

1 **Biodiversity implications of coppice decline, transformations to high forest** 2 **and coppice restoration in British woodland**

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9 **Abstract**

10 Coppice systems are amongst the earliest forms of woodland management known and on some sites
11 their use has been documented for centuries. Distinctive assemblages of plants and animals are
12 associated with such systems and are highly valued in nature conservation terms. The richness of
13 such assemblages, and conversely, the species that do not thrive under coppice, are linked to the
14 alternation of relatively short light and dark phases and the juxtaposition of stands at different stages
15 in the coppice cycle.

16 We review how and why the biodiversity of former coppice woods changes in response to
17 abandonment and conversion to high forest. We focus on the situation in the UK, based on recent
18 published literature searches and the authors' extensive experiences of the practical issues involved in
19 the conservation of coppice woodland systems.

20 Vascular plants in the ground flora, invertebrates of open glades and scrub, and small birds of
21 the understorey may have become more abundant in coppice than they would have been under
22 'natural' forest conditions. By contrast epiphytes dependent on mature trees and species of large-
23 sized deadwood are less favoured by coppice management.

24 Coppice systems developed to meet the local community needs. As social and economic
25 conditions changed, so coppicing declined and the woods were transformed into high forest through
26 neglect or deliberate management. High forests differ from coppice stands in their spatial and
27 temporal dynamics and consequently in their wildlife particularly with respect to their vertical
28 structure pattern; extent of open space and young growth; spatial heterogeneity; tree and shrub
29 composition; and browsing levels.

30 Three issues for the conservation of biodiversity arise from these changes:

- 31 • what priority and resources should be given to halting further decline, by maintaining coppice
32 compared to allowing sites to develop with more ‘natural’ high forest structures and
33 dynamics; will associated high-forest species recolonise?
- 34 • if we restore coppice systems, will the species assemblages present in the past also recover,
35 under current and future changes in environmental conditions; i.e is the transformation
36 reversible under current environmental conditions?
- 37 • are there other ways in which ‘coppice-associated’ species might be maintained?

38 We identify research gaps and proposals to address these issues.

39 **Keywords:** coppice, Britain, conservation, wildlife, restoration, high-forest

40 **Introduction**

41 Our ancestors would have noted, perhaps often with frustration, that cutting down a tree does not
42 necessarily kill it: many broadleaved species send up several or more vigorous shoots from the cut
43 stump, at least some of which may be capable of becoming big trees in their own right (Koop 1987).
44 The evolutionary origin of this adaptation is uncertain, but it is undoubtedly a useful response to the
45 activity of beavers in floodplain landscapes, to avalanche and landslips on steep slopes, the effects of
46 windblow, or even, it has been suggested, to the damage that might have been caused by the lost
47 mega-fauna that once roamed Europe (Monbiot 2013).

48 Nor were our ancestors slow to take advantage of the coppice habit. The small straight stems
49 arising from a stool were easily cut, transported and worked in societies that relied primarily on
50 human muscle power. Evidence from prehistoric settlements and trackways across Europe suggest
51 that coppice material was commonly being used even then (Kreuz 1992; Rackham 2003; Out 2010).
52 Classical writings refer to the practice (Grove and Rackham 2001). From the Medieval time onward
53 there are frequent writings dealing with how coppice woods ought to be managed, as well as court
54 records dealing with situations where such management guidance had not been observed; for example
55 livestock being allowed into the woods and causing damage to the coppice regrowth (Rackham 1990,
56 2003). Many different crafts and industries built up that made use of coppice products (Edlin 1949).
57 Scattered amongst the underwood some trees (standards) might be left to grow on to provide larger-
58 sized timbers. People might collect litter and bracken for animal bedding, deadwood for firewood,
59 fungi, berries and honey for food. Some controlled stock grazing and even small scale arable
60 cultivation might take place amongst the trees and shrubs.

61

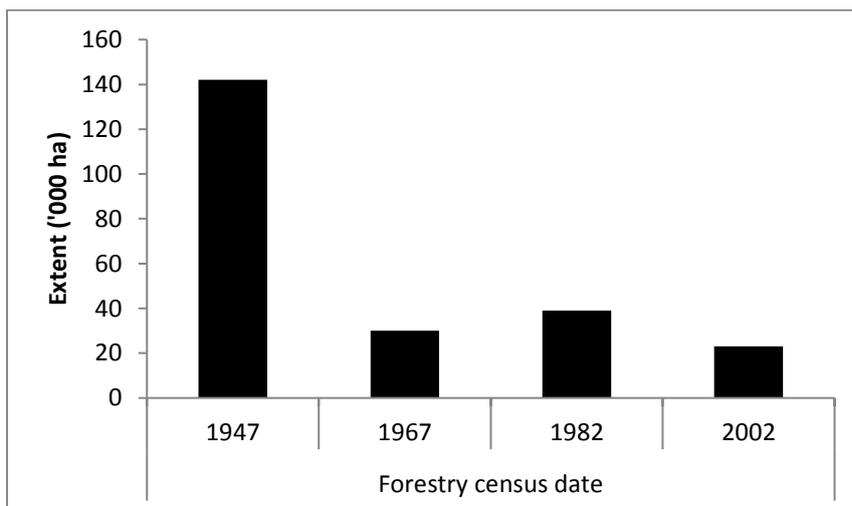
62 Across Europe relatively large areas are still recorded as coppice (Buckley and Mills 2015a),
63 particularly in south-eastern countries; rising fuel prices have revived interest in the use of firewood in

64 both urban and rural areas. However, this is set against a general pattern of decline in this way of
 65 managing woodland elsewhere.

66 In this paper we review how and why the biodiversity of former coppice woods changes in
 67 response to abandonment and conversion to high forest. We focus on the situation in the UK, based on
 68 recent published literature searches (Buckley and Mills 2015a,b) and the authors' extensive
 69 experiences of the practical issues involved in the conservation of coppice woodland systems. We
 70 identify some key issues that need to be addressed by conservation managers and foresters if the
 71 distinctive species assemblages of coppice are to be maintained in future and identify some research
 72 gaps and proposals to address these issues.

73 **Coppice in the UK**

74 In the UK coppice management started to go into decline in the late 19th, early 20th centuries
 75 (Buckley and Mills 2015a) with many areas not cut since the second world war. It hardly features in
 76 recent forest inventories (Figure 1), although there are reasons to believe that it has been under-
 77 recorded (D. Bartlett personal communication). (Areas of mature coppice may not be distinguishable
 78 from abandoned stands in aerial photographic surveys; coppice working may fall outside the usual
 79 requirements for felling licences if the stems cut are of small diameter; it may not qualify for any
 80 restocking grants, so is not picked up in the general forestry regulations systems.) Abandonment of
 81 coppice systems may leave the woods open to damage through unrestricted grazing or clearance; or
 82 the woods may continue to exist, but be transformed through neglect into high forests. High forests
 83 frequently have a different tree and shrub composition to the coppices they replace and certainly a
 84 different structure and dynamic pattern.



85

86 Figure 1. Extent of coppice ('000 ha) in Great Britain (from Hopkins and Kirby 2007, based on
 87 Forestry Commission census reports).

88

89 The decline of coppice management in Britain has been proposed as contributing to declines
 90 in particular groups of species during the twentieth century (Hopkins and Kirby 2007; Buckley and
 91 Mills 2015b); examples in Table 1. We therefore explore what are the features of the coppice system
 92 that allowed a distinctive suite of species to thrive; how these assemblages change in the
 93 transformation to a high forest structure; and the feasibility of maintaining ‘coppice’ species either
 94 through restoration of coppice management, or other means.

95 **Table 1.** Studies suggesting a link between species-declines and loss of open woodland and young
 96 growth, such as is created by coppicing

- 97 • Of six butterfly species associated with clearings in woodlands, three have shown marked
 98 national declines: a 77% decline since 1970–82 in the case of the High Brown
 99 Fritillary *Argynnis adippe* (Asher et al. 2001).
- 100 • Kirby et al. (2005) found a reduction in ground flora species richness in woods surveyed in
 101 1971 and 2001 associated with increasing basal area of trees and shrubs (basal area often
 102 being closely associated with canopy cover).
- 103 • The decline of coppice woodland management is probably a significant factor in the present
 104 scarcity of dormice, *Muscardinus avellanarius* (Bright and Morris 1990)
- 105 • Changes in woodland structure were thought to be the most likely driver for many of the bird
 106 declines observed in a resurvey in 2003/4 of woods first visited in the 1980s or earlier. These
 107 structural changes may have been driven by changes in woodland age, reduction in
 108 management and deer browsing (Amar et al. 2006). Fuller (1992) reported on the high
 109 densities of migrant song-birds that could be sustained in worked coppice.
 110

111 Note that throughout this paper reference to coppice systems includes simple coppice and
 112 coppice-with-standards plus variations on these, unless specified otherwise. Pollarding and wood-
 113 pastures are however not considered (Hartel et al. 2015; Plieninger et al. 2015).

114 **Distinctive features of coppice from a biodiversity perspective**

115 Views differ on whether the natural landscape of Europe was predominantly closed forest or more like
 116 wood-pasture (Peterken, 1996; Vera 2000; Kirby and Watkins, 2015b). Both might contain natural
 117 analogues of coppice structures, with presumably at least, some of the species seen in coppice today.
 118 However the assemblages that we now associate with coppice woods, and value from a conservation
 119 perspective, are the product of many centuries, possibly millennia of management. Coppices are as
 120 much a form of cultural landscape as hay meadows or heathland.

121 The distinctive biodiversity of coppice woods (Buckley 1992; Buckley and Mills 2015b),
 122 compared to high forest stands can be linked to a number of features summarised below: the short
 123 cutting cycles, the high degree of spatial heterogeneity, high woody species diversity, freezing of
 124 genetic composition, lowered risk of wind-throw, high export of nutrients, limited amounts of fallen
 125 deadwood, limited/controlled grazing pressure.

126 Coppices are typically cut on cycles of 5-30yrs. The open stands after cutting have much
127 higher richness and cover of vascular plants, e.g. Ash and Barkham (1976), Ford and Newbould
128 (1977). Clear-fells in high forest can show a similar level of plant richness, but at any one time a
129 smaller proportion of the wood will be in the open stage because stands are cut-over only every 80-
130 120 years (Kirby 2009, 2015). Plants that rely on seed banks to survive the dark phase of forests have
131 a higher chance of being able to last from one open phase to the next in a coppice than in high forest
132 (Van Calster et al. 2008); there are more frequent opportunities for the flowering of species that
133 survive the dark phase in vegetative form (Barkham 1992). However species that survive better under
134 partial shade and high humidity, such as some bryophytes, are likely to be disadvantaged by these
135 regular periods of opening up of the canopy with higher light and temperature conditions (Edwards
136 1986).

137 Cutting of coupes tends to be on a relatively small scale with all ages of coppice being
138 maintained close together: this produces a high degree of spatial heterogeneity. Invertebrates of
139 temporary gaps are thus more likely to be able to spread from one gap to the next, but equally there
140 can be good spatial continuity for species such as the hazel dormouse *Muscardinus avellenarius* that
141 are predominantly arboreal (Fuller and Warren 1993; Bright et al. 2006). Localised heterogeneity of
142 woodland structure allows opportunities for a variety of different songbirds to co-exist (Fuller and
143 Henderson 1992).

144 High woody species diversity often occurs in coppice crops because there are regular
145 opportunities for light-demanding species to regenerate; in high forest systems shrubs and short-lived
146 trees tend to decline as the tree canopy matures and becomes denser. This provides more
147 opportunities for serial feeders such as hazel dormice that rely on a sequence of flowers, fruits and
148 seeds over the season (Bright et al. 2006). However, at various times and places this diversity of
149 woody species has been reduced by deliberate selection for particular trees or shrubs to ‘improve’ the
150 coppice, favouring hazel *Corylus avellana* in southern England, sweet chestnut *Castanea sativa* in
151 Kent, or oak *Quercus* spp, in western Britain (Peterken 2015).

152 Some ‘freezing’ of the genetic composition of stands may have occurred because of the
153 predominance of regrowth from the stools, which can be hundreds of years old. However the degree
154 to which this has happened in practice, and its significance, is uncertain (Buckley and Mills 2015a).
155 Stool regeneration may have preserved genetic diversity that existed prior to strong selection for
156 straight timber trees, or reduced it because there have been reduced opportunities in the last few
157 centuries for new combinations of genes to emerge that are selected for current, rather than distant-
158 past conditions.

159 There can be a lower risk of windthrow because the stems are shorter compared to high forest
160 systems, which also means reduced soil disturbance from pit and mound formation: in South-east

161 England the 1987 Great Storm re-introduced English ecologists to this phenomenon in neglected
162 coppices (Kirby and Buckley 1994). Lack of such natural soil perturbation may be countered by high
163 anthropogenic disturbance through the creation of sawpits, charcoal hearths, woodland banks and
164 ditches, and any past arable cultivation (Rackham 2003).

165 Greater export of nutrients may occur from coppice woods because the poles are harvested
166 young when there is a greater proportion of bark to wood than with the felling of high forest stands
167 (assuming that the branchwood is left on site). This may not lead to nutrient deficiencies if the rates
168 of nutrient release in the soil from weathering of the underlying parent material are sufficient to
169 compensate for such losses over the growth cycle. On acid, nutrient-poor substrates, there may
170 however be the potential for some nutrients to become limiting, particularly if the losses are
171 exacerbated by other practices such as litter collection. Reduction in nutrient availability has been
172 suggested as a possible reason for the trend to lengthening cutting cycles seen at some sites over time
173 (Rackham 2003).

174 Reduction in soil fertility through these processes could also contribute to the richness of the
175 ground flora by reducing the potential for competitive species to dominate (Dzwonko and Gawroński
176 2002) on reasonably fertile sites. On less fertile sites plant richness might decline, but the effect would
177 be less obvious because acidic, low nutrient, woodland communities tend to be poorer in vascular
178 plant than rich ones to start with (Rodwell 1991).

179 Fallen dead wood is usually very limited in worked coppice, particularly in the larger size
180 classes, because most stems are harvested while still small. Any material lying on the ground was
181 likely to have been removed for firewood, even down to small twigs for kindling. Kirby et al. (1998)
182 reported less than 20m³/ha of fallen deadwood in worked coppices, but up to 60m³/ha in those that
183 had been abandoned.

184 Recently, more attention has been paid to dead wood and its attendant species within living
185 trees (Siitonen and Ranius 2015): this habitat may be provided to a small degree in large old coppice
186 stools and in pollards created on boundaries of coupes or the wood itself. In the past the standard trees
187 in coppices would generally have been harvested while still comparatively young and sound.
188 However, as a result of abandonment many former standard trees are now important for their internal
189 deadwood resource because they have reached the age (c.150 years) where hollowing of the main
190 trunk is likely to start (Ranius et al. 2009).

191 Coppice regrowth is potentially vulnerable to grazing and levels of grazing were therefore
192 limited and controlled. When the woods were still actively worked in the 19th century, deer numbers
193 in the UK were low and there would have been many more people working in the woods on a daily
194 basis to keep wild animals away from the regrowth. Livestock grazing was often permitted within

195 woods but generally not for the first few years after cutting. Internal boundaries such as banks were
196 used to keep animals temporarily out of areas (Rackham 2003) and stock might be herded to the same
197 effect. Control of grazing levels to protect regrowth would also inadvertently improve conditions for
198 grazing-sensitive species. Many ‘woodland’ plants now show reduced flowering or growth under
199 heavily grazed conditions: Cooke and Farrell (2001) for example illustrate various impacts of deer
200 grazing on bramble growth (*Rubus fruticosus*), bluebell (*Hyacinthoides non-scripta*) growth and
201 flowering. Sensitive plants may become limited to situations such as rock ledges inaccessible to the
202 animals (Kirby 2001).

203 All the above factors could and did vary in different ways across sites, landscapes, regions
204 and over time, creating highly heterogeneous conditions and a rich variety of wildlife.

205 **The consequences of the transformation from coppice to high forest for biodiversity**

206 Transforming coppices to high forests changes their composition, structure and dynamics: these will
207 also be affected by whether the transformation is by neglect or active management. Commonly there
208 are changes in the vertical structure of the woodland, reduced scope for open stage species, reduced
209 landscape-scale heterogeneity, changes in the tree and shrub layer composition and in
210 browsing/grazing levels.

211 Usually the biggest change is in the vertical structure of the woodland, with some loss of
212 density in the understorey, the development of a taller canopy layer and a deeper overall foliage
213 profile. Individual trees may grow to larger sizes, with greater potential for cavity development and
214 formation of internal dead wood (Ranius et al. 2009). Larger trunks and branches mean more
215 potential for increased fallen dead wood where the transformation is through natural processes (Kirby
216 et al. 1998). Active management may involve additional clearance of the understorey and felling
217 large trees before they start to hollow out.

218 There will be reduced scope for species of open space. A lower proportion of the woods are
219 in the open stage at any one time and there are longer periods between light phases occurring at any
220 one point. However under a managed transformation thinning, selective felling, and ride
221 maintenance, may ensure some continuity of this habitat element (Warren and Fuller 1993).

222 Landscape-scale heterogeneity is likely to be reduced because a large part of the mid-rotation
223 of a high forest cycle is relatively uniform in terms of the plants and animals it supports. The most
224 distinctive periods in conservation terms are the early post-felling phase and the old growth stage
225 (which is usually not reached in managed high forest because it is beyond the felling age) (Warren
226 and Key 1991). Landscape-level uniformity in woodland structure may be exacerbated where large
227 areas of forest undergo a shift in structure at the same time. In Britain many former coppiced

228 broadleaved woods were cut over in the Second World War (HMSO, 1952; Foot 2010), but then
 229 largely left unmanaged in silvicultural terms. A large proportion of the broadleaved resource is
 230 therefore in the middle of the high forest rotation phase, of limited value to coppice specialists, but
 231 also generally not old enough to have developed old growth features. This seems likely to have
 232 contributed to declines in open stage plant and bird species richness at a national level (Hopkins and
 233 Kirby 2007). There are likely to have been biodiversity gains in terms of closed canopy species
 234 (Hamblen and Speight 1995), but mainly of species that were common anyway.

235 The woody species composition usually changes, for example the promotion of oak through
 236 increasing the number of standard trees; the deliberate favouring of one of the coppice species; or the
 237 clearance and replanting of the coppice layer. From the 1930s until the 1980s many ancient formerly
 238 coppiced woods were replanted with conifers (Spencer and Kirby 1992). However, even where the
 239 transformation is by neglect, there is often a reduction in the shrub layer and of the shorter-lived, less
 240 shade-tolerant trees: for example the birch generation (*Betula* spp.) that invaded many woods
 241 subsequent to the Second World War, at their last major coppicing, is now dying out (Kirby et al.
 242 2014). The shifts in the composition of the woody layers are likely to alter the vascular plants and
 243 bryophytes on the woodland floor, for example through changes in light and warmth levels at ground
 244 level, litter type and abundance; the nature of lichen assemblages because of different tree bark
 245 characteristics; the resources available as flower, fruit and seed for food for bird, mammals,
 246 invertebrates (Mitchell et al. 2014).

247 Livestock grazing in coppice and managed high forest has largely died out in much of Britain
 248 although it is not actually illegal as it is in parts of central Europe. In neglected former coppices in the
 249 uplands the effects of often uncontrolled grazing can have both positive as well as negative effects in
 250 biodiversity terms (Mitchell and Kirby 1990; Kirby et al. 1994). At the same time deer populations
 251 have increased with widespread effects across a range of species groups (see papers in Fuller and Gill
 252 2001).

253 **Does transformation matter from a nature conservation perspective?**

254 Globally there is a focus in forest conservation on ‘natural forests’, with the general presumption to
 255 remove or reduce human impact (except for specific purposes such as controlling invasive species)
 256 and let the forests develop under their own dynamic. A series of indicators of potential naturalness
 257 has been developed for European forests (Bastrop-Birk 2014).

258 There certainly is a place for strict minimum intervention reserves in Britain, particularly in
 259 stands which have always been treated as high forest in a relatively low intensity way (Parviainen et
 260 al. 2000). The best documented of such reserves in Britain is, in fact, a former coppice-wood
 261 (Peterken and Mountford 2005). However among the species of greatest conservation concern are

262 those that are unlikely to thrive under high forest conditions and hence the emphasis in conservation
 263 guidance on trying to maintain some more open woodland, for example as coppice. The same
 264 concern can be seen elsewhere in Europe e.g Miklin and Cizek (2014). .

265 The extent that we emphasise coppice as the desirable management system in any particular
 266 case depends on the relative value placed on ‘winners’ versus ‘losers’ in that coppice-high forest
 267 system (Buckley and Mills 2015b), but also on the extent of the overall shift from coppice to high
 268 forest in the landscape as a whole. Areas with a high number of ‘red-listed’ species dependent on
 269 coppice or other forms of open woodland should be a priority; similarly if the general trend in the
 270 landscape is towards high forest, coppicing should be promoted simply to maintain a diversity of
 271 ecosystem types.

272 **Biodiversity of restored/maintained coppice under changing environments**

273 An implicit assumption in the conservation community in Britain is that if coppice management is
 274 maintained, the associated plants and animals will also continue to thrive. However that assumption
 275 can be challenged.

- 276 • Many of the activities associated with coppice in the past such as litter collecting are no
 277 longer carried out; twigs and small branches are less often collected for firewood. Leaving
 278 branches and twigs scattered over the whole stand may make it more difficult for people to
 279 walk through the stand, particularly if it gets overgrown by brambles. On some sites it gets
 280 collected into piles and left, or, less so now than in the past, burnt. Such branch piles take a
 281 long-time to break down and change the soil conditions underneath them, as do bonfires
 282 where they are still used.
- 283 • Climate change and pollution mean that the environment in which coppicing takes place is
 284 not the same as in the past.
- 285 • The herbivore pressure from deer has increased.
- 286 • Tree diseases are spreading. For example, how will our ash coppices and their associated
 287 wildlife fare under the spread of ash dieback caused by *Hymenoscyphus fraxineus* (Mitchell et
 288 al 2014)?
- 289 • The landscape around coppice woods is now generally more ‘hostile’ to the spread of species
 290 between sites because of agricultural intensification. Many scattered trees, hedges and
 291 streams that provided an element of connectivity through farmland for woodland species have
 292 been cleared, increasing the effective fragmentation of the landscape (Peterken and Allison
 293 1989).

294 If there has been a break in the practice of coppicing then additional factors may limit its restoration
 295 and the recovery of its associated wildlife.

- 296 • Some of the woody species may have been lost.
- 297 • Some stools may have died, or fail to resprout when cut, resulting in large gaps in the canopy
- 298 after cutting.
- 299 • The buried seed bank is likely to be depleted.

300 **Alternatives approaches?**

301 If restoring coppice is not practical, or may not generate the expected biodiversity gains, should we
 302 accept that some species will simply become less abundant (or less obvious) in the landscape,
 303 particularly if there are gains in other species? It is already the case that large areas of the country
 304 have completely lost some of the butterflies formerly associated with coppice clearings. We might
 305 have to consciously re-set the base-line for what we expect woodland conservation to deliver, perhaps
 306 valuing woods more for their autumnal displays of fungi associated with a build-up of deadwood, for
 307 example, rather than for an abundance of spring flowers.

308 An alternative is to explore how high forest systems that provide the type of wood-products
 309 that society now demands can be modified to allow greater opportunities for coppice-associated
 310 species. Managers have for example attempted to build elements of the ‘coppice environment’ into
 311 high forest systems through, for example, small-scale cutting alongside rides and tracks (Warren and
 312 Fuller 1993; Buckley et al. 1997). This has been successful in the short term on many sites, although
 313 over time the spread of coarse grasses may make these areas less suitable for maintaining the key
 314 butterfly populations (Pollard et al. 1998).

315 More work is also needed on whether shelterwood, group selection systems and other forms
 316 of continuous cover forestry that involve smaller-scale, but frequent interventions, are more
 317 favourable to coppice species than clear-fells. On the one hand the time between each phase of gap
 318 creation and local disturbance at a point is reduced and may become comparable to that of a coppice
 319 cycle. On the other hand the small scale of gap creation and disturbance may mean that they are
 320 quickly filled by expansion of competitive species such as bramble that are already established under
 321 the canopy.

322 Consideration of the condition of the landscape around coppice woods will become more
 323 important as climate change means that maintaining species at a particular site indefinitely becomes
 324 ever more uncertain. Loss of hedges, scattered trees, wooded streamsides, etc, has left woodland
 325 patches functionally isolated and fragmented, even where their area and distribution has not changed.
 326 While it seems logical to assume this will have contributed to long-term species losses direct evidence
 327 that this is the case, or that rebuilding linkages will benefit species, is scarce (Bailey 2007) although
 328 see Quine and Watts (2009), Brouwers and Newton (2010) . Similarly it is hoped that some of the
 329 species formerly associated with coppices might flourish in more irregular large-scale mosaics of

330 grassland, scrub and woodland that might develop under large-scale rewilding projects with free-
331 ranging large herbivores (Vera 2000). There are indications that this might be the case from projects
332 such as that at the Knepp Estate in Sussex (<http://www.knepp.co.uk/>): nightingale *Luscinia*
333 *megarhynchos* populations on the estate have increased since it was transferred from conventional
334 farming to a more extensive rewilding-type management.

335 **Conclusions**

336 Coppice woods have been part of the British and wider European landscape for much of the
337 Holocene. They have developed distinctive plant and animal assemblages that are worthy of
338 conservation, alongside those of high forest, because they contribute to the overall diversity of
339 ecosystems.

340 These assemblages change under the transformation to high forest and gap-phase species are
341 particularly at risk of being lost or reduced substantially in abundance. Given that the general social
342 and economic trends currently favour high forest systems, conservation efforts need to target those
343 that may be lost and hence promote coppice and other traditional management practices such as
344 wood-pasture. On the whole the promotion of such systems is not limited so much by lack of research,
345 or understanding of the species needs, as by lack of markets for the products from low-intensity
346 management systems such as coppice.

347 Even if promotion of coppice systems is successful in the short term in maintaining past
348 coppice assemblages, we should expect increasing changes as the environmental context changes.
349 National and local monitoring schemes must continue to be able to pick up changes in coppice species
350 at stand, wood and landscape scales.

351 For the longer term we should explore how ‘coppice species’ can be maintained across
352 landscapes, in non-coppice situations that fit with modern socio-economic patterns. This will require
353 further research on which species can be maintained in open spaces within high forest systems, but
354 also on where-else they can occur in the landscape, e.g. perhaps along scrubby motorway verges. We
355 also need more research on how to develop landscapes that will allow coppice species to migrate
356 through the countryside as climate change or tree diseases make some sites permanently unsuitable
357 for them.

358 The alternative is to decide which species we are prepared to lose.

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