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The selection of biodiversity indicators for business landholdings

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FOR BUSINESS LANDHOLDINGS

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SUMMARY

Businesses are seen as the next stage in delivering biodiversity improvements linked to local and UK Biodiversity Action Plans. Global discussion of biodiversity continues to grow, with the Millennium Ecosystem Assessment, updates to the Convention on Biological Diversity and The Economics of Ecosystems and Biodiversity being published during the time of this project. These publications and others detail the importance of biodiversity protection and also the lack of strategies to deliver this at an operational level. Pressure on UK landholding businesses is combined with significant business opportunities associated with biodiversity engagement. However, the measurement and reporting of biodiversity by business is currently limited by the complexity of the term and the lack of suitable procedures for the selection of metrics. Literature reviews identified confusion surrounding biodiversity as a term, limited academic literature regarding business and choice of biodiversity indicators. The aim of the project was to develop a methodology to enable companies to identify, quantify and monitor biodiversity.

Research case studies interviews were undertaken with 10 collaborating organisations, selected to represent 'best practice' examples and various situations. Information gained through case studies was combined with that from existing literature. This was used to develop a methodology for the selection of biodiversity indicators for company landholdings. The indicator selection methodology was discussed during a second stage of case study interviews with 4 collaborating companies. The information and opinions gained during this research was used to modify the methodology and provide the final biodiversity indicator selection methodology.

The methodology was then tested through implementation at a mineral extraction site operated by a multi-national aggregates company. It was found that the methodology was a suitable process for implementation of global and national systems and conceptual frameworks at the practitioner scale. Further testing of robustness by independent parties is recommended to improve the system.

KEYWORDS

Environmental Management Systems, Biodiversity Metrics, Biodiversity Action Plan, Corporate Social Responsibility, Conservation

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CHAPTER 1 - INTRODUCTION

1.1 Introduction

This chapter introduces the research project and details the need for the research with reference to the current state of the art. The aims and objectives of the research project are provided at the end of this chapter.

1.2 The Need for the Research

In the UK biodiversity has declined notably in recent decades (Natural England, 2010). This has been attributed to many factors, particularly changes in land management practices from those initiated around 1000 years ago that developed such rich biodiversity in Central Europe (Piorr, 2003). Examples for the UK include losses during the twentieth century of: 98% of wildflower meadows, 448,000 km of hedgerows, over two million skylarks and 95% of high brown fritillary butterflies (Avery et al., 2001). DEFRA (2002a) list the following decreases in biodiversity: farmland bird populations fell by almost 50% between 1977 and 1993 though have been relatively stable since; water voles have disappeared from 94% of the sites where they were previously recorded and unimproved lowland meadows declined by 97% between the 1930s and the 1980s.

Reid & Miller (1989) detail the scientific basis for the conservation of biodiversity in their World Resources Institute publication. They express the view that the diversity of life is an irreplaceable asset to humanity and to the biosphere. It provides both immediate and long-term benefits, and its maintenance is essential to sustainable development worldwide. Biodiversity conservation should be seen as the management of human interactions with the variety of species and ecosystems so as to maximise the benefits they provide today and maintain their potential to meet future generations' needs and aspirations. This can be seen as a key text for its content and context of its publication date. It was the precursor to the now ubiquitous Convention on Biological Diversity (CBD) that is seen to drive current biodiversity practice. Biodiversity is a vital resource in addition to its intrinsic, non-use value and in this respect biodiversity fits neatly into sustainable development. The CBD describes key objectives as the conservation of biodiversity, sustainable use of biological resources and equitable sharing of biodiversity benefits. The CBD is introduced here and described in greater detail in Chapter 2.

The Convention on Biological Diversity (CBD) from the 1992 Earth Summit in Rio de Janeiro required each ratifying country to develop a national biodiversity strategy to identify important species and habitats and focus efforts for their conservation and enhancement. The United Kingdom produced a Biodiversity Action Plan (BAP) in 1994 outlining current biodiversity initiatives, targets for key habitats and species and the development of a UKBAP Steering Group. The UKBAP provides the guidance for biodiversity work at a national level and requires that biodiversity issues be addressed by Local Authorities (LAs) through Local Agenda 21 (LA21), an initiative requiring each LA to develop a BAP for their environment. Therefore, through the CBD, UKBAP and local BAPs (LBAPs), biodiversity developed an increasing profile throughout tiers of government during the 1990's.

In addition to layers of government, businesses are seen by many nature conservation organisations as the next step for biodiversity policy development and there is a strong business case for addressing biodiversity (Earthatch, 2002). Businesses have been officially invited to actively contribute to international goals for biodiversity at the eighth meeting of the Conference of the Parties (COP8) to the Convention on Biological Diversity (CBD), held in Curitiba in March 2006 (Houdet, 2008).

Many businesses are seen to have a direct link with biodiversity, for example the extractive and utilities industries, but increasing numbers of businesses are realising that incorporating biodiversity within environmental and social policies is vital for lasting economic success (Earthwatch, 2002a). The increasing emphasis placed upon sustainable development, Corporate Social Responsibility (CSR), Socially Responsible Investment (SRI) and transparent environmental reporting reinforces the business case for addressing biodiversity. Business and the natural environment can be mutually compatible as reported by Cardskadden & Lober (1998). Within this study the non-profit organisation the Wildlife Habitat Council encouraged and supported corporations in the USA to voluntarily manage lands for wildlife and biodiversity protection. From this study of 164 sites, reported benefit to business included 95% of organisations specifying improved employee morale, 72% reporting improved relationship with environmental groups, 60% noting an improvement in community relations, 49% reporting an improved relationship with regulators. Financial benefits in terms of cost savings were recorded from 50% of the study's corporations. Therefore, in addition to ecological concerns and stakeholder pressure to address wildlife and biodiversity as a business issue, companies are able to identify benefits and economic motivations to protect and manage biodiversity (Stead & Stead, 1995). Armsworth et al. (2010) identified that

businesses have enormous potential to benefit biodiversity with their capacity to mobilize human, physical and financial resources and are often in control of large landholdings and have supply chains with far reaching impacts on biodiversity and ecosystem services. Armsworth et al. (2010) go on to state:

> *"To realize this potential, businesses require support from researchers in applied ecology to inform how they measure and manage their impacts on, and opportunities presented to them by, biodiversity and ecosystem services."*
>
> (Armsworth et al., 2010)

Houdet (2008) described a situation prior to 2005 where biodiversity was considered an issue too complicated for businesses to become involved with and that it was different from the issue of climate change, which has an easy accounting unit as 1 tonne of carbon. Houdet states that:

> *"Biodiversity was seen as an exogenous constraint, to be addressed by helping preserve some charismatic species, which would in return be beneficial to the company's reputation."*
>
> (Houdet, 2008)

Methods of incorporating biodiversity into existing business systems have been developed over recent years, and are still in development. Research undertaken by Calow (2009) has made particular advances in the area of integrating company BAP priorities into Environmental Management Systems (EMSs). However, businesses leading in this area now require techniques for the quantitative monitoring, review and reporting of their biodiversity initiatives. In order to successfully incorporate biodiversity into EMS, Key Performance Indicators (KPIs) are required. This is explained by Carruthers & Tinning (2003):

> *"The process used in environmental management systems (EMS) implementation is predicated on the need for information to flow back to the manager to assist their management choices. In this way, the indicators of most use are those that the manager can determine and utilise."*
>
> (Carruthers & Tinning, 2003)

The development of a process for selecting biodiversity indicators would provide businesses with the KPIs and data for effective continuous improvement for their EMSs, BAPs and external reporting to sustainable share index questionnaires such as the Business in the Environment Annual Review of Corporate Environmental Engagement.

The lack of existing information within research is highlighted in the conclusion made by Armsworth et al. (2010) where it is stated:

> *"businesses are asking diverse ecological research questions, but publications in leading applied ecology journals and research council funding reveal limited evidence of direct engagement with businesses. This represents a missed opportunity for ecological research findings to see more widespread application."*
>
> (Armsworth et al., 2010)

Houdet (2008) details establishing a working group to provide input into research for the integration of biodiversity into business strategies. The aim of this was to create a biodiversity equivalent of greenhouse gas accounting. Within this research it is identified that current EMS primarily refer to the management of resources and the control of emissions and effluent. Houdet (2008) goes on to describe how the intrinsic complexity of biodiversity means businesses encounter problems incorporating biodiversity alongside existing criteria in EMS when:

- Defining clear objectives;
- Constructing sets of suitable indicators; and,
- Decision-making.

Particularly motivating in relation to the author's thesis is the problem of constructing sets of suitable indicators. Further reinforcing the need for the author's research, Houdet & Loury (2008), detail the requirements of practitioners, stating that:

> *"In the field, managers of industrial sites are often faced with thorny choices. For example, what taxonomic groups should be used to monitor the health of an ecosystem in the face of limited financial resources?"*
>
> (Houdet & Loury, 2008)

Questions raised by Armsworth et al. (2010) also show the need for research into biodiversity measures, examples include:

> *"Do current metrics adequately capture the full breadth of ecosystem impacts? What other metric are needed to capture those?"*
>
> (Armsworth et al., 2010)

The author's research aims to provide businesses with a process to measure, monitor and report the condition of biodiversity on company landholdings through the development of methodology for the selection of biodiversity indicators.

It was decided during the initial stages of the research that biodiversity issues outside of company landholdings, such as supply chain / procurement and biodiversity risk assessment of investments would not be included in this project. Research conducted by Whatling (2010) has made advances in the field of biodiversity assessment within company supply chains.

1.3 Aims and Objectives

The overall aim of the project was to develop a methodology to enable companies to identify, quantify and monitor biodiversity and report on the progress of biodiversity objectives within existing business systems.

The overall aim of the project will be achieved by meeting the following objectives:

1. Conduct a literature review to gain knowledge and understanding of work undertaken to date relating to:
    a. Biodiversity as a discipline;
    b. The relationship between biodiversity and business; and,
    c. Biodiversity indicators.
2. Identify businesses covering a range of industrial and commercial activities that have active biodiversity initiatives, and establish their willingness to collaborate in the research.
3. Determine the drivers motivating organisations to engage with biodiversity issues.
4. Evaluate the establishment and implementation of biodiversity objectives within the collaborating businesses.
5. Undertake studies of collaborating businesses to inform the research procedure.
6. Construct a methodology for the selection of biodiversity measures within an environmental management framework.
7. Undertake trials of the proposed methodology and evaluate its viability.

CHAPTER 2 - LITERATURE REVIEW

2.1 Introduction

This chapter delivers Objective 1 as stated in Chapter 1, reviewing literature to gain understanding and knowledge in relation to biodiversity, business and biodiversity and the measurement of biodiversity. This review has been grouped into the following categories to distinguish key aspects of the research.

- Biodiversity - the term, its history and interpretation
- The Importance of Biodiversity
- Ecosystem Services and the Ecosystem(s) Approach
- Economic Valuation of Biodiversity
- Biodiversity, Business and Sustainable Development
- Environmental Management Systems
- Biodiversity Action Plans
- Indicators

Literature search methods have been varied, scientific journal databases including ISI Web of Science, Ingenta (BIDS) and Science Direct have been utilised. Business and general databases including Proquest and ISI Web of Knowledge have been used for some aspects of the literature searching. In addition to searching for academic articles a large volume of material was gathered from government and non-government organisations such as the Department for the Environment, Food and Rural Affairs (DEFRA), English Nature (EN) / Natural England (NE), Earthwatch, United Kingdom Biodiversity Group (UKBG), the Joint Nature Conservation Committee (JNCC), The Wildlife Trusts and corporate publications.

As the focus for the project is development of a methodology for developing biodiversity objectives within business systems the literature review process focused upon practicable and relevant information for such an application.

2.2 Biodiversity – The term, its history and interpretation

2.2.1 Origins of ‘Biodiversity’

The term biodiversity has only been in widespread use since the early 1990’s, predominantly due to the signing of the Convention on Biological Diversity at the ‘Earth Summit’ in Rio de

Janeiro in 1992. Biodiversity as a term was developed through use in the 1980s, from early roots in the US Strategy Conference on Biological Diversity, held in 1981. Most famously credited are both the US National Academy of Sciences (Wilson & Peter, 1988) and Walter G Rosen for use at the National Forum on BioDiversity in September 1986 (Scottish Biodiversity Group, 2001). The Convention on Biological Diversity (CBD) is regarded as the starting point for widespread use of the term. The CBD was developed and signed by over 150 heads of state at this time, and is the strongest and original piece of legislation (or agreement) to perpetuate the developments in biodiversity awareness and knowledge.

2.2.2 Interpretations and understanding of 'Biodiversity'

There are many definitions of biodiversity and the following descriptions and quotations should provide insight into their variability and abundance.

> *"Biodiversity is the entire living component of the natural world and embraces all plant and animal species, ecosystems and communities associated with terrestrial, aquatic and marine habitats."*
>
> (Environment Agency, 2000)

> *"Biodiversity is the variety and diversity of all living things and the systems of which they are a part."*
>
> (UNEP, 1995)

The definition of biodiversity from the CBD details three levels of biodiversity:

> *""Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems."*
>
> (CBD, 1992)

This distinction of genetic diversity (diversity within species), species diversity (diversity between species) and ecosystem/habitat diversity (diversity of ecosystems) is also the structure of the definition used in the pre-dating World Resources Institute publication (Reid & Miller, 1989) where biodiversity is defined in the following way:

> *"Biodiversity is the variety of the world's organisms, including their genetic diversity and the assemblages they form. It is the blanket term for the natural biological wealth that undergirds human life and well-being."*
>
> (Reid & Miller, 1989)

Despite these definitions and the many others available, there is much confusion and misinterpretation of the term biodiversity and many additional components have been attached to the term, alternative approaches viewed and conceptually related terms alluded to when using the noun ‘biodiversity’. It is an embracive concept, referring to the entire ecosphere and all of its ecosystems, living components and ecological processes and evolution (Earthwatch, 2002). The breadth of the concept reflects the interrelatedness of genes, species and ecosystems. Because genes are the components of species, and species are the components of ecosystems, altering the make-up of any level of this hierarchy can change the others (Reid & Miller, 1989). UNEP-WCMC (2005) assess that biodiversity has become a term that is ever more difficult to define as it has gained currency.

To demonstrate the myriad of elements contributing to the term, Kaennel (1998) conducted surveys of 125 documents to create the domain tree of biodiversity shown in Figure 2.1. This neatly illustrates the apparent complexity of the term ‘biodiversity’. The vast scope of subject areas covered by ‘biodiversity’ and the numerous components comprising the term make for easy confusion in discussion and written documents.

In ecological sciences the term ‘diversity’ has a scientific background and is fixed to clearly defined rules (Buchs, 2003). Taking the term biological diversity literally may promote the conservation of a diverse a set of species (Solow, 1993). In general use, and in use by ‘secondary users’ such as politicians and business analysts, biodiversity can be a very individual and confusing term. Scientifically, (bio-)diversity has two components, the diversity component being the number of different elements within the set, and the evenness of the set, i.e. the degree of balanced frequency of each element. In common use the evenness of the set is often ignored, meaning the term ‘biodiversity’ is often used to express the number of different elements - most often this means number of species. This understanding and use of ‘biodiversity’ lends itself to an approach solely dictated by the need for increased numbers of different species.

Figure 2.1 - Domain Tree of Biodiversity (Kaennel, 1998).

Development of the term has extended beyond species richness as the term has aged and it is often used for varieties, genotypes, habitat types and landscape structural elements (e.g. shrubs, stonewalls, hedgerows, ponds)(Buchs, 2003). This approach fits the CBD three tier model more comprehensively than species richness alone.

> *"Biodiversity as a concept (expressed as the 'variety of life') is completely abstract and difficult to understand."*
>
> (Gaston, 1996)

Biodiversity as a term and as a focus for enhancement is uncertain and inadequate if it is not clearly defined before commencement of a project.

Houdet (2008), corroborating the multitude of elements which define biodiversity as previously described, dedicates six pages including several figures to providing an understanding of the term and components of biodiversity. Critically, the definition includes strong emphasis on the human component of biodiversity and it is stated that:

> *"diversity of cultures and ways of life in turn relates to the diversity of the ecosystems in which cultural and biological diversity exist in a reciprocal relation."*
>
> (Houdet, 2008)

The confusion and lack of a simple universal definition is a barrier between business and biodiversity. The scientific language used by ecologists and nature conservation organisations, and the incompatibilities with the business language used throughout the private sector, has hindered communication and progress in addressing biodiversity at an organisational level (pers. Comm. Calow, 2003). This confusion, and the imbalance between science and policy has been discussed by authors including Ghilarov (1996) and Hamilton (2005). Ghilarov (1996) states that from the initial use of the term, biodiversity has been associated with politics and environmental technology rather than with the science of ecology. Hamilton (2005) theorises that biodiversity has only a vague origin in scientific literature and that this uncertain foundation may have led to the current ambiguity surrounding the term. Both authors take a standpoint which views biodiversity as a concept that lies on a spectrum between science (ecology) and policy. Hamilton (2005) specifically states that biodiversity is well entrenched in the world of environmental management and policy and that it is a useful tool from a sociological and political perspective, even if it has substantial theoretical (scientific) limitations. These descriptions of the term biodiversity by Ghilarov (1996) and Hamilton (2005) may represent one end of the spectrum of understanding or

misunderstanding. UNEP-WCMC (2005) state that the term biodiversity has become ever more difficult to define and that there is little fundamental agreement as to what it means.

The confusion surrounding the term 'biodiversity' is only part of the incomplete link between businesses and biodiversity. Many nature conservation organisations focus only on the benefits to biodiversity (e.g. saving or creating habitats) and ignore the business benefits, thus reducing the opportunity for generating enthusiasm within many businesses.

The following sections highlight the importance of biodiversity, the link to UK business and the opportunities for businesses that engage with biodiversity.

2.3 The Importance of Biodiversity

The importance of biodiversity is well documented, and the reader is referred to: Duelli & Obrist (1998) & (2003), Buchs (2003); Daily (2000) & Daily & Ellison (2002); DEFRA (2001a), (2002) & (2002a); Earthwatch (1998) & (2002a); Houdet (2008); ECNC (2003); CIRIA (2003); IUCN (1997) & (2002); MA(2005); Reid & Miller (1989) & UKBAP (HMSO, 1994). Biodiversity is important as a resource as much as for its intrinsic value. Biodiversity provides most of our foods and medicines, natural habitats help control soil erosion, flooding and treatment of waste. As the very nature of biodiversity is so complex it is impossible to understand completely the effects of diminishing numbers of species or habitats and what benefits will be lost. People like to know that species and habitats exist and can flourish, even if they are never seen. Important philosophical arguments about the intrinsic value of biodiversity include concepts such as the uniqueness of species, the right to exist and the irreversible nature of extinction (Hamilton, 2005). All of these factors are elements of the importance of biodiversity.

2.3.1 UK Biodiversity

The UK has a varied and rich biodiversity due mostly to historic land management practices and more specifically the small-holding, extensive farming methods developed over the past 1000 years or more. However, during approximately the past 100 years, with the rise of intensive land management practices, biodiversity has decreased dramatically (Piorr, 2003). The intensive grazing regimes, increased use of chemical fertilisers, herbicides and pesticides and modern, intensive farming techniques have all had negative impacts on UK biodiversity. Combine these changes in agricultural practice with the sharp rise in population, associated land-take for housing, increased infrastructure and unsustainable economic growth, and UK biodiversity has a much reduced prime resource in which to flourish.

However, Britain has a long history of wildlife interest and many thousands of naturalists have observed and recorded Britain's wildlife over many decades. Environment Agency (2000) conclude that this historic data provides a solid background from which it can be shown that Britain still has relatively high biodiversity, although certain species and habitats have declined, sometimes severely, in recent decades.

Examples of biodiversity loss from Avery et al. (2001) and DEFRA (2002a) are:

- 98% of wildflower meadows lost in past 100 years;
- 448,000 km of hedgerow lost in past 100 years;
- 95% loss of high brown fritillary butterflies;
- 40% overall decline in House Sparrow, 97% decline in some urban areas;
- 66% drop in marsh fritillary numbers from1990-2000.

The following section provides an overview of the global issue of biodiversity, ecosystem services and other related topics in order to show the wider context of this thesis.

2.4 Ecosystem Services and the Ecosystem(s) Approach

"Human well-being depends upon the continuing supply of services provided by ecosystems"
(MA, 2005).

"Ecosystem services are services provided by the natural environment that benefit people"
(Defra, 2007a).

Until recently, most ecosystem services could be regarded as 'free' based upon their abundance and the level of demand upon them. Economic activity was limited and what did take place had little significant impact on the world's ecosystems (Daily, 2000).

The CBD definition of biodiversity describes three levels of biodiversity: diversity within species, diversity between species and diversity of ecosystems. Implementation of the CBD included the development of plans and strategies (Article 6 of CBD, United Nations, 1992). Strategies based upon ecosystems were known as 'the ecosystem approach' and this was defined in Annex A of The Convention of the Parties 5 (COP5) Decision V/6 (United Nations, 2000).

"The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way."

(United Nations, 2000)

Annexes A & B to COP5 Decision V/6 describe and set out principles of the ecosystems approach and these are summarised below:

"Annex A – Description of the ecosystem approach

1. *The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.*
2. *An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization. It recognizes that humans, with their cultural diversity are an integral component of many ecosystems.*
3. *This focus on structure, processes, functions and interactions is consistent with the definition of "ecosystem" provided in Article 2 of the CBD. This definition does no specify any particular spatial unit or scale. Thus the term "ecosystem" can refer to any functioning unit at any scale. It could, for example, be a grain of soil, a pond, a forest, a biome or the entire biosphere.*
4. *The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Measures may need to be taken even when some cause-and-effect relationships are not yet fully established scientifically.*
5. *The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. Indeed, there are many ways in which ecosystem approaches may be used as the framework for delivering the objectives of the Convention in practice."*

(United Nations, 2000)

"Annex B – Principles of the ecosystem approach

6. *The following 12 principles are complementary and interlinked:*
   Principle 1: The objectives of management of land, water and living resources are a matter of societal choice.
   Principle 2: Management should be decentralized to the lowest appropriate level.
   Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
   Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context.
   Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
   Principle 6: Ecosystems must be managed within the limits of their functioning.

Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
Principle 8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long-term.
Principle 9: Management must recognize that change is inevitable.
Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines."

(United Nations, 2000)

A number of key points are contained within this description and principles of the ecosystem approach. Significant links to subsequently developed approaches and ways of considering biodiversity are included, specifically Principle 5, specifying that maintenance of ecosystem services should be a priority target of the ecosystem approach. Research into ecosystem services has grown since the time of this definition of the CBD ecosystem approach in 2000 with the Millennium Ecosystem Assessment (MA) being the most significant compilation of scientific work in this area. As described by Ring et al. (2010), the MA put the ecosystem services concept centre stage.

The MA was established to provide an assessment of the functions ecosystems provide for human well-being and the options for the conservation of these functions. The MA was a process contributed to by governments, scientists, NGOs and the private sector and the report was published in 2005. The MA is a response to government requests for further information relating to the Convention on Biological Diversity, the United Nations Convention to Combat Desertification, The Ramsar Convention on Wetlands and the Convention on Migratory Species.

The MA covers the linkages between human well-being and ecosystems, introducing an ecosystem definition:

"An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit."

(MA, 2005)

The assessment covers all ecosystems and concentrates on ecosystem services, which it divides into and defines as:

- Provisioning services;

- Regulating services;
- Cultural services; and,
- Support services.

The MA gives several examples as the resulting services or benefits of ecosystems linked to the categories it divides ecosystems services into and Table 2.1 summarises this.

Ecosystem	Service	Sub-categories
Provisioning	Food	Crops, livestock, capture
	Fiber	Timber, cotton, silk, hemp,
	Genetic Resources	-
	Biochemicals, natural medicines	-
	Fresh Water	-
Regulating	Air Quality regulation	-
	Climate regulation	Global, regional and local
	Water regulation	-
	Erosion regulation	-
	Water purification and waste	-
	Disease regulation	-
	Pest regulation	-
	Pollination	-
	Natural hazard regulation	-
Cultural	Cultural diversity	-
	Spiritual and religious values	-
	Knowledge systems	-
	Educational values	-
	Inspiration	-
	Aesthetic values	-
	Social relations	-
	Sense of place	-
	Cultural heritage values	-
	Recreation and ecotourism	-
Support	Soil formation	-
	Photosynthesis	-
	Primary production	-
	Nutrient cycling	-
	Water cycling	-

Table 2.1 – Summary of Millennium Ecosystem Assessment Ecosystem Services categorisation

Although a considerably human-centric approach, the MA does acknowledge intrinsic value and the fact that some human actions towards ecosystems will be affected by a consideration for the intrinsic value of a species or ecosystem. Different scales of assessment are acknowledged by the MA. The ideal is considered to be a global assessment rather than a national type of ecosystem assessment because some processes are global and products, goods and services are often transferred across regions. However, sub-global assessments are recognised as being of value for those decision makers working at the same scale (for example, a national or ecosystem-specific scale).

Whilst this is the accepted standard starting point for ecosystems service categorisation, DEFRA (2007) propose that what is more important than the specific groups, categories or terminologies is the recognition that ecosystems provide valuable services for people. DEFRA (2007) lists the benefits that ecosystems provide to human well-being as the following:

- natural resources for basic survival, such as clean air and water;
- a contribution to good physical and mental health, for example, through access to green spaces, both urban and rural, and genetic resources for medicines;
- natural processes, such as climate regulation and crop pollination;
- support for a strong and healthy economy, through raw materials for industry and agriculture or through tourism and recreation; and,
- social, cultural and educational benefits, and wellbeing and inspiration from interaction with nature.

Within the preface of the MA (2005) report it is conceded that the scientific and assessment tools required for cross-scale assessments are only beginning to be developed.

House of Commons Environmental Audit (2007) states that:

> *"The conclusions of the MA are clear. Human activity is fundamentally and extensively changing the world around us, leading to extinction on a massive scale. The extent of this loss should not be underestimated. It points to a sixth great extinction, on a par with historic global extinction episodes caused by asteroid impacts."*
>
> (HMSO, 2007)

Additionally:

> *"The Millennium Ecosystem Assessment (MA) framework is widely accepted as the standard approach to categorising ecosystem services"*
>
> (Defra, 2007).

However, Ring et al. (2010) state that although the MA did a thorough job of assessing effect of policies on ecosystem services and human well-being, there is still a lack of basic information about the interrelationship between ecosystem services and human well-being. In relation to this the House of Commons Environmental Audit (2007) comment that non-specialists can find it difficult to access information contained in the MA reports and that messages were not presented in ways that maximise relevance to other development issues. Hiedenpää et al. (2011) document how the ecosystem approach has been launched and hailed from above, derived from global principles and norms such as those embedded in the Convention on Biological Diversity and Millennium Ecosystem Assessment.

Daily & Ellison (2002) give several examples of the ecosystem services approach in practice and give examples where these functions have been acknowledged by governments, societies and businesses. One such example is the case of flood prevention engineering versus restoration of a natural river and floodplain in Napa, California, USA. In this instance, flood prevention through construction of straight concrete channels, flood walls and levees was rejected by the local community, community groups and local government and national government departments. In place of this, a scheme was approved which returned land to floodplain, removed low bridges over the river, demolished properties in the floodplain and introduced bends and low levels to the river that encouraged the natural development of marshes and other floodplain habitat. Despite understandable opposition from some residents, particularly those who had farmed land that was being returned to floodplain and fans of historic buildings that were to be demolished, the scheme resulted in considerable financial benefits. These included saving an estimated $22 million annually by eliminating flood damage to property, saving $4 million in reduced flood insurance costs and other gains such as $300,000 annual revenue from the newly created hiking and bird watching trails. Other benefits included the creation and protection of habitat, which is noted as being increasingly financially valuable as protected species legislation increases. Additionally a natural river system improves water quality by the filtering action of wetlands and may even improve air quality in the local area. Daily & Ellison (2002) describe this project as a remarkable investment in ecosystem capital following a century of degradation and loss – the

natural assets of the river and floodplain were restored, supporting ecosystem services including flood protection, habitat for fish, birds and other wildlife and a source of scenic beauty for outdoor recreation and tourism.

Biological diversity is an essential requirement for the continuing supply of ecosystem services. In most situations, greater biodiversity provides greater or a more dependable and resilient supply of ecosystem services. Biodiversity is declining in many places, along with a decline in the area of near-natural ecosystems (MA, 2005).

The UK Department for Environment, Food and Rural Affairs (DEFRA) Ecosystems Approach is described in DEFRA (2007a & 2007b) and is described against a context of previously fragmented and complex framework of policies for nature conservation, pollution control and protected areas management. In summary it is proposed that the approach will provide a more effective way to deliver DEFRA's environmental outcomes, allow for better informed decision making, improved prioritisation of resources and more effective communication and greater awareness of the value of the natural environment and ecosystem services.

2.5 Economic Valuation of Biodiversity

2.5.1 Introduction

"The world's ecosystems are capital assets"

(Daily et al., 2000)

The economic valuation of biodiversity has been hotly debated in relation to suitable methods and the various components of biodiversity and ecosystems services. A strong case has been put forward that biodiversity should not or cannot be assigned economic values and that it is an anthropocentric approach that accepts the substitutability of different forms of capital or is 'weak sustainability' as described by Pearce & Atkinson (1993) and Godard (1995).

More recently the lack of ability of standard economic accounting systems to accurately take into account ecosystems services and biodiversity has been reported in The Economics of Ecosystems and Biodiversity (TEEB) Interim Report (European Commission, 2008).

Ecosystem Services are linked in much literature to valuation and authors such as Houdet (2008, 2009a & 2009b), Daily (2000), Daily et al. (2000, 2009) have written specifically about

business and the integration and valuation of biodiversity and ecosystem services. Prior to the publication of landmark reports such as the Millennium Ecosystem Assessment (MA) and TEEB, Daily (2000) and Daily et al. (2000) described how natural capital, relative to other forms of capital is poorly understood, scarcely monitored and often undergoing rapid degradation. With the importance of biodiversity and ecosystem services being only realised upon major or complete loss, ecosystem capital is typically undervalued if considered at all.

In the UK, DEFRA (2007a, 2007b) explain that environmental assets provide benefits that enhance economic performance, offer new investment and employment opportunities and improve living standards for all. Like other assets, level of condition of these assets directly affects the benefits that can be derived from them. As also acknowledged by Daily & Matson (2008) and others, DEFRA (2007a) state that the natural environment is being used in a non-sustainable way and ecosystem services are being degraded, affecting the flow of benefits.

2.5.2 TEEB

The TEEB report was published in 2008 and provides information from leading experts worldwide of the need for improved valuation metrics for pricing natural resources, specifically ecosystem services. The report details the increasing pressure on biodiversity and ecosystem services globally, then arguing the case that current economic valuation does not accurately reflect natural systems and services.

> *"Managing humanity's desire for food, energy, water, lifesaving drugs and raw materials, while minimizing adverse impacts on biodiversity and ecosystem services, is today's leading challenge for society."*
>
> (TEEB, 2008)

The above quote illustrates the balance that the TEEB report provides information to address. The report provided the first all in one package of information on biodiversity and ecosystems services valuation.

Chapter 1 of the TEEB report sets the context of increasing biodiversity loss and degradation of ecosystems services. It describes a 'defective economic compass' that does not take into account the life-giving functions of biodiversity and ecosystems. Instead, economic metrics focus on GDP and the principle that a benefit received now is worth more than the same benefit received in the future (the notion of discounting). The report covers the spectrum of natural capital valuation from assigning economic value to the natural products such as

timber, through the functions that ecosystems provide such as water filtration, to the unknown potential future benefits that may be contained within biodiversity such as new medicines.

The TEEB report communicates these ideas in several examples, including the case-study of Haiti, reproduced below:

Figure 2.2 – Haiti Case Study (TEEB, 2008)

Beyond the introductory and context setting chapters at the beginning of the report, some guidance is given at a global and national level for new accounting systems which take into account more than GDP and traditional economic metrics. Four broad messages are conveyed:

- Rethink today's subsidies to reflect tomorrow's priorities;
- Reward unrecognised benefits, penalise uncaptured costs;
- Share the benefits of conservation; and,
- Measure what you manage.

Reference is given to the corporate level within discussion of the final message of the above list. This provides a link to the Corporate Social Responsibility sector and the gradual recognition that there is a need to redefine corporate success. In recognition of consumer pressure (both to provide products that are desired and pressure to supply these products

responsibly) it is stated that a major goal of future work is to develop standard metrics for consumer footprint (in terms of land, water and energy use).

The biodiversity indicator selection methodology developed in this thesis fits into this context, providing the means for measuring biodiversity impact of land-use by business.

Previous authors had written on the economic valuation of biodiversity prior to the publication of TEEB (for example, Turner et al., 2003; Edwards & Abivardi, 1998; Limburg et al., 2002) and had discussed elements of what is covered in the TEEB report. In particular, the notions of a precautionary principle approach to valuation of biodiversity and ecosystems and the risks of valuing the unknown. This is addressed in the TEEB report during Chapter 3, which covers the economic process of applying discount rates and the ethical dilemma this raises when considering non-financial benefits. The uncomfortable view of economic valuation of natural capital expressed in earlier literature is described in TEEB as follows:

> *"There are probably benefits that we have not yet identified, so we are able to assess, even in qualitative terms, only part of the full range of ecosystem services. We will probably never be able to assess the full range. It will be possible to make a quantitative assessment in biophysical terms only for part of these services – those for which the ecological "production functions" are relatively well understood and for which sufficient data are available. Due to the limitation of our economic tools, a still smaller share of these services can be valued in monetary terms."*
>
> (TEEB, 2008)

The TEEB report goes on to state that:

> *"It is therefore important not to limit assessments to monetary values, but to include qualitative analysis and physical indicators as well."*
>
> (TEEB, 2008)

These uncertainties of the value of biodiversity and ecosystems and the limitations of standard economic valuation tools are cause for concern among ecologists and biodiversity professionals. There is the fundamental question whether economic valuation is appropriate to apply to life-giving functions of biodiversity and ecosystems (TEEB, 2008).

The issue of 'conservation costs' is raised in TEEB (2008) and the idea of cost benefit analysis of the cost of conserving biodiversity and ecosystems is raised versus the benefits that such biodiversity and ecosystems provide.

Edwards and Abivardi (1998) cover many of these arguments, stating that:

> *"We must shift our attention increasingly to the preservation of biological diversity within the major forms of land-use. High priority must be given to finding ways of restoring biological diversity and enhancing ecosystem function in those areas which have already been seriously damaged."*
>
> (Edwards & Abivardi, 1998)

At this time (1998), Biodiversity Action Plans were just entering the mainstream for Local Authorities and environment-conscious businesses in the UK. Edwards and Abivardi go on the make the argument that conservation must shift from being the interest of a minority to the mainstream of social and economic activity. The argument presented is that which would later be expanded and presented in the Millennium Ecosystem Assessment and the TEEB report:

> *"A powerful new argument for protecting biodiversity has emerged in the past 10 years: we need it for our survival. This realisation has grown gradually as a result of the increasing scale of environmental problems we face, such as acidification, eutrophication of waterways, extreme flooding events, destruction of the ozone layer and climatic change."*
>
> (Edwards & Abivardi, 1998)

TEEB (2008) describes how new methods and technologies are being developed in order to reduce the human demand on natural services and these include reducing fossil fuel consumption in combustion engines, developing renewable energy technology, sustainable architecture using renewable materials and local sourcing. The methodology developed in this research for the selection of biodiversity indicators is viewed by the authors as broadly fitting into this category and scale of contribution to the global biodiversity and ecosystem service context. The methodology has been designed through collaboration with UK landholding organisations over a period of time when there has been step-change achievements in the global biodiversity and ecosystem services debate and approach. While the global discussions have raised the importance of biodiversity and ecosystem services to a level almost equalling climate change and carbon, this methodology aims to provide an organisational level tool for measuring biodiversity where previously it has not been included in the group of 'significant' environmental aspects – carbon, energy use, waste, water use, pollution to air and water etc.

These practitioner level requirements are also referred to in the Interim TEEB report. Although the majority of the TEEB report is targeted at the international and national policy making audience, it is recognised that:

"At the corporate level, too, there is gradual recognition of the need to redefine corporate success and enhance performance measurement and reporting to reflect a broader vision for the corporation"

(TEEB, 2008)

2.6 Biodiversity, Business and Sustainable Development

"The MA showed that degradation of ecosystem services is a threat to businesses' bottom line."

(HMSO, 2007)

The MA synthesis report "Ecosystems and Human Well-Being: Opportunities and Challenge for Business and Industry" (2005) states that corporate organisations should:

"Take business decisions that anticipate growing customer preferences for sustainably supplied services, new regulations, competitor strategies, investor demands for sustainable business models, and the establishment of market mechanisms.

For example:

- *reduce carbon emissions,*
- *decrease nitrogen and phosphorus loading,*
- *increase efficiency of water and energy use,*
- *protect natural habitat and biodiversity,*
- *achieve the sustainable management of natural resources, and*
- *make decisions informed by the full "life-cycle" costs of products."*

(MA, 2005)

The motivation to "protect natural habitat and biodiversity" is where the focus of the research detailed in this thesis sits in relation to the wider context of ecosystem services, the ecosystem approach and larger scale, global policy-making in relation to these topics.

Although businesses require profit to survive, many have recognised that long-term sustainable development requires good environmental and social performance together with the economic performance previously focused upon (Earthwatch, 2002). Much of the improvements in environmental performance over recent years have been driven by cost-cutting benefits or the fear of prosecution or public scandal. Business has been quick to recognise that money can be saved through effective waste and energy management, providing profit increases. Regulatory authorities have historically been concerned almost exclusively with chemical pollution in the form of emissions to land, water and air. The combination of these factors has shaped businesses' development of environmental policy

during the last two to three decades. In recent years businesses have begun to realise that environmental issues can be addressed for competitive advantage and that good environmental performance can improve products, services and market share through effective reporting and public relations.

> *"Sharing responsibility and taking action for biodiversity is not about charity"*
> (Earthwatch, 2002)

Biodiversity is an aspect of environmental management which has not been exploited by the mainstream for competitive advantage. Earthwatch (2002) report that many businesses are poorly informed of biodiversity risks and most are unaware of the plethora of opportunities biodiversity can provide to improve corporate performance. Inadequate biodiversity management can impose risks on business performance, market place position or profitability. Challenges to legal operating or development licences, such as those illustrated by Plaut (1998), damage to public relations or brand image, claims for environmental damages or liabilities, lower ratings in financial markets and other impacts may all result from poor biodiversity management. Thorough and well thought out biodiversity management can alleviate all of these problems and bring many opportunities to businesses. Stakeholder relations can be enhanced, ethical consumers and socially responsible investors attracted and sustainable growth programmes and overall corporate social responsibility reinforced. Several outline methodologies have been developed for the integration of biodiversity into business operations but most focus several levels of the methodology at the integration and introduction of biodiversity as a topic to existing business systems and fall short of details of how to implement and develop biodiversity objectives drafted through this integration procedure. It is not that the implementation and subsequent measurement, monitoring and reporting has been forgotten but that methods for these aspects are assumed to exist or thought not immediately necessary. Many businesses fall into the trap of producing a policy without actually implementing any on-the-ground work (Calow, 2003).

> *"The business case for managing biodiversity is primarily to manage risks, capitalise on opportunities and meet corporate social responsibilities"*
> (Earthwatch, 2002a).

Currently in the United Kingdom there is no legislation forcing business to deal specifically with biodiversity and biodiversity impacts. However, wildlife legislation that does exist includes the Countryside and Rights of Way Act (CRoW), the Environment Act, Wildlife and Countryside Act, Protection of Badgers Act, European protected species under annexes II

and IV of the EC Habitats Directive such as all species of bat, great crested newt and otter. This indirect legislative pressure, and anticipation of future legislation from CBD and subsequent UKBAP and Local Agenda 21 (LA21) work, pushes businesses to address biodiversity (Fermor, 2003).

There is increasing recognition among business that good economic performance is inextricably linked to environmental and social performance; the three component elements of the sustainability concept. This coincides with the advent of socially responsible investment (SRI) and sustainability / SRI share indices such as FTSE4Good, Business in the Environment Index and the Dow Jones Sustainability Index alongside increasing ethical consumerism (ISIS, 2004). Many organisations have increased attempts to address all three aspects of sustainable development. However, biodiversity is often overlooked as an element of environmental performance (Hayward, 2002) and is seen as separate to corporate social responsibility. Biodiversity is an issue that should be considered as an integral part of CSR and sustainability programmes (Earthwatch, 2002). Alfsen-Norodom and Lane (2002) support this, discussing specific strategies from The International Conference on Biodiversity and Society, stating that in order to achieve sustainable human society an integrated approach to environmental conservation is required.

For a majority of businesses addressing biodiversity issues, the main driver is market pressures and the desire to be innovative / market leaders. With the rise of several sustainable investment financial indices and the increasing awareness of SRI, many large businesses have considerable CSR budgets. In the past couple of years the aspects organisations are required to address in order to be listed on these sustainability indices have included biodiversity. The quantity of biodiversity questions and the detail required appears to be increasing each year. An extract illustrating an example of such biodiversity questions is provided in Figure 2.3.

If Biodiversity is one of your company's most significant impact areas, complete this question INSTEAD of one of either Question 15 or 16.

17 Impact Area: BIODIVERSITY

If you choose to complete the following questions on Biodiversity, could you please indicate if you are completing it primarily with regards to your direct or indirect impacts. Please note that this question will not be scored.

 Direct impacts (for example through land that you own, use or manage).

 Indirect impacts (for example through your supply chain and/or investments)

17.1 Management and reporting

Do you assess and manage your impact on biodiversity?

 No.

 Yes, it is assessed across relevant business operations, but not managed within a corporate strategy.

 Yes, it is assessed across relevant business operations, and managed within a corporate strategy.

Our impact is measured as follows:

Please state: CORPORATE OBJECTIVE or INDICATOR (qualitative or quantitative):

……

PERFORMANCE MEASURE:……..

DATA PERIOD:……

 Yes, it is assessed across relevant business operations and managed within a corporate strategy, which is publicly available. Our impact is measured as follows:

Please state: CORPORATE OBJECTIVE or INDICATOR (qualitative or quantitative):

……

PERFORMANCE MEASURE:……..

DATA PERIOD:……

List of supporting evidence and clarification (as appropriate)

……..

Figure 2.3 - An extract from the 2003/4 Business in the Environment Survey

Plaut (1998) discusses how as a result of implementing environmental auditing and environmental management systems, the private sector is increasingly focusing not just on compliance with laws, but on continuous improvement in environmental practice and performance as a marketplace demand. Many businesses have realised, or are beginning to realise, that they can market specific environmental diligence as an attractive asset. The green approach has, and should continue to grow rapidly and newer / specialist areas such as biodiversity can offer organisations the opportunity to lead the field and gain market advantage. In a survey of 200 chief executives, chairmen and directors from 10 European countries, Business in the Community (2002) found nearly 80% agreed that companies which integrate socially and environmentally responsible practices will be more competitive; and 73% accept that "sustained social and environmental engagement can significantly improve profitability".

Plaut (1998) also states:

> *"There is significant pent-up public desire for environmental improvement and greener industry analogous to the auto manufacturers' marketing safety."*
>
> (Plaut, 1998)

Despite this, Norfolk Biodiversity Partnership (2003) comment that:

> *"Biodiversity conservation is often seen as the poor cousin, or optional extra in terms of environmental management, with the big three – energy, waste, water and transport - taking all the glory and resources."*
>
> (Norfolk Biodiversity Partnership, 2003)

Plaut (1998) lists the following as benefits of environmental management systems to businesses:

- improved environmental management;
- market greener products;
- meet government, public and customer environmental requirements;
- avoid liability and extra costs;
- improve safety on the job;
- reduce waste;
- improve process efficiency;
- enhance product receptivity;
- plan and assess better, including environmental impact; and,
- reflect a better image.

Earthwatch (2002) list the following as opportunities arising from biodiversity programmes:

- secure licences to operate;
- strengthen the supply chain;
- bolster stakeholder relations;
- appeal to ethical consumers;
- ensure sustainable growth;
- attract socially responsible investors; and,
- improve employee productivity.

Land management for wildlife conservation can be promoted by business and communicated to the general public much more easily than CO_2 emissions or ozone depletion. The public are much more able to understand and even experience business efforts in the area of

biodiversity conservation undertaken in their natural environment and this puts the business in a positive light, and thus being seen as a good neighbour. This is reinforced by Fischer & Young (2007) who found that members of the public have rich mental concepts of biodiversity, irrespective of their scientific knowledge. Another study by DEFRA (2002) found that 52% of respondents thought the protection of wildlife was 'very important' even though they did not know what biodiversity itself meant. Christie *et. al.* (2006) found that the public has positive valuation preferences for biodiversity and is largely indifferent to how biodiversity protection is achieved. However, this partial understanding of the elements which make up a good biodiversity protection or enhancement strategy may be responsible for the prevalence of 'green wash' – the practice of green marketing based on limited positive environmental impact or action (Zaman et al, 2010).

Objective 3 of this project (as described in 1.3) is to identify the drivers motivating businesses to engage with biodiversity. This review of literature provides a background to the topic and commences the addressing of this objective. Further investigation into this area was completed in the case studies detailed and reported in Chapters 5 – 10.

2.7 Environmental Management Systems

The topic of Environmental Management Systems (EMS) is well documented and the reader is referred to IEMA (2009), Envirowise (2009) and Calow (2009). Formal EMS began with BS7750 published in 1992 as the first official environmental management standard. EMS have been developed and improved since the Rio Earth Summit by organisations such as the Business Council for Sustainable Development in Geneva, the United States Council for International Business in New York City and the Global Environmental Management Initiative in Washington D.C. (Plaut, 1998). From these and other organisations' work, two dominant systems have emerged: ISO14000 and EMAS.

ISO14000 follows procedures analogous to the widely used quality standard ISO9000 (Quality Management), but focusing on environmental management, auditing and performance measurements. Additional elements, including green labelling, life cycle analysis and supply chain management, have been developed through the evolution of the ISO14000 EMS. Industry has globally agreed the ISO approach, based upon continuous improvement cycles, pollution prevention and systematic environmental auditing.

The ISO 14000 EMS continues to grow in popularity and is widely adopted throughout the U.S.A. and Europe. Businesses can either adopt the standard and become certified or they can simply follow the guidance and demonstrate conformance, the latter being preferred by many U.S. organisations.

The implementation of ISO14000-based EMS begins with an initial environmental review, aiming to identify all significant environmental aspects, relevant laws, regulations and existing environmental procedures (Zobel & Burman, 2004). This initial environmental review forms the basis for the development of an environmental policy, environmental objectives, targets and environmental management programs. When the system has been developed it is audited to check efficiencies, and management must review and make improvements. Figure 2.4 displays the ISO 14001 cycle with continuous improvement (ISO14001 is part of the ISO14000 EMS).

Figure 2.4 – ISO 14001 Cycle

EMAS – Eco-management and Audit Scheme is an EU-regulation scheme, not as widely implemented as the international ISO14000 based EMS, but still widespread in use throughout Europe. Essentially EMAS works in a very similar way to ISO 14000, and in the past couple of years EMAS requirements have been equated to those of ISO14000, allowing certification to EMAS by an ISO14000 EMS route. Further information on the EMAS is available from a number of sources, including IEMA (2009).

At the start of this research in 2003, there were 76 EMAS registered organisations, and 3,000 ISO 14000 registered organisations in the UK (Environment Agency, 2004). Many other companies adopt the principles of the standard, without moving to full certification.

The reader is referred to research undertaken by Calow (2009) for further reading. This work details extensively the structure of EMSs in relation to biodiversity integration potential and can be considered as good a reference as is currently available (Fermor, 2004). Many large organisations currently addressing biodiversity issues do so through their environmental management systems (EMS) (Calow, 2003). ISO14000 includes biodiversity, but it must be identified during the initial environmental review and only has to be included if it is considered by the assessor as a significant impact area (aspect). Therefore, there are many companies who address biodiversity issues independently of an EMS, often through a company BAP and the targets contained within such a plan.

Many other companies implement formal EMS and disregard the biodiversity component, believing it not to be a significant impact area. According to Calow (2003), this is often due to lack of relevant biodiversity training or knowledge amongst environmental assessors and auditors, furthermore many EMS specialist professionals also do not have relevant training or knowledge in the biodiversity area. This is supported by Zobel & Burman (2004) who state that research on the process of identification and assessment of environmental aspects in EMS is lacking. However, in order to be able to establish a suitable environmental policy it is vitally important that an organisation be aware of its significant aspects. The environmental aspects are key to the development of effective environmental performance indicators (EPIs). The performance of an EMS is measured with the use of carefully selected indicators. During the audit process the performance of the management systems will be assessed using relevant indicators such as the area of UK BAP priority habitat. This kind of measure links to larger scale / government indicators and monitoring over time can indicate expansion or retraction of the habitat and may even drive investment to expand the valuable habitat. Indicators and EMS are discussed in more detail in section 2.7, with particular reference to biodiversity measures.

2.8 Biodiversity Action Plans

As introduced in 1.2, Biodiversity Action Plans (BAPs) have been developed in recent years to form part of an integrated approach to environmental conservation and are constantly increasing in occurrence. The CBD is the framework convention, giving decision making

powers to member countries, that prompted national policies to be developed independently, but with the same over-arching goal of conserving biodiversity. There are no lists of protected species or habitats within the CBD, instead an integrated approach to the conservation and sustainable use of biological resources is prescribed.

The UKBAP was published in 1994 and details priority habitats and species that have been selected because of threats to them or noted decline in extent or population. It is from the UKBAP that most other BAPs have been developed. Most local authorities have developed and published a BAP and these are designed to link into larger regional plans and ultimately the UKBAP. Company BAPs can also link into this hierarchy and such a link can be a positive boost to the company's biodiversity profile.

A BAP is generally a document outlining biodiversity aims and objectives for a given area and time-scale. The document will typically list target species and habitats and have aims, objectives and goals for each species and habitat. Generally there is also an introductory statement outlining the author's commitment to biodiversity, a biodiversity policy, details of partnership working and relevant legislation. All UK local authority BAPS and several other BAPs can be accessed via the UKBAP website (www.ukbap.org.uk). This is the best resource for BAP specific information and to see examples of BAP structures and differing approaches.

For the majority of organisations who do address biodiversity issues, a BAP is often the central document / commitment around which the performance and policy revolves. The BAP is the lead for all biodiversity work undertaken and is the point of reference against which all biodiversity performance data is measured.

Recent advances in the production of BAPs have lead to increasingly quantified targets, following the SMART (specific, measurable, achievable, relevant & timed) format. These can be measured against and results reported in conjunction with the centralised Biodiversity Action Reporting System (BARS), to help build the link to the UKBAP.

2.9 Indicators

2.9.1 Introduction

Indicators are used to indicate. They are used when the measurement of an entire data set is impracticable or beyond resource limits. For example, EEA (1999) provide the example of body temperature being used to provide critical information on our physical condition. In finance, politicians and monetary analysts use indicators, such as the level of unemployment and base rate of interest in a carefully selected indicator suite to make comment on the economy as a whole. For economic indicators, such as the retail price index, a representative selection of products forming a "shopping bag" is used to measure inflation and key economic changes (SBSTTA, 2003). Though imperfect, these measurements are recognised by most people and are effective.

In terms of environmental indicators, EEA (1999) explain that they provide information about phenomena that are regarded typical for, or critical to, environmental quality. For example, the number of a key species in one location is interesting to know, but when coupled with information about environmental degradation or pollution for that area, the data can be analysed and compared to data on the same key species in a les degraded / polluted area. Then the real significance of the key species data is the message conveyed about environmental quality of an area.

> *"Communication demands simplicity. Indicators always simplify a complex reality. They focus on certain aspects which are regarded relevant and on which data are available."*
> (EEA, 1999)

In relation to policy-making, environmental indicators are used for three major purposes:

- To supply information on environmental problems, in order to enable policy-makers to value their seriousness;
- To support policy development and priority setting, by identifying key factors that cause pressure on the environment; and,
- To monitor the effects of policy responses.

In addition, environmental indicators may be used as a powerful tool to raise public awareness on environmental issues. Providing information on driving forces, impacts and policy responses, is a common strategy to strengthen public support for policy measures.

With regard to environmental management systems, ISO guidance 14031 provides guidance on environmental performance indicators (EPIs), their use and application. It divides EPIs into two distinct categories: operational performance indicators (OPIs) and environmental condition indicators (ECIs). The intention of this distinction is to show which indicators are used to measure the performance of the management system (OPIs) and which are used to measure the condition of the impacted environment (ECIs).

The European Environment Agency (EEA) (1999) document an indicator approach known as the Driver, Pressure, State, Impact and Response (DPSIR) model that is described as a causal framework for describing the interactions between society and the environment. EEA (2007) define the DPSIR indicator categories as follows:

- *"**D**riving forces are the social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption and production patterns. Primary driving forces are population growth and development in the needs and activities of individuals. These primary driving forces provoke changes in the overall levels of production and consumption*

- ***P**ressures include the release of substances (emissions), physical and biological agents, the use of resources and the use of land. The pressures exerted by society are transported and transformed into a variety of natural processes which manifest themselves in changes in environmental conditions.*

- ***S**tate is the abiotic condition of soil, air and water, as well as the biotic condition (biodiversity) at ecosystem/habitat, species/community and genetic level.*

- ***I**mpacts on human and ecosystem health, resource availability and biodiversity result from adverse environmental conditions.*

- ***R**esponses are the measures taken to address drivers, pressures, state or impacts. They include measures to protect and conserve biodiversity (in situ and ex situ), and include, for example, measures to promote the equitable sharing of the monetary or non-monetary gains arising from the utilisation of genetic resources. Responses also include steps taken to understand the causal chain and develop data, knowledge, technologies, models, monitoring, human resources, institutions, legislation and budgets required to achieve the target."*

(EEA, 2007)

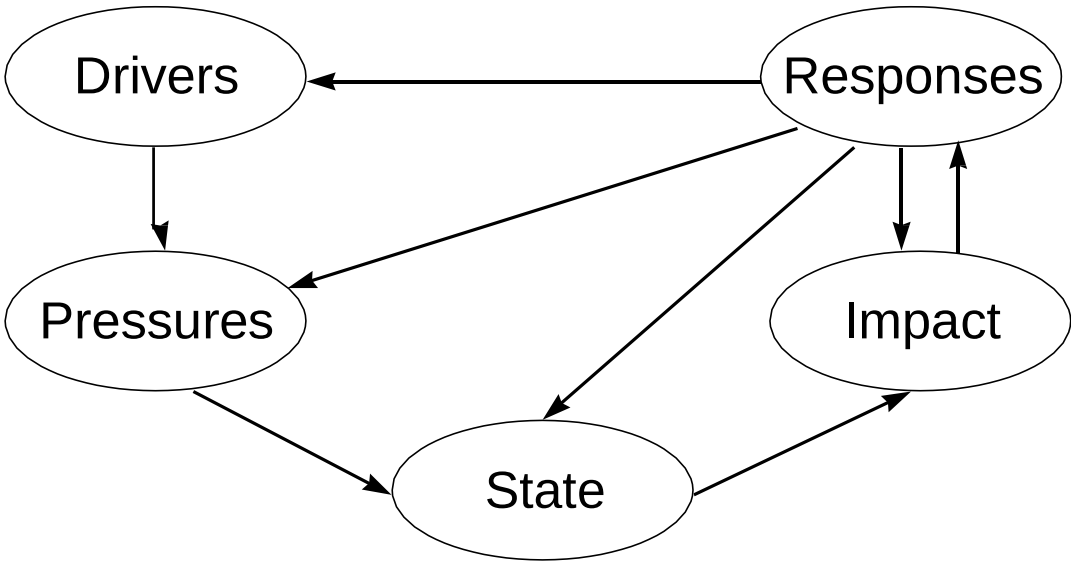

Figure 2.5 – DPSIR Framework for Reporting on Environmental Issues

In regard to the context of this research project the selection of indicators by businesses for assessment of landholdings should understand the relationships between the drivers, pressures, state, impacts and response. Although this project is concerned with organisation level / scale assessment of biodiversity as opposed to national-level concerns of biodiversity, society and policy making, parallels can be drawn between the DPSIR elements and overall model and the methodology for the selection of biodiversity indicators that is the main subject of this thesis.

Organisations want to address biodiversity in the same way that they address other environmental variables like energy and waste. Therefore they wish to measure the state of biodiversity within their influence / landholding. However, to determine the measures of biodiversity ‘state’ they are thinking about the wider natural environment, the drivers and pressures upon them to address biodiversity and the ability to assess their operational impacts upon it to determine suitable responses. This approach follows the DPSIR model. However, the EEA literature is targeted towards government / national approaches to environmental issues and can appear detached from the often smaller spatial scale of business practitioners.

The business or landowner scale is often described as the operational level and this research projects seeks to operationalise some of the higher level strategies and indicator frameworks and approaches such as proposed by DPSIR and the EEA. Although the influence of DPSIR and other higher level strategies is not always legislative pressure directly targeted toward individual environmental aspects such as biodiversity, there is pressure, both government-

and market-derived, to address environmental management and corporate social responsibility in working practices. Biodiversity is an aspect of environmental management and corporate social responsibility with an increasing status and is becoming apparent as a future 'standard requirement' alongside 'traditional' environmental aspects such as energy use and waste. This scenario creates and opportunity for market leading innovators to gain ground over competitors by being amongst the first to address the biodiversity that they influence.

The DPSIR approach is a useful tool at the level for which it is designed and applied. The approach describes the relationships between and the consequences of environmental problems, and links human activities to their environmental impact and shows the links of responses to these environmental impacts. The schematic of the DPSIR framework provided as Figure 2.5 shows the links and interrelationships and EEA (1999) discuss the need to understand the Drivers, Pressures, State, Impacts & Responses but also the links between the DPSIR elements.

To confirm the relationship between the indicators which are the subject of this research project and the wider context description and typology of indicators given by the EEA in their documentation of the DPSIR approach – the specific metrics that are most in line with other indicators used by organisations in the UK (and wider) for the measurement of environmental variables at an operational level are State indicators and the State indicator is defined in the EEA (1999) publication as:

> *"State indicators give a description of the quantity and quality of physical phenomena (such as temperature), biological phenomena (such as fish stocks) and chemical phenomena (such as atmospheric CO2-concentrations) in a certain area. State indicators may, for instance, describe the forest and wildlife resources present, the concentration of phosporous and sulphur in lakes, or the level of noise in the neighbourhood of airports."*
>
> (EEA,1999)

2.9.2 Biodiversity Indicators

Biodiversity indicators are a hotly debated topic, and many different opinions exist on the best approach or method to adopt. Researchers are becoming steadily more aware of the complexity of biodiversity measurement and the need to identify biodiversity indicators has become a research priority in recent years (Ferris & Humphrey, 1999; Noss, 1990; Ratcliffe, 1993). The quotations below show different thoughts regarding biodiversity indicators. The

variability in definition and understanding of biodiversity indicators is as diverse as the definition and understanding of the term biodiversity (as described in 2.1).

> *"Biodiversity indicators portray the status of, and trends in, biodiversity, as well as related pressures and responses."*
>
> (JNCC, 2002)

> *"Indicators are the "eyes and ears" of society, similar to a cockpit for a pilot. They are a prerequisite for adaptive and cost-effective policies."*
>
> (SBSTTA, 2003)

Biodiversity is too extensive to allow measurement of all its components. Duelli & Obrist (2003) explain that because the biodiversity of even a small area is far too complex to measure comprehensively and to quantify, suitable indicators have to be found. It is obvious from this complexity of biodiversity that no one indicator can be used to measure biodiversity (see Duelli, 1997, Duelli & Obrist 1998 & 2003, Eiswerth & Haney 2001). Duelli (1997) addresses this point, stating that total species richness could serve as a criterion but is impossible to assess. In the JNCC publication 'Biodiversity Indicators in your Pocket' (2007), it is acknowledged that indicators are not expected to describe all the changes in biodiversity but are best seen as indicative of the general state of biodiversity. Different aspects of biodiversity require individual indicators. Ideally, such biodiversity indicators would correlate in a linear fashion to the element of biodiversity under investigation. Duelli & Obrist (1998) explain that there is a need for indicators that show either quantitative relationships to overall biodiversity (i.e. correlation) or at least are qualitatively connected. Duelli & Obrist (2003) go on to describe how those who have a responsibility to compare and evaluate biodiversity have a strong incentive to develop scientifically reliable and repeatable indicators. Ultimately this increases the financial cost of the indicators and those controlling financial resources may require a more cost effective approach. These compromises strengthen the notion that choice of indicator or indicators is of vital importance. Failing & Gregory (2003) state that indicators should be concise, relevant and meaningful to decision makers. This paper provides an overview of mistakes repeatedly made in forest biodiversity policy decision making. The authors suggest that a balance between scientific insights and public values is required to effectively define and use biodiversity indicators. The mistakes that Failing & Gregory (2003) list include ignoring the management context, avoiding summary indicators or indices because they are thought overly simple and failing to link indicators to decisions. Eiswerth & Haney (2001) support this view and explain that the choice of measures to use in

a given context depends on the research or policy objectives at hand. They expand this to demonstrate that relevant metrics (indicators) may include combinations of indicators that reflect diversity and the amount of diversity at risk.

> *"A single variable or composite indicator cannot measure biodiversity; only a representative suite of indicators applied in sample areas can achieve this picture of biodiversity."*
>
> (SBSTTA, 2003).

These differences in opinion reflect the different understanding and definitions of biodiversity described in Section 2.2. Most obvious is the spectrum of understanding of biodiversity between hard science discipline and policy tool / social topic. Confusion also occurs amongst user groups when discussing biodiversity indicators, often between biological components being used to indicate some other factor (e.g. lead concentration in water) and the measurement of biodiversity using an indicator which does not have to be a species or biological entity. Hansson (2000) states, an indicator may be a species, a structure, a process or some other feature of a biological system, the occurrence of which ensures the proper functioning of the most important aspects of biodiversity for that system. More commonly biodiversity is seen as species richness and indicators are desired that enable the quantification of this richness. This appears dismissive of the other two key components of biodiversity: community and genetic diversity; but as indicators are required for use by non-specialists the species approach that links with the most common understanding of biodiversity is thought by many to be most appropriate.

There is a necessity to develop indicators for biodiversity and landscape (OECD, 1997). On a large scale the goal is a standardised approach allowing for the comparison of results from around the world (Osinski et al., 2003). On a smaller scale, regional, local or company the common goal is a standardised approach that will allow for simple comparison and reporting of scientifically sound results. Osinski et al. (2003) state that the smaller the observed area, the more characteristics can be surveyed and that descriptions of cause and effect relationships are more viable.

For the purpose of biodiversity monitoring within business systems, indicators must be scientifically robust enough to withstand scrutiny, yet useable and understandable for non-specialists. All biodiversity indicator choice must be balanced so that an optimum between scientific reliability and repeatability and financial / resource outlay and usability is reached. However, from the number of different understandings and debate in academic literature it

appears that a scientifically perfect indicator is an impossible entity and that a 'keep it simple' approach should be adopted. This should focus on pragmatism and keep in mind that indicators need to be well understood by policy makers and the general public (DEFRA, 2001a; Earthwatch 2002a & Hamilton, 2005).

Choosing indicators is more than simple science; it is an art that requires experience and knowledge of weighting factors. For example, the number of indicators chosen depends upon costs and the information needed, but the relationship between these factors is not linear. In addition, other factors may influence indicator choice, existing schemes or institutional preferences. Indicators themselves cannot be said to be good or bad, effective or ineffective, as it is their suitability for the purpose they are being used for that should be justified. SBSTTA (2003) state that:

> *"Choosing indicators is the art of measuring as little as possible with the highest possible policy significance."*
>
> (SSBTTA, 2003)

Although 'policy significance' is not the most appropriate aim for many scenarios where biodiversity indicators are required this statement fits into the 'keep it simple' principle that is seen as a common thread throughout much guidance literature (DEFRA, 2001a; SBSTTA, 2003; Earthwatch, 2000; Avery et al., 2001.). It links with the idea of balance being achieved between scientific information gained and resource outlay. The majority of guidance literature available for developing indicators and monitoring biodiversity, whether at a national or organisational level, suggest a pragmatic approach. This involves not getting preoccupied with details such as key-species, weighting values and specific habitat classifications systems, not complaining about lack of data but using what data is available and not trying to meet all criteria for each indicator. The general consensus of opinion is that tackling indicators should be problem orientated, focusing on human impacts, not natural fluctuations or details that are not beneficial to the application and 'doing' of indicator-based monitoring.

A UNEP-WCMC (2005) project to develop biodiversity indicators for national use concluded that due to biodiversity being a concept that is still hard to define and that has little fundamental agreement as to what constitutes it, when selecting indicators of it there is a general lack of consensus. Therefore it was proposed that indicator selection should be tackled by determining what questions various stakeholders would like answered about biodiversity and selecting metrics to provide this information. This UNEP-WCMC project to

develop biodiversity indicators for use at a national scale reported that up to time of the projects' workshop in 2000:

> *"although much had been written about them* (biodiversity indicators)*, most of this was from a theoretical standpoint and much of it lacked focus and clarity."*
> (UNEP-WCMC, 2005)

This commentary on the state of literature on applied biodiversity indicators up to this date supports the need for additional research to provide focused information on the subject. Several key questions were raised and documented in the Biodiversity indicators for National Use (BINU) project, including to what extent same approaches are applicable at different scales and across different ecosystems. Although not directly answered, this question of scale is important for situating the research contained within this thesis. Indicators will be designed or chosen based on stakeholders demands, some of which are similar at a global, national, local scale and others which vary when considering different scales or contexts. For example, the difference between national level indicator for policy development and indicators of biodiversity state on a corporate landholding for assessment of impacts from business activities – the latter of which is the focus of the author's research.

2.9.3 Types of Biodiversity Indicator

Indicators can be single variables or composites, both being useful for different purposes. Single variable indicators provide detailed information often useful for management policy and can be individual components of a composite indicator. Composite indicators provide broader information, useful for policy making and communication purposes. This concept can fit with the model suggested in ISO14031, where indicators fall into two broad categories, Environmental Performance Indicators (EPIs) and Environmental Condition Indicators (ECIs). The ECIs are designed to provide detail about the condition of the environment and could be considered 'state' indicators using terminology used in other literature (e.g. Osinki *et. al.*, 2003; OECD, 1999 & Buchs, 2003) the information they provide is useful primarily for management and operations. The EPIs are more likely to be composite indicators as they are required in order to assess performance of a system / policy and can probably be more easily communicated as single reflections of environment / biodiversity in public communication.

The UK biodiversity indicators reported in the annual 'Biodiversity Indicators in Your Pocket' (BIYP) publications (JNCC, 2007; JNCC, 2011) include 6 focal areas, each comprising a

number of measures that, when all combined, provide an overall picture of the state of biodiversity. This reinforces the notion of a suite of indicators being required to give a comprehensive overview metric of biodiversity. Table 2.2 summarises the focal areas and indicators from the 2011 BIYP publication.

The selection of biodiversity indicators for a business landholding context and scale that is the subject of this thesis may be able to utilise indicators from this approach to fit into a national indicator framework. However, due to scale, several of the habitat types listed are likely to be irrelevant (e.g. sustainable fisheries, woodland management, biological river quality) depending on the location, landscape and constituent habitats of any given business landholding. Therefore, based on prior developed approaches for biodiversity indicators at different scales and using conceptual framework for broader environmental and other indicators, it is proposed that a methodology is required for the selection of biodiversity indicators for business landholdings.

Table 2.2 – Summary of Focal areas and indicators from Biodiversity Indicators in Your Pocket (JNCC, 2011)

The following is a list of generic environmental conservation / biodiversity indicators and measures gathered from sources including the literature reviewed within this chapter and the author's own ecological knowledge and experience. The list is by no means exhaustive but

should serve to illustrate the variety, type and volume of indicator options available within literature, guidance notes and through consultation with involved parties and organisations.

Possible biodiversity indicators include:

- area of land under commitment to environmental conservation;
- characteristic landscape features of the land type (farmland, woodland etc.);
- habitat areas, area of semi-natural grassland, broadleaved woodland etc;
- population of key land-type birds, woodland, farmland, wetland etc;
- species richness of vascular plants;
- SAP species index abundance;
- Distribution of species or habitats (patchiness, evenness);
- the area of high priority habitat that is not developed (or farmed);
- cumulative core areas of semi-natural habitats;
- total linear space of habitat, relative to total area managed;
- dominance of invasive species measured as area covered vs. total area managed;
- percentage of area dominated by native vegetation. Measures footprint of native vegetation on the landscape;
- adoption of best management practices linked to biodiversity objectives;
- percentage of habitats which are semi-natural;
- the size of native managed space vs. total area managed. Also size of managed area vs. average site/unit/field size; and,
- System indicators:
    - context – land area of organisation;
    - input – number of ecologists employed, budgets spent on biodiversity;
    - output – number of HAPs & SAPs published; and.
    - outcome – number of SAP species present, extent of HAP habitat.

Biodiversity indicators should only be seen as a means to the final goal of implementing effective conservation measures. Indicators should give informed direction to implementation and monitoring programmes, in order to effectively assess impact on biodiversity (positive or negative) a baseline and policy objectives are required. Current state can then be established and future states can be compared and linked to policy and management.

2.9.4 Species / Species Groups as Biodiversity Indicators

This is the ecological approach with the most current and ongoing academic research taking place. To survey for one group (e.g. birds or butterflies) and be able to extrapolate the

findings as a representation of wider species richness or biodiversity state is the focus of most investigations. Species are being recorded and correlation coefficients between species or groups are being calculated. The hope is that strong positive correlations can be identified to identify those species or groups which accurately represent others. For example, survey of butterflies which then represents total invertebrate biodiversity. There is a wealth of literature on species as indicators, surrogate taxa, the multi-species approach and other fields of investigation. Examples of these studies are reviewed to provide an introduction to the wealth of indicators available as a pool to select from when considering which indicators will be suitable for a given practitioner / operational level application. This field of research is expanding and many new indicators studies are likely to be published each year, increasing the pool of indicators to select from.

Sauberer et al. (2004) studied the agricultural landscape of eastern Austria, investigating 8 terrestrial organism groups as potential biodiversity indicators. Bryophytes, vascular plants, gastropods, spiders, ortopterans, carabid beetles, ants and birds were assessed using four methods: correlated species counts, as surrogate measures of overall species richness, a multi-taxa approach and using a simple complementarity algorithm. In total 215 bryophytes, 960
vascular plants, 96 gastropods, 215 spiders, 46 orthopterans, 181 carabid beetles, 40 ants and 118 birds were recorded. 21 out of 28 species richness correlations between the groups were positive and significant. Each group was significantly correlated with the combined species richness of all other groups. The highest correlations between a single taxon and overall species richness were found in vascular plants and birds. Testing a multi-taxa approach, all 28 combinations of two-taxa as surrogates for overall species richness were significant. Of these combinations the “shopping baskets” of vascular plants + birds or gastropods + ants were most highly correlated with pooled species richness of the six other taxa. The authors concluded that surrogate groups can be used at the landscape level to assess biodiversity in agricultural landscapes. It is discussed that the scale of assessment is highly significant and that other studies vary from local to continental scale (< 0.1 km^2 to 100,000 km^2), often revealing contradictory data.

Albrecht (2003) conducted a study investigating arable weeds as indicators of conservation effort in agricultural ecosystems. Investigations in this research included interaction between weeds and heterotrophic consumers and correlations between weeds and total species diversity. The results indicated that arable weeds are ‘key species’, the loss of them leads to serious changes in the remaining biocenosis (self-sufficient community) via habitat and food

chain relations. It was found that two measures per annum, one before any herbicide treatment and one before harvest was most reliable at providing an estimation of the total species spectrum.

Ferris & Humphrey (1999) provide a review of potential biodiversity indicators for application in British forests. Within this work an approach is developed whereby it is suggested that using 2-3 compositional indicators (indicator species or species groups [surrogate taxa]) and 2-3 structural indicators (physiognomy of stands and associated structures) provides a picture of biodiversity in forests.

Maes & Van Dyck (2004) investigated the suitability of a threatened butterfly species versus a multispecies group as habitat quality and biodiversity indicators in Belgium. The findings were that the single threatened butterfly species as an indicator did not reliably correlate with habitat quality or overall species diversity. However, the number of the multispecies group identified at a site did positively correlate with species diversity and habitat quality. The multispecies group comprised two birds, two dragonflies, two butterflies, two vascular plants and one grasshopper.

Roberge & Angelstam (2006) studied the suitability of bird species for wide scale assessment of forest biodiversity in Northern Europe. The research concluded that within deciduous forests the presence of a few species, specifically members of the woodpecker and tit species, indicated overall diversity to a high value of correlation. In coniferous forests as greater number of species were highly valued as indicators, including the three-toed woodpecker and the bullfinch. Species that were extinct from many of the study sites were found to be among the best indicators in the sites where they were recorded (middle spotted woodpecker, three-toed woodpecker and white-backed woodpecker).

Scott et al. (2006) demonstrate through investigations in Cheshire combined with comparable data from literature that the number of bog spider indicator species proved to be a suitable surrogate for the conservation value of the total invertebrate fauna of bogs.

Frego (2007) researched the potential for bryophytes to be used as indicators for forest integrity, which in turn is interlinked to sustainable forest management and biodiversity conservation. It was discussed that although bryophytes are sensitive to changes in management and detrimental impacts to the forest, particularly anthropogenic impacts, there are too many difficulties in reversing this causal relationship in an indicator fashion to use

identification of bryophyte species of abundance of a bryophyte population to make inferences about forest integrity. In summary it was concluded that bryophytes posses some characteristics suitable for indicator species but there is further research needed to confirm widely applicable suitability.

Comparisons of these investigations into surrogate taxa can be problematic due to the specialist locations or scope of the research conducted. This specialism means that comparisons of studies cannot give solid conclusions as it is very rare to be able to compare like with like. It is possible to build a picture of how useful certain surrogate taxa maybe. For example, some of the most widely investigated species are the butterflies and the following studies all provide insight but somewhat conflicting final conclusions to their individual studies.

Gutierrez & Menendez (2007) investigated whether hotspots of butterfly diversity in the Picos de Europa National Park protected area were indicators of unique species assemblages and species of conservation concern. Data was collected to evaluate a possible relationship between butterfly diversity and carabid beetle diversity as well as other species of European conservation concern. The research conclusion suggests that butterflies cannot be relied upon as indicators of other priority species groups such as carabid beetles and that conservation efforts based on areas shown to support higher butterfly diversity only partially preserves other species of conservation concern.

Contrasting the above to some extent Pearman & Weber (2007) monitored birds, butterflies and higher plants in Switzerland to test a hypothesis that common species can be used as indicators of total species groups and overall biodiversity. This research found that overall species richness of butterflies is correlated to the richness of Red Data and other rare butterflies. The authors discussed how monitoring of butterflies may provide information on rare butterflies as well as species richness of other taxa. Results showed that species richness amongst the 3 groups (birds, butterflies and higher plants) is always positively correlated. However, the correlation coefficient is never above 0.69, indicating strength of relationship may be questionable and where other authors (e.g. Frego, 2007) choose to prompt for more detailed research and further testing in different scenarios before coming to conclusions about the usefulness of the results gathered, other authors choose to communicate the potential benefits of their findings with a lesser emphasised (but still present) narrative on the limits to transferability and universal adoption of surrogate taxa as indicators.

Within the same species group (butterflies), but with a slight change to focus and hypothesis of research, Ricketts et al. (2002) investigated whether butterfly diversity could be used to predict moth diversity. Findings suggest that (1) butterflies are unlikely to be useful indicators of moth diversity at a local scale; (2) phylogenetic relatedness is not a reliable criterion for selecting appropriate indicator taxa; and (3) a habitat-based approach would more effectively conserve moth diversity in this landscape and may be preferable in many situations where indicator taxa relationships are untested.

2.10 Chapter Summary

The biodiversity indicator selection methodology developed in this thesis is designed to operationalise the concepts described by several of the key publications in the field of biodiversity and ecosystem services. Where the majority of literature in this subject area communicates to an audience concerned with this issue at a global and national scale, the operational implementation of many of these concepts is targeted towards businesses. The current state of knowledge and literature resource is biased towards policymaking at the international and national level, although several publications concede that there is a gap in current knowledge concerning the implementation of concepts of biodiversity measurement and valuation and the undertaking of an ecosystems approach.

The indicators that are to be selected by businesses for use in their management and reporting of biodiversity are in the category described in most literature as State indicators. These indicators fit into the range of other indicators measured by businesses in relation to the environment – tonnes of CO_2, litres of water consumed, kilograms of waste to landfill etc. With businesses used to measuring, managing and recording environmental aspects in this manner the matching approach is the most suitable method for integrating biodiversity into business practises. This strategy is based on the literature findings that many businesses have little or no experience in biodiversity and that the first engagement of companies with this issue should be encouraging and an ‘easy-win’ in nature.

CHAPTER 3 - THE RESEARCH PROCESS

3.1 Introduction

This chapter describes the research stages completed for this project. It describes the techniques and processes used and provides explanation of their selection. The chapter is structured in order of research stages as they were implemented during the research project. The stages of the research were:

- Selection of collaborating organisations;
- Corporate information gathering;
- First multiple case study;
- Development of a biodiversity indicator selection methodology;
- Second multiple case study; and
- Development of the final biodiversity indicator selection methodology.
- Application of the final biodiversity indicator selection methodology.

Preceding the descriptions of the above research stages is an introduction to case study research methods. This is provided because of the prominent role of this research approach within the project. It is also provided because it is more commonly used in social science research, whereas this project was completed from an applied science and real world problem standpoint.

3.2 Introduction to Case Study Research

3.2.1 Introduction

There is a wide selection of information available on the subject of case study research. The account below is provided as a summary and introduction to the chapter. Further information can be found in Yin (2003a, 2003b), Coolican (1994), Yates (2004), Hague & Jackson (1996) and more.

Yin (2003a) states that using case studies for research is one of the most challenging endeavours of social science. However, case studies are the preferred approach when the focus is on contemporary phenomenon in a real-life setting. The case study provides unique information, unavailable through other methods. Information gained from these studies is often amalgamated into a theory, technique or approach which furthers the pool of knowledge. It is by this path that many case studies act as a stimulus for further research (Coolican, 1994). The case study technique provides the researcher with a tool that allows all the intricate and holistic aspects of real-life events to be captured and described.

The case study method can be criticised as a somewhat unstructured and largely un-replicable study on an individual or group. It could be considered a holistic but not generalisable approach, not technical enough for scientific use (Coolican, 1994). There is opportunity for the case study to become unreliable, no two cases are the same and many studies are un-replicable. However, Bromley (1986) argues that case-studies are the 'bedrock of scientific investigation'. It is due to the uniqueness of the situation that case study methods are selected as the research method. Checks on reliability can be made by comparing information gained from different sources where this is available. This is also where the concept of 'triangulation' plays a part, comparing two views of the same thing.

Case-studies have the potential to gather information about phenomenon that are so unique or unexpected where research in a more experimental or pre-planned sense would lack capacity. This concept is supported by the study of multiple personality by Osgood et al. (1976) in which very rare experiences are recorded and analysed. Such studies may provide a first insight into a topic with potential for further investigation. Another value of the case-study method is the opportunity to gather a collection of information on a topic from multiple case studies. Information may be pooled and analysed, perhaps to link variables or inform further quantitative study. However, Coolican (1994) states that regardless of whether case-

studies provide an impetus for further research or not, the depth of information they provide is a value in itself.

3.2.2 Case Study Methods in this Project

A case-study research approach was chosen for this research project for several reasons. Firstly, it was chosen because the overall focus of the project was at the practioner / operational level. The project was developed to look at a real-world situation and provide solutions that are practical. The intended outputs of the research were hoped to be implemented by non-academics in a business setting. These outputs can only be useful to these people if they have been developed in a way that engages with business during the research programme. Secondly, the subject of biodiversity indicators in a business context has not been extensively researched previously, as described in Chapter 2. Therefore, despite a comprehensive literature review it was felt that issues and sub-topics may well exist that could not be foreseen. If a rigid experimental method was developed it is likely that these areas would be insufficiently explored. This lack of investigation could ultimately limit the value of the research outputs. Finally, the use of multiple case-studies with pooling of results, combined with information gathered from existing literature was thought to be a well rounded approach from which to develop a methodology.

Additionally, case-study methods had been employed in previous research undertaken by Calow (2009), on the subject of integrating biodiversity into environmental management systems (EMS). This research highlighted the need for further research into biodiversity measurement, ultimately creating the opportunity for the research documented in this thesis. This previous successful use of a multiple case-study approach in a near-identical research field reinforced the notion that the approach was suitable for the circumstances. It also gave the author confidence that it could be implemented in a situation where liaison with busy professional people and their organisations was necessary.

The specific characteristics of the research methodology were refined through the processes described in Chapters 4 and 5. These chapters further explain how the research methodology had to be adaptive to situations that arose through the aforementioned liaison with business (see Chapter 4). It also had to utilise research techniques (see Chapter 5) that were flexible enough to be manipulated on-the-spot whilst talking to those professionals and organisations of the case study group.

The research programme was developed with the project objectives (as detailed in 1.3) which provide structure for a staged approach. Accordingly, there were two linked case-studies undertaken. Both were multiple case study methods, with fewer selected participants forming the second case study. The final stage of testing was a real-world implementation of the biodiversity indicator selection methodology for a UK aggregates company's mineral extraction site.

Although a list of selection criteria were drawn up for all potential participating companies, in reality the actual choice has been dictated by which ones were willing to participate. The companies that were finally used, however, fulfilled the operational criteria set and did represent wider industrial management processes currently in use within the subject area. The continual changing business scene proved to be problematic, when individual project 'champions' within a business were replaced or disappeared. Under these circumstances, efforts to maintain relationships used-up a lot of the available research time. However, these events highlighted the difficulty in dealing with the reality of this type of case research, which is dependent on empowerment from the top-down and cross-departmental cooperation to implement the ideal as promoted in the company literature. The severing of management links in a command chain is likely to be analogous to many immature company environmental management systems, where the awareness and perception of significance of these specific issues, in terms of the wider organisations responsibilities, is fragmented. As such, the unfolding situation has proved useful for the overall business orientation and appreciation of the research project and highlights the difficulties faced within industry management.

This approach to choosing collaborating companies for the research can be described as 'selective sampling' (Schatzman & Strauss, 1973) and is based on the calculated decision to sample a specific type of interviewee based upon preconceived but reasonable initial dimensions which are worked out in advance.

3.2.3 Data Collection

According to Miles & Huberman (1994), collecting and analysing qualitative data can be undertaken following different approaches. For this project, interviewing using a semi-structured interview was decided upon to gain factual information about an approach and also to illicit opinions of the interviewee about the subject area and what was felt to be the problems, opportunities and what was required to advance the subject area from their perspective. This approach of gaining opinions on a subject approach follows a

phenomological perspective which is based upon the idea that there is a multiplicity of worldviews and not everyone shares the same worldview (Yates, 2004). The goals of this type of research are to achieve an in-depth understanding and detailed description of a particular aspect.

Field notes were taken during interviews as it was felt that the introduction of recording devices would seriously inhibit the communications. This was considered most likely in the discussion of difficulties that the focal organisation has had or is still experiencing in the field of biodiversity assessment. The omission of any stress induced by a tape recorder was also perceived as a useful benefit for the building of relationships between interviewer and interviewee in the relatively short amount of contact time available in this project. The collection of field notes versus recording of interviewees comments also circumvented the need to involve organisations' legal teams and restrictive confidentiality agreements in relation tot he publication of results for some of the collaborating partners.

Field notes were taken during the interview discussion, guided by the questions that had been formulated to guide the discussion. Notes were only made to record areas of the conversation that related to the questions or topic area. This was the approach taken as the use of interviews was a fact and opinion gathering exercise as opposed to other types of studies often conducted by social scientists employing interview techniques (for example, the study of language used when discussing a particular subject or observations of body language exhibited during an interview). This is a key difference in the use of interviews and qualitative data in this study versus the use of interviewing in many text book social science studies and guides to the technique.

The field notes were completed with any additions from memory or filling in of blanks and completing sentences done within the same day as the interview was conducted. This editing was vital to ensure that analysis taking place at a later date did not have to interpret what was meant by unfinished sentences or messy handwriting.

This compilation of field notes during the interview and editing immediately after the interview is both the data gathering and also the first filtering of information provided by the collaborating organisations. It is described by Yates (2004) that initial data may seem confusing but the analysis of data begins with the first interview. It follows that the next interviews will be informed by understanding and hypotheses developing and this guidance increases as new data is collected and analysed. Yates (2004) also states that data collection

never entirely ceases because coding and memoing continue to raise fresh questions that require new data or re-examination of previous data.

3.2.4 Data Analysis

Data analysis involved the coding of interview field notes. As described by Yates (2004), initial or open coding involved scrutiny of the interview notes to produce concepts that seem to fit the data. This is a process which constantly updates or snowballs, with the surfacing of information bearing questions upon the questions and hypotheses previously raised. Coding has been described as:

> *"The general term for conceptualizing data; thus, coding includes raising questions and giving provisional answers (hypotheses) about categories and about their relations. A code is the term for any product of this analysis (whether a category or a relation among two or more categories)."*
>
> *(Strauss, 1988)*

This interactive process between the researcher and the data is described by Yates (2004):

> *"The point is really that the potential is not so much in the document as in the relationship between it and the inquiring mind and training of a researcher"*
>
> *(Yates, 2004).*

Yates (2004) also describes how the coding is grounded in data as well as on the conjunctive experiential data, including the technical knowledge that the researcher brings to the process. This grounding in both sources of data (interview data and literature (orientation)) leads to analysis and thinking about concepts and their relationships without becoming too engrossed in literal translation of field data.

This description of 'grounded-in-data' relates to the ideas of grounded theory, although a true grounded theory approach was not taken into the case study interviews – questions were developed in advance following literature review and other 'orientation' activities. However, a goal of grounded theory is the generation of a theory that accounts for a pattern of behaviour (Yates, 2004). The generation of such theories occurs around core categories / common threads and it was the pursuit of these core categories / common threads that was a focus during coding. The findings (and development of core categories / common threads) were returned to the relevant literature to add theoretical depth, help authenticate and provide the context in the current knowledge.

3.2.5 Criticisms of the approach

As described by Yates (2004), the more data available, the more certain core categories and themes become. However, due to time and available resources (specifically the available time of the interviewees and number of them available for the study), the author had to decide on core categories /common threads with a smaller scale dataset than considered desirable. There is the risk that a smaller dataset can lead to a prematurely developed theory (in the form of the methodology) which has limited explanatory power.

Additionally, although acknowledged by Yates (2004) as a key part of the process (see previous quote), the influence of the researcher on the process of analysis is strong and will inevitably lead to some bias of the routes of investigation that are taken and core categories / common threads that are identified from the field notes. It is required that the researcher has:

> *"a rigorous spirit of self-awareness and self criticism, as well as an openness to new ideas that is often the hallmark of research studies of good quality"*
>
> *(Seale, 1998)*

The ways in which analysts begin to categorise data will still always depend upon the aims of their research and theoretical interests (May, 2001). May (2001) recommends that the approach should maintain openness to modification and challenge of pre-conceived ideas and interests based on what is found in the interview data analysed. This awareness and style of approach was adopted by the author, although influence from recent and ongoing literature review processes and ideas theoretical interests and overall background must be acknowledge as an influence on the analysis process and possible source of bias to the method.

3.3 Selection of Collaborating Organisations

In order to undertake case study research, the project required individuals, businesses and other organisations to engage with. The selection of these participants is described further in Chapter 4. A process with selection criteria was developed to ensure that the collaborating organisations would be a positive component of the overall project. The approach to selecting these collaborators was documented to provide transparency to the research approach.

Additionally, this information would assist any other research that may wish to repeat the processes used during this project.

3.4 Corporate Information Gathering

Accompanying the initial round of interviews to complete the first multiple case study of the research project was a session of information gathering. This was to complement the specific and rich information provided by the representatives of the collaborating organisations. General information on each organisation was provided by simple internet searches and reading of the collaborating organisations' websites. Further information was found in publicly available documents - company annual reports, environmental reports and corporate responsibility reports.

This stage of the case study was particularly important as way of concentrating the focus of the initial interview stage. Without the need to discuss company operations, structure or general environmental policy it meant interview time was optimised. This is particularly important given the busy schedules of the majority of interviewees.

The combination of information from this session with the outputs of the initial interviews and previous literature review provides the basis for honing the research and beginning to develop a methodology.

3.5 First Multiple Case Study

The initial round of interviews formed a multiple case study of 10 organisations. The aim of this stage of the research process was to tap into the current status of business and biodiversity. This obviously required selecting organisations that were engaged with the biodiversity agenda to some extent. Additionally to gain information on the 'best practice' methods in this field it was desirable to talk to organisations regarded as being at the forefront of biodiversity work. The protocol for this multiple case study was to gain further understanding of the current state of biodiversity work being implemented by business. To understand what different organisations are doing, to what extent, how they are doing it, who in the organisation is doing it, their experiences in doing it, the processes involved, how they would change their approach if they were to start again and, importantly, what they desire to progress their biodiversity work. This final component was a key part of this multiple case-

study as the desires of companies in the specific area of biodiversity management is ultimately what this research project aims to deliver.

Private sector businesses and non-commercial organisations were interviewed as part of this multiple case study. It was decided to approach the research in this manner, at this stage, for several reasons. Firstly, the best-practice organisations recognised by biodiversity professionals and literature span the public and private sectors. Secondly, as described in Chapter 4, obtaining the co-operation of organisations for research purposes has its difficulties. Therefore, it was felt better to maximise on potential information than to limit this by setting inclusion criteria.

Supporting this was the previous point regarding best-practice organisations. Despite the overall aim of the research being focussed on 'business', the information gained at this stage did not require such a focus. Finally, looking ahead to the outputs of the research and the hope that they would be useful to as many people as possible, it was decided that this inclusion would increase the potential audience finding the research useful.

The first multiple case study design was aimed to provide a large amount of information, to inform the research process at the earlier stages. The information required would provide insight into the current state of the art in a business and organisational context. The literature review process would complement this by providing the state of the art in an academic and literary sense. Chapter 5 details in greater details the exact nature of the questions included in the questionnaire used as a checklist in these informal, semi-structured interviews. Also included in Chapter 5 is a rationale behind the questionnaire and interview approach used in this stage of the research.

3.6 Development of a Biodiversity Indicator Selection Methodology

The biodiversity indicator selection methodology was developed through a process of amalgamating information gathered from literature, information from collaborating organisations and the author's understanding of the concepts and relationships that are held within all of these separate elements. Pre-existing conceptual frameworks (e.g. DPSIR), environmental management system processes, suites of national and other biodiversity indicators and the pool of species, habitat and other surrogate indicators were particularly influential in the building of the methodology.

3.7 Second Multiple Case Study

The trial of the draft methodology was undertaken within a case study framework. A multiple case study of four organisations was chosen as a means of assessing the effectiveness of the draft methodology. The organisations were selected by the author to represent a variety of business types, varying in size, operations and degree of advancement in addressing biodiversity.

The draft methodology was applied to each organisation's individual situation as far as possible. This was done using the information obtained from the first case study, see sections 3.2.1 and 3.2.2 above. The author then worked through the flow chart process (Figure 7.1) that forms the backbone of the methodology. For each organisation a degree of biodiversity and ecological knowledge has to be applied in the delivery of the methodology. This input was documented and formed part of the questionnaire for the final interviews.

The final interviews were more informal in their delivery, mostly because of the relationships between interviewer and interviewee that had been developed over the course of the research project.

Despite this informality and discussion style there was a checklist of questions to structure the interviews. The detail of the questions and interview technique are documented more fully in Chapters 5 and 8. The protocol for this case study was to understand the suitability of the draft methodology for use by a range of businesses. It was also to gain advice for improvements to the methodology.

The interviews covered whether the representative from each company understood how the methodology had been applied and if they agreed with how it had been applied. This would cover whether the correct information had been used to inform decisions in the process. It would also hope to discover how useful the system was to the organisation. Ultimately the interviews were trying to determine whether or not the draft methodology was 'fit for purpose'. This encompasses how effective it is, how easy to understand and use, how flexible it is to differing situations.

The results of these interviews help to improve the methodology. Additionally the results can be turned into educational case-studies to enhance the usability of the methodology as an output of the research.

The second case study design used in this research looked at fewer organisations. This was due in part to the different level of detail required. It was also influenced by the intermediate stage of the research, the development of the biodiversity indicator methodology. A final contributing factor to the design of this multiple case-study was the desire to represent different business types. Businesses of a different size, from different industry sectors or with different levels of previous biodiversity work complete would provide a useful range of implementation to assist the understanding of this research in the real world.

3.8 Development of the Final Biodiversity Indicator Selection Methodology

In a similar process that the development of the first biodiversity indicator selection methodology, this stage took information from the second multiple case study and use it to refine the methodology. The information from the second multiple case study was used in combination with knowledge gained from the prior research stages, including the literature review.

3.9 Application of the Biodiversity Indicator Selection Methodology

In order to test the biodiversity indicator selection methodology, the process was applied at Aggregate Industries' Back Lane Quarry in Lancashire. The application of the methodology is documented in Chapter 10 and illustrates how drivers and constraints influence the selection of biodiversity indicators. This application of the methodology also provides a knowledge contribution and practical guide for businesses interested in biodiversity measurement, indicators selection and monitoring of the state of biodiversity on their landholding(s).

CHAPTER 4 - SELECTING COLLABORATING ORGANISATIONS

4.1 Introduction

This chapter describes the processes used for the selection of collaborating organisations and the gaining of their co-operation. This engagement with businesses fulfils Objective 2 as described in section 1.3.

4.2 Selecting potential collaborating organisations

With the business focus of this research project it was important to engage with relevant organisations as soon as possible. This allowed insight to be gained that would have otherwise been unavailable and started building relationships to further facilitate the transfer of information. It was important, however, to have a method of selecting these organisations that could be reported.

It should be noted that it is not the intention of this research to take a random sample of businesses to gather information from. Instead the research aims to study organisations demonstrating ‘best-practice’ and a variety of other willing organisations that are at various stages of developing a biodiversity programme. In order to study ‘best practice’ biodiversity programmes it was deemed necessary to engage with both private and public sector organisations. It is known that organisations outside the private sector are implementing biodiversity programmes and examples of such were thought to be useful contributions to the research.

Despite the use of the term ‘business’ in the original project description and brief engagement with this broad range of organisations gave perspective on biodiversity programmes active throughout several different operational activities. The approach also differed from several previous works (Calow 1999, Young 1999, Earthwatch 2000) that solely studied the private sector.

4.3 Criteria for selecting potential collaborating organisations

The following criteria were developed in order to direct the selection process and provide a reportable method for the selection of potential collaborating organisations. The development of these criteria was informed by the literature reviewed, the biodiversity research previously undertaken by Calow (2009) and discussions with Calow and Fermor (Middlemarch

Environmental Ltd). The following list of criteria that the organisations should fulfil was developed to guide the search process:

- Biodiversity awareness demonstrated – e.g. BAP, biodiversity in EMS, biodiversity mentioned in reporting;
- Cover a range of market sectors / Industrial groups;
- The range should include different stages of implementing biodiversity objectives;
- Should be UK based or have landholding site(s) in UK;
- Ideally a previous biodiversity assessment of a landholding site will have been conducted (and available); and,
- Be willing to collaborate, and have a primary contact.

It was important to find organisations that had already identified the importance of biodiversity and that they were interested in tackling the issue. As this research deals primarily with the selection and use of biodiversity indicators for landholdings it is going to be of most use to those organisations which have previously established a biodiversity policy and a consensus on their approach. Organisations that have yet to approach biodiversity as an issue are not likely to be able to input a lot to the research. It was also considered desirable to have a range of business sectors represented in the research programme. The greater the range of different operational activities observed and providing input into the research, the more applicable and practicable the final product should become.

With landholdings being a key component of this research it is vital that organisations' have some form of 'green' landholding that is their responsibility to manage. It is also important for the practical side of completing trial studies that a component of this landholding is within the UK. To assist with this aspect of the research it would be useful if organisations' had a previously completed biodiversity or ecological assessment to act as a historical dataset. This may be in the form of a structured ecological survey or a more ad-hoc series of notes. There was no number set for the quantity of organisations to have collaborating with the research, it was considered more important to have a number of primary contacts that were enthusiastic about the research and willing to provide information. Travelling distance was taken into consideration when selecting potential collaborators but given the relatively few occasions when face-to-face meetings would be essential no large emphasis was placed upon this.

4.4 Sources for selecting potential collaborating organisations

In order to have a reportable methodology for the search for collaborating organisations the following list of sources and methods was recorded:

- Socially Responsible Investment (SRI) Indexes (FTSE4Good, BiE, Ethibel, Dow Jones Sustainability Index);
- Companies previously identified by Calow (2009) in BAP/EMS integration research;
- Middlemarch Environmental Ltd (Industrial Sponsor) client list;
- Searching key documents produced by EN, DEFRA etc. (eg. Natural Partners, UKBAP document);
- List of companies linked to LBAPs (UKBAP website);
- Web-search of biodiversity aware companies ('biodiversity' in annual report);
- Companies identified in literature review process;
- Earthwatch CERG list;
- MACCP2 web list;
- Project Sigma and Project Acorn participants; and,
- Attendees of Middlemarch Environmental Ltd Biodiversity Workshops.

This process is not entirely free of bias, several factors of influence are evident. Firstly, organisations that actively work on biodiversity were targeted, rather than a selection of all business. In addition, those organisations chosen to collaborate are the organisations that were willing to participate, the ones that made contact following enquiries and who had an effective point of contact. This self-selection and points of bias combine to ensure that those organisations collaborating with the research programme were those with a pre-established biodiversity awareness and staff that were pro-active in the areas of biodiversity and research. With the purpose of the research being to develop a methodology for the selection of biodiversity indicators and to provide further information for organisations' to develop their biodiversity work, these elements of bias are not felt to detrimentally influence the research process. The collaboration with business and non-profit organisations provides insight into which business systems (e.g. sustainability management systems, environmental management systems etc.) the research outputs would have to fit into. The mix of public and private sector organisations was appropriate to gain knowledge as to the needs and wants of business within the field of biodiversity indicators. Therefore, selection of best-practice organisations and those with pro-active staff members in the environment and biodiversity area were deemed suitable contributors to the research process.

4.5 Obtaining the co-operation of organisations

Establishing contact with organisations in order to invite them to collaborate with the research was carried out by a number of methods. Once a list of possible collaborating organisations was developed contact had to be made with an appropriate person to address the invitation to participate. This proved to be a greater obstacle than first anticipated and many resources had to be utilised to achieve the goal. The tools and resources employed during this process include contact details from a number of sources, including a contact list produced during research undertaken by Calow (2009) and a client contact list compiled by Middlemarch Environmental Ltd. In addition to these resources, contact details were obtained and confirmed using methods such as telephone calls to the organisations using contact details provided on websites and literature and e-mailing contacts provided on organisations' websites.

The process for obtaining the collaboration of selected organisations is outlined below.

1. For all, contact organisation and confirm or get new contact details for Environment Manager or equivalent for correspondence regarding biodiversity.
2. Send an invitation and introductory letter to the relevant person in each organisation, asking if they wish to be part of the research and if they would be able to provide information on their organisations biodiversity work.
3. On receipt of replies from each organisation, arrange a meeting with the representative to exchange information and make first point of contact in developing the relationship.
4. Develop a series of questions or issues to discuss with each organisation and schedule meetings to discuss the questions/issues. Further build the relationship with each organisation, better relations will further facilitate the release of a greater amount of information.

Organisations where successful contact was made are listed below

- Center Parcs
- Severn Trent Water
- BAA
- British Waterways
- National Forest
- Network Rail
- Lands Securities / Trillium
- Astra Zeneca
- National Trust
- Allianz Cornhill
- British Airways
- B&Q
- BP
- Telford & Wrekin Borough Council

- Biffa
- Co-operative Bank
- Elmwood College
- Environ
- Norwich City Council

These companies were then contacted to arrange a preliminary meeting. This stage of establishing the final collaborating organisations required a concentrated effort, as very little or no relationship had been established previous to this time. As busy environmental managers, the majority of contacts required several attempts by different means (telephone, e-mail, letter) to finalise a meeting timetable. In some cases it was decided that the organisation was unable to contribute to the research at this point, given the efforts and means undertaken to begin the relationship. Any extended attempts to organise the preliminary meeting was thought to indicate a difficulty in ensuring a reliable contact point in the organisation. These situations were anticipated likely to remain as such and hinder the progress of the research project.

The final list of organisations willing to collaborate with the research, and able to provide a point of contact for a preliminary meeting, is provided below.

- BAA
- Center Parcs
- National Forest
- National Trust
- Land Securities / Trillium
- Severn Trent Water
- British Waterways
- Network Rail
- Allianz Cornhill
- AstraZeneca

Preliminary meetings and discussion of the research project, including benefits to all parties involved were undertaken either face to face or by telephone. Important outcomes of these meetings were decisions regarding future contact, particularly if the primary point of contact already established was the most suitable individual. If another person was recommended contact details were provided, otherwise the most efficient means of contact (e.g. Telephone, e-mail etc.) was established. In some cases documents were provided for background information and a copy of the research aims and objectives were given to all persons met. Information was exchange by e-mail and post with those parties where a face to face meeting was not possible. Relationship building between the organisations and Aston University and between individuals within those organisations and the researcher was a vitally important

result of these preliminary meetings. These relationships reduce the effort required when making future contact and assisted in the transfer of information.

CHAPTER 5 - QUESTIONNAIRE DEVELOPMENT

5.1 Introduction

This chapter documents the questionnaire approach used in the case study method described in Chapter 3. A background to questionnaires in research is also provided for context, particularly given the use of social science research methods for this applied science / environmental management research topic. Following this background are details of the development of the questionnaire used in the first case study interviews.

5.2 The questionnaire approach

5.2.1 Types of questionnaire

Various types of questionnaire are available to the researcher. Differences between questionnaires are based on two main areas, the overall form or layout and the individual question type. Essentially questionnaire layout is described by the degree to which it is structured.

A highly structured questionnaire will typically have controlling factors such as numbered questions to be answered in order, a time limit and / or it will be mandatory for respondents to answer all questions. Any number of instructions are possible, depending on the development of the questionnaire and the audience it will be presented to. A high level of structuring is often required or preferred when the respondent will be answering in isolation from the distributor of the questionnaire, such as in mailed out surveys. The structure aims to increase consistency between responses and reduce individual interpretation of what is required.

Alternative to this is the unstructured questionnaire. This may allow respondents to answer any number of questions, in any order and in any time. The questions may be selected by the deliverer depending on circumstances, previous answers or relevance to the respondent. The unstructured questionnaire is often used when delivery by a knowledgeable person is possible. The questionnaire structure can be altered by this person during delivery, tailoring it to gain the most information in each situation. This type of questionnaire is often delivered in an interview scenario, where the interviewer has significant knowledge of the subject.

Questionnaires can be structured to varying degrees and the amount of structuring cannot simply be described by assigning a category. This is because of the great individuality of any

given questionnaire, stemming from the designers choices; size, focus, aims, sample size, delivery options etc. It is important to recognise this individuality when attempting to describe the structural type of a questionnaire, almost any degree of structuring is possible and potentially suitable (Coolican, 1994)

Conversely, question type can generally be divided into two distinct types, forced-choice or open-ended. Forced choice questions give a number of predetermined options for the respondent to choose from and are easier to score and analyse than open ended questions. However, the only information that can be gained from forced-choice questions is contained within the choices given by the questionnaire designer. The designer must therefore know the ranges of answers that can be expected, or that are relevant, from the question in focus. With open-ended questions the respondent is given the opportunity to state a position in their own words. These answers can provide useful information that the questionnaire designer may not have previously considered. The downside to open-ended questions is that responses are harder to analyse as they cannot be scored as easily as forced-choice questions, which may have simple yes/no or numerical responses.

A questionnaire may use either type of question and any combination of the two to gain the information required, as decided by the designer of the questionnaire

5.2.2 Questionnaire delivery

How a questionnaire is to be delivered is a strong determining factor in the choice of structuring and types of questions employed. What information is required and how it is deemed best to gain that information should determine the delivery method, although available resources may affect the decision.

Broadly there are two types of delivery techniques, self-administered and interview. Self-administered questionnaires are those given to people for completion and, usually, very little assistance is available in case a respondent does not understand a question or has a query. A self-administered questionnaire must be carefully prepared and monitored to yield a good response rate, editing and tryouts are almost essential. The questions must be constructed carefully, to be understandable, unbiased and necessary.

Interview delivery involves some degree of human contact, either face to face or by telephone, whereas a self-administered questionnaire may be a mailed out type of survey. Interviews can be conducted by trained interviewers, following rules given by the

questionnaire designer(s), or by the questionnaire designer themselves, depending on conditions. An interviewer may deliver only the questions exactly as they are written or may be allowed to prompt and help if this is deemed useful and appropriate. Generally, the more input the interviewer gives, the greater the potential for bias. However, in a situation where a complex subject is the topic of the questionnaire, some explanation and prompting may yield far greater information from the interviewee than a cold-face reading questions.

Interview technique is important for engaging the help of interviewees and gaining the information required to complete the survey. The importance of the interview and the value of the answers should be impressed upon the interviewee, the subject matter should engage the co-operation of the interviewee. Interviews benefit from the personal interaction that is intrinsic to them in this respect, it is more effective to explain and engage a respondent face to face or even over the telephone than with a self-administered questionnaire.

5.2.3 Quantitative vs. Qualitative data

Quantitative data consists of number scores, often the results of forced-choice questions in the context of questionnaires. These numbers can be more easily analysed than qualitative data because they can be used directly in statistical tests, or transformed using the same formula for all – reducing the possibility of bias. Qualitative data is non-number results, often text answers and often from open-ended questions. The analysis of qualitative data often involves the manipulation of text, requiring input from the analyser and introducing an extra stage where bias can influence results. The techniques that exist for data analysis are discussed in more detail in Chapter 6.

5.3 Questionnaire development

5.3.1 Introduction

The knowledge available through literature review suggested that considerable information on the subject of biodiversity approach in business was not yet known or documented. Understanding that such a complex and subjective topic is unlikely to be understood in every detail it was most appropriate to structure a questionnaire around open-ended questions, to invite discussion and expand the possible scope of the information gathered through the interview process. Open-ended questions by their nature invite the gathering of qualitative data and this approach of a semi-structured, informal questionnaire, delivered face to face by the researcher described extensively in sociology literature (e.g. Coolican, 1994; Patton, 1980 & Yates, 2004). This approach was adopted for this particular research as the author wished to gain the maximum information about the biodiversity approach through the interview series. This provided insight for the development of an approach to assist in this 'real-world' problem, as opposed to confirming or discounting a completely set, preconceived hypotheses. Understanding the approach that was to be adopted and the background theories to this approach allowed the categories and individual questions to be developed in a more focused manner.

5.3.2 The Question Development Process

The final questions used for the research questionnaire were developed through a five stage process. The stages conducted were:

- Initial 'brainstorming';
- Discussion with research colleagues, industrial sponsor and business contacts;
- Development of a draft questionnaire;
- Pilot tests;
- Development of a final questionnaire.

The initial 'brainstorming' was conducted shortly after completing a large part of the literature review and following discussions with research colleagues. A large list of questions that may have all yielded some degree of information on the topic area of biodiversity in an organisational context was compiled. The rationale for these questions was based on the author's insight into the topic area from the literature review process that led up to this stage of the research. The questions were designed to address gaps in knowledge or recurring questions and discrepancies in the literature. For example, the opening question of the

questionnaire deals with the definition of biodiversity which is something discussed extensively in literature. Questions on driving forces behind biodiversity programmes were included to explore the influence of initiatives from environmental charities and government (e.g. Earthwatch publications and the BAP process). Similarly, questions on partnership working and biodiversity methodologies were included to gather information on the engagement of business with external partners and the knowledge of and uptake of existing biodiversity assessment processes. Questions were included to record what the collaborating organisations were using as biodiversity indicators in order to compare to literature examples of biodiversity indicators. This was designed to fill a gap in the knowledge at a practitioner level and link to the well reported academically investigated biodiversity indicators.

These questions were presented to research colleagues, the industrial sponsor and business contacts during meetings and networking during September and October 2004 and input from this helped in the next stage of the process, the drafting of a questionnaire. The list of questions was summarised by the author through the combination or removal of similar questions and the grouping of questions into topic areas to provide added structure to the questionnaire.

Two collaborating organisations agreed to partake in a pilot test of the 1st draft questionnaire. Representatives from Severn Trent Water and BAA were the initial interview subjects and provided largely positive feedback on the questions chosen. The influence this pilot test of the questionnaire and interview process had was on the approach of the author as the researcher delivering the questionnaire. It was found that the answers of some questions might negate the need for subsequent questions and that in order to maintain the flow of the discussion the interview had gained it was necessary to miss questions out or to rearrange the order that the questions were delivered. This meant a shift in approach in the degree of structure the questionnaire had, from defined as structured to utilising a less structured approach. The outcomes of these pilot tests shaped the final questionnaire, provided in 5.4 below.

5.4 The Final Questionnnaire

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*

Who identified it as an issue? *What is their position in the organisation?*

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*

How long have you been addressing biodiversity? *Quantitative.*

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*

Who has overall responsibility and decision making role for the biodiversity programme?

How is biodiversity communicated as an important issue to the board and to the staff?

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*

How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*

How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*

Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*

Section 3 - Biodiversity Indicators

What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*

How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*

How is this information used? *Reporting, adjustment of targets, adjustment of approach?*

How many indicators do you feel would be a manageable and practicable number?

0-5 6-10 11-20 21-40 41+

Who conducts the recording / monitoring work? *Staff / Consultants / WT?*

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*

Section 4 - Biodiversity Experience / Advice

What have been the biggest hurdles you have faced when implementing your biodiversity programme?

What have been the biggest benefits from implementing a biodiversity programme?

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?

What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?

CHAPTER 6 - RESULTS OF THE MULTIPLE CASE STUDY

6.1 Introduction

This chapter begins with an outline of the processes followed to analyse the data gathered from the multiple case study. The main body of the chapter provides the results of the case study interviews. The chapter is structured in order of the case study questionnaire (as detailed in Section 5.4).

6.2 Analysis Techniques

Techniques exist for both quantitative and qualitative data analysis. The analysis of quantitative data generally follows a more structured pattern - numeric data is collected, compiled / adjusted and analysed using widely accepted statistical tests. Significance of values can be derived, tests of difference, assessment of correlation and more complex analyses can be undertaken using pre-described methodologies. The analysis of qualitative data, however, involves processes and methods far more likely to vary between individual studies and open to more influence or bias. Qualitative data is often organised into categories to some extent but unlike quantitative data these categories are analysed for their meaning and their unique qualities and the insights they provide (Coolican, 1994).

This processing of information is often performed manually by the researcher. However, software packages do exist for content analysis of qualitative data, rigorously reducing information down to quantified units suitable for statistical testing. Upon investigation of such software (e.g. NVIVO) it becomes apparent that its advantages are best seen when analysis of large data sets is required and manual interpretation would be incredibly repetitive and labour intensive. For smaller investigations the time required to become familiar with such software is greater than that required to undertake manual analysis. In addition, the benefits of automated analysis (lack of researcher influence, minimising bias) are negated by the loss of insight and the ‘personal’ interpretation in projects where this appropriate and necessary.

Therefore, the information processing for this research was undertaken manually, by the author. Whilst this allows the maximum information to be gained through insight and understanding of the raw data, it also creates greater potential for influence during the process. Maximum care was taken to avoid any conscious external input or skew to the results. Interpretation of the meaning of statements and terms were reinforced wherever

possible through further contact with the interviewee. This conflict of positive versus negative effects of 'interpretation' is common to many works employing social science research methods. Whilst it is important to acknowledge, there are no accepted solutions or alternatives.

6.3 Summary of the Participating Organisations

6.3.1 Severn Trent Water

Severn Trent Water is a large utility company dealing with water treatment and supply. It is the world's fourth largest privately-owned water company - serving over 8 million customers across the heart of the UK, stretching from the Bristol Channel to the Humber, and from mid-Wales to the East Midlands (www.stwater.co.uk). It is part of the Severn Trent group which has 'Environmental Leadership' as its motto / banner and works towards upholding this status. Severn Trent Water is a major UK landholder with over 1700 sites spanning 13 counties and covering approximately 26,000 Ha.

All water companies have a statutory obligation to further nature conservation from the era of the public water authorities. This code of practice and the Water Act are monitored by DEFRA. The Severn Trent Water BAP provides structure for implementing this obligation and was formally developed six years prior to the interviews. Biodiversity was identified as an issue since the preparation and publication of the UKBAP in 1994. However, the interviewee was keen to highlight the point that nature conservation work has been ongoing since privatisation of the water authorities and the creation of Severn Trent Water many years prior to the development of the UKBAP. The Severn Trent Water BAP has been revised since the interviews and now includes an updated set of targets for 2005-2010. Further information is available through the Severn Trent Water website (www.stwater.co.uk) and the Severn Trent PLC corporate website (www.severntrent.co.uk).

6.3.2 BAA

BAA own and manage airports throughout the UK including London Heathrow, London Gatwick, London Stansted, Glasgow, Edinburgh, Aberdeen, Southampton and Naples. However, for this case study only the London Heathrow complex was discussed. As part of the Heathrow complex is the large and expanding Heathrow International airport site. Importantly there are several additional smaller sites in the vicinity that are owned and managed by BAA.

There are strict management restrictions associated with airports and surrounding land. Particular restrictions concern the presence of birds at any location where they may increase the risk of bird strikes. Biodiversity suppression measures have to take place on the airfield in order to reduce attractiveness to birds, including control of wild flowers, reduction of soil-dwelling insects, management of grass length and sward quality. There are ongoing programmes to monitor and disperse birds (www.baa.com)

Additional concerns that affect the management of the BAA Heathrow sites are the community 'being a good neighbour' programmes that are very important to BAA. Examples of such schemes include provision of open space for the local community - for dog walking, exercise and education activities. Therefore management of land must be multi-purpose.

The management of biodiversity on BAA managed land at London Heathrow is constrained by these operational aspects and commitments to other issues. However the BAA London Heathrow complex was provisionally awarded the Wildlife Trusts Biodiversity Benchmark and is committed to continuous improvement to achieve the full, revised award in 2007/8. Biodiversity management at the Heathrow complex is based upon a system of ecological impact assessment (EcIA) and the subsequent preparation of biodiversity action plans for the various landholdings making up the Heathrow complex. Further information is provided and updated through the BAA website (www.baa.com), through accessing the London Heathrow specific information and selecting options for corporate responsibility and local community action.

6.3.3 British Waterways

British Waterways manage the 2,200 mile network of inland waterways and a number of reservoirs and other landholdings.

Multi-use of the canal networks mean that improvement works must meet targets for community projects, recreational transport use, nature conservation and structural/engineering requirements. Competing demands for the waterways to provide a variety of functions for millions of users makes the conservation of waterway habitats a complex task. British Waterways own summary of this is provided neatly in the quote below taken from their website.

> *"Conserving waterway biodiversity is about maintaining a balance, which we work hard to try and achieve."*

(www.britishwaterways.co.uk)

Selected habitats and species are targeted for focused biodiversity management, including; hedgerows, towpath verges, waterway banks and waterway channels. Species selected include water voles, otters, amphibians, reptiles, fish, molluscs, land insects and birds. Other habitats and species are managed and conserved alongside this list of headline species and habitats. Changes made to the populations / area and distributions of these species and habitats could be reported, thereby making these the indicators for British Waterways' biodiversity programme. At the time of the interviews and this research this aspect is not fully investigated and exploited by British Waterways.

Further company information and details of environmental policies and programmes, including biodiversity, can be found at www.britishwaterways.co.uk.

6.3.4 AstraZeneca

As a very large, multi-national pharmaceutical company, Astra Zeneca has a large portfolio of landholdings throughout UK and the rest of the world. For the purpose of this research UK landholdings and habitats were focused upon. The larger, priority landholdings in the UK include Alderley Park, Macclesfield, Charnwood, Avlon and Brixham. However, when discussing the organisational aspects, the whole organisation was considered. This was largely due to the fact that the interviewee had the knowledge and responsibility to cover these areas.

The history of nature conservation and biodiversity for UK landholdings has been focused upon those sites which are more obviously rural, natural or with a high proportion of green space. The flagship example is Alderley Park, Cheshire where a full time estate manager promotes nature conservation and biodiversity projects.

Increasing as part of an organisation-wide corporate responsibility programme, biodiversity interests at AstraZeneca are still at an early stage. Many aspects of positive biodiversity management have taken place at Alderley Park, although little of this has been formerly directed and monitored. The interviewee is keen to formalise the work undertaken at Alderley Park as a trial to further expand biodiversity management across all UK sites and potentially landholdings internationally. Further information can be found at www.astrazeneca.com, specifically listed under the Corporate Responsibility headings.

6.3.5 Land Securities

Land Securities is the UK's largest Real Estate Investment Trust with a commercial property portfolio worth over £14 billion (www.landsecurities.com, 2007). This portfolio is based around commercial property management and covers a huge area of land, of which only a small proportion is 'green' space. There are opportunities for biodiversity management of these green areas, however the major positive impact and management of impacts opportunities exists at the planning and construction stages of a Land Securities new-build development.

Unique amongst the collaborating organisations, the driver behind the development of a Land Securities biodiversity programme was a specific client requirement. A methodology was devised by consultants for the assessment and scoring of existing sites to determine those for further investigation. This rapid assessment methodology was based on species recorded on site, area of semi-natural habitat as a percentage of the overall site area and location (urban, sub-urban, rural). Any site with more than 10 species, greater than 20% site area covered by semi-natural habitat or in a rural location was shortlisted for further assessment.

Embarking on a very large scale and long-term development project at the time of the interview, Land Securities had decided to employ a dedicated biodiversity consultancy company to manage all ecological aspects of this latest project. Further information on this project and the company as a whole can be accessed via the company website www.landsecurities.com.

6.3.6 Center Parcs

Center Parcs have four holiday village complexes across the country (Sherwood Forest, Elveden Forest, Longleat Forest and Whinfell Forest), all were developed with the company ethos to improve the natural environment and maintain or continue to improve it throughout the life of the complex. Management of the natural environment has been a continual part of the company's operations and records for all the sites going back to the organisation's roots in Holland over 30 years ago.

Each of the four holiday villages covers approximately 160 Ha and can host between 3956 and 4668 guests per week. Each village is designed to enhance an area of previously low or damaged biodiversity value and forest management plans are the key tool for the improvements.

Center Parcs is described as a “flagship, within the leisure industry, for its environmental philosophy, policy and practice.” by Dr David Sheppard (English Nature). The forest management plans have also gained awards from the Chartered Landscape Institute accompanied by the following praise: “Center Parcs landscape management plan is a fully co-ordinated, integrated, dynamic, enlightened and workable document”.

The whole organisation was considered during the case study and the interviewee was able to provide detailed information about all of the existing holiday villages. In addition, information about proposed holiday village developments was discussed. Also, detailed information was provided for the Sherwood Forest site, particularly examples of biodiversity initiatives and species information.

Further information can be found at www.centerparcs.co.uk, specifically by selecting the ‘Company Information’ tab.

6.3.7 The National Forest Company

The National Forest Company has a fairly distinctive structure amongst the other case study organisations. They have a focused area of influence, primarily 520 square kilometres of Derbyshire, Leicestershire and Staffordshire and the aim is to increase woodland area to cover about a third of the area. Woodland cover has increased from 6% in 1991 to over 17% in 2006. The profile of The National Forest Company has also increased over this period.

Landholdings are influenced but not owned or rented. The National Forest Company provide landowners with funding for reforestation and wildlife enhancement schemes. They have a series of targets to meet as part of their overall aim to create an integrated series of habitats across the region. This is also quite distinct amongst the other organisations of the case study. Biodiversity enhancement works are a primary focus of the organisation and monitoring of performance is not something that is a bolt-on or additional workload to daily operations. They serve to provide information in this case study as a best practice organisation and to give different perspectives to the issues concerning biodiversity and how businesses address it.

More information about the National Forest and The National Forest Company can be found at www.nationalforest.org.

6.3.8 The National Trust

The National Trust is a charity and completely independent of Government. It protects and opens to the public over 300 historic houses, their gardens and grounds plus 49 industrial monuments and mills. The National Trust has a history of protecting aspects of the natural environment for their intrinsic value. This also maintains public recognition of The National Trust as a good conservation organisation, which leads to increased membership.

They have a dedicated ecological survey team and the majority of the properties and land they own have estate managers responsible for upkeep whom are often resident at the site. It is quoted that £20 million is spent on coast and countryside conservation projects each year.

The research interview covered the entire organisation with specific site used as examples to illustrate key points during the interview. Certain specific biodiversity survey questions were answered by the survey team via e-mail at a later date. Interestingly, The National Trust provide a different standpoint compared with several of the other case study organisations. They are less interested in the reporting of biodiversity and nature conservation achievements for public relations benefits or corporate gain. The biodiversity survey team and nature conservation staff strive to measure and understand improvements made on landholdings in order to maximise biodiversity opportunities in the future.

More information on the history and landholding of the National Trust can be found via www.nationaltrust.org.uk.

6.3.9 Network Rail

With a land ownership of over 57,000 hectares, mostly linear, all over the UK and including 317 SSSIs, Network Rail is one of the UK's largest landowners. The primary concern of Network Rail is safety. All land management decisions are made with safety first, but the organisation is committed to maintaining and improving biodiversity wherever possible.

Network Rail's Biodiversity Action Plan was developed with a different structure because of these other concerns that impact land management. For example, species protection guidance is outlined and information on specific site issues are given. This approach aims to provide all staff and contractors with all protected species legal requirements and best practice guidance for dealing with SSSIs and other important wildlife features. However, it differs from the standard structure used by the majority of BAPs – primarily it does not set targets to improve habitats or increase species populations. Engineering and safety priorities

are of greatest importance, but with assessment of SSSI condition being publicised the need for improved management of these landholdings has been realised.

Network Rail provided input from an organisation where operational activities are a major constraint to habitat improvement, nature conservation and general biodiversity improvement. Despite this, the organisation holds influence over a vast landholding and has will to maintain and enhance habitats where possible given operational constraints.

Further information about Network Rail can be found at www.networkrail.co.uk.

6.3.10 Allianz Cornhill

Allianz Cornhill is a financial organisation that provides products such as Cornhill Insurance services, the well known Pet Plan insurance and other, corporate financial services.

For this case study it was the UK, Cornhill, organisation that was discussed. The parent company, Allianz, is based in Germany and was not discussed in any detail as this case study. The company has a limited landholding in the UK, with mostly urban office locations. However, there is a training facility is a semi-rural location in Surrey with a high proportion of green space. This training facility (Ewhurst) was the focus of the company's biodiversity work and also the main discussion point of the interview.

The results of the initial interview with Allianz Cornhill were cross checked with those gained through a second interview with a different member of staff at the company. This provided insight into the different perspectives on the organisations biodiversity work. It also provided general ideas about how different perspectives are present within any organisation.

Further information can be found on the company website (www.allianz.co.uk).

6.4 Common Threads of the Interviews

Section 1 – The Organisation and Biodiversity

Analysis of the first section of the questionnaire revealed strong common themes across the case study group. Most used a definition of biodiversity copied or only slightly adapted from that in the CBD and the UKBAP. The definition used by the organisations is not only that which is found in documents but the definition by which members of staff understand biodiversity. These definitions shape the approach to biodiversity carried out by staff at all levels from planning through to implementation.

How and why biodiversity was identified as an issue that needed to be addressed was a topic for longer discussion during all interviews. Many felt it the first opportunity in the interview to publicise all the positive impact they have had on biodiversity. It was clear from this that the interviewees were, in the majority, very enthusiastic about biodiversity and nature conservation. Biodiversity was recognised by several organisations of the group as an issue to address following the publication of the UKBAP in 1994 and the subsequent work of Local Authorities producing LBAPs. Alternatively, many of the organisations were already engaged with nature conservation and ecology work prior to this time. Indeed multiple interviewees reported that the organisation ethos was to improve the natural environment. In the case of Severn Trent Water (STW) the nature conservation work embedded in daily operations originated from requirements developed during the privatisation of the water authorities. For these organisations there was merely a shift in focus and a change in terminology around the mid 1990s. Other interviewees spoke for organisations without a history of land management or nature conservation work. How biodiversity became an issue for this group is very closely link to the drivers or reasons for doing biodiversity work.

Drivers are the reasons, the pushes or pulls, ‘why’ an organisation does something. The reasons why this group of organisations without a history of conservation work became involved with biodiversity can be generalised. Pressure from important clients, Local Authorities or local Wildlife Trusts, or regulatory and planning bodies lead several organisations to address their biodiversity impact. The option to answer questions in the Business in the Environment (BiE) questionnaire also motivated interviewees to develop a biodiversity programme. These are also some drivers found to be common to all of the case study group.

There were clear common threads found when analysing the responses to the question on drivers or reasons behind biodiversity being addressed as an issue. It is clear from the discussion about drivers that the enthusiasm of the interviewee is a major driver behind the organisation addressing biodiversity. This was not listed as a reason by any of the interviewees however, but was a noted observation by the interviewer. Drivers which were listed included those briefly mentioned above, questions in the BiE questionnaire, pressure from clients and the pressure to build a good reputation with regulators and planning authorities. Questions in the BiE questionnaire relating to biodiversity policies and systems are seen by some of the case study organisations as an opportunity to gain points and compete against other companies in their business sector. By addressing biodiversity the most comprehensively and achieving the highest ratings, a company will gain publicity, recognition and ultimately increased business. Pressure from clients was mentioned in general terms by several interviewees but more specifically by Land Securities. Requirements from an important Government controlled client were the major motivation to create biodiversity systems and undertake biodiversity assessments of landholdings for Land Securities.

Pressure from, and the opportunity to build better relationships with, regulatory bodies such as the Environment Agency and English Nature is a common reason cited by the case study group. The ability to be treated more leniently in negative situations such as minor pollution incidents is a major motivator for some interviewees to create positive impact on biodiversity within their landholdings. This reputation-building driver is one common to the interviewees and emphasised as very important and productive.

For companies involved in construction or development projects as part of their operations, building a reputation regarding planning was seen as vital to the longevity of the company. For example, Center Parcs explained that because of the reputation they have with respect to the sympathetic nature of their developments, new proposals are usually supported by the local wildlife groups and environment team on the planning boards. These benefits are seen by the case study group as definite business advantages over competitors. All interviewees regard biodiversity as a business opportunity, being a chance to gain competitive advantage. In most of the organisations the person responsible for delivering a biodiversity programme was the interviewee. Jobs titles differed but the only exceptions were those where it had been initiated by somebody in the past that the interviewee did not know.

All of the case study organisations had commitments to biodiversity. Common examples of this commitment included having a company BAP, a biodiversity policy and a requirement to report biodiversity in annual, environment or CSR/CR reports. The average length of time that the case study organisations had been addressing biodiversity specifically (using biodiversity terminology) was five years.

However, there were two distinct groups, those with six years or more experience and others with three years or less. This can also be correlated to the drivers behind developing a biodiversity programme. Those companies with six or more years history addressing biodiversity come from a background of nature conservation and/or have the concept of ecology and conservation within the ethos and drive of the organisation. Examples of these organisations include the National Forest Company, Center Parcs and the National Trust.

The interviewees were asked whom they considered as most effective within their organisation in the delivery of biodiversity objectives. The most commonly cited person or part of the organisation was the interviewees themselves together with members of their environment/ecology/landscape teams where they existed. They also confirmed that in most cases they were the person or level of the organisation that had the role of decision making and responsibility for their organisation's biodiversity programme.

Questions on the communication of biodiversity issues and status, both internally and externally, got extensive responses during interview. As these questions are common to audits across a broad range of subjects it is possible that the interviewees may have prepared for, or been expecting, this line of questioning. Within the extensive responses there were clear similarities in methods used by the case study group. Internal communication to the widest range of staff members was done by means of company intranet pages and e-mail newsletters. This was supported by hard-copy newsletters and company magazines. Additionally there was the posting of articles on boards and information points around buildings. Communication between staff directly involved in the biodiversity programme, particularly to board level and to operative level, was conducted differently. Most of the organisations with established biodiversity systems reported internally to the board level either as funding opportunities arose or at regular intervals, monthly being the most common. Communication within the team and to biodiversity or landscape operatives was more frequent and less formal according to the majority of interviewees.

The reporting of biodiversity performance (i.e. BAP progress, site status, implementation of systems) drew briefer responses overall than the previous line of questioning. However, upon explanation of the links between the questions, the interviewees confirmed that the scheduled reports to board level in particular contain information on progress and status of the biodiversity programmes. External reporting of biodiversity performance differed more widely between organisations of the case study group. The annual report format, whether it be an environment report, a sustainability report, a corporate responsibility report or other was the most common formal reporting method used by the interviewees organisations. How biodiversity was reported in these documents was investigated more fully later in the questionnaire interview process. However, several organisations provided further reporting of biodiversity performance than the single annual report. Reporting against biodiversity key performance indicators (KPIs) in EMSs was done by those with such systems in place to incorporate biodiversity. Others provided site management statements with detailed information on the nature of work undertaken on different sites within the organisations landholding. Ad-hoc reporting of biodiversity achievements was common amongst the group, frequently on websites and newsletters.

Section 2 – The Biodiversity Approach

The aspects of business that biodiversity was considered for across the group was fairly uniform. All of the case study group considered biodiversity impacts on their landholdings. This was expected as it was a desirable criteria for participation in the research. Some of the group expressed ideas of how they were hoping to reduce any possible negative impact on biodiversity through selective purchasing. However, a notion of buying fairtrade goods, sustainable timber and other procurement policies is not directly addressing biodiversity impacts of their organisation through the supply chain. When asked if they would be interested in research to assist with this assessment of biodiversity in the supply chain all interviewees responded positively. The explanations for this enthusiasm all had the common link that biodiversity was seen by the case study group as a growing field. Forward thinking and pro-active actions regarding biodiversity are seen as a means to gain a degree of competitive advantage. This may be achieved through the promotion of ‘market leading’ biodiversity work or simply being ahead of possible future regulation.

With understanding of the case study group’s general biodiversity programmes, the details of individual approaches were further investigated. A common theme to all was the linking of their biodiversity programmes to external BAPs or schemes. All had links to LBAPs, with some organisations having input into the creation of these plans and others using the

information in them to inform their own programmes. This was most commonly achieved through liaison with local wildlife trusts and local authorities that administer the LBAP. Commonly the organisations also had ties to other local biodiversity schemes controlled by these organisations. Through this liaison most interviewees felt that they benefited from knowledge input from specialists in the local area. It was also felt that the exchange was two-way with the information and positive impacts on biodiversity achieved by the companies being gladly received by the local organisations.

The case study organisations had a variety of different structures to list their biodiversity objectives and targets. The most common was a standard BAP format, developed with the help of ecological professionals and the liaisons described above. Most of these BAPs were of a format similar to the original UKBAP. This comprises an introduction to the issue and outline of the plan but largely depends upon the specific habitat action plans (HAPs) and species action plans (SAPs). Within this format there are tabulated lists of objectives and targets. The most common criticism of this approach, as noted by the interviewees, is the failure to make targets quantifiable. For example targets such as “increase amount of reedbed across landholdings” are far harder to measure and report against than “create 2500 m^2 of new reedbed”. Severn Trent Water followed the BAP approach and the interviewee was particularly keen to emphasise the importance of having a BAP to focus biodiversity works. It was felt by the interviewee that having the BAP provided a ‘roadmap’ for biodiversity work, allowing money and non-financial resources to be aimed at target habitats, species or projects. By guiding biodiversity work in such manner, greater achievements were made. These comments were supported by the interviewee from Center Parcs, who felt that having a guide to biodiversity work was useful for several staff and contractors. He explained that for many people and projects, the Center Parcs Forest Plans provided reminders of the overall biodiversity aims that were related to all land-based works. Even the interviewee considered this ‘reminder’ valuable despite having written most of the Forest Plans himself.

Interestingly, several of the interviewees were revising company BAPs at the time of the interviews to address this point. Specifics of monitoring and reporting objectives and targets were investigated in more depth further in the interviews. The discussion at this stage concentrated on the ‘paper’ or system side of the interviewee’s biodiversity programmes.

The most common methods for developing these biodiversity objectives and targets involve the interviewee, their biodiversity and ecological knowledge combined with that of their team. Commonly this is supplemented by work carried out by specialist consultants. This takes the

form of surveys of company landholdings to provide detailed information for the interviewee and team to use. Alternatively, information is provided by the organisation and a specialist consultant will develop the series of objectives and targets useful for the situation based on their expert knowledge.

Similarly for the implementation of on-the-ground biodiversity work, sometimes it will be done by staff within the organisation, whereas others use sub-contractors. Often specialist works such as habitat creation programmes are to be undertaken by specialist subcontractors. This did not correlate with size of organisation or the history of biodiversity work within an organisation. The decisions were explained by the interviewees as being purely business based, dependent on getting the best delivery of a project within financial restrictions. Staff skills also influenced the implementation of biodiversity work. If members of staff were able to carry out the planned biodiversity work then this was often preferable to employing sub-contractors from a financial perspective.

The measurement and recording of biodiversity work is most often achieved through the design of projects. As most projects are designed and programmed similar to any engineering works, a detailed specification is produced. This specification is drawn up at the start of a project and signed off upon completion. Through this specification several measurable features will be present and the job only confirmed as complete when they have been achieved. For example, a habitat creation specification may include the dimensions for a water body (area, volume, length of perimeter), area of reedbed created, number of plants planted or length of hedgerow created. These provide quantifiable elements and indicators of biodiversity improvements.

Section 3 – Biodiversity Indicators

What the case study organisations measure to give a picture of biodiversity was a key question and discussion point in these initial interviews. For a small minority of the group the initial answer to this question was a negative. It required some discussion before realising that although no formal measures were necessarily in place as biodiversity indicators, measurements and records had been kept.

Standard ecological surveys were used in a structured manner by the majority of the organisations. The surveys used included the JNCC Phase 1 Habitat Survey, National Vegetation Classification (NVC) or Phase 2 Survey and specific fauna or flora surveys. These organisations used habitat survey techniques as the basis of their biodiversity assessment

method. Often the habitat assessment was an ongoing programme, particularly for those organisations with multiple sites, designed to survey each site every five years. For other organisations the habitat assessments were less structured. For example, Astra Zeneca produced a habitat map and conducted surveys on its flagship biodiversity site but did not extend the assessment to all landholdings. The National Forest Company compiled information on the habitats present at sites they became involved with as part of the funding application process as opposed to surveying sites on a rotational basis.

Three of the organisations (British Waterways, Center Parcs and The National Trust) also conducted a structured programme of more detailed ecological surveys. Surveys for particular species were the methods used. Target species included local, UK and company BAP species, Red Data Book species and traditional habitat indicator groups such as farmland breeding birds.

A minority of the organisations used much simpler measures for biodiversity or biodiversity potential or they did not realise that information they had collected for other purposes could be used for the assessment of biodiversity. For example, the rapid assessment methodology used by Land Securities provides detail of what area of habitat exists at a site but does not go into classifying the habitats to the detailed categories of the JNCC Phase 1 Habitat Survey methodology. During the interview discussion with Allianz Cornhill, the initial response was that they do not measure anything to assess biodiversity. However, upon prompting and discussion it was discovered that records had been taken of the number of trees planted, the amount of wildflower seeds and plugs sown/planted and approximate area, and the size of the water feature created. These measures could be considered sufficient given the stage that the company is at in its biodiversity programme. Network Rail simply measure area of ‘green’ land and area of SSSI land under the organisation’s influence. This is updated as new information is available through development works taking place or the organisation’s influence being expanded or reduced.

A significant proportion of the collaborating organisations reported that they could only undertake the survey methods that were possible given the staff resources they had available. This was driven by a larger financial restriction for the biodiversity programme and the surveys that could be undertaken using staff expertise were carried out mostly because of the enthusiasm and motivation of the individual staff members. Resourceful and commendable as this was, it led to a rather ad-hoc survey approach. Surveys would be conducted for bats because a member of the team had an outside interest but similar surveys

for other protected species (badgers, great crested newts etc.) would not be performed. Drivers or constraints other than ecological information were influencing the selection of what was being surveyed. However, this information should be considered as 'extras' and the process not considered negatively as a seemingly unstructured approach to biodiversity information gathering. What is more important is the information these answers provide about how companies decide upon what is going to be measured to gain a picture of the state of biodiversity.

For those companies who conduct detailed ecological surveys beyond Phase 1 Habitat Survey, the justifications for doing so share common themes. The National Trust and British Waterways have dedicated ecology teams or several individual ecologists to provide ecological information to the whole organisation. This approach has been long established and is based on the organisations' close relationship with the natural environment. Similar in many ways is Center Parcs, the interviewee described how their approach was developed through an intention to "survey everything". In reality the survey programme that Center Parcs implements is unique. Most importantly it conducts surveys of all holiday villages on an annual basis, more regularly than any of the other case study organisations. This provides information for the annual ecological monitoring reports including general habitat mapping and ecological condition details but also reports on the status of the many important species and groups that Center Parcs monitors. Additionally a large proportion of the survey work is conducted by independent surveyors, ecologists and consultants. Great attempts are also made to retain the same people to conduct these surveys each year for maximum consistency. Most other organisations follow the more generally accepted ecological approach of surveying a site at intervals of several years, as mentioned previously.

Where there are no set intervals for a biodiversity survey programme it was commonly because information was collected on a particular site or species / group on an 'as needed' basis, depending on issues arising elsewhere in the organisation. Other justifications for the choice of biodiversity survey techniques that occurred multiply included advice provided by consultants or from the ecological knowledge of site managers or members of the organisations environment team.

How all of this information is used could be seen on one hand as unique to each organisation if specific details are the focus but on the other hand commonalities can be identified. Using the information to report on biodiversity is common to all of the case study participants. The differences in how, why and to whom the information is reported provides common themes

and differences between the organisations. The majority of the organisations use the information to adjust their biodiversity targets and overall biodiversity approach in the long-term. In the short-term, annually or as information becomes available, biodiversity measures are used in internal and external reports and publicity material. These reports and publicity material update the audience on progress against biodiversity targets or the implementation of capital projects that include biodiversity elements. Differences between the organisations and their reporting of biodiversity performance are all about how public they wish to make their results. Some of the case study organisations did not publicise any of their results of biodiversity measurement. This is due to a lack of confidence that they are 'doing everything right'. It was reported by multiple interviewees that if they were to publicise all of their biodiversity results then they would be positioning themselves for criticism and negative comments. Those who did make biodiversity information available often limited it to the techniques used and/or the sites they were focusing on, rather than reporting the results of biodiversity surveys. There were also the organisations of the case study group that had much less experience behind their biodiversity programme and for those interviewees it was hard to respond to this line of questioning. They could only speculate how they would use information as they had not gone that far down the road of their individual biodiversity programmes. The information gained from discussion with these organisations did not provide any information or suggestions particularly different from that provided by the more established organisations.

It was found that responses to the questions about the people chosen to conduct the biodiversity recording and monitoring work followed similar patterns. The majority of organisations were able to answer confidently about who conducts their biodiversity monitoring and recording work. Most of the more experienced organisations said that consistency in this area was important to their biodiversity programme as they intended to use the data for comparison over time. In order to see changes in biodiversity accurately, generally accepted ecological knowledge acknowledges this emphasis on consistency. The choice of people to conduct this work is dependent on the resources the organisation has within its own staff and the financial resources it assigns to the biodiversity programme. Some of the larger organisations, such as The National Trust and British Waterways, use their own staff ecologists almost exclusively for the biodiversity monitoring and recording work. However, other large organisations such as Center Parcs and Severn Trent Water use consultants and other external specialists almost exclusively to deliver this element of their biodiversity approach. There appears to be no obvious differentiation between organisations that correlates to their choices in this area. The organisations with less experience in this

area found it difficult to answer these questions with the same confidence as those described above. This can be explained by the limited timescale these companies have been addressing biodiversity.

The final question of this section asked interviewees what they desired in this area to assist them accurately measure biodiversity within their landholdings. Common responses can be broadly divided into three similarly sized groups for these questions. The first group responded from a stance that could be described as confidence in their current procedures. They believed that they had developed a good system from information that was available and the ecological knowledge of their organisation's staff and consultants. Although they would be interested to see further information and systems that may develop, they did not feel they *desired* anything to enhance their system.

The second group of responses expressed an strong interest in having a standard approach or guidance. This was desired in most cases for reasons of comparisons between similar companies, or companies within a particular sector. It was also said that if an accepted guidance was available then it could be audited against and companies could be awarded a level or a range of levels, depending on their impact on biodiversity on their landholdings. A standard guidance would also give companies confidence that what they were doing was suitable and 'right'. This may also increase the likelihood of more public reporting of biodiversity results or progress against targets.

The final group of common responses were those that included desires for there to be legal requirements or financial incentives for monitoring biodiversity. In some ways the interviewees reasons for desiring this comes from a desire for all companies to be addressing biodiversity, and that they were willing to start the process before others but still had some reluctance. In effect they did not wish to 'jump' if they did not have reassurance that others would follow. Also, if financial incentives or legislation were in place driving companies to address biodiversity then accompanying guidance would be present. This guidance would detail what was required to meet the law/gain the financial motivators. Therefore it can be seen as a very similar desire to the second group of responses – a desire to be guided.

Section 4 – Biodiversity Experience / Advice

This final section covered the experiences of the interviewees in addressing biodiversity. It specifically asked for the hurdles and benefits that had been encountered during this process.

Hurdles faced by the collaborating organisations whilst implementing their biodiversity programmes share common themes. Overall this could be described as lack of 'buy-in'. As stated by interviewee from AstraZeneca "biodiversity is seen as only a very small part of a grand scheme."

A lack of committed financial support from organisation, including money for capital projects, ongoing works and also for staff was reported by the majority of interviewees. Allocation of staff and money resources was further mentioned as a hindrance to the biodiversity programme within their organisations. A reluctance or lack of commitment from staff, often 'front line' staff, was reported. However, board level staff were also described as seeing biodiversity as something that can be dispatched with token gestures of support. Staff were reported to commonly respond when asked to address biodiversity, "what's it got to do with my job", "it's another bit of paperwork, just like H&S" – it is seen as adding to a list of other things staff have to do. Most interviewees explained this was due to a lack of education about the issue and why it is important.

Outside partners such as Wildlife Trusts were often described as seeing funding from the businesses as being free and easy to generate, causing hurdles in the building of partnerships when no funding was available.

Internally, understanding exactly what the definition of biodiversity is and focusing on not just discussing the 'how important it is' and 'it's a great opportunity' type questions but actually 'doing' biodiversity work was seen as an important barrier to break through. Also, understanding all the different BAP targets and different formats from different regions was a lengthy task for some of the interviewees with geographically spread landholdings.

Benefits from implementing a biodiversity programme also share common themes. The altruistic reasons were motivators for many of the individuals interviewed, namely, the notion of conserving biodiversity for its intrinsic value, "making a positive difference to biodiversity". Also stated were the results of the points that were driving the process, including improved relationships with advisory bodies and regulators, English Nature (now Natural England), Environment Agency and local groups like the Wildlife Trusts, Local Authority and local interest groups. In turn, this improves the organisation's planning reputation and treatment during non-compliance incidents.

Initiating a biodiversity programme also gave the individuals and the organisation more confidence to deal with biodiversity issues and answer biodiversity questions when they arose. This enabled greater confidence to publicise and gain recognition of the good work done to conserve biodiversity. Perhaps linked to recognition of good work or otherwise, there were reports of increased pride in staff that their organisation is doing something good for wildlife, providing them with the opportunity to see more habitats and species as well. Additionally, several interviewees stated how it had built a communication network within the company – partly through this staff interest.

In terms of continuing the biodiversity work and improving systems, the BAP and general biodiversity approach provided structure that has focused work and resources in certain areas. It gives a good agenda to report against and compare to over time, both positive and negative changes. Achievements given by interviewees include: increasing points in the Share Indices (Dow Jones) & BiE questionnaire; gaining the Wildlife Trusts' Biodiversity Benchmark; good local publicity – local awards, environmental and business. Allianz Cornhill specifically reported that the CEO was now more interested in biodiversity and other environmental issues. Land Securities reported that it not only met the requirements of its client that had driven the biodiversity programme. It had also gained clients by increasing knowledge in this particular field.

6.5 Chapter Summary and Conclusions

The common threads show the similarities and differences between the collaborating organisations in terms of their approach to address the issue of biodiversity on their landholding. In summary, an overview of this stage is that guidance for businesses to follow is considered to be a beneficial input to the current situation. Therefore the overall aim of the project (to develop a methodology to enable companies to identify, quantify and monitor biodiversity and report on the progress of biodiversity objectives within existing business systems) is still deemed to be a positive and practical contribution to knowledge. The following chapters detail the development and testing of the methodology based upon the knowledge gained from the case study interviews and the literature resource.

CHAPTER 7 - DEVELOPMENT OF A METHODOLOGY FOR THE SELECTION OF BIODIVERSITY INDICATORS

7.1 Introduction

This chapter describes the process of developing the biodiversity indicator selection methodology. It documents the reasoning behind the stages of the methodology and provides an overall description of the process of executing the methodology. Reasoning for each stage of the methodology came from literature sources (see Chapters 1&2), the results of the multiple case study (see Chapter 6) and the author's amalgamation and understanding of this information.

7.2 Methodology Format

The methodology was developed through the combination of the information and knowledge gained by the author through the previous stages of the research. Primarily it was from the information found through the literature review, assimilated and written up. This was used with the practical knowledge and insight gained from the multiple case study performed previously.

The literature review process gave in-depth understanding of the history of biodiversity as a term and a subject that has grown to the extent in which it is addressed by a wide range of people, groups and organisations. It also provided an academic background to the measuring of biodiversity and the traditional approach to biodiversity indicators.

Although these knowledge areas formed a large part of the basis to this research programme, alone they could not provide enough information to allow the author to develop the methodology for the use of biodiversity indicators by business. Additional information was required from the perspective of businesses and organisations, and individuals within those organisations. The information gained from this angle of the research (carried out as the multiple case studies) provided the author with knowledge of existing business environmental systems and existing successful approaches to biodiversity.

Combined, these two information gathering and investigative exercises provided the wide range and complete spectrum of information required for this topic area to allow the development of a methodology.

The methodology was designed to be used by business primarily but may be flexible enough to be adapted for use by non-commercial organisations as well. The aim was to provide a framework for companies to follow to tackle the biodiversity issue in their organisation. It covers all business sectors and importantly, it allows for any previous amount of biodiversity work completed. It includes a cycle structure, mimicking the widely adopted and understood 'cycle of continuous improvement' used in the ISO 140001 environmental management system. This provides a mechanism that ensures companies will continue biodiversity work and not just see the approach as a one-off exercise to be completed and then crossed off a list of tasks. The structure also reflects the elements of the DPSIR model, incorporating drivers, pressures, state, impacts and responses. Although not a complete mimic of the DPSIR model (as illustrated in Figure 2.5), the methodology is closely related to the elements and links described by the EEA DPSIR concept and this is shown in Figure 7.2. All stages best described as drivers and pressures are coloured green and enclosed by a round square, state stages are highlighted with a red oval, impacts with a yellow triangle and responses with a blue hexagon. For the methodology proposed drivers and pressures have been combined when describing in a DPSIR context because it is felt that in a business landholding context the two elements create the same effects on the selection process and will both be affected similarly by any responses that results from the implementation of the methodology. It is felt that the State and Impact stages most directly relate to the original definitions and interrelationships in the EEA (1999) DPSIR model. However, the stage in the biodiversity indicator selection methodology that is highlighted by the blue hexagon and labelled as "response" in a DPSIR context is marked as such because it is felt to be the stage that could be influenced through increased funding or other input if a greater / lesser Impact was required. For example, in a DPSIR context, it may be felt that an adverse impact (from operational activities) on the State of biodiversity is too great and therefore a funding increase to train more company managers (e.g. in biodiversity sympathetic operational methods) would be a suitable "response".

The flow-diagram or decision matrix format was chosen for its simplicity and familiarity. During the interviews of the multiple case study this format was suggested as a suitable output of the research project. Most people and organisations are familiar with flow-diagrams and how to use them, following the flow and addressing the issues and making decisions where specified. This similarity to existing business approaches has been the concept of the research throughout.

This process framework is important for the concept of getting people to the same level in a background approach to biodiversity. The entire process provides the techniques for the selection and use of biodiversity indicators, although the specific decisions about indicators do not appear until beyond halfway through the process diagram. The process diagram is provided as Figure 7.1.

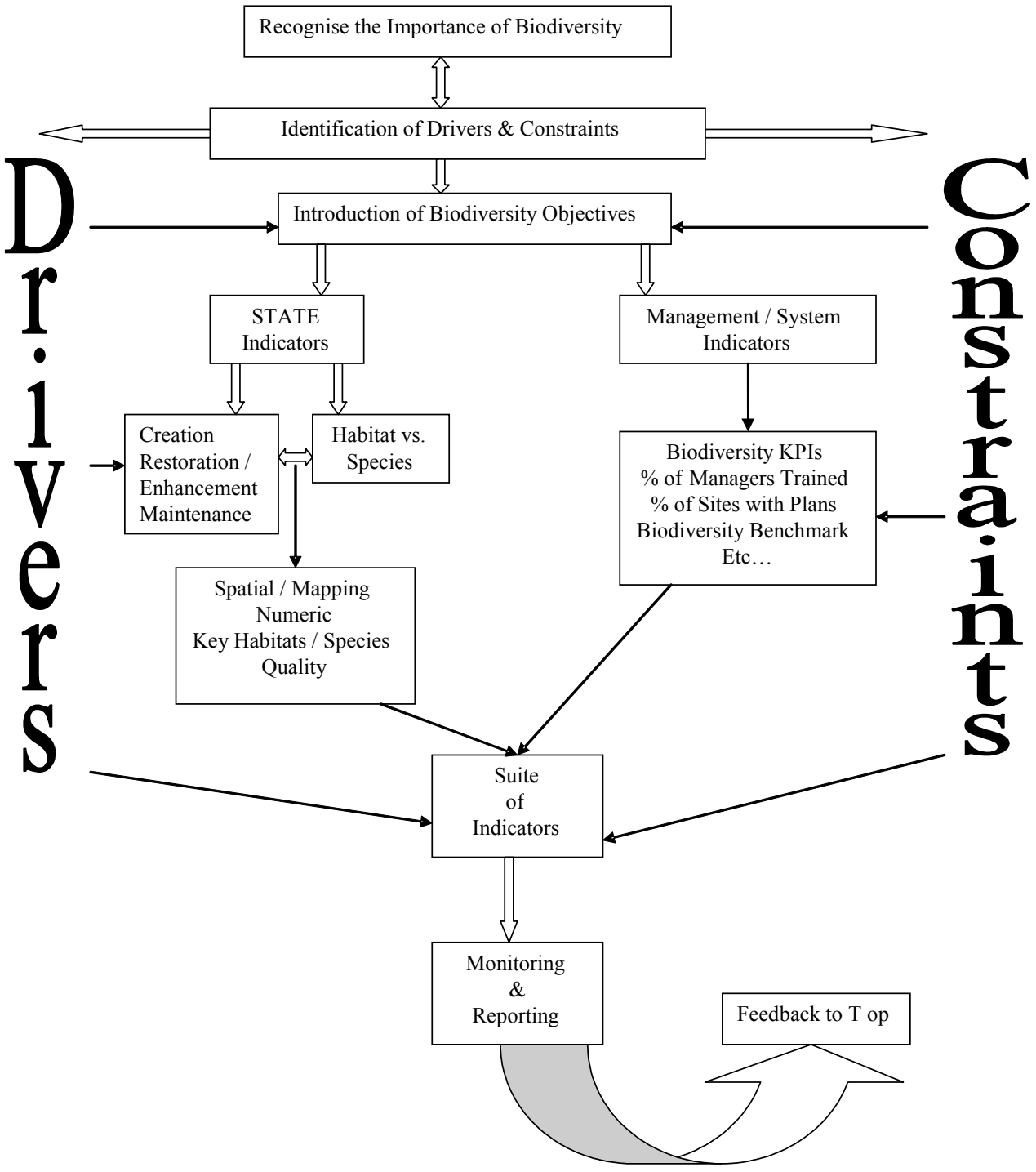

Figure 7.1 –Biodiversity Indicator Selection Methodology

Figure 7.2 – Relationship between the DPSIR model (EEA, 1999) and the Biodiversity Indicator Selection Methodology

7.2.1 Recognise the Importance of Biodiversity

This is possibly the most crucial part of the plan. An organisation must have recognised that biodiversity is an important issue and that the organisation needs to address it.

It was decided that in order for this methodology to be relevant a company must have recognised the importance of biodiversity. This stage was determined in part from the results of the 'selecting collaborating organisations' experience that formed part of the research (Chapter 4). From that task it was clear that companies that are not engaged with biodiversity simply would not be involved or interested in the process this methodology provides. That is to say that both the methodology is not relevant to companies not addressing biodiversity and that if a company does wish to embark on the process the methodology provides then they must first recognise biodiversity as an aspect of their business that is important to address.

This begins the learning and understanding experience within the company about biodiversity as an issue, why it is important to the company and what the company wants to gain from dealing with biodiversity. This first stage was designed as a common-sense start to the methodology.

From the case study interviews it was apparent that all case study organisations clearly recognise the importance of biodiversity. Recognition of biodiversity importance came from company ethos, the publication of UKBAP & LBAPs, client pressure or regulator/authority pressure. For example, Land Securities were forced to address biodiversity of landholdings as a contract requirement for a major client. Other companies, such as Center Parcs and Severn Trent Water, had a close relationship with the natural environment and were aware of the publication of the UKBAP and LBAPs. In turn they developed their own BAPs and this process raised the organisational recognition of biodiversity as an important issue.

Literature from Earthwatch (2002, 2002a) clearly outlines the importance of biodiversity for business. These publications are a good starting point for businesses who may wish to better understand the business case for addressing biodiversity.

7.2.2 Identification of Drivers and Constraints

This stage of the methodology is interlinked with the recognition of biodiversity importance because it is quite likely that an organisation will have identified importance through one or more drivers that have developed or arisen. One collaborating organisation explained that they had no proper recognition of the importance of biodiversity prior to a potential client

insisting that they address the issue. This driver led the organisation to quickly recognise the importance of biodiversity and develop a biodiversity programme (as described in Section 6.4).

An in-depth investigation into which drivers are motivating the biodiversity programme will make the further stages of the methodology far easier to negotiate. Constraints are included here as it is similarly important to identify what financial, resource or operational restraints will impact on the biodiversity programme and the process of applying this methodology. Many organisations will be able to conduct this investigation into drivers and constraints themselves, but it is likely that some organisations will benefit from external help. This would provide an 'outside-in' view and knowledge and experience from a biodiversity professional. Drivers and constraints put simply are:

> "We want to do this because of [DRIVER]…"; and,
> "We aren't able to do that because of [CONSTRAINT]…".

If all drivers and constraints are identified before proceeding it is expected that all further stages and decisions will be made in the most informed manner. The study of drivers and constraints will help to build the picture of the organisation and its relationship, or desired relationship, with biodiversity. For example, if an organisation recognises it is being driven by external pressure to 'do no harm' then later decisions maybe influenced by this. Land management may be performed to the extent of maintenance only, ensuring no negative impact but not investing into substantial biodiversity improvement schemes. Conversely, a business may be seeking competitive advantage through its biodiversity work. In this situation, large scale habitat creation or biodiversity improvement projects may be undertaken and maximum reputation benefits sought.

The case study organisations repeatedly raised the idea of taking into account different business situations. This includes the day to day operations, the ethos of the organisation, budgets for environmental and biodiversity work, staff resources and many other factors which differentiates organisations from one another. As an example of contrasting situations, the Center Parcs holiday concept is based on the natural environment and this ties into every angle of their business. Whereas Network Rail have very many other high priority operations that take precedence over biodiversity work, predominantly safety concerns and engineering works. These differences, and the issues they raise, are also mentioned in several of the guidance literature publications that were reviewed (Chapter 2).

The sheer volume of response to driver and constraint questions in the case study interviews was a deciding factor in the placement of this task in the overall process of selecting biodiversity indicators for business. The process diagram (Figure 7.1) shows not only the 'Identification of Drivers & Constraints" task but also how these drivers and constraints influence the stages following, constantly affecting choices to be made for the more specific selection of biodiversity measures/indicators. Therefore, an understanding of organisational drivers and constraints should be established earlier in the process of developing a biodiversity programme and selecting biodiversity indicators.

7.2.3 Introduction of Biodiversity Objectives

Directly influenced by drivers and constraints, this stage is designed to focus an organisation onto setting commitments to biodiversity. This may be a biodiversity policy or a biodiversity component within a wider environmental policy or statement. Objectives and targets within a biodiversity action plan (BAP) may also be seen as a commitment to biodiversity.

This stage is essentially where an organisation develops its own individual biodiversity approach. Information gathered from the investigation into drivers and constraints is combined with internal knowledge, expert guidance and information from external parties. Contact with organisations such as local Wildlife Trusts, LBAP officers, neighbouring landowners etc. should be sought. This enables the biodiversity commitments / policies / objectives / BAPs to be developed with a holistic nature to them – taking into account the operations of the company, drivers and constraints, geographical location, external guidance and internal wishes. All factors can then be amalgamated to produce a highly tailored biodiversity commitment.

This stage of the methodology is something that is common to most management system approaches. It is setting out the company's approach and confirming the commitment to biodiversity. Commitments and policies are familiar to most organisations, whether they are for health and safety, ISO140001, the Wildlife Trusts' Biodiversity Benchmark or other management systems or assessment criteria.

The case study organisations all commented that having a policy, series of targets, an action plan or other biodiversity aim or objective(s) was important and helpful. This was particularly well documented in the interviews with Severn Trent Water and Center Parcs. The interviewee from Severn Trent felt strongly that one of the most valuable aspects of a

company BAP (or similar plan) was the guidance that it provided, becoming a ‘roadmap’ for biodiversity efforts.

For these reasons it is felt important that organisations develop an action plan or similar strategy early in the process of developing their biodiversity work. However, developing a complete BAP will require discussions and investigations about what to measure / monitor, target efforts towards and how to focus efforts on habitats versus species. All of these considerations are included as later stages of the biodiversity indicator selection methodology developed (Figure 7.1). Therefore it should be understood that although the methodology is represent as a flow diagram, several of these stages may be tackled at any one time. It should not be treated as a strict decision matrix, whereby a stage must be ‘answered’ prior to commencing a later stage.

Beyond this point the process splits into two strands, one for management or system indicators and one for ‘state’ indicators. This split is based on the concepts detailed in 2.7.1, particularly the similar split made in ISO14031, together with the information gained from the case study interviews detailed in 6.2.

7.2.4 Management / System Indicators

These are the indicators or measures of how well the system is performing. They focus on measuring what steps have been made to address biodiversity through business management. For biodiversity a good example may be a company BAP as the system and a suitable system indicator could be ‘number of target projects commenced’ or ‘percentage of target projects completed’. Measurement of number of assessments made, percentage of staff trained in biodiversity issues and number of sites with biodiversity management plans are all common examples of this type of indicator. The Wildlife Trust’s Biodiversity Benchmark is an assessment of a company’s biodiversity performance and focuses primarily on the management system, identifying what policies and documents are in place, whether they are delivered and how review of these is incorporated in overall business systems.

Management and system indicators are not entirely separate from the ‘state’ indicators described below. Management systems are put in place to perform and these indicators provide a means of tracking performance and scrutinising what they have achieved.

This stage in the biodiversity indicator selection methodology continues the link to management systems and the familiarity that most businesses have with this style of approach. The interviewees from the multiple case study emphasised that biodiversity

should ‘fit’ into the same approach and systems that other environmental and wider business aspects use. Most businesses are familiar with key performance indicators (KPIs). Essentially that is what these management / system indicators are. There are a key component of the ISO14001 environmental management system but are not limited to environmental systems, indicators are commonly used in other business areas such as finance.

A number of the case study organisations operate an ISO14001 accredited environmental management system (EMS) or a similar EMS, often based upon the principles of ISO14001. This stage in the methodology is included to illustrate how this type of indicator sits alongside the more on-the-ground ‘state’ indicator and how input from both is combined at a later stage for monitoring and reporting purposes. As mentioned above, this stage also provides some familiarity for participants and most will be able to deduce suitable measures for biodiversity management/system indicators based on working with similar environmental systems. From the interviews of the multiple case study it was clear that the people who are likely to be using this methodology are often experienced with environmental management systems and other business systems using KPIs.

7.2.5 State Indicators

These are the on-the-ground indicators, they measure the level of biodiversity on the landholdings – showing the ‘state’ of biodiversity. These are the indicators which pose most difficulty to companies and non-specialists as there is much confusion about what they are, which to use and how to combine different ones. These indicators are measures of biodiversity, generally a number of these are used to measure different components of an ecosystem and then assessed together to give an overview of the state of biodiversity for the area surveyed. An explanation of the terminology and more information regarding the ‘state’ indicator approach is provided in Section 2.7. This approach saves resources over a ‘measure everything’ approach and is much more accessible to a wide range of organisations. As covered in the literature review (Section 2.7), it is impossible to measure every component of an ecosystem. Duelli & Obrist (2003) explain that biodiversity of even a small area is far too complex to measure comprehensively and to quantify. Therefore even extensive survey series are still assessment by sampling. All of the case study organisations understood this point and most reported that resource limitations would also make it impossible to measure every species and habitat characteristic of a landholding. Therefore decisions have to be made about what sampling (survey) is undertaken.

This is the crucial part of the research, this methodology provides a process for organisations to follow to assist in the selection of biodiversity indicators for their landholding. The 'state' indicator strand of the process and the stages within it are based on a combination of information. This includes the basic need for the research (as outlined in Chapter 1), several key pieces of literature and the scarceness of directly related academic literature or guidance material available (see Armsworth et al., 2010 & others, Chapter 2), the responses from case study organisations (particularly those summarised in Chapter 6, Section 6.4) and discussions with case study participants and professional and academic ecologist colleagues.

7.2.6 Creation, Restoration/Enhancement, Maintenance

The study into drivers and constraints (as described in Section 7.2.2) should assist in identifying the company's view and approach for this section. In order to correctly select biodiversity indicators, the aim for each site should be determined. For example, any number of contributing factors may influence an organisation to pursue a habitat creation scheme for a particular landholding. If this project included the planting of trees, the creation of wetland habitats or another habitat creation practice, this will influence the choice of biodiversity indicators. Essentially:

Creation – The creation of a habitat type that has no firm evidence of pre-existing on the site in recent history. For example, the creation of ponds and wetland features on land that has been pasture for many years, or the planting of trees on open land. Creation as mitigation for damage caused elsewhere can be a contentious issue, especially when the activity can fail to fully restore or compensate for the loss elsewhere or be seen as providing an excuse for actions that are destructive to biodiversity (Vaughn et al., 2010).

Restoration / Enhancement – 'Adding-to' an existing habitat or landscape feature. This may be a creation program on land that once held the habitat type, expanding the size of a particular habitat type, adding quality to existing habitats through creation projects or management techniques.

Maintenance – Not trying to change existing habitats and species compositions but to maintain their qualities and often management to halt succession.

Deciding on these principles of biodiversity work for a site helps to narrow the selection of biodiversity indicators.

Factors which may influence this decision making include information from the organisation's general practice towards biodiversity. These principles should be identified through the previous stages of driver / constraint assessment and outlined in biodiversity policies or action plans. An example of these practices may be where an organisation wishes to improve the level of biodiversity on landholdings which include SSSI ownership. Additionally, influence on this stage of the process is likely to come from the characteristics of the site in question. A landholding may have very high quality habitats present and the best approach may be determined to be a continuation of management. Undertaking this management may fulfil some initial restoration of the habitats, eventually becoming a maintenance project as the habitats reach a peak biodiversity level. However, if a site is of relatively low to moderate biodiversity value and there is limited potential for gains in biodiversity without significant input of resources, it may be decided that maintenance and 'no negative impact' is the most appropriate approach. The resources may be better allocated elsewhere, possibly on a site with greater potential for biodiversity improvements and associated publicity and reputational benefits for the organisation.

There are many combinations and permutations of existing site value, levels of available resources, environmental motivations of an organisation and other factors that may influence the outcome of this stage of the process. What is considered important, and why this stage has been included in the methodology and at this point, is that an organisation has this discussion and considers these choices to better inform their selection of biodiversity indicators.

The inclusion of this stage of the process came from the experiences of the author undertaking and analysing the case study interviews and associated discussions with participants. From a small but varied group of organisations it was clear that differing situations, motivations, resources and conditions existed for each. This influenced how they initiated biodiversity work for the landholding under their control. For example, Center Parcs' entire company ethos and philosophy includes protection and enhancement of the natural environment. During case study interviews and related discussions with the interviewee (as detailed in Chapter 6) it was revealed that they also realise the public and planning authority reputational benefits of such a philosophy. This background means that funding for biodiversity and natural environment works is substantial compared with other organisations. The resulting decisions for land management lean in favour of habitat creation and restoration/enhancement schemes as opposed to a purely maintenance / conserve only what already exists approach.

Center Parcs are recognised as a flagship organisation for biodiversity enhancement and gain business benefits because of this work. However, this is not necessarily the correct approach for all organisations to adopt and is why an assessment of drivers and constraints was included early in the methodology. Another case study example to illustrate this is Network Rail. Unlike Center Parcs, Network Rail is unlikely to receive direct business benefits through habitat creation schemes on their landholding. After all, they do not attract customers based on a pleasant surrounding like Center Parcs. Despite this, there is potential for serious negative impacts on the business if damage occurs to the natural environment, particularly a reduction in the status of SSSI landholding. Therefore Network Rail is likely to take a maintenance approach to biodiversity on its landholding, conserving what is already present and, importantly, doing no damage to habitats and species under its influence.

7.2.7 Habitats vs. Species

This stage should often be addressed simultaneously with the previous. It is another question of focus and can be influenced by similar factors. The overall drivers influence this stage considerably, particularly if the organisation has a champion species, statutory requirements to manage specific species (through SSSI notification etc) or particularly important species (Red Data List, UKBAP, LBAP etc.) that should not be ignored when deciding the potential future of a site. There has been a general trend in recent years to move away from focusing just on rare species and towards a more inclusive and holistic approach of habitat focus. The idea behind this habitat approach is not new, simply the notion that if the habitat is correct then key species are likely to utilise it. It also provides a more buffered approach in terms of monitoring as species can come and go more quickly than habitats, potentially causing problems when reporting them as an indicator of overall biodiversity.

An interviewee gave an example of this during the multiple case study. They stated that Golden Eagle (*Aquila chrysaetos*) was present at one of their sites and that this was as much of a risk as it was an opportunity. There was the obvious opportunity to publicise the presence of these spectacular birds on their land. However, they explained that if they were to focus heavily on this species they risked severe criticism and scrutiny if the species ceased to be present at the site. The use of the site by the eagles may be subject to factors entirely out of the control of the company. The eagles could move to a more favourable site, die naturally or move away for unknown reasons. This change would impact heavily on the company's biodiversity monitoring and reporting if too much emphasis was placed on this species as an indicator. Whilst they offer great opportunities if used as a species champion

and promotional species, the eagles are so few in number that loss of one breeding pair could disproportionately convey an image of biodiversity loss.

The English Nature document 'Biodiversity: Making the Links' (Simonson & Thomas, 1999) identifies the associations between species and habitats and provides examples of how habitat and species programmes can operate together. For example, the Bittern (*Botarus stellaris*) is shown to be associated with the priority habitat of reedbed and with a secondary importance for fens and coastal and floodplain grazing marsh. It is also associated with lowland heathland and eutrophic standing waters. Therefore, management of these habitat types to improve quality or increase area could be undertaken if Bittern was an important species for a site or organisation. Monitoring of habitat area, perimeter, location / mapping and habitat quality would provide information on the progress of these management works and would be relatively simple to collect. Surveys for Bittern could be undertaken also and may indicate the occurrence and quality of key habitats. However, outside factors can affect the distribution and abundance of Bittern numbers, altering the survey results and possibly leading to incorrect inferences being made about the habitats within the landholding.

Ultimately these discussions and decisions are unique to an organisation or situation. It is a vital stage to the process of indicator selection but one that is likely to require significant inputs about the site ecology, business approach to biodiversity and the application of ecological knowledge. Chapter 2 discusses the relative merits of species as indicators in more detail and the paper by Hilty & Merenlender (2000) provides a good introduction to the issue of using fauna as indicators of ecosystem health.

The inclusion of this stage was developed for the accumulation and analysis of a large amount of literature and case study research information, similar to that described for the previous stage. The only explicit example of this type of discussion / debate about priorities is the revisions made to the Severn Trent Water BAP that were being finalised during the time of the case study interview process. Severn Trent Water made a decision to move from a traditional BAP approach of multiple SAPs and HAPs to a reduced number, based on HAPs covering broader habitats.

The development and inclusion of this stage was also based on the observations made of case study organisations. Several case study organisations would be considered successful in terms of their biodiversity work, even labelled flagship organisations in some instances. However, different approaches existed to the habitat versus species dilemma, none of which appeared to influence overall success. It was fairly straightforward to interpret that having an

approach more tailored to the organisation increased the success of the biodiversity programme.

7.2.8 Spatial / Mapping, Numeric, Key Habitats/ Species, Quality

The above stages lead into the stage where an almost infinite number of different biodiversity indicators has been considerably reduced based on the specific intentions and focus for a site and/or organisation.

These different types of indicator (spatial, numeric etc.) cover most of the main groups that can be utilised following this methodology. Types of indicator should be chosen guided by the previous 2 combined steps which tailor the company biodiversity strategy / drivers / constraints to the individual site or situation. The identified drivers and constraints feed into this stage quite heavily as different indicator types are more or less complex with associated high or lower resource requirements. For example a habitat quality assessment may utilise detailed survey techniques and computer analysis of the results to give indication of habitat quality. This will require specialised knowledge and experience and could be costly to conduct. It will however produce very comprehensive and informative results. In contrast if a habitat creation programme is undertaken, a simple count of number of trees planted or area of open water created would be a much simpler indicator. If a habitat management scheme is underway, survey may be assessing populations of key / indicator species. For management of ancient woodland habitat, typical indicator flora may be surveyed for to ensure the ancient woodland characteristic is maintained. Breeding bird assemblages and invertebrate populations may compliment this survey.

This stage of the methodology is not an end-point or a solve-all list of the perfect indicators for the given organisation or situation. The process to this point will have narrowed the choice of indicator and developed an organisations understanding of their interest with respect to biodiversity.

In-depth descriptions of indicator types, examples and references to important texts are provided in Chapter 2 (Section 2.9 in particular). There may be enough information within Chapter 2 for an organisation to simply select indicators that are provided as examples. It is anticipated that the information in Chapter 2 will enable a greater understanding of the biodiversity indicators that are available. It is recommended that when selecting biodiversity indicators for a company landholding an up to date review of the academic literature is undertaken. This field is expanding at a rapid pace and articles detailing the use of species and groups as indicators of wider biodiversity are being published regularly.

Although this stage only acts as a prompt for a company to select their biodiversity indicators, the preceding stages should make these choices more straightforward. The text included in the box of the flow-chart really only provides this prompt and a guide to the types of indicators that should be considered.

From the case study interviews and associated discussions, it became clear that most participants and organisations would like a system that directed them to exactly which biodiversity indicators to use for their situation. However, due to the complex nature of biodiversity, the huge variety of business operations and landholdings and potential changes over time of attitudes to biodiversity, legislation and unforeseen circumstances, it is would be unwise to propose a system that could select worthwhile biodiversity indicators for any given situation at any time.

This stage and the next are likely points in the process where an organisation may invite expert guidance from specialists in the field. External parties may also add value from their perspective 'looking in' to the organisation and landholding.

7.2.9 Suite of Indicators

This is where the input of expert biodiversity knowledge and experience is likely to influence the quality of the process. The two types of indicator, management/system and state, come together here to give an overall view of biodiversity for the site or whole organisation. A combination of carefully chosen 'state' biodiversity indicators, which cover all the key aspects of a site (such as all the habitat types / key species / key groups) will give a good picture of the actual quality of biodiversity on the landholding. If multiple sites are owned or included in this stage of the methodology (e.g. To give a picture of biodiversity for the whole organisation) then indicators can be combined. These state indicators compiled with the management/system indicator give an overall picture of the organisation's biodiversity component on landholdings AND an assessment of how well it is managing its impact on biodiversity.

Building a useful suite of indicators requires a degree of holistic ecological knowledge. This is sometimes referred to by ecological professionals as the 'understanding' of the environment. This knowledge and approach is required to build a suite of indicators that provides information on all of the ecological aspects of the landholding. For example, a company landholding may have an area of high ecological value woodland with important (BAP, locally scarce, Red List, Company Champion) breeding bird, invertebrate and flora

populations. The suite of indicators should include measures to cover all of these aspects. This may mean one indicator or multiple for each component, or fewer, multi-use indicators that give more overall pictures. The suite of indicators should gather all important information on biodiversity for a given situation, including that information which is useful to an organisation for reporting purposes. The suite should be comprised of indicators developed around both the biodiversity of the site, and the organisation. An example suite of indicators could consist of:

- Population of breeding birds;
- Extent of UK BAP Priority Habitats;
- Presence / extent of Japanese knotweed (an invasive species);
- Habitat connectivity; and,
- Biological water quality of aquatic habitats.

Chapter 2, Section 2.9, covers in detail the rationale behind using multiple indicators, in the form of a group or suite, to best provide a measure of biodiversity. Within Chapter 2 are references to publications that detail examples of where this has been successfully implemented, including the components of indicator suites. As with the previous stages of this process framework, it is anticipated that each site, situation and organisation will have different requirements and scenarios. Therefore, the information provided here and within the other chapters of this document will assist but not complete this stage of the process for most organisations. A useful example of a complementary suite of indicators is that described in the JNCC (2007) Biodiversity Indicators in Your Pocket publication. The list of indicators and the six focal areas they are grouped into is provided in Table 2.2. The suite covers a range of priority species and habitats, protected area extent, land in sustainable use (farmland, fisheries, forestry), habitat connectivity, funding, level of public engagement and threats such as pollution and invasive species.

This stage is a product of information from literature (Chapter 2) and the case study. As a stage in the biodiversity indicator selection methodology it is a product of all previous stages of the process that have been developed. It is a conclusion of the indicator selection part of the process. It is a point where reflection on previous stages can take place and these stages may be revisited and altered as felt necessary following this. There is no single clear reference to building a comprehensive suite of indicators in the results of the case study interviews (Chapter 6). This is to be expected as this stage of the process is as much an ‘answer’ to the wishes of the case study organisations as the process itself.

7.2.10 Monitoring & Reporting

Monitoring and subsequent reporting of successes and improvements is often a driver for organisations. A large number of organisations report all environmental aspects (waste, energy, emissions to air / water etc.) in annual reports and commonly each aspect has text describing the importance and the initiatives carried out over the year in question. In nearly every case this is supported by a graph showing change in that aspect over time. For example, waste management will display perhaps 5 years of the quantity of waste disposed of. Similarly for energy use, emissions of NOx to air, carbon emissions or waste recycled. Biodiversity is a different aspect altogether and does not lend itself to this graphical representation easily, however it is possible to display indicators or combinations of indicators developed through this methodology in such a way as to be a useful indicator for company reporting. Developing techniques to accurately report biodiversity alongside other environmental aspects was a major driver for the research project.

Several collaborating organisations stated that developing techniques to report biodiversity in a similar fashion to energy and waste is a major motivator in their assistance with the project. This point was provided during a number of the interviews of the multiple case study (Chapter 6). Some of the organisations raising this point had the desire to compare themselves against other organisations, competing to prove their superiority. For comparison with other companies however it is thought that due to individual approaches and inputs to the methodology it would be almost impossible to create meaningful results. The current standard for this type of comparison are systems such as the BiE annual questionnaire and report which ranks companies. If this system could incorporate more detail concerning indicators and monitoring then it has the potential to grow as organisations develop their biodiversity programmes. Additionally, the Wildlife Trust's Biodiversity Benchmark is an externally audited verification that a company is comprehensively addressing biodiversity. It does not, however, provide a score, meaning companies cannot compete beyond simply gaining the Benchmark. The process developed through this research will assist companies to gain and exceed the criteria of BiE annual questionnaires and the Biodiversity Benchmark. There is the possibility that if several organisations, or sites or departments within an organisation follow the methodology produced by this research they will have enough in common to allow for a degree of comparison.

Monitoring is important for the feedback aspect of this process. Only with good information can monitoring provide useful input to the process to allow for a dynamic and adaptive approach. For example, it may become apparent that the suite of indicators is not measuring every aspect of biodiversity to the desired amount and additional indicators or a change in

indicator is required. The most likely monitoring use of this process is to feed the information gained from the biodiversity indicator approach into the ongoing biodiversity management. Having comprehensive and accurate biodiversity information from this indicator approach will ensure that on-the-ground ecological management is having maximum positive impact. Importantly, the information will also draw attention to any management situation that is having a negative or neutral impact.

Several references were provided from the literature (Chapter 2) and the multiple case study (Chapter 6) that resources are often reduced, changed or at a constant minimal level for biodiversity work within an organisation. This process ensures that biodiversity and ecological management resources are optimised.

7.3 Chapter Summary

The methodology, illustrated in the flow-diagram (Figure 7.1), provides a pathway for organisations to follow in order to address biodiversity measurement on their landholdings. It provides a method for deriving necessary information, understanding individual situations and selecting appropriate biodiversity indicators. The determination of which specific biodiversity indicators and the combination of indicators is explained but no universal solutions are provided. Chapter 2, section 2.9, provides a list of suggested indicators and multiple examples of tested surrogate taxa indicators to support organisations in selecting appropriate biodiversity indicators for their requirements.

To many experienced and knowledgeable ecological professionals this methodology may appear to be a clear and simple description of the way they would deal with biodiversity measurement for a landholding. The importance of this research is the description and communication of this ecological knowledge, processes and techniques. As identified in the literature and during the multiple case study, a large number of environmental managers and business people responsible for land management have little prior understanding or experience of biodiversity management. By providing this pragmatic ecological knowledge, the methodology has great potential to engage more organisations with biodiversity. Additionally, this knowledge and understanding of ‘on the ground’ methods to tackle biodiversity measurement in a specific business landholding context is not well represented in academic literature, despite biodiversity measurement studies being abundant either a government / national level, or in academic, ecology research papers. Consequently this research contributes to the overall knowledge resource by providing an academic report of

operational/practitioner level biodiversity measurement techniques specifically reference business landholdings.

In order to ensure appropriate relevance to business and the practitioner level it was considered necessary to test and improve the methodology developed and detailed in this chapter. Therefore the following chapters detail a case study review and analysis of the methodology and the resulting improvements that were made to the flow diagram and process. This is followed in Chapter 10 by a testing of the methodology in a UK business scenario (Back Lane Quarry, Aggregate Industries UK).

CHAPTER 8 - CASE STUDIES OF THE METHODOLOGY FOR SELECTION OF BIODIVERSITY INDICATORS

8.1 Selecting Case Study Organisations

8.1.1 Introduction

For the case study, companies were required that could provide input into the discussion about possible improvements to the methodology. It required more of an interactive relationship than the multiple case study. Whereas the first round of interviews required answering questions in a discussion context to draw out maximum information, this case study aimed to evaluate the methodology and required positive and negative feedback from the participating companies. This requirement meant that the relationship between the author and the representative of the organisation should be as established and comfortable as possible. Improvements from this part of the research process are considered key to producing a methodology that is applicable to the real world. The improvements should not be limited due to politeness or an immature relationship between the interviewer and interviewee.

Organisations that had previously collaborated in the research were a good starting point to select for this stage of the project. From these organisations a smaller number would need to be selected. The lessons learnt from the initial interviews, particularly the time required to arrange interviews, influenced the decision to limit the number of companies to four at this stage. Which four organisations was the next question that had to be addressed.

It was decided that this stage of the research could have two main purposes. Primarily it should serve to guide improvements to the methodology and improve its relevance to real-world situations. That is, it should be able to be adapted to different businesses, whether they be different in size, business activity or their attitude to biodiversity. Furthermore, it should be able to cope with the fact that businesses change over time and in response to varying circumstances. With regard to biodiversity, business focus changes, finances available for biodiversity work change, staff change and different enthusiasms are seen. Given this potential for different application requirements it was always understood that any successful methodology should be flexible enough to be adapted for any given situation. However, it is the ease with which these adaptations are possible that dictate the success of new systems, and it was to enable this that further opinions from business participants in the research was necessary.

Assessment needed to be made of how easy the methodology was to understand, given a typical situation that may arise in the business world - that is, an advisor meeting with an environment manager or other person to present a biodiversity approach for an organisation within the time frame of a typical meeting, one to two hours. Improvements to the methodology and the means of explaining it were sought, and in particular, input was needed as to how the system 'fitted' alongside or within business systems. It was important to understand whether those people who would potentially be using this methodology to guide their biodiversity approach understood the logic of the process. During the discussions, suggested improvements would be asked for from the interviewees. These potential improvements would include the most likely ways in which they may adapt the methodology if they were to use it for their own biodiversity programmes. Input may also come from where they feel the limitations of the methodology are. Limitations could be the relevance of the approach to their particular situation. It may be the structure of the methodology and how it does not simulate existing processes in the organisation, making implementation and understanding by other staff more complicated. The process of drawing out positive and negative feedback on the methodology would serve to improve it for final presentation as an output of the research.

The secondary function of this stage of the research was also about producing the best possible outputs of the research. Examples of how the four case study organisations would adapt the biodiversity indicator selection methodology for their own situation are provided in Section 8.2. This information will help to guide businesses when approaching the methodology in the future, by providing examples of how others would modify the approach. This would hopefully mean more organisations will be likely to adopt the methodology in the future.

8.1.2 Selection Criteria

In order to maximise the usefulness of this phase of the research, it was decided that the four case study companies should represent a diversity of different business situations in order to provide different perspectives and input to improve the methodology. Different size organisations, different business sectors and different degrees of previous biodiversity work completed were considered important variances. The variety of the contributing parties should also help future organisations to understand the process and relate it to their own situation as described in Section 8.1.1.

Contacting the organisations to arrange this stage of the research would also act as a filter in the selection of the case study group (as described in Chapter 4 when selecting the first

group of collaborating organisations). As with attempts to arrange interviews in the first phase of the research, some contacts were unable to participate due to their workloads and the window of time in which these interviews had to be conducted. However, many were very keen to maintain their involvement and see the progress of the project since the last contact with the author.

8.1.3 Case Study Organisations

The companies decided upon for this evaluation / application of the methodology stage of the research were Allianz Cornhill, Center Parcs, Severn Trent Water and Warwickshire Wildlife Trust. All of these organisations had been involved in the research prior to this stage and good relationships were held with the contacts for each. More detailed descriptions of these organisations are provided in Chapter 6, Section 6.3.

8.2 Results of the Case Studies

8.2.1 Structure of the Interviews

Unlike the initial interviews, these discussions did not follow a series of predetermined questions. The structure of the methodology (Figure 7.1), was used to guide all of the interview discussions, with each stage being discussed.

The elements of each interview were:
How relevant is this to your particular situation?
What would you change if using this for your organisation?
Is this located correctly in the process overall?

These simple questions were not designed to provide a rigid structure to the interviews, they just illustrate the investigative component of the discussion. The interviews were also used to ascertain an impression of how well the methodology was understood when explained by the interviewer. Additionally, meetings were used to seek the opinions of the interviewees, as environmental professionals, on the layout, structure and logic behind the methodology.

8.2.2 Allianz Cornhill

At first, Allianz Cornhill had difficulty relating the methodology to the small size of their single ‘green’ landholding. The interviewee commented that the examples given to illustrate some of the stages gave an impression of being for multi-site, large landholding organisations. However, due to the advances that Allianz Cornhill had made since the initial interviews for the multiple case study, understanding of the process was comprehensive. The interviewee

appreciated the need for the process framework and was interested in investigating the individual stages of the flow diagram.

As an organisation that has made biodiversity efforts for over three years, Allianz Cornhill have some recognition of its importance. However, the interviewee voiced the opinion that there had been a lack of company vision and understanding of the relevance of biodiversity. It was felt that only from the biodiversity achievements of the previous years had the recognition its importance reached wider parts of the organisation. The interviewee said the time was needed to prove the relevance of biodiversity to the organisation, not only the importance, but also the opportunities it provides. Being a financial services company, with little direct biodiversity impact, the issue could be easily sidelined if no opportunities or benefits were demonstrated. However, the interviewee reported the success of their biodiversity programme had led to it gaining the backing of the finance directors.

This linked to the drivers and constraints stage of the methodology. The interviewee stated that the lack of company vision and understanding of the relevance of biodiversity was a serious constraint. With the progress made over the previous years this constraint has become less severe. This stage of the process was agreed by the interviewee to be a very important part of a company commencing a biodiversity programme. One stated driver for Allianz Cornhill was the enthusiasm, information and support provided by the local BAP co-ordinator. This support was an important influence in the writing of a biodiversity policy and targets for the company. This process fits within the ‘introduction of biodiversity objectives’ stage of the methodology. An important activity linked to this stage was joining local biodiversity partnerships, specifically the Surrey Urban Biodiversity Partnership. Information and support from this source helped guide the development of biodiversity objectives. Additionally, this partnership became another driver for the company biodiversity programme. This information from the interviewee supports the inclusion of this stage in the methodology.

At one point the flow-diagram representation of the methodology (Figure 7.1) forks into two routes, ‘state indicators’ and management/system indicators. This divide between the different types of indicators had to be explained to the interviewee, as the relevance of the management/system indicators was not entirely clear. It is essentially about KPIs, used similarly in management systems for other business areas. The interviewee was concerned that this type of indicator was not something the organisation needed. In part this concern was due to the examples given in the diagram, since they apply to larger organisations, or those with greater landholdings / multiple ‘green’ sites. As a result of needing to explain this

aspect of the methodology, both interviewee and interviewer gained better understanding of this stage and the confusion which came about. The interviewee realised that the management system for biodiversity, being developed at the time of the interview, possibly had some links to this side of the methodology and acknowledged the relevance of this to the organisation.

The ‘state’ indicator aspect of the methodology was more readily understood, largely because it was felt that this aspect of biodiversity is where practical information and guidance resources are lacking and businesses are struggling. The interviewee was expecting this part of the discussion as it is seen as the on-the-ground work - observing and measuring biodiversity. The representation of those as progress boxes in the flow diagram were easily understood and the relevance confirmed. However, the sequence was described as “a little confused”, because of the two simultaneous input arrows, a two-way arrow and the outlying drivers and constraints (see Figure 7.1). An observation was made by the interviewee about the words wording in the boxes of the flow-diagram and alternatives were suggested. For example, the stages of discussion about focus, whether habitat or species, site maintenance or improvement, could be described by a stage / box labelled ‘discussion’.

The following stage(s) leads into selecting the most appropriate type of indicators. The interviewee had expected a list of exactly which indicators to use for a given situation. Following discussion of complexity of different situations/locations/organisations, the interviewee conceded that being ‘spoon-fed’ indicators to use was not realistic. However, the author determined that further guidance within this part of the methodology was required.

The diverging sides of the process (State & Management Indicators) come together at the building a ‘suite of indicators’ stage. This was found to be clear to explain and understand, particularly following the earlier discussion of the ‘state’ indicator selection. The concept of choosing measures that complement one another, comprehensively covering all appropriate elements, was thought worthwhile and a clear convergence point for all the previous stages. Furthermore, following previous discussions regarding the complexity of providing exact indicators for a company to use, the idea that this stage may require external expert input was accepted and acknowledged as a good point for any external / consultant guidance.

The monitoring/reporting stage of the process (see Figure 7.1) was seen as a common-sense stage by the interviewee. This was partially because being able to better understand biodiversity on the company landholding and reporting the positive impact of company work was an initial driver in the process for Allianz Cornhill. Similarly, the feedback to the top,

thereby creating a process cycle, was considered essential. It provides a parallel to existing company processes and management systems, and ensures that the biodiversity work is ongoing. It also provided reassurance to the interviewee that biodiversity programmes could change with new circumstances and that not every aspect of biodiversity had to be addressed at once.

The major conclusions of the interviewee from Allianz Cornhill were the need for an increase in clarity and a further stage of guidance on the choice of specific indicators. A large proportion of the methodology was greeted with approval and agreement. Importantly, it was not suggested by the interviewee that any aspect of biodiversity indicator selection had been omitted from the process.

8.2.3 Center Parcs

Having an existing and very comprehensive biodiversity management system, Center Parcs had a vast resource of knowledge to assist with the refinement of the methodology. In contrast to the other three organisations used in this case study, Center Parcs were already monitoring a significant number of species and habitats. The interviewee had been involved in Center Parcs ecology/biodiversity management for over ten years. The current company strategy was supported by the interviewee and had recently come under his control.

The first stage of the methodology seemed an anomaly to the interviewee. As an ecological professional working in a devoted environmentally orientated organisation, recognising biodiversity as an important issue is taken for granted. It was agreed, upon discussion, that a company would have to recognise biodiversity as important in order to seriously follow the route of biodiversity management. This stage of the process was felt unnecessary from the viewpoint that if an organisation was looking for ways to select biodiversity indicators, the recognition of biodiversity as an important issue would be a necessary pre-requisite.

The study to formally identify drivers and constraints was firmly supported by the interviewee. It was felt that there is a tendency for ecology professionals to rush into the immediate selection of habitats, species and natural features as measurement and monitoring tools. This stage would force investigation of the business-wide drivers and constraints. In particular, a lack of human resources was identified as a constraint at Center Parcs, since the large number of ecological surveys prescribed for monitoring biodiversity required more skilled people than were often available. This has caused issues where staff are working extended hours to complete their workload, external consultants are contracted to complete surveys at greater financial cost or surveys are completed at inappropriate times

of year. Often the staff resource issue has meant that desirable continuity of surveyors performing year-on-year monitoring is broken. This can reduce the value of the survey data because of inconsistencies caused by surveyor differences (identification skills, interpretation of percentage cover etc.)

A major driver given as an example for Center Parcs was data collected by a marketing study that used visitor feedback information. This showed that visitors identified the natural environment setting of Center Parcs villages as the most important and most enjoyable part of their experience. These results have driven the biodiversity programme to ensure the quality of the natural environment is maintained or improved. By doing so Center Parcs can predict more visitors will be attracted to their villages and their loyalty retained. As a result, the financial resources available for biodiversity work have significantly increased, further driving what is possible within the biodiversity programme. An additional driver is the Red Squirrel (*Sciurus vulgaris*) Species Champion for the organisation. The Species Champion approach provides motivation and direction for a biodiversity programme and can lead to significant publicity and reputation benefits if successful. Whilst considered a driver by the interviewee, the dichotomy that a species champion can also constrain a biodiversity programme was discussed. If resources are limited and a large proportion are devoted to a single species champion, then other important species can potentially be neglected. There may also be conflict between the most appropriate ecological management for a champion species and what is most appropriate for the landholding/area/wider ecosystem. In order to balance the focus on high profile and photogenic species, such as the Red Squirrel, Center Parcs also undertakes rare species recovery programmes. Examples of these include a Song Thrush (*Turdus philomelos*) scheme at Sherwood Forest, and a rare moth project at Elveden.

Center Parcs had five year targets for biodiversity as its major component of the ‘Introduction of Biodiversity Objectives’ stage of the methodology. These targets are distributed to all directors, general managers, deputy general managers, services managers and senior conservation rangers to ensure they form a solid commitment and not just and piece of paperwork. Alongside these five year targets are specific and comprehensive biodiversity management plans for each Center Parcs forest complex.

The interviewee agreed with the division into two types of biodiversity indicator; state and management/system. The interviewee emphasised that his role was more inclined to work on the state type of indicators due to his practical ‘park ranger’ background and history at the organisation. The outputs of this would feed into management systems as indicators, for

example, progress towards targets for a species/habitat are described using the red, amber, green system. Red represents no progress towards a target, amber indicates progress towards a target achieved and green means target achieved. For a given Center Parcs village, the conservation team focus on delivering on-the-ground management to meet the targets set. The management system would use the information to assess biodiversity performance by having an indicator that was number/percentage of red, amber or green targets. An increase in performance could be shown by an increase in the percentage of targets that were green, or a reduction in the 'red' targets. The interviewee used this example during the discussion to highlight how the management and state indicators were different. However, further discussion prompted the recognition that this example also illustrates how the two types of indicator are actually linked. The separation of the two indicator routes was still considered preferable by the interviewee, even if just to divide a complex subject and make it more manageable.

When discussing the stages of the methodology concerning state indicators, the interviewee was supportive of the process, but still felt the best possible approach would be to 'measure everything'. This has been the Center Parcs approach for several years and, for them, has been successful in monitoring the biodiversity of their landholdings. The concept of selecting a strategy for a landholding, area or the whole organisation based on a habitat / species debate and a goal of creation / restoration / maintenance was considered good for determining where limited resources should be spent. The interviewee did not feel that Center Parcs should adjust their 'measure everything' strategy to a more targeted set of measures. The thinking behind this was that if everything is measured, the information for specific aims would be gathered anyway. There is also the reassurance that no important aspect will be missed due to selecting a group of measures that does not cover all elements of biodiversity for a given location. For example, if management practices produce negative impacts for a species or group, it will be recorded through a 'measure everything' approach. If the species or group was not considered part of the measurement programme as consequence of producing a streamlined strategy, it could possibly be irreversibly damaged by incorrect management practices. This argument linked to the next stage of the methodology process flow diagram – Suite of Indicators.

Building a suite of indicators is about considering all elements of biodiversity and ensuring that indicators cover these elements. Ideally there should also be some degree of complementary overlap of measures collected. A single indicator should not be relied upon as the only measure of one aspect of biodiversity. This concept was discussed and the interviewee suggested that this is why habitat based indicators are preferable to species and

species groups in many instances. By measuring a habitat type or feature (area of woodland, length of aquatic-terrestrial interface), inferences about conditions for several groups of species (birds, invertebrates etc.) can be made with overlap and reinforcement of results. The need to cover all important aspects of biodiversity, ideally with multiple measures, when building a suite of indicators was confirmed by the interviewee as vital if this approach was to be taken. A 'measure everything' strategy was still considered preferable by the interviewee however.

The monitoring and reporting stage and feedback loop were only briefly discussed during the interview. The interviewee felt that these were just common sense stages of a methodology concerning biodiversity measurement or any management system. Through these comments it was confirmed that they are necessary, albeit obvious to an ecological professional with many years experience.

Generally the interviewee supported the entire methodology, the use of a flow-diagram as representation of it and the logic behind the process. The major discussion point and area of variation from the Center Parcs' approach was concerning the methodology's principle of selecting a limited set of indicators versus the 'measure everything' approach. Whilst there is little criticism to be made of the 'measure everything' strategy from an ecological perspective, it was felt that the resources consumed by this approach could be reduced and the savings used for biodiversity enhancement projects. This is not a criticism of the Center Parcs approach, only an observation that the 'measure everything' strategy is not feasible for many companies due to the limited resources available.

8.2.4 Severn Trent Water

The Severn Trent Water interviewee had many years of ecological knowledge and experience and had recently (less than one year) taken over the role of from the interviewee who had collaborated in the earlier stage of this research (see Chapter 6). Despite this change of research contact a good working relationship had been established as a consequence of previous posts held by the researcher, where the interviewee was a long standing client contact.

The initial stage of the methodology was thought to be essential for Severn Trent Water - the interviewee explained that this recognition came from the historic management of the natural environment and the company history (as a regional water board before privatisation). The interviewee also commented that continued reinforcement of the importance of biodiversity was provided by the advancing status of protected species legislation, the rising profile of

BAPs and from continued pressure exerted by English Nature and the Environment Agency. These factors link to the assessment of drivers and constraints stage, especially the requirements of protected species legislation. Several examples of drivers and constraints were given by the interviewee, and from this enthusiastic response it was clear that this stage is regarded an important part of developing a biodiversity measurement approach. The large number of sites owned and managed by the company was given as a constraint and under investigation this was found to be linked to limited finances allocated to biodiversity. Prioritising sites is how Severn Trent Water addressed this constraint. Another constraint, as significant as financial restrictions, was the need for operational activities to come first (i.e. they take priority over aspects of biodiversity other than meeting legal requirements). The nature of the organisation's business is the treatment and supply of water to a large area of England and Wales, and this takes priority when making decisions about landholding management. Although easy to understand, this is a constraint on the management of landholdings for biodiversity.

Drivers behind Severn Trent Water's biodiversity approach included the previously mentioned history of the organisation and requirements tied into this history (as discussed in Chapter 6). More recent drivers, and ones that were in the interviewee's thoughts at the time of the interview, included the Severn Trent Group share index position and the linked Business in the Community Environmental Engagement annual questionnaire and ratings / ranking. This is as close to a financial measure of the biodiversity and environmental programme as Severn Trent can achieve, and provides motivation and evidence for gaining future funding from higher levels within the organisation. Another driver that was stressed as very important to the organisation is the reputational benefits of a successful biodiversity programme. As an organisation and industry that is closely regulated, building a good environmental reputation makes discussion and negotiations with planning authorities and regulators like the Environment Agency, run more smoothly. When negative incidents do occur, a water pollution incident for example, the positive relationship and good reputation of the organisation can help to reassure inspectors, planners and other officials. Similarly, a good reputation with planners can help development proposals be approved due to the relationship, trust, and reassurance that has been built up. Whilst this is true for most aspects of the environment (water, energy, waste etc.), biodiversity has the ability to raise the reputation of an organisation above competitors, because of its relative new profile and the complexities in addressing it effectively.

Biodiversity objectives at Severn Trent Water are contained within the company BAP. This document was being updated at the time of the interview and accordingly the interviewee

wished to discuss change in length. It transpired that the original, comprehensive and detailed BAP was in the process of being simplified for easier understanding and accessibility. Habitats and species actions will be grouped into broader habitat categories to reduce the total number of headings within the document, although it was emphasised that the detail of the original will not be lost. In addition to the original Severn Trent Water BAP objectives, there has been the addition of targets driven by the DEFRA Public Service Agreement (PSA) to improve SSSI status by 2010 (DEFRA, 2008). The organisation has multiple SSSIs either partially or completely within its landholding, and therefore may have provided an important contribution to the achievement of the PSA target of achieving 'favourable' or 'recovering' status for 95% of English SSSIs by 2010 (which post-2010 has been removed as policy has been updated)

A very similar view of the benefit of structured biodiversity objectives was given by this interviewee as was previously described by the former interviewee from Severn Trent Water during the first interviews (Chapter 6, Section 6.4). It was felt by both that the company BAP, or any formal structure of biodiversity objectives, was important for maintaining the focus of biodiversity improvement programmes, securing internal and external funding for enhancement schemes and as a achievement check list – providing motivation when goals are met.

The splitting of the flow diagram at this stage was understood by the interviewee and the rationale behind the split understood. However, it was suggested that the flow diagram structure could be significantly improved by following formal flow charting rules, symbols and practices. It was believed that this would improve the universal understanding and applicability of the process. The interviewee was very helpful in providing examples and this point was taken forward for subsequent development of the diagrammatic representation of the process. The separation of 'state' and 'management' indicators was a logical step for the interviewee, particularly as within Severn Trent Water they perform different functions and are the responsibility and undertaking of different people.

The management and system indicators are concerned with the functioning of system processes, along the lines of a quality assurance and monitoring process, to ensure progress is being made and to measure the progress. This is achieved through the selection of KPIs which have relevance to the biodiversity programme, but do not directly link to actual biodiversity per se. For example, Severn Trent Water monitor their ecological survey programme and set a KPI of how many sites have been surveyed. This provides information on the system and there is a link to biodiversity performance (i.e. ecological survey should

lead to better understanding, leading to better informed management / decisions / opportunities for improvement). However, this KPI provides no biodiversity information; nothing relating to habitats or species / flora or fauna. This latter information is provided by the other branch of the methodology, where the state of biodiversity within landholdings and providing guidance for selection of indicators is addressed.

The state indicators section was seen by the interviewee as the area in which most guidance was needed - a view shared by other interviewees. It was felt that for an organisation like Severn Trent Water with many different landholdings over such a wide area, it would be best to select biodiversity indicators on a site by site basis to take into account local and regional differences in landscape, species distribution, etc. The previously reported comments made by the interviewee regarding flow charting etiquette were repeated at this stage, as it was felt that the stages were a little confusing and would benefit from wording differently and structuring to the accepted standards. Despite this, the processes of state indicator selection were supported by the interviewee. In particular, the stages which involved debate of priorities and focus for a site (Creation / Restoration, Enhancement, Maintenance and Habitat vs. Species) were approved of. It was stated that these stages were highly significant, and relate closely to the drivers and constraints which would have been previously identified. Examples were given by the interviewee that related to the setting of priorities for site biodiversity work. In particular the biodiversity works to be undertaken at SSSI sites, where the focus should be clearly defined following the measurement criteria for the PSA, the SSSI notification and survey information and what may give most benefit back to Severn Trent Water (e.g. stabilisation of a protected species population versus expansion of BAP priority habitats.). The interviewee felt that these two stages, which required priorities to be defined before selecting the specific measures, were a critical part of the overall selection methodology. It was felt that they were aspects that a person with ecological knowledge should always consider and would not omit from a measurement programme. However, it was acknowledged, without prompting, that non-ecology professionals would benefit greatly from the guidance. This was welcomed by the author because it reflected on an issue that originally initiated the research project; that most environment managers in larger organisations have limited formal knowledge and training in ecology and biodiversity. The ‘prompt’ provided by these stages of the indicator selection process will also ensure that all practitioners follow the same procedure as opposed to relying on individuals to use their ecological knowledge in an unstructured manner. The following stage relates to the selection of state indicators.

The following stage of the biodiversity indicator selection methodology was of most interest to the interviewee. Similar to the previous interviewee from Severn Trent Water, the current contact was expecting this stage to provide a list of exactly which indicators to use for individual sites. However, with discussion, it was agreed that there is too much variation in all of the preceding stages of the selection process (drivers, constraints, organisations operations, location, site characteristics, habitat vs. species priorities etc.) to enable a definitive list to be provided. This step of the flowchart represents the action of choosing a list of indicators that are, or judged to be, most appropriate given the information gathered from the previous stages. The interviewee commented that this point in the process is likely to be where ecological knowledge or experience would be useful. In the case of Severn Trent Water, this is the stage at which the interviewee would be required to advise colleagues about the selection of indicators. In particular, it was noted that an understanding of what the measurement activities are involved for any given indicator influence whether it can be delivered within the constraints that are present. This practical knowledge may be limited for a non-ecology professional. This stage is also where a multi-site organisation such as Severn Trent Water would have to consider issues of consistency across sites, regions etc. The interviewee clearly understood the need for indicators to be selected based on local/site/regional/company criteria, but raised an un-anticipated concern that large organisations such as Severn Trent Water require some consistency in approach, and this applies even down to detailed measures like the assessment of biodiversity on individual landholdings. For this reason it may be that a number of more generic indicators would need to be chosen that were applicable across all of the Severn Trent Water landholdings, whilst still providing some useful data to the biodiversity assessment and monitoring process.

The convergence stage in the process sees the two biodiversity indicator paths coming together - to build a suite of indicators. Specific comments the interviewee made at this stage of the process were that the flow diagram could be annotated to explain that this is the point where company-wide indicators are combined together with all site based indicators and then assessed to see whether all target areas of interest are represented. This should then lead to company reporting and informing company policy alongside reporting back the status of sites and the ‘state’ of biodiversity on an organisations landholding. This was also believed to be where the most linkage to the Severn Trent Water wider environmental management systems, procedures and monitoring could be made. This linkage / integration / comparison to other environmental aspects would also constrain or inform the selection of biodiversity indicators in the future.

The final stage prior to feedback is the monitoring and reporting process and this was discussed thoroughly with the interviewee. Severn Trent Water recognise the public relations and reputational benefits that can be gained from promoting positive environmental achievements. Within the organisation, as communicated by both interviewees that participated in the research, there is a desire to perform better than their competitors and be ranked higher in published league table (such as those discussed in Chapter 2). This competitive nature has already been described in the multiple case study (Chapter 6). When discussing monitoring and reporting specific to Severn Trent Water, the interviewee made a clear distinction between internal monitoring, relating specifically to biodiversity/ecological management, and the internal and external reporting of biodiversity performance. Using their current system, Severn Trent Water are able to report on the performance of the biodiversity system. This is the elements relating to the management/system branch of indicators in the authors flowchart. Severn Trent Water has data on the number of sites that have been surveyed, the number of sites with biodiversity management plans and other similar EMS-style KPIs. These measures are considered by the interviewee to be particularly useful in communicating progress to high levels in the organisation and to external stakeholders. However, the interviewee referred most often to the organisation's Annual Environmental Report, produced by the Conservation, Access and Recreation Department.

Currently the biodiversity component of this Annual Report is highly qualitative. To a degree this relates to the qualitative nature of the majority of the company BAP targets, but it is also due to a lack of site-based quantitative ecological data. The interviewee described ideas to integrate the biodiversity indicator selection process and the quantitative indicators it may lead to, into this Annual Report. This would allow a greater quantitative reporting element in the biodiversity section and make it comparable to the other large topic areas, such as waste and energy. The actual methods of reaching this ultimate goal through the adaptation of the biodiversity indicator selection process proposed by the author, and the existing (and re-developed) Severn Trent Water BAP were not exhaustively investigated during the evaluation interviews because of time constraints. However, the interviewee saw potential in adapting the biodiversity selection framework alongside the BAP that was currently being reviewed, in order to develop a complete system of biodiversity targets and measurement (using indicators determined through this selection framework). This would enable the ultimate goal of biodiversity improvement and robust, quantitative reporting of success, to be delivered.

The feedback process was initially considered by the interviewee as logical and important, but not an area that needed discussion. It was felt that all organisations continually improved

their processes by learning from previous results. However, certain comments were made that are of value to other organisations. The interviewee said that the timescales required for the completion of the process described in the indicator selection flowchart, should be individual to the organisation. For Severn Trent Water it was discussed that the interviewee would try to tie the timescale into existing processes like the BAP review intervals, or the environmental reporting process. This would enable the reporting of the biodiversity indicator data to inform decisions about objectives and targets. In turn the reporting and review processes for company BAP and environmental reports may influence the selection of biodiversity indicators.

The final elements of the interview with Severn Trent Water involved a wider discussion about the role Geographic Information Systems (GIS) have in the measurement and recording of biodiversity indicator information. The interviewee raised the topic earlier in the evaluation interview process, mentioning how it may influence, possibly as a constraint, the information that was gathered and recorded. GIS is a powerful tool that the interviewee clearly was in favour of using for managing environmental information. In an organisation like Severn Trent Water, where GIS is used by many departments, it would provide a useful database for recording ecological survey information. It can then be accessed at any point in the future and quantitative information extracted for monitoring and reporting purposes. The example of this flexible use given by the interviewee, was that the input of an Extended Phase 1 Habitat Survey (JNCC, 1993) map could later be a source of measures such as area of priority habitat, length of species-rich hedgerow or perimeter of standing water, for any given site. Although not directly related to a specific section of the biodiversity indicator selection framework, these comments about the adaptation of the technique to different situations provide justification for the design of a flexible system.

8.2.5 Warwickshire Wildlife Trust

Warwickshire Wildlife Trust represent a dedicated wildlife and biodiversity organisation, a small to medium sized enterprise and a not for profit / charity organisation. The author had a longstanding relationship with Middlemarch Environmental Ltd, an ecological consultancy company wholly owned by Warwickshire Wildlife Trust and hence the interviewer had a developed relationship with the interviewee prior to the evaluation interview. This facilitated a comfortable exchange of information, ideas and criticisms when discussing the various stages of the biodiversity indicators selection framework.

Although the interview covered both Warwickshire Wildlife Trust and Middlemarch Environmental, distinctly separate comments and ideas emerged relating to the two

organisations, because of the differences in how activities and business procedures. The Wildlife Trust's long-term management of reserves is a defining difference between the organisations. In contrast to the Wildlife Trust, the consultancy nature of Middlemarch Environmental has a relatively short time scale influence over a great number of sites outside of its direct ownership or control. Due to position within the organisations, the interviewee had extensive knowledge and could provide an insight into both scenarios and how the biodiversity indicator selection framework may be adapted and used by either for their different requirements.

As was concluded by all interviewees during evaluation interviews, the first stage of the framework was thought to be obvious and a little unnecessary if the company was already considering following an approach for the selection of biodiversity indicators. However, the compilation of a brief written report at this stage was suggested by the interviewee, since this would enable an organisation to formally describe what aspects of biodiversity were considered as important, and would provide a lead into the next stage of the process. The following stage of identifying drivers and constraints could then be an expansion of the first document suggested by the interviewee. This stage was seen by the interviewee as an opportunity to add organisation specific and operational activity information in particular into the initial document detailing the importance of biodiversity.

For both Warwickshire Wildlife Trust and Middlemarch Environmental common drivers and constraints were highlighted during the interview. It was felt that this stage is one of the most important for any organisation as identifying the drivers and constraints will influence the complete biodiversity programme. Consequently, if they are not correctly identified and considered at each following stage, the effectiveness or relevance of the indicators selected may be reduced.

The splitting of management indicators from state indicators was seen as logical and important by the interviewee. Particular insight was available due to the timing of the interview. Middlemarch Environmental was developing systems to gain ISO14001 certification. Therefore the interviewee equated the management indicators as being the style of KPIs that would be appropriate for the ISO14001 certified EMS. It was also observed by the interviewee that this style of indicator is not as closely dependent on ecological knowledge and experience and that most EMS practitioners should be able to deduce a series of sensible measures to ensure biodiversity risks are identified and progress is being made.

The state indicators were the topic area that the interviewee felt was of most value to organisations that already had some ecological experience and knowledge. The guidance provided on what to consider when selecting indicators was welcomed, but the multiple arrows of the flow chart were confusing especially with regard to which order they should be considered in, or whether there was an order at all. The view was also expressed that the debate required to inform indicator selection did not necessarily have to lead to distinct choices of 'habitat' or 'species', 'creation' or 'maintenance'. Indicators should be able to be selected to represent a more holistic approach with some habitat focus together with champion species, for example.

The adaptation of the process for Warwickshire Wildlife Trust and Middlemarch Environmental would be different. The Wildlife Trust would consider the possibilities, drivers, constraints and strategies on a site by site basis, informed to a large degree by ecological survey information and available resources for future work. Middlemarch Environmental would be more concerned with establishing measures that could feed back information on all the positive biodiversity impacts it had achieved either over a period of time or by geographical region. For this reason it would probably have a large habitat focus with associated protected species information.

As mentioned previously in this section, the stage describing building a suite of indicators was discussed in-depth during the evaluation interviews. Of particular interest to the interviewee was how this would be linked to other stages of the indicator selection process and whether these links and considerations would be applicable to all organisations. It was suggested by the interviewee that building a suite of indicators should involve pre-defined components, or division of the suite into sections. These would cover, for example, positive impacts, negative impacts, habitat indicators, species indicators, etc. This approach is something that Warwickshire Wildlife Trust and Middlemarch Environmental might adopt, but it is unclear whether it would be suitable or necessary for all organisations. It was agreed by the interviewee that this stage in the biodiversity indicator selection process is important as a compilation point. All the gathered information from the biodiversity indicators can be compiled and assessed for any gaps in ecological completeness before the monitoring and reporting stage begins.

Monitoring and reporting for Warwickshire Wildlife Trust and Middlemarch Environmental would be mostly an internal process. It would be a measure of the organisation's performance - how great a positive influence it has had on the natural environment. It would also provide evidence for the EMS so that auditing could be simplified (through the use of

quantitative information on performance). The interviewee could also see potential in the future for the publication of the information on positive impact on biodiversity that the organisation has had. This may be for commercial purposes for Middlemarch Environmental or as information for members of the Wildlife Trust or to encourage new membership of the Wildlife Trust.

Feedback of information to the beginning of the selection process was seen by the interviewee as it was seen by other interviewees – as a necessary and important but obvious stage of the procedure.

8.3 Summary of Chapter

The information gained from the interviewees during this case study was used to inform changes to the biodiversity indicator selection methodology as intended following the initial development that is documented in Chapter 7. This stage in the research process provided an analysis and review of the initial biodiversity indicator selection methodology. The changes made following this review are detailed in Chapter 9 and the methodology is also explained stage by stage in Chapter 9 prior to being tested as a hypothesis as documented in Chapter 10.

CHAPTER 9 - DEVELOPMENT OF THE FINAL METHODOLOGY

9.1 Introduction

This chapter details the final development of the biodiversity indicator selection methodology following completion of the detailed case study interviews with Allianz Cornhill, Center Parcs, Severn Trent Water and Warwickshire Wildlife Trust. The original methodology was discussed during these interviews and this is documented in Chapter 8. The development of the original methodology was based on information from literature sources (Chapters 1 & 2), the results of the multiple case study (Chapter 6) and the author's amalgamation and understanding of this information. The original methodology is shown in Figure 7.1.

9.2 Revisions to the Methodology

A number of revisions were made to the methodology following the completion of the detailed case study interviews with Allianz Cornhill, Center Parcs, Severn Trent Water and Warwickshire Wildlife Trust. These revisions are detailed below and culminated in the production of a final biodiversity indicator selection process flow chart which is provided as Figure 9.2 at the end of this chapter. The revisions to the process are described in order of flowchart stages. Figure 9.1 provides the final flowchart with each stage labelled for ease of reference.

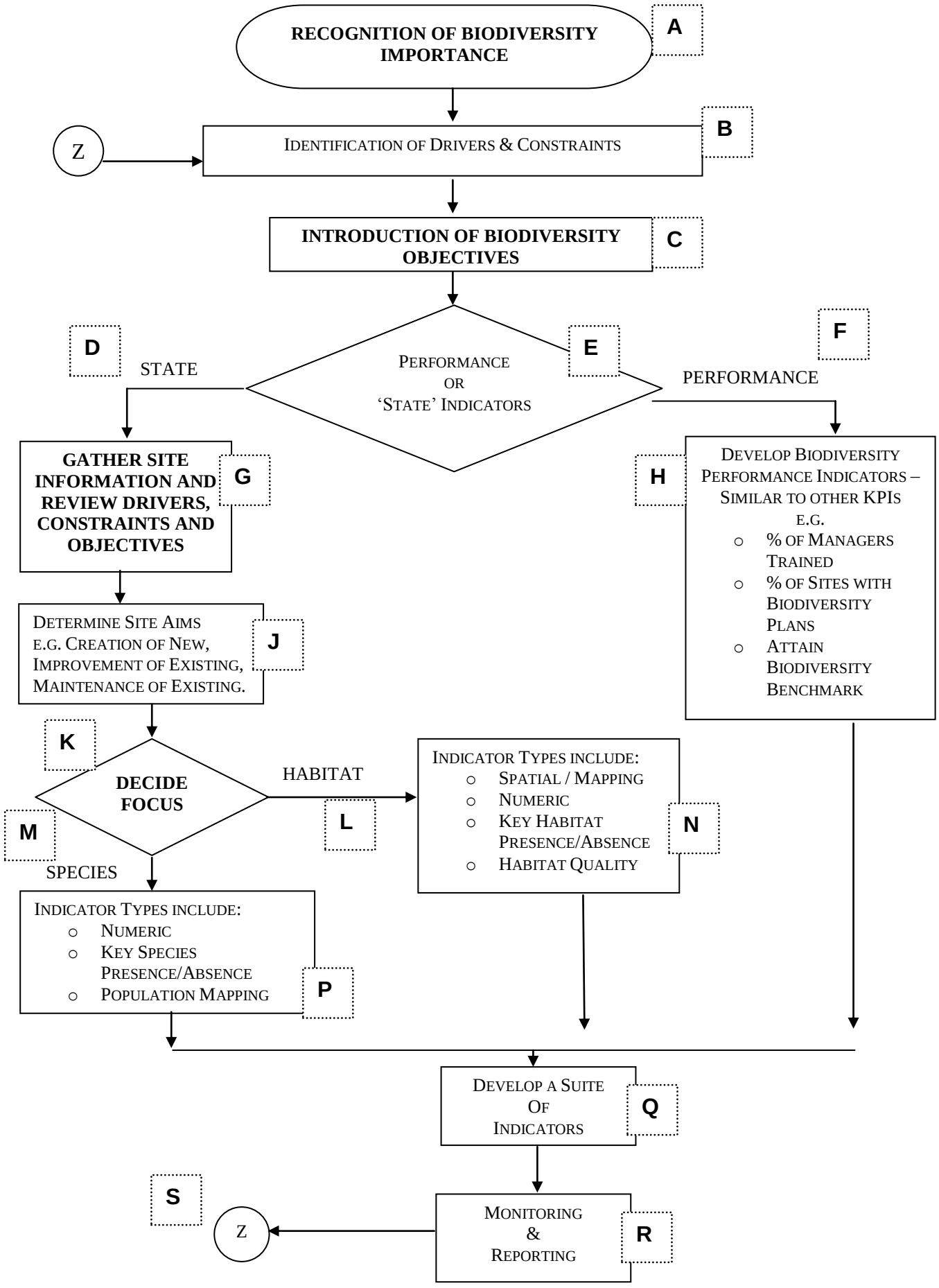

Figure 9.1 – Labelled Final Biodiversity Indicator Selection Methodology Flow Diagram

The first and most significant revision to the flowchart was the adoption of standard flowchart formatting following advice of interviewees from Severn Trent Water and Warwickshire Wildlife Trust (as detailed in Chapter 8). Specifically, this involves the use of only horizontal and vertical lines, the used of square and diamond shaped boxes to represent stages and decisions respectively and the removal of the continually inputted 'drivers' and 'constraints'. This change impacts the visual appearance of the flowchart significantly and applied to all stages A-S of Figure 9.1.

Despite this large change to the visual appearance of the flowchart, the principles and stages of the process remain unchanged. What the change in formatting does is bring about more clarity of understanding of the process for readers. By adopting standard formatting ambiguity is minimised when reading and implementing the process. A good example of this is the first decision 'diamond' in the flowchart. Marking this point as a decision helps explain to a reader that at this point a choice should be made about whether they wish to select indicators for performance measurement or to assess the state of biodiversity on a landholding (n.b. there is no restriction on the number of times a user can 'run through' the flowchart and choose performance or state indicators to cover all elements of an organisation).

The second distinct change made to the flowchart was the rewording of stages. This was prompted both by comments made by the interviewees from the four organisations and also the author's observations. In particular the author noted that lengthy explanations were required more so for particular text / stages in the original flow diagram than for others. Firstly, following the order of the flowchart (stages D, E & F), the division of state indicators from management / system indicators was revised. This change in text was carried out alongside a change in the formatting to a decision diamond graphic. Text was changed for flowchart stages E & F from 'Management / System Indicators' to 'Performance' indicators. The change was made because of the similarity of this style of indicator to other, more familiar, Key Performance Indicators (KPIs). The interviewees from all organisations participating in this research are used to the term and concept of KPIs and using complementary language to identify these biodiversity performance indicators aims to increase the speed of understanding of concepts within the selection methodology.

Secondly, the text of the other decision and related stages (K, L & M) was reworded for reasons very close to above, particularly increased clarity. It was also for the same main reason that this modification was made. This was the lengthy explanations of the thinking behind the stage and the information required in order to make the decisions that had to be

undertaken during the detailed interviews. The particular alteration to these flowchart stages was both the re-formatting, described above, and the re-wording. Wording was changed from ‘Habitat vs. Species’ to a decision box labelled ‘decide focus’ (stage K, Figure 9.1) and two output choices labelled ‘habitat’ and ‘species’ (stages L & M respectively). The decision box prompts the reader that a choice of focus is required at this stage. Summarised, habitat focus is the philosophy that creation, expansion and/or improvement of habitats will provide necessary foraging, commuting and breeding features for a range of species. Species focus is the concentration of conservation efforts on species, normally protected, endangered or high profile species. In the context of business landholdings, there may be a species which the organisation is a champion for. This is described in more detailed in Chapter 2, and involves the promotion of conservation efforts towards a particular species for increased recognition (whilst also benefitting that species in question). More detailed explanations of these styles of approach and thinking are provided in Chapter 2.

Rewording was also undertaken to stages J, H, N, P & Q as labelled in Figure 9.1. These stages were changed from simple listing of outputs or subject to a description of the process and thinking involved. For example, stage J was originally: ‘creation’, ‘restoration / enhancement’, ‘maintenance’. This became ‘determine site aims e.g. creation of new, improvement of existing, maintenance of existing’. The transformation from a list to a sentence is designed to improve understanding of the thinking and information that is required and what is needed before progression to the next stage. Similarly, stages H, N, P & Q are described by comprehensible text rather than a comment or list style labelling of the flowchart box.

It was apparent that the ‘state’ indicators path of the flow diagram was the area both of most interest and of confusion to the interviewees during the detailed case studies. For this reason the above rewording was undertaken to clarify the processes, the thinking behind them and the information required as part of these stages. In order to enhance this path of the flow diagram further, an additional stage was added, labelled as stage G in Figure 9.1. This extra stage is intended to ensure that the necessary information is gathered before proceeding into the stages that decide thinking, aims for site(s) and selection of indicator types. The addition of this extra stage was decided upon following comments from interviewees during the detailed case studies. All interviewees wanted to know what type of ecological survey was required before embarking on the process, or questioned how decisions about creation of new habitats or enhancement of existing and could be made without understanding current conditions. Whilst this stage does not prescribe a particular style or specification of preliminary ecological survey, it does require that site information is

collected and drivers and constraints of relevance to the organisation and its site are considered before proceeding further into the methodology.

As described in Chapter 8, the interview discussions and the suggestions for improvements and modifications made by the interviewees directed the changes to the methodology to be focused upon clarity, which was achieved through formatting and wording. This is noted as changes could have been made to the content, thinking and logic of the process if such comments were prevalent in interviews. It should also be noted at this point that although the major driver for changes to the methodology at this stage were the comments provided during case study interviews, the author's knowledge and understanding of the subject area influenced which changes were made and to what extent changes were made. For example, the interviewee from Severn Trent Water was looking for a system that prescribed exactly which measures (e.g. length of hedgerow, area of reedbed etc.) should be selected. In this case it was decided that taking a reader through a process that lead to a choice of different indicators and groups of indicators was more beneficial than a totally pre-decided set of routes. This approach was felt to be more flexible and as such applicable to more organisations and situations. The idea raised by the interviewee from Severn Trent Water was not dismissed without consideration but considered alongside knowledge and understanding gained from in-depth review of literature and the first case study interviews (as detailed in Chapter 6).

The final biodiversity indicator selection methodology produced is illustrated in Figure 9.2. This is considered to be a significant output of the research project and of significant importance and use for organisations that wish to measure biodiversity on landholdings. This methodology provides a structure for information gathering, decision making and the selection of biodiversity indicators to measure biodiversity and monitor and report changes.

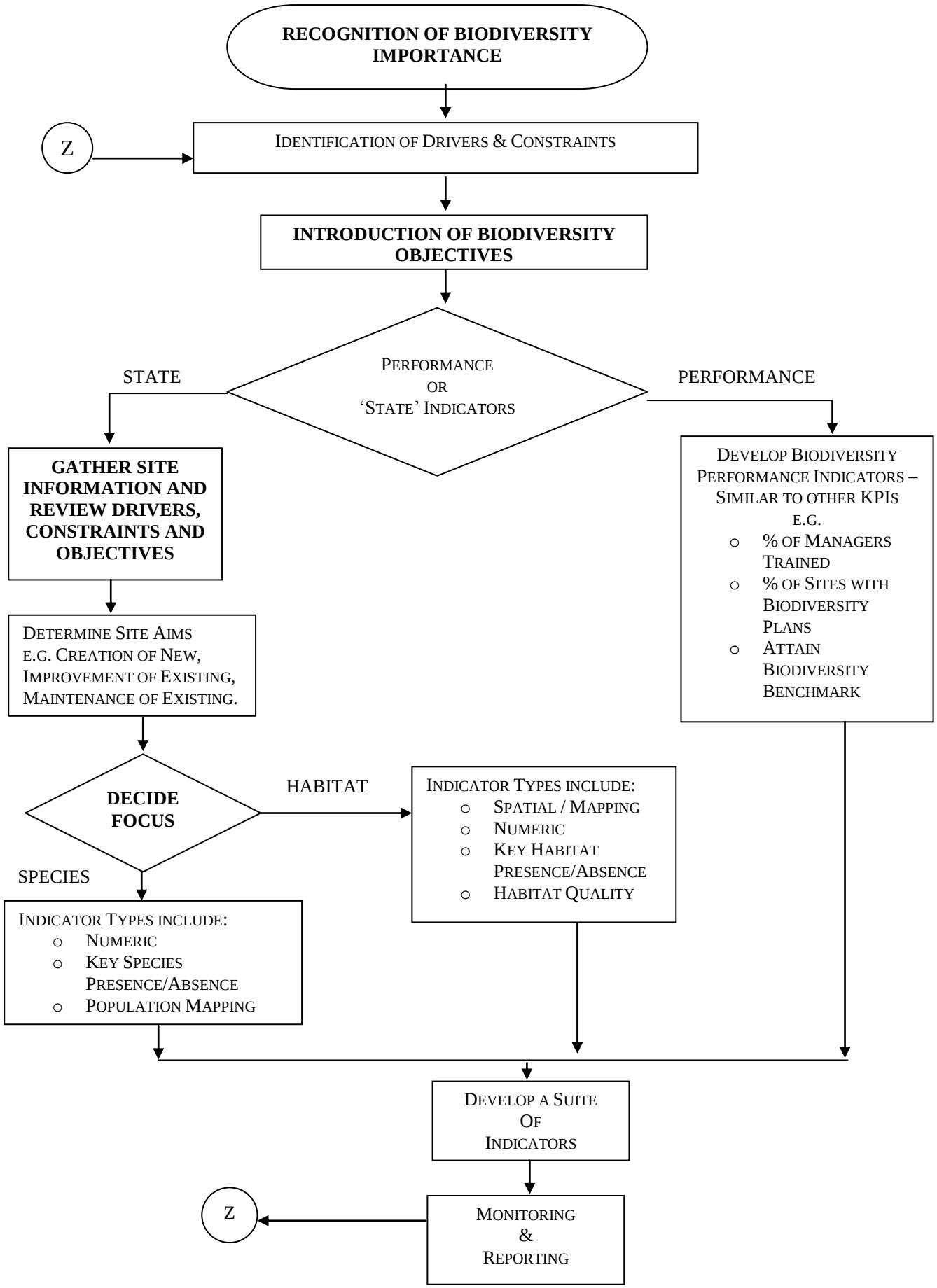

Figure 9.2 – The Final Biodiversity Indicator Selection Methodology

CHAPTER 10 – APPLICATION OF THE METHODOLOGY

10.1 Introduction

This chapter details the application of the biodiversity indicator selection methodology in a real-world setting. The methodology was adopted by Aggregate Industries for Back Lane Quarry in Lancashire. This testing was designed to determine the suitability of the methodology for use at the practitioner / operational level. The documented process of adoption and adaptation by an organisation will also assist any futures users of the methodology. The utilisation of the methodology for the selection of indicators was completed for practical application for implementation within one year of the process and was not undertaken as an academic task. The methodology was applied to Aggregate Industries Back Lane Quarry by the author with organisational requirements provided by the Aggregate Industries Estate Manager for the North of England. Regular meetings were held for information gathering, to explain the methodology and to discuss the choices made when working through the methodology.

10.2 Aggregate Industries & Back Lane Quarry, Lancashire

Aggregate Industries quarries, manufactures and supplies a wide range of heavy building materials to the construction industry (Aggregate Industries, 2010) and the Back Lane Quarry produces dry limestone aggregates. In addition there is a roadstone coating plant, concrete products factory (operating under a separate planning consent) and aggregate bagging operation on site. The latest planning permission for quarrying at this site was issued in 1988 by Lancashire County Council allowing unlimited extraction of limestone at the site until April 2048. Figure 10.1 shows the location of Aggregate Industries' Back Lane Quarry.

The Aggregate Industries representative that provided the information which guided the selection of biodiversity indicators was the Estate Manager for the North of England. His role includes the management of planning permissions for existing sites, assessment of potential new extraction locations and delivery of corporate strategy relating to outputs, health and safety, environment and corporate responsibility. Although covering the entire Aggregate Industries north of England region, the Estate Manager was based at Back Lane Quarry and therefore had extensive knowledge of the site. This location was also utilised on 4 occasions

for meetings to discuss the selection of biodiversity indicators. Through these on-site meetings the author was able to gain a first-hand understanding of operational and other constraints, such as health and safety requirements relating to safe access to quarry edges and waterbodies. Additional consultation was undertaken with the Biodiversity Restoration Advisor for the North Region of Aggregate Industries UK operations, the Lancashire Wildlife Trust's Senior Conservation Officer, Lancashire County Council Environment Directorate and Lancashire County Council Ecologist in the form of two site walkover meetings.

Figure 10.1 – Location of Back Lane Quarry, Lancashire, UK

10.3 What was the Nature of the Company's Landholdings?

Back Lane Quarry is located at National Grid Reference SD 511 693, approximately 8.5 km north of Lancaster. To the east of the quarry is the M6 motorway, Leapers Wood Quarry is to the north, the village of Nether Kellet to the south and agricultural landuses to the east. The total landholding covers an area of approximately 70 ha, extending approximately 1.3 km by 0.8 km. At the time of writing (2010) approximately 45 ha were actively being quarried. The remaining area consists of broadleaved woodland, calcareous grassland, semi-improved and improved grassland, hedgerows, ephemeral/ruderal vegetation, tall ruderal, scrub and waterbodies.

Using records and information provided by Lancashire County Council Environment Directorate a number of nature conservation sites with statutory and non-statutory protection within 2 km were identified. These are summarised in Table 10.1 below.

Site Name	Designation	Brief Description	Proximity
Helks Wood	BHS: county importance	Ancient semi-natural woodland with extensive limestone pavement	On site E
Kit Bill Wood	BHS: county importance	Ancient semi-natural woodland	On site NE
Long Riddings Wood	BHS: county importance	Ancient semi-natural woodland	On site S & NW
Hawthorns Rocks	BHS: county importance	Pasture on limestone outcrops.	On site S
Helks Wood Farm Pasture	BHS: county importance	Grassland habitat with diverse flora	100m E
Over Kellet & Nether Kellet limestone pavements	Limestone protection order: regional importance	Limestone pavement	200m E
Leaper's Wood, Bowman Stout Wood & Slack's Wood	BHS: county importance	Ancient semi-natural woodland with extensive limestone pavement	200m N
Lundsfield Quarry Central	BHS: county importance	Artificial habitat a mosaic of habitats and diverse flora	250m W
Long Dales Lane Fields	BHS: county importance	Grassland with limestone outcrops	300m S
South of Cock's Wood Limestone pavement & crags, Over Kellet	BHS: county importance	Exposed rock habitat with associated grassland and diverse flora	400m ENE
Kellet Road Verges	BHS: county importance	Grassland with diverse flora	500m N
Whorleys Moss	BHS: county importance	Woodland and scrub with diverse flora	500m SW
Cock's Wood	BHS: county importance	Semi-natural woodland with limestone outcrops	500m NE
Thwaite House Moss	SSSI: National Importance	Swamp & fen habitats with associated woodland and diverse flora	600m WSW
Dunald Mill Crags	BHS: county importance	Limestone grassland	750m S
Intack Wood	BHS: county importance	Small, wet, semi-natural wood with stream and numerous ponds. Species rich ground flora.	750m S
Key BHS = Biological Heritage Site			

Table 10.1 – Nature Conservation Sites within 2 km of Back Lane Quarry, Lancashire.

Site Name	Designation	Brief Description	Proximity
Dunald Mill Hole	BHS: county importance	Limestone cave system, neutral grassland, stream, trees and scrub with associated vegetation.	770m S
Swantley, Nether Kellet	BHS; county importance	Limestone cliff with ancient semi-natural limestone grassland, supporting plants listed on the provisional Lancashire Red Data List (RDL)	770m S
Lundsfield Quarry North	BHS: county importance	Artificial habitat a mosaic of habitats and diverse flora	750m WNW
Lundsfield Quarry South	BHS: county importance	Artificial habitat a mosaic of habitats and diverse flora	800m SW
Over Kellet Pond	BHS: county importance	Wetland habitat with diverse flora & fauna, supports a Lancashire RDL species and great crested newts	1 km NE
Over Kellet Crags	BHS: county importance	Exposed rock habitat with associated grassland and diverse flora including a provisional Lancashire RDL plant species	1 km NE
Lancaster Canal	BHS: county importance	Artificial habitat with a range of associated flora, including kingfisher, several provisional Lancashire RDL plants and good Odonata assemblage	1 km NW at nearest point
Twaite End Pasture	BHS: county importance	Semi-natural grassland with diverse flora	1.2km W
Carnforth Steamtown	BHS: county importance	Semi-natural calcareous and neutral grassland including a provisional Lancashire RDL species	1.4km NE
Carnforth Ironworks	BHS: county importance	Slag heaps and species-rich grassland with invertebrate value, supports a Nationally Rare bee	1.6km NNW
Crag Bank	SSSI: National Importance	Varied flora including species rich fen, marsh and calcareous grassland	1.6km E
Hawkshead Woodlands	BHS: county importance	Woodland and scrub habitat	1.8km SW
Crawstone Wood	BHS: county importance	Semi-natural woodland	2km WSW
Key BHS = Biological Heritage Site			

Table 10.1 (cont.) – Nature Conservation Sites within 2 km of Back Lane Quarry, Lancashire.

The data acquired also included protected species records for a 2km area around the quarry. These include records of four Nationally Scarce plant species within 2km of the quarry - seaside centaury *Centaurium littorale*, variegated horsetail *Equisetum variegatum*, fen pondweed *Potamogeton coloratus* and blue moor grass *Sesleria caerulea*. The record for blue moor grass comes from within the survey area at Hawthorn Rocks BHS. All four of these species are listed as Scarce on the Provisional Lancashire Red Data List (RDL). Additional species on the provisional Lancashire RDL recorded in the surrounding area include marsh helleborine *Epipactis palustris* (Vulnerable) and bee orchid *Ophrys apifera* (Sensitive). Bluebell *Hyacinthoides non-scripta*, also recorded in the surrounding area, is listed on Schedule 8 of the Wildlife and Countryside Act 1981, but is only partially protected in respect of restrictions on its sale. In addition, there is an old record of bird's nest orchid *Neottia nidus-avis* (listed as Near Threatened on the JNCC Red Data List) from the 1970's from Kit Bill Wood.

In addition, there are records of European protected great crested newts *Triturus cristatus* from the area surrounding the quarry and older records of Red Squirrel *Sciurus vulgaris* (from 1970) (protected under the 1981 Wildlife and Countryside Act). Both species are priority national Biodiversity Action Plan (BAP species). Pipistrelle *Pipistrellus pipistrellus*, long-eared *Plecotus* sp., Noctule *Nyctalus noctula* and Natterer's *Myotis natteri* bats have also been recorded in the search area; all are European protected and local BAP species. Brown hare *Lepus europaeus* has also been recorded, a national and local BAP species. Badgers *Meles meles*, protected under the 1992 Protection of Badgers Act, have also been recorded within the search area.

A large volume of bird records were also received, including barn owl *Tyto alba*, listed on Schedule 1 of the 1981 Wildlife and Countryside Act, as well as several species of conservation concern, three of which are also national BAP species – bullfinch *Pyrrhula pyrrhula*, reed bunting *Emberiza schoeniclus* and song thrush *Turdus philomelos*. (The latter two are also local BAP species). Kingfisher *Alcedo atthis*, a further Schedule 1 species, has been recorded at Lancaster Canal BHS.

The nationally rare wall mason bee *Osmia parietina* has been recorded at Carnforth Ironworks.

Previous survey work (SLR, 2006) undertaken at the quarry found evidence of badgers in woodland surrounding the quarry. Survey work also located a number of adder's tongue ferns *Ophioglossum vulgatum* in the western part of the landholding. A cave feature in the

back quarry face was identified as having the potential to support roosting bats and was surveyed by SLR in September 2003. It was considered unlikley to support hibernating bats, being washed with rain water, but fissures within the cave and elsewhere in the rock face could offer summer roosting opportunities for bats.

In order to gather information on habitats and species an Extended Phase 1 Habitat Survey was undertaken by Middlemarch Environmental Ltd in 2007 (Middlemarch Environmental, 2007). This survey was commissioned by Aggregate Industries as it is a standard practice approach when a company landholding is required to enter into the planning system. This survey identified the following habitats within the study area:

- Broadleaved Woodland;
- Calcareous Grassland;
- Semi-improved Grassland;
- Improved Grassland;
- Hedgerows;
- Scrub;
- Ephemeral / Ruderal Vegetation;
- Tall Ruderal Vegetation; and,
- Standing Water.

These habitats and the operational quarry are mapped on Figure 10.2.

This information about the company, the site operations and existing ecological information from the local biological records centre and the survey work undertaken by consultants was used in the various stages of the biodiversity indicator selection methodology. The use of this information in the working-through, adoption and adaptation of the methodology is detailed in the following sections.

Figure 10.2 – Phase 1 Habitat Map for Back Lane Quarry

10.4 What Drivers and Constraints were Considered?

During initial discussions with the Estate Manager, the first stages (A-C on Figure 9.1) of the biodiversity indicator selection methodology were covered and the factors specific to this site and project were identified.

In respect to the first stage of the biodiversity indicator selection methodology, Aggregate Industries has a corporate commitment to biodiversity and has won awards for various site restoration programmes after completion of aggregate extraction. An example of this is for Little Paxton Quarry which has been progressively restored and now includes 325 acres of SSSI designated Nature Reserve. The Little Paxton Quarry has been recognised in the BTO/Hanson Challenge, winning awards in 2002 and 2004 and also the Quarry Products Association in 2004. The company was also the first in the construction sector to develop a company-wide Biodiversity Action Plan (BAP), first published in 2002 and covering a period of 5 years (www.aggregate.com). Specific to Back Lane Quarry and the Estate Manager responsible for this project, recognition of the importance of biodiversity has been reinforced through the setting of Planning Conditions by Lancashire County Council for continued extraction – demonstrating to those concerned at Aggregate Industries the importance of biodiversity within the planning system, and the importance of biodiversity to the continuation of business activities at Back Lane Quarry.

Planning condition 9 requires details to be submitted on the stripping of grassland habitats and its use in the restoration of other areas of the quarry. Planning condition 36 requires details of thinning works to be undertaken to improve ecological diversity of woodland and remove inappropriate species. Planning condition 40 requires a method statement for the management and mitigation of protected species and breeding birds.

The identification of drivers and constraints for the selection of biodiversity indicators for Back Lane Quarry was a significant component of the initial discussions. These discussions were undertaken through email correspondence and included the provision of an initial project brief by Aggregate Industries relating to the discharge of planning conditions and the company's future plans to achieve the Wildlife Trust's Biodiversity Benchmark. Other forms of communication included a number of telephone discussions and a face to face meeting at Back Lane Quarry offices. During these communications the drivers and constraints were established.

Constraints on biodiversity indicator selection:

- Financial constraints – Company allocated £2000 to establish monitoring programme with a maximum £1000 average annual spend on monitoring work.

Preference would be given to indicators which could be measured by local wildlife trust employees and volunteers or by consultants at a small cost. This limited the number of multi-visit/multi day surveys and those requiring outside resources, such as laboratory identification or extensive GIS/IT support/Aerial Photography etc.

- Operational constraints including health and safety requirements; access is restricted at quarry edges and in the operational part of quarry.
- Public access constraints - Public footpaths in woodland east of active quarry require trees to be assessed and managed for safety due to this public access.
- Planning constraints – The indicators should provide information to supplement the requirements of a number of planning permission conditions. This pushed the focus of the indicator selection towards woodland because of the requirement for a woodland management regime as a planning condition. Habitats such as the calcareous grassland and limestone pavement have to be translocated as part of the planning permission and this meant that these habitats gained a raised status.
- Other constraints - Factors influencing the indicators selected were the input from the local authority ecology team and community feedback regarding the future management of the site. The site has public access, neighbours and recreational users and Aggregate Industries have a community engagement/satisfaction policy which pays specific attention to the requests of local communities.

Drivers for the selection of biodiversity indicators:

- Planning Drivers - to meet planning requirements for management of non-operational land.
- Company objectives – Aggregate Industries wanted to make the management of non-operational land at Back Lane Quarry as a flagship example for the company and to work towards achieving the Wildlife Trust's Biodiversity Benchmark and produce a system beyond simple compliance.

The biodiversity objectives for this scenario link very closely to the drivers and constraints detailed above. They were identified as: the meeting of planning conditions and internal requirement for community satisfaction to ensure the continued extraction at Back Lane Quarry; and, the beyond compliance management of non-operational land to raise Back Lane Quarry to flagship status within Aggregate Industries and assist with the application for award of The Wildlife Trust's Biodiversity Benchmark.

The determination of how biodiversity was recognised as important by Aggregate Industries (A), the identification of drivers and constraints (B) and the introduction of biodiversity objectives (C) for the project also gave a strong steer to the decision to follow

a performance and / or ‘state’ indicator path (D-F) when implementing the methodology. The focus on a single site as a unique entity (to be raised above as a flagship site for biodiversity) within Aggregate Industries portfolio of sites meant that performance indicators (F) were not required to be selected at this time. Aggregate Industries representatives in informal discussion explained that the measurement of biodiversity performance was something undertaken at a corporate level and the selection of indicators for this purpose was not within the scope of this study. This ruled-out (H) within the biodiversity indicator selection methodology flow diagram (Figure 9.1).

10.5 The Pool of Available Indicators

The pool of available biodiversity indicators for Back Lane Quarry was determined by the preceding stages in the methodology (A-F, Figure 9.1) and incorporated background company, ecological and operational information and other drivers and constraints (as provided in sections 10.2 to 10.4). This information was reviewed as per the stage (G) in the methodology flow diagram (Figure 9.1).

The determination of the site aims that forms stage J in the methodology flow diagram (Figure 9.1) was influenced by the planning condition for the quarry which requires improvement of the ecological diversity of the woodland. Other factors bearing on this stage was the company’s biodiversity policy which holds a message of protecting biodiversity or enhancing where possible. These influences led to site aims of biodiversity protection with enhancement specifically in woodland areas and also for any other areas where it is possible (within the constraints). This influenced the types of indicators to be selected by preparing for stage K where indicator focus and approach was decided upon, particularly the balance of habitat versus species indicators and the balance in ethos between the two.

The financial restriction to the project and future monitoring limited indicators to those which could be delivered by the Aggregate Industries landscape division and Lancashire Wildlife Trust staff. This was particularly limiting to specialist surveys requiring lengthy investigative processes, laboratory and other external expenditure. The general pool of indicators from which the selections were made for Back Lane Quarry was drawn from current knowledge on tested biodiversity indicators and indicator theory, which is provided in Chapter 2.

Higher taxa measures as surrogates for overall biodiversity were considered a feasible approach in relation to the financial constraints and the available surveyor skill levels. These higher taxa measures include surveys of vascular plants, birds, mammals,

butterflies and other historically well-sampled groups. Measures of invertebrate groups (other than butterflies), lower plants and other organisms were ruled out because of the specialist knowledge, and the time required to conduct the surveys and the consequent high cost.

In addition to the preference towards higher taxa groups it was considered that habitat measures concerning the structure of habitats, the presence / absence / abundance of specified features and other physical environmental variables would be valuable in terms of the information provided for the financial cost to Aggregate Industries. Examples of these features include forest structure, ground flora and quantity of deadwood in forest stands as described by Ferris & Humphrey (1999) and Humphrey et al. (1999).

For stage K, it was decided that grassland and woodland habitats should form the basis for habitat indicators (M) of biodiversity because the planning conditions required specific ecological works in these habitats that incorporate monitoring. Consequently ecological monitoring would be taking place in these habitats and selection of habitat indicators based on other habitats would require additional resources that were not available. However, most significantly, these habitats are the subject of planning conditions because they are the most significant habitats from an ecological value and biodiversity perspective. Therefore logic suggests that they should form the basis for habitat focused biodiversity indicators because they will almost certainly contain the greatest diversity of species. Also subject to planning conditions were protected species and breeding birds. It was decided that breeding birds would be selected as a species based indicator (L) for the potential simultaneous benefit of potentially recorded charismatic species that Aggregate Industries likes to publicise as benefitting from quarrying activities (e.g. Peregrine). Another species indicator selected was to be vascular plant based, as it was determined that the assessment of habitats would be likely to include the recording of plant assemblages and efficiency would be maximised.

Once the combination of some habitat and some species indicators had been decided upon, and which habitats and species were to be the basis of these indicators, there was a process of combining previous information and inputs, particularly drivers and constraints to determine what the indicators would actually be – what measures would be taken / how records would be compiled (Stages N & P). The organisation had a desire to produce as many numeric outputs as possible to align biodiversity assessment with other environmental and performance measures. This was felt to be an approach that would assist with communication and easy biodiversity ‘state’ / progress monitoring by many audiences over time. The numeric element will be met by counts for the species indicators

(P), correlation coefficients produced through statistical analysis of NVC habitat assessments and measures of woodland physical components including dead wood abundance and stand structure that will require a scoring system to be developed. Habitat quality assessments and general recording will produce qualitative indicator outputs and mapping (N).

10.6 The Final Suite of Indicators Selected and Delivery of the Indicators

Final discussions and decisions were made on which indicators to select, bearing in mind ideas of complementarity, covering the widest range of biodiversity and insuring against impacts of external influence as much as possible. For example, environmental effects on a single species group may not be felt to as great an effect on another species group or represented so highly when monitoring habitats. This formed Stage Q of the methodology as represent in the flow diagram (Figure 9.1).

Monitoring of the habitats referenced to in the planning conditions was proposed as agreed during early consultation with Aggregate Industries and the setting of this as an objective (C) for the study. Using standard survey methods known and understood by most ecologists was felt to be a suitable approach to minimise survey costs and ensure consistency if different surveyors were used year to year due to the preference for volunteers for this task. Consequently for woodland habitats the National Vegetation Classification (NVC) survey was specified to record species and communities. Also recorded were physical environmental measures, including quantity of deadwood and descriptions of stand structure and age estimates. For calcareous grassland habitats, the NVC survey approach was also adopted, to record vascular plant species and abundance. Physical environmental measures in this habitat type were limited to measures of grazing impact and physical damage (such as may be caused by unauthorised access). In both habitats, permanent quadrats would be established using GPS co-ordinates, painted marks in-situ and photographic records. Both woodland and calcareous grassland surveying monitored the effect of management and translocation activities associated with the planning conditions. The NVC surveys also provide vascular plant inventories for use as a surrogate taxa biodiversity indicator (as supported by literature including Sauberer et al., 2004).

Breeding bird surveys were selected as the fauna measure (surrogate taxa) to provide an indicator of overall biodiversity. Breeding birds were also shown to be suitable surrogate taxa for overall biodiversity in research completed by Roberge & Angelstam (2006). The identification of bird species and populations using Back Lane Quarry partially fulfils the planning condition requirement for the preservation of protected species. Additionally a

variety of charismatic bird species including peregrine and wading bird species such as little ringed plover and oystercatcher are closely associated with quarries. The presence of such species within a quarry environment provides a good public relations opportunity for good news stories about the protection of biodiversity and some of the benefits quarries provide for notable species.

The use of these indicators falls within the limitations dictated by the constraints, particularly with respect to budget and restricting survey skills and requirements to those available within a local wildlife trust or general ecological consultancy company. They are also not techniques requiring expensive equipment or highly time consuming survey methods. It was also decided through discussions at several meetings that Aggregate Industries require that the indicators provide the maximum amount of information possible for the survey effort and financial outlay. The data gathered would inform both the habitat management plans and the monitoring of the translocated calcareous grassland habitat, both of which are prescribed in the planning conditions.

More specific to the measurement of overall biodiversity within the landholding, habitat monitoring using NVC survey provides vascular plant inventories and relative abundances which is a surrogate measure for overall biodiversity. Similarly, breeding bird assemblages are used for the same purposes, but are fauna based. The two types of surrogate taxa approach will also be employed as a combined measure of overall biodiversity, since they can be balanced against one another to reduce the influence of external environmental factors which may affect breeding birds or vascular plant success in a given single year.

The breeding bird survey indicators also provide an opportunity to record species which are often used as flagship species for promotional purposes and successful community engagement. Species such as the Peregrine *Falco peregrinus* provide a useful tool for engaging the local community and promoting the wider biodiversity efforts of an organisation such as Aggregate Industries. Quarry sites are known for the wide expanses of bare ground and ephemeral waterbodies which provide habitat for wading birds and other bird species that require similar habitats that have declined in abundance in previous decades.

The final indicators selected for Back Lane Quarry were therefore:

- Breeding Birds: Quantitative records of species count and counts of breeding pairs. Qualitative and mapping records of territories and areas / habitats used within the Back Lane Quarry landholding.

- Vascular plants: Woodland and calcareous grassland habitats. Quantitative records of total species numbers. Mapping and qualitative records of species location and abundance.
- Woodland habitat quality: Quantitative records of NVC community and correlation coefficients / closeness of fit to 'ideal' NVC communities. Quantitative, qualitative and mapping records of stand structure (percentages ground flora, under/mid/upper storey vegetation, density of stand and quantity of deadwood).
- Calcareous grassland habitat quality: Quantitative records of NVC community and correlation coefficients / closeness of fit to 'ideal' NVC communities. Quantitative, qualitative and mapping records of micro habitats and features (heavy rabbit grazing, notable species locations, scrub encroachment / succession).

10.7 The Planned Monitoring Actions

Forming Stage R of the methodology (Figure 9.1), permanent quadrats will be established during the first year and baseline data gathered for monitoring the woodland and calcareous grassland habitats that are to be managed and/or translocated as part of the extraction permitted under the planning permission and associated planning conditions. The NVC surveys and additional physical environmental indicators will be conducted on an annual basis.

Breeding bird surveys will also be conducted annually. The areas of the quarry with specific bird interest may be visited more frequently during the annual survey season but this will be informed by the data gathered during years 1-3. This decision is driven by the importance placed by Aggregate Industries on potentially discovering charismatic species to champion at the site. In order to avoid narrowing the focus of these monitoring surveys, every 5 years the scope of the breeding bird survey will widen to cover the entire quarry landholding with consistent effort.

The information provided by these surveys will indicate the state of biodiversity within the Back Lane Quarry landholding. Following the surrogate taxa approach, the inventories of vascular plants and breeding birds, collected over time, will show changes in the state of biodiversity. Number of species and number of individuals or breeding pairs of each species is a reportable, quantitative output of this indicator survey.

The physical environmental data gathered from woodland and grassland habitat (stand structure, dead wood abundance etc.) will indicate the ecological value and qualities of

these habitats to support biodiversity. These will be reportable as quantitative outputs to assist with interpretation by non-technical audiences.

NVC survey data will be analysed using MAVIS (Centre for Ecology and Hydrology (CEH), 2000) software or equivalent packages to determine correlation coefficients between the surveyed habitat and the 'ideal' communities described by Rodwell in the British Plant Communities volumes (Ed., 1991). This software package also provides other quantitative outputs from the vegetation assemblage data entered that includes Ellenberg (1988) indicator values for wetness, light levels, fertility and pH and Grime's (1979) CSR characteristics (Competitors, Stress-tolerators and Ruderals).

These quantitative outputs will be used for reporting and communication purposes, especially where the metrics will sit alongside other environmental figures (tonnes of waste, kilograms of CO_2, litres of water etc.).

When evaluating the impact of habitat management and the operational activity of the site, the indicator data will be used in its fullest package as both quantitative outputs and qualitative records provided by the surveyors and ecologists who will build an understanding of the site. Examples of this additional information would be the locations of territories of breeding birds and the locations of any notable vascular plants and what environmental or micro-habitat features there are associated with. This finer detail will ensure management activities are applied to locations where they will provide most benefit and no harm. For example the felling of non-native or undesirable trees species to open the woodland canopy may be desired to increase the quality of habitat as reported by the NVC coefficient scores. With the extra information on vascular plant location and preferences observed, this felling can be located away from areas where shade-loving notable vascular plant and micro-habitats are located.

10.8 Fitting this process with Aggregate Industries' Existing Systems

Aggregate Industries have company-wide policies and approaches for different environmental processes, but do not implement a strict top-down system applicable to all sites and locations. There are corporate plans and policies for environmental concerns, including biodiversity. The biodiversity plan contains the vision, aim and objectives for the entire organisation with respect to biodiversity and each site must be aware of and pay heed to what the organisation is trying to achieve as a whole. However, each individual region and site can follow a management system or gain awards (such as the Wildlife Trust's Biodiversity Benchmark) independently of other sites. This is influenced by the individual nature of planning consents and the conditions, requirements and agreements

within them. Therefore the implementation of the biodiversity indicator selection methodology for the Back Lane Quarry site did not have to fit into company-wide processes or systems. In this regard there were no explicit decisions made or discussions held to fit the indicators, reporting outputs or other factors into larger environment or other business systems. However, through the discussions, communications and decisions that informed the implementation of the methodology, there was an Aggregate Industries approach injected into the project that would be a different influence had it been undertaken with a different organisation. This is evident the finances allocated to biodiversity for the site in questions and the strong links with local Wildlife Trusts and how this influenced the decision making process, steering the selection of biodiversity indicators.

In contrast, with a view back to the collaborating organisations that participated in the first multiple case study of this research project, a company such as Center Parcs may have allocated greater financial resources and supported the use of specialist ecological surveyors to conduct assessments with increased financial costs due to their company ethos and their history of addressing biodiversity and ecological survey in this manner.

10.9 Evaluation of this Application of the Methodology

This case study was undertaken to test the applicability of the methodology at the practitioner level for which it was designed, within a real world situation. In scientific experimentation terms this could be described as the testing of a hypothesis but also shares some likeness to an engineering process testing a prototype for functionality after being built form research and theories.

With similarities to previous stages of this research, the selection of a collaborating organisation to participate in this case study was subject to influences of self selection and the restrictions of timing and availability. However, had a situation been feasible whereby an organisation could have been shortlisted from a large group of potential candidates, Aggregate Industries are likely to be suitable for selection. The organisation has a recognition of biodiversity and experience addressing biodiversity and nature conservations issues, is a multi-site landholding company and operates in a sector with obvious impacts on the natural environment. If the methodology developed through this research is adopted by organisations in the commercial sector it is quite likely that the process of self selection, or seeking out of a suitable tool to address the organisations need, will mirror the process by which Aggregate Industries came to be collaborating partners for this case study evaluation – through making contact with the author having heard about the research or through networking and publicity/promotion of the approach.

Although the stages of the methodology have been described in distinct sections and the decision making process for each part of the methodology made distinct in this chapter there were less meetings held than methodology stages and a lot of the discussions took place covering several stages of the methodology in one meeting. For example, deciding which indicators to adopt, from stage G to Stage Q was completed in the order described but often with overlapping discussions, particularly regarding how indicators would overlap with one another and whether the most efficient use was being made of financial resource spent. Also, the idea of balance and complementarity was voiced through several stages by the representatives from Aggregate industries, possibly due to their previous involvement with EMS KPIs and other performance measures and management systems.

The adaptation of the methodology to fit with and help fulfil planning requirements was a strong driving force in the result of decision stages. This determined the lack of need for any performance measures as per stages F and H (Figure 9.1), possibly without full exploration of whether there could be benefits from exploring the potential of these measures, especially at a site (Back Lane Quarry) level because it was clear from the discussions that there was no potential to influence company systems or indicators as part of the case study. The financial constraints were strongly maintained by the Aggregate Industries representatives and were based largely on their pricing experiences from external consultants and prior engagement with Wildlife Trust surveyors. Although this research was undertaken with a strong focus on the operational / practitioner level of biodiversity implementation work, this case study is potentially limited for applicability to other situations by the strict financial spending range specified by the collaborators. Had there been a number of funding situations explored, indicators that included specialised techniques for monitoring, or species groups that require intensive survey effort could have been included in discussions and therefore documented for potential audiences to consider.

However, the way in which the methodology developed in previous chapters could be adopted with significant adaptations and influenced by strongly influential drivers and constraints, whilst still maintaining the process and stage as represented in the flow diagrams (Figure 9.1 and 9.2) is a positive result for the hypothesis that this approach fits with organisations' views, requirements and understanding of biodiversity (as per previous case studies (Chapters 6 and 8), and the review of literature undertaken (Chapter 2). Aggregate Industries were satisfied with the results of collaborating with this research to build the case study. Particularly this was expressed in relation to the fixed financial constraints and how they felt it would not normally (based on previous engagement of

professional ecological consultants) be possible to have developed a comprehensive suite of indicators that took into account the situational requirements and be delivered for the fees available.

The testing of the methodology in the way described in this chapter is considered suitable for the assessment of appropriateness and applicability. This chapter also forms a useful output of the research for future practitioner application as it documents an application of the methodology. However, limitations exist and further evaluations of the methodology are desirable. Drawing parallels with traditional scientific testing, this implementation at a UK business landholding was not completed alongside a 'control site'. Therefore it is difficult to identify the extent of impact that has been made by the provision of the biodiversity indicator selection methodology versus what may have been devised by the business / site manager independent of the author's research and input. Future testing would benefit from a dual scenario, 'control' versus implementation analysis if a suitable experimental design and collaborating organisation can be arranged.

Additionally, the application of the methodology by the author in this study does not provide a suitably independent test of the methodology and how it can be used by an organisation or environmental professional separate from the author. Future testing in this area is considered likely to be highly beneficial and it would also allow a more comprehensive evaluation of how much input is required by and ecologist, biodiversity consultant or other environmental professional. It is suggested that future testing should include application of the methodology by an independent person. This may be in the form of an external party / consultant supporting an organisation or wholly within an organisation. Such testing would provide information for further development of methodology and additional case studies to support future adoption of the methodology by companies.

CHAPTER 11 - DISCUSSION

11.1 Introduction

This chapter provides an evaluation of the methods and outputs of the project and considers potential further research.

11.2 Project Context and Evaluation

11.2.1 Project Origins

The project was initiated through the recognition that businesses are seen by many nature conservation organisations as the next step for the biodiversity policy development (Earthwatch, 2002) and that businesses have been officially invited to actively contribute to international goals for biodiversity at the eighth meeting of the Conference of the Parties (COP8) to the Convention on Biological Diversity (CBD), held in Curitiba in March 2006 (Houdet, 2008). However, at the practitioner level, where biodiversity protections and gains will be made by businesses the limited information available to businesses on the issue of biodiversity measurement was apparent. A large amount of confusion was also being caused by the different understandings or lack of understanding of the term biodiversity at the practitioner level. Also identified was a lack of engagement of actual biodiversity work within private sector organisations. This was due partly to the lack of understanding of what biodiversity involves and also the lack of material available on the approach to measuring biodiversity.

Both the paucity of information for the layperson and the needs of business in relation to biodiversity are detailed by Armsworth et al. (2010). Armsworth et al. (2010) provide a summary of the context into which the research in this thesis sits, both in terms of academic literature and the operational needs of business.

> *"businesses require support from researchers in applied ecology to inform how they measure and manage their impacts on, and opportunities presented to them by, biodiversity and ecosystem services."*
>
> (Armsworth et al., 2010).

Particularly important for this project, was the issue of complexity. Many companies and environmental professionals were reluctant to tackle the biodiversity issue because of its seeming complexity. This complexity is borne partly out of the lack of research focused specifically on practitioner-level biodiversity measurement and the abundance of scientific ecology research. The ecology purist may frown upon 'biodiversity' as a toned down version of the science of ecology that includes social elements and provides snapshot

information for policy makers but without the rise of the term biodiversity, very few companies would have engaged with the ecological component of the natural environment – instead preferring to focus on the easily quantified environmental components such as air and water pollution, energy use, raw material sourcing and waste to landfill.

As acknowledged by UNEP-WCMC (2005), the literature review revealed a lack of specific, focused information on biodiversity indicators for business and the practitioner level, despite an abundance of key documents and literature on biodiversity importance, policy making, measurements and accounting at a global and national governmental level. Throughout the mid-stages of this research programme the Millennium Ecosystem Assessment (2005), The Economics of Ecosystems and Biodiversity (2008), development of the Convention on Biological Diversity with Convention of the Parties (COP) progression and national level documents including DEFRA (2007a) and DEFRA (2007b), amongst many additional academic and other papers were published. This development of the global concern for biodiversity loss and the development of the ecosystem approach continued without support for the implementation of biodiversity measurement or advice on how to operationalise these global and national level concepts at a practitioner level. This is explicitly expressed in the work by Armsworth et al. (2010) and discussed in more detail in Chapter 2 of this thesis. However, there is a limited amount of academic literature acknowledging the gap between the global, policy-focused publications of biodiversity and ecosystem services, the recognition of opportunity and pressures on business to mobilise and have enormous positive impact on biodiversity and the lack of applied research providing methods to enable practitioners to measure biodiversity.

Information in the area of biodiversity indicators in the ecological research field is growing and many studies have been completed to investigate hypotheses based on historic assumptions that, for example, breeding bird diversity is a good surrogate for overall habitat health and biodiversity. Further information and multiple examples of this research are provided in Chapter 2. In summary, through a process of measuring a potential surrogate like breeding bird diversity as well as more detailed measures of total biodiversity, or habitat health, and then statistically analysing the relationship, judgements are made about the correlation relationship between the surrogate and total. These studies are often complex and conclusions of researchers can vary from those willing to accept low levels of correlation as a potential indicator link to others who dismiss anything but very strong positive correlation as suitable for use of the given surrogate for measurement purposes. Unfortunately the complexity of the majority of these studies severely limits their accessibility to businesses and practitioners (Armsworth et al., 2010).

The recent (June 2011) UK Government Natural Environment White Paper – "The Natural Choice: securing the nature of value", incorporates elements of an ecosystem approach and appreciation of ecosystem services with valuation of natural capital to set out the future approach to the natural environment in the UK. In relation to this thesis, businesses are specifically addressed. For example, in terms of natural capital valuation it is stated that:

> *" Better accounting – by business and by government – would enable better choices, so that society can use natural capital sustainably."*
>
> (HM Government, 2011)

In relation to biodiversity indicators for business, the limitation of current guidance for environmental measures for business is stated and an objective is set to:

> *"issue new guidance for businesses by 2012 on how to measure and report corporate environmental impacts."*
>
> (HM Government, 2011)

This new guidance will follow the same approach as current systems for reporting greenhouse gas emissions to ensure consistency for all environmental aspects including waste minimisation, water use and biodiversity impacts. This concept mirrors the author's objective (as developed from interviews with collaborating organisations as reported in Chapter 6) for the research documented in this thesis that biodiversity should be measured and reported alongside more commonly assessed EMS aspects (e.g. water use, pollution to air etc.).

Biodiversity is specifically referred to in a number of sections of the document but is incorporated into every element of the natural capital discussion as result of the authors' definition of the term (see Figure 11.1). A commitment to publish a new Biodiversity Strategy for England is made and key reforms are given as:

- Supporting Local Nature Partnerships;
- New Nature Improvement Areas;
- Ecologically coherent planning; and,
- Piloting biodiversity offsets.

The methodology developed in this research project may find future uses in the biodiversity offset context in addition to its intended business landholding application

because HM Government state that biodiversity benefits should be delivered in a measurable way as compensation for any losses as a result of development. The measurement of biodiversity relies on indicators (as described in detail in Section 2.9) and it is proposed that any selection of indicators should follow a process of consideration such as the methodology presented in this thesis.

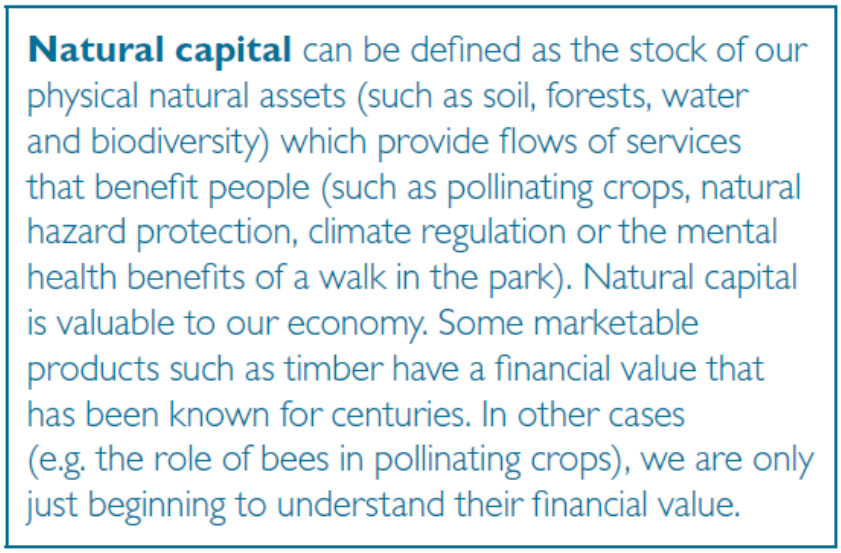

Figure 11.1 – HM Government (2011) definition of natural capital

This latest development in UK policy reinforces the need for consideration of biodiversity both as an integral part of natural capital and as an important constituent part of an ecosystem approach that includes new valuation methods. The methodology for the selection of biodiversity indicators developed in this research fits into this approach for the future years as a practitioner-level tool.

11.2.2 Project Evaluation

The project made a contribution to knowledge through the gathering of biodiversity indicator information, experiences and opinions from environmental professionals using structured interviews. The provision of real world information, opinions and views in an academic research project provides credibility to the project from both the business and the academic perspectives. The use of structured methods for interviews and the presentation of information in an academic document provides scientific credibility that is appreciated by the business and professional community. From an academic perspective, added value is gained through the incorporation of real world perspectives and the ongoing input of biodiversity practitioners to a process that could otherwise be entirely developed based on academic literature which currently lacks in the area of practitioner

implementation of theories and new directions relating to biodiversity and ecosystem services.

Another original factor of this research project is the combination of the real world data with academic information from journals and other published material. The combination of both types of information is considered to be an important factor of the research and indicative of the overall concept behind the research. This concept is based upon the acknowledgement that biodiversity as a topic is based somewhere on a spectrum between science and policy. This understanding of the term biodiversity and its study is explained in greater detail in Chapter 2 (Section 2.2). In summary, biodiversity is not identical to the hard scientific discipline of ecology and neither is it a meaningless buzzword that can be replaced by another term. The development of the use of the term biodiversity (and latterly ecosystem services) has increased the engagement of policy makers with the natural environment – landscape, ecosystem, species, habitat and genetic diversity. It is a version of the study of this natural environment that takes into account human activity, needs and desires and the other aspects of sustainable development (economic and social sustainability).

This combination of information involved the author's amalgamation of the results to develop the biodiversity indicator selection methodology based on pre-existing conceptual frameworks such as the EEA (1999 & 2005) DPSIR model and with reference to global and national indicator sets including the UK indicators (JNCC, 2007). In relation to the DPSIR model, the methodology developed in this thesis operationalises a very similar set of stages and relationships. The DPSIR model is a general causal framework but one which is described in the EEA (1999) text in the context of national and international government. Stages are described with reference to changes in populations – population growth, lifestyle changes and the responses that can be made at a policy making level. This has been modified to the organisation / institutional scale, using the inputs of collaborating organisations, to be applicable at a practitioner level.

The proposed biodiversity indicator selection methodology was tested by a process of implementation in a genuine business scenario. The testing of the methodology was completed at a mineral extraction site within an organisation that has multiple UK landholdings and is part of an international business (Aggregate Industries UK is owned by Holcim, which operates in 70 countries and employs 80,000 people). This shows that the research links in to the global debates on biodiversity protection and ecosystem services. It shows the importance of the practitioner level and how by addressing the gap and filling the link between the international policy making debate of biodiversity and

ecosystem service and the practitioner level will allow practitioners to effectively measure, manage , conserve and enhance biodiversity. In turn this feeds benefits and growth back up the scales to the global scale if all businesses can, and do, address biodiversity to the extent at which they currently address environmental concerns that are more easily measured and reported (e.g. energy, waste, pollution levels). This research contributes knowledge to the development of this 'missing' link – to operationalise global concepts at the practitioner level.

The case study provides original information and a contribution to knowledge with both the explanation of how the biodiversity selection methodology was applied and by reporting a practitioner business perspective on biodiversity. The drivers and constraints that influence decision making when addressing biodiversity were reported, as was the level of influence of corporate level, national and international policy on these decisions.

The development of the biodiversity indicator selection methodology that is at the centre of this thesis can be likened to the development of a process for, as an example, quality assurance or health and safety management. That is, the stages and factors of that process are based upon previously successful practices and knowledge of a particular subject area and situation. Each organisation implementing it may develop a bespoke set of these processes, based upon a generic guide or principle. The evaluation of the methodology by the implementation with Aggregate Industries illustrates this adaptation approach and describes it for future adopters.

The methods used for the research in this project are similar to those being prescribed in the biodiversity indicator selection methodology. There was an understanding that this topic is a real-world problem and only with input from practitioners could it be advanced. This has led to the production of a methodology for use by biodiversity practitioners but with strong links, reference to and understanding of the global biodiversity and ecosystem services debates and policy developments. The global pressures on biodiversity and ecosystem services are documented in the large and well-known publications that include the Millennium Ecosystem Assessment (2005), The Economics of Ecosystems and Biodiversity (2008) and also the collection of academic literature preceding these landmark titles (including but not limited to Daily 2000, Daily & Ellison 2002, Duelli & Obrist 1998, 2003, Piorr, 2003). The research project itself, although engaging with business and tackling this practitioner level problem, is based on the academic investigation principles of a defined aim and objectives, a documented methodology, thorough investigation of the current state of the art and a structured and reasoned written report of activities, fully referenced and reviewed.

The research contributes to knowledge in the areas of biodiversity and ecosystem services, applied ecology, business and biodiversity, environmental management and others. The knowledge provided is a contribution to the requirement that is referred to in texts including MA (2005) where it is stated that the scientific and assessment tools required for cross-scale assessments are only beginning to be developed. This research and the knowledge it contributes is part of the development of assessment tools required. Where the House of Commons Environmental Audit (2007) comments that non-specialists can find it difficult to access information contained in the MA reports, the knowledge contribution in this thesis will go some way to engaging the non-specialist with the concepts of operational biodiversity assessment.

The TEEB (2008) report acknowledges a need to develop performance metrics at the corporate level and states that metrics could contribute to a consumer footprint measure. The research documented in this thesis provides a contributing to the current knowledge in the form of a methodology for the selection of biodiversity metrics at the practitioner level. These metrics will be required to develop corporate performance measures and the consumer footprints metrics. For example, the Aggregate Industries case study biodiversity metrics will provide information which could be associated with the products of the study site, Back Lane Quarry.

11.2.2 Research Method

The use of interviews to gather information from collaborating organisations was an approach which is utilised more often by social science, where interview techniques are used extensively for insight into opinions, experiences and to build a wide picture of complex social issues. For this study the use of interviews was selected as an approach to gather information on business and biodiversity from practitioners. Interviews were selected for the benefit they provide when dealing with time-constrained professionals who otherwise may not find the time to complete paper questionnaires or other information gathering techniques. However, the use of what is widely seen as a social science research method created some issues. During social science research, the techniques are used for slightly differing purposes to those of this research project. For this research, a very pragmatic approach was taken, methods were selected that would most efficiently and appropriately provide the information required. This information was the insight and knowledge of practicing environmental professionals, something not available in literature but vital to developing a practicable methodology for business. This contrasts to the social science studies using the same basic techniques, these studies place more emphasis on analysis of interview transcripts and the subject as the research

topic is often relating to the people in a situation, rather than the systems, methods, techniques and other factual information. For this research project this balance of focus is firmly towards the latter. The case studies and interview-based information gathering in this project were used to develop something further (the biodiversity indicator selection methodology), as opposed to being the central component and output of a research project.

Tackling a 'real-world' problem is inherently more complex due to its lack of pre-determined structure compared to a 'standard' scientific experiment. The above manipulation of qualitative research methods was required to provide information needed to successfully develop a useful methodology for business, in the 'real-world' / practitioner level. In order to mitigate criticism of the way these social science research techniques have been exploited to progress the project, explanations have been included (Chapters 3, 5 & 6) to describe how and why these methods have been used. Stages in the research project where researcher influence and the knowledge of the author directed the process have been documented. This acknowledgement of situations where decisions were made based upon knowledge developed from information from a variety of sources is given to assist the reader. It is also provided to ensure that possible assumptions that decisions are directly linked to data, as would be expected in a 'traditional' science experiment, are not made.

Evaluating this research approach, considering alternatives and contemplating new research in this field, the information gathering approach for this project could have incorporate additional stages or different techniques. One possible approach would be to analyse corporate literature that was available in the public domain and also that literature which could be provided by the collaborating organisations that may not be public documentation. Another approach that could have been adopted was an in-depth study of one organisation which already implements a biodiversity measurement, monitoring and management strategy that is recognised (with corporate awards etc.) as being a leader in the field. Another, very different, approach would have been the use of interview techniques to gather much more qualitative data with full transcripts on the opinions of environmental and biodiversity practitioners about their opinions and experiences of biodiversity as an environmental aspect. This social science type study may also help fill the gap between high level, large scale debate on biodiversity and policy for an international audience and what is required at a practitioner level to contribute to the conservation of biodiversity. However, all of these alternative approaches to the gathering of information and general research methodology for the project encounter limitations to the quality of information likely to be provided and the quality of the output of a project

based on these methods. For example, the collection of information from literature in the public domain or willingly provided by collaborating partners is likely to be limited by businesses caution to provide written accounts of negative situations and scenarios. This caution was much less apparent when having face to face discussions with individuals from collaborating organisations and conversations were often very candid.

The timescale of the project constrained the possible engagement with collaborating organisations. As discussed in Chapter 4, several representatives from potential partner businesses were ruled out of the research due to unavailability at the time of the first multiple case study. With a greater amount of time allocated to the information gathering stage it may have been possible to collaborate with a greater number of organisations, thus providing a wider spread of information and increasing the strength of the common threads extracted from the data. Alternatively, with more time available it may have been possible to gather information form more contacts within each organisation or even partners to their biodiversity work, for example, local wildlife trusts or volunteer groups.

11.3 Further Research

11.3.1 Further Work

There are many opportunities for further work in this area, specifically to follow-on from this research project and more widely to investigate issues that were raised during this project. The primary work to follow this research will be to implement the methodology at pilot study organisations.

Additional further work to develop more specialised biodiversity indicators for business. There are opportunities for these to be specific in respect to business sector, size, location and other business characteristics. Studies are also required specific to UK habitat type, i.e. biodiversity indicators most appropriate for UK upland oakwood, floodplain grassland or lowland heath. Since the active research period of this project (2003-2007) several of these studies have been published and momentum in this field appears to be growing. However, due to the large number of different habitats and even regional differences between the same habitat in the UK, Europe and worldwide, there are many situations still to be researched.

Whereas this project only looked at landholdings there are many other aspects of biodiversity assessment / measurement / performance that could be considered for a business. The major impact area that many large organisations have is their supply chains. This research project made no attempt to investigate biodiversity impacts of businesses supply chains. A colleague at Aston University has been simultaneously

researching biodiversity risk assessment of supply chains (Whatling, 2010). Combining supply chain and landholding assessment of biodiversity would be an interesting research area to investigate. Further research to assess risks and levels of risk associated with biodiversity issues in commercial investments is also recommended.

CHAPTER 12 - CONCLUSIONS

12.1 Introduction

This chapter concludes the project and describes where the aims and objectives (as described in Section 1.3) have been met. A summation of the approach and contribution of the project is provided with reference to the original aim.

12.2 Project Aim

The original aim of the project as provided in Section 1.3, was:

> *"To develop a methodology to enable companies to identify, quantify and monitor biodiversity and report on the progress of biodiversity objectives within existing business systems."*

This aim has been met by the development of the biodiversity indicator selection methodology. This is provided graphically in Figure 9.2 with the text of Chapters 7 and 9 detailing each stage, and the implementation of the process. The methodology provides structure for the selection of indicators to measure biodiversity, allowing monitoring and reporting of the current state on landholding and performance of systems against biodiversity objectives. The methodology is applicable to any business size, industry sector and prior engagement with biodiversity. By adopting standard flowchart formatting and having the 'continuous improvement' cycle structure it is a parallel to many existing environmental management and other business systems. This allows it to be implemented within, or alongside, existing business systems.

A trial implementation that also serves as an example study was undertaken and is documented in Chapter 10. This trial of the methodology was a successful study despite being limited in wider applicability by the constraints and other characteristics of the host company (as described in Chapter 10).

Achievement of the project aim was completed through realisation of the 7 project objectives, as provided in Section 1.3. How and where each objective was met is discussed below.

12.3 Project Objectives

Objective 1:

> *"Conduct a literature review to gain knowledge and understanding of work undertaken to date relating to:*
>
> *a. Biodiversity as a discipline;*
> *b. The relationship between biodiversity and business; and,*
> *c. Biodiversity indicators.*

This objective was met by conducting an extensive literature review into biodiversity as a term and a topic, its evolution and current biodiversity studies and practice. Business engagement with biodiversity was reviewed, including non-academic literature and published material. Current knowledge on ecological indicators was established, with specific focus on those with a biodiversity emphasis. The results of this literature review are provided in Chapter 2.

Objective 2:

> *"Identify businesses covering a range of industrial and commercial activities that have active biodiversity initiatives, and establish their willingness to collaborate in the research."*

This objective was met through the process described in Chapter 4. This included the identification of potential collaborating businesses, selecting criteria for short listing organisation, and establishing contact with 10 case study participants. This achievement of this objective commenced the relationships between researcher and case study participants. The establishment of these relationships facilitated the transfer of business focused information and opinions from environmental professionals. The case study interviews, as reported in Chapters 6 and 8, provided a significant insight into business systems that would not have been available without the realisation of this objective. Contact and collaboration with business and networking throughout the project enabled the collaboration with Aggregate Industries for the implementation of the methodology as the trial study documented in Chapter 10.

Objective 3:

"Determine the drivers motivating organisations to engage with biodiversity issues."

During the literature review process (Chapter 2), published drivers pushing organisations to address biodiversity were described. However, the larger contribution to the completion of this objective came from the multiple case study. Chapter 6 provides the results of these case study interviews, which include responses to questions about drivers motivating engagement with biodiversity issues. Understanding these drivers improved the development of the final methodology by taking into account their variety and different magnitudes. The trial of the biodiversity indicator selection methodology in Chapter 10 provides a more detailed case study, including the drivers that influence biodiversity indicator selection and how this affects the implementation of the methodology.

Objective 4:

"Evaluate the establishment and implementation of biodiversity objectives within the collaborating businesses."

The questions within the multiple case study interviews prompted discussions about biodiversity objectives. These discussions, specifically common threads, are provided in Chapter 6, Section 6.4. Information about the different formats of, and approaches to setting biodiversity objectives influenced the final biodiversity indicator selection methodology, and became a central stage in the process. The case study at Aggregate Industries documented a practitioner approach to setting objectives in the real world, in conjunction with the biodiversity indicator selection methodology developed during this research.

Objective 5:

"Undertake studies of collaborating businesses to inform the research procedure."

The relationships with collaborating organisations and their input during the multiple case studies has made a very important contribution to this project. The details of these studies are provided in Chapters 6 and 8, although it should be noted that many of the organisations collaborated throughout the duration of the research by means of providing information and opinions. The influence of these studies on the final biodiversity indicator selection methodology was significant. The flexibility of the methodology was dictated by the variety of situations, including drivers, constraints and operational activities, discussed. The implementation of the biodiversity indicator selection methodology at Back

Lane Quarry for Aggregate Industries tested the delivery of the approach and provided insights and results discussed in Chapter 10.

Objective 6:

> *"Construct a methodology for the selection of biodiversity measures within an environmental management framework."*

The final biodiversity indicator selection methodology is provided in Figure 9.2. The construction was a process involving literature review information (Chapter 2), collaborating organisations (see Chapter 4) and multiple case studies (as reported in Chapters 6 & 8). The methodology was not developed within a strict environmental management system framework, instead the focus of the research was to provide a flexible methodology that could fit into, or alongside, existing systems of any kind within a business. The change in approach allows more adaptability and still provides a methodology that can be integrated into an EMS. The methodology was tested at Back Lane Quarry and the findings and evaluation of the approach is provided as Chapter 10.

Objective 7:

> *"Undertake trials of the proposed methodology and evaluate its viability."*

This objective was completed indirectly through the second case study process. The first representation of the methodology was discussed in detail with 4 collaborating organisations. This process and results are document in Chapter 8. The interviewees provided opinions on modifications they would make if implementing the methodology in their organisations. Through undertaking this process with 4 collaborators, all representing different business sizes, industry sectors and prior experience measuring biodiversity, the project benefitted extensively. Following the update of the biodiversity indicator selection methodology as informed by this second case study a real-world trial of the methodology was completed. This trial was completed within the constraints and drivers of the collaborating organisation and site. This trial of the biodiversity indicator selection methodology showed that the methodology was flexible to adapt to the different scenarios it needs to work for. As a single operational-level trial for the methodology, the results are limited in terms of balance and comparability between different companies, sectors or landholding styles.

12.4 Summation

The methodology developed by this research project provides practical guidance for businesses tackling the real-world/practitioner issue of biodiversity measurement and

achieved the overall aim of the project. The approach is based upon the latest information from literature, combined with information and opinions from environmental professionals gathered using structured research methods. The resulting methodology was then tested and improved through research with organisations from a variety of industry sectors, with differing biodiversity impacts and experience. A real-world, practitioner/operational level trial of the biodiversity indicator selection methodology was completed with Aggregate Industries at an active quarry in Lancashire.

The final output of the project is a biodiversity indicator selection methodology that is based upon the most relevant information, obtained using established research methods. It is flexible enough to be applicable to all business types and uses a structure an approach that allows ease of understating and integration with existing systems. For those organisations that have extensive prior experience addressing biodiversity, it can be a documented methodology that can be considered when modifying existing approaches. The organisations it will provide the largest opportunity for are those newly introduced to biodiversity.

It has been acknowledged that many environmental professionals are lacking in knowledge of biodiversity issues and approaches, particularly in comparison with waste, energy and pollutant parallels. The methodology developed by this project provides a structured route to address biodiversity, allowing non-specialists to follow an approach based on knowledge, principles and practitioner experience, of an expert ecologist. Implementation of the methodology is considered possible with or without external guidance by a biodiversity professional. The information provided in section 2.9 is the basis for the pool of indicators for a business to select from when implementing the methodology. However, as acknowledged in that section and elsewhere, the academic literature resource is vast and continually growing in the field of surrogate taxa and tested biodiversity indicators and suites of indicators. Therefore, assistance from a biodiversity professional (such as a consultant ecologist with relevant experience) is likely to provide the optimum delivery of the methodology for a company. Alternatively the manager implementing the methodology may be able to research the latest developments and / or the most relevant (based on landscape type, business sector, geographic location etc.) biodiversity indicators in the academic literature to achieve the same optimisation.

In conclusion, this research project has produced a methodology for the selection of biodiversity indicators for business landholding. This provides organisations and practitioners with a scientifically robust method for establishing biodiversity measurement within existing systems. For individual companies this will enhance the sustainability of

their activities and provide an opportunity to gain competitive advantage. By addressing all company landholdings, for UK biodiversity it provides significant opportunities for protection and increases.

A significant contribution to knowledge has been made by operationalising the indicator / measurement / performance metric component of the global biodiversity and ecosystem services concepts documented as lacking in several academic papers and key international publications.

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APPENDIX 1

Collaborating Organisation	**Astra Zeneca**
Interviewee Name	**Ross Brown**
Interviewee Position	**Environmental Strategy Manager (UK)**
Date	**03/03/2005**

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*
Written definition, copied from somewhere, in biodiversity strategy – developed through site visits: 3 sites a year – Puerto Rico, Sweden and UK

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*
Influenced by SHE reporting and the GRI. Pressure from Global Environment Manager.

Who identified it as an issue? *What is there position in the organisation?*
Global Environment Manager

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*
Influence on the organisation from the global environment manager.

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*
Biodiversity features in the Corporate Responsibility Report.

How long have you been addressing biodiversity? *Quantitative.*
2 years

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*
Global Environment Manager / Global SHE department / strategy

Who has overall responsibility and decision making role for the biodiversity programme?
Global Strategy/ SHE manager

How is biodiversity communicated as an important issue to the board and to the staff?
The environmental strategy manager reports to senior staff. It also comes into the annual budget communications and undertaking of 3 surveys per year.

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?
Landholdings. Starting to consider supply chain – related to concerns about bioprospecting.

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*
Wildlife Trusts are involved with some site surveys and management. The aim is to look at possible LBAP links and local WTs in future,

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*
n/a – none are set at present

How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*
Consultants and staff for estate inventory work. Some volunteers.

How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*
Consultants and staff for estate inventory work. Some volunteers.

Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*
Annual report to board, based on GRI format – just to see if we are 'meeting company standards'.

Section 3 - Biodiversity Indicators
What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*
A range of habitats and characteristic plant species, invasive species, management of habitats, inhabiting fauna. Habitat based mapping using aerial photo and a GIS database of the built environment.

How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*
Recommendations from consultants and other environment managers. General ecological knowledge and site-based knowledge.

How is this information used? *Reporting, adjustment of targets, adjustment of approach?*
Reports to develop strategy – list of best practices. Looking at public reporting for the future.

How many indicators do you feel would be a manageable and practicable number?
0-5 6-10 11-20 21-40 41+
Site by site basis – based on numbers of species, area of site with designation (eg. SSSI), area of habitats, visible flora and fauna.

Who conducts the recording / monitoring work? *Staff / Consultants / WT?*
Site personnel, external consultants.

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*
Raise public awareness of AZ biodiversity work.

Section 4 - Biodiversity Experience / Advice
What have been the biggest hurdles you have faced when implementing your biodiversity programme?
Financial and staff time resources – biodiversity is only seen as a very small part of a grand scheme.
Site managers can be very guarded about species and habitats present, especially protected species.
Outside the UK there is often a cultural hurdle where people are not bothered about the natural environment.

What have been the biggest benefits from implementing a biodiversity programme?
Building a communication network within the company. Building the moral of staff. Building recognition of positive work with external agencies. Hopeful of good publicity - local trusts and communities.

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?
Look at broader level -maps and aerial photos before moving into on site work.

What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?
It can be fun, try it, it is very positive and rewarding. Helps to build networks on site. Gives high-level benefits – relations with agencies and public image.

Collaborating Organisation	**Center Parcs**
Interviewee Name	**Alex McLauchlan**
Interviewee Position	**Ecology Manager**
Date	**22/10/2004**

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*
Written definition in BAP style document, created by CP.

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*
Center Parcs was established in the 1960's and was built around nature (a slogan 'to be at one with nature') Has had eco and forest management plans since 1994-96 (dependent on location) and was one of the first companies to have a BAP.

Who identified it as an issue? *What is there position in the organisation?*
The organisation has always been aware.

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*
The organisation's ethos. Biodiversity is acknowledged as a business advantage eg. The red squirrels that are promoted at one village. Also working with LBAPS – eg. Wildflowers at Elveden (+ moths and associated inverts) and Notts BAP, heathland has become a priority.

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*
Forest Management Plans and EMS.

How long have you been addressing biodiversity? *Quantitative.*
Since approximately 1993 as biodiversity, landscape management plans or forest management plans.

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*
Conservation rangers or external surveyors. Also, local bird groups etc.

Who has overall responsibility and decision making role for the biodiversity programme?
Landscape manager / Ecology Manager (interviewee)

How is biodiversity communicated as an important issue to the board and to the staff?
Monthly board meetings include a presentation by the ecology manager (interviewee). ISO14001 Ems processes, newsletters, biodiversity mission statement in EMS statement. Staff undergo tests, there are weekly village briefings for interesting topics (eg. Wildflowers emerging on roadsides).

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?
Landholdings – holiday villages
Supply chain – ISO14001 requirements for suppliers. Within business aspects/sustainability, biodiversity is included.

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*
Sherwood Forest Village is linked to the LBAP for Nottinghamshire and other villages have a similar relationship with local plans.

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*
A 5 year review process, adding new targets or removing ones that are completed. Local and national initiatives influences the selection and the ecology monitoring data provides guidance.

How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*
Staff and sub-contractors

How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*
Staff and long-term subcontractor surveyors. Measures undertaken at all sites and for an extensive number of species groups and habitats. Locally important surveys only undertaken at the relevant site – eg. Red Squirrels in Whinfell Forest, moths in Elveden.

Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*
Monthly reports lead to an annual report on biodiversity. On website and new link direct to nature is being developed. An environment section (including biodiversity) is due to be added to the guests introduction books.

Section 3 - Biodiversity Indicators
What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*
TOTAL LIST IN FOREST MANAGEMENT PLAN - Extensive numbers of surveys for flora, birds, inverts etc..
How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*
Based on the general belief that it is best to survey for everything – giving reassurance that nothing is slipping through the net and being harmed.

How is this information used? *Reporting, adjustment of targets, adjustment of approach?*
For internal communication and reporting. For the ongoing review of management practices, monitoring of progress against targets.

How many indicators do you feel would be a manageable and practicable number?
0-5 6-10 11-20 21-40 41+
Depends on the site – mapping of a site to show habitats, then flora, birds, mammals (potentially several species), reptiles, invertebrates (potentially several species), streams and ponds.

Who conducts the recording / monitoring work? *Staff / Consultants / WT?*
Staff (conservation rangers) + consultants and local groups.

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*
Due to the nature of Center Parcs (as a leader in this field), it is not thought that there are any major improvements needed soon.

Section 4 - Biodiversity Experience / Advice

What have been the biggest hurdles you have faced when implementing your biodiversity programme?
Not an issue for CP but it is understood that usually the financial resources and board commitment are hurdles for biodiversity.
For CP, getting surveyors and then retaining them long-term so that they can deliver consistency is important.

What have been the biggest benefits from implementing a biodiversity programme?
Seeing what has been created, the improvements. Staff enthusiasm and ownership. Actually making a difference. Getting a good planning reputation.

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?
None – it is smooth running and good.

What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?
Getting quality surveyors.
Set targets and what you want to achieve first, including researching local targets.

Collaborating Organisation	**Land Securities**
Interviewee Name	**Christopher Moore**
Interviewee Position	**Sustainability Manager**
Date	**09/02/2005**

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*
Written definition in the Environment and Biodiversity policy statement, created by Land Securities to link biodiversity into business procedures and development procedures.

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*
Department for Work and Pensions was the initial driver – in relation to the 1800 buildings that Land Securities own/manage that fell into the 'greening government' strategy. Also as part of the large Kent Thameside development and now seeing the links with CSR as a package.

Who identified it as an issue? *What is there position in the organisation?*
Environmental services department

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*
Publicity. Stakeholders require it more frequently. A new approach to the environment.

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*
A published biodiversity statement in ISO 14001 EMS. BS8555 groupwide, includes biodiversity.

How long have you been addressing biodiversity? *Quantitative.*
1.5 – 2 years

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*
Chief Executive

Who has overall responsibility and decision making role for the biodiversity programme?
Environmental services

How is biodiversity communicated as an important issue to the board and to the staff?
Intranet, species briefing notes (eg. bats), environmental briefings, a biodiversity management programme. Monthly environmental newsletter 'greenland'. Checklists and procedures.

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?
All aspects – procurement: fair-trade outside UK, red tractor in UK, sustainable timber, 'care4' wild animal adoption, endangered species work (contributions) UK and worldwide.

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*

Wildlife Trusts Biodiversity Benchmark, BAP for Kent Thameside development, Exeter & Canterbury links to local BAPS.

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*
By the planning process and consultants support on big projects. Ecological survey conducted in house and then move to outside help from wildlife trusts or consultants as required.

How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*
On capital projects biodiversity is included within engineering works and implemented by contractors awarded the work through normal tender process.

How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*
Not particularly well, not incorporated into enough schemes yet to review due to time considering biodiversity. Something to consider.

Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*
Only internal communications

Section 3 - Biodiversity Indicators
What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*
A scoring mechanism is used, roughly based on species x habitat
x location

How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*
External consultants developed this as a rapid assessment tool for the DWP contract and it has been used for site assessment of other new and existing locations.

How is this information used? *Reporting, adjustment of targets, adjustment of approach?*
Currently data is just gathered. A system adjustment is due soon and this will help develop landscape management plans from the info – planting regimes etc.

How many indicators do you feel would be a manageable and practicable number?
0-5 6-10 11-20 21-40 41+
Project by project basis 10-20 to 100+

Who conducts the recording / monitoring work? *Staff / Consultants / WT?*
Consultants

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*
Guidance for business on what biodiversity is – is it just species in a given area, also reminders for all not to forget obvious such as bats in London (and other built up urban areas). Maybe something in planning to trigger assessment early.

Section 4 - Biodiversity Experience / Advice
What have been the biggest hurdles you have faced when implementing your biodiversity programme?

Commitment from front line staff, highlights a need for education, large training exercise. Lack of knowledge within the organisation, species ID – needed a 'Collins photo-guide to biodiversity'

What have been the biggest benefits from implementing a biodiversity programme?
Meeting client targets that were causing problems. Personal benefits, understanding the importance of species – education for all involved. Helpful in negotiating new contracts.

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?
Nothing different as yet, it is still a new project and is continually improving, not ready for a formal review yet.

What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?
Use the Wildlife Trust's Biodiversity Benchmark to start - it is simplified to see where you are – is there potential or not.

Collaborating Organisation	**National Forest**
Interviewee Name	**Audrey Brown**
Interviewee Position	**Land Use Officer**
Date	**11/08/2004**

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*
As written in NF BAP, derived from the CBD.

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*
It is a core issue/basis of the business – creating new landscape, it is obviously intrinsic in creating a National Forest.

Who identified it as an issue? *What is there position in the organisation?*
Government: setting up the NF Company approximately 10 years ago. The initial idea came from the countryside commission and forestry commission. The new forest / national forest idea emerged around 1990/1991.

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*
Core to the business of creating a NF and general countryside work. It is a driver due to government funding and their sign-up to the CBD. The NF has an opportunity to physically do practical work to make a big difference and it has the knowledge and commitment.

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*
A Biodiversity Action Plan, the 2nd edition recently released. Wider sustainability features in all business plans and documents.

How long have you been addressing biodiversity? *Quantitative.*
10 years

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*
Interviewee

Who has overall responsibility and decision making role for the biodiversity programme?
Interviewee

How is biodiversity communicated as an important issue to the board and to the staff?
BAP a key document – it is endorsed by the board and staff are notified. Website is used for communications. Verbal communications and use of summary sheets. It is seen as an education process – to make it an everyday part of the business.

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?
Supply chain and landholdings.

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*

Linked to LBAPs for Staffs, Derbys, Leics and all partner BAPs up to regional and then national targets. Other links include to BTCV and private land-owner grant-aids and businesses.

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*
Steering Group and external consultants drew up the first BAP with stakeholder discussions for targets. A critical review of the 1st BAP informed the development of the 2nd edition and this was then sent out to the original steering group. This led to 2 species action planes, an amalgamated mesotrophic and eutrophic water plan, linear habitat plan, new plan for orchards and the dropping of calcareous grassland as a plan.

How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*
Grant-aid to landowners that can include businesses etc. Implementation of work is by the land-owner appointing contractors. Specific habitat creation can be linked to the local wildlife Trust.

How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*
Contract details exist for all projects – all details are listed for management and habitat creation. To ensure these are delivered, surveys are conducted after project completion. These can vary from in-depth full surveys to information gathering from informal data sources.

Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*
Yes. Internally and externally. The Annual Review for all partners. Annual data entry into the BARS system. Also some articles in the newsletter on an ad-hoc basis.

Section 3 - Biodiversity Indicators
What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*
Habitat areas and type. Informal species records and some full surveys (often using volunteers).
How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*
Based on government requirements for the issuing of grant aid – to ensure projects completed to specification.

How is this information used? *Reporting, adjustment of targets, adjustment of approach?*
Used to report progress against targets and to adjust targets as required. Legal requirement to monitor and report back to DEFRA. For general internal and external reporting.

How many indicators do you feel would be a manageable and practicable number?
0-5 6-10 11-20 21-40 41+
Only obvious/straightforward ones

Who conducts the recording / monitoring work? *Staff / Consultants / WT?*
A variety of people – volunteers, consultants, staff, local WT. The steering Group also monitor projects.

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*
Nothing more than is already available.

Section 4 - Biodiversity Experience / Advice

What have been the biggest hurdles you have faced when implementing your biodiversity programme?

An inclination of some stakeholders to go for a tokenistic approach. A lack of education about the issue and it's importance.
Getting information from partners re. monitoring data.

What have been the biggest benefits from implementing a biodiversity programme?

Biodiversity Improvements, creation of a better environment, more wildlife. Pride of staff, they are happy about it – seeing new species. Good publicity and recognition.

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?

With BAP, no need to allocate lead partners to specific plans/targets. Generalisation of the BAP is a good thing.

What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?

Don't be too specific – talk to others who have done the works already. Learn from others and communicate.

Collaborating Organisation	**National Trust**
Interviewee Name	**Rachel Fickweiler**
Interviewee Position	**Biodiversity Manager**
Date	**12/04/2005**

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*
Varies in documents – often tailored to the audience.
For organisation it is kept simple – "the diversity of all living things – species and habitats"

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*
Always in the organisation – the core purpose of the NT is to conserve. Mid 1990's the terminology of biodiversity started to be used.

Who identified it as an issue? *What is there position in the organisation?*
Relates to above – always has been part of the organisation

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*
As a charity a core purpose for the setting up of the NT was protecting aspects of the Natural Environment for it's intrinsic value. Recognition of the National Trust as a good conservation agency leads to better publicity and more members.

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*
Nature conservation policy and strategies for each region.
UKBAP commitments (as lead partner on many plans).
SSSI ownership
Conditions to ownership on many legacies and financial commitments related to these.

How long have you been addressing biodiversity? *Quantitative.*
Since mid-90s as biodiversity

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*
At a high level the Nature Conservation directorate. Regionally and locally, the wardens and property managers.

Who has overall responsibility and decision making role for the biodiversity programme?
Head of Nature Conservation

How is biodiversity communicated as an important issue to the board and to the staff?
Communication can be difficult in the NT as a large organisation with different department and national coverage. Nature Conservation section has influence on strategies at a policy level and produces a nature conservation newsletter to all staff. Also produce article for a more scientific journal type publication for key staff.

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?
Landholdings.

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*
Links to the UKBAP and LBAPs as lead partner on many action plans

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*
National strategies are set through internal consultation and discussion, these lead to regional approaches, often based on important species and filtered down into individual property management based on generally accepted good ecological practice.

How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*
Property managers and wardens. Some volunteers and contractors.

How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*
Recording takes place at the property level but is not always communicated back up the chain for national records. Currently part of the BARS system but having difficulty due to this issue.

Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*
Biodiversity performance reporting does not keep up with the amount of nature conservation and biodiversity work that is done. There is a survey programme undertaken by a team that includes naturalists, botanists and an entomologist and a large amount of this information is made publicly available.

Section 3 - Biodiversity Indicators
What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*
Ecological survey team conducts a suite of surveys at sites on a rotational basis.

How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*
Follows guidance from National partners and uses research proven methods such as NVC.

How is this information used? *Reporting, adjustment of targets, adjustment of approach?*
For publicity material. To inform decisions on policy, not just necessarily Nature Conservation policy and decisions.

How many indicators do you feel would be a manageable and practicable number?
0-5 6-10 11-20 21-40 41+
Any, dependent on site characteristics.

Who conducts the recording / monitoring work? *Staff / Consultants / WT?*
Biodiversity Survey Team

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*
Nothing, all seems ok at present.

Section 4 - Biodiversity Experience / Advice
What have been the biggest hurdles you have faced when implementing your biodiversity programme?

Lack of resources, money for staff and individual projects. Non-continuity of ecological staff/posts. Resource allocation / staff time.

What have been the biggest benefits from implementing a biodiversity programme?
Focusing of work and resources in areas.
Raising profile, publicising and staff awareness.

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?
Approach is okay, resources and above issues are limiting factors but probably the same for many orgs.

What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?
Can use the UKBAP process for structure / starting point. Take advice from other people. Listen to experience. Be realistic and deal with plans that can be implemented – have got to be able to do! Set realistic targets - lots of paper is often developed – needs more implementation.

Collaborating Organisation	**Severn Trent Water**
Interviewee Name	**Geoff Nickolds**
Interviewee Position	**Conservation, Access and Recreation Manager**
Date	**20/12/2004**

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*
Written on the front of STW BAP, taken from UKBAP.

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*
Conservation has been done since privatisation. 1995-1998 it was identified as biodiversity where previously it had been conservation or land management. The shift to biodiversity provided an agenda and priorities that reinforced existing conservation practices.

Who identified it as an issue? *What is there position in the organisation?*
Interviewee

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*
The Estate management statutory obligation to further conservation from the Water Act and code of practice (DEFRA monitored). A BAP provides an agenda for this. Also the recognition of biodiversity as being of growing interest to analysts and ethical investment and CSR.

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*
BAP and EMS key aspect/cornerstone.

How long have you been addressing biodiversity? *Quantitative.*
Since 98/99 as biodiversity

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*
Interviewee and conservation, access and recreation team

Who has overall responsibility and decision making role for the biodiversity programme?
Interviewee for decision making but responsibility for some elements is escalated to directoral level.

How is biodiversity communicated as an important issue to the board and to the staff?
Monthly reports on progress with unscheduled reporting of significant achievements. An annual Conservation, access and recreation report to staff. Also, newspapers – local and in-house. Email communications to staff, including in-house competitions. Displays in staff restaurants.

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?
Landholdings / management of the estate. Interested in supply chain assessment

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*
Operational in 13 counties and 20+ EN Natural areas. Operate in England and Wales.STW take information from local BAPs, meet with LBAP teams on specific issues and projects. Wildlife Trusts are the main partnership conduit but also liaise with RSPB and others.

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*
Based on SSSI condition data and also site survey data compiled by consultants.

How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*
Staff rangers for site management. Grounds maintenance sub-contractors. Staff conservation volunteers.

How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*
Similar to engineering projects, capital works have numbers of areas, trees planted etc. Support from local birds groups, BTO. Otters and Rivers WT project provides info. Phase 1 Habitat Surveys and consultant surveys undertaken. Assessment of grounds maintenance regime and requirements.

Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*
Externally in an annual report. Internally, monthly on biodiversity and BAP, detailing actions for biodiversity.

<u>Section 3 - Biodiversity Indicators</u>
What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*
Woodland grant scheme for woodland details.
Phase 1 habitat surveys over a set period of time (20% of sites a year to ensure all are no more than 5 years old).
Upland farmland in Environmentally sensitive areas.
Land in Countryside Stewardship Schemes -data on field use/habitats.

How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*
The need for data to develop and advance the BAP. Decided on a standard ecological approach and the survey of sites over a time period.

How is this information used? *Reporting, adjustment of targets, adjustment of approach?*
Reporting. Used to adjust BAP – recent review slimmed-down species targets and concentrated on habitat action plans.
The information also revealed that red squirrels do not exist where they had been assumed to be – therefore targets for red squirrel were removed.

How many indicators do you feel would be a manageable and practicable number?
0-5 6-10 <u>11-20</u> 21-40 41+

Who conducts the recording / monitoring work? *Staff / Consultants / WT?*
Consultants, staff, volunteers, BTO, BTCV, partner organisations – WTs.

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*

Universally accepted standards so that all were working to the same methodology – either sector by sector or based on landholding. Habitat specific guidance – eg. Woodland management. Comparison of habitat value.

Section 4 - Biodiversity Experience / Advice

What have been the biggest hurdles you have faced when implementing your biodiversity programme?

Engaging support and understanding in the organisation. Making sense of differing LBAPS in different regions. Measurement of achievements.

What have been the biggest benefits from implementing a biodiversity programme?

A good agenda now to report against and allows comparison.

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?

To be guided by own assets/landholding and not by external suggestions.

What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?

Take local priorities into account but focus most on site characteristics.

Collaborating Organisation	**BAA Heathrow**
Interviewee Name	**Emma Humphrey**
Interviewee Position	**Sustainable Development Manager**
Date	**07/12/2004**

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*
BAA Heathrow Stategy: "the diversity and variety of wildlife and the habitats that support it". Based on ecology knowledge and how it was defined by the partner wildlife trusts and the Mayors Strategy for London. It is part of corporate policy.

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*
Historic. Landscape Manager has been with organisation for 15-20 years and the landscaping and biodiversity element has increased and developed over that time. Camp 4 property was left as a conservation site and is now planned to not be used so will stay as a conseration site. The management of green areas for landscape and biodiversity also provides a good community opportunity – 'being a good neighbour'.

Who identified it as an issue? *What is there position in the organisation?*
Ecology and conservation was identified and addressed by the landscape manager. Biodiversity, as a new issue / term, was identified during the compilation of the sustainable development management system.

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*
Having landholdings, balancing reservoir in nature reserves etc. means a requirement to look after them. Community involvement is very important at BAA and there is local interest in green spaces and biodiversity. Doing well at this means good scores in corporate indices and getting a good planning reputation.

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*
Biodiversity Policy at a corporate level. Biodiversity is a key aspect in the SDMS for Heathrow , therefore there are objectives and targets associated with it.

How long have you been addressing biodiversity? *Quantitative.*
3 years as biodiversity. 10 years plus as ecology and conservation. Eg. Surveys go back 15 years +.

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*
Property development team have been crucial for doing the works and implementing the BAP. Interviewee has driven policy work and anything other than on the ground site work.

Who has overall responsibility and decision making role for the biodiversity programme?
Sustainability Director has overall decision making role and responsibility.

How is biodiversity communicated as an important issue to the board and to the staff?
To staff via the 'enviro-news' monthly newsletter, emails and notice boards. Airport community newspaper to outside businesses. Holding a sustainability awareness day. Communicated to board level and other teams either one on one or through presentations.

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?

Landholdings – owned sites and inspections done on those that are rented out. Supply chain and purchasing, projects and development – integrating it into the assessment process.

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*

Linked to UKBAP, Local BAP and Mayors Strategy for London. Linked to the local biological records centre to share data using the recorder 2000 software. The landscape and water quality manager has links with the local authority and wildlife trust through contacts built up over time.

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*

BAPs and whatever capital projects are done each year. Internal staff knowledge (landscape manager) and through liaison with consultants and local BAP groups.

How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*

Property tem and a landscape contractor. Heathrow volunteers do coppicing, clearance etc as a holiday incentive programme (120 people).

How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*

BAP database and spreadsheet managed by Landscape manager. Also measurement of volunteer actions. Indicators for the supply chain are being developed.

Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*

Externally more than internally. Annual sustainability report and a chapter is dedicated to biodiversity. Targets achieved are communicated to the board on a quarterly basis.

Section 3 - Biodiversity Indicators

What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*

All recording done on a volunteer basis - some volunteer bird specialists, a spider surveyor, bat recording. Only formal recording is landscape contract management and volunteer day records.

How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*

Cost is very important – only using in-house expertise for surveys. Methods come from experience, expertise, LBAP, earthwatch guidance but all down to what internal specialisms are available.

How is this information used? *Reporting, adjustment of targets, adjustment of approach?*

To adjust BAP targets / objectives and inform the nature database.

How many indicators do you feel would be a manageable and practicable number?

0-5 6-10 11-20 21-40 41+

The above per site for monitoring but for corporate reporting a maximum of 3-4

Who conducts the recording / monitoring work? *Staff / Consultants / WT?*

Staff and landscape contractors. Consultants have been used in the past

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*
Communicable figures for high level progress monitoring. A recognised standard for what to measure. This would help with credibility in reporting + how to report.
What to measure, how to measure it, how to report it. A standard. Or an independent auditor assessing each time / place.

Section 4 - Biodiversity Experience / Advice
What have been the biggest hurdles you have faced when implementing your biodiversity programme?
Recently it has been getting resources for monitoring the site work. Biodiversity is not high enough priority and actions and results are hard to measure. Education and communication – learning what biodiversity is. The costs and expertise required .

What have been the biggest benefits from implementing a biodiversity programme?
Conserving biodiversity (altruistic), recognition of doing well, achieving good points in corporate indices (Dow Jones) and getting the Wildlife Trust's Biodiversity Benchmark. Keeping local community on-side. Awareness of what is on site (biodiversity).

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?
Raise more awareness internally

What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?
Use already available guidance e.g. Earthwatch guidance and BAP guidance.

Collaborating Organisation	**Network Rail**
Interviewee Name	**Liz Howarth**
Interviewee Position	**Environment Manager**
Date	**10/08/2004**

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*
From the UK BAP into company BAP.

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*
In 1998/99 David Bellamy wanted the Largest National Park as the rail network. Through talks with the chairman and the co-development of the BAP and also the rising protected species importance / impact – newts, badgers etc.

Who identified it as an issue? *What is there position in the organisation?*
Environment Manager for EA zone – Tony Ellis – The interviewee now delivers / administers the issue over the whole Network rail area.

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*
Looks good –PR, BiE index questionnaires when a private company. Now, corporate reporting. BAP is a good vehicle to bring together strategies. Various legal drivers for sites (SSSIs) and species.

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*
Environment Policy includes habitats. Procedure for habitats and species / vegetation management. Included in EMS since 1999.

How long have you been addressing biodiversity? *Quantitative.*
Since 2000 as a pilot plan in the EA region

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*
Environment Team communicates it to operations team. Capital projects give best results where it is a development on a given piece of land.

Who has overall responsibility and decision making role for the biodiversity programme?
Head of Environment – board decides on major decisions.

How is biodiversity communicated as an important issue to the board and to the staff?
Training courses (biodiversity as one and included in others). General briefings, and newsletters. Inter and intranet. Environmental awards preparation. If key issues arise (BAP related) it is reported to the board.

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?
Landholdings. Some procurement issues – FSC for timber, biodegradable oils in machines.

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*
Linked in an ad-hoc basis with local wildlife trust sites.

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*
Favourable conditions targets for SSSI based on DEFRA numbers, no binding commitment, Section 28g CRoW Act – enhance where possible.

How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*
Contractors for vegetation management but staff for track work. Capital projects delivered by contractors.

How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*
Only on major projects as part of the scope of works monitoring – not an integral part of the works currently.

Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*
Internally based on negatives or issues arising.

Section 3 - Biodiversity Indicators
What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*
Area of 'green land'.
Hectares of SSSIs.

How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*
BAP process

How is this information used? *Reporting, adjustment of targets, adjustment of approach?*
For publicity materials and internal understanding

How many indicators do you feel would be a manageable and practicable number?
0-5 6-10 11-20 21-40 41+
At a systems level

Who conducts the recording / monitoring work? *Staff / Consultants / WT?*
None or very little undertaken.

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*
GIS mapping tools, especially for SSSIs and similar to phase 1 survey approach.

Section 4 - Biodiversity Experience / Advice
What have been the biggest hurdles you have faced when implementing your biodiversity programme?
Education and explaining what biodiversity means. Communicating that "Liking the countryside outside of work and in work is linked". Being seen as adding to a list of other things people have to do.

What have been the biggest benefits from implementing a biodiversity programme?

Developing a good relationship with English Nature and enhancing this over time.
Confidence to manage something concerning biodiversity.

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?
BAP document could be smaller and have less reading involved – more useable for on-site – less intimidating. Spend more time finding out what operational staff do.

What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?
Undertake training and advice for staff being affected by it.

Collaborating Organisation	**Allianz Cornhill**
Interviewee Name	**Mike Delaney**
Interviewee Position	**Finance Director**
Date	**14/03/2005**

Section 1 - The Organisation and Biodiversity

How does your organisation define biodiversity? *How is it approached? / what department is it group with? / Is there a written definition or one predefined to follow?*
No written definition – based on a '3 pillars of sustainable development approach'

How (and why) was biodiversity identified as an issue? *By formal assessment (Initial env. Review / EMS)? / Enthusiastic staff member? / External pressure?*
Pressure from above (Allianz Europe) and Local Authority encouragement on the more rural ewhurst site project. The opportunity at Ewhurst (it's 'greener').

Who identified it as an issue? *What is there position in the organisation?*
Vicky Flynn – Community and staff role as communications officer.

What do you see as the drivers or reasons behind biodiversity being addressed as an issue? *Stakeholder interest / Share index position / Market leadership / Risk management / external pressure?*
Local Authority pressure, publicity opportunities, staff pressure.

What commitments to biodiversity do you have? *Is there a biodiversity policy / statement? Is biodiversity in an EMS – where does it enter (in policy or key factors or objectives / targets).*
Committed to Sustainable Development and see biodiversity as part of this.

How long have you been addressing biodiversity? *Quantitative.*
2-3 years

Which person or level of your organisation has been most effective in delivering the biodiversity programme? *Can be interviewee*
Vicky Flynn as the persuasive personality keeping it on track.

Who has overall responsibility and decision making role for the biodiversity programme?
Interviewee and at a European level, Dr Astrid Zwick (Allianz.de)

How is biodiversity communicated as an important issue to the board and to the staff?
Internal communications – magazines, websites. Actions communicated.

Section 2 - The Biodiversity Approach

What aspects of the business is biodiversity considered for – Landholdings, supply chain, others, all?
Landholdings (Ewhurst)

How is your biodiversity work linked to external schemes? *LBAP, UKBAP, Local wildlife trust schemes?*
Local Wildlife Trust link

How are biodiversity targets set for landholdings? *External guidance from BAPs / consultants etc? Based on recorded data?*
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How is biodiversity work implemented? *Existing staff / adjustment of existing operations, new contractors / volunteers?*

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How is biodiversity work (or a general level of biodiversity) recorded or measured? *At what frequency / sample of sites?*
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Do you report on biodiversity performance? *Internally / externally, reporting progress (BAP) state of biodiversity (level) or qualitative reports?*
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Section 3 - Biodiversity Indicators

What do you measure to give a picture of biodiversity? *To obtain a value for biodiversity, overall?*
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How was this decided upon? Does it follow any particular guidance or methodology? *Does it follow an externally developed system – research proven / EN / Defra etc.*
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How is this information used? *Reporting, adjustment of targets, adjustment of approach?*
-

How many indicators do you feel would be a manageable and practicable number?

0-5 6-10 11-20 21-40 41+
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Who conducts the recording / monitoring work? *Staff / Consultants / WT?*
Volunteers in the company

What would you desire in this area to assist in the accurate measurement of biodiversity within landholdings managed by your organisation? *Set Guidance specific to industry / operations, guidance notes, lists of indicators?*
Tax rebates – financial incentives, economic benefits.

Section 4 - Biodiversity Experience / Advice

What have been the biggest hurdles you have faced when implementing your biodiversity programme?
Sometimes difficult to engage internal people. Money being seen by outside schemes as being free.

What have been the biggest benefits from implementing a biodiversity programme?
Good for staff – well known by all of company. Good local publicity. Surrey business awards, south-east business awards. CEO now more interested in green issues – car share schemes, green electricity. Responsible employer view from staff.
Team building, and building links with council, wildlife trust and local tree wardens.

How would you alter your approach or tackle the obstacles differently if you were to start from scratch?
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What advice would you give to people considering starting / increasing or reviewing their own biodiversity programme?
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