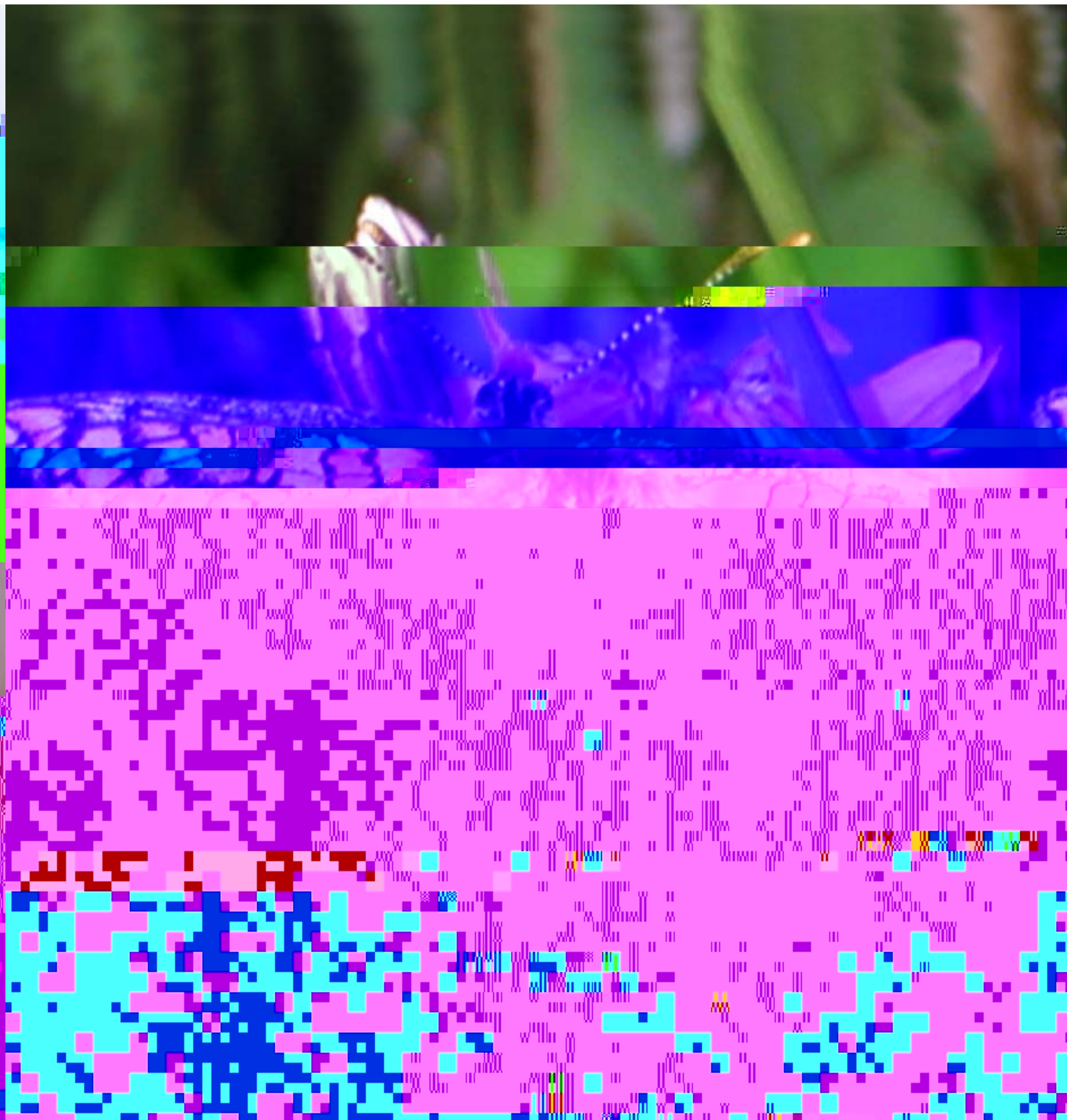
The butterfly handbook

General advice note on mitigating the impacts of roads on butterfly populations



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HIGHWAYS AGENCY

The butterfly handbook

General advice note on mitigating the impacts of roads on butterfly populations including a case study on mitigation for the Marsh Fritillary butterfly along the A30 Bodmin to Indian Queens road improvement scheme

Forward

The second half of the last century saw dramatic changes in the countryside of Britain. Our native wildlife continues to be threatened as habitats are damaged or destroyed. Butterflies have probably never been as endangered as they are today following decades of loss of key semi-natural habitats such as flower-rich grasslands. This report is extremely valuable and timely as it concerns an increasingly important habitat for butterflies and other insects. Road verges can help conserve butterflies and other wildlife as they are an opportunity to provide suitable breeding habitats for many species, and provide crucial links between the patches of habitat that remain.

Butterflies are highly sensitive indicators of the environment and we know that conservation measures for this group will help many other less well-known components of our biodiversity. Road verges already provide valuable habitats for a wide range of species but this report shows how they can be made even better and contribute an ever more important role in the future. This report contains a large number of practical suggestions that I hope are adopted widely in road verge design and maintenance to maximise their potential in conserving our rich wildlife heritage.

Dr Martin Warren
Chief Executive
Butterfly Conservation

Key habitat features include:

- A varied topography with warm or sheltered microhabitats
- Larval foodplants in the particular condition required by the species
- A varied vegetation structure (e.g. a range of turf heights)
- Shelter
- Nectar sources
- The presence of ants as required by some species (these ants may occupy particular habitats with high temperature levels)
- Continuous suitable management

It is important when planning for a particular species that its ecology is understood, especially concerning egg-laying behaviour and larval habitats (see Box 3 for Marsh Fritillary). There is no single habitat requirement that suits all butterfly species. It should be noted that habitat requirements for adults and larvae may be different for the same species. For the more mobile species, the resources used by the adult and larval stages of a single individual may be kilometres apart (Cowley et al 2000). In the case of Chequered Skipper, the habitat required by males (areas of sparse vegetation on drier ground on woodland edge) is different from the habitat required by females (areas with abundant nectar plants) (Ravenscroft 1994).

populations (Morris et al 1994). Most of the butterflies living in closed local populations exist as metapopulations (Box 4).

Box 4: Metapopulations

Metapopulations are formed from a number of connected colonies. They are characterised by occasional movement between local colonies, with colonisations and extinctions. There can be frequent local extinctions, but the population survives in the wider area and can re-colonize available habitat (Gilpin & Hanski 1991). Only one or two females from each generation are required for gene flow to be maintained between isolated colonies (Nei et al 1975). The two extreme models put forward are:

Metapopulation dynamics mean that we need to consider butterflies at the regional or landscape scale, not just at site level. Management decisions for key species should be considered in relation both to the distribution of existing colonies in the area and to the distribution of unoccupied but suitable habitat available for future colonisation. Desk-top studies supported by survey work will allow ecologists to construct maps of the current populations and available habitat. If the distance a particular butterfly can travel is known, then gaps greater than this distance indicate the boundaries of the metapopulation area. As an example, the lack of suitable habitat patches in an area over 10km wide is likely to prevent the spread of the Silver-spotted Skipper from occupied regions into more distant areas where all the suitable habitat patches are vacant (Thomas & Jones 1993). Meadow Browns will return to familiar habitat patches rather than non-familiar ones if given the choice, so that dispersal to new sites is less common than might otherwise be predicted, although they will also find new habitat by using a systematic search strategy (Conradt et al 2000). The effective long-term conservation of these and most other butterflies requires the protection of metapopulations

2.1 I ?

New roads can be used to link wildlife areas. They

In general terms, the smaller the gap between habitat patches the quicker the vacant patch can be colonized (Thomas, Thomas, & Warren 1992); in this context stepping-stone habitat patches can speed up the re-colonization of vacant sites. The more isolated a patch, the less likely it is to be occupied, and the greater the gap between habitat patches the longer it takes for the vacant patch to be colonized. The maximum natural single-step colonization distances are different for each species; they have been calculated for some of the rarer butterflies, e.g. 0.6-1km for Silver-studded Blue and 1.4km for Black Hairstreak (Thomas, Thomas, & Warren 1992). Conservation decisions in road design should therefore

Box 12: Twyford Down

Twyford Down has come to symbolise the destruction of high quality wildlife habitat by new roads; in fact, the true picture is one of biodiversity enhancement, particularly for butterflies. The route was fixed but it was proposed in mitigation to recreate downland in places, e.g. on the restored route of the existing Winchester bypass. The key stages in habitat assessment and creation were as follows:

- Appointment of scientific advisers (in this case from ITE)
- Surveys of animal and plant communities along the route (1991 –1992)
- Surveys of adjacent areas to ensure that reconstructed downland would contain appropriate plant and animal communities
- Identification of key habitats and species
- Design of the habitat restoration programme
- Preparation of the restoration sites
- Introduction of relevant plants in suitable proportions by turf translocation, seeding and plug plants
- Manipulation of management techniques to drive the development of the plant and animal communities, e.g. by mowing and grazing
- Monitoring the botanical and invertebrate communities for ten years after habitat restoration and translocation, e.g. by fixed botanical quadrats, pitfall traps and suction samples for invertebrates, butterfly transects, and mark-release-recapture experiments.

The habitat restoration has been shown to be successful for butterflies, and many of those species of butterfly that inhabit the area now have additional populations on the restoration area, many at higher densities than on the rest of the site. In particular, the numbers of Chalkhill Blues increased here in the first 3 years following the opening of the M3, with a few individuals flying across the road which indicates that the metapopulation structure in this area has been improved as a result of mitigation for butterflies (Thomas, Snazell & Ward,hat.ies (Ts that tt as e72opuRm6nazell ,]as e72opy549 scn0.025 Tw( )-3765 scn6nazell , /Ftterflies

2.3.2 Increased habitat fragmentation and barriers to movement

Habitat fragmentation is one of the main conservation issues arising from the modern intensively farmed landscape and roads add to this effect by creating barriers to the movement of butterflies. The main barrier effect is created by the nature of bare, un-vegetated road surfaces which butterflies are reluctant to fly over, although it is possible that arable land presents a greater barrier to butterfly movement than roads (Box 9).

The effect on butterflies appears to depend on the species concerned (Box 13). Roads are probably no barrier to the movements of those butterflies such as Large White, Small White, Red Admiral and Small Tortoiseshell which live in open populations (Annex 2), but may impede species with closed populations (Munguira & Thomas 1992). In a detailed study of butterflies and roads (Munguira & Thomas 1992), 10-30% of Meadow Browns, Marbled Whites and Common Blues (all species living in closed populations) were found to cross the road during their adult flight period and males were more likely to cross than females e.g. the proportion of Meadow Browns found crossing a road was in the ratio 1.5 males : 1 female. Importantly, butterflies are known to cross narrow roads with broad open verges more easily than wide roads with no adjacent suitable habitat. In a wide motorway such as the M3 at Twyford Down (Box 12), marking experiments indicated that only 2-7% of the local Chalkhill Blue population crossed the road (Thomas, Snazell & Ward 2002), while the M56 presents a substantial barrier to male Orange Tips, reducing movement across the motorway by around 90% when compared to movement between other patches in the surrounding area (Dennis 1986).

The barrier effect of roads may be increased or decreased by design factors, e.g. increased shading may create apparent barriers (Dennis 1986). Turbulence may also prevent butterflies crossing. Dennis (1986) found that Green-veined Whites were heavily buffeted by traffic and either carried across, after being lifted high in the air, or returned to same side of the road. The number of vehicles per minute is an important factor, although Thomas, Snazell & Ward (2002) suggest that the aerodynamics of modern vehicles allow butterflies to be swept up and over speeding cars (in contrast to the more upright, less streamlined vehicles of previous years).

2.3.3 Road kills

It appears that the amount of traffic on the roads has no apparent effect on the abundance and diversity of butterflies on the roadside verges (Munguira & Thomas 1992) and butterflies can be seen feeding undisturbed on flowers swaying in turbulence (Feltwell and Philp 1980). However, butterflies can be killed when crossing roads and recent studies in Illinois (Mckenna et al 2001) indicate that butterfly mortality can be extremely high, especially for migrant species such as the Monarch (with an estimated death rate of up to 500,000 Monarchs in a single week) (Box 14). In Britain, mobile species such as the Pieridae (whites and yellows) may be the worst affected; for example, Munguira & Thomas (1992) found that 7% of Large Whites were killed by vehicles along a road at Bere Regis in Dorset, compared to only 0.6 – 1.9% of sedentary species such as Marbled White and Common Blue.

Road kills depend to some extent on the number of vehicles using the road, but Mckenna et al. (2001) found that butterfly mortality peaked at a rate of 13,500 vehicles per day, after which mortality declined. It is possible that butterflies become more reluctant to cross roads when there is a constant stream of traffic, perhaps because increased turbulence knocks them down at the side of the road before they attempt to cross. In tourist areas such as Cornwall and Devon, increased holiday traffic coincides with peak summer populations for some butterflies, so that butterfly road kills are likely to be comparatively high unless traffic is almost continuous throughout the hottest parts of the day.

Box 14: Butterfly mortality along roads in Illinois, U.S.A.

Summary of road and butterfly data from Illinois:

Illinois has
- 138,000 miles of road network
- Estimated 20 million butterfly kills including:
  - 80% Pieridae
  - Nymphalidae
  - Hesp scn-u8 Tw[Nymphalidae)]TJ-2.0457 -1.2 TD0 Tw( )Tj ET/GS3 gs BT/F7 1 Tf641verarious grass species (English Nature 1994).

Hesp scn-u8 Tw[Nymphalidae)]TJ-2.0457 -1.2 TD0 Tw( )Tj ET/GS3 gs BT/F76.7919 Tm0.69412 0.67843 0.31765 scn0various

2.3.4 Pollution

Muskett & Jones (1980) found no general detrimental effect on roadside macro-invertebrates from road traffic pollution (species diversity did not vary with increasing distance from road) and increased pollution caused by high traffic volumes along roads appears to have no apparent direct effect on the abundance and diversity of butterflies on the verges (Munguira & Thomas 1992). However, biological responses to increased pollution may take several years to become apparent, perhaps only when pollutants have reached specific threshold concentrations (Ashmore 2002).

There may also be indirect effects on butterfly populations that are less easy to quantify. For example, soil and vegetation near roads may contain high concentrations of lead (now reduced with the introduction of catalytic converters) and zinc (due to tyre dust and lubricating oil) (Wade et al 1980). In fact, the elevated nitrogen concentrations found in plants on roadside verges may be beneficial for some invertebrates, e.g. moth species (Port & Thompson 1980), because nitrogen is important in the diet of insects for growth and reproduction; on the other hand, added nitrogen can result in the increased dominance of particular grasses on chalk downland and the replacement of heathland by vigorous grasses (English Nature 1994), which can affect key butterfly communities. Grassland communities can also be changed by the prolonged application of de-icing salts which can raise soil pH values and be toxic to trees, shrubs and various grass species (English Nature 1994).

Additional causes of pollution include dust pollution (Farmer 1993) and the formation of low level ozone, both of which can affect plant growth and therefore larval feeding. Carbon monoxide and sulphur dioxide appear to have little effect on the ecology of roadside habitat (Ashmore 2002).

3 The statutory agencies and the legal framework

3.1 H A

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The Highways Agency is responsible for encouraging and managing for biodiversity on its land, totalling around 30,000 hectares of so-called “soft estate” (i.e. the land defined as within the highway boundaries but not part of the carriageway). The Highways Agency has published a Biodiversity Action Plan which explains how the Agency will enhance the nature conservation value of its landholdings over the next ten years (Highways Agency, 2002). The Action Plan includes plans for the following habitats: boundaries, grasslands, heathlands, water and woodland. Two butterfly species are mentioned; Adonis Blue (with a full action plan) within the grassland habitat plan (Box 15) and High Brown Fritillary (with a short species statement) within the woodland habitat plan. The single action for High Brown Fritillary is to record suitable habitat on Highways Agency land and highlight it in the Environmental Database. The Highways Agency records ecological and environmental information on its own database.

3.2 I AC

Roads which will affect SSSIs or SACs are covered by the following legal framework.

3.2.1 SSSIs

Statutory Instrument No 1241 Highways requires nature conservation matters to be addressed if the proposed route is within 100 metres of an SSSI or national nature reserve (Highways (environmental assessment effects) Regulations Statutory Instrument No 1241. HMSO. London 1988).

Box 15: Highways Agency Biodiversity Action Plan: Adonis Blue

Although not yet recorded on Highways Agency land, suitable habitat for Adonis Blue occurs at a range of sites on the trunk road and motorway network including the A303 near Yarnbury in Wiltshire. The BAP lead partner for Adonis Blue is Butterfly Conservation.

The following actions by the Highways Agency are listed:

- Inform local area managers in network areas 3, 4 and 5 on appropriate management of verges for the Adonis Blue
- Survey verge habitat for Adonis Blue and its larval foodplant of Horseshoe Vetch and record results on the HA Environmental Database
- For all new road schemes and road improvements in network areas 3, 4 and 5 search for records in the initial desk study and survey at stage 2. Avoid habitat loss for Adonis Blue wherever possible
- Where impact is unavoidable, consider options for compensatory habitat enhancement, linkage and removal of barriers to dispersal
- Ensure existing sites are managed appropriatee0 sitEnsure ebTg Is O

3.2.2 Natura 2000 sites

Article 6(3) of the Habitats Directive 1992

Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment

of its implications for the site in view of the site's conservation objectives. In light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. (Natura 2000 aims to establish a network of protected areas as a coherent European ecological network of SPAs and SACs under Article 3(1) of the Habitats Directive).

Article 6(4) of the Habitats Directive 1992

Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest.

Site integrity has been defined in the following way in PPG9 (DoE, 1994):

The integrity of a site is the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or levels of populations for which it was classified (Paragraph C10. PPG9).

Byron (2000) suggests that this principle can be applied at all levels of sites in the conservation hierarchy and also to sites outside the designated areas, not just to SSSIs and SACs.

3.3 L

23 butterfly species are protected by law, of which 6 species have full protection (Annex 3). Legislation for butterflies is largely designed to protect butterflies from collectors and does little to protect the habitats in which butterflies live (Asher et al 2001). The only British butterflies listed under the Habitats Directive (1992) are the Large Blue (protected as a species) and the Marsh Fritillary (listed as a qualifying interest feature for SACs where the habitat is protected). Detail on the Marsh Fritillary is provided

4 Site evaluation and mitigation

4.1 E

B

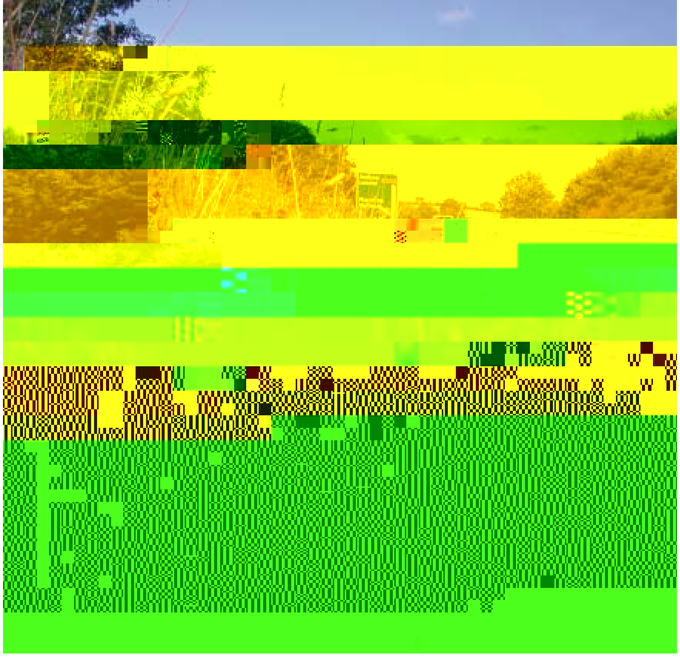
E

M

I

The key consideration in evaluating the impact of road developments on biodiversity is that there is no significant reduction in overall biodiversity; the biodiversity of the area should be enhanced wherever possible (Byron 2000). The impact of any road scheme should be considered at the local and landscape level; this is especially important for those butterflies which live in metapopulations. Suggested stages in impact assessment are shown in Box 17. It is important that ecologists have early input into proposals for new road schemes because the route chosen may have important positive effects for butterflies (e.g. linkages between habitats) or negative effects (e.g. barriers to movement within metapopulations). Surveys should be undertaken at suitable times of year to ensure that the current position of butterfly populations within the area is fully understood, including mapping suitable but vacant habitat that could be naturally colonised.

Assessment of the area to be surveyed should be based on the pattern of existing butterfly populations and the known distance over which key species can colonise new areas. Vacant but potential habitat should be mapped over a wide enough area to encompass the entire metpopulation. The impact of the road on the viability of the populations of key species can then be assessed. It is essential that the survey is designed and managed by butterfly experts who understand the ecology of the key species present. The ability to identify butterfly species is not in itself a sufficient qualification for this assessment work.



Butterfly-rich verge on the A303. A Spalding

Box 17: Suggested site evaluation of new roads for their impact on butterfly populations

Stage One: Impact assessment

- Carry out a desk study to determine key species resident or previously resident in the area
- Assess area to be surveyed including metapopulations of key species
- Assess the nature conservation status of the route e.g. SACs, SSSIs, CWS etc
- Assess the route in the context of Natural Areas, national and local BAPs, Butterfly Conservation's Regional Action Plans
- Carry out surveys to establish the presence of priority species and suitable habitat within the area agreed
- Assess the effect of the road on the viability of populations of key species within the surrounding landscape at the metapopulation scale
- Assess the barrier effect of the road on butterfly populations

Stage Two: Mitigation assessment

- Assess the potential of the road as a wildlife corridor and stepping-stone habitat
- Assess the route alignment: north, south, west or east-facing slopes will benefit different butterfly species
- Assess the soil suitability for wildflower mixes and identify appropriate plant species to support butterfly populations
- Identify seed/plant sources from the local area
- Identify management and monitoring programmes

It is possible to predict butterfly distributions based on habitat types and foodplant distribution, especially for sedentary species such as Common Blue and Silver-studded Blue, but survey work is more reliable. Detailed surveys for all High Priority species (Box 1) should be carried out where these are known to occur (or have recently occurred) within the survey area; surveys for Medium Priority species should be carried out where they are fully protected (e.g. Swallowtail) or where the regional populations are of national importance.

4.2 D

It is important to avoid high quality wildlife habitat where Priority butterfly species are known to occur, or have recently occurred. The design of three proposed motorway extensions have been significantly altered on the basis of the potential harm they would cause to butterflies, two for the Black Hairstreak (M1, M40) and one for the Chalkhill Blue (M3) (Thomas, Snazell & Ward 2002).

Once the route of the new road development has been decided, the key mitigation for alleviating damage to butterfly populations will be the potential of the road to provide habitat links connecting existing and potential butterfly habitat in the area (Box 17). Detailed mitigation will be dependent on the route alignment as different aspects are suitable for different butterflies (Box 18), depending largely on requirements for warmth. Temperature analysis (e.g. with laser thermometers) can show whether it is advantageous to modify an area topographically (Morris et al 1994) to provide the warmest microclimates appropriate for key species. The optimum sites for butterflies have a diversity of habitat to cope with varying climatic conditions, so that in hot dry summers butterflies can move to cooler areas with thicker soil less prone to drought, and in cool wet summers butterflies can move onto areas with thin dry soils that heat up quickly in the sun; a varied topography (as provided in road cuttings and on embankments) is especially important with anticipated climate change.

Box 18: Butterflies suitable for different aspects of road cuttings and embankments

All aspects	**south-facing**
Dark Green Fritillary	Adonis Blue
Duke of Burgundy	Brown Argus
Gatekeeper	Chalkhill Blue
Marbled White ?	Grayling
Meadow Brown ?	Green Hairstreak
Ringlet	Northern Brown Argus
Small Heath	Silver-spotted Skipper
	Small Blue
	Small Copper
	Wall

Partly taken from Morris et al 1994.

5 Road design

5.1 I

E

Nature conservation issues must be incorporated from the earliest stages of project development (Highways Agency 2001) and it is important that designs for new roads are approached from an ecological engineering standpoint; they should be the result of a partnership between planners, engineers, landscape architects, archaeologists, amenity groups and ecologists (Morris et al 1994). As engineers and landscape designers may have little knowledge of biodiversity and less knowledge of invertebrates, it is important to include insect habitats in the very earliest designs (Thomas, Snazell & Ward 2002).

The key design features of the new road include the following:

- Roadside verges
- The central reservation
- Cuttings and embankments
- Swales
- Attenuation reservoirs
- Compensation land

Setting the timetable for habitat restoration at the start of the operation is critical; it is essential to do things in season e.g. planting plugs, seeding etc. It is important to time activities according to the main construction contract, i.e. when habitat becomes available for translocation, when cuttings and swales are built etc.

Habitat creation for butterflies follows key stages (Box 19). It is important to identify the minimum viable habitat required by each target species and design a network of habitat patches along the road corridor in association with adjacent suitable habitat (occupied or vacant); each habitat patch should be within flight reach of the adjacent habitat for the target species, e.g. 0.6-1 km for Silver-studded Blue (Thomas et al 1992). Where possible, road design should retain or create natural habitat links to assist butterfly movement, e.g. appropriate landscaping of the road corridor which create opportunities for natural species migration

Box 19: Key steps in roadside habitat design and creation for butterflies

- Identify target species
- Identify other butterfly species occupying the same habitat as target species for habitat integrity
- Identify habitat requirements e.g.:
  - Minimum viable habitat
  - Larval foodplants in correct position
  - Short or long sward
  - Bare ground
  - Shelter
  - Presence of ants
  - Nectar sources
- Identify key areas for butterfly colonisation and movement, e.g. south or north-facing banks; marshy areas
- Design network of habitat patches along the road corridor in association with adjacent suitable habitat (occupied or vacant)5 0.12157 0.12549 scn0.0249 Tw( )-388.3( )-8st

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(Highways Agency 2001). The possibility of linking habitat patches in an intensive agricultural landscape should be investigated as an environmental mitigation measure of new roads, as occurred with the design of the M40 (Box 10). The use of verges along road bridges to link both sides of a new road should be considered in some cases; bridges have been used in this way to enable wildlife to cross over the high speed railway line on the Channel Tunnel Rail Link and in the Netherlands Ecoduct bridges have been used to link wildlife habitat to compensate for habitat fragmentation (Box 20).

Box 21b: Brief notes on habitat creation (heath and grassland) for butterflies

5.2.2 Topography

Many invertebrates (including butterflies and ants) prefer small scale habitats with a variety of micro-climates. Temperature readings taken across areas with humps and hollows will show a greater range in temperatures than temperature readings across flat land; for example, Morris et al. (1994) found a 90C variation in temperature across an anthill 23cm

within the motorway fence line (Bickmore 1992). Many plants can be pot-grown and planted as mature

6.5 H

- Maintain open areas with bare ground suitable for warmth-loving species such as Silver-studded Blue and Grayling
- Rotationally cut/burn heathland areas

6.6 G

- Management of sward heights depend on the target butterfly species (see Box 11)
- Grassland management of level areas, cuttings and embankments should be by cutting or mowing
- If possible, mow between late September and early May (Munguira & Thomas 1992); it may be necessary to mow a narrow strip near the road more often than this for safety reasons
- Cuttings can either be raked into piles adjacent to any scrub areas and left to rot or removed completely (e.g. by baling); if it is possible that eggs have been laid, cuttings should be left on site
- Only part of the site should be cut in any one year
- Maintain a mosaic of mown and unmown areas (Munguira & Thomas 1992)
- Grazing is not possible within the road corridor for reasons of safety but may be possible on compensation land. Appropriate grazing regimes (e.g. with sheep, cattle and/or horses) will depend on the particular butterfly species to be managed for
- Rabbit grazing may be a key part of the management process
- Damage to ant hills should be avoided when mowing
- Avoid the use of flails which will do damage to the invertebrate fauna (BUTT 1986); rotary cutters are preferable
- Consider mowing corridors through long grassland to provide shorter grass areas (BUTT 1986)

Monitoring should be considered for all nature

Annex 1: Butterfly species and their associated habitats highlighting (in bold) those species likely to be associated with roads

Annex 2: [illegible] of British butterflies (from Thomas (1984) and Warren (1992))

Annex 3: Butterfly species protected by law

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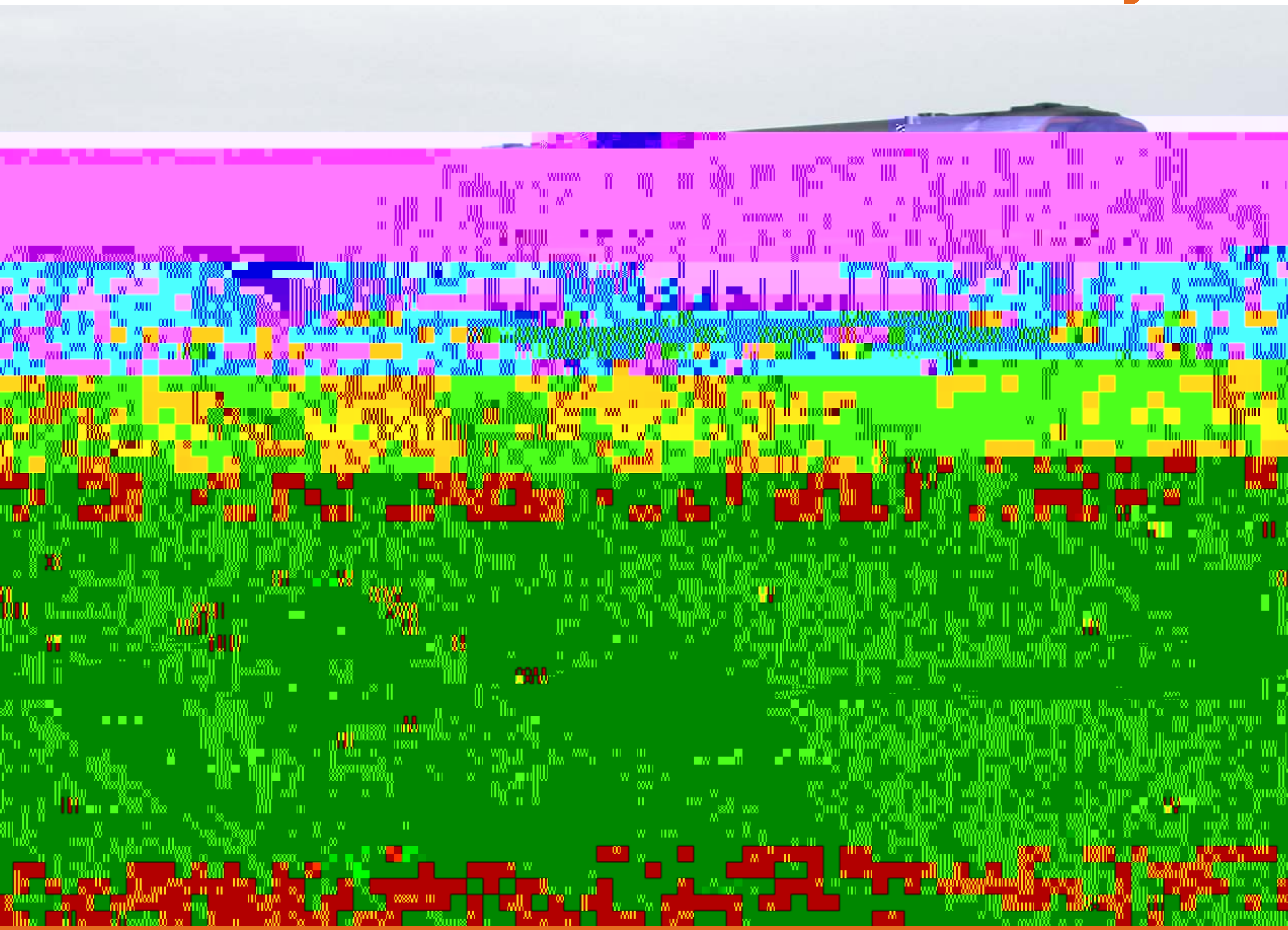
The A30 road improvement
A case study



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QUEENS' IMPROVEMENT
DESIGNATIONS

A30 B I

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M F

I

The current route of the A30 trunk road between

Within a metapopulation of the Marsh Fritillary, extinction may occur due to changes in habitat quality, reduction in population size (small populations will have a greater chance of extinction) or attack by predators such as larval parasitoids. The chance of colonisation will depend mainly on isolation (the distance an individual has to travel from a neighbouring population).

To ensure the long-term viability of a Marsh Fritillary metapopulation it is important to have:

- Good quality breeding habitat
- A long-term management regime
- A series of sites across the landscape both occupied and unoccupied by the butterfly
- Short distances between these sites (i.e. a low isolation factor)

A30 M F

The downgrading of the existing A30 contributes to a European LIFE Nature project focused on the SAC. This is a 5 year partnership project aimed at securing the Marsh Fritillary population of mid Cornwall by removing 6km of trunk road that currently dissects the SAC; the road scheme will help reduce habitat fragmentation and link currently isolated habitat within the Goss and Tregoss Moors SSSI. By contributing to the LIFE Project, the downgrading of the existing trunk road will help fund habitat management work on 9 project sites covering an area

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the central reservation and the sides of cuttings and embankments will benefit more widespread butterflies, in particular Silver-studded Blue, Grizzled Skipper and Dingy Skipper.

If these opportunities can be realised, the size of Marsh Fritillary habitat patches will be increased and the distances between existing breeding sites will be reduced by creating stepping-stones to facilitate colonisation. Suitable breeding habitat can be created through a combination of mowing, grazing, scrub clearance and re-seeding with devil's-bit scabious.

The unique partnership of the road scheme and LIFE Nature project will improve the habitat area and quality across the landscape helping to ensure the long-term viability of the Marsh Fritillary metapopulation within the Mid Cornwall Moors.

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The success of any mitigation should be monitored during and after the construction period. It is important that monitoring should take place within the first year although it will take some time for restored or re-created habitat to establish and detailed monitoring should begin two – three years after construction. Monitoring should take place in order to inform future road design elsewhere in Britain and particularly to establish best practice for creating suitable habitat conditions for the Marsh Fritillary.

English Nature, the Rural Development Service, and the Countryside Agency. Working in partnership to conserve and enhance our landscapes and natural environment, to promote countryside access and recreation as well as public well-being, now and for future generations.

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