Research in support of the UK Biodiversity Action Plan: forest management and priority species

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Background

The research programme in support of the Species Action Plans (SAPs) began in 1998, using in-house expertise and building partnerships with experts/researchers in other organisations in order to meet the Forestry Commission's commitment to the UK Biodiversity Action Plan (UKBAP). The work undertaken within the programme is directed by the targets agreed within the SAPs, and has at the core an aim to understand how forest operations and woodland management impacts upon the Priority species. The goal is to pass this information on to forest managers and policymakers in a form that can be used to conserve and benefit species.

Introduction

Policy context

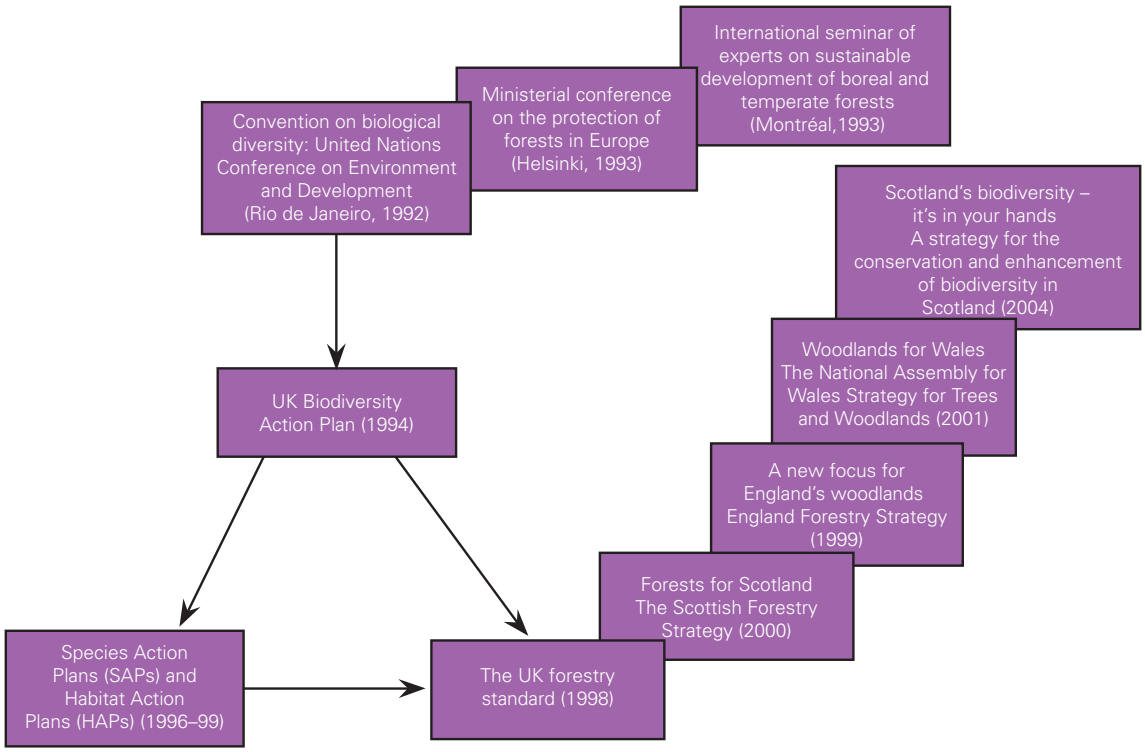
In response to the Convention on Biological Diversity signed at the Earth Summit in Rio de Janeiro in 1992, the UK government produced the UK Action Plan for Biodiversity (UKBAP; Anon., 1994) and the UK Steering Group's report (Anon., 1995) – see Figure 1. These documents identified our rare native species; 382 species were either in rapid decline or globally threatened, and urgent action was considered necessary for these 'Priority' species. A Species Action Plan (SAP) was written for each, detailing the status, threats and targets for its conservation and recovery. The plans were published between 1995 and 1999. Priority habitats have also been identified and a similar process followed for these (Anon., 1994; Anon., 1995).

The amount of work entailed in carrying out the SAPs is large and the cost has been estimated at around £55 million over the 10 years of the plans (Anon., 2000a). An approach of voluntary partnership has been encouraged with the responsibilities shared between government and non-government organisations (all of which are attempting to find resources within expenditure constraints). Detailed actions are set out for a number of organisations within the plans.

The Forestry Commission (FC) has a clear commitment to the conservation of biodiversity and this is incorporated in the FC's policy statements on sustainable forest management in The UK Forestry Standard (Anon., 1998), and the English, Scottish and Welsh Forestry Strategies (Anon., 1999; Anon., 2000b; Anon., 2001). Each asserts that management should aim to conserve

Figure 1

Policy context for Species Action Plans in the UK.



Priority species and that successful application of forestry strategy should be measured as progress towards the UKBAP targets. The Species (and Habitat) Action Plans have been suggested as a source for policies and practices relevant to the management of biodiversity in planted forests in the UK (Rollinson, 2003). The UKBAP is cited as the 'cornerstone' of the Welsh Forestry Strategy. Specific actions are given in the English Forestry Strategy, e.g. to target grants to enhance woodlands for the benefit of Priority species. More recently, the FC has identified the need for guidance on management requirements of woodland SAP species, in their response to a review of their support of sustainable management of woodlands in England (Anon., 2002). In the government's Scottish biodiversity strategy (Anon., 2004), delivering actions and outcomes of the UK Species (and Habitat) Action Plans is a primary focus.

There are 135 SAPs linked to woodland where the FC is identified as a partner in the work plan and 61 of these where the actions identified are for providing information through research (Table 1). The majority are woodland species ranging from liverworts to mammals, but a few e.g. marsh fritillary (*Eurodryas aurinia* Rottemburg) are open ground species.

Table 1

Priority species for which the Forestry Commission (FC) is a partner in the delivery of the Biodiversity Action Plan (see Harding, 1999).

Species group	Number of plans where FC is named as a partner	Number of plans where FC is partner in delivery of a research or advisory task	Species for which research is being carried out by FC
Birds	13	10	capercaillie *(Tetrao urogallus)*, Scottish crossbill *(Loxia scotica)*
Mammals	8	7	Bechstein's bat *(Myotis bechsteinii)*, dormouse *(Muscardinus avellanarius)*, lesser horseshoe bat (*Rhinolophus hipposideros)*, otter (*Lutra lutra*), red squirrel *(Sciurus vulgaris)*
Amphibians and reptiles	2	1	–
Vascular plants	15	8	juniper *(Juniperus communis)*, small cow-wheat *(Melampyrum sylvaticum)*, twinflower *(Linnaea borealis)*
Lower plants	33	13	stipitate hydnoid fungi *(Hydnum, Hydnellum, Bankera, Phellodon, Sarcodon)*
Invertebrates	64	22	argent and sable moth *(Rheumaptera hastata)*, chequered skipper *(Carterocephalus palaemon)*, narrow-headed ant *(Formica exsecta)*, pearl-bordered fritillary *(Boloria euphrosyne)*, scarce lime bark beetle *(Ernoporus tiliae)*, Scottish wood ant *(Formica aquilonia)*, waved carpet moth *(Hydrelia sylvata)*

Prioritising research needs

A review of research needs for forestry-related SAPs provided a shortlist of species for which work was a priority (Broome, 1999). The review took account of progress made since the SAPs were published and used a number of criteria to prioritise, including dependence of species on woodland habitats, vulnerability of species to forest operations, emphasis of task on research action and formal role in delivery of the SAP, i.e. Lead Partner/ Contact Point.

The maturity of knowledge on a species determines what action is required. The knowledge of each species and the steps necessary to acquire information to guide conservation is laid out in the Action Plans. As shown in Figure 2 there are five typical stages of knowledge acquisition in understanding the status and requirements of species and identifying applicable conservation management. In this article, the sequence of stages will be explored using the current research programme.

Figure 2

Stages of knowledge acquisition used in research for the Species Action Plans and the type of tasks carried out at each stage.

Stages	Tasks
Distribution and status	• Basic surveys of presence/absence • Assessments of frequency and condition of population
Autecology	• Detailed population level studies to understand habitat requirements
Impacts of management (levels of tolerance)	• Field scale management experiments/trials of measures to enhance habitats
Guidance preparation and knowledge dissemination	• Results of trials/experiments interpreted for guidance notes, presentations/talks etc • Expert advice for particular situations
Monitoring impacts of recommended management	• Systematic checks of species and habitat responses to management, feedback to distribution and status

Distribution, status and condition

Knowledge of distribution, status and condition of species is necessary for underpinning research and conservation actions. For the majority of the species covered by the research programme, much is already known. However basic knowledge on the distribution and condition is lacking for some, and two examples are discussed here.

Scarce lime bark beetle

The scarce lime bark beetle (*Ernoporus tiliae* (Panzer)) is a deadwood specialist that in Britain is believed to feed almost exclusively on small-leaved lime (*Tilia cordata* L.). It has Red Data Book Category 1 (Endangered) designation and has been included on the priority UKBAP list due to its apparent decline in post-war years. The FC is Lead Partner for the SAP. Understanding the current status and distribution of the scarce lime bark beetle in England was necessary to meet the SAP target of providing advice to landowners and managers on the presence and conservation management of the species. This was tackled through an extensive survey of small-leaved lime woodlands, over two seasons, by an expert under contract to FC. Past records of *E. tiliae* were gathered to establish sites from which the beetle was once known and these, along with the remaining major small-leaved lime areas, were then targeted. Lime stands were assessed for beetle presence and colony size and the structure of their deadwood habitat was recorded. Based on these findings a change in species status has been proposed and the information gathered will allow site management guidance to be targeted to the key locations of *E. tiliae* (Drane, 2003; Broome *et al.*, submitted) – see Figure 3.

Juniper

Juniper (*Juniperus communis* L.) forms an important component of a range of semi-natural vegetation types and is one of Britain's three native conifer species. It is widely distributed throughout Britain in a variety of habitats but only in Scotland is it found as part of the woodland ecosystem. Juniper has been designated a Priority species due to its decline in distribution and poor population viability and regeneration ability.

Investigating the extent and condition of woodland juniper on FC ground formed our contribution to a Scotland-wide survey of juniper. The project was led by Scottish Natural Heritage (SNH), to provide the evidence on which to set priorities for regional action in the maintenance and restoration of juniper populations.

A sample of three 10 km squares within each Natural Heritage Zone (Anon., 1997) with historical records for juniper were selected and juniper occurrence mapped. Based on this, 1 km squares containing woodland, open ground and prostrate juniper (J. *communis* subsp. *nana*) populations were surveyed in detail. Information was collected on population size, health (disease, fire and browsing damage) and age structure of the bushes, and regeneration potential and characteristics of the sites where juniper grew.

Analysis of juniper extent and condition by 10 km square provides an idea of where the species is secure to where it is extremely vulnerable. Areas have been identified for conservation action for all juniper types: open, montane and woodland (Sullivan, 2003). Woodland juniper made up one-third of the sample and a more detailed review of this data is under way.

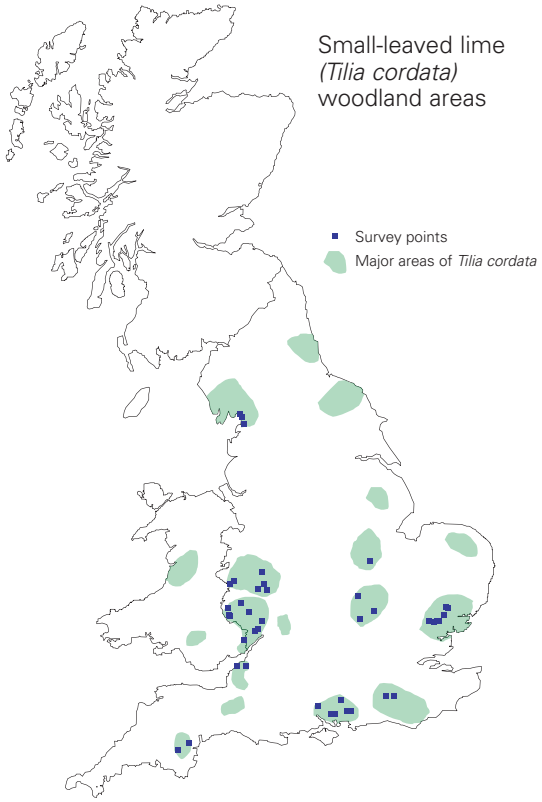
Autecological research

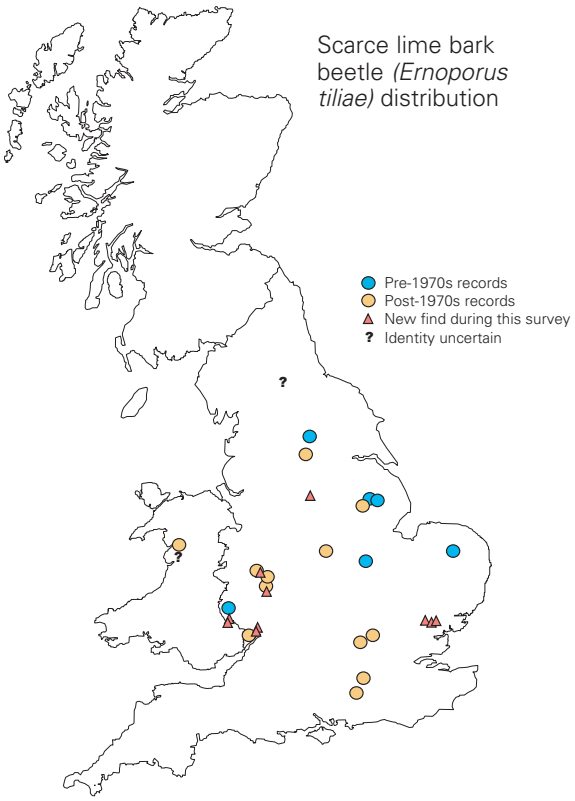
Knowledge of the basic requirements of a species is fundamental to its conservation. Without such information, managers do not know the type of habitat that should be maintained or provided. Detailed studies, usually conducted at the population level, provide information on specific requirements and may indicate what habitat features are critical for a species survival.

Figure 3

Scarce lime bark beetle *(Ernoporus tiliae)* survey results and recommendations.

The survey re-established *E. tiliae* presence at most of its historical locations in England (total 17 sites). This is a picture not of decline but of restricted range and habitat requirements: *E. tiliae*'s distribution is very local but widespread. Red Data Book (RDB) status change is suggested from RDB1, a status reserved for those species with a single population or occurring in vulnerable habitats or in continuous decline, to RDB3, owing to the beetle's dependence on a vulnerable habitat.





Argent and sable moth

The habitat requirements for many of the species in the research programme are already known. An exception to this is the argent and sable moth (*Rheumaptera hastata* L.), shown in Figure 4. This species of day-flying moth is found in a northern and southern form (subsp. *nigrescens* and subsp. *hastata*, respectively). The southern form is considered to be very rare, with only a few locations of known presence and a growing number of counties from where it is now extinct (Green, 2001). It was thought that the species was associated with lowland birch regrowth or

Figure 4

Argent and sable moth *(Rheumaptera hastata* L.).

scrub in coppice or ride situations. Gauging the importance of woodland or coppice management for this species required an understanding of microhabitat requirements. Over the past three years, in conjunction with Butterfly Conservation, populations have been studied in three woodlands in lowland England. Sapling birch (*Betula* sp.) up to a metre tall, that are in full sun for most of the day, appear to be essential for the larvae of this species. The results imply that management must seek to retain birch in actively coppiced sites and on well-lit ride sides (Green, 2004).

Impacts of management: threats and opportunities

Understanding how forest management practices affect species is central to this stage of research. Experiments that explore the impacts of operations ranging from those perceived as beneficial to those considered detrimental are used as the preferred basis for management guidance.

Common dormouse

Traditionally, the common dormouse (*Muscardinus avellanarius* L.), shown in Figure 5, is associated with broadleaf woodlands and coppice dominated by hazel. However the species has been found on many ancient woodland sites that have been planted with conifers in the past (PAWs sites). There is an increased move towards restoring such woodlands by conifer removal, raising the question of whether this would be detrimental to the dormouse. The ecology of dormice in conifer sites and methods of conserving dormice that are consistent with various silviculture systems are required research actions in the SAP.

A conifer removal experiment has recently been initiated in Wyre Forest, in the Midlands, in an area where Forest Research (FR) has been studying dormice for some years. Studies of population size, habitat use and home ranges in

Figure 5

Common dormouse *(Muscardinus avellanarius).* (Chris Pierce, Sussex Wildlife Trust)

the area provide baseline data. Three thinning treatments and a small-scale clearfell treatment have been applied to a 17 hectare area. The impacts of damage to dummy nests by different harvesting systems have been investigated. Dormouse use of the woodland after harvesting will be studied through nest box occupation level and radio-tracking and will help identify practices that are least disruptive to the population.

Twinflower

Twinflower (*Linnaea borealis* L.), illustrated in Figure 6, is a creeping perennial which regenerates vegetatively, producing single clone patches considered to be self-incompatible, i.e. fertilisation and seed set will not occur when pollen is supplied by flowers of the same clone (Neiland and Wilcock, 1997; Kohn and Ennos, 2000). Now restricted to the pinewoods of NE Scotland, twinflower was once more widespread, occurring in old pine plantings in northern England. Shading is considered to be one of the main threats to the species. Intense shade is thought to kill the plants but some shade is considered necessary for good growth and flowering (Erriksson, 1988). A key target in the SAP is to achieve self-sustaining populations capable of sexual regeneration.

Figure 6

Twinflower *(Linnaea borealis).* (Cath Price)

Understanding what light levels are most beneficial and how these can be achieved through stand manipulation appears important. A collaborative project between Plantlife, SNH and FR is under way at a privately owned mature pinewood in Speyside which has been thinned to an experimental design. Monitoring responses of 26 twinflower colonies has been carried out before, immediately after and one year after thinning; plot light levels and stand characteristics have been assessed pre- and post-thinning. Preliminary results suggest that increased light levels and/or disturbance have a detrimental effect on twinflower growth and flowering (Maier, 2002) but it will be several years before the colonies are expected to respond fully to the treatments.

Providing guidance

Converting research findings into guidance is an essential stage in the research process. Guidance provided by the SAPs programme varies and encompasses practical management guidance through to strategic advice to support forest policy decisions; examples of both types are given.

Juniper

Recently there has been much interest among land managers in planting juniper either by expansion of existing populations or inclusion in new planting schemes (Falconer, 2002; Woods, 2003). Guidance was needed on the best methods for growing juniper and for establishing plants in the field. Results from propagation and establishment trials carried out by FR over the past 10 years have been drawn together in a FC Information Note: *Growing juniper: propagation and establishment techniques* (Figure 7), where implications of the findings for managers are discussed. Topics covered include the advantages and disadvantages of growing juniper from cuttings or from seed, where and how to collect seed to maintain the genetic character of populations and how to strike cuttings and germinate seed. To help with successful establishment, advice is provided on the importance of weed control, types of shelters that are most effective and the impacts of fertiliser on bush growth. This guidance was developed particularly for managers involved in the practical management of juniper in the Uplands.

Figure 7

Information Note 50 on growing juniper.

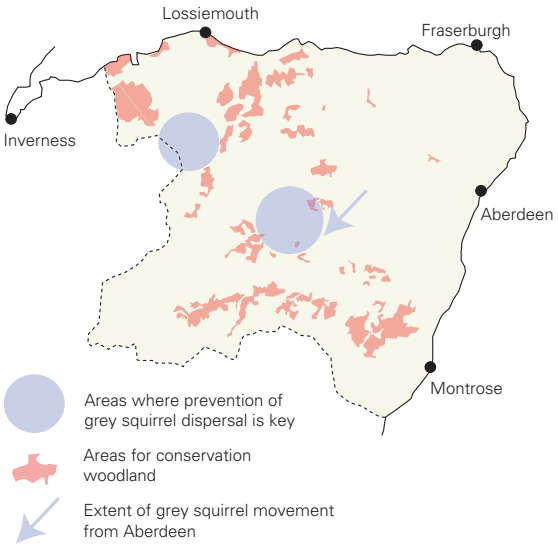
Red squirrel

Britain's native squirrel, the red squirrel (*Sciurus vulgaris* L.), is in serious decline in England and Wales but remains widespread and locally common in Scotland (Anon., 1995). The ecology of the species has been researched for many years and there is now a good understanding of the habitat requirements and the main reasons for its decline. Red squirrels are core woodland species that can survive in both deciduous and conifer habitats but appear unable to compete with grey squirrels in deciduous habitats or when the woodlands are small and fragmented. Conservation efforts have focused on identifying large conifer woodlands as red squirrel refuges. The method for refuge identification has been laid down in a set of rules based on squirrel population status, and woodland and landscape characteristics (Reynolds and Bentley, 2001).

Scotland, in contrast to England and Wales, has a substantial number of potential woodland refuges, and guidance was required on which woodlands to prioritise for conservation action. The refuge identification rules were applied to all woodlands in north and central Scotland using Geographical Information Systems (GIS) analysis. This analysis drew together information from national datasets such as the National Inventory of Woodlands and Trees (Anon., 2000c) and site data, for example woodland composition and management that were gathered during discussions with woodland managers and owners. The project report (see Poulsom *et al.,* 2004) provides a list of woodlands ranked by suitability for red squirrel conservation and an analysis by region of key woodland complexes and their qualities as squirrel refuges (Figure 8). Guidance available in the report may help to inform decisions on Forest Habitat Network design and targeting of woodland management incentives.

Figure 8

Priority woodlands for red squirrel conservation in Grampian.



Monitoring the effect of recommended management

Management guidance is normally based on the results of designed experiments and expert knowledge/opinion. Where possible it is important to monitor the impacts of recommended management as a check on whether the management is appropriate and as a way of refining the guidance. This type of work is suitable for species whose ecology and response to management is already well known. Examples are given of two such current studies: capercaillie and chequered skipper butterfly.

Capercaillie

The capercaillie (*Tetrao urogallus* L.), Figure 9, is a woodland grouse which in Britain is restricted to the pinewoods of Scotland. After becoming extinct in the late 1700s, it was reintroduced in the 19th century, and its reintroduction numbers peaked in the 1970s (approximately 20 000 birds). The population has since fallen to under 1000 (in 2002); if this rate of decline were to continue it is estimated that the species would

become extinct by 2010 (Caledonian Partnership, 2003). Urgent Conservation Management for Scottish Capercaillie is a partnership project bringing together more than 20 private forest owners, government and non-government organisations to carry out practical measures to improve habitat for capercaillie (with part funding from the European Commission's LIFE-Nature Programme). Research carried out both here and in Scandinavia has provided a clear picture of the habitat requirements for capercaillie, and management to create these optimal conditions is being undertaken as part of the LIFE project.

One action is the thinning of areas of Scots pine stands to improve the forest floor vegetation for capercaillie. To ascertain that management prescriptions are correct, thinning has been carried out to an experimental design (using four thinning treatments) at two sites: Easter Ross and Strathspey. Vegetation monitoring is under way; measurements have been made before thinning and will continue for each year for the duration of the project.

Development of a high cover of blaeberry (*Vaccinium myrtillus* L.), which is linked to the light climate of the woodland floor, is known to be key for capercaillie survival as blaeberry is host to the invertebrates on which the capercaillie chicks feed. The numbers of invertebrates that blaeberry will sustain is also thought to be linked to light levels; the aim is to develop the project to investigate these issues.

Chequered skipper butterfly

The more specialist butterflies are becoming increasingly rare in Britain as the semi-natural habitats which they depend upon become fragmented or disappear (Asher *et al.,* 2001). This is particularly a problem in southern England where the pressure for land is greater. Butterflies are generally warmth-loving species

Figure 9

Male capercaillie *(Tetrao urogallus).*

and the greatest species diversity tends to be found in the south of Britain. Some of Britain's rare butterfly species are able to survive in the cooler north where semi-natural habitats tend to be more abundant, and where the correct micro-climate characteristics can be found (Asher *et al.,* 2001).

One such species is the chequered skipper (*Carterocephalus palaemon* Pallas) which is now confined to an area of the Great Glen in Lochaber where the northern climate is moderated by four large lochs: Linnhe, Lochy, Arkaig and Eil. This area is also rich in other butterfly species including the pearl-bordered fritillary (*Boloria euphrosyne* L.), another UKBAP Priority species. In recognition of this, FC Scotland, in partnership with Butterfly Conservation are managing a large site on the shores of Loch Arkaig as a butterfly reserve. The site consists of an area of open ground with scattered woodland, and two blocks of mature Sitka spruce (*Picea sitchensis* (Bong.) Carr.) dominated conifer plantation, described in Figure 10.

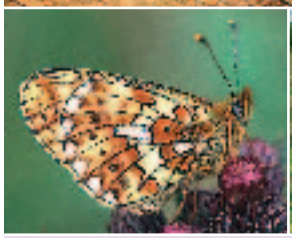
Figure 10

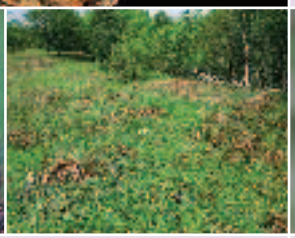
Monitoring of habitat management at the Forestry Commission's butterfly reserve by Loch Arkaig in Lochaber, north west Scotland. (Butterfly photos: David Whitaker; habitat photo: Paul Kirkland)

The site is located 14 miles north of Fort William, on the north shore of Loch Arkaig. It comprises 80 ha of open ground with scattered woodland, bracken, dry heath and acid bog, and 260 ha of mature Sitka spruce-dominated conifer plantation.

The site is being managed for the two UKBAP species, the pearl-bordered fritillary and the chequered skipper. The habitat requirements of these species are well understood.

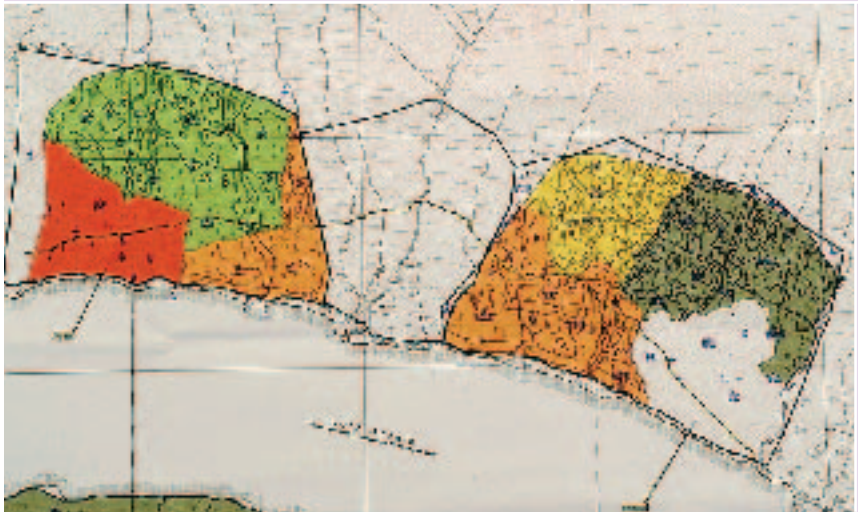
The majority of the butterflies are to be found in the open area. Summer grazing by cattle is being used to maintain and improve the ground vegetation for butterflies. Effectiveness of this management regime is being monitored by FR.





Larvae of the pearl-bordered fritillary require violets growing among thin bracken litter. The violet leaves are food for the larvae and the bracken litter provides resting sites which are at higher temperatures than the surrounding vegetation.

The chequered skipper larvae feed on purple moor-grass, but as they do not pupate until the late autumn they will only survive on tussocks that are growing vigorously and will continue green into the autumn. Such tussocks occur in flushed conditions only. Some level of shelter is also required and purple moor-grass in flushed conditions with surrounding tree cover provides the ideal conditions.



Phases in the restructuring of conifer plantation are colour coded. Non-coloured area has already been felled and is the site where FR is monitoring vegetation development.

Results from the baseline survey of the clearfelled area show that food plants and nectar sources already exist, albeit at very low levels.

At this site, the majority of the butterflies are to be found in the open areas, especially among the scattered woodland where there is more shelter. In the past, sheep and deer have grazed the area, but the grazing regime has been changed to summer grazing by cattle only. The aim is to improve the vegetation structure for pearl-bordered fritillary larvae, increase the nectar sources and stimulate tree regeneration on the more exposed parts of the site. Provision of such precise conditions requires careful management and the effect of the management prescription designed to deliver these needs to be monitored. FR have designed and are implementing the monitoring at the butterfly reserve. Using permanently marked quadrats, vegetation composition is being assessed annually in early summer, with the aim of detecting significant changes in butterfly food-plant availability. On a broader scale, the occurrence of nectar sources and tree seedlings are also being assessed across the site through a series of permanently marked transects.

In the conifer plantation, the FC have embarked upon a process of restructuring, with sequential areas being felled and replanted over the next 30 years. As the woodland is restructured, open areas will be created, if only temporarily. For a time, these might support the food plants and nectar sources for the target butterflies. Harvested coupes are being monitored from shortly after felling until the replacement crop closes canopy to chart the development and decline of ground vegetation. This should identify whether suitable ground cover can develop, at what time this is likely to happen, and for how long it will persist. Such information will allow timing of felling to be scheduled so as to provide a continuity of butterfly habitat throughout the forested area.

Links to other research programmes

The research programme described above is part of the biodiversity research grouping within FR. There are links between many of the work areas and information generated can be of use in other research programmes. For example:

- Autecological and management data is being organised and delivered through the Habitats and Rare, Priority and Protected Species decision support system (HaRPPS).
- Data can be used to build species profiles for use in the model Biological and Ecological Evaluation Tool for Landscape Ecology (BEETLE) which will allow the suitability of habitats at the landscape scale to be assessed (Watts *et al.,* in prep.).
- Guidance on conservation measures for a species may also require consideration of its genetic conservation. This is particularly true for juniper, which can show distinct differences in genetic character between populations. Being able to assess genetic variability of species in order to advise on the importance of a local population's conservation is likely to become increasingly important.

New SAPs research areas

The research programme has now been running for four years and research activities are taking place in all of the areas that were identified as priorities at its outset. The programme is evolving and new work is planned. New work areas for 2004–05 include supervision of a project to identify potential priority woodlands for Bechstein's bat (*Myotis bechsteinii*), collation of data on wood ant distribution in Scottish forests (including *Formica aquilonia* Yarrow and *F. exsecta* Nylander), habitat management and grazing trials for black grouse (*Tetrao tetrix* L.) and supervision of a PhD on stipitate hydnoid fungi (*Hydnum, Hydnellum, Bankera, Phellodon, Sarcodon* spp.). The work of the programme has also developed in response to changing research needs and pressures exerted by the forestry, environmental and conservation sectors. As a result, new species that are being, or will be, given attention include otter (*Lutra lutra* L.), small cow-wheat (*Melampyrum sylvaticum* L.) and the pine marten (*Martes martes* L.).

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