not uniform. For example, it is easier to classify habitats than flora. In addition, although there is generally abundant taxonomic information on certain species, such as birds, information on other species, such as lichen is, to say the least, problematic. However, in developed countries, such as the UK, data on many species is abundant.

The possible accounting system for natural wildlife assets follows a hierarchical model comprising three stages: recording, valuing and reporting. There are six levels of hierarchy arranged in order of criticality. For example, level 1 merely categorisies habitat type and natural capital status, while level 6 comprises a general inventory of flora and fauna by total population. The six levels of natural inventory are arranged in a pyramid of hierarchical criticality in figure 1. This model is discussed more fully below in section 2.3 under the three major headings: recording, valuing, reporting.

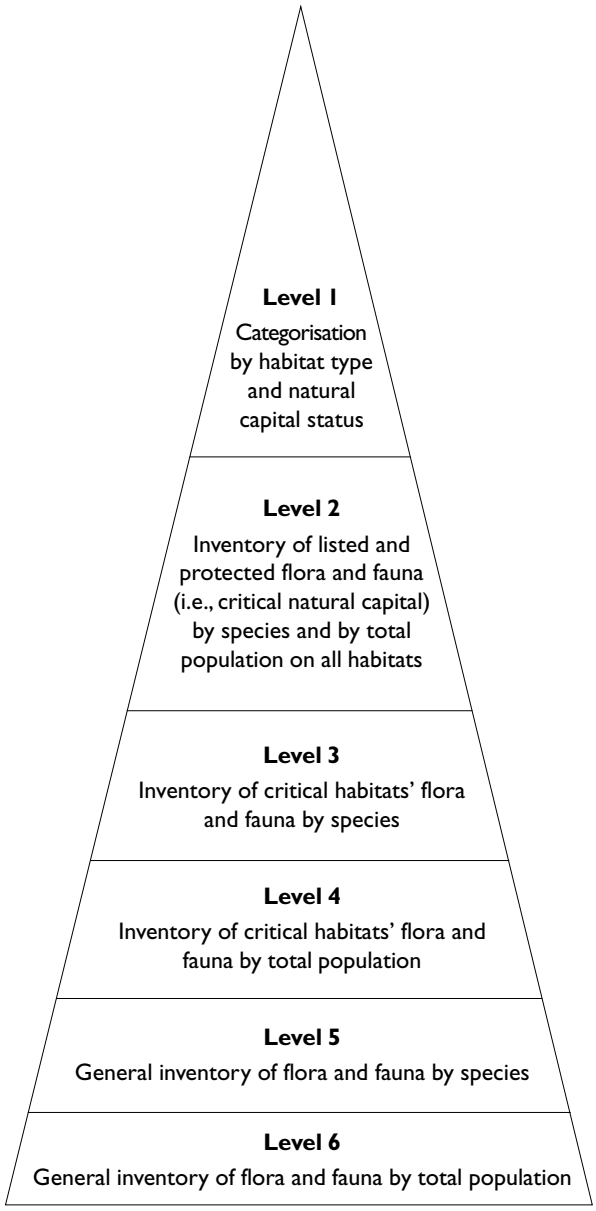

Figure 1 : Natural inventories: hierarchical criticality.
Source, Jones, 1996, p.291

2.3 The model

a. Recording

The three major components of the natural inventory are wildlife habitats (land or water), flora and fauna.

Wildlife habitats. Wildlife habitats are classifiable using several possible national and international classification schemes such as the Nature Conservancy Council Scheme or the National Vegetation Classification Scheme (NVC). Essentially, these schemes involve classifying habitats into a number of categories. These habitats are then categorised as either critical natural capital or sustainable natural capital. In the UK, there are various types of protected area such as Sites of Specific Special Interest (SSSIs), Natural Nature Reserves (NNRs), Special Protected Areas (SPAs) or Special Areas for Conservation (SACs). Collection of the habitat data represents the first stage of the natural inventory (see figure 1).

Flora and fauna are obviously interconnected. Some flora and fauna are relatively easy to identify (for example, birds) while others, such as lichens, are extremely elusive both to identify and to record. As with habitats, flora and fauna can be divided into critical and non-critical. Critical species are principally those that are endangered (survival unlikely if present causal factors continue); vulnerable (likely to move into endangered categories in near future; and rare (at risk). Information on critical species is available from a variety of sources, such as the UK Biodiversity Action Plan (1994) and the Red Data publications.

Inventory stages. The model comprises six broad levels of hierarchial criticality. Gradually, more extensive data are reported. A level 1 inventory is restricted to habitat type and natural capital status. This provides the first tier of information. Levels 2-6 focus on the flora and fauna. At the first hierarchical levels, the focus is on critical species. Level 2, for example, assesses all the critical flora and fauna both by species and by population on all habitats. For level 3, the focus is on the critical habitats. All species on these habitats are surveyed.

Levels 4 to 6 provide broader data. At level 4, the level 3 inventory is replicated but at population level. At level 5, there is an inventory of all flora and fauna by species and this is mirrored at level 6 when the general inventory is by total population.

Overall, the aim of the model is to attempt to provide an overview of an organisation's stewardship of its natural assets. Some natural assets are easier to map than others and data in some areas are more easily available than in others. The highest inventories are normally those where the data are most readily available. Therefore, it is reasonable to think that while most organisations could undertake a level 1 and 2 inventory, a level 6 inventory would generally prove impossible.

b. Valuing

The valuation of natural assets is a highly contentious issue. Essentially, the arguments crystallise, on the one hand, into those who believe that putting a value on wildlife, habitats, flora and fauna is signalling that they are for sale at that price and, on the other hand, into those who believe that if a realistic valuation can be determined then wildlife assets should be valued.

Putting value on the wildlife of the estate is perhaps unethical (Hamilton, 1994) as it suggests that wildlife is a good that can be traded. If a sufficient amount of money is raised, the good can be destroyed as the money value will replace it. The intrinsic value of nature in itself is ignored. However, Pearce (1993), in support of valuation, argues that environmental economics does not seek to price 'intrinsic' values, but the *human* perception of intrinsic values.

The view taken here distinguishes between critical and non-critical natural assets. Critical assets, because of their criticality, are considered to be essential to biodiversity. Recognising this, they are not valued. By contrast, non-critical assets are valued. Value can be thought of in two ways: 'use' and 'non-use' (Turner, Pearce and Bateman, 1993). Two types of use valuations were considered: market use value (e.g., timber sales) and non-market use value (e.g., conservation value). A 'non-use' value is hard to identify, (e.g., preserving biodiversity) or bequest value (e.g., leaving for future generations). Owing to the difficulties in assigning these values, they are not dealt with further here. For both critical and non-critical assets an ecological grading is attributed. This ranges between grade 1 (habitats with very great ecological worth), and grade 5 (habitats with very little ecological worth). Such a grading is already used to grade farmland in the UK (Norton-Taylor, 1982).

c. Reporting

Nowadays, environmental reporting is common. Organisations report a range of environmental reporting either in stand-alone environmental reports or as part of their annual report.

Ideally, the last stage of the natural inventory system would involve companies summarising and abridging their organisations' natural inventory for dissemination to their stakeholders. Obviously, the more natural inventory data reported, the better. However, at a minimum organisations could report upon their critical habitats and species (i.e., a level 1 or a level 2 natural inventory).

2.4 Cosmeston pilot study

The model was piloted on Cosmeston Lakes Country Park, a 220-acre mixed habitat site in South Glamorgan, Wales, UK. The park was owned and administered by the Vale of Glamorgan County Council and managed as a conservation and recreational resource. The model was tested for the years 1991 and 1992. The results are presented in Jones (1996) and are summarised below.

A level 1 survey showed the site to be a mixture of managed critical and managed non-critical habitats, comprising primarily woodland, scrub, calcareous grassland, other grassland and open water. The ecological grading ranged from 1 to 4.

The level 2 inventory showed the following critical species: three amphibians, two bats, eight birds, two butterflies, two reptiles and four wild flowers. Particularly noteworthy were the 397 bee orchids, a nationally rare species.
The only other inventory that it proved feasible to undertake at Cosmeston was a level 5 species inventory. This surveyed the flora and fauna by species and habitats. By its very nature, it subsumed the level 3 inventory. The results of this survey showed, at least, 244 fauna species and 357 flora species.

There was no open market valuation for the park. Only the non-critical habitats were valued. An amenity valuation was provided for 31 December 1991 at £662,000. However, there was also an old chemical tip. The estimated costs to clean this up varied from £0.5 million to £2 million. The ecological grading was mostly 1 or 2 (very good or good).

The data were collected and the inventory was shown to be feasible. However, the data were not externally reported. Given the size of the park and its public sector nature, there was a recognised need to carry out a natural inventory on a large-land owning company in the private sector. In order to test the model, the Elan Valley Estate which is owned by Hyder plc a UK public limited company, was selected.

3. The Elan Valley

The Elan Valley Estate is located on the Ceredigion / Powys border, in Wales, to the west of the town of Rhayader. The Elan Valley is owned by Hyder plc, with 94% (17,400 hectares) leased to the Welsh Water Elan Trust. At 181 square kilometres, this is the largest single area of land owned by a national water company. The primary role is water catchment and storage and there are four reservoirs, which supply water to Birmingham and South Wales. They were originally constructed when Neville Chamberlain wanted a reliable supply of clean water for Birmingham (Butler, 1999). Conservation and recreation are secondary objectives. There is a popular visitors' centre and the area particularly attracts ramblers and ornithologists.

The Elan Valley lies within the Cambrian Mountains and consists of rounded hills and undulating dissected plateaux. Some of the steeper valleys are covered by deciduous woodland. Other important habitats include coniferous woodland, bog, meadow and moorland. Most of the estate is covered by 12 separate Sites of Special Scientific Interest and it includes the Claerwen National Nature Reserve. The Estate also forms the major part of the 30,000 hectare Elenydd-Mallan Special Protection Area under the European Wild Birds Directive.

3.1 Habitats

Ten habitat types are identified using National Vegetation Classification (NVC) categories.[1] The habitats identified were:

- *Molinia caerulea* dominated moorland*
- *Agrostis/Festuca/Nardus* grassland*
- improved pasture
- species rich meadow and semi-natural rough grazing (SNRG)*
- heather dominated moorland*
- bracken dominated moorland*
- broadleaved woodland*
- coniferous woodland
- bog and mire*
- reservoir and lake.

*The critical habitats are those 'key habitats' listed in the UK Biodiversity Action Plan.[2] They are marked above with an asterisk.

Table 1: Areas under designation

	Classification (Hectares)		
Habitat	**NNR**	**SSSI/SPA**	**SAC**
Molinia caerulea dominated moorland	500	11,700	
Agrostis/Festuca/Nardus grassland	60	1,850	
Specie- rich meadow and SNRG		40	
Heather-dominated moorland		450	
Broadleaved woodlands		100	
Bog and mire	200	2650	1,500
Total	**760**	**16,790**	**1,500**

All these habitats except 'improved pasture' occur within four types of 'Protected Areas' on the estate (see table 1) (Bell and Ball, 1991). Each habitat may occur in multiple protected areas. The relevant designations are:

- National Nature Reserve (NNR)
- Site of Special Scientific Interest (SSSI)
- Special Protection Area (SPA)
- Special Area for Conservation (SAC).

a. *National Nature Reserve (NNR)*

An area of high nature conservation value managed to provide opportunities for research or to preserve animals and plants, and geological or physiological features of special interest.

NNRs are declared by the conservation agencies such as the Countryside Council for Wales, under the National Parks and Access to the Countryside Act (1949) or the Wildlife and Countryside Act (1981).

b. *Site of Special Scientific Interest (SSSI)*

An area notified under the Wildlife and Countryside Act 1981 as being of special nature conservation interest. The SSSIs are notified by the national conservation agencies. In the case of the Elan Valley, this is the Countryside Council for Wales.

c. *Special Protection Area (SPA)*

A site designated under Article 4 of the EC Directive 79/409 on the conservation of wild birds (The Wild Birds Directive). This requires

member states to take measures to preserve a sufficient diversity of habitats for all species of wild bird naturally occurring within their territories, whether breeding, wintering or on passage.

d. *Special Area for Conservation*

A site designated under Article 4 of the EC Directive 92/43 on the conservation of natural habitats and of wild fauna and flora (The Habitats and Species Directive, 1992). This requires member states to take measures to maintain or restore natural habitats and wild species at a favourable conservation status (i.e., to maintain a healthy breeding population with sufficient habitat).

3.2 Flora and fauna

Both flora and fauna are classified at the broadest level (i.e., birds, mammals, broadleaved tree species, flowering plants). Six groups of fauna and eleven groups of flora are identified. Where possible, English names have been given. For many of the lower plants and invertebrates, however, only scientific names are available (Schumacher, 1990; Stewart, 1991). 'Critical species' have been given either an actual, or an estimated, population level.

Critical species are birds and mammals on the 'short' and 'middle' list as well as birds with an 'unfavourable conservation status' as stated in the UK Biodiversity Action Plan. Invertebrates are listed as priority species and in the Red data publications. Critical bryophytes are those on Red Data Lists and which are listed as 'threatened in the EU'. The only critical vascular plant is the Red Data listed Bog Orchid.

3.3 Data collection

The data were collected over many years and by different surveyors. The information used was taken from documents such as management plans and past surveys undertaken on the estate.

The number of species is essentially a best estimate for the average numbers of each species in a year. If an inventory such as this were to be included in the corporate annual report there would therefore be a problem, in that the numbers of species would be unlikely to change, except when a specific survey was undertaken.

4. Results

The following section provides the findings from the site's records regarding species and habitats. The information is given under the inventory levels as described in Jones (1996).

4.1 Level 1: habitat type and critical status

The purpose of this level is to provide a baseline habitat classification. For convenience, a market value is given in table 2. Further details of these values are provided in table 8.

None of the habitats are *self-sustaining* habitats as described by Gray (1992). The extent of management, however, is not great. For the most part, management is the control of the number of sheep grazing. Other management is the fencing out of sheep, regeneration of coniferous woodland and the control of invasive, non-native species. With the removal of grazing, oak and other broadleaved woodlands would be *self-sustaining*.

Part of the estate (3,800 hectares, about 20%) is classified as 'critical'. This reflects the high

Table 2: Level 1- habitat type and critical status

Habitat	Non-Critical (ha)	Critical (ha)	Ecological Grade	Market Value: Average annual value (1999) £000
Molinia caerulae dominated moorland	11,200	-	3	£1,949 Total value for non-critical grassland and moorland
	-	500	3	
Agrostis/Festuca/Nardus grassland	1,790	-	3	
		60	3	
Improved pasture	170	-	3-5	
Species rich meadow and SNRG	-	40	1	
Heather dominated moorland	-	450	1	
Bracken dominated moorland	500	-	2-4	
Broadleaved woodland	-	100	1	-
Coniferous woodland	310	-	1-3	35
Bog and mire	-	2,650	1	-
Reservoir and lake	600	-	1-5	102,003
Other (visitor spend)	-	-	-	100
TOTAL	**14,570**	**3,800**	**-**	**104,087**

overall ecological value of the estate and its importance for nature conservation. The large areas designated as SSSI, SPA and SAC, also support this view.

Although the timber value of the softwoods on the estate is given, the production of timber by sound silvicultural practice is not the top priority of the forestry. The priorities are the protection of water supplies, the conservation of soils, animals and plant communities, and the maintenance of a visual amenity.

The income from the reservoir is based upon the national figure for the provision of water to domestic consumers, which is currently 82.35 pence per cubic metre. The figure given is a minimum amount; with increased demand this figure may rise to £137 million per annum. The total also includes £3,000 from the sale of fishing permits, which are sold by the estate.

Each habitat has been given an ecological value of 1 to 5, with 1 being the highest. These gradings reflect the importance of these habitats locally and as recognised by the various protected areas designations listed above, the relevant EU directives and the UK Biodiversity Action Plan.

Table 3: Ecological grading

Habitat	Percentage	Ecological grade
Improved pasture	40	3
	40	4
	20	5
Bracken dominated	60	2
	30	3
	10	4
Coniferous woodland	10	1
	40	2
	50	3
Reservoir and lake	5	1
	95	5

For some habitats, a range of ecological importance is given. This is because all areas of the same habitat are grouped together despite having different ecological values. There are several reasons for the differing ecological importance, such as age, soil quality, intensity of grazing or numbers of species present. Table 3 provides a break down of the ecological grading within the specific habitats.

4.2 Level 2: critical natural capital by species and by total population on all habitats

The objective of this level of natural inventory is to show the organisation's stewardship of its critical natural assets, both fauna and flora. Overall, the numbers of species are best estimates, but give a good indication of the size of population (see table 4). Overall, 44 critical species are identified: 3 mammals, 17 birds, 5 invertebrates, 1 butterfly, 1 moth, 5 bryophytes, 9 lichens, 2 flowering plants and 1 broadleaved tree. The number of birds is particularly well represented. This area is particularly noted for the successful repopulation of the red kite. Identifying numbers of lichens and bryophytes is extremely difficult. A single plant can cover a vast area with many flowering heads, but still count as one plant (bracken or rhododendrum would be good examples of this). A possible solution is counting flowering heads, as is done for the bog orchid. For this reason, no numbers of individual species could be attributed to the lower plants.

4.3 Level 3: Inventory of critical habitats flora and fauna by species

The objective of this level of inventory is to look at the critical habitats more closely. In order to give an indication of the species present in critical habitats compared with the estate as a whole, the number of critical species present in critical and non-critical habitats is given (see table 5). There are 3108 species in all habitats. Excluding invertebrates, where the breakdown is unknown, 1232 species are present in the non-critical habitats with 1472 species being present in the critical habitats. Although critical habitats only account for 20% of the area, they contain a high proportion of the total species found. This is because the critical habitats represent the best examples of the different habitats on the estate.

4.4 Level 4: Inventory of critical habitats' flora and fauna by total population

Information on the numbers of total populations for *all* species on the estate is not available (see level 6 inventory f or more detail). Table 6 thus provides population figures for the critical species alone. The figures are given as a percentage of the total population and provide a rough estimate of the numbers present. Again bird species, particularly skylarks, are well represented.

Many of the bird species are recorded as being 100% present in the critical habitats. However,

Table 4: Level 2 – critical natural capital by species and by total population on *all* habitats

Critical species	Number of species
Fauna	
Mammals	
Brown hare	<20
European otter	<5
Pipistrelle bat	<1000
Birds	
Skylark	400-800 pairs
Song thrush	40 pairs
Linnet	1-3 pairs
Reed bunting	30 –100 pairs
Spotted flycatcher	20 –30 pairs
Bullfinch	6 – 8 pairs
Short eared owl	0 – 4 pairs
Dunlin	20 – 40 pairs
Hen harrier	0 – 1 pairs
Peregrine	5 – 7 pairs
Kestrel	2 – 5 pairs
Swallow	20 – 40 pairs
Green woodpecker	3 pairs
Curlew	0 – 2 pairs
Redstart	50 – 100 pairs
Stonechat	4 –8 pairs
Red kite	10 pairs
Invertebrates	
(Includes reptiles)	
Coccinella 5 –punctata	Unknown
Ctenophora flaveolata	Unknown
Exechia pectinivalva	Unknown
Pyrrhidium sanguineum	Unknown
Coenosia paludis	Unknown
Butterflies	
Pearl bordered fritillary	Possibly none
Moths	
Argent and sable	Possibly none
Flora	
Bryophytes	
Jungermannia caespiticia	Unknown
Cryptothallus mirabilis	Unknown
Campylopus atrovirens	Unknown
Discelium nudum	Unknown
Splachnum sphaericum	Unknown
Lichen	
Catillaria globulosa	Unknown
Gyalidea subscutellaris	Unknown
Cetraria sepinicola	Unknown
Cladonia luteoalba	Unknown
Pannaria conoplea	Unknown
Parmelia taylorensis	Unknown
Parmeliella jamesii	Unknown
Stricta fuliginosa	Unknown
Stricta limbata	Unknown
Flowering Plants	
Bog orchid	6-40 spikes
Floating water plantain	100 – 500 plants
Broadleaved Trees	
Sorbus anglica	10 trees

Table 5: Level 3 – critical habitats' flora and fauna by species

Flora and Fauna	Number of species in all habitats	Number of species in non-critical habitats	Number of species in '*critical habitats*'
Fauna			
Mammals	20	20	17
Birds (breeding)	180 (106)	160	135(95)
Invertebrates	1,500	Unknown	Unknown
Butterflies	28	20	27
Moths	210	110	200+
Dragonflies/damselflies	17	17	17
Flora			
Ferns	26	20	23
Sphagnum mosses	18	14	18
Sedges	26	26	26
Rushes	11	11	11
Broadleaved trees	16	12	16
Coniferous trees	8	8	0
Grasses	35	22	35
Orchids	8	2	7
Flowering plants	315	250	300
Lichen	380	330	350
Mosses and liverwort	310	210	290
Total	**3,108**	**1,232**	**1,472**

because of their great mobility this may only be one of several habitats they frequent. For instance, linnets feed, but do not breed, in the hay meadows.

The data show the importance of the critical habitats for critical species, especially for the number of birds and lichen. Of equal importance is the fact that many critical species do not occur in the critical habitats. This highlights the importance of the need to conserve all habitats, not just those that are rare nationally.

4.5 Level 5: general inventory of flora and fauna species

There are a large number of species of flora and fauna on the estate, over half being lower or flowering plants (see table 7). Gaining accurate numbers for these species is also the most difficult, because of their size, distribution across the entire estate and, particularly for the lower plants, difficulties in identification. Undoubtedly many lower plants and invertebrates remain to be discovered. No figures at all have been given for fungi: an estimate would be about 150+ species.

Table 6: Level 4 – critical species in critical habitats by total population

Critical species	Total population	Number of species' population in critical habitats
Fauna		
Mammals		
Brown hare	<20	0
European otter	<5	0
Pipistrelle bat	<1000	100%
Birds		
Skylark	400-800 pairs	15%
Song thrush	40 pairs	70%
Linnet	1-3 pairs	100%
Reed bunting	30 –100 pairs	0
Spotted flycatcher	20 –30 pairs	40%
Bullfinch	6 – 8 pairs	100%
Short eared owl	0 – 4 pairs	50%
Dunlin	20 – 40 pairs	50%
Hen harrier	0 – 1 pairs	100%
Peregrine	5 – 7 pairs	100%
Kestrel	2 – 5 pairs	100%
Swallow	20 – 40 pairs	100%
Green woodpecker	3 pairs	100%
Curlew	0 – 2 pairs	0
Redstart	50 – 100 pairs	75%
Stonechat	4 –8 pairs	90%
Red kite	>10 pairs	100%
Invertebrates		
Coccinella 5 –punctata	Unknown	0
Ctenophora flaveolata	Unknown	100%
Exechia pectinivalva	Unknown	100%
Pyrrhidium sanguineum	Unknown	100%
Coenosia paludis	Unknown	Unknown
Butterflies		
Pearl bordered fritillary	Possibly none	100%, if not extinct
Moths		
Argent and sable	Possibly none	100%, if not extinct
Flora		
Bryophytes		
Jungermannia caespiticia	Unknown	0
Cryptothallus mirabilis	Unknown	100%
Campylopus atrovirens	Unknown	0
Discelium nudum	Unknown	0
Splachnum sphaericum	Unknown	0
Lichen		
Catillaria globulosa	Unknown	100%
Gyalidea subscutellaris	Unknown	0
Cetraria sepinicola	Unknown	0
Cladonia luteoalba	Unknown	0
Pannaria conoplea	Unknown	100%
Parmelia taylorensis	Unknown	100%
Parmeliella jamesii	Unknown	100%
Stricta fuliginosa	Unknown	100%
Stricta limbata	Unknown	100%
Flowering Plants		
Bog orchid	6-40 spikes	0
Floating water plantain	100 – 500 plants	0
Broadleaved Trees		
Sorbus anglica	10	0

4.6 Level 6: general inventory of flora and fauna by total population

This level of the inventory could not be completed because the amount of information required is too great. Detailed data on population sizes are only available for the rarer species or those that are monitored for a particular reason.

4.7 Value

As well as the ecological inventory a monetary value has been applied to the non-critical habitats. Section 4.7 a, (Market use value,) provides one market use value, using payments for the estate. This is summarised in Table 8. An alternative valuation is provided in 4.7 b, (Alternate 'use' value method). This uses the Tir Gofal scheme implemented in Wales.

a. *Market use value*

The market use value is the revenue raised through estate activities, water supply, timber and income from sheep farming (sheep meat and subsidy payments). Other incomes are fishing returns and visitor spending. The market use values have only been applied to non-critical habitats. However, the valuation was first calculated on all habitats and then prorata'd.

Table 7: Level 5 – general inventory of flora and fauna by species

Flora and fauna	Number of species	Number of critical species
Fauna		
Mammals	20	3
Birds	180	17
Invertebrates	1,500	5
Butterflies	28	1
Moths	210	1
Dragonflies/damselflies	17	0
Flora		
Ferns	26	0
Sphagnum mosses	18	0
Sedges	26	0
Rushes	11	0
Broadleaved trees	16	1
Coniferous trees	8	0
Grasses	35	0
Orchids	8	1
Flowering plants	315	1
Lichen	380	9
Bryophytes	310	5
Total	**3,108**	**44**

Table 8: Annual market prices for non-critical habitats of the estate based on 1999

Income type	Value £000 All habitats	Value £000 Non-critical habitats
ESA payments: £25.00 /ha for 14,710 ha	368	342*
HLCA payments: £5.25 for 40,000 ewes	210	195*
SAPS payments: £30.50 for 40,000 ewes	1,220	1,133*
Sale of sheep meat	300	279
Total from grassland and moorland	2,098	1,949
Income from visitors	100	100
Timber yield	35	35
Water supply/fishing returns	102,003	102,003
Total	**104,236**	**104,087**

* Prorata'd across non-critical hectarage.

i. *Environmentally Sensitive Area (ESA)*
These are payments made to farmers for farming in an 'environmentally sensitive way'. Part of the Elan Valley is in the Cambrian Mountain area, and a condition for payment is farming to encourage heather moorland through lowering grazing pressures. The grazing limits are one ewe to two acres in summer and one ewe to four acres in winter.

ii. *Hill Livestock Compensatory Amounts (HLCA)*
These are payments per livestock unit made to farmers on hill farms to compensate for the harsh farming conditions. They are paid mainly by the UK government.

iii. *Sheep Annual Premium Supplements (SAPS)*
These are similar to HLCA, but only for sheep. The payments are funded by the EU.

iv. *Sale of sheep meat figures*
These are calculated on the approximate number of sheep produced for sale in 1998 at the average price during the marketing period.

These four values (ESA, HLCA, SAPS, and sale of sheep meat) account for the value placed upon the grassland and moorland of the estate. To break down the values further would be very difficult because of the grazing patterns of the sheep.

v. *Income from visitors*
This is *not* based on profit, but based upon the average spend of visitor to the visitor centre. There are two outlets in the centre: a café and gift shop.

vi. *Timber yield*
This is the value of the annual increment of timber gained by the plantations. This is an approximate value because the value for timber changes throughout the year.

vii. *Water supply/fishing returns*
The value of water supply is based upon the maximum amount that a water company can charge its customers per litre of water and the amount of water that is delivered to the water company each day. The total annual amount varies with demand and ranges from £102 million to £137 million. The minimum is taken in Table 8.

There are other estate incomes, which are not included here, such as grant aid from the Woodland Grant Scheme. There is undoubtedly, given the environmental importance of the estate, huge opportunities for grant aid from European and national sources.

Under this valuation method it is important to note that almost all the valuation arises from the water supply income. Even taking the lowest valuation for this, it constitutes 98% of the market use value.

b. *Alternative 'use' value method*

The valuations given above only provide a value for those habitats on the estate with a market value. The following section attributes value to a larger area of the estate by using an agri-environmental scheme, which gives a monetary value to the conservation of different habitat types.

i. *Tir Gofal*
Tir Gofal is the new agri-environment scheme for Wales introduced in 1999. It is a scheme available throughout Wales to all farmers and to those with control over land. Its aim is to encourage farmers to maintain and enhance the agricultural landscape and its wildlife. It replaces ESA and Tir Cymen (a pilot scheme available in four regions in Wales) and is funded by the EU and UK government. The management of the scheme is the responsibility of the Countryside Council for Wales.

The scheme provides payment under four categories:

1. land management
2. creating new permissive access
3. capital works
4. training for farmers.

The scheme pays farmers for the management of certain habitats. The rarer the habitat the greater the payment. Table 9 uses the payments under category 1, for land management, to place a value of the land on the Elan estate.

Table 9: Tir Gofal payment for non-critical habitats

Tir Gofal	Tir Gofal category	Hectarage (Ha)	Payment / Ha £	Total* £
Habitat				
Molinia dominated moorland	Unenclosed acid grassland	11,200	15	168,000
Agrostis/Festuca/Nardus grassland	Unenclosed acid grassland	1,790	15	26,850
Improved pasture	n/a	170	n/a	
Bracken dominated moorland	n/a	500	n/a	
Coniferous woodland	n/a	310	n/a	
Reservoir and lake	n/a	600	n/a	
Access*		**Metres (M)**	**Payment /M**	
Footpaths (metres)	-	720,000	0.15	108,000
Bridleways and cycleways (metres)	-	7,200	0.30	2,160
Disabled routes (metres)	-	4,000	0.30	1,200
Educational access	-	-	-	500
Total				**306,710**

n/a: no payment given under Tir Gofal

* Allocated on the ratio of critical to non-critical habitats.

The value given, £306,710, reflects the annual nature conservation value of the estate based on the Tir Gofal payments. This value is substantially lower than the market value, and values a wider range of habitats. The overall value is not as important as the fact that this provides a value that can be monitored over time to see whether the value changes with management. The value given to a habitat by the Tir Gofal scheme may change if it becomes rarer and more endangered. Habitat type may also change. For instance, coniferous woodland may be replanted as broadleaf woodland. This would raise the value of the estate as broadleaf woodland has a higher value per hectare than coniferous woodland. The Tir Gofal valuation may be useful in comparing the nature conservation of different estates where habitats are significantly different. For this reason, we include the valuation for the full Tir Gofal scheme in appendix B.

A problem with this is that some habitats are not given a value, such as coniferous wood and bracken dominated moorland. This appears to make them worthless and non-contributors to the estate's overall value, which is obviously not so. It is, therefore, worth considering assigning a value to these habitats so that they are included in the overall value of the site. This value could be low, say £10 per hectare, but would recognise the area's existence, which in some cases may be large.

To make comparisons between sites a value per hectare could be given; in the case of the Elan Valley this would be £21.05 (£306,710/14,570 hectares). As the payment structure gives higher values to rarer or more fragile habitats, the value given will be higher for the sites with the highest area of rare/fragile habitats.

ii. *'Use' value – non-market*

The non-market value can include the value of the valley for its recreational benefits or scenic beauty. The large number of visitors to the valley suggests that there is a large recreational /scenic value, however, there is no cash valuation for this. A useful value could be produced by using the travel cost method (Clawson and Knetsch, 1966). This would look at expenses incurred in visiting the valley (petrol, time, food and accommodation) as well as the socio-economic profile of the visitor and relate this to a value that a visitor places upon the site.

Non-market 'use' values include the use as a habitat for species to live in. Such values are nearly, impossible to place a value upon and instead it is simply noted that the site has a high value for wildlife (which can be seen in the large number of species it supports).

4.8 Reporting

The data are aggregated and have beee offered to Hyder plc to include in their annual report.

5. Summary and conclusions

5.1 Summary

This research has applied a method of recording and valuing habitats, flora and fauna to the Elan Valley Nature Reserve, owned by UK company Hyder plc. The model shows that there are:

- 10 types of habitat, with 20% being accorded critical status; ecological gradings are given to the habitats, with species-rich meadow, heather-dominated moorland, broadleaved woodland, and bog and mire proving the richest
- 44 critical species, with 17 critical species of birds
- 3,108 species in all habitats
- several possible valuation methods for the non-critical habitats including market prices and Tir Gofal payments. The critical habitats were not valued, showing their 'priceless' nature.

It is, therefore, possible for organisations to develop comprehensive models by which they can monitor their stewardship of natural assets. This will allow better conservation and enhancement of Britain's habitats, flora and fauna.

5.2 Feasibility

Table 10 provides a summary of the ability to complete each level of the inventory. The grades are on a 1-10 scale (1 = not at all and 10 = excellent). The gradings are based on the work at Elan Valley Nature Reserve.

The work was aided by the availability of excellent records at the Elan Valley. Other sites may not have such comprehensive information or species lists.

Table 10: Feasibility of inventory levels

	Data availability
Level 1	10
Level 2	4
Level 3	8
Level 4	1
Level 5	8
Level 6	1

Of the six levels in the inventory all but one (level 6) were completed. The level six inventory could not be completed owing to the amount of data required. A level four inventory was completed, but only for critical species. This was again because of difficulties in gaining the data required. Levels 1, 3 and 5 have the greatest ease of data availability. One of the problems, however, was that the data were not available on annual basis.

5.3 Key indicator testing

On a site as large as the Elan Valley it would be impossible, without vast resources, to undertake detailed, regular surveys for all species. To overcome this, it may be possible to include a handful of species in the inventory that are regularly surveyed, often as a result of grant aid from the Countryside Council for Wales or a similar organisation. For instance, the common sandpiper and skylark are surveyed regularly to assess annual populations. The use of such 'indicator' species could be used to assess underlying conditions of the site. Table 11 shows a record for the common sandpiper on the Estate. Such records for a handful of species could be used to show an overall 'health' of the wildlife on the site.

These indicator species would form a good continuous record. A natural inventory could then be conducted at regular intervals, say, every five years.

Table 11: Common Sandpipers recorded between 1975 and 1997

Year	Number of pairs found
1997	25
1995	21
1994	31
1993	31
1992	26
1976	39
1975	32

5.4 Future research

The feasibility of the natural inventory has now been tested on a small country park and on a large land-owning organisation. In both cases, it showed promise as a means of monitoring an important aspect of corporate environmental performance, the corporate stewardship of natural assets. There is now a need to extend the testing of the model to other corporations and also a need to test the idea of providing annual indicator species data.

6. Endnotes

1. Unlike Jones (1996), this project used the National Vegetation Classification (NVC, 1990) categories. This was preferred to the Nature Conservancy Council (1990) classification because of its more detailed taxonomy and its widespread use by conservation organisations.

2. In order to test the model fully , this study uses the UK Biodiversity Action Plan (BAP) to determine critical habitats. This departs from the Jones (1996) approach premised on SSSIs, NNRs and SPAs. This is because in the case of the Elan Valley the non-critical areas would have been very small, consisting only of improved grassland and some coniferous woodland.

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8. Data sources

The data used were taken from various reports made by the Elan Valley rangers and other field workers.

Appendix A: Summary of flora and fauna

1	2 No. of species	3 No. of critical species	4 No. of non-critical species	5 Critical species
Mammals	20	3	17	Brown hare European otter Pipistrelle bat
Birds (recorded) (Breeding birds)	180 106	17	163	Skylark Song thrush Linnet Reed bunting Spotted flycatcher Bullfinch Short eared owl Dunlin Hen harrier Peregrine Kestrel Swallow Green woodpecker Curlew Redstart Stonechat Red kite
Invertebrates	1500	Unknown	Unknown	*Coccinella 5 – punctata* *Ctenophora flaveolata* *Exechia pectinivalva* *Pyrrhidium sanguineum* *Coenosia paludis*

6	7	8	9	10	11
No. of critical species	**% population in critical habitat**	**No. of critical species in critical habitats**	**No. of species in critical habitats**	**No. of species in non-critical habitats**	**Non-critical species in critical habitats**
<20	0	1	17	20	16
<5	0				
<1000	100				
400-800 pairs	15	15	135	160	120
40 pairs	70		95		
1-3 pairs	100				
30 –100 pairs	0				
20 –30 pairs	40				
6 – 8 pairs	100				
0 – 4 pairs	50				
20 – 40 pairs	50				
0 – 1 pairs	100				
5 – 7 pairs	100				
2 – 5 pairs	100				
20 – 40 pairs	100				
3 pairs	100				
0 – 2 pairs	0				
50 – 100 pairs	75				
4 –8 pairs	90				
>10 pairs	?				
?	0	Unknown	Unknown	Unknown	Unknown
?	100				
?	100				
?	100				
?	?				

Summary of flora and fauna (continued)

1	2	3	4	5
	No. of species	**No. of critical species**	**No. of non-critical species**	**Critical species**
Butterflies	28	1?	27	Pearl bordered fritillary
Moths	210	1	219	Argent and sable
Dragonflies/Damselflies	17	0	17	-
Flora				
Ferns	26	0	26	-
Sphagnum mosses	18	0	18	-
Sedge	26	0	26	-
Rush	11	0	11	-
Broadleaved trees	16	1	15	*Sorbus*
Coniferous trees	8	0	8	-
Grasses	35	0	35	-
Orchids	8	1	7	Bog orchid
Flowering plants	315	1	314	Floating water plantain
Lichen	380	9	371	*Catillaria globulosa* *Gyalidea subscutellaris* *Cetraria sepinicola* *Cladonia luteoalba* *Pannaria conoplea* *Parmelia taylorensis* *Parmeliella jamesii* *Stricta fuliginosa* *Stricta limbata*
Mosses and liverworts	310	5	305	*Jungermannia caespiticia* *Cryptothallus mirabilis* *Campylopus atrovirens* *Discelium nudum* *Splachnum sphaericum*

6	7	8	9	10	11
No. of critical species	**% population in critical habitat**	**No. of critical species in critical habitats**	**No. of species in critical habitats**	**No. of species in non-critical habitats**	**Non-critical species in critical habitats**
1?	100	1	27	20	26
?	100	1	200+	110	200
-	-	-	17	17	17
-	-	-	23	20	23
-	-	-	18	14	18
-	-	-	26	26	26
-	-	-	11	11	11
10	100	0	16	12	16
-	-	-	0	8	0
-	-	-	35	22	35
6-40	0	1	7	2	7
100-500	0	0	300	250	300
?	100	6	350	330	345
?	0				
?	0				
?	0				
?	100				
?	100				
?	100				
?	100				
?	100				
?	0	1	290	210	284
?	100				
?	0				
?	0				
?	0				

Appendix B: Tir Gofal payments for all habitats

Tir Gofal	Tir Gofal category	Hectarage (Ha)	Payment /Ha (£)	Total (£)
Habitat				
Molinia dominated moorland	Unenclosed acid grassland	11,700	15	175,500
Agrostis/*Festuca*/*Nardus* grassland	Unenclosed acid grassland	1,850	15	27,750
Improved pasture	n/a	170	n/a	-
Species-rich meadow and SNRG	Unimproved neutral grassland	40	145	5,800
Heather-dominated moorland	Upland heath	450	50	22,500
Bracken-dominated moorland	n/a	500	n/a	-
Broadleaved woodland	Broadleaf woodland – ungrazed	100	125	12,500
Coniferous woodland	n/a	310	n/a	-
Bog and mire	Blanket bog	2,650	40	106,000
Reservoir and lake	n/a	600	n/a	-
Access		**Meters (M)**	**Payment /M**	
Footpaths (metres)	-	900,000	0.15	135,000
Bridleways and cycleways (metres)	-	9,000	0.30	2,700
Disabled routes (metres)	-	5,000	0.30	1,500
Education access	-	-	-	500
Total				**489,750**

Note: n/a = no payment given under Tir Gofal

Appendix C: Suggested annual report summary

Natural inventory

As part of its ongoing commitment to the environment, Hyder plc conducted a natural inventory of Elan Valley with Professor Michael Jones of Cardiff Business School. The project was funded by the Association of Chartered Certified Accountants and data were collected by Jon Matthews.

The natural inventory collected data about the Elan Valley's habitats, flora and fauna focusing, in particular, on critical (i.e., recognised as nationally rare) habitats, and rare and endangered species. A comprehensive inventory was collected and is available on request. Ten important habitats were identified, split into critical and non-critical. The flora and fauna of the Elan Valley are diverse: 3,108 species were identified, with 44 of them being rare or endangered.

Habitats

Habitat type and critical status

Habitat	Non-critical (ha)	Critical (ha)	Ecological grade	Market value of non-critical habitats. Average annual value (1999) £000
Molinia caerulae dominated moorland	11,200	-	3	1,949 Total value for grassland and moorland.
	-	500	3	
Agrostis/Festuca/Nardus grassland	1,790	-	3	
	-	60	3	
Improved pasture	170	-	3-5	
Species-rich meadow and SNRG	-	40	1	
Heather-dominated moorland	-	450	1	
Bracken-dominated moorland	500	-	2-4	
Broadleaved woodland	-	100	1	-
Coniferous woodland	310	-	1-3	35
Bog and mire	-	2,650	1	-
Reservoir and lake	600	-	1-5	102,003
Other (visitor spend)	-	-	-	100
Total	14,570	3,800	-	104,087

Flora and fauna

Each habitat is given an ecological grade with 1 being of the greatest ecological value. A provisional market value is ascribed to the non-critical habitats. No value is attached to the critical habitats – not because they are valueless, but in recognition of their criticality.

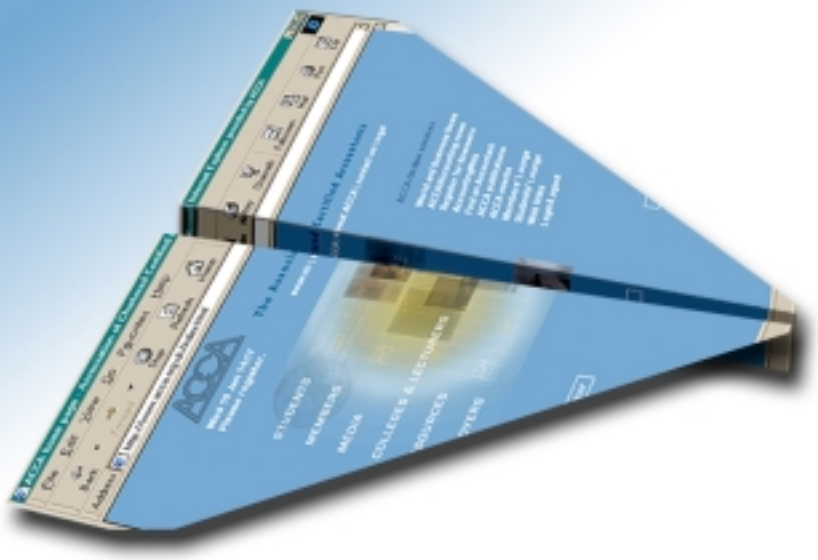
General inventory of flora and fauna species

Flora and fauna	Number of species	Number of 'critical' species
Fauna		
Birds	180	17
Butterflies	28	1
Dragonflies/Damselflies	17	0
Invertebrates	1,500	5
Mammals	20	3
Moths	210	1
Flora		
Broadleaved trees	16	1
Bryophytes	310	5
Coniferous trees	8	0
Ferns	26	0
Flowering plants	315	1
Grasses	35	0
Lichens	380	9
Orchids	8	1
Rushes	11	0
Sedges	26	0
Sphagnum mosses	18	0
Total	**3,108**	**44**

To illustrate, there are 17 species of rare and endangered birds. Particularly notable are the raptors with 5 to 7 pairs of peregrines and 10 pairs of red kites.

Critical birds

Bullfinch	6 – 8 pairs
Curlew	0 – 2 pairs
Dunlin	20 – 40 pairs
Green woodpecker	3 pairs
Hen harrier	0 – 1 pairs
Kestrel	2 – 5 pairs
Linnet	1 – 3 pairs
Peregrine	5 – 7 pairs
Red kite	10 pairs
Redstart	50 – 100 pairs
Reed bunting	30 –100 pairs
Short eared owl	0 – 4 pairs
Skylark	400 – 800 pairs
Song thrush	40 pairs
Spotted flycatcher	20 – 30 pairs
Stonechat	4 – 8 pairs
Swallow	20 – 40 pairs



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