Design opportunities: reptiles

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1. Introduction

The suitability of a designed or managed site to meet the need of reptiles will depend on the existing site conditions, surrounding habitats and ability of designers/managers to identify and maximise the site's potential to meet the ecological requirements of these animals. Reptiles need habitats in which they can regulate their temperatures, connected to areas suitable for breeding, feeding, sheltering and hibernating. By considering wildlife potential at the early site appraisal and planning stages, many sites could accommodate or be adapted to provide for reptiles, eg railway embankments, major road corridors, landscape screens and buffers to retail and industrial estates, open spaces, edges to sports fields, country and urban parks, ornamental gardens, canal corridors and cycle ways.

It is impossible to identify solutions appropriate to all sites or for all species in such a short paper. Instead the elements of the design process identified in Bray and Foxford (this volume: *Design opportunities: overview*), ie the design strategies, detailed design, management and monitoring of sites, will here be considered in further detail looking at developing opportunities for reptiles.

2. Developing design strategies

The development of a design strategy for reptiles in any scheme relies on the identification of opportunities for these animals. This process requires recognition of the basic needs of reptiles, summarised in Table 1 (based on Foster, this volume: *Amphibians and reptiles - the species and their ecology*), and an understanding of certain simple ecological concepts (see Quayle, this volume: *Ecological concepts*). This section considers how the basic ecological needs of reptiles can be built in to the general principles of a site's design and in the production of strategy statements.

2.1 General design principles for reptiles

The general principles to increase the opportunities for reptiles on sites are:

Early planning: consider reptiles at an early stage in all designs, and include the need/desire for their conservation in the project brief where possible.

Basic needs: ensure all hibernating, feeding, breeding and sheltering elements of species are incorporated in the design/management plans. Be aware of the annual activity of animals to minimise disturbance through correct timing of operations.

Maximise southerly aspects which provide sheltered, unshaded areas for basking.

Maximise opportunities: design elements; banks, slopes, open and undisturbed areas to provide habitats; if existing reptile populations exist maximise their range.

Connect sites and habitats within and between sites; minimise fragmentation of habitats and barriers and hazards between areas suitable for reptiles.

Encourage natural solutions to design problems and features, eg constructed wetland and reedbeds to clean surface water run-off - and open retaining structure, dry stone walls and gabions instead of mass concrete constructions.

Provide mosaics of varied vegetation, topography and ground structure to allow regulation of body temperature. This should include open areas for basking, while retaining shrubs for shelter, and include other features for shelter and for hibernation.

Table 1. Basic needs of reptiles - landscape requirements

Breeding needs	
Unshaded sand/light soil for egg laying	sand lizards
Piles of rotting vegetation, muckpiles, sawdust piles or similar for egg laying	grass snakes
Live young (therefore need basking areas for gravid females)	common lizards, adders, slow worms, smooth snakes
Food sources	
Varied vegetation and topographical structure to provide for:	
• Invertebrates, notably insects and spiders	common lizard, sand lizard
• Invertebrates, notably slugs	slow worms
• Amphibians, also fish and some mammals	grass snakes
• Small reptiles and mammals	adders, smooth snakes
Shelter	
Day-time temperature usually above 15oC for activity	all reptiles
Well vegetated areas for refuge/cover:	
• gorse and mature heather	all species, specifically smooth snakes, sand lizard
• scrub, brambles and rough grass	grass snakes, adders, common lizard, slow-worm
• Sand dune habitat (thick marram/sea lyme grass tussocks)	sand lizards, common lizard
Areas for basking:	
• areas with sunny aspect	all species
• features in the sun to bask on	common lizards
• open areas with low vegetation	snakes
• open features in sun, gaps in long vegetation, rocky, south-facing banks	all species
Protection from cats	all species, notably common lizards, adders, slow worms
Refuges: logs, rocks, shrubby vegetation	all species
Variation in topography, gullies, banks	all species
Sand and light soil for burrowing	sand lizard
Hibernation sites	
Structure protected from frost, and predators, in winter, eg tree roots on embankments/cracks in soil/small mammal burrows	all species
Well drained south facing bank	all species
Sand/light soil for burrowing	sand lizard

2.2 Strategy statement

Strategy statements develop general design principles to define and identify opportunities for incorporating reptiles within a particular project. Strategies are therefore site specific. From the strategy the design stages can be identified. The following (Boxes 1, 2, 3) are examples of statements for hypothetical sites, based on real issues:

Box 1. Golf course - development and management plan

Brief: To enhance opportunities for reptiles in the development of a golf course in an area in current agricultural use (hypothetical example).

Principles and opportunities

- Large site with close proximity to existing habitats
- Scope for incorporating range of habitats in out-of-play areas
- Scope for terrestrial habitat and habitat linkage between areas in site and off-site
- Management in the long term can be consistent with reptiles needs
- Scope to deliver Local Biodiversity Action Plan objectives

Strategy

- Find out whether there is any existing interest on the site
- Find out what species occur nearby and what would be 'appropriate' for the area
- Identify critical factors for these species and design areas within landscape scheme to incorporate them
- Allow natural colonisation from adjacent habitats
- Consider need for translocation
- Ensure long term management for reptiles on site
- Incorporate monitoring to ensure all the above stages are achieving objectives

Design stages

- Survey site
- Prepare project proposals and detail design requirements to accommodate reptiles looking at:
  - ❑ design and planting of out-of-play areas around course
  - ❑ maximising scope for linkage between out-of-play areas and with existing habitats near the course (minimising fragmentation)
  - ❑ scope for positive features in other landscaped areas, eg car parks (especially with view to minimising fragmentation and maximising linkage)
  - ❑ site management needs (maintain diverse structure) and maintenance (eg location of compost heaps [on site], rabbit control measures [avoid gassing])
- Management plan for restored areas
- Monitoring programme for site and scope for change to management

Box 2. Car park landscaping in heathland area

Brief: To provide visually attractive landscaping to reflect the natural habitats of the area and provide scope for further reptile habitats and connection between natural habitat areas (hypothetical example)

Principles and opportunities

- Small areas on site but with existing habitats in close proximity
- Scope for providing small areas for reptile habitats
- Scope for habitat linkage and for minimising effects of fragmentation between existing habitats and within car park
- Areas will have a value as visual landscape but will otherwise be undisturbed
- Provides opportunity to promote nature conservation

Strategy

- Find out what reptiles are found nearby
- Identify main features that benefit these species
- Maximise linkage of green areas to natural habitats
- Maximise areas of habitats planted with native species; use banks, building with an appropriate material and soils to allow creation of crevices and survival of local plant species (eg acidic soils in heathland areas)
- Maximise continuous 'corridors' within site
- Allow natural colonisation from nearby land
- Incorporate monitoring to ensure all the above stages are achieving objectives

Design stages

- Survey (field or literature study, or local expert advice)
- Prepare project proposals
  - ❑ maximise linkage of greenspace
  - ❑ increase topographical variation
  - ❑ minimise disturbance to key sensitive areas
- Prepare detailed design requirements to accommodate reptiles looking at:
  - ❑ breeding sites (on-site compose areas [grass snakes] or bare ground areas [sand lizards]
  - ❑ hibernation areas
  - ❑ Providing cover
  - ❑ directing people away from sensitive areas, eg by choice of planting, location of pathways etc
- Prepare planting strategy: use appropriate native species, ideally of local provenance (and especially so if connected to a nature reserve); avoid invasive species or varieties
- Management plan for planted areas; ensure maintenance of structure
- Monitoring programme for site and scope for change to management

Box 3. Management of railway embankments for reptiles

Brief: To offer reptile habitats and connection between natural habitat areas within constraints of line-side management requirements (hypothetical example)

Principles and opportunities

- Long, linear sites with existing habitats, often on banks, and scope for enhancement
- Low levels of access/disturbance
- Scope for incorporating habitats on other areas of land holding
- Scope habitat linkage with existing and potential sites elsewhere
- Line-side management objectives are consistent with reptile needs
- Legislative requirement to consider protected reptiles

Strategy

- Find out what is currently on the sites
- Find out what is likely to be able to colonise sites/use them as 'corridors'
- Maximise potential for reptiles
- Link to management objectives of nearby sites within and outside railway land holdings
- Allow natural re-colonisation or expansion of population
- Ensure long-term management plan is developed for reptiles
- Undertake monitoring

Design stages

- Survey (field or literature survey, or advice from local expert)
- Determine objectives for conservation management (linkage/on-site population management)
- Identify scope for replanting, habitat regrading and detail design features (if needed) to:
  - ❑ provide banks and mounds
  - ❑ provide over-wintering areas
  - ❑ provide breeding sites
- Determine vegetation management plan to:
  - ❑ minimise tree shading
  - ❑ maintain ground and shrub layer vegetation structure
- Ensure other issues are addressed in management plan, notably:
  - ❑ use of herbicides
  - ❑ rabbit control measures (avoid gassing)
  - ❑ compost/vegetation disposal
- Look to publicity and promotional aspects, eg to link to local Biodiversity Action Plan projects
- Develop monitoring programme with scope to influence future management plans

3. Detailed design

Figures 1 to 4 in Bray and Foxford (this volume: *Design opportunities - overview*) provide some ideas for site design details suited for reptiles. While it is not possible to be prescriptive, the following looks at factors in design important to meet reptiles needs.

3.1 Site layout

The site layout is very important in the creation of sustainable reptile habitats. The following highlights important considerations.

- Area of habitats: larger patches are better than isolated ones. Connecting habitats should be provided where necessary.

- Connecting habitats within and between sites should be in excess of 4m wide with width increasing as corridors lengthen. Include features for reptiles for shelter, breeding, basking, feeding within corridors.

- Avoid relying solely on areas too close to heavily publiced areas or those populated by cats. Design in undisturbed areas, minimising human interference and short cuts; divert tracks away from sensitive sites, or if necessary preclude the public by fencing or shrubs. 'Buffer zones' may be needed between disturbed and undisturbed areas.

- Physical barriers - such as roads, high kerbs which interrupt connecting habitats should be avoided. Where barriers are unavoidable, provide suitable crossings, eg tunnels or 'bridges' (Stumpel, this volume: *A Dutch perspective*), increasing the width of tunnels as they increase in length; generally reptiles are not attracted to long dark tunnels.

- Maximise southerly slopes within the overall layout to provide warm, sheltered and shaded areas for basking. Ensure proposed planting areas or buildings will not shade them.

3.2 Design features important to reptiles needs

Many features can be built into schemes but these will be site specific depending on site condition and target species. By considering here the basic design features needed for reptiles these can be developed to suit any particular site.

- **Maximise banks and create banks where non-existent.** Angled surfaces give increased exposure to the sun and increase ground surface area; maximise the south-west to south and south-east facing slopes. Generally the taller the better, providing a variety of angled slopes but a 30-50° gradient is a sensible target. Banks can be created by ground modelling or retaining walls.

- **Variable topography of the site.** Mounds and uneven ground surfaces provide further 'basking areas' and a variety of different hot and cold spots.

- **Varied ground structure** provide cracks and fissures for reptiles for refuges and over-wintering sites. Various approaches can be used; filling holes with 'brick rubble' mixed with earth and woody material can be a simple approach for achieving good ground structures. In heath or sand areas care is needed to ensure a sufficient depth of

sand to allow burrowing and to ensure that the soil pH or nutrient levels are not affected.

- **Hibernation sites.** These can be created when making varied ground topography. Providing rock features, crevices, gaps in mature tree roots, log piles, etc can provide hibernation sites for different species; ensure they are placed in a sunny aspect, well drained, away from flooding and protected from frost.

- Other 'features' should be provided such as log piles, dry stone walls to give habitat variety and refuge sites.

- Planting such that the shading on southerly aspects is minimised, ensuring a good cover of 'shrubby' vegetation and ground herbage. There are no precise prescriptions. However, good reptile areas are often dominated by varied structured vegetation between, say, 10 and 80 cm in height with *c*10-20% cover of low or open ground (< 5cm) and *c*10-20% cover over 1 m high. This should be in a generally unshaded mosaic of uneven height vegetation. A good ground cover of moss, grass or mulch will enhance the value of the open habitats for the widespread reptiles though *c*5-10% bare sand is required for sand lizard breeding.

- **Sources of food.** Habitats can be designed to improve the food availability (see Table 1); for grass snakes ponds with amphibians are valuable; good vegetation structure with a range of plants attractive to insects will make the site rich in invertebrate prey for lizards. Slugs should be encouraged as a main prey for slow-worms. In turn lizards are needed as food for adders and smooth snakes. Small mammals (food for snakes) can be encouraged by good connectivity of sites and a structurally varied vegetation.

- **Breeding habitats.** Some species need suitable sites for egg laying, eg grass snakes and sand lizards (see Table 1). These should be located in warm areas exposed to the sun and connected to places in which reptiles live. Sand lizards need sand (ideally 5-10% of ground area), whilst grass snakes can be provided for by providing muck heaps, sawdust piles, wood chippings or compost heaps (the bigger the better, usually at least 2 m in size). Compost heaps can include almost any decomposing organic material; however a mix of grass cuttings and dry leaf/wood chippings ensure snakes can burrow into the pile. It can be in a loose pile or contained in a wooden or metal box, provided there is easy access for snakes. Corrugated iron sheeting on top of heaps can make them more attractive as breeding sites and for general use by reptiles. A base made of crossed branches or logs can help aerate the pile and allow access by snakes. Avoid digging over heaps until October or after April. Other species give birth to live young. For these it is important that basking areas are provided for females when they are gravid.

While concentrating on positive benefits it is important to avoid negative factors.

- **Avoid dense planting** or tree planting that causes (or will cause) high levels of shading.

- **Avoid stabilising ground** with certain forms of matting or mesh that either prevent burrowing or may provide a direct hazard to reptiles (eg nylon netting for snakes).

- **Avoid planting shrubs that create dense shade**, kill off ground vegetation and invade habitats both within the site and other areas away from the site (eg rhododendron or *Gaultheria shallon* (Shallon) especially in heath areas, sea buckthorn (in dune areas).

- **Avoid increasing nutrients** or altering pH's in certain soils, or importing unsuitable topsoil, subsoil or soil ameliorants, eg especially on heaths, that allow species to grow that are inappropriate to the management objectives of the site.

4. Maintenance and management plans

Both the nature of any planned maintenance and the timing of the work will affect reptiles. Therefore, both these factors need to be considered when developing maintenance plans (see Foster, this volume: *Amphibians and reptiles - the species and their ecology*). Correct provisions and prescriptions in management schemes are essential for the survival of reptile population.

When preparing management plans it is important to:

- Maintain a structurally diverse vegetation that provides a combination of open ground and dense cover.

- Retain good topographic structure and provision of various habitat features.

- Work at appropriate times of year; where ground disturbance is needed do this when the animals are active (late April through late August); cut shrubby vegetation in winter (from October to late March).

- If ground vegetation needs to be cut when reptiles are active this should be for only small areas and using a high cut (ideally using a brush cutter) to a height of 10 cm or more. Cut in sections to allow reptiles to escape or work from one corner of the site to the other.

- Keep cut vegetation on site as compost heaps.

- Avoid major habitat changes that involve loss of structure: do not cut extensively or use burning as a management tool (except in very limited circumstances).

- Avoid blanket applications of pesticides that can affect plant structure and food chain for reptiles (exceptions are where certain specific chemicals are applied, eg to control bracken). (see also Appendix 1, this volume).

- Avoid allowing tree cover to shade the site.

- Avoid extensive earth moving, or similar, without a prior assessment of the needs of reptiles and detailed proposals to safeguard them.

5. Monitoring and revision of plans

Monitoring methods need to reflect the objectives of the project. For reptiles, the aims would normally be to ensure the persistence of certain species making sure that the reptile populations are becoming established and/or expanding their range within a site. Expert advice and assistance is needed for monitoring.

The usual methods of monitoring reptiles will include (see also Appendix 4, this volume):

- Monitoring the presence of animals, usually by survey during Spring (April-June). Survey may involve simply searching 'hot spots', using a network of refuges (eg tin sheets) or fixed walks across a site. It is very hard to achieve a 'quantitative' estimate though fixed effort surveys (eg equal lengths of time doing survey work) may allow comparisons to be made between years.

- Checking that breeding has occurred by looking for signs of egg-laying (eg scrapes in sand for sand lizards) in early summer May-June, or signs of young animals which generally appear late summer/early Autumn (depending on species).

- Checking habitat condition

  - presence of good and diverse structure to vegetation
  - existence of features for hibernation, etc
  - connection between different sites/areas within the site.

If the objectives are not being met, or if the habitat is becoming less suitable there may be a need to amend the maintenance or management plan to address the probable causes.

6. Conclusion

There is an increasing need to maximise our immediate surrounding for conservation. By adopting a strategy which considers wildlife early in the planning stage of schemes and following them through to monitoring, projects can be better adapted to provide new habitats for reptiles. As part of the process interpretation boards, or public information on the project can be used to explain and justify a scheme and thereby increasing awareness of conservation issues in all environments, whether natural or man-made.

The Pond *Life* Project - a European Union funded community-based project providing opportunities for Amphibians

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Introduction

Ponds are small landscape features of importance to wildlife. This is especially so where they are concentrated in clusters and where pond density is high. They can create a distinctive inter-dependent wetland patchwork of considerable variety and richness. Ponds are often associated with other types of semi-natural habitats including scrub, semi-natural grassland and marsh. This association contributes significantly to the development of habitat connections ('stepping stones') in, and the overall biodiversity of, agricultural landscapes. Ponds are vital for the survival of **all** our native amphibian species - it is where they breed.

During the past fifty years agricultural change has ensured that the great majority of these small water bodies no longer useful to agriculture and, as a consequence, few pond-rich areas remain in north-western Europe today. The number of ponds in the landscape has continued to decline at an alarming rate as the intensification of agriculture, urban and industrial development, and vegetational succession proceed with undue haste. Less than 300,000 ponds now remain in Britain with north-west England and Cheshire in particular (with 10% of all ponds) still representing the last remaining pond-rich landscape in the country. Despite its undoubted national significance recent research undertaken in Cheshire strongly suggests that without adequate protection and appropriate management few will remain in the farmed landscape by the middle of the next century. It follows, therefore, that if the ponds disappear then so too will the plants and animals that we associate with them.

In order to address this issue an application was made in 1994 to the *Life* Programme of the European Union (EU).

The *Life* Programme of the European Union (EU)

This programme was established in 1992 to contribute to the development and implementation of EU environmental policy by co-financing demonstration projects which support the Fifth Environmental Action Programme. With an initial budget of over £500 million the *Life* Programme is supporting a range of projects which promote the perspective of sustainable, lasting and environmentally aware development.

The Pond *Life* Project

The Pond *Life* Project with total project costs of £1.1 million was launched in March 1995 having received over half a million pounds from the EU *Life* Programme, for a four year project aimed at protecting and managing ponds and other small water bodies in north-west England and other European locations. With fourteen partners in north-west England and four in Belgium, Denmark and the Netherlands, the Pond *Life* Project partnership represents a radically different approach to pond conservation. The project aims to:

- offer farmers and land managers an opportunity to use their skills to steward the pond landscape (pondscape) and hand it on in good order to future generations;

- to encourage local communities to care for their own pondscape heritage a grassroots approach to pond conservation;

- to improve and maintain the diversity and local character of the lowland agricultural landscape in north-west England and influence decisions elsewhere;

- to conserve and extend a declining wildlife habitat;

- focus conservation effort and resources so that they are used to generate greatest public benefit;

- be applicable throughout the United Kingdom and elsewhere in Europe where pond-rich landscapes are also threatened;

Community-led conservation

At the cornerstone of the Pond *Life* Project is a community-led conservation scheme in which local people are given the responsibility of looking after ponds in their locality. The Pond Warden Scheme is, in the short-term, seen as the way forward, giving local people the opportunity to care for their local environment. Of course, there are positive advantages in such an approach as people form a great local resource providing a variety of :

- skills
- expertise
- monitoring
- vigilance
- local knowledge
- contacts

The majority of small water bodies in the United Kingdom lie on private land and, as a first step, there is always the need to seek permission for access from the farmer or landowner. Often, it is much easier for a local person to get permission, to gain trust and to be pro-active. This bottom-up approach lies at the heart of the Pond *Life* Project. In order to help Pond Wardens in their duties the Pond *Life* Project holds a series of regular workshops throughout the year in village halls and community centres to impart knowledge about ponds and their ecology. Five workshops are held during the year and they include:

- Getting started (November)
- Amphibians (March)
- Great crested newts and the law (May)
- Plants, dragonflies and damselflies (June)
- Pond management techniques (September)

Each workshop is led by a local expert who spends the morning talking about the subject and follows up in the afternoon with pond visits in the locality.

The aim of these workshops is to produce a highly motivated, well trained workforce capable of monitoring the changes which are taking place to the ponds in their locality, able to talk and influence farmers and landowners about the value of these small water bodies and, if at all possible, to encourage the digging of new ponds in suitable locations.

Pond Wardens are encouraged to collect as much information as possible about ponds in their locality. In order to help them with this task, survey sheets of varying complexity are available for them to complete. Information is returned to the Pond *Life* Project in September and is entered into the Pond Information Network, a sophisticated Geographic Information System, which allows the handling and management of large data sets. With over 30,000 small water bodies still remaining in north-west England this system will be built up so that a comprehensive picture of the region's pondscape will gradually emerge.

In addition to the work of local volunteers, the Pond *Life* Project has also pioneered the launch of *Regional Pond Networks* which, meeting at six monthly intervals, bring together practitioners from local authorities, NGOs, conservation organisations, members of the farming community. These networks will bring together all who have a part to play in the protection and management of small water bodies in the landscape and ensure the emergence of a coherent regional strategy for pond conservation.

Pond *Life* Project Outputs

The Pond *Life* Project will result in a number of well defined outputs. These include:

- an environmentally aware local community with a better understanding and appreciation of ponds and the pondscape and the measures needed for their protection
- a *Best Practice Manual* for farmers and local communities promoting the sustainable management and restoration of small waterbodies in the agricultural landscape
- a series of workshops and seminars for land-use planners, farmers and community volunteers together with regional and European conferences
- an extended Landscape Audit System - the *Pond Information Network* - on a GIS for use as a visual demonstration package for land-use planners, farmers and community groups
- increased protection of the pond resource and improvement of habitat quality
- maintenance of existing populations of endangered species and, where practicable, expansion and re-establishment

Conclusion

The Pond *Life* Project will advance, interpret and apply the concept of sustainability to the development and implementation of small water bodies into the planning and management of the agricultural landscape of north-west England with application elsewhere in the United Kingdom, and in a similar set of European Union locations. Existing mechanisms for pond protection have proved ineffective, consequently the principal emphasis of the project is placed upon conservation by and within local communities. Groups and individuals will, in a supportive network, be able to draw upon scientific, organisational and administrative expertise provided by a working partnership of public and voluntary sector bodies in north-west England, Belgium, Denmark and the Netherlands.

Amphibians and reptiles in agricultural and urban landscapes in the Netherlands; design of and provision for sub-habitats and corridors

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Introduction

Amphibians and reptiles are threatened animals. They need to be protected by the conservation of their habitats. In the Netherlands, such conservation can be practised most effectively through designating nature reserves. However, both animal groups also have important habitats in the wider landscape and, with special care, opportunities exist for ensuring their long term survival there. A national policy plan has been produced in the Netherlands that provides a framework for nature conservation at the landscape level. At lower levels there are also many opportunities for creating (sub-)habitats and for providing means for helping the migration and dispersion of these animals.

This paper shall:

a. outline the National Nature Policy Plan;

b. mention the habitats and habitat needs of amphibians and reptiles in the urban and agricultural environment; and

c. describe some practical measures that can be considered when designing landscapes.

The National Nature Policy Plan

Following the Second World War, a national programme for consolidating and re-allocating land (in Dutch: 'ruilverkaveling') was carried forward to rationalize agriculture. This, together with the explosive growth of urbanisation and the construction of infrastructure, resulted in the destruction and degradation of nature and the landscape on a disastrous scale. Changes from small scale, low impact, traditional farming practices (Lambert 1985) to large scale, modern and highly mechanised farming further added to the loss of wildlife and natural habitats. Only a modest number of sites were safeguarded as nature reserves in the countryside and often these were small or isolated.

It became apparent, though perhaps rather late in the day, that a structural approach was needed to improve the quality of the landscape and its value to nature. As a consequence, the National Nature Policy Plan (NNPP) was drawn up and came into force in 1990 (Ministerie van Landbouw, Natuurbeheer en Visserij 1990; van Zadelhoff & Lammers 1995). The main aim of the plan is the sustainable preservation, restoration and improvement of nature and the value of the landscape. The country is divided into nine regions, each having its own distinctive physio-geographic character. While the plan is directed primarily at the 'habitat level', it is also valuable for developing conservation objectives for animal and plant species and for promoting geological features, local cultural history and environmental perception. The plan spans a 30 year period (1990-2020) during which time its objectives are expected to be met. The NNPP represents a strategic plan at the national level.

The basis of the NNPP is the National Ecological Network (NEN). This network consists of core areas, nature development areas (ie for ecological improvement) and corridors (Figure 1). Core areas are large areas (>500 ha) with existing nationally or internationally significant nature conservation value. These include forests, large water bodies, estates and valuable cultural landscapes and are important for providing nuclei of nature conservation interest. Areas are identified for further developing the nature conservation interest where these offer realistic opportunities for becoming of national or international importance. Ecological corridors are comprised of both landscape and artificial features that help migration between core areas. In order to protect the network, for example against pollution or drying out, buffer zones will be added where needed. The exact delineation of these zones has yet to be determined.

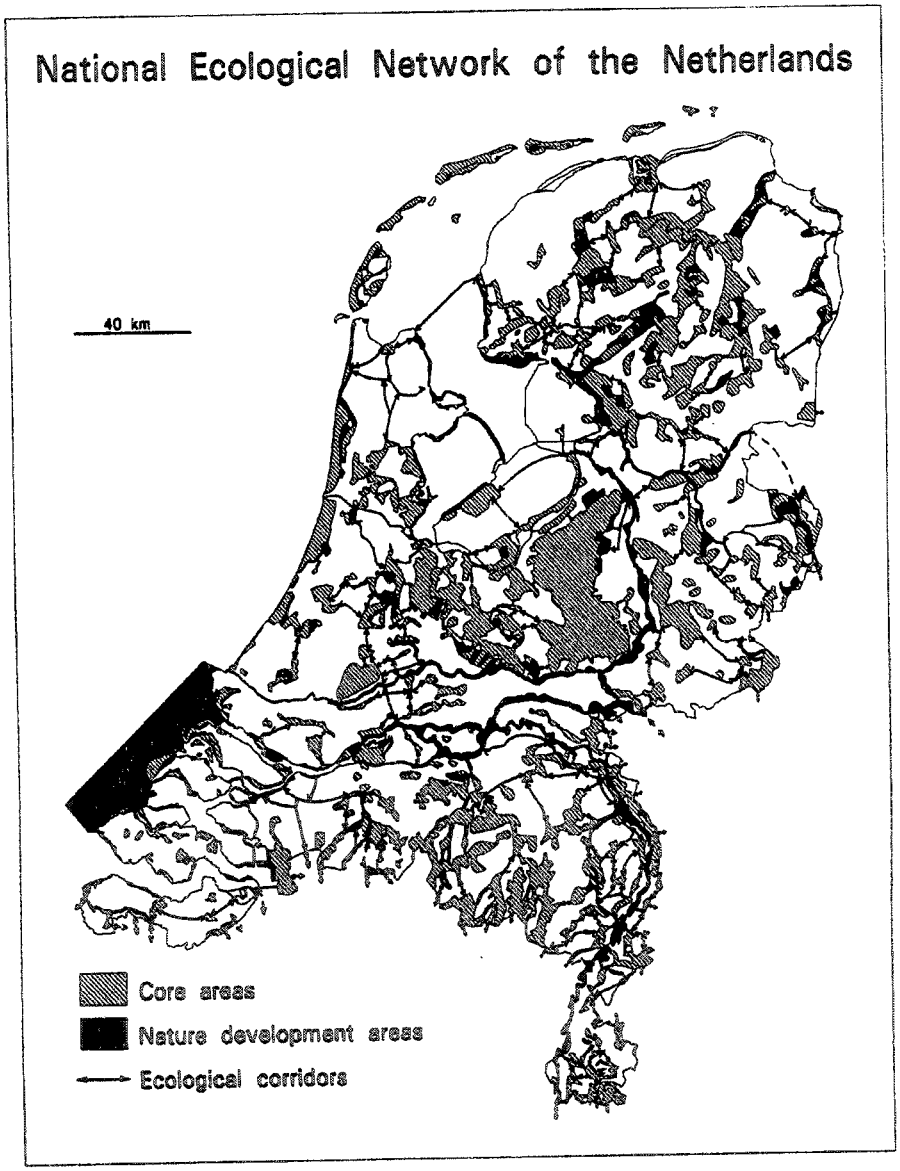

Figure 1 : The National Ecological Network : the basis of the National Nature Policy Plan

The achievement of the NEN is dependent upon protection through the planning process. The 'Structure Plan for Green Areas' provides an integrated approach to the protection and realization of the NEN and sets the planning framework for other rural policy plans : agriculture, out door recreation, landscape, forestry and fisheries. Land acquisition is also required and money has been allocated for this purpose. Finally, management agreements are needed to maintain and to enhance the value of these areas.

Prioritisation at the species level is done by identifying a suite of target species using three criteria : a. international importance, b. evidence of a decline at the national level and c. rarity at the national level. Species meeting two or more of the criteria have been selected and a list of 657 target species has been produced. Amongst these are four species of amphibian and two species of reptile. Of these six species only two, the grass snake (*Natrix natrix*) and great crested newt (*Triturus cristatus*), are indigenous to Britain.

Plans, however, only have a value if they produce real benefits in the field. Though the plan has been put into operation, after five years no major projects have been completed. The grass snake plan, presented below, gives some indication of how such measures can be put into effect.

Amphibians and reptiles

Amphibians and reptiles are two separate classes of animal and have different ecologies, use different habitats and have different conservation needs. Despite this they are traditionally grouped together under the collective name 'herpetofauna'. Although there are differences, there are also similarities in the way these animals use the landscape, eg in respect to vegetation structure and the 'scale' of their activities.

a. Habitat requirements

- Generally small home ranges; fairly sedentary behaviour within these (amphibians move less than 2-3 km in any season; reptiles usually less than 1 km (even for snakes, which move much further than lizards)).

- Poor colonisers, limited ability or instinct to move long distances. Tend to move most as immatures. Colonisation potential is improved if new potential habitats are adjacent or nearby.

- Amphibians and reptiles use both aquatic and terrestrial habitats. In this paper the importance of terrestrial habitat will be emphasised as the importance of these features are generally less understood, even though both amphibians and reptiles spend more time in these habitats than in aquatic ones, and the importance of ponds is mentioned elsewhere (eg Hull *et al*, this volume: *The Pond LIFE Project*).

- All species have specific demands on their habitat yet generalisations can be made that can help in the design and management of landscapes at the general and the more detailed levels (eg see Strijbosch 1991) :

    i. Topography : some species prefer southerly aspects (most reptiles), others avoid them.

    ii. Character of soil and substratum : sand lizards need sand for egg laying; many amphibians require loose ground for burrowing.

iii. Vegetation structure : Horizontal and vertical plant growth will result in varying degrees of complexity of structure of leaves, twigs and stems. The species of plant is largely immaterial except with regard to its growth pattern. Many species of herpetofauna require a varied vegetation structure for their thermal regulation or for managing the regulation of their body-water levels. A good structure will also offer physical protection against predators and will harbour a large number of invertebrates and other prey species.

- Generally reptiles prefer open vegetation, needing the warmth of the sun for their activity, while amphibians tend to be found in more closed vegetation. Exceptions are slow-worms *Anguis fragilis* and natterjack toads *Bufo calamita* respectively. Varied vegetation structures that allow animals to make choices are the best. Such areas include 'transition zones' between dense and open habitats, eg where woodlands border on pasture; open glades in forests.

- Both amphibians and reptiles are ectothermic ('cold blooded'); this means of body temperature regulation is very economical and so these species can live in areas where there is low productivity. For this reason heathlands can be very valuable habitats.

- Different areas are often used for different activities, eg mating, egg-laying, feeding and over-wintering. Separate reproduction, summer and winter habitats can often be recognised. While it is often possible to have all these areas in close proximity in designated nature areas or at least connected by suitable habitats, in the agricultural or urban landscapes they may be separated by some distance or by unsuitable habitats. Problems arise, even in traditional 'cultural' landscapes, where areas are separated by large hostile areas or by barriers such as roads, wide canals, walls and closed fences. To prevent isolation, these sub-habitats must be connected.

- Quality of habitat is important; quality may be related to water chemistry, vegetation cover, vegetation structure, exposure to the sun, size and management practice (including use of pesticides and fertilizers). A range of sub-habitats provided through an interconnected network provide the best opportunities for, and minimize risks to, populations. If one site becomes unsuitable movement to other areas (and subsequent recolonisation) is possible. These processes are best described in terms of 'metapopulation dynamics' (see Quayle, this volume: *Ecological concepts*)

b. Habitat types

There are 16 species of amphibian in the Netherlands (including a hybrid 'species' called the edible frog *Rana* kl. *esculenta*). There are seven species of reptile, but the wall lizard (*Podarcis muralis*) is extremely rare and confined to a single locality. There are differences in the use of different sub-habitats between species and these, perhaps with the exception of the terrestrial habitats used by newts (van Gelder & Grooten 1992), are fairly well known. The likelihood of any particular species being found in an area will depend upon the geographical distribution of the species and on the local character of an area. For a number of relevant sub-habitats (which are also termed 'small landscape elements') an estimate of the number of different herpetofauna species that may be encountered there is given (Table 1). This is based on published literature and field experience. These numbers are only estimates but serve to show the relative importance of the different sub-habitats to herpetofauna.

Table 1 : The importance of small landscape features as potential (sub)-habitats for amphibians and reptiles in the Netherlands. Numbers represent estimated maximum number of species associated with each (sub-)habitat type.

Aquatic	Farmland ponds	11
	Garden ponds	8
	Ditches	8
	Marshes	8
	Moorland pools	7
	Lakes	5
Terrestrial	Rough vegetation	12
	Bushes	11
	Wooded banks	11
	Heathland	11
	Wooded copses	10
	Gardens	10
	Bramble bushes	8
	Hay meadows, tall grass	8
	Railway embankments	8
	Old buildings, ruins	8
	Hedgerows	6
	Sand dunes	5
	Road-side verges	4
	Fields	3
complexes	Quarries	14
	Stream valleys	10
	River/canal banks	9
	Parks	7

Designing a landscape

When designing a landscape with a view to conserving amphibians and reptiles, the following steps should be followed :

1. Know and recognise potential (sub-)habitats for amphibians and reptiles.
2. Carry out a survey to determine which (sub-)habitats are being used by which species.
3. Safeguard at least the best existing areas ('foci') in the scheme.
4. Create new (sub-)habitats wherever possible.
5. Connect old and new (sub-)habitats by way of 'stepping stones' and corridors.
6. Draw up a management plan and make sure it is implemented.
7. Ensure that the people involved are informed about amphibians and reptiles and provide advice/education if needed.

The following sections provide some examples of the types of opportunities that can be developed in the landscape.

a. Grass snake

The grass snake is the only species of reptile that is comparatively widespread in the agricultural and even urban landscape in the Netherlands. It is threatened and declining and scores as a target species in the NNPP. For these reasons it receives special attention. Habitats for these snakes are found in four landscape types in the Netherlands (Smit & Zuiderwijk 1991) :

1. Estates : often having a combination or patch-work of deciduous forests, gardens, ponds, leaf and compost heaps, log piles, old buildings and stables, etc, these landscape types are particularly good for grass snakes. The largest numbers of this species are found on estates.

2. Forest and heathland complexes bordering on farmland : farm yards often provide egg-laying sites.

3. Moorland with a mosaic of meadows and marshes and where either forest or ruderal vegetation is present.

4. Dykes constructed of basalt blocks, bordering on farmland or wasteland : this is a typical situation found eg along the borders of Lake IJsselmeer, to the east of Amsterdam.

Complexes of (sub-)habitat types are especially important. In these mosaics different features are found, such as forests, forest edges, grasslands and small water bodies (ponds, ditches). Linear features and edges are important and Smit & Zuiderwijk (1991) have estimated that a length of 10 km of edges, ditches, verges, dykes and rough vegetation are needed for every 100 ha of habitat. Even in the outskirts of Amsterdam such a complex of (sub-)habitats exist and grass snakes are found in the mosaic of ditches, allotments and railway embankments.

A plan has been drawn up for creating grass snake habitats in the new IJsselmeer polder area (Flevoland) (Smit & Zuiderwijk 1991). The objective is to attract grass snakes from neighbouring core areas along ditches and canals. These corridors will have a plentiful supply of fish and amphibians (prey species) and they will be further improved by incorporating features such as hedgerows, bushes and banks. Management is required to maintain these sub-habitats in a good condition for snakes. To maintain a healthy 'metapopulation', an objective of the plan is to ensure that sub-populations are not more than 3 km away from each other. Therefore new habitats are created at these distances. Larger distances can only be covered if the inter-connecting corridors also serve as a part of the habitat (eg providing feeding, breeding and / or resting areas) and not solely serve as a migration route. Therefore, in such cases, corridors will be widened and further enhanced to allow them to function in this way.

Particularly important features in grass snake habitats are places for egg-laying. Grass snakes are known to deposit their eggs in piles of leaves, compost and manure heaps, rotting hay and crevices between stones exposed to the sun (Zuiderwijk *et al* 1991). These features are simple to create, simply by making piles of dung or waste plant materials. Generally dead leaves or compost are more effective than dung alone. In these the warmth and humidity generated from decomposition at a depth of several tens of centimetres into the heap is ideal for incubating the eggs. These are often referred to as 'heating heaps'. Grass snakes are often resident to 'their' heaps. In a survey of a grass snake area on the Friesland/Drenthe border in 26 out of 36 newly created heaps (65%) eggs were found. They also proved to be valuable habitats for slow-worms (van de Bogert 1989). Van de Bogert (1995) provides a prescription

for making grass snake heaps : the minimum size should be 2.5 x 1.5 x 1 m and an optimum age is 1-2 years. Heaps should therefore be replaced every two years and it is best to provide a 'rotational' series of several heaps of different ages at any site.

b. Provision for amphibians and reptiles

Creating 'heating heaps' is the only technical provision for improving the breeding success for the widespread reptile species. The exception is the rare sand lizard. This latter species needs open sand for breeding close to vegetation and, where this species occurs, sandy patches or traces of open ground (eg linear firebreaks) should be created. For the other species the provision and correct management of appropriate (sub-)habitats in nature reserves is of primary importance. Yet even for these other species the provision of corridors linking core reptile areas is important to maintain a healthy 'metapopulation'. Lizard species are generally poor dispersers. Therefore corridors need to provide a series of linked habitat patches which can sustain individuals or small populations. To do this features such as banks, hedges, bramble bushes, etc, need to be provided.

The majority of amphibian populations are likely to be found in the wider countryside and not confined to nature reserves. Therefore, there is a much greater need for the provision of particular features in the landscape to help their conservation. Since 1982, many pond action plans have been implemented. These have resulted in the restoration, management and creation of thousands of ponds. Placing an emphasis on breeding habitat is generally a very successful management strategy for amphibians (Stumpel & van der Voet 1995), although rare and threatened species may require other specific measures. Other technical measures for amphibians are mostly to address the problem of animals being killed when crossing roads (Vos & Chardon 1994; Anon 1995) :

- Kerbstones with longitudinal grooves that can prevent amphibians falling into drains during their migration.

- Fencing along a roadside with pitfall traps placed along the length from which animals can be captured and carried over the road in buckets. This reduces mortality but requires considerable volunteer effort.

- Erection of warning signs and imposing speed restrictions can help reduce mortality. Mortality is often caused by air turbulence, created by moving vehicles sucking the animal towards the wheels. This seems to be a major cause of death (eg of toads) with traffic moving over 55 km/hour (34 mph).

- Tunnels. Various designs of dry tunnel are in use. Their success depends largely on the design of the fences used to channel animals into the tunnel. U-shaped culverts of 80cm width, with dry ledges along the channels can also work; however, these narrow tunnels should not be too big otherwise they will be less effective for helping amphibians migration.

- Closing roads. At a number of sites, roads are closed to all traffic during the spring migration period; this is, of course, the most effective method.

c. Provision for other animals

Other animals are also catered for in the cultural and urban landscapes. Bergers & Kalkhoven (1996) have reviewed the effectiveness of various features provided for different groups of animals in the landscapes of north-western Europe (Table 2).

Table 2 : Efficiency of small landscape features and other provisions for assisting the movements of animals (modified from Bergers & Kalkhoven 1996)

Small landscape elements	Ungulates	Mustelids	Small mammals	Breeding birds	Reptiles	Amphibians	Butterflies
Canal/ditch	-	-	-(+)	-	-(+)	++	-
Vegetated bank	-	++	+++	+	+	+++	++
Road verge	+	+	+++	-	+	-	+++
Wooded bank/hedgerow	++	+++	+++	++	+	+	+++
Constructions							
Vertebrate exit	+++	+++	+++	-	+	+	-
Gutter/gully	-	+	++	-	+	+++	-
Culvert + ledges	-	+	++	-	+	++	-
Small tunnel/pipe	-	++	+++	-	++	+	-
Drift fence	++	++	++	-	++	++	-
Large tunnel/viaduct	++	+++	+++	-	+++	++	-
Cerviduct/ecoduct	+++	+++	+++	+	+++	+	+

+++ Very effective
++ Moderately effective
+ Less effective
- Not effective
(+) Some species only

Often amphibians and reptiles also benefit from these measures. Some examples are :

- Viaducts are essentially wide tunnels under roads, etc. The wider and higher they are, the better they function as a subway for animals. Culverts under roads can be designed to assist the management of animals so that they function as viaducts (see Plate 1).

- Ecoducts are bridges for animals crossing over roads, etc. Large, wide ecoducts created primarily for deer and wild boar (so called 'cerviducts') appear to be multifunctional and are valuable to a range of animals. Recently an ecoduct has been designed especially for amphibians through employing management practices that have allowed a mosaic of high and low vegetation to develop and by digging ponds close by (see Plates 2 and 3)

- Barriers that are designed to prevent the erosion of canal banks create problems for animals since they often prevent animals from being able to leave the water. Locally, these can be interrupted and connected to a small marshy area, or small steps can be built into them (these are called 'vertebrate exits'). These escape routes will also be used by migrating amphibians and grass snakes.

Plate 1: Culvert at Boertskotten (east of Oldenzaal) beneath A1 motorway: detail

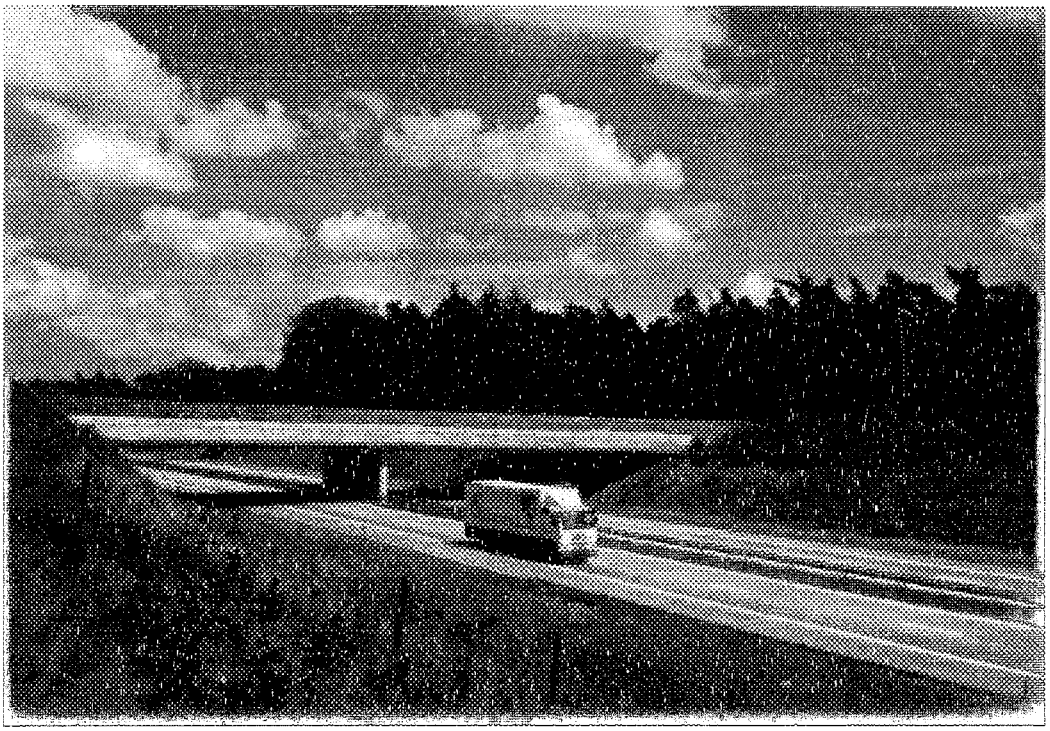

Plate 2. Ecoduct at Boerskotten (east of Oldenzaal) over A1 motorway

Plate 3. Ecoduct at Boerskotten (east of Oldenzaal): showing vegetated area on top of ecoduct (note high sides used to screen large animals from noise and lights of traffic below)

- Management of road verges as corridors, or even as sub-habitats, for animals will yield benefits for reptiles. Vegetation structures that are ideal for butterflies have been created by a well designed mowing regime where vegetation is cut later and higher than usual. Although still only done as experimental measures, such provisions have proven to be attractive to adders (*Vipera berus*).

- Provisions for bats, such as the restoration of underground ice-houses and the creation of cavities in noise barriers along motorways are not directly intended to help herpetofauna. However, the closing of underground marl pits (which are important hibernation sites for bats) has had a significant benefit for amphibians, such as the midwife toad (*Alytes obstetricans*), that have been found over-wintering in the entrances to the caves (Vergoossen 1990). The restoration of interrupted wooded banks and tree lines as corridors for bats (Limpens & Kapteyn 1991; Verboom & Huitema 1997) may also provide corridors that help with the dispersal of amphibians and reptiles.

- Even simple provisions, such as piles of logs or tree stumps, placed as shelter for mammals (eg the polecat *Mustela putorius*), for example under viaducts or in tunnels, will function as sub-habitats for grass snakes, common frogs, common toads and newts.

Conclusion

Amphibians and reptiles are threatened groups of animals which urgently need adequate protection and management of their habitats by the responsible authorities and other organisations. Any additional help in the urban, agricultural and wider landscapes will contribute to their conservation. If the needs of these animals are given proper consideration,

the designed and managed landscape can make a significant contribution to the well being of these species through safe-guarding existing sites, creating sub-habitats and making corridors. Some examples from the Netherlands illustrate the sort of features that can be considered and designed into landscaping schemes. The value of these to amphibians and reptiles is increased if the (sub-)habitats form part of a well managed network of sites interlinked by corridors.

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Appendices

Appendix 1. Safeguarding herpetofauna from agrochemical use in the designed landscape

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Introduction

Agrochemicals represent an important management tool in the designed landscape. Fertilisers may be used to promote growth of grasses, shrubs and trees. Pesticides may be used to control weeds, pests and diseases. Although a wide range of pesticides is approved for such use, herbicides (weedkillers) are likely to be the most frequently used. Fortunately these tend to have, not surprisingly, lower toxicity to vertebrate life, including reptiles and amphibians. Pesticides designed to kill animal life, such as rabbits or slugs, are likely to be of greater toxicity to our native herpetofauna.

Reviews have been published on the effects of environmental pollutants on both reptiles (Hall, 1980) and amphibians (Power *et al*, 1989). The latter literature is much more extensive for a number of reasons. Amphibians might be exposed on land as adults or immatures, or in water as any life stage from eggs to adults; whereas exposure of reptiles will be more or less restricted to exposure on land. Therefore the opportunities for reptiles being affected and/or being studied are more limited, and amphibians, especially the larval stage, have frequently been utilised to study pollutant effects in both the laboratory and field. Despite this, new pesticides are not routinely tested against amphibians (or reptiles), and too little is known to conclude that safety standards for other vertebrate classes are totally adequate for the protection of herpetofauna (Hall & Henry, 1992).

The best approach to take in this paper is to outline potential effects, so that readers appreciate what might go wrong, and then conclude with some general advice.

Effects can be divided into:

- direct effects: herpetofauna is itself exposed to the agrochemical and thereby affected;
- indirect effects: other organisms are exposed and affected, and then have a knock-on effect on herpetofauna.

Direct effects

Lethal poisoning. Herpetofauna incidents implicating agrochemicals are not frequently reported in the UK. Thus in the Wildlife Incident Investigation Scheme, run by the Agriculture Departments, pesticide incidents in recent years have been restricted to two involving the slug killer, metaldehyde (Greig-Smith *et al*, 1990; Fletcher *et al*, 1994). Pesticides are not a factor in the widespread mortality of common frogs *Rana temporaria* noted in the UK since about 1985 (Cunningham *et al*, 1995). Even in an intensively agricultural area, such as East Anglia, when the use of persistent organchlorines was at its height in the 1950s and 1960s, this was probably only one factor contributing to the decline of the frog (Cooke & Ferguson, 1976). Nevertheless the potential exists for carelessly applied pesticides to affect herpetofauna at specific sites. For instance, amphibians or reptiles sheltering in holes might be killed during rabbit control. Because of this hazard, the sodium cyanide product, Cymag, carries a label warning to alert users to possible effects on non-target wildlife using rabbit holes.

There is also potential for poisoning of aquatic stages of amphibians, although very few herbicides are approved for use in or near water (MAFF, 1985). This means that for tackling troublesome weeds growing beside water, eg Japanese knotweed *Reynoutria japonica*, a formulation of glyphosate may be approved but a product containing picloram would not; but both types of product could be used in a terrestrial situation away from water. Products approved for use in or near water should not cause unacceptable effects on aquatic life if used as stated on the label. Many terrestrially applied pesticides that are toxic to aquatic life have statutory buffer zones beside water bodies to reduce the risk of overspraying and drift.

There is literature indicating that fertilisers may be toxic to tadpoles (Berger, 1989; Baker and Waights, 1993), although later work by Baker (pers. comm.) indicated that toxic effects in the laboratory did not occur if pond water rather than distilled water was used as the test medium. Granules of fertilisers, such as ammonium nitrate, can be acutely toxic to frogs, but fortunately are of low persistence and therefore are probably of low risk in the field (Oldham *et al*, in prep.; Lawson, 1995).

Sublethal poisoning. If herpetofauna are exposed to levels of agrochemicals that are insufficient to kill them, then sublethal effects might result. While it is easy to speculate about reproductive and other effects in adults, effects are more likely to be detected in tadpoles as these are exposed continuously to any aquatic residues, are very numerous and are developing rapidly. Thus deformities can be seen in exposed tadpoles and studying such abnormalities might be a means of monitoring pollutant effects more generally (Cooke, 1973, 1981).

Secondary poisoning. If pesticides are used to control the prey of herpetofauna, then there is a possibility that lethal residues will be passed on to the predator. Thus Hall (1980) cited instances of snakes being killed after feeding on poisoned prey, such as rodents. These examples occurred outside the UK, but the metaldehyde poisoning of frogs referred to above may have involved secondary poisoning via the target slugs.

Indirect effects

Indirect impacts may include effects on the food supply of herpetofauna. The food supply might be animal or vegetable in nature, the prey species affected might be targets or non-target species for the agrochemical application, and effects on the herpetofauna may be beneficial as well as detrimental. As an example of a beneficial effect, in ponds treated with the herbicides diquat or dichlobenil, macrophytes died allowing some algal species to bloom and provide extra food for frog and toad tadpoles (Cooke, 1977).

There may also be effects on the degree of cover provided by vegetation. This could make herpetofauna more vulnerable to predation or it could affect prey dependent on that vegetation (a "double" indirect effect). The effect of terrestrially-applied herbicides on non-target aquatic vegetation, because of drift or other movement towards water, has been surprisingly little studied (Cooke & Burn, 1995). There were indications, in the ponds mentioned above to which diquat was directly applied, of reduced numbers of smooth newt larvae *Triturus vulgaris* (Cooke, 1977). The subject of indirect effects of pesticides on birds is currently attracting much concern (eg Marchant *et al*, 1990; Cooke & Burn, 1995). Similarly, over-zealous, chemical tidying is likely to reduce the carrying capacity of habitat for our commoner native herpetofauna.

Recommendations

It is not the intention of this short paper to provide management prescriptions for certain activities eg removing aquatic or terrestrial weeds, but rather to focus in on the safe use of agrochemicals. Among pesticides, herbicides are likely to be most frequently used. A guidance document to environmental protection and the management of vegetation in non-agricultural situations has been published by DoE (1992). This can be developed to give general advice on using pesticides on sites where there is a herpetofauna interest:

- is vegetation control necessary?
- if so, are herbicides required or can physical methods (or a combination of the two) be used?
- how do the herpetofauna use the habitat/landscape?
- what direct or indirect problems might result from herbicide use (refer to the sections above on effects)?
- how can any problems, eg water contamination, be avoided or minimised?
- take all necessary precautions before, during and after herbicide application.

English Nature used herbicides on its own reserves (Cooke, 1991) but we:

- consider non-chemical methods first;
- choose from a short-list of approved herbicides that are unlikely to cause problems;
- apply as specifically as possible eg by a paint brush or a wiper;
- attempt to rectify any factor that caused the weed problem in the first place.

For other pesticides, especially those that are marketed to kill animal life, even greater caution is required as direct toxic effects are more likely than with herbicides. If significant exposure of herpetofauna may occur, then the use of such products should be avoided unless there are over-riding considerations eg concerns for human health. There are solutions for some problems; for instance where control of mosquito larvae is necessary, the use of *Bacillus thuringiensis israelensis*, rather than a conventional insecticide, is unlikely to pose a significant direct or secondary poisoning threat to amphibian tadpoles (see Cummins & Gore 1985).

As regards fertiliser application, avoid uses that will lead to direct exposure of herpetofauna, eg to granules, or to run-off contaminating water bodies.

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Appendix 2. Roadside gulleypots and amphibians

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1. Background

Every year thousands of amphibians become trapped in roadside gulleypots as they migrate to and from their breeding ponds. Research in north-east Wales and anecdotal evidence from many other parts of the UK has now highlighted the extent and significance of this avoidable problem. Ironically, roadside gulleypots and kerbstone systems mimic the amphibian pitfall trap survey method that is often used for capturing amphibians.

2. Why are roadside gulleypots so effective at capturing amphibians?

Amphibian populations often have to cross roads when migrating to and from their breeding ponds. Successful migration across roads can often be impaired by the presence of vertical kerb stones. These vertical kerbstones direct animals onto the grilles of roadside gulleypots. Once on top of these gullies, animals fall into the gulleypots below. Animals trapped within these gulleypots are unlikely to be able to escape.

3. Are roadside gulleypots likely to adversely affect great crested newt populations?

Although no research has been undertaken to answer this question, it seems likely that smaller amphibian populations may be particularly susceptible to the adverse affects of roadside gulleypots. For example, during one three month study of an estimated population of 800 animals, 129 were found trapped in gulleypots. Capture rates such as this may eventually cause the extinction of smaller newt populations.

4. What can be done?

A series of both temporary and permanent solutions have been proposed to address this problem, although, to date, none have been field tested. Arguably the best long term solution is a surface water drainage scheme that does not require the inclusion of gulleypots (eg run-off is piped directly into storm water lagoons). Alternative solutions, some of which are illustrated on the following pages, include:

- The installation of permanent amphibian fencing and tunnels to prevent amphibians migrating across roads.
- The use of angled, lowered or indented kerb stones.
- Installation of temporary or permanent amphibian ladders.
- Modifications to gulleypot grille designs.
- Specially designed amphibian friendly gulleypots.
- The use of permeable road substrates.

Acknowledgements

The Countryside Council for Wales would like to acknowledge the work of the Deeside Urban Wildlife Group; the Clwyd Reptile and Amphibian Group; Wainhomes (Chester) Ltd and Wrexham County Borough Council. Without this help, quantifiable data would not be available.

Suggested further reading

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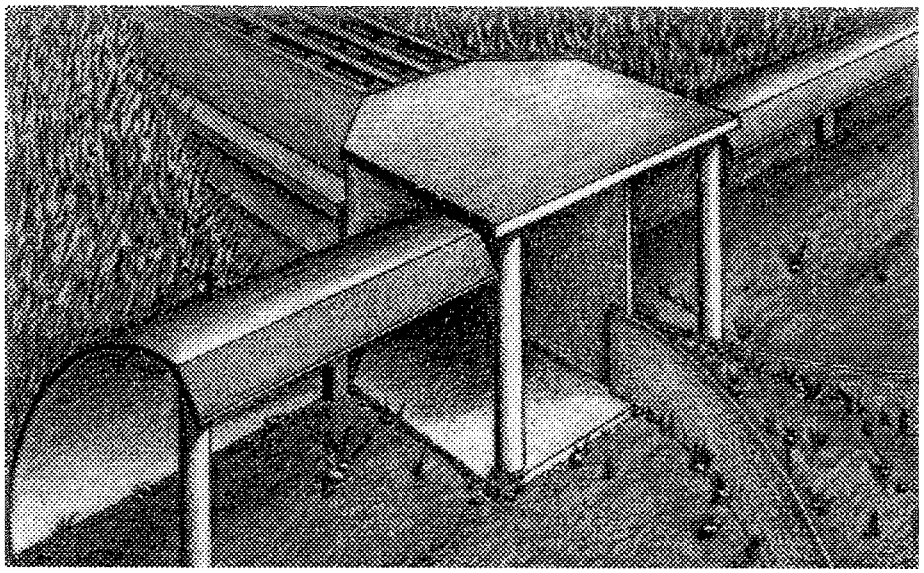
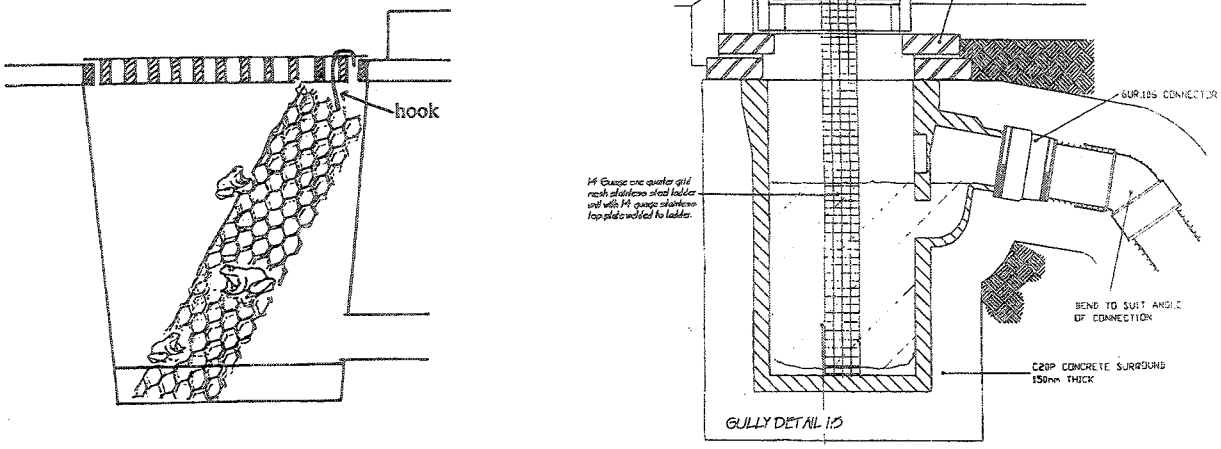
Some possible solutions

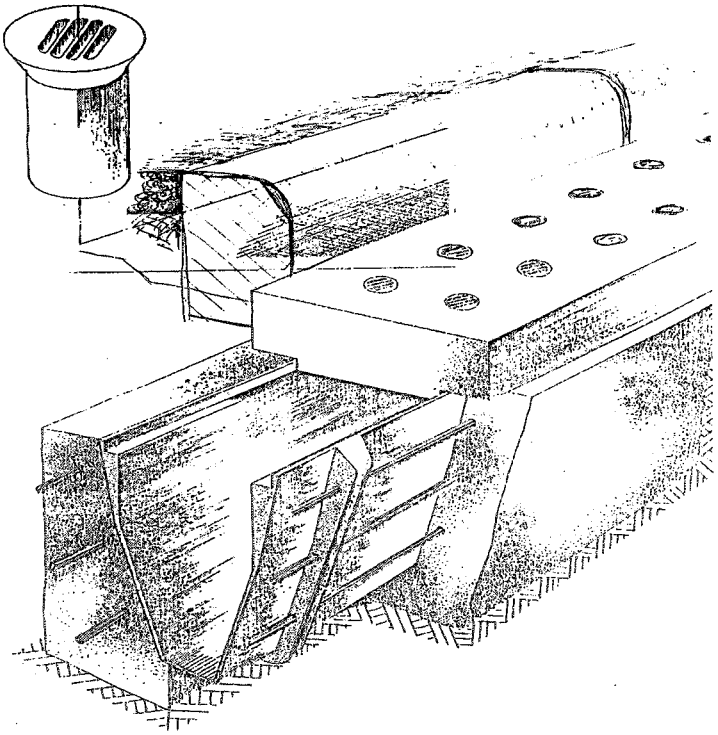


Permanent fencing and tunnels (provided by and reproduced with permission of: ACO Cranfield Ltd)

Angled and steep sided kerb stones (provided by and reproduced with permission of: George Barker, English Nature; HCIL and *Urban Wildlife News*): Angled kerb stones allow amphibians to climb easily from the gutter. Steep sided kerbs channel amphibians along gutter and into gullypots.



Installation of amphibian ladders (provided by and reproduced with permission of: HCIL and Wainhomes (Chester) Ltd)



Modified grille designs (provided by and reproduced with permission of: Wrexham Maelor Borough Council)

Appendix 3. The law and licensing requirements

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English Nature, Northminster House, Peterborough PE1 1UA.

All amphibian and reptile species native to Britain are protected to some degree by conservation legislation. This is brought about by the **Wildlife and Countryside Act 1981** with further protection to a small number of species being given by the **Conservation (Natural Habitats & c.) Regulations 1994**. This British legislation implements the E.C. **'Habitats and Species' Directive** and other international conventions (such as the Council of Europe's convention on European wildlife and habitats, known as the **Bern Convention**) that place international obligations on the UK to conserve reptiles and amphibians. In essence there are three levels of protection afforded to the 12 native species of reptile and amphibian.

1. 'Fully protected': This relates to the smooth snake, sand lizard, natterjack toad and great crested newt (this level of protection is also given to marine turtles when found in British waters). The legislation makes it illegal to:

    - intentionally or deliberately kill, injure or capture;
    - deliberately disturb;
    - damage or destroy breeding sites or resting places or places used for shelter or protection;
    - possess these animals or any parts or derivatives of them unless acquired legally;
    - sell, barter or exchange or transport for sale these animals or parts of them.

2. 'Partial protection': this relates to grass snakes, adders, common lizards and slow-worms. The legislation makes it illegal to:

    - intentionally kill or injure;
    - sell, barter or exchange or transport for sale these animals or parts of them.

3. 'Protection against trade' : this relates to the four common amphibians, the common frog, common toad, smooth newt and palmate newt. The legislation makes it illegal to:

    - sell, barter or exchange or transport for sale these animals or parts of them.

The law also prohibits the release of non-native species to the wild.

The legislation covers all life stages; spawn/eggs, tadpoles and adults.

There are some cases where the law allows these actions to occur. For example injured animals can be kept to tend them provided they are released as soon as they have recovered and 'mercy killing' of severely wounded animals is allowed. The law also allows actions that

would otherwise be illegal provided these are the incidental result of a lawful operation and could not reasonably be avoided.

Licences can be issued to allow otherwise prohibited acts (eg capturing and handling great crested newts). Licences for scientific study and conservation, education and photography are issued by the statutory conservation organisation (English Nature, Countryside Council for Wales or Scottish Natural Heritage). Occasionally other licensing authorities, such as the Ministry of Agriculture Fisheries and Food (MAFF) or Department of Environment, Transport and the Regions (DETR) are needed. For example MAFF are responsible for licensing actions where these are necessary for public health and safety; DETR are the licensing authority for sale and for the release of non-native species and, under the Conservation (Natural Habitats & c.) Regulations 1994, for "reasons of over-riding public interest".

In addition to conservation legislation, animal welfare legislation (eg **Protection of Animals Act 1911**) prohibits cruelty to all reptiles and amphibians when in captivity (which includes temporary captivity such as being caught in a net or a trap).

Appendix 4. Survey and monitoring

Tony Gent
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It is often important to look for the presence of amphibians and reptiles before a scheme is undertaken on a site, or to look in the immediate vicinity to see whether these animals are present so that they can be catered for in any design scheme. Also, to assess the success of any project or the effects of management, it is important to monitor the populations of these species. Visits over a number of years will allow an understanding of how the amphibians and reptiles on site are faring and will help guide management to ensure that it is meeting the needs of these animals.

Much has been written about survey and monitoring for both amphibians and reptiles (see 'Further reading' list) and this note is intended only to identify principles in outline.

Survey

The objectives of survey can be:

- to check for the presence or absence of a species
- to assess the size or extent of a population

Monitoring

The objectives of monitoring are usually to see how a population is faring. This requires repeated surveys, usually between years. To do this we often need information about some or all of the following :

- continued presence of adult animals (showing survival)
- breeding success
- successful development of young, from eggs (where appropriate), through immatures to adult

Often some quantitative estimates are required, eg. to see if populations are increasing, decreasing or staying the same in size.

Methods

Licensing requirements

Methods that involve capturing, handling or disturbance to great crested newts, natterjack toads, smooth snakes or sand lizards need to be licensed by the statutory conservation organisations (Countryside Council for Wales, English Nature or Scottish Natural Heritage).

Amphibians

The best way to survey amphibians is to take advantage of the seasonal migrations to breeding ponds. Breeding times vary, between species and in different areas, so survey times should follow suit. Various methods are available.

- Looking for adult animals, usually at night by torch-light. Frogs and toads will be seen swimming with their heads above water or sitting on pond edges; newts will be seen under water. Direct 'counts' can give a quantitative means for measuring changes in population size; though they can be good 'relative' measures, it is hard to assess actual population size from these counts.

- Looking for eggs : frog spawn is distinctive and counts of numbers of clumps gives a quantitative assessment of population size; toad spawn is easy to see but often hard to count; likewise newt eggs can be seen laid individually and wrapped in vegetation. Though counts are hard to do, some indications like 'few' or 'many' or 'tens, hundreds, thousands' can provide some quantitative index for assessing long term success.

- Tadpole or 'metamorph' (froglet / toadlet / eft) counts : usually measured only as 'few' or 'many' or 'tens, hundreds, thousands'. This is a valuable thing to measure as it shows that breeding has occurred and that the pond is good enough to allow development.

- Catching with nets : a useful technique for seeing if newts (in particular) are present in ponds that are hard to survey visually (eg. weedy or murky ponds). This method is rather disruptive and can damage vegetation; consistent sampling (fixed period of time, or fixed number of sweeps of a net) can allow comparisons between years. This method allows assessment of both adults and tadpoles.

- Bottle traps : a technique using traps made from soft drink (squash) bottles, cut in half with the conical end inverted into the base section to form a trap, similar to a lobster pot in design. Newts get caught in the traps. This method requires considerable care as, once trapped, newts can drown.

- Terrestrial searches : it is harder to find amphibians when on land. However they can be recorded using:

    - ❑ 'refuge searching' : turning over logs, or placing certain materials, eg. carpet tiles on the ground, below which the animals take cover

    - ❑ pitfall trapping : placing bucket traps in the ground often in conjunction with 'drift fencing' which channels the animals towards the traps (labour intensive and requires frequent checking)

Reptiles

Generally hard to survey to obtain quantitative information. They do not show such obvious seasonal migrations, though snakes do often congregate around particular hibernation areas and can be seen here early (March / April) and again late (September / October) in the year. Reptile behaviour is greatly influenced by the weather; you do not see them if it is too hot or too cold.

- Generally, survey is best carried out between April and end of June, and again in early September

- Warm, partially cloudy days, or spells following rainy weather are often the best periods for survey. Snakes and lizards seem to prefer slightly different conditions; snakes are often seen out longer when the weather is cooler

- Survey for lizards (except slow-worms) generally relies on looking for basking animals; logs, ant hills, slopes, etc, often provide features that favour lizards and so these are often the best areas to concentrate search effort.

- Looking under 'refuges', typically pieces of corrugated iron sheeting specifically placed for this purpose, will help survey for slow-worms and snakes. These warm up quickly and early in the day, or in cooler cloudy weather, provide cover for reptiles. They can become too hot very quickly.

- Quantitative survey often relies on simply counting animals, but allowing standardisation for time spent searching.

- Looking for young animals : it is very hard to find young snakes, though grass snakes may be seen around egg laying areas (eg. compost heaps) from late August. Common lizards breed early and small, black lizards about 4 cm (1.5") in length may be seen any time from late June; small, copper-coloured young slow-worms from mid-August onwards are a sign that this species has bred on site that year.

How many visits

The more the better, generally it is difficult to be sure to get any reliable estimate of animals numbers in less than 10 visits during the best times and in good conditions. However it is often sufficient to undertake fewer visits to confirm the continued presence of animals and obtain some idea whether a healthy population persists in the area.

Further reading

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FOSTER, J. & GENT. T. (Eds) 1996. Reptile survey methods : proceedings of a seminar held on 7 November 1995 at the Zoological Society of London's meeting rooms, Regent's Park, London. *English Nature Science Series No. 27*. Peterborough: English Nature.

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GRIFFITHS, R.A., RAPER, S.J. & BRADY, L.D. 1996. Evaluation of a standard method for surveying common frogs (*Rana temporaria*) and newts (*Triturus cristatus, T. helveticus* and *T. vulgaris*). *JNCC Report No. 259*. Peterborough: Joint Nature Conservation Committee.

READING, C.J. 1996. Evaluation of reptile survey methodologies : final report. *English Nature Research Reports No. 200.* Peterborough: English Nature.

Appendix 5. Programme

Opportunities for Amphibians and reptiles in the designed landscape

Seminar at the Jodrell Lecture Theatre, Kew Gardens, Kew Road, Richmond, Surrey

Wednesday 24 January 1996

Programme

Chair: Bob Bray

1000	Welcome (*Keith Duff, Chief Scientist, English Nature*)
1010	Introduction (*Tony Gent, English Nature*)
1030	Amphibians and reptiles - the species and their ecology (*Jim Foster, Froglife (Herpetofauna Conservation International Ltd)*)
1100	Coffee
1130	Ecological concepts in conservation (*Andrew Quayle, Sparsholt College*)
1200	Opportunities through the planning system (*Phil Lomax, Eastleigh Borough Council*)
1230	Lunch and posters

Chair: Tony Gent

1400	Landscape design and management opportunities (*Bob Bray, Landscape Architect*)
1445	Designing the pondscape-opportunities for amphibians (*Andrew Hull, John Boothby, PondLife project and Ian Marshall, Cheshire County Council*)
1515	Tea
1530	A Dutch perspective: conserving reptiles and amphibians in the 'wider landscapes' (*Anton Stumpel, Institute for Forestry & Nature Research, The Netherlands*
1600	Conclusions and general discussion
1630	Meeting ends

Appendix 6. List of attendees

Peter Thompson	British Coal Opencast
Sue Stockley	British Coal Property
Dominic Smith	British Coal Property
Janice Kerby	R J Budge mining
Richard Copas	NRA (Thames)
Andrew Heaton	NRA (Severn Trent)
George Barker	English Nature
Julia Wycherley	Surrey Amphibian & Reptile Group
Keith Andreae	Surrey Amphibian & Reptile Group
Alison Tutt	Surrey Wildlife Trust
Susie Holt	Surrey Wildlife Trust
Karen Renshaw	Society for Ecological Restoration
David Bullock	National Trust
Adam Wallace	FWAG
Fred Currie	Forestry Authority
Justine Smith	W S Atkins
Louise Jones	W S Atkins
Caroline Aylott	W S Atkins
Robert Evans	W S Atkins
Tara Talbot	Landscape Architect (Cobham Resource Consultants)
Martin Noble	Forestry Commission (FE)
Rachel Thomas	English Heritage
Caroline Roberts	WWF
Luke Brook-Lynne	The Broads Authority
Gary Kennison	The Broads Authority
Richard Bullock	Wildfowl and Wetlands Trust
Ron Foster	Redland Aggregates
Ashley Leftwich	Penny Anderson Associates
Grant Jones	National Power
Nick Moulton	Herpetological Conservation Trust
Monica Green	British Herpetological Society
Matthew Ellis	CCW
Clive Herbert	London Amphibian & Reptile Group
Betty Platenberg	Christchurch College, Canterbury
Andrew Grey	Manchester Museum
Ann Waite	Kent Trust for Nature Conservation
Alex Ewing	Kent Regional Amphibian Group
John Boothby	Pond*life* Projects
Ian Marshall	Cheshire County Council
Pip Perry	Deeside Urban Wildlife Group
Andy Bascombe	Ove Arup & Partners
Richard Tazewell	Poole Borough Council
Dave Bird	British Herpetological Society
Tony Sangwine	Highways Agency
Roger Worthington	Forest Enterprise
Michael Bridgeman	Waverley Borough Council
Betsy Ruggles	InterGen
Dave Green	Conservation Consultancy
David Simms	Blue Circle Industries
Clare Williams	Durrell Institute of Conservation Ecology

Mark Bridger	Kew Gardens - Garden Supervisor
Felicity Frost	Kew Gardens
Leigh Margery	Kew Gardens
Alan Hulme	

Speakers

Keith Duff	English Nature
Tony Gent	English Nature
Jim Foster	Froglife (Herpetofauna Conservation International Ltd)
Andrew Quayle	Sparsholt College
Phil Lomax	Eastleigh Borough Council
Bob Bray	Landscape Architect
Andrew Hull	Pond*Life* Project
Anton Stumpel	Institute of Forestry and Nature Research