

The concept of woodland diversity: a review

by Norman Dandy, Seumas Bates and Zoe Pearson

Summary:

Over the past few decades, the promotion of diversity as a management goal has become a central element of 'best-practice' within British forestry and woodland management circles. Diversity and diversification are often intrinsically tied to the prioritisation of conservation objectives, the promotion of 'nativeness' in species selection, and the urgency of building woodland resilience in the face of pests,

diseases, climate change and other threats. By tracing the idea of a 'diverse' woodland through historical context and contemporary usage, this paper seeks to help us better understand the term and challenge certain assumptions about it that are taken for granted, including the idea that a woodland cannot be both productive and ecologically rich.

Introduction

Maintaining and increasing diversity within our woods and forests is perhaps one of the most widely shared contemporary goals amongst forest managers both in the UK and beyond. Biological diversity of species, genes, and ecosystems, along with structural diversity across our landscapes and over time, are viewed more or less ubiquitously as an intrinsic good. Even within commercially oriented plantations – commonly thought of as simple monocultures – some level of species and structural diversity is usually sought or (increasingly) mandated within incentive and standards schemes. Currently, the link between diversity and the resilience of our forests is especially prominent as the forestry and woodlands sector, along with others, seeks to respond to climate change and the threats posed by pest and diseases. But where has this shared management goal come from?

The DiversiTree project, funded by the Future of UK Treescapes programme, is focused on answering questions such as this. In this article we set the context for that project by exploring how the concept of diversity has evolved in relation to our woodlands and forests. We set it in its historical and political contexts and seek to demonstrate both its long cultural roots and contemporary meanings.

Biological diversity, the conservation movement and British forests

Perhaps the single most significant 'moment' in the modern evolution of ideas about the importance of diversity

within environmental systems was the 1992 Rio 'Earth Summit' which produced the *Convention on Biological Diversity* (CBD). The first line of this landmark international agreement explicitly highlights and acknowledges "the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components". It went on to create numerous obligations for its signatories to protect diversity, including the duty to undertake environmental impact assessments – familiar

to many in the forestry world. Also to emerge from Rio were the 'Forest Principles' – a non-legally binding declaration relating to the sustainable management of forests that identified forests as "rich storehouses of biodiversity" (United Nations, 1992). Of course, the CBD (and Forest

Principles) didn't emerge from a void. The ecological sciences had been in full flow demonstrating the complex interrelations of ecosystems and species for decades. In the political arena, the United Nations' 1987 Brundtland Report (*Our Common Future*), for example, had "stressed the importance [of] conserving the sum and variety of species on earth" (McConnell, 1996).

It was, therefore, primarily from the conservation movement that explicit contemporary concerns about diversity in woods and forest emerged. Indeed, whilst discussion of diversity was not prominent in pre-1990s forestry science, it is notable that those contributions that did engage with the subject emanated from conservation-oriented scholarship. For example, in his 1972 paper *The*

“The link between diversity and the resilience of our forests is especially prominent.”



Figure 1. In the 1970s management moved towards establishing more diverse woodland.

Conservation of Bird Life in the New Coniferous Forests, Kenneth Williamson emphasised the “the great value of diversity – a good mixture of tree species and types of cover from high canopy to thick hedgerow, with an irregular pattern and outline giving the maximum ‘edge effect’.” (Williamson, 1972). He also voiced the emerging negative opinions about plantation forestry and noted opportunities for future improvement through management:

“Many areas of dull conifer monoculture, with a very low density and diversity of bird-life, which are now nearing maturity and will soon be felled, could be made vastly more attractive to amenity and wildlife when the next rotation of planting begins.” (ibid).

Later in the 1970s, in his ‘Management Principles’ George Peterken identified the need to “Encourage diversity of (i) structure, (ii) tree and shrub species, and (iii) habitat” (Figure 1) as being essential for integrating nature conservation into woodland management (Peterken, 1977).

With the scientific and political worlds thus building

towards the ‘Earth Summit’, concern for the conservation of diversity grew further amongst foresters during the late 1980s and early 1990s. Calls for the conservation of genetic diversity increased (e.g. Soutar and Spencer, 1991; Ledig, 1988) and links began to be made between diversity and management resilience. Hummel, for example, noted that “Diversity enriches the environment, and a wider choice of options enables forest managers to respond more effectively to differing wishes and circumstances of forest owners.” (Hummel, 1991).

Scientific forestry, the state, and the simplification of forest complexity

Embracing biological diversity posed a substantive challenge to forestry in the UK, and elsewhere. Since the late 18th century, developments in Western European political and economic systems led state sponsored ‘scientific forestry’ to direct its energy in the opposite direction: the simplification of forest complexity (Scott, 1998). Natural forests had long proved tricky terrain for increasingly centralised government bureaucracies which

struggled with their complexity. This included the need to reliably understand and measure timber yields: knowledge that was (and still is) important for predicting stable tax revenues. This led foresters, initially, to seek to standardise forest resource assessment within the natural forests from which they drew their vital timber resources (Lowood, 1990). Subsequently, they attempted to actually create ordered forests that were “easier for state foresters to count, manipulate, measure and assess” (see Scott, 1998). Whilst the idea of a tree ‘plantation’ reaches back to at least the 17th century in Britain (Rackham, 2006), the scientific foresters of the 19th century and beyond were to create enormously simplified ecologies with very few tree species, designed to facilitate straightforward intervention and management based on easily understood written protocols. The public forest estate that British foresters found themselves managing at the time of the ‘Earth Summit’ was to a significant extent, a legacy of this approach (Figure 2).

Prior to that time, forest policy in the UK made almost

no reference to diversity (e.g. see Forestry Commission, 1991). There was a clear shift, however, following Rio and the Ministerial Conference on the Protection of Forests in Europe which saw the adoption, in 1993, of the *Helsinki Guidelines*. These included a resolution (H2) focused explicitly on the conservation and increase of biodiversity and subsequent policy statements, such as 1994 *Sustainable Forestry: the UK programme* (UK Government, 1994), contained whole sections on the subject. The fit of this agenda with Britain’s predominantly broadleaved ‘native woodlands’ was reasonably clear. However, plantation forests owned both by the state and many private land-managers – the artefacts of ‘scientific forestry’ and bereft of tree species diversity – were less obviously aligned. This led foresters to seek ‘new perspectives’ (e.g. Innes, 1993; Poore, 1995) to underpin forestry practice: reflecting on what was meant by biodiversity and, critically, promoting the diversity that *could* be found in plantations (Figure 3). As one review of a new ecology textbook exclaimed, “With



Figure 2. A plantation monoculture in northern Scotland.



Figure 3. Natural regeneration in a forest in the Highlands of Scotland.

a little thought, plantations can be immensely diverse and attractive!” (Houldershaw, 1994). In fact, a great deal of thought and analysis was put into this effort. The Forestry Commission undertook a major research effort in the late 1990s both to quantify the contribution of planted forests to Britain’s biological diversity and to assess potential changes to management approaches that would promote biological diversity (e.g. Ratcliffe and Peterken, 1995; Kerr, 1999). This work “challenge[d] the notion that plantations are ecological deserts” (Humphrey et al., 2003) and concluded that, despite dominant perceptions, “plantations make a positive contribution to biodiversity conservation in the UK” (Humphrey et al., 2002).

A longer view: intuitive practice and woodland diversity

Monocultures as seen in ‘modern’ production forestry are not the historical rule. It is useful to consider the above-mentioned ‘scientific’ model of forestry – which prioritised financial productivity and understood forests in terms of officially extracted and mathematically quantifiable timber yields (Lowood, 1990) – within a much longer historical context during which ecological diversity, not monoculture, was the norm. In fact, if we look back further historically, we see that the contemporary management of woodlands as both productive and ecologically complex places is a return to a long-established normality. As shall become evident, humans have long been interacting with, using, and managing diverse forests.

There is, of course, substantial debate surrounding when humans first began formal ‘woodland management’, as opposed to less formalised ‘intervention’ in woodlands,

however Bleicher and Staub (2023) argue that the practice dates back at least to the Neolithic period. In the British context, Rackham’s concept of ‘woodmanship’ highlighted the earliest interactions between humans and natural woodland: particularly in the forms of coppice and wood pasture. Whilst the impact on diversity may be unclear, Rackham contends that this ‘management’ drove changes in species composition (Rackham, 1994; 2000). It is beyond the scope of this paper to offer a comprehensive narrative of woodland management over the many thousand years of human history, yet it is indeed useful to note that there is some evidence that human intervention generated increases in biological diversity. It is, of course, challenging to conclude whether this ‘management’ of diversity was conscious or, more likely, intuitive and founded on culturally shared principles that emerged over time.

Tipping et al. (1999) used palynological data to determine that prehistoric regions containing settled agricultural communities in Scotland approximately 6000 years ago saw a measurable increase in local woodland biodiversity. It is noted, that this environmental management or ‘modification’ went beyond simple tree removal, but instead represented a more complex display of landscape manipulation and management to better suit the needs of the associated human community. A by-product of which (intended or otherwise) was an increase in biodiversity.

Prehistoric modification of woodlands can also be seen amongst hunter-gather communities, however, with an outcome of this often being diversification (Innes and Blackford, 2023). There is evidence that Mesolithic hunter-

gatherer societies in northern England utilised fire as a tool to both clear understory vegetation, as well as to thin and open areas of woodland. These authors argue that it is probable that among the motives for this practice was that of promoting biodiversity and generating space for desirable and useful plants to appear and spread.

Moving forward in time, others have discussed the diversity of woodlands managed in the medieval period in Europe. Lewit (2009) has extensively explored the impact the fall of the Western Roman Empire had on rural life, arguing on page 91 of *Pigs, presses and pastoralism* that “In western Europe, forms of both land use and of settlement changed. We can discern a tendency away from specialized production towards diversification, regeneration of woodland and marshlands, and less intensive land use”. Others have also discussed this shift, with practices such as coppicing (Rotherham, 2011) and woodland-pasture usage (Moreno et al., 2019) having a direct, positive, impact on the diversity of flora and fauna in the local ecosystems and woodlands. Indeed, where there were pre-19th century arboreal monocultures such as chestnut orchards, there is evidence that in some regions these were conceptualised as part of agriculture, and thus somewhat distinct from ‘forestry’ (Moreno et al., 2019).

Indeed, managed yet diverse woodlands were the norm in Western Europe in the Middle Ages. Wood was, of course, a critically important source of fuel during this period, with archaeological evidence of significant variety in wood species utilised in charcoaling activities in Ireland (Lyons, 2018), and other research detailing the complexity and ubiquitousness of coppicing practices in Moravia during the same timeframe (Szabó, 2015). Other research has pointed to medieval woodland management that actively maintained diverse woodland ecosystems for reasons other than producing firewood. Holl and Smith (2007), for example, draw on historical evidence of woodland grazing and the associated ‘shieling’ system in the Scottish Highlands as guidance for contemporary woodland restoration work which promotes rich biodiversity, arguing that understanding this historical system, or practice, should be key in more recent diversification efforts. These studies and others point to medieval woodlands being actively and deliberately managed for human needs, resulting in the maintenance and generation of increasingly diverse, complex woodland ecosystems.

Finally, it is also important to acknowledge that even during the height of the 19th century focus on woodlands and forests as simplified productive spaces,



Figure 4. Lithograph of animal nesting boxes from Gloger (1865).

there is evidence that some managers were still working to preserve and even increase diversity within their woodlands. Although generally outside the mainstream, some managers in Germany recognised the significance of ‘habitat trees’ which were of key importance to maintaining local wildlife populations. Indeed, in some cases this promotion of diversity within these forests extended to the construction of artificial bat and bird boxes within them (Mölder et al., 2020; Figure 4). From just this limited overview of historical woodland management, we have evidence of the continuance, protection, and even promotion of diversity as common facets of early human-arboreal interventions.

Contemporary understanding of woodland diversity: function and resilience

In today’s forestry and woodland management arena there is once again widespread recognition that diversity is a positive and desirable characteristic for our forests.

Diversity is, however, understood in numerous different ways. In the DiversiTree project we talk about diversity at a range of scales – ‘from microbes to minds’! Whilst variation between the trees is maybe most obvious to many of us, we can see diversity everywhere depending on which element of the tree, forest, or landscape we are focused on: amongst genes, microbes, understorey, fauna, ecological interactions, stands, compartments, vegetation structure, management approaches, and across forests and woodlands in the landscape. This breadth has actually led some to question the usefulness of ecological diversity as a scientific concept, and certainly its measurement is considered challenging at best (Daly et al., 2018).

Whilst conservation – i.e. the protection and promotion of biological diversity – may be the most common general driving force for forest management, there are numerous other potential motives. Commercial forestry is often considered the antithesis of diverse forests, however, there are clear economic benefits to holding a portfolio of diverse timber species, at least at a landscape scale. Furthermore, continuous cover forestry strategies are introducing further diversity of species and structure to commercially productive and profitable systems at a finer scale which also allows for ecological continuity and renewal. There is also clear visual amenity value derived from variety in forest species and structure (Edwards et al., 2012). Currently, however, it is perhaps the link between diversity and ecological resilience which is at the heart of contemporary forest management thinking – a concept which, to some extent, brings a coherence to the breadth and complexity of understandings of diversity, and which is considered essential to respond to actual and anticipated impacts of climate change and other threats.

Diversity is commonly viewed as a central component of forest and woodland resilience (DEFRA, 2018) on account of the supportive role it is considered to play in a system absorbing or adapting to changing conditions or external shocks (Mentges et al., 2023). Whilst there are numerous contingencies and interdependencies within a woodland ecosystem, in short, greater diversity is generally considered to provide greater resilience. There are perhaps two cornerstones to this relationship: *functional redundancy* and *response diversity*.

Functional redundancy relies on there being a number of different components (e.g. species) within a system which contribute to one of its functions. Where this is the

case, the absence of one of these components can be compensated for by others occupying the same functional niche (Correia et al., 2018). Thus, a mixed species woodland providing the ‘function’ of rainfall interception and flood mitigation, would continue to carry out that function (albeit potentially at a reduced rate) even if one of the tree species providing it was lost to a pest or disease (Figure 5). The DiversiTree project is exploring functional redundancy in relation to the ecological associations between Scots pine, Sitka spruce and other flora and fauna (e.g. lichens, birds, beetles) that live on them. What species might be used to add diversity to Scots and Sitka forests which would provide a home to those associated same species were Scots or Sitka be lost from them?

Response diversity relates to the different responses to disturbance that are expressed by different components within a system. Response diversity is considered high if many species providing the same function respond differently to the same disturbance event. This maximises the chance that one or more species within a functional

niche will respond in a way that bypasses the disturbance effects (Correia et al., 2018). A useful example of this is the varied capacities of tree species to cope with fire.

Woodland diversity is not, however, a purely ecological matter.

Socio-economic diversity mediates ecological diversity. Studies of the management of Mediterranean chestnut forests have, for example, revealed the interactions between long-standing cultural norms and ecological resilience (Michon, 2011). In these *Castegnetu* forests, the cultural pride taken in the wide array of chestnut varieties contributes to the ecosystem resilience (by increasing genetic diversity of the tree species, contributing to functional diversity). In turn, the *Castegnetu* increases the response diversity of the human-system, providing a variety of subsistence and income avenues which have allowed its human communities to adapt to evolving economic conditions over time (Michon, 2011). Plurality of landownership, and the consequent variety of land management motives and goals, has also repeatedly been shown to contribute to the response diversity of environmental systems (e.g. Van Schmidt et al., 2021; Lopes et al., 2011; although research focused directly on forest systems is lacking here). Research has also shown that forest management strategies oriented towards resilience – using harvesting and natural regeneration to

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Figure 5. Diverse and mixed-use river woodland in North Wales.

reduce species dominance and establish a more diverse stand structure – do not necessarily compromise economic outcomes (Dymond et al., 2014).

In these ways, contemporary ecological and social analyses may perhaps be describing the functions of diversity which have been known – intuitively, without modern scientific detail – through practice for a long time. Our ‘modern’ context, which demands a response to increasingly unpredictable future conditions, has maybe created a focus on resilience – cast in terms of scientific truths – that is simply the latest culturally created understanding or framing of diversity and its benefits. In this modern attempt to rationalise complex forests through resilience-oriented science, some may hear echoes of state-led efforts to simplify and rationalise the forests of the 18th century.

Diversification: the contemporary challenge

Human management of our woods and forests that generates diversity – in many forms – has been the norm throughout human history. Monoculture forestry has been only a temporary, and relatively brief, diversion from this path. It has, however, left a substantive legacy for today’s land managers – faced with climate change and globalisation – to deal with. Can we reasonably expect those in the UK’s forest industry to diversify their forests and still compete in the global wood and timber trade, as well as produce more and more timber for use as a sustainable material ‘at home’? Can we reasonably expect that our conservation sector – focused on ideas of ‘nativeness’ and species lists – diversify their woodlands with ‘climate smart’ tree species that have a better chance of surviving in our changing climate? The DiversiTree project is seeking to play its part in answering these questions and whilst there are still many specific elements to think about, the evidence for a positive and resilient relationship between people and woodland diversity is clear.

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