ECOSYSTEM SERVICE MODELLING

RULE-BASE DEVELOPMENT – SUGGESTIONS FOR USER

Contents

JNCC Joint Nature Conservation Committee

Environment SYSTEMS

Fabis consulting

Biodiversity			
CICES Ecosystem Service Typology:			
Section	**Division**	**Group**	**Class**
Regulation and Maintenance Provisioning Cultural	Encompassed in all CICES divisions.	Encompassed in all CICES Groups.	Encompassed in all CICES Classes.

Biodiversity description	Biodiversity is an important supporting ecosystem service that underpins a majority of ecosystem services and provides benefits to most aspects of human wellbeing (Norris et al., 2011). Biodiversity describes the range and diversity of species existing and includes genetic diversity within species and between different taxa in any area. Certain habitats and biogeographical regions tend to have more biodiversity than others. Biodiversity is related to the range of different niches available, with heterogeneous landscapes generally possessing a higher biodiversity value than homogenous systems (Ratcliff, 1977). Climax communities of semi-natural habitats that have been present for a long period of time tend to have the highest biodiversity, as over time they can develop specialized niches (Crawley, 1997). Humans alter the composition of biological communities through a variety of management activities. Some of these activates are bringing about increased rates of species invasions and extinctions (Hooper et al, 2005). Management of land, air and water, occurs at a variety of scales, from the localised individual field or plot level, though to the landscape level. At all these different spatial scales, management can have a major effect on the biodiversity of the habitats (Ratcliff 1977). Land use change and increased pollution have been, and continue to be, major drivers of change across the different habitat groups within the UK (Norris et al. 2011). There are many national, regional and local policies that seek to maintain biodiversity and prevent further decline.

Factor 1a - Soil	
Soil Types	Soil, as a host for many forms of life and a growing medium for terrestrialhabitats, has an important influence on biodiversity. In general undisturbed soil maintains a higher level of biodiversity; disturbed soils and bare soils have much reduced biodiversity value (Pankhurst *et al*., 1997). Human management of the soil can be a significant factor in terms of biodiversity; as well as the inherent nature of the soil itself (examined further below) (Brady and Weil, 2008)
Mineral	Mineral soils are generally well aerated. The presence of oxygen allows a varied assemblage of species to develop. Soil pH also influences species diversity with pH neutral soils supporting the most diverse ecosystems. Soil texture is also a key factor affecting the pore size and permeability of the soil and therefore the amount of water and oxygen present, in the soil, and the ratio to which each is present. Sandy soils are mostly formed from large rounded particles which create large pore spaces and facilitate easy passage for water through the soil; they therefore drain freely and can be prone to draught. Clay based soils, are composed of small, platy particles which align with one another, have small pore sizes and adsorb water to their surfaces, rather than allowing free flow through the soil. Clay soils are also compact

	easily, thus decreasing their water and oxygen holding capacity and reducing the amount of biodiversity they are able to support. Soils with a mixed loamy texture tend to have greater water holding capacity (Brady and Weil, 2002). Soil macrofauna, in particular earthworms, open up the macro pore spaces in soils and play an important role in maintaining soil biodiversity by allowing water and air to move freely within the soil system (Brady and Weil 2008).
Organo-Mineral	Where the top horizons of the soil are peat based the pH tends to be acidic and soils are often water logged. This creates conditions which are normally less diverse, compared to mineral soils (Brady and Weil 2008).
Organic	Organic soils provide a highly water-logged and often very acid environment. These extreme conditions normally result in a lower biodiversity than mineral soils (Brady and Weil 2008) although they do support scarce habitats.
Factor 1b - Geology	
	Geology has an influence on biodiversity (Cottle, 2004). This is mainly through the influence the underlying geology has on the soil pH and mineralogy as parent material inputs (Brady and Weil 2008). This can be particularly strong in areas where the geology is near the surface with very thin soils. For example, in areas underlain by limestone and chalk the resulting soils support calcareous grasslands; which have a high biodiversity and many unique species. In parts of the UK the solid geology is buried beneath drift deposits of glacial clays. Here the soils tend to be dominated by fine clay particles and they are therefore prone to waterlogging and often not as diverse as those developed more directly from the solid, mineral, geology. When considering the geological factors that influence soils biodiversity, the depth of the rocks, and the drainage characteristics of the underlying rock, affects the soil types that develop (Brady and Weil 2008).

Factor 2 - Habitat		
Biophysical Properties of habitats		The structure of the vegetation both above and below ground has a profound effect on biodiversity. The more complex the structures and the more varied the niches or locations for biodiversity development the greater the diversity of species found in an ecosystem. Therefore, deciduous woodlands which have occasional clearings and also contain trees, shrubs and understory species supports far more species of fauna and flora than most grasslands; where the vegetation has only 1 or 2 layers and fewer ecological niches available for species to inhabit. Time is also an important consideration, habitats present for many centuries allow specialist species to develop and thrive. However, some small perturbation of systems can enhance biodiversity by creating new available niches and varied environmental conditions that enable species with traits adapted to environmental disturbances and fluctuations to colonise. Large areas of long established habitats tend to have higher genetic diversity (Silverton, 2004).
Below ground physical features	**Root depths**	Below ground physical features of habitats are important for biodiversity by influencing the range of species that can inhabit the soil (Wall and Moore, 1999). Deep rooting species introduce large pore spaces deeper into the profile than shallow rooting species. The deep roots and larger pore spaces provide a more advantageous air/water ratio deeper into the soil profile allowing more organisms to thrive. (Brady and Weil, 2008).

Below ground biological features	**Species richness**	Below ground biological features are important factor governing biodiversity. It is largely a ‘hidden’ biodiversity but very important in the lifecycle of many species of insects and invertebrates and as shelter and refuge for many below-ground dwelling mammals and birds. (Brady and Weil, 2008).
Above ground physical features	**Biomass/ Canopy Height**	Above ground physical features of habitats are important for biodiversity. More diversity within the structure of the vegetation above ground provides a greater breadth of ecological niches that can be occupied by a greater number of organisms and therefore increases the overall levels of biological diversity (Naeem et al., 2010).
Above ground biological features	**Species Richness**	Above ground species richness is a direct record of biodiversity. Where only habitat data is available the influence of structure should be included to provide an idea of likely niche availability for other species groups (Wheeler and Shaw, 1991).
Other effects (How other data can be used as a proxy indicator)		Currently there is still a lack of quantitative data that demonstrates a clear link between current biodiversity status and trend data with the delivery of ecosystem services within the UK (Norris *et al*, 2011). To start looking at biodiversity at a landscape scale, habitat data, such as NVC Phase 1, Landcover Map, and IHS, could be used to spatially describe the criteria set out in the nature conservation review which was used to identify and select national SSSI designated sites (NCC, 1989). The criteria defined in the nature conservation review (Ratcliff, 1977) sets out a number of evaluation factors to consider when examining and mapping biodiversity. For instance: **Naturalness** – from (e.g. BAP Priority) – those habitats which have received little modification by humans (which are particularly rare). **Size** – The area of a patch of habitat must be sufficient to be resistant to edge effects and invasive species, as well as being resilient to future environmental changes (Laurance and Yensen, 1991). **Diversity –** The higher the plant community species richness, the higher the diversity within the habitat. This is difficult to accurately compare as some plant communities are intrinsically more species rich than others. Detailed habitat classifications such as Annex I or NVC, which take into account the presence of species and communities, can be added to the broader habitat classifications to model species diversity. **Connectivity –** Habitats which are well connected are less likely to suffer edge effects and are more likely to support a greater number of organisms that inhabit that particular ecological niche (Laurance and Yensen, 1991). Fragmented patches (depending on size) can only support smaller populations and are therefore less resilient to stochastic event and less resistant to impacts.

Factor 3 - Landform	
	Landform only influences biodiversity in so far as it contributes to the range of above-ground or below-ground habitats that can be sustained. There is no inherent difference in potential biodiversity dependent on landform.

Factor 4 - How it is managed	
Negative Management	Negative management, leading to reduced biodiversity includes: • Felling of woodlands • Paving over of gardens and other areas creating larger expanses of sealed land surfaces • Increasing cultivation productivity of agricultural land, thus reducing the presence of wild plant species and invertebrates • Increased soil disturbance • Increased destruction of natural habitats • Poor management of existing habitats • Fragmentation of existing habitat leading to reduced genetic resources • Pollution impacts from agricultural diffuse pollution, point source pollution from urban areas and air pollution.
Positive Management	Positive management, leading to increased biodiversity includes: • Planting of woodlands, • Maintenance of gardens and other areas of natural soils in urban areas • Reduced cultivations on agricultural land increasing the prevalence of wild plants and invertebrates (Battershill and Gilg, 1996) • Reduced soil disturbance • Reduced destruction of natural habitats • Better management of existing habitats • Restoration of natural habitats • Traditional management of hedges.

References

Battershill, M. R., & Gilg, A. W., **1996**,. Traditional farming and agro-environment policy in Southwest England: Back to the future?. *Geoforum*, **27**(2), *133-147*.

Brady N C and Weil R R (2008) The Nature and Properties of Soils. Prentice Hall/Pearson Education

Cottle (2004) Geology and biodiversity making the links. English Nature. [online] available at: http://publications.naturalengland.org.uk/publication/135006 (accessed on 12th August 2013)

Crawley, M. (Ed), **1997**, Plant Ecology. 2nd Ed. Blackwell Science. Oxford. 3.

Hooper, D. U., Chapin, F., S., Ewel, J., J., Hector, A., Inchausti, P., Lavorel, S., Lawton, J., H., Lodge, D., M., Loreau, M., Naeem, S., Schmid, B., Setala, H., Symstad, A., J., Vandermeer, J., and Wardle, D., A., **2005** Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. Ecological Monographs. **75**, 3–35

Laurance, W. F., & Yensen, E., **1991**. Predicting the impacts of edge effects in fragmented habitats. *Biological Conservation*, **55**(1), *77-92.*

Nature Conservancy Council, **1989**, Guidelines for selection of biological SSSIs: Rationale Operational approach and criteria:-detailed guidelines for habitats and species group. Nature Conservancy Council. Peterborough.

References

Norris, K., Bailey, M., Baker, S., Bradbury, R., Chamberlain, D., Duck, C., Edwards, M., Ellis, C, J., Frost, M., Gibby, M., Gilbert, J., Gregory, R., Griffiths, R., Harrington, L., Helfer, S., Jackson, E., Jennings, S., Keith, A., Kungu, E., Langmead, O., Long, D., Macdonald, D., McHaffie, H., Maskell. L., Moorhouse, T., Pinn, E., Reading, C., Somerfield, P., Turner, S., Tyler, C., Vanbergen, A., Watt, A., **2011**, Chapter 4: Biodiversity in the context of Ecosystem Services. In: UK National Ecosystem Assessment. UNEP-WCMC, Cambridge

Naeem, S., Bunker, D, E., Hector, A., Loreau, M., Perrings, C (2010) Biodiversity, Ecosystem Functioning, and Human Wellbeing

Ratcliff D. J., **1977**, A Nature Conservation Review Cambridge University Press

Silvertown, J., **2004**, Plant coexistence and the niche. *Trends in Ecology & Evolution* **19**.11, pp*605-611*.

Wall, D., H., and Moore, J., C., **1999**, Interactions underground: soil biodiversity, mutualism, and ecosystem processes. *BioScience* **49**.2, *pp109-117*.

Wheeler, B. D., and Shaw, S. C., **1991**, Above-ground crop mass and species richness of the principal types of herbaceous rich-fen vegetation of lowland England and Wales. *The Journal of Ecology*, 285-301