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EVEN-AGED PLANTATIONS AS A HABITAT FOR BIRDS

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SUMMARY

Large-scale afforestation of uplands in Britain has particularly affected parts of southern Scotland. Breeding song-bird populations were censused using the mapping method on selected plots at different stages of forest development, from the original use of the moorland for grazing until forty years after planting.

Song-bird densities were least on the unplanted moorland, where only skylark and meadow pipit were common. At the young and pre-thicket plantation stages, a variety of species such as chats and willow warbler colonized the plantation. Some of these prefer scrub and were displaced when the canopy closed. In thicket and thinned plantations only species typical of conifer forests, such as goldcrest, chaffinch and wren remained. Total breeding song-bird densities were about three times greater in pre-thicket plantations than on moorland, and four to six times greater in thinned plantations.

Tree species, soil fertility, the diversity of vertical structure, and breaks in the forest cover may all influence bird populations. In particular, spruce supported more song-birds than pine, and communities were diverse where foliage profiles covered a wide range. Areas within the forest replanted after wind-blow held the same species as the first rotation at the same stage. Pre-existing hardwood remnants within the plantation made little difference to the species present.

Several species use the forest as a refuge, but also require other habitats, e.g. the sparrowhawk, which nested in forests and other woodlands but often hunted outside plantations.

In southwest Scotland sparrowhawks bred more successfully in valley woods than in hill forestry plantations. In the interior of a large plantation growth rates of nestlings were lower and their mortality was considerably higher than on its lower edge and nearby valley woods. Differences were attributed to differences in the food supply, which was abundant in some woods in the valley, but sparser and more difficult to catch in plantations.

The controversy surrounding the wildlife in large forestry plantations is discussed. Against the gains in total song-bird densities when moorland is afforested, several open country species have been displaced, and the raven is declining due to afforestation and consequent loss of sheep carrion.

RÉSUMÉ

Le reboisement à grande échelle des hautes terres de Grande Bretagne a pris place en particulier dans de nombreuses régions du Sud de l'Ecosse. Des populations d'oiseaux chanteurs ont été resencés en utilisant des relevés dans des endroits choisis pendant des étapes différentes du développement de la forêt, de la lande d'origine, utilisée comme pâturage jusqu'à quarante ans après la plantation.

La population d'oiseaux chanteurs était la plus mince dans les landes avant la plantation où l'on ne trouvait que l'alouette et la farlouze. Au stade de fourré, différentes espèces, tels que le tarier et la fauvette, colonisaient la plantation. Certaines préféraient les buissons et s'en allaient au moment de la fermeture des cimes. Dans les plantations au stade de gaulis et de perchis eclairci il ne restait plus que les espèces typiques des forêts de conifères, tels que le roîtelet huppé, le pinson et le troglodyte mignon. La concentration d'oiseaux chanteurs était environ trois fois plus grande dans les plantations avant l'état de fourrés, que dans les landes et quatre à six fois plus grandes dans les plantations éclaircies.

Les essences, la fertilité des sols, la diversité des structures verticales et des coupures dans le couvert peuvent aussi influer sur les population d'oiseaux. En particulier

les épicéas possédaient plus d'oiseaux chanteurs que les pins et la diversité des feuillages entraînait une diversité des communautés d'oiseaux. Des parties de la forêt replantés après des coups de vent possédaient les mêmes espèces que pendant la première rotation à stade identique. Des feuillus préexistants n'ont que peu d'influence sur les espèces présentes.

Plusiers espèces utilisent la forêt comme refuge mais ont besoin aussi d'autres habitats, comme l'épervier, par exemple, qui fait son nid dans les forêts et autres régions boisées mais qui chasse en dehors de plantations.

Dans le sud-ouest de l'Ecosse, les éperviers se multiplient mieux dans les bois de vallées que dans les forêts sur les hauteurs. A l'intérieur d'une grande plantation, le taux de croissance des oisillons est plus bas et leur mortalité bien plus élevée que dans les lisières plus basses ou dans les bois proches des vallées. On a attribué cette différence aux différences de nourriture plus abondante dans les bois de vallées mais plus rare et plus difficile à attrapper dans les plantations. Il y a beaucoup de controverses au sujet de la faune sauvage dans les grandes plantations forestières. Bien que la densité totale d'oiseaux chanteurs ait été plus grande au moment du boisement de la lande, plusieurs espèces de rase campagne ont été déplacées et le nombre de corbeaux est en déclin à cause du boisement qui a eu comme conséquence une diminution des carcasses de mouton.

ZUSAMMENFASSUNG

Durch die grossräumigen Aufforstungsmassnahmen im britischen Hügelland wurden insbesondere weite Teile Südschottlands erfasst. Dabei wurde eine Kartierung brütender Singvögelbestände in ausgewählten Gebieten während verschiedener Entwicklungsphasen des Waldes von der ursprünglichen Nutzung des Moorlandes als Weide bis vierzig Jahre nach der Bepflanzung durchgeführt.

Im Moorland, wo nur Lerche und Wiesenpieper verbreitet waren, gab es die wenigsten Singvögel. In den ersten unterholzfreien Stadien der Pflanzung, siedelte sich eine

Vielfalt von Arten, wie beispielsweise Steinschmätzer und Weidenlaubsänger an. Einige von ihnen bevorzugten Buschwerk und wurden verdrängt, als sich das Blätterdach schloss. In Pflanzungen mit Dickicht und lichten Beständen bleiben nur Arten zurück, die für Nadelwälder typisch sind, wie sum Beispiel Goldhähnchen, Buchfink und Zaunkönig. Insgesamt gab es in noch unterholzfreien Pflanzungen dreimal so viel brütende Singvögel wie im Moorland und in lichten Pflanzungen vier- bis sechsmal so viel. Faktoren wie Baumart, Bodenfruchtbarkeit, Dichte und vertikaler Aufbau des Bestandes können die Vogelpopulationen beeinflussen. Zum Beispiel war die Singvogeldichte in Fichtenbeständen hoher als in Kiefernbeständen. In einem vielfach gegliederten Kronendach von Laubbäumen war die Zusammensetzung der Vogelwelt artenreich. Windbruchflächen wiesen nach Auspflanzung dieselben Arten auf, wie die Erstaufforstung im gleichen Stadium. In den verbliebenen natürlichen Hartholz-Bestandesresten wurden kaum Unterschiede bei der Entwicklung der vorhandenen Arten festgestellt.

Einige Arten suchen im Wald Schutz, brauchen aber auch andere Habitate. Ein typisches Beispiel hierfur ist der Sperber, der in Wäldern und anderen Baumgebieten nistete, aber häufig ausserhalb der Pflanzung jagte.

In Südwestschottland brüteten Sperber in Auewäldern mit grösserem Erfolg als in Bergwäldern. Im inneren Teil einer grossen Pflanzung war die Wachstumsrate von Nestlingen geringer und ihre Sterblichkeit beträchtlich höher als am Waldrand und in nahen Auewäldern mit geringerer Höhe über NN. Der Unterschied wird dem Nahrungsangebot zugeschrieben, das in einigen Auewäldern reichlich, in Pflanzungen jedoch spärlicher und schwieriger zu erbeuten ist.

Die Kontroverse um das Tierleben in grossen Auffortstungsgebieten wird diskutiert. Dem Gewinn einer im ganzen grösseren Singvogelverbreitung bei Aufforstung von Moorland steht die Vertreibung verschiedener Arten gegenüber, die offenes Gelände brauchen. Zum Beispiel verschwindet der Rabe immer mehr infolge der Abnahme von Schafkadavern nach Aufforstung.

INTRODUCTION

During the past sixty years a policy of large-scale afforestation has been put into practice in Britain. The areas affected have been chiefly the uplands of Northern England, Wales and Scotland, where moorland previously used for the grazing of sheep and cattle, has bees planted with conifers. Two introduced species, Sitka spruce (Picea sitchensis) and lodgepole pine (Pinus contorta) form the bulk of the plantations, which, because of their planting regimes, can be described as 'even-aged'.

Such plantations of exotic trees have often been popularly condemned as being virtually devoid of wildlife, but there have been few quantitative assessments in which changes due to afforestation have been measured. The work reported here was done under a contract from the Nature Conservancy Council.

SONG-BIRD COMMUNITIES OF PLANTATIONS

Study areas and methods

Plots were established in three forests in the Dumfries and Galloway region of southwest Scotland. These were Ae Forest, situated on the edge of the Lowther Hills; Clatteringshaws Forest, entirely on upland in the Galloway Hills; and Eskdalemuir, a large young forest also on upland. Most of the study plots were on infertile hill ground, between 150 and 350 m above sea level, except at Eskdalemuir where they were at up to 425 m.

Within Ae and Clatteringshaw Forests the range of study plots encompassed habitats categorized as unplanted sheep walk under grass and heather (Calluna vulgaris), and young, pre-thicket, thicket and thinned plantation. Only unplanted heather and young trees were studied at Eskdalemuir.

With the exception of one and one half plots of Norway spruce (Picea abies), the plots were planted with Sitka spruce, sometimes mixed will small percentages of lodgepole pine or larch (Larix spp.). They were chosen for uniformity within their boundaries whenever this was possible.

Territorial song-birds were censused on each plot using the mapping method, following Williamson (1964). The plot, from 10 ha in thinned plantation to 25 ha on unplanted ground, was first mapped accurately. Each census consisted of ten early morning visits to the plot between late March and mid-June on which all song-birds observed, either by sight or sound, were marked on a copy of the large scale map. At the end of the season, these maps were used for the construction of further maps, one for each species, showing its occurrence on the plot over the series of ten visits. These species maps were used to estimate the position of territories, using well-established procedural rules, such as a requirement for at least three clumped observations to constitute one

territory (International Bird Census Committee 1969). Numbers of territories on the plots were counted, and divided by the area of the plot to give densities, standarized as the number of breeding pairs/sq.km for each species occurring on each plot.

The densities of more sparsely distributed non-passerines, such as waders, grouse and raptors, were not estimated due to shortage of time and manpower, although they were present on the plots.

RESULTS

A summary of the census results is given in Table 1, where scientific names of bird species are listed.

The succession of song-bird communities can be examined by considering the densities of the commoner species in relation to tree height (Fig. 1).

The skylark, dependent on grassy habitats for food and nest sites, was the only species to be at its highest density on unplanted grassland, and was the first to disappear as tree cover developed. By comparison, meadow pipit densities increased markedly when exclosure of the land from grazing animals allowed ground vegetation to flourish, and these birds were more tolerant of the developing tree, remaining in openings and along firebreaks until the canopy closed.

Two species typical of open bushy habitats, the stonechat and whinchat, took up territories in the plantations as soon as the trees suitable perches for them, and while they could still nest in the tussocks of grass below the trees. Their period of tenure in any particular plantation area would be short, perhaps only five years.

Willow warblers which take their insect food from the needles of trees, remained in the plantations until a later stage than the ground-feeding chats. At the pre-thicket stage this was the commonest species, but their numbers dwindled as the canopy closed and their ground nesting sites were lost. They were not found in thinned plantations.

The wren was the first of the species present in mature plantations to appear on the plots of young trees planted on heather. Its requirements for food and nesting are found in cover close to the ground, and the density of wrens in thinned plantations was related to the abundance of brash and fallen trees. Other colonists of pre-thicket plantation were chaffinch and robin, which became most numerous at the thicket stage, and the canopy feeding and -nesting goldcrest, which reached high densities in the thinned plantations. The common species to occupy the plantations last was the coal tit, a hole-nesting species which frequently uses crevices at the bases of trees for its nest sites in plantations. They did not establish themselves until the trees reached the thicket stage. It is thus apparent that over a forty year period of

Table 1. Song-bird communities at different stages of forest development.

afforestation	Unplanted heather moor	Unplanted grassy sheepwalk	Young trees plot'	'Jubilee	Pre-thicket	Thicket	Thinned
tation	Heather Eriophorum vaginatum	Molinia Juncus spp	Thick growth of grasses. Myrica gale Heather		Trees touch but do not form closed canopy. Heather, Myrica gale between trees.	Closed canopy, impenetrable. No ground vegetation.	Little or no ground vegetation.
e (yrs)	0	0	2-4	7-8	12-14	23-26	34-39
ht range (m)	0	0	1-2.5	3-5	7	12-15	20
f plots	1	3	3	1	2	3	4
f censuses (10 visits)	1	4	4	2	2	5	6
2 years total densities re km^{-2})	72	72-103	71-128	357-384	231-252	302-443	318-425
umbers of species	2	2-4	3-6	13-14	9	6-10	6-10
	A v e r a g e	d e n s i t i e s	o f	i m p o r t a n t	s p e c i e s		
preference:							
open country							
scrub							
forest							
ark	20						
da arvensis							
ow pipit	52						
us pratensis							
ntar							
nthe oenanthe							
bunting							
ria schoeniclus							
echat							
icola torquata							
chat							
icola rubetra							
net				26			
thia cannabina							
low warbler				95			
lloscopus trochilus							
n				33	53	46	
glodytes troglodytes							
crest				24	29	104	
ulus regulus							
pell				15	23		
thia flammea							
in				15		48	
thacus rubecula							
ffinch						80	
gilla coelebs							
tit						36	
us ater							
thrush						5	
dus philomelos							
ock							
alla modularis							
ia							
thia spinus							
creeper							
hia familiaris							

forest growth, the composition of the song-bird community changes entirely as all the species initially present lose their required habitats, and are replaced by others, some of which are themselves only present for a transitory period. The same observation can be made of the non-passerine birds, as species such as lapwing (Vanellus vanellus), curlew (Numenius arquata), redshank (Tringa totanus), snipe (Gallinago gallinago), red grouse (Lagopus l. scoticus) and merlin (Falco columbarius). are replaced in young forest by black grouse (Lyrurus tetrix), short-eared owl (Asio flammeus) and kestrel (Falco tinnunculus), and later in mature plantations by woodcock (Scolopax rusticola), woodpigeon (Columba palumbus), sparrowhawk (Accipiter nisus) and tawny owl (Strix aluco).

FEATURES OF FOREST STRUCTURE WHICH INFLUENCE BIRD POPULATIONS

Tree species

The tree species forming the forest are an important influence on song-bird communities. The greatest difference occurs between broad-leaved and coniferous woods, each of which has its characteristic species, although the majority of British woodland birds are found in both. Studies in Finland (reviewed by van Haartman 1971) showed that there were consistently more breeding birds in birch (Betula spp.) than in spruce, and in spruce than in pine. Even-aged plantations in Britain are almost entirely of conifers, particularly spruces and pines. When studying plantations at the thinned stage, it was found that total song-bird densities were approximately twice as great in spruce as in pine, when there were also fewer species (Moss 1978a). In this context Newton & Moss (1977) pointed out that pine has less foliage per unit area than spruce, and hence less habitat for insects. In Finland the differences between spruce and pine were of a lower magnitude (von Haartman 1971).

Soil fertility

Within forests of a particular tree species, soil fertility influences many aspects of productivity, including that of subsidiary vegetation and of insects. Thus it was noted earlier that in Ae Forest the 'Jubilee plot' pre-thicket plantation, where growth of trees and other vegetation was vigorous, supported a much more abundant and diverse bird population than might have been expected from the age and structure of the trees alone. Again Finnish studies showed that bird densities decreased with decreasing soil fertility, as indicated by the type of vegetation of the forest floor (Haapanen 1965).

Diversity of structure

In North American woodlands MacArthur & MacArthur (1961) found that diversity of song-bird populations was directly related to the diversity of the height structure of the vegetation, so that the more layers of trees and shrubs a wood

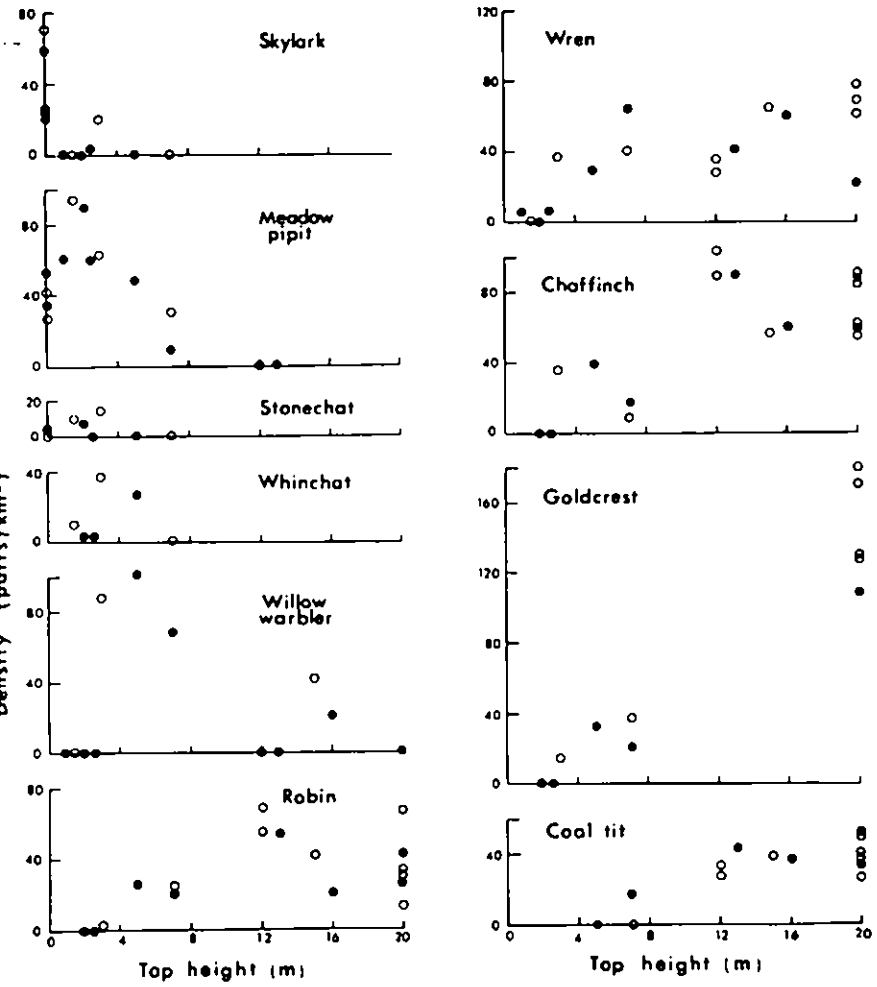

Fig. 1. The density of song birds in even-aged plantation in relation to the top height of the trees. 1976 data ○, 1977 data ● . N.B. Not all zero densities are shown.

contained, the more bird species were found there. The same relationship was found in Scotland when a sample of woods, both planted and semi-natural, coniferous and broad-leaved, was considered (Moss 1978b). This observation is easily understood, since a wood with a great diversity of vertical structure contains sufficient ecological 'niches' for a large variety of woodland bird species to find territories there. When the structure is simple, only a few species occupy all the available niches. No similar result was obtained for plantations which had not yet reached the thicket stage, probably because of the presence of a number of species adapted to scrub, rather than understory.

The implication for even-aged plantations is that because they have an artificially low diversity in their height structure, their bird populations are low in species diversity. For example, thinned spruce plantations described earlier held six to ten breeding species, while a neighbouring multi-structured mixed wood supported eighteen species (Moss 1978a).

However, a relationship between total numbers of pairs of song-birds and structural diversity was not found, since for example plantations with low diversity provided excellent habitat for a few species and so total densities there were not particularly low.

Breaks in the forest structure

The most frequent breaks occurring in the structure of an even-aged plantation are due to rides and firebreaks, to clearfelling, windblow and the practice of leaving remnants of original woodland during planting, usually in the form of hardwood fringing watercourses or on valley sides.

The large scale clearfelling of plantation blocks followed by subsequent replanting is only just beginning in Britain, and few areas exist where its effect on bird populations can be studied. However, a similar situation has occurred where large areas have been windthrown and subsequently cleared and replanted and a brief survey of some such areas was made in Ae Forest. The species present among young trees and at the pre-thicket stages of replantings were the same as on the first rotation though meadow pipits were by comparison sparsely distributed. Cleared ground before replanting appeared to be completely devoid of birds, unlike the sheepwalk before initial planting.

It has occasionally been the practice among foresters to leave existing remnants of hardwoods along stream sides or in steeply sloping gullies, and these breaks might be though to provide a refuge for hole nesting bird species such as blue and great tits (Paru caeruleus and P. major) or redstarts (Phoenicurus phoenicurus) which favour mature broad-leaved trees. Such a gully approximately 50 m wide crossed one of the plots studied in Ae Forest, but there was no evidence that its

old oaks (Quercus spp) attracted any extra breeding birds. As an added inducement, nest boxes were provided in this gully but none was occupied in two breeding seasons. Similarly, S.J. Petty (pers. comm.) found that a belt of alder (Alnus glutinosa) approximately 50 m wide within a plantation in Galloway had no effect on the composition of the bird population there. However, a belt of rank heather, approximately 100 m wide containing rocky bluffs which had been left beside a stream in Kielder Forest, Northumberland, allowed merlins to continue nesting.

THE PLANTATION AS A REFUGE

So far, the plantation has been considered only as a habitat for those birds which are totally dependent on it for nesting, feeding and roosting, at least during the breeding season. However, for a number of species it is used as a refuge for one or more of these activities, while not usually providing all their requirements. In the majority of such species, the forest is used as a nesting habitat but the bird finds part of its food elsewhere. For example, mistle thrushes (Turdus viscivorus) nesting in the plantations often feed on adjacent pastures, and buzzards (Buteo buteo) nest in forests but hunt over surrounding open country. This type of use of the plantation can be illustrated by describing the relationship between the sparrowhawk and its habitat, a species which has been studied intensively in recent years.

The sparrowhawk is a relatively small, agile woodland predator whose prey consists almost entirely of birds. It builds its nest by preference in a coniferous tree within a forest block, but for clear access the nest is usually close to a break such as a stream or ride. It typically hunts along woodland edges, including those formed by clearings, rides or rivers, and hedgerows in more open country, and relies on a surprise attack rather than a prolonged chase in order to capture its prey. Recent research into the ecology of the sparrowhawk in southwest Scotland has investigated its relationships with the environment and with its food supply. Newton (1972) found that in continuous woodland, sparrowhawk nest sites were regularly spaced, but that the mean distance between them differed by a factor of three to four between Annandale in southwest Scotland and Speyside in the central Highlands. Data from further study areas in different parts of Britain were used (Newton et al. 1977) to show that nesting density was inversely proportional to altitude and proportional to land quality. Both these relationships were thought to arise as the result of variations in food supply with altitude and land quality.

Newton (1976) compared a number of aspects of sparrowhawks' breeding success between small valley woods, hillside forestry plantations, and the large plantations at Ae

Forest. In valley woods, compared to hill forests, mean laying dates were earlier, mean clutch and brood sizes were larger, a greater proportion of nests produced young, and more nestlings survived.

These differences were consistent in the three years studied, though not all statistically significant in every year. The net result was that sparrowhawks nesting in the valley woods were considerably more productive of young than those in the hill forests. It was thus difficult to understand why birds occupied the hill forests when there were vacant territories in the valley, unless the plantation habitat offered them some advantage balancing the reduced nesting success.

My own studies of sparrowhawks (Moss 1976, 1978c) also compared aspects of breeding performance between birds nesting in the large Ae Forest and in small woods in the adjoining Annan valley. Daily growth rates of the nestlings were measured and the causes of mortality were assessed. The results showed that the study area could be divided between nests in the valley woods and the lower edge of the plantation as one group, and those in the higher and remoter parts of the plantation in another. Nestlings gained weight at rates which were on average 20 per cent lower in the interior of the forest than in the valley and forest edge, and the birds with lower growth rates also suffered greated fluctuations in weight.

Differences in mortality were also marked, 48 per cent of nestlings in the forest interior died when aged between two and twenty-four days compared to only 5 per cent in the valley and forest edge. Only 22 per cent of forest interior broods survived without any mortality, while in the remainder of the study area 87 per cent of parents all raised their young to fledging. The major causes of mortality were starvation as a result of competition within the brood (37.5 per cent of all deaths), exposure in wet weather (25 per cent) and predation by tawny owls (17.5 per cent).

Almost all the differences observed within the study area could be attributed to the food supply. Censuses of song-bird populations in woodlands (Moss 1978a) showed that in the valley woods there were abundant sources of prey within easy reach, if not in the coniferous woods actually preferred by sparrowhawks for nesting. The species present in the valley woods, such as thrushes (Turdus spp) tended to be larger on average than those predominating in the plantations, so enhancing their attractiveness as sources of prey for hawks. Valley woods were also easily accessible to the birds breeding along the edge of Ae Forest. By contrast, birds in the interior of the forest could either hunt for the sparser prey there, for example on the edges of windblows and stream sides, or they had to fly relatively long distances to the valley

woods in search of richer sources of prey. Radio-telemetry studies showed that the birds frequently followed the latter course, and one female regularly travelled 9 km to hunt when she had large young in the nest.

The consequences for broods in the interior of the forest were that competition occurred within broods which were too large to be supported by the poor food supply, and the weaker nestlings died. The female was forced to hunt away from the nest and the nestlings died because of exposure in wet weather or were eaten by predators. Those nestlings which did survive had reduced growth rates which may well have left them less fit to survive the difficult period after fledging.

The conclusions of both Newton's and my own studies were that the large even-aged plantation offers extensive areas which are attractive to sparrowhawks as habitats in which to nest, presumably with a minimum of disturbance from other birds due to the regular spacing of nests. However, from the studies of breeding success there appears to be a selective disadvantage in nesting in the interior of the plantations, and one might expect birds to show a greater preference in choice of nest site for the valley woods than was observed. The optimum environment from the point of view of both food supply and nest site would appear to be close to a forest edge which borders the valley.

DISCUSSION

In recent years there has been frequent debate, sometimes heated and too often ill-informed, on the merits and demerits of the afforestation of Britain's uplands. As a starting point, the detractors of forestry plantations often describe the moorland which has been lost as the 'natural' vegetation of the uplands, whereas it is often the consequence of centuries of over-grazing by sheep and of burning, resulting in the removal of the natural forest cover of Scots pine (Pinus sylvestris). birch and oak. These circumstances should be borne in mind when comparing the effects of afforestation on bird populations in Britain with its effects elsewhere in the world where plantations have replaced natural forests; in the latter case one might expect a decline in diversity and number of birds.

Even-aged plantations as habitats for birds have both gains and losses by comparison with moorland. On one side, there is an increase in song birds, both in numbers and species. Total song-bird densities in plantations were four to six times as high after twenty-five years as they were on moorland. In the course of its development, the plantation provided suitable habitats for a range of other song-bird species typical of scrub so that the total breeding species list of a forest containing areas at each stage of growth would far exceed that of moorland alone.

In addition, plantations provide refuges for a number of other species although, as in the case of the sparrowhawk, it may be those parts of the forest which are close to outside sources of food which are of greatest value. This is an example of the classic 'edge effect' (Odum 1959), where the boundary between two ecological zones proves richer than the pure habitat of either.

Against the gain in song-bird numbers with afforestation must be balanced the loss of moorland species, which was underestimated in this study restricted to song-birds. Although they are sparse in terms of pairs/sq.km many species of waders are dependent on unplanted uplands as their breeding habitat.

Populations of other species have also suffered from afforestation, sometimes indirectly as in the case of the raven (Corvus corax). Marquiss, Newton & Ratcliffe (1978) have attributed a 34 per cent decline in the raven population over fifteen years in southern Scotland and Northumberland to the removal of sheep, their main food source, following afforestation. Ravens often deserted traditional breeding sites concurrently with planting in the surrounding area. The merlin may also be suffering a similar reduction due to loss of its preferred moorland habitat, and deserves more detailed research.

It is often evident from arguments used by the opponents of large-scale afforestation that their aesthetic considerations favour the open moorland landscape rather than 'regimented rows of trees'. A certain amount of claustrophobia is experienced once the canopy closes, views are lost, and rides become 'tunnels through the spruce needles'. Appreciation of the birds is probably more difficult for the visitor when he is in a forest than when he is on the moor, since although they are present in the plantations at greater densities, the birds are less obvious to the observer, hidden as they often are by the tree canopy. It is much easier to see a skylark singing overhead against a blue sky than a goldcrest lost up among the spruce needles.

In conclusion, the best management of upland forestry for birds appears to be a policy favouring small, even-aged plantations forming a patchwork of blocks of differing ages within any one forest area, rather than large-scale cover by forests of uniform age. Some valleys and moorlands should be left entirely free of planting, since many species are dependent on unplanted uplands for breeding. Forest managers may plan their planting programmes to achieve such a forest containing the full range of growth stages, and unintentionally they may often be helped towards such a pattern by the occurence of windthrows.

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