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Advice for the management of flightlines and foraging habitats of the barbastelle bat *Barbastella barbastellus*

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Advice for the management of flightlines and foraging habitats of the barbastelle bat *Barbastella barbastellus*

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1. Understanding barbastelle survey information and records

Recent in-depth radio-tracking and survey work with a number of bat species has begun to show a substantial element of resource partitioning between the sexes in the summer months. There are strong indications that this is the case with barbastelles. A few males may be found within the area of prime habitat used by a maternity colony, but the majority of males are spread far and wide in sub-optimal habitats. There is no discernable sex difference in the echolocation calls of barbastelles. This means that bat detector records of barbastelle calls may represent males who may be several tens of kilometres away from the nearest nursery colony. To understanding the significance of any record of barbastelles, it is essential to know the sex and sexual state of the individual bat concerned.

Until the mid-1990s virtually nothing was known about the habitat requirements of barbastelle bats, but since then, there has been a number of studies across their range in Europe and the UK. Most of what is known about the flightlines and foraging habitats of female barbastelle bats is based on data on a colony in West Sussex that has been studied since 1996. This colony, at Ebernoe Common, was the first in Britain to be studied systematically, and is currently the only one for which there are comprehensive data on the foraging behaviour of multiple females. However, information that is gradually accumulating from other studies supports the evidence presented in this report, which is that female barbastelles make use of well-established, extensive flightlines and foraging habitats that are far removed from their roosting area. Consequently, while the picture that is emerging of their ecology, behaviour and habitat requirements comes largely from one local population, there is good reason to believe that it has much broader applicability. Similar habitat requirements have been observed in Europe.

1.1 Flightlines and foraging habitats of female barbastelles

Female barbastelles congregate in the spring to form colonies in which they give birth and raise their young. Most of these maternity colonies are located in areas of mature woodland, and each colony uses the same area year after year. Every night during the spring and summer females disperse from the woodland along established routes or flightlines to foraging areas that may be several kilometres away. To a large extent a female's ability to feed herself and her offspring will depend on the condition of these flightlines and foraging habitats. Thus, any habitat management plan for barbastelles must take into consideration both the wood in which their roosts are located and the broader landscape surrounding that wood. More specifically, management of the surrounding area must focus on the maintenance of established flightlines and foraging areas.

2. Flightline habitat requirements

2.1 Typical flightline lengths

The lengths of flightlines can vary from a few kilometres to as many as twenty kilometres. The average length of flightline for pregnant female barbastelles is about eight kilometres in West Sussex. Close to the roosting site, several females may share common flightlines but the longest flightlines generally end in a section that is only utilised by one bat to access its most distant foraging habitat. The arrangement of these routes resembles tall, branching trees, with several bats sharing the path along the trunk and major limbs, but separating off into smaller branches, each of which ends in a discrete individual foraging area. In some cases the branches may be sparse with the foraging areas located close to the main trunk. Depending upon the distribution of the colony's major food resources, some initial sections of flightline may have as many as twenty bats using them.

2.2 Flightline requirement to connect foraging areas

The distance that bats will travel before stopping to forage may be influenced by a combination of factors, including the season, the weather, the foraging time left available in that night, and the metabolic state of the individual concerned. Consequently, each bat needs a series of potential foraging sites along its regular flightline. The evidence from radio-tracking is that each adult female repeatedly uses the same flightline, and that juveniles eventually follow their mothers out along these flightlines and become familiarised with the routes and foraging zones along them.

Avian predators are a major threat to bats flying in daylight conditions. Because of the short nights in summer and the long commuting distances of barbastelles they must emerge early in order to have sufficient foraging time. The threat from predatory birds is lowered if bats can remain in dark, shaded woodland and within a metre or two of the ground. By following shaded woodland tracks and overgrown hedges, several kilometres can be covered by bats before the daylight has finally gone. Eventually most of these shaded routes end with an open space that stops the bats proceeding further until darkness descends.

In open country the natural tree lines which create potential flightlines follow watercourses, and many bat species have flightlines that follow these natural features. The wet habitats along rivers and streams also provide the series of potential foraging sites strung out in a linear fashion that barbastelles require. The ideal example of a barbastelle colony of the distant past would be of a small catchment with dense woodland on its headwaters and wooded river valleys leading down to a wide zone of water meadows and finally reed beds and sand dunes before reaching the sea. Roosts would be in the headwater woodlands and the barbastelles would have individual foraging areas spread up and down the catchment’s tributaries and the main river. The colony's territory boundaries would be set by the extent of the catchment area. Flightlines in such a situation would be basically two major routes, upstream and downstream, rather than the six major and two smaller routes we see out of Ebernoe today.

In our heavily modified landscape many of the naturally connected riverside tree lines have been interrupted or removed, and in many cases new plantation woodlands cut across hills and connect catchments. Colony territories have become difficult for the bats to define as

they now often have an unnatural access to new foraging possibilities in adjacent catchments where there may already be neighbouring barbastelle colonies.

The extent of this problem is yet to be fully understood but evidence of the effects of neighbour colony proximity is visible in the dogleg route of Ebernoe bats accessing the lower Arun and Rother floodplain. None of the area of The Mens woodland has ever been recorded as being entered by barbastelle bats from the core colony at Ebernoe. They all pass around the western boundary of the woodland block and then swing east. A second colony has now been confirmed in the central area of The Mens and at Idehurst Hurst and it would seem that The Mens western woodland boundary is also the territorial boundary between the Ebernoe colony and The Mens/Idehurst colony.

2.3 Structure and species composition of vegetation along barbastelle flightlines

Woodland and hedgerow structure along flightlines is of more importance to barbastelles than the particular plant species. It is the degree of shade cast and the directness of the route that matters. When the bats first leave Ebernoe they commute at high speed, making for the most productive foraging area of the night, and ignoring foraging opportunities on the way. In consequence unbroken dense strips of mature woodland connecting down to water with continued wooded features is an ideal pattern of vegetation. The most favoured routes often have old tracks or rides running down the length of the interior. Tree species producing a low spreading twiggy structure over a thick understorey will increase shade, but the bats do require a clear central trackway. When flightlines cut across large woodland blocks these woodlands themselves are usually utilised as secondary foraging areas by at least some of the bats. If trackways are available they are still used as flightlines but if unavailable the bats may take many different routes across the woodland block using the gap between the top of the understorey and the base of the canopy.

2.4 Management of the flightlines

In an ideal situation managing and enriching the vegetation along flightlines will go a long way towards maintaining them. This practice should extend outwards to at least six kilometres from the roosting woodlands. By the time bats have travelled this far from the roost it has usually become dark enough for them to cross more open spaces. Where woodland connectivity breaks down into small hedgerows, increasing the hedgerow width to about ten metres by planting a second line of trees and shrubs parallel to the existing hedgerow will eventually create effective flightline conditions. A central pathway should be left between the hedgelines. There is frequently scope for public footpaths to be treated in this way, improving both the public environment and the flightline. The larger the hedges are allowed to grow, the more effective the flightline cover they will provide. Trimmed hedges provide very poor cover to commuting bats and when essential, such work should be confined to a single side of the double hedge line in any one year. Uniformity is not desirable either in species mix or structure, however tree species with a natural growth form of tall clean trunks, such as Ash and Beech, should be avoided. It should be emphasised that the continuous double hedge line is an ideal, and if a long section requires attention then even small sections of new planting will improve the situation for the bats.

Connectivity is the key to flightlines. Breaks in flightlines can delay the onset of foraging for commuting bats. If breaks cannot be crossed with new double hedgerow planting then

enrichment of the foraging habitat on the roost side of the flightline break is another option. This will benefit bats waiting for increased darkness before crossing the flightline gap and is an option that becomes more practical with increasing distance from the roost.

While the preferred practice on agricultural land adjoining flightlines is to maintain established grassland, the effects on flightlines from adjoining arable land are minimal provided that agricultural practice is good, with no spray drift and with the extensive provision of untreated headlands. The agricultural practice on land adjoining foraging habitat located along flightlines is a very different matter and is considered in S.9.

As watercourses and their margins form such a major component of flightlines they also require consideration. The types of water features followed vary from larger hedgerow ditches up to medium-sized rivers. As with hedgerows, connectivity of bankside vegetation is beneficial out to at least twelve kilometres from the roost area. A stream with tree lines on both banks and the canopies touching creates an ideal flightline, as the stream becomes wider one bank with a wider line of trees becomes preferable.

As foraging areas will be located along the waterway water quality is important. In terms of insect availability, clean waterways are more productive right through the seasons than those with a low level of pollution, which tend to have a boom and bust pattern of production of insect biomass.

The sudden felling or pollarding of woodland blocks alongside flightlines can be extremely disruptive, causing the bats to make extensive detours, or suffer from delays or isolation. Such operations can usually be staged over a prolonged period to avoid major breaks in a flightline. Where work is unavoidable it should be carried out at times of the year when the bats will be least sensitive to such disruption, which would be October to March. The preferred option is always to save the trees along the flightline route. Such tree works would also have a serious impact on secondary foraging areas and this is considered in S.8.

2.5 Areas where the connectivity of current flightlines is failing in the West Weald

There are eight flightline routes out of the Ebernoe roost area. These are dealt with in clockwise fashion starting in the north. Areas beyond six kilometres from Ebernoe Common are not considered, as darkness has normally arrived by the time bats reach this distance from the roosts.

North: Flightline 1

The flightline leading to the north is one of the most connected, and consequently the most effective route. The flightline has an early branch leading to the north west and branches again north of the Northchapel road. In all these cases the bats are following watercourse woodlands upstream. This route is a fine example of the preferred flightpath habitat. Gaps do appear between the stream headwaters and major woodland blocks to the north at SU 965305 SU 968308 and to a lesser extent at SU 979305, connective planting at these locations would be beneficial. Beyond these locations woodland is well connected out to the final foraging areas on the stream headwaters of the next catchment.

East: Flightlines 2 and 3

Flightline 2 gives access to the Little Arun catchment woodlands and the Wey navigation canal around Loxwood. Much of the route is along hedgerows even from the Ebernoe Common roost woodlands. A single hedgerow connection lies between the north east corner of Ebernoe Common and the west bank of the River Kird, SU 987277. This hedgerow would benefit from a double hedge line down to the tributary of the River Kird, and then an increased width of planting along the stream down to the main river. The best option would be to plant alongside existing hedgerows to form the new double line. A further double hedgerow planting to connect all the small woodlands in an east-north-eastward direction, following the flightline, will improve connectivity further away from the roosts out in the direction of Loxwood, from TQ 000290 east-north-eastwards.

Fightline 3 leaves Ebernoe to the south of Butcherlands Farm following woodland towards the River Kird. This eventually provides access to both woodland and wetland foraging in the Kirdford area. The flightline is failing at SU 988271 and could also be improved by planting along the river Kird southeast of Isling bridge at TQ 000263.

South: Flightlines 4 and 5

The southern Flightline 4 is seriously broken at SU 991237. A public footpath crosses this open area that is currently arable farmland. Hedgerow planting on both sides of the public footpath would eventually close this very exposed gap, although a wider planting to produce a narrow woodland strip would be more beneficial. It is this region that forms the major break in connectivity between The Mens woodland block and the Ebernoe woodland block.

Flightline 5 diverges from Flightline 4 at SU 982250 and follows the small stream south through the village of Byworth. Woodland clearance on a long stretch has rendered this too open and light in the midsummer evenings. It is however still utilised in the darker months, or during returns to the roost in the middle of the night. This suggests that even minimal improvement in cover will be utilised along this watercourse. It would be a major undertaking, but extremely beneficial to reinstate its entire length, as the current Flightline 4 passes very close to the territorial boundary of the adjoining barbastelle colony in The Mens.

South and southwest: Flightlines 6, 7 and 8

Three separate flightlines leave Ebernoe to the west and southwest. Flightline 6 has two possible routes through Petworth Great Park. The south- southwestern Flightpath 6 is good until a failing section between the south end of Palfrey Copse and the north end of Hoads Common at SU 968258. Beyond this it is good again until Petworth Great Park at SU 960228. In the Great Park the ridgeline of trees along the western side of the Park has been, and continues to be, lost to age. There is scope to recreate this connective feature. South of the Great Park much more substantial hedge lines are required to connect to the Rother floodplain. Recent new hedge planting of a single line of hawthorn is an improvement, but is inadequate for the purpose of a substantial flightline. The second route through Petworth Great Park connects the small foraging areas around the ponds in the park, then also passes south across the agricultural area following scant cover. Most of this route would benefit from increased planting, but particularly around the ponds and across the wide, open areas.

The central western Flightline 7 leads to the next tributary of the Rother. Small breaks in continuity occur at SU 955261.

The final western Flightline 8 is good in its initial stages, but has several major breaks as it crosses agricultural land around the Petworth to Northchapel road at SU 953282 and again west of Lurgashall at SU 935273.

2.6 An older pattern of flightlines and foraging areas

Landscape changes over time, brought about by the unnatural new connectivity created by forestry planting and increased agriculture with its associated drainage schemes, have altered the connectivity, composition and diversity of barbastelle flightlines and foraging areas. There has undoubtedly been a reduction in the total available foraging area within a radius of ten kilometres of Ebernoe, and this may well have led to the rather extreme commuting distances now observed.

Re-establishing more natural, geographically based, woodland connections up and down watercourses and their minor tributaries will lead to direct flightline connections between the barbastelle's preferred foraging habitats. It will also shorten flightlines and increase the productivity of 'en route' foraging areas.

This restoration of older flightline patterns should be seen as the ideal solution to fragmentation problems with flightlines, but it would be a very large, long-term project. Re-connecting the current flightlines may be the only pragmatic approach. It will certainly produce faster results. The stream which rises south of Balls Cross and runs east of Petworth through the village of Byworth is an example of such an old flyway (5). Currently the route is the southern flyway 4 following the woodlands on higher ground slightly to the east.

3. Foraging habitat requirements

3.1 Diet

The barbastelle bat is a specialist predator on small lepidopteran species that possess hearing organs. A number of research projects have investigated the insect fragments that remain identifiable in faecal pellets. All workers have come to the conclusion that small moths, and in particular micromoths, form the bulk of the diet during virtually all months of the year. Many of the alternative prey species are associated with wet habitats or are species of seasonal abundance. All are small and generally soft-bodied. The small tympanate moths that form over ninety percent of the diet are largely from the families Pyralidae, Geometridae, Arctiidae, Noctuidae, Tortricidae and Gelechiidae.

3.2 Seasonal foraging patterns

The seasonal peaks in activity and metabolic demands differ between the sexes. For females the peak in metabolic demand will be for three and a half months in May/June /July/Aug, coinciding with the birth and rearing of young. For males, the peak demand is likely to be in autumn and winter, coinciding with mating activity.

3.2.1 Seasonal abundance of dietary items and synchronised breeding.

In winter a wide range of small insect species will be taken but moths still form the bulk of the diet. Few other bat species exploit these resources in winter, but well-documented ones include *Pipistrellus pipistrellus, P. pygmaeus* and *Plecotus auritus.* All these species find winter foraging in the same areas and are at least potentially in competition with barbastelles. Barbastelles are winter active bats and can be found foraging right through the winter months provided the temperature remains at eight degrees C or above within dense woodland. Foraging bats do not follow the same patterns observed in the summer months, but remain within about a kilometre of their roosts.

In spring and early summer female barbastelles steadily forage outwards towards more open habitats than their preferred dense winter woodlands and the flight path pattern is steadily resumed. With the increasing temperatures moths become available in a wider range of habitats than in winter but are more numerous in proximity to wetter, more sheltered habitats.

In summer it is the super-abundance of moths, and particularly micro-moths, over unimproved grasslands, wooded riversides, hedgerows and water meadows that make it worthwhile for barbastelles to commute the large distances necessary to exploit them. At times in late June and July it can be like driving through a snowstorm of moths when following a feeding bat. The breeding female population exploits this resource and remains active all night. This period coincides with the period of greatest metabolic demand on the female bats, and the seasonal abundance in food in effect allows them to breed. The latter end of this period of abundance in August allows inexperienced juvenile barbastelles to gain weight before winter. Barbastelles will vary their birth dates according to the advancement of the season. Young may be born at any time from mid-June to the start of August. As the same factors affect all members of a colony, in any given year births still tend to be loosely synchronised but are normally spread over at least two weeks and occasionally up to five. During the summer season the males are only active for fairly short periods of the night and, from the small amount of data available, seem to forage entirely in woodlands within a kilometre of their roost site.

Moth abundance in open areas drops sharply after the first cold nights and the bats return to more enclosed woodlands and warmer wooded watersides to forage. Depending upon the season August/October signals the start of mating. This is not well documented in the UK. Accounts from France speak of groups of females all roosting with single males. How this effects foraging territory is not known.

3.3 Foraging habitat used by female bats

These can be summarised as old meadows, hedgerows and woodlands often in rich valley bottoms during summer and dense old growth deciduous woodland habitats in the colder months. In high summer, foraging in open heathland and moorland is also recorded. Many of the known British colonies are within commuting distance of the sea, and at least three colonies are recorded as utilising dune, marsh and established coastal grasslands.

The habitat types utilised by the Ebernoe nursery colony consist largely of the flood plains of rivers and streams together with woodlands in proximity to the watercourse. As bats move away from the roost area, woodlands form most of the intermediate foraging zones. Many of these are quite wet. The final destinations of most bats are larger floodplain meadows,

particularly on the Arun and the Rother. Normally each bat has a territory of open meadows with an adjoining area of scrub or woodland. To the north and west of Ebernoe the foraging areas are much more enclosed by woodland and the streams are much smaller. In consequence the major foraging areas here are very tightly linear following streams and their floodplains. Several of the bats have a tributary stream each.

3.4 Foraging habitat used by male bats

In common with many other bat species, foraging habitats of male barbastelles are sub-optimal when compared to those of the females. Although there is a little overlap of foraging habitat between the sexes, female colony territory is fairly exclusive and it seems to be unusual for them to be in close proximity until late summer and winter.

Male barbastelles have been recorded in a large range of woodland types, including many dryer habitats. It is probable that the size of the foraging territory varies according to the productivity of the woods concerned. Resource partitioning between the sexes may play a part in the selection of territories.

Male bats retain the close association between their foraging areas and their roosts but may visit a series of scattered roost sites and do occasionally form
loose associations with other males, often around some underground feature. Such groups of male animals seem to be located at some distance from female nursery roosts and the foraging areas seem not to overlap to any great extent. They have not been observed to form the flightlines characteristic of female breeding groups.

Small aggregations comprising mostly males with a very few females and juveniles may be found flying at selected underground sites from July to end of September. They do not seem to day roost at these locations. These underground sites are frequently the same locations as those used by male bats in spring and summer. This may be similar behaviour to that recorded with *Myotis* bat species and known as swarming.

3.5 Size of feeding territories

In summer a lone male barbastelle forages over approximately one square kilometre of woodland habitats. It seems able to satisfy its metabolic requirements in about one third of the available foraging time. By contrast a pregnant female barbastelle must forage all night in the much more productive but seasonal water meadow habitats and range over a foraging area which can be more than five times the size of that of the male. These figures are not precise and will vary with the actual location and season. When meadow foraging areas are surrounded by woodland and less exposed, the foraging areas utilised are smaller. This is probably as much to do with the number of prey items actually on the wing, and consequently available, as it is to do with prey abundance.

The possible foraging habitats located along each female bat's flightline are normally much smaller than the most distant major foraging zone. Patches closest to the roost area are usually shared by the colony members and may seasonally be left clear by adults as exclusive juvenile foraging zones, although more data is required on this. Most colonies seem to have one large productive foraging zone very close to the roost woodlands to fill the juvenile and shared requirement.

Patches of old growth oak woodland and the small floodplains of woodland streams and rivers are frequently the habitat types associated with the 'en route' foraging areas. They can be as little as one hectare in extent or, as is often the case with the woodland types, much larger.

3.6 Density of foraging barbastelle bats in the landscape

Foraging barbastelles are spread very thinly in the landscape. Even within the healthy colony from the Ebernoe roost the density of bats in late summer is rather less than one female or juvenile bat to six square kilometres. This figure, of course, includes a very large area of land that the bats very seldom, if ever, use as it consists of unsuitable, largely arable habitats. The foraging habitats themselves form a select and vulnerable set of the more stable and productive habitats; a small percentage of the total area, but rich in diversity.

3.7 Changes in the location of principal foraging territories over time

Drainage of fields and meadows, scrub clearance and the felling or planting of new areas of woodland can all lead to semi-permanent changes in available foraging areas. Such changes have the potential to cause dramatic alteration in the breeding success of barbastelle colonies. When too many foraging opportunities are lost along a flightline, the bats will cease to use it, even if its connectivity is maintained. Increasing foraging opportunities along the sections of flightline used in early evening lowers the requirement for long distance commuting in poor weather. In fine weather the bats normally ignore such close sites and head rapidly for the highly productive distant zones.

3.8 Management of foraging habitats

Management of habitats to promote insect, and especially micro-lepidopteran, biomass is the rather difficult goal. Old established unfertilised grasslands and water meadows are naturally highly productive of insect biomass. Where such areas are exposed to prevailing wind the number of nights when the moths are on the wing can be greatly restricted. Shelter belts or even a series of isolated trees, such as spreading willows, can be highly effective in slowing wind speeds and increasing insect availability.

It is very difficult to make all encompassing statements when dealing with so many different small moth species, however the larvae of many of the more abundant species feed on basal stems and roots rather than the upper sections of grasses. It would seem therefore that light grazing would have little effect on the moth biomass. Hay cutting on the other hand does greatly and suddenly alter local insect availability at a very susceptible time of year for the pregnant bats.

In the scrub and wooded habitats, apart from total clear fell, scrub or understorey removal is potentially the most damaging operation. Understorey plants are the larval foods of many small moths, the Geometridae in particular. Such operations will also increase local wind speeds and lower the humidity, both changes that will lead to lower insect abundance and availability. Woodland that is basically old-growth, but with a very wide selection of types within it, from glade to dense high forest, should be a management aim. Where coppicing work is necessary it should be carried out in small patches so as to maintain woodland humidity and retain low wind speeds.

Forestry operations within foraging areas in woodland adjoining watercourses are another problem. The best that can be done when such work is unavoidable is felling selectively over time, rather than the more usual practice of clear felling. Tree lines should always be left along the watercourse itself. If light, selective felling is well practiced leaving an understorey intact, it can often be beneficial in promoting insect availability. Trees with rot cavities or woodpecker holes should always be left intact.

The small floodplains along streams in woodlands should be left to develop naturally with no attempts to drain them or clear blockages. Open areas that flood in winter on such woodland streams become highly favoured foraging spots in summer.

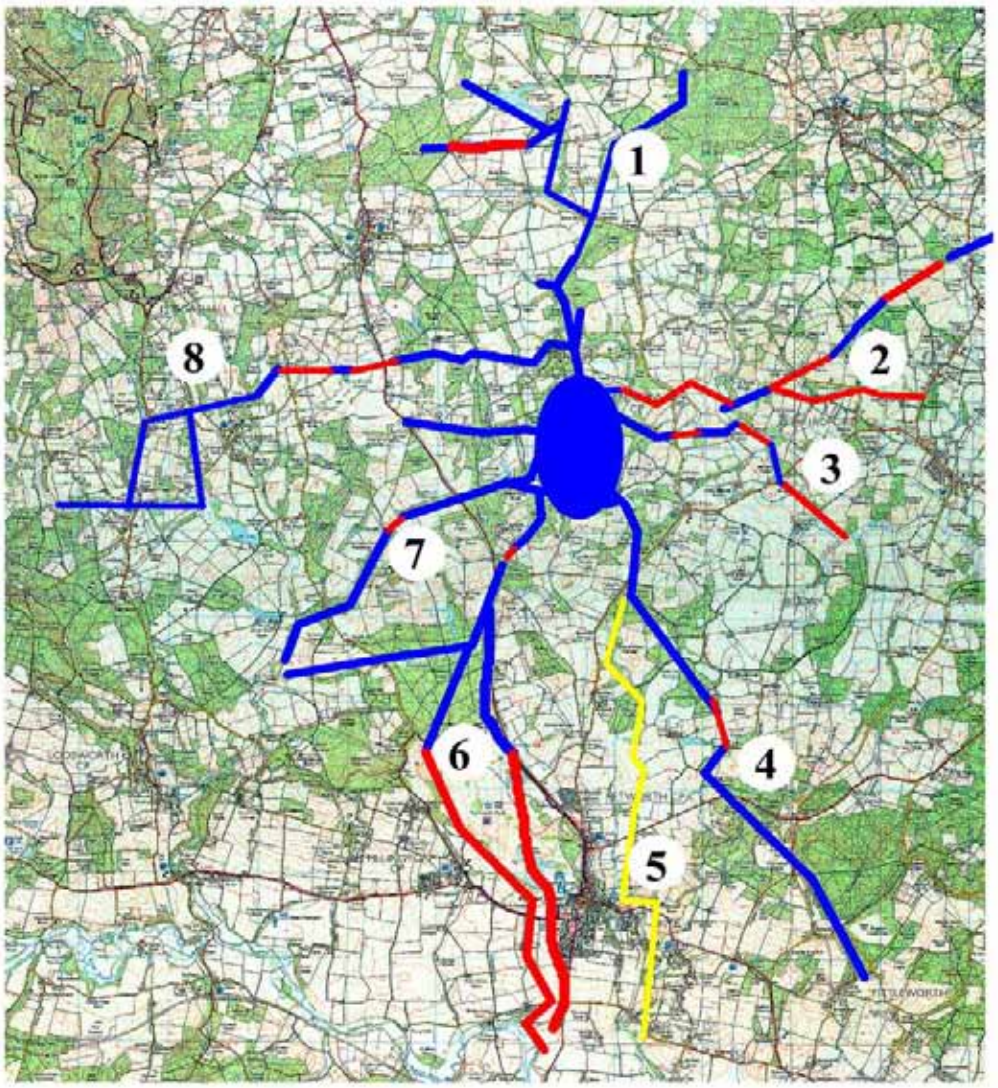
3.9 Management of land adjoining foraging areas

Generally speaking, barbastelles prefer established natural or semi-natural habitats that are fairly stable in character and require little maintenance. Two external factors do however have a noticeable effect the productivity of barbastelle foraging areas.

Many foraging zones benefit from the drift of insects in from adjoining fields or open habitats. When the open areas themselves are too exposed or low in productivity to be beneficial foraging sites a concentration of insects can still occur on the lee side of the first obstruction to the wind. Such situations are extensively exploited by many bat species including barbastelles. Inherently rich old oak woodland bordered by old unimproved grasslands or pasture is the ideal situation for this, but it does also occur on hedgerows across open ground.

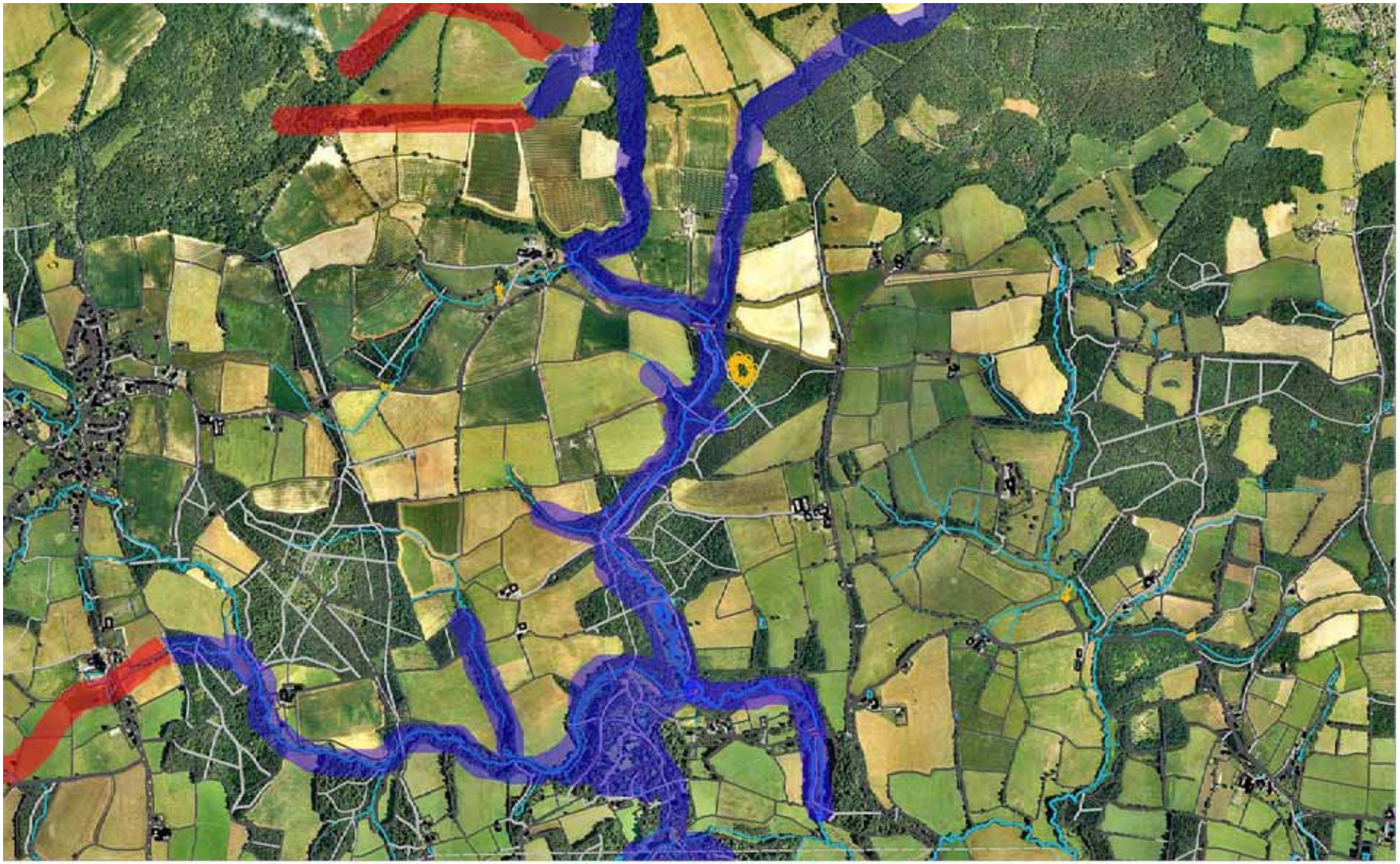
Arable land adjoining woodland or wet foraging habitats has the constant possibility of contamination damage from the run off of herbicides, pesticides or fertilizer, any or all of which will alter availability or abundance of insect life. Contamination of the watercourse itself may cause total loss of foraging areas where exploited species are moths with aquatic larval stages.

Barbastelle flightlines from Ebernoe Common

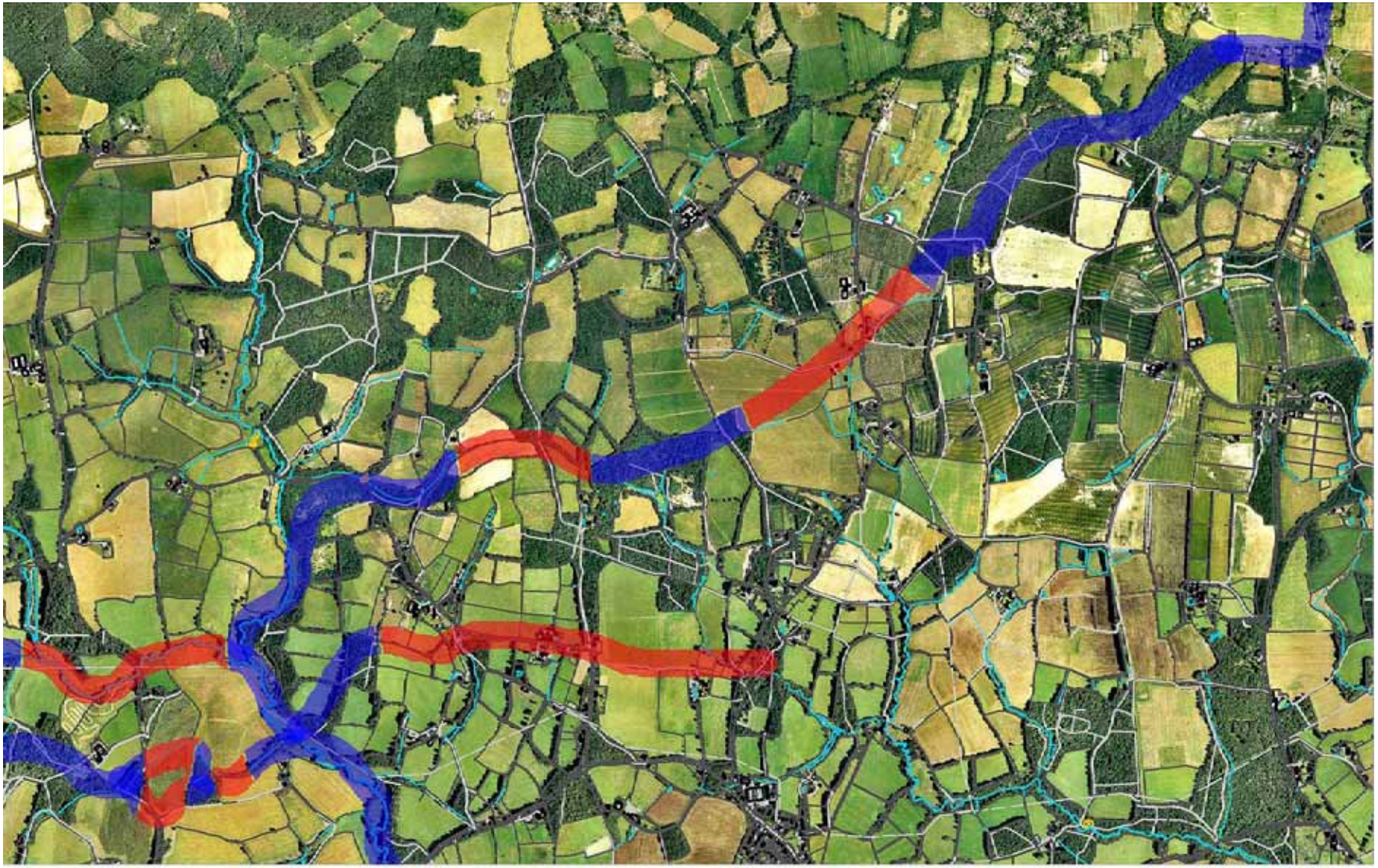


Barbastelle flightlines follow natural features such as streams as long as these retain sufficient cover in close proximity. When this cover is lost the route will only be used under dark conditions. The routes shown are used nightly in the summer months but may change slightly according to the prevailing weather. All routes actually go considerably further than the illustration shows.

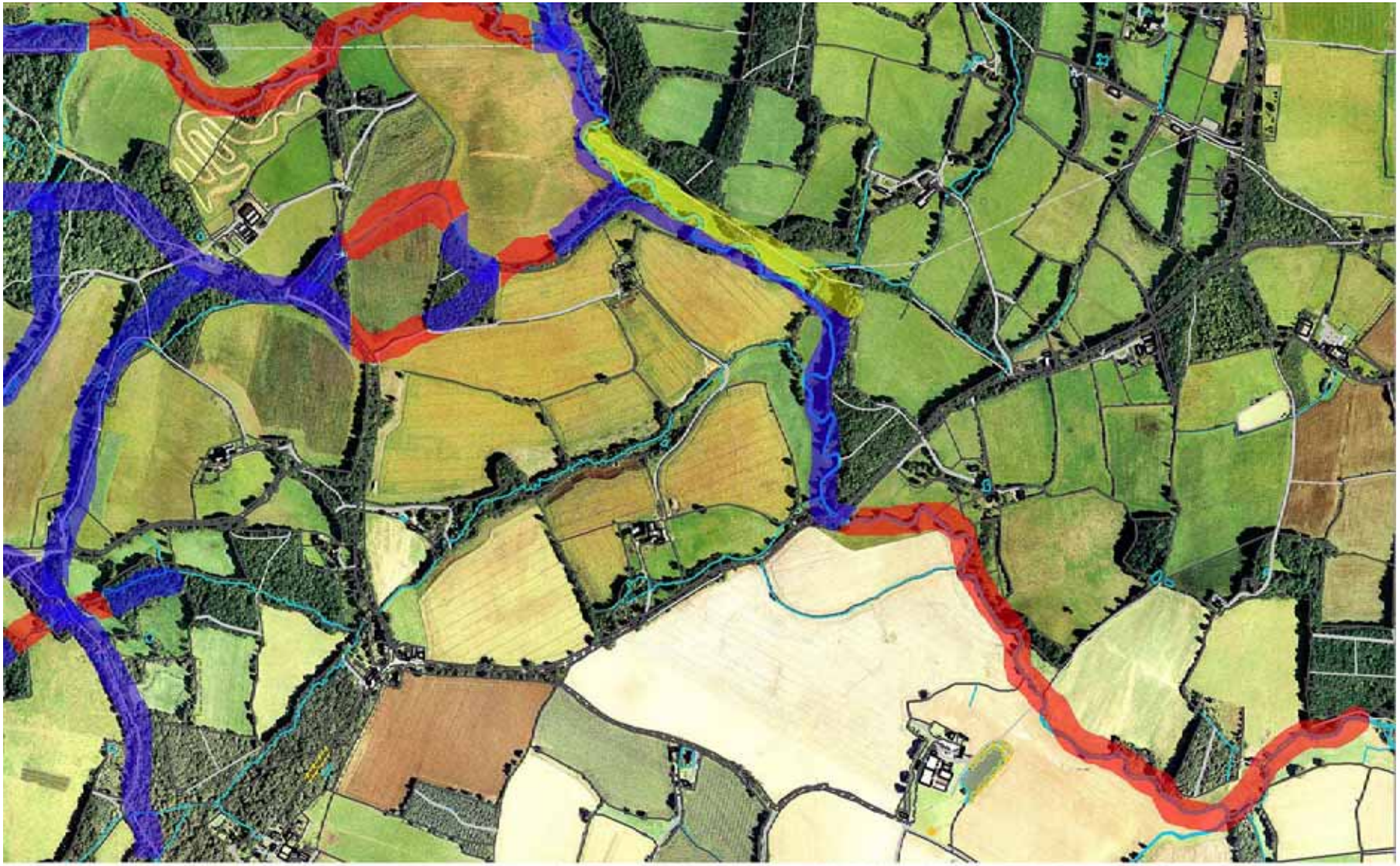
Forage areas are scattered along the flightline routes. On routes 1,2,7,8 all the forage is located on stream side woodlands and small glades. The other routes have similar sites on route but final areas are extensive water meadows and occasional wet woodlands.



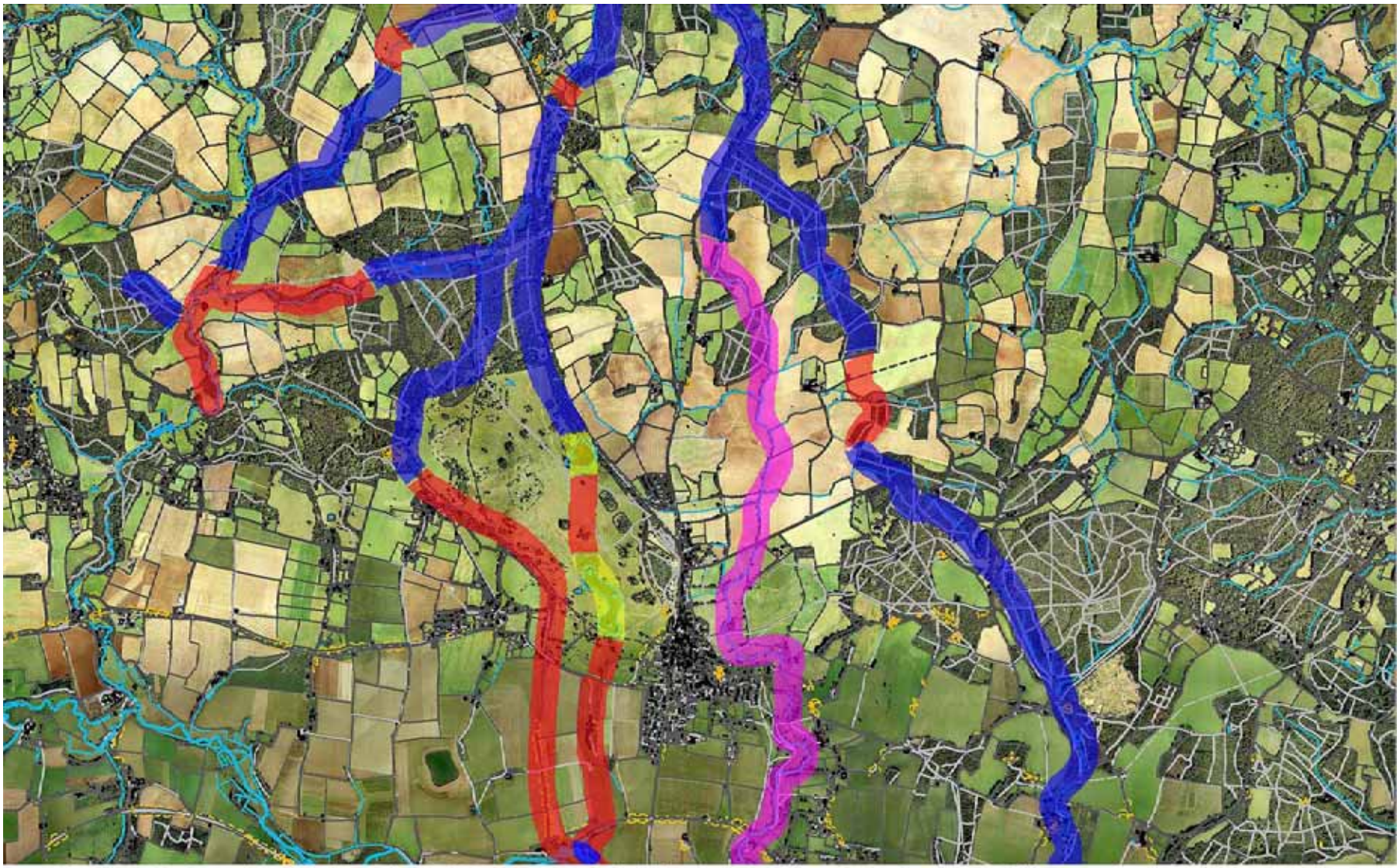
Ebernoe Barbastelle flightline 1.
Blue wash areas show existing good flightlines and forage areas. Red wash areas are failing or poor.



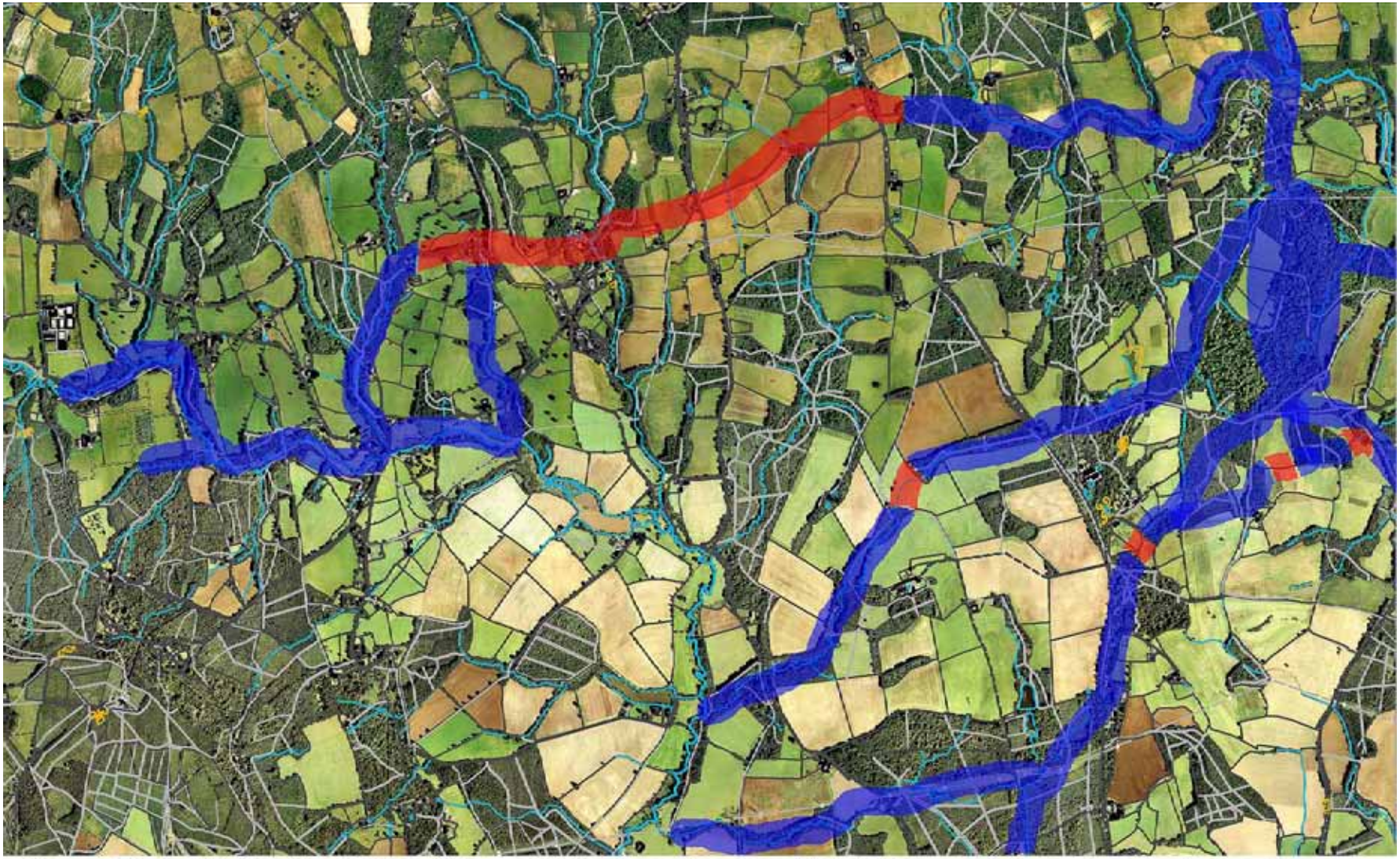
Ebernoe Barbastelle flightline 2. Red wash indicates inadequate flightline cover across the areas.



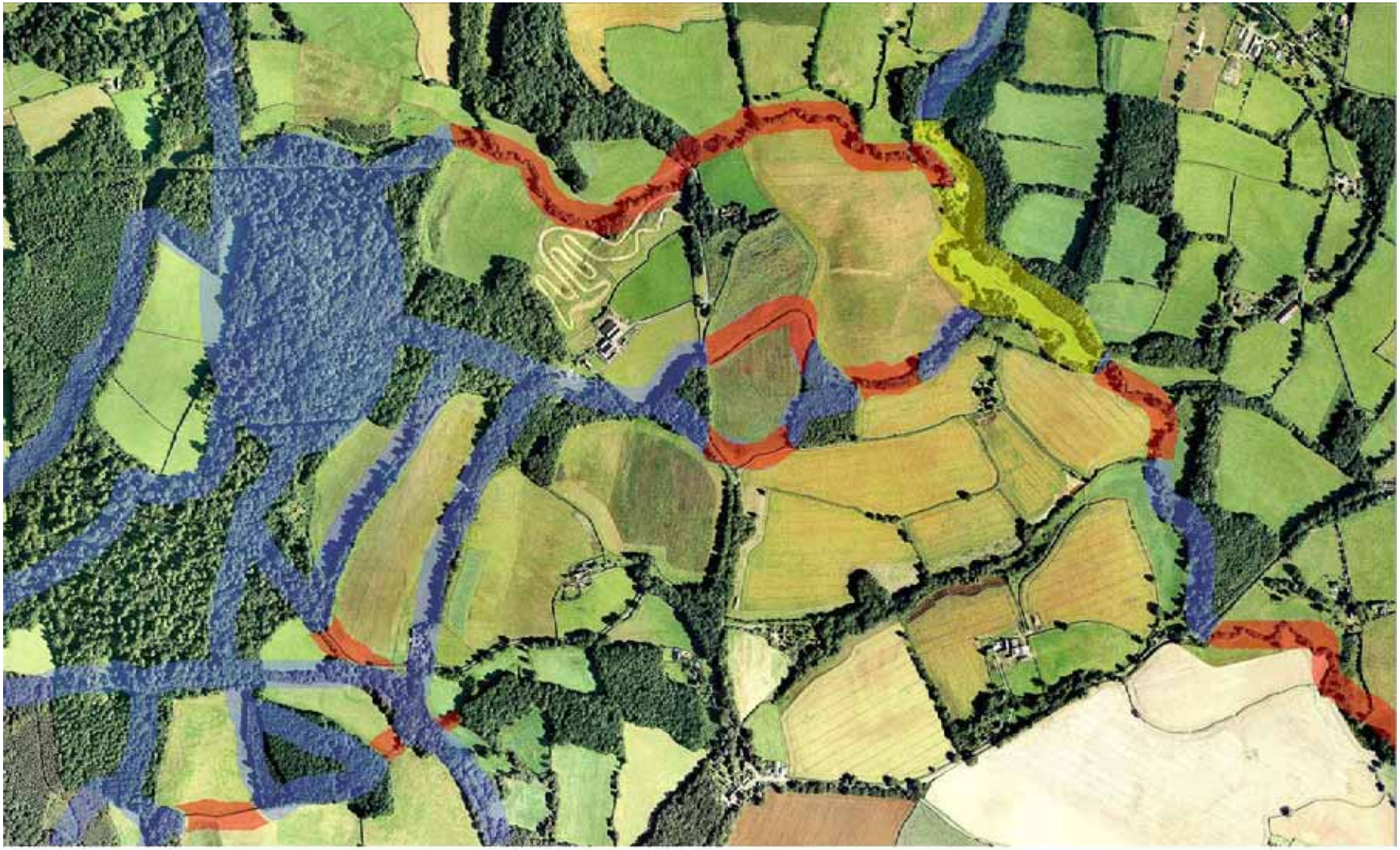
Ebernoe Bartbastelle flightline 3. Red wash areas indicate failing cover on flightlines. Yellow Wash areas indicate forage areas with scope for improvement



Ebernoe Barbastelle flightlines 4,5,6. The blue wash is an intact flightline, the red wash is failing cover, the yellow wash represents forage areas without sufficient cover and the magenta wash is a probable failed flightline.



Ebernoe Barbastelle flightline 7, 8. The blue wash indicates good or acceptable flightlines and forage areas on streams. The red wash indicateds a lack of cover on the flightlines.



Barbastelle flightlines from Ebernoe Common across Butcherlands Farm.
Failing areas are washed with red. The yellow area is a forage zone that could be enriched by more shelter to the west.

WOODLAND FLYWAYS

When flightlines pass through woodlands the bats normally follow streams or woodland tracks.
Such woodland features are only followed if the general direction is correct, if it is wrong they will be totally unused.
Without such interior woodland features the barbastelles will follow a direct path using the space between the canopy base and the top of the understorey.

Barbastelles utilising flyways fly at sustained high speeds over several kilometers before pausing to forage. Woodland tracks become high speed flyways with the bats moving at about chest height. The dark zone in the shade of overhead trees and understorey gives a considerable measure of protection from avian predators.
When such trackways lead towards water features they can become ideal sites to monitor for the presence of barbastelles.

Examples of good and still developing connective cover on Barbastelle flightlines.

Tracks such as these can take thirty or fourty years to mature.

The trackway on the left has terrific potential but is currently only just old enough to begin to show some cover for flightlineing bats. Currently this double hedge line has no tree species in it or overhead cover.

Maintaining footpaths or vehicle tracks along such double hedge lines is beneficial to the maintainance of a clear central heavily shaded corridor for the bats to fly along.

The double hedge line to the right is much more mature and is lined with Oak, Birch and hazel as well as the normal hedgerow species.

This particular flightline is currently utilised by Barbastelles, Bechstein's, whiskered, Brandt's, and both species of Pipistrelle to access woodland at either end of the connective feature.

Maintainance on these flightlines is low as they are virtually linear woodlands. The conditions they create provide connective corridors for many species other than bats.

A lost flightline?

The photogaphs show a stream line that flows from the Balls Cross region south to pass through the village of Byworth east of Petworth. This route is now only ever used under conditions of darkness. The bats now utilise the more wooded flightline 4, further east, under normal commuting conditions. The original direct route has much scope for improvement.

EXAMPLES OF 'ON ROUTE' FORAGE AREAS

The floodplain of a small woodland stream makes ideal forage conditions and forms the route of a flightline.

Woodland margins that border on to established wet grasslands also form productive forage and flightline routes.

FINAL FORAGE AREAS OF FEMALE BARBASTELLES

Arun floodplain meadows above, and riverine woodlands, below.

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