
**VOLUME 10 ENVIRONMENTAL
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MANAGEMENT
SECTION 4 NATURE CONSERVATION**

PART 4

HA 81/99

**NATURE CONSERVATION ADVICE IN
RELATION TO OTTERS**

SUMMARY

This Advice Note gives advice in relation to otters and other mammals.

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Nature Conservation Advice in Relation to Otters

* A Government Department in Northern Ireland

Summary: This Advice Note gives advice in relation to otters and other mammals.

REGISTRATION OF AMENDMENTS

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**VOLUME 10 ENVIRONMENTAL
DESIGN**
**SECTION 1 THE GOOD ROADS
GUIDE - NEW ROADS**

PART 9

HA 81/99

**THE GOOD ROADS GUIDE
NEW ROADS
NATURE CONSERVATION ADVICE IN
RELATION TO OTTERS**

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1. INTRODUCTION

1.1 The otter (*Lutra lutra*) is one of Britain's most rare and elusive of mammals. Once established on river systems throughout the UK, it suffered a dramatic decline during the 1950s, retreating to isolated populations in Scotland, Wales and South West England. As a result of improving water quality, strategic conservation efforts and sensitive river management, along with a successful release programme, the otter is returning to much of its former range. They can now be found in all 8 Environment Agency regions (Strachan and Jefferies, 1996) and virtually the whole of Scotland (Green and Green, 1997). Otter populations have been in decline throughout Europe and the UK population is recognised as one of international importance. As a result, the otter is protected under UK and European law which is designed to conserve the animal and its habitats.

1.2 However, this increase in population has led to a sharp rise in otter road casualties and such accidents account for 60% of violent deaths in the UK (Woodroffe, 1994). New road schemes and improvements to existing roads which do not take the needs of otters into account in their design and construction could seriously affect the successful re-colonisation of some areas as well as adversely affecting existing populations. The problem of road casualties amongst otter populations has been targeted in both the Biodiversity Steering Group's Action Plans (Biodiversity: The UK Steering Group Report, 1995) and the Joint Nature Conservation Committee's (JNCC) document "A Framework for Otter Conservation in the UK: 1995 - 2000" (JNCC, 1996) as requiring immediate attention. As a result of these reports, Government policy is to reduce and, where possible, eliminate possible threats to otter populations and these guidelines are a product of this policy. Careful design of road schemes can assist in the implementation of this policy.

1.3 The general principles for mitigation described here may also be applied to other mammals, eg badgers (see DMRB 10.1.5. Chap 1). The conservation of riparian habitat for otters will also benefit other animals. The water vole (*Arvicola terrestris*) is another species listed on Schedule 5 of the Wildlife and Countryside Act (1981) and is also included in the Biodiversity Steering Group report. This species

also requires the retention of suitable banks for burrowing and vegetation for food. Various species of birds and fish will also benefit if the water course is left undisturbed or restored to a 'natural' condition.

1.4 The advice notes presented in this chapter provides the range of mitigation measures representing the best practice guidelines to date as recommended in a range of situations, and explains the correct use and positioning of them, as far as is possible for a generalised case. These guidelines are not intended as a substitute for credible mitigation advice based on experience and tailored to each individual situation. It must be borne in mind that there is no general solution which covers all sites, and each location must be assessed individually by an expert in otter ecology to provide an appropriate, effective suite of mitigation measures.

1.5 This advice note applies to schemes for new roads and to improvements to existing roads where they cross watercourses and wetlands that are a part of otter habitat. The upgrading, widening or repair of many roads currently in operation can provide many opportunities for reducing otter casualties especially in areas where otter road kills have been reported. In order to reduce the effects of existing roads the provision of mitigation should be considered whenever improvements or major maintenance works are planned.

1.6 Mitigation of the effects of roads on otters is not just concerned with the conservation of the otter. Road safety is an important consideration and can be improved by discouraging wild animals from crossing the carriageway.

1.7 It should be noted that all references to 'the relevant statutory bodies' apply equally to English Nature (EN), the Countryside Council for Wales (CCW), Scottish Natural Heritage (SNH) and the Environment and Heritage Service in Northern Ireland: Countryside and Wildlife (ES: CW) unless otherwise stated. The Environment Agency (EA) have responsibility for environmental protection and for promoting the enhancement of natural habitats within river catchment areas within England and Wales. They should be consulted on all proposals affecting watercourses or wetlands. This role is filled by the Scottish Environmental Protection Agency (SEPA) in Scotland.

2. KEY ISSUES

- Otters should be considered in the design, construction and maintenance of all new roads that will affect the species habitat.
- Mitigation for the effects of existing roads should always be considered when improvements or major maintenance works are planned adjacent to water courses.
- It is important to recognise any water course, water body or wetland as a habitat and wildlife corridor and that all these areas have potential as otter habitat. It is also important not to create barriers to the re-colonisation of habitat by otter populations.
- English Nature (or the equivalent statutory body in Scotland, Wales and Northern Ireland) should always be consulted where otter habitat is likely to be affected.
- Each site will require its own mitigation design and this will require the skills of an experienced otter expert.
- Any mitigation that is included is also likely to benefit other species.
- Otter populations with low densities will be most at risk through road casualties.
- Otters do not recognise scheme boundaries. Mitigation design will need to consider areas adjoining the scheme where otters might be affected.
- Maintaining an undisturbed river corridor with safe crossing points is the ideal design of mitigation.
- Survey work for otters should be completed as part of the environmental assessment process for all new schemes and improvements to existing roads.
- Surveys of the area for signs of otters and important habitat features, eg resting sites and breeding areas, should begin at an early stage in the design process and these surveys should be repeated every 3 months over the course of one year during the consultation and construction process.
- Competent assessment work is critical to the success of any mitigation efforts. All surveys should be conducted by experts in otter ecology and survey techniques.
- Any recommendations and designs proposed must not be altered without discussion with the consultant.
- Fencing will require inspection every 6 months during the life span of the road to ensure no weak points have developed, as breaches in the fence can negate the efficacy of all measures. Any defects found should be made good immediately.
- Otters use different types of features for shelter. These could be natural or man-made and are an important component of good habitat. Any such features should not be removed without consultation with English Nature, or the relevant statutory body.
- Artificial holts can be constructed away from the road. However expert advice is essential to evaluate the chances of the success of such an operation, and to oversee any such work being carried out.
- All mitigation schemes should be in place before a new scheme is open to traffic, and at the earliest possible stage during construction.
- Effective maintenance and monitoring is required to assess the effectiveness of the mitigation techniques used and to initiate any remedial action.

3. PROTECTION STATUS

European legislation protecting otters

3.1 The otter is protected under European Law, being listed in Annexes IIa and IVa of the EC Directive (92/43) “The Conservation of Natural Habitats and of Wild Fauna and Flora” (the Habitats Directive), and applied in the UK under Conservation (Natural Habitats &c.) Regulations 1994. Under these regulations it is also an offence to damage or destroy an otter’s place of shelter, whether intentionally or accidentally, and to deliberately disturb an otter.

3.2 This legislation requires the UK to encourage the management of countryside features and habitats that allow the migration and dispersal of species. “Rivers and their banks” are cited as one such example. It also enables the designation and conservation of Special Areas of Conservation (SACs) and in some cases otters may be a reason for site designation. It should be noted that development affecting an SAC will only be allowed in particular circumstances.

3.3 The otter is also listed in Appendix II of the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats), to which the UK is a signatory.

UK legislation protecting otters

3.4 The EC Habitats Directive is implemented in this country by Statutory Instrument 2716, Conservation of Natural Habitats Regulations 1994 except Northern Ireland where they are implemented under Statutory Rules (NI) 380, 1995.

3.5 The otter is currently protected under the 1981 Wildlife and Countryside Act which includes England, Wales and Scotland. In Northern Ireland, the otter also has the same degree of protection under the Wildlife (NI) Order 1985. Being listed under schedules 5 and 6, it is an offence to deliberately kill, injure or take an otter without a licence. It is also illegal to disturb, damage or destroy holts or other place of

shelter, or to place any trap in a position where it will cause bodily injury to any animals.

3.6 The otter also has protection under the Wild Mammals (Protection) Act 1996 and the Welfare of Animals Act (Northern Ireland) 1972, which makes it an offence to inflict unnecessary suffering on any wild mammal.

3.7 English Nature (or the equivalent statutory body) must be consulted and their agreement sought before any action is taken, which under normal circumstances, would be subject to a licence.

3.8 A licence is required from English Nature (or the equivalent statutory body) if an otter is known to be in residence on site and will be physically disturbed. If a holt or other resting site is discovered during preliminary surveys or during construction, the contractors should discuss with English Nature on how to proceed. Alternatives should be considered so as to avoid disturbing the holt. It is not acceptable to remove a holt, stating that it “could not reasonably be avoided”, as preliminary surveys should have located the holt and alternatives considered.

3.9 Scottish Natural Heritage have become concerned that far too many holts are being destroyed without due consideration of the consequences. As a result, any proposal in Scotland should be discussed with SNH to determine if a licence is required for the operation.

A summary of each Act is provided in Annex A.

Other relevant non-statutory documents

3.10 Biodiversity: The UK Steering Group Report, published in 1995, outlines the Government’s responsibilities in accordance with the Biodiversity Treaty, signed at Rio de Janeiro, in 1992. This document is not law, but the Government is now committed to protecting biodiversity. The Biodiversity Steering Group Report contains a set of guidelines outlining in a series of Action Plans designed to protect certain species and habitats. The otter is one of those species listed and road

casualties are identified as a cause for concern. The objective of the Otter Action Plan is to restore breeding otters to all areas where they have been found since 1960, by 2010. Also many of the otter's habitats are listed, along with another riparian mammal, the water vole (*Arvicola terrestris*) (Biodiversity: The UK Steering Group Report, 1995) (Annex B).

3.11 Any development that may disturb or damage species and habitats listed in the Biodiversity Action Plans, should respect the ideals of the Biodiversity Treaty, and should be designed and implemented to avoid or minimise all adverse effects.

4. GENERAL CHARACTERISTICS

Description

4.1 The otter is a member of the mustelid family of mammals, which includes the badger, stoat and weasel. They are dark brown in colour and average about 1m in length with males weighing up to 9 kg. They are streamlined in appearance, with a flattened head and thick tapering tail, ideal for swimming. Otters are carnivorous and they forage in rivers, lakes and streams, surviving on a diet of fish and amphibians, as well as hunting in the sea, where their diet consists of fish and crustaceans. Otters will also take small mammals and water fowl when necessary. They are mostly nocturnal and are very secretive creatures with a strong sense of curiosity. The otter is often confused with the American mink, (*Mustela vison*) but the mink is a much smaller animal, with males averaging 300 mm and weighing only 1.5 kg. The otter is also more adept at swimming than the mink, with only its eyes and nose showing above water.

Numbers and Distribution

4.2 Otters were once widely distributed throughout the river systems and coastline of the British Isles. However, pollution and persecution by man led to a severe drop in populations throughout the UK in the 1950s, and the otter retreated to strongholds in parts of South West England, Wales and Scotland. The otter is now starting to return to its former haunts in all parts of the country, with a recent survey of England

finding evidence of otters in all 8 Environment Agency regions (Strachan and Jefferies, 1996). The natural population recovery has been encouraged by a widespread and strategic conservation effort to increase awareness of the otters' needs, to enhance habitats and to improve river and wetland management and environmental protection. The return has been boosted by two reintroduction programmes by the Otter Trust and the Vincent Wildlife Trust, with animals released in areas of Eastern and Southern England. In total, 105 otters had been released by the end of 1994 and many are known to have bred successfully, through sightings of mother and cubs. However, 13 animals have been lost, 7 of them through road traffic accidents. The latest survey for Scotland shows otters to be in all parts of the country with very few exceptions (Green and Green, 1997). Both Wales and Northern Ireland also have significant populations. Britain has been at the forefront of otter conservation from an early stage and as a result of the conservation effort outlined above is one of the species' principal strongholds in Europe. It is almost impossible to estimate accurately the numbers of otters in a particular area, but otter populations are still vulnerable and every effort should be made to encourage and maintain viable populations. DNA fingerprinting techniques are being developed which may lead to more accurate population estimates being possible in the future.

Social Behaviour and Reproduction

4.3 Otters, unlike badgers, are not social animals, but live individually along stretches of river, coastline or inland water bodies. They are inquisitive animals, investigating changes in their surroundings and marking them as their own home range. Male home ranges usually overlap two or more female home ranges and it is thought they can detect the female's breeding condition by her urine. Females are capable of having 1 litter a year (although it is thought only 60% do so) and will rear the cubs over a period of 10 - 12 months. Litter size can vary, but the average is close to 2. Otters have no fixed breeding season throughout most of the UK, and so cubs can be born in each month of the year. Otter cubs are usually born away from the main river in secluded areas, and the mother will be very secretive, taking care not to leave signs of her presence in the area. The cubs will spend their first year learning to hunt from their mother and then disperse to establish their own territories but; throughout that first year, they are dependent on their mother.

4.4 Otters therefore do not breed rapidly and local mortality can adversely affect local populations. In areas where otters may be re-colonising, it is important to recognise that just one road casualty could seriously affect the expanding population. It should be remembered that the British otter population is still considered vulnerable and, at low population levels, accidental mortality could be the deciding factor for survival in an animal with such a low reproductive rate. Large populations of animals can absorb relatively high numbers of casualties, but a limited population with no corridors for migration in or out will suffer extinction if a large percentage of individuals die a premature death. This is especially important if the animal involved is a female that is pregnant or with dependent young, as the cubs will also perish.

4.5 Any preventative measures taken to minimise these effects, especially in areas of low population density, can create a significant advantage for the conservation of the otter.

4.6 Advice on aspects of otter ecology and conservation, including practical conservation measures can be obtained from the Environment Agency and from English Nature (or their national equivalents). For information relating to particular areas or regions, EA regional conservation officers and local wildlife and otter trusts should be consulted. The EA has published advice on practical otter conservation: 'The Otters and Rivers Technical Handbook' (NRA 1993), currently being updated, which covers aspects of otter ecology, field signs and practical conservation measures.

5. HABITAT

5.1 Otters live in most freshwater habitats and in many coastal areas and offshore islands. They may use any source of water within their home range for foraging or exploring. This includes many of the smaller streams which provide an invaluable source of food and secluded areas for cover especially for females when rearing cubs. These streams are also used by dispersing juveniles or adults to travel from one catchment to the next, searching for new areas to colonise. **It is important to recognise any watercourse as a habitat and wildlife corridor, along which many**

species may disperse or migrate and that all watercourses have potential as otter habitat. The EC Habitats Directive and the Biodiversity Action Plans note the importance of these habitats and the consequences of poor management.

5.2 Otters prefer rivers and streams which provide good cover and plenty of food. Although good swimmers, swimming is still an inefficient way for otters to move around the countryside. The preferred option is to run along the bank especially if moving upstream, against the flow of water. Otters tend to use the bank that is free of obstructions and so it may only have low lying vegetation with a path indicating its use by otters. They are not restricted to major waterways, but can be found in marshes and on small streams as well as lakes and reservoirs. Their preferred habitat in these areas is one with good vegetative cover, such as scrub with herbaceous vegetation. Reeds and other emergent vegetation have been shown to be an important resource for providing shelter and food. Woodlands also provide plenty of cover with old and fallen trees providing possible holts and a dense understorey providing cover above ground. Ponds, bogs and marshes also provide cover and more importantly, food, mostly amphibians.

5.3 In some areas of the country, the sea provides a vital resource. This is particularly true in the Highlands and Islands of Scotland, where many otters are killed on roads while travelling between the sea and coastal lochs to areas of freshwater. Many of the roads built in this area follow the coastline, due to ease of design and construction. This in turn disrupts a complex habitat that has many suitable resources and so is densely populated by otters. In this situation the otters need to pass from the sea to sources of fresh water and do so by following the streams that run down to the coast. This is essential for otters that spend most of their time foraging in the sea, so they can wash the salt water out of their fur. This is to retain its insulating properties. Access along these streams is therefore crucial for these animals and must be provided in any road improvement or construction work. Also much of the coastline provides numerous sites for shelter and these must be accommodated in the road design.

5.4 As otter populations increase, they will spread into areas which may not appear suitable. Already there is plenty of evidence to suggest that otters are now

present in Glasgow and other major cities. So road construction in urban areas may also impact on otters and its consequences should also be considered.

Holts and couches

5.5 The otter uses many different sites for shelter, such as holts and couches, depending on availability. Holts are rarely constructed by the otter. Instead the animal utilises any suitable structure within its range such as a hole in the river bank, hollow trees, the crowns of pollarded willows, cavities in rock piles or tree roots, peat tunnels, or some man made structures. Many otters will seek shelter above ground, using couches which are usually formed from vegetation used as bedding which are located in areas of scrub, reed beds or long grass. Large stands of riparian gorse and other scrub or tussock sedge and extensive reedbeds are particularly important habitats.

5.6 On inland waterways, holts and couches are used to rest during nocturnal foraging and for lying up during the day. They are also important for breeding. Female otters prefer to use areas that are secluded to avoid disturbance by man and other species and both holts and couches are equally important for this purpose. These areas also tend to be away from main rivers up to a kilometre away on a small tributary and can also be located up to 500 m away over land. Coastal otters, such as those in Shetland, are more restricted to the use of holts due to the habitat available. Holts in Shetland are burrows in the peat often containing freshwater pools for bathing.

5.7 Otters are secretive animals and so holts can be difficult to identify, especially if a female has young. In this instance, she will reduce her sprainting activity around the holt, so as not to attract the attention of other otters and predators. It is also essential to note the importance of dense vegetation as this could provide suitable resting places and may indeed shelter an otter.

Home range

5.8 Each otter has its own home range, which it defends against other individuals of the same sex. The size of these home ranges varies depending on the habitat and food availability and can cover many kilometres, with males averaging 35 km and

females 20 km along rivers. This home range will contain the various requirements that the animal needs on a day to day basis. It will combine several habitat types, allowing for different food resources at different times of year, areas of cover and sources of fresh water if located near the coast. Most home ranges appear to overlap, but usually conflicts are avoided by the use of spraint as a marker, informing other otters of the presence of a particular individual in the locality.

5.9 Any road, therefore, that passes over or between potential otter habitat(s) will bisect otter territories, forcing the animal to come into contact with the road, if no alternative crossing point is provided.

Sprainting

5.10 The home range is defined by the otter's droppings, called spraints. These are usually black in appearance and sweet smelling, unlike those of the mink which are foul and rancid. They are located at prominent points in the otter's home range, such as ledges, boulders, under bridges and tree saddles. Sign heaps may also be used for the deposition of spraint. These heaps are usually earth or sand pushed into a small mound to form a landmark and can be located on beaches, under bridges and on otter runs. The scent of these spraints acts as a signal to other individuals of the resident's presence and condition. Sprainting is subject to seasonal variations, due to food availability, presence of young and other factors. It is not possible to determine accurately the numbers of otters present, but it may be possible to determine the frequency of otter use by repeat survey over the course of several days.

Field signs

5.11 The identification of spraint and holts is the standard method for determining otter activity in a particular area. Footprints can be used as an indicator of activity if the conditions are right for leaving prints. They are usually best identified when seen in mud or compacted sand. The otter has 5 webbed toes, each with claws, although these may not be clearly defined. Each print is around 50 - 60 mm wide. Otters also use areas where they groom and rolling on the ground creates beds of flattened vegetation. They use paths that run along and away from the river bank, which may end in slides when the path enters the water.

6. MORTALITY

6.1 An adult otter, like the badger, has no natural predators in Britain. Although capable of living in excess of 10 years in captivity, the average life expectancy of a wild otter is thought to be just over 3 years (Kruuk 1997). Many otters will not survive their first year while others will die a natural death, by starvation, drowning in floods, disease, or as a result of injuries incurred fighting other otters.

6.2 However a large percentage of otters die as a result, directly or indirectly, of man's activities. Of these, an average of 60% of recorded deaths in the UK are road casualties (Woodroffe, 1994), although this increases to as many as 86% in Scotland (Green and Green, 1997). Over 180 animals have been killed in South West England alone since 1986. It is important to note that this may only be the tip of the iceberg, for many casualties are never recorded and some carcasses may never be found. This number may seem small but should be considered in light of an estimated population of 350 otters in England in the 1980s (Harris *et al*, 1995).

6.3 Seasonal peaks in mortality have also been identified, with the majority of animals being killed during November /December and March/April. These correspond with periods of high rainfall, when the rivers are in flood, and with the main period of otter activity coinciding with rush hour traffic.

6.4 **Therefore the inclusion of mitigation measures on new and improved roads and the provision of mitigation on existing roads wherever the opportunity or need arises could make a major contribution to reducing the number of otter casualties and their impact on the population as a whole.**

6.5 The otter is currently expanding to re-colonise parts of the country where it has not been seen in the last 30 years. It is in these areas that a single road casualty has the most impact, because the population has yet to become established and it may take many years for new animals to arrive.

7. OTTER SURVEYS

7.1 Otter surveys should be carried out as part of the ecological assessment under DMRB 11: Environmental Assessment, wherever a scheme is likely to affect otter habitats or populations. Effects on otters should also be considered in relation to all small schemes, improvements and major maintenance projects in areas where otter populations exist or are expanding. Effects on otters should always be considered wherever work may affect a watercourse, including the rebuilding and improvement of small bridges and culverts. Surveys should be carried out and mitigation for potential or existing effects on the habitat and population should be considered. Otter populations are constantly changing and their expansion is not always predictable; in order to avoid adverse effects on the recovery of the population it may be necessary to include mitigation in areas where otters are not readily apparent.

Environmental Assessment: Stage 1

7.2 During Stage 1 desk study, areas of known or potential otter habitat should be noted. The severance and/or destruction of links between important areas of habitat should be avoided.

Environmental Assessment: Stage 2

7.3 At this stage the study should identify all areas of known otter habitat within the study range, together with areas into which populations are likely to spread during the design life of the scheme and which may be affected by the routes or alternatives under consideration. In some cases it may be appropriate to carry out a walk over survey to supplement available information as part of surveys for nature conservation.

7.4 During this stage, the possible distribution trends of otters in the areas affected and how any proposed schemes might affect these populations should be ascertained. Information about otter populations and habitat within the study area can be obtained from the relevant statutory body, the Wildlife Trusts and the Environment Agency. A list is provided in Annexes B and C. Otter surveys for England, Wales and Scotland

are also readily available from the Vincent Wildlife Trust. Records of previous road casualties in the area may also be available from the EA or Trusts. Where a lack of up to date information is important to the choice of route it will be necessary to conduct a survey.

7.5 Possible indirect effects on habitat and the potential effects of construction on specific areas of habitat should be assessed for each route or alternative.

7.6 Apart from direct mortality, the most important potential impacts involve the severance of territories and migration routes, along with the degrading and destruction of habitat and places of shelter. Surveys should therefore focus on these issues, highlighting in particular areas where the road will cross or pass close to a water body, so identifying areas where otters and the road are most likely to come into conflict.

Environmental Assessment: Stage 3

7.7 Where necessary, the assessment for the preferred option and the information provided by the Environmental Statement, where this is required, should be based on detailed survey work which will enable the extent and significance of any potential effects on populations and habitat to be identified. Opportunities to provide beneficial effects such as habitat enhancement should be included. The proposals for mitigation based on the assessment should be developed in sufficient detail to be confident that they can be effectively installed and maintained. Where otters are known or are likely to be present the survey should establish the extent of their presence. The survey should be conducted with the view that otters could colonise the area during the life of the road and should establish the nature and extent of potential otter habitat affected by the road. Potential adverse effects and opportunities for their avoidance or mitigation through variations in alignment or detailed design should be assessed.

7.8 Whilst potential effects should be identified, care should be taken concerning the confidentiality of information about the location of a protected species. Specialist otter reports containing site specific information, and in particular information about the location of holts, should not be made publicly available.

7.9 The surveyor commences by identifying which rivers and streams might potentially be affected by the proposal, if they have not already been identified in the Stage 1 ecological assessment. **Any water course that can be identified, should be surveyed; otters are not restricted to main rivers.** If the project is to upgrade and improve an existing road, the surveyor should identify any areas where otter casualties may have already occurred on the existing road. The water courses should then be surveyed for 2 km either side of the proposed route, both banks being surveyed if necessary. Spot checks should also be conducted on bridges within 5 km either side of the proposed route. The area surveyed is mapped along with the positions and densities of spraint, holts, couches, and other field signs. The full length should be surveyed, even if evidence is found in the first few metres, to obtain an idea of density and frequency of use. Note: the absence of spraint or other signs does not necessarily preclude otters from the area.

7.10 The survey can then be widened to include other water bodies in the area, eg lakes, reservoirs, ponds or the coastline if appropriate. Again the surveyor must identify a starting point and walk a minimum of 300 m in both directions. In coastal areas, this should be extended to 2 km either side of the starting point. A suitable starting point would be where flowing water enters or leaves the area. If surveying lakes or other large water bodies, the surveyor may want to consider surveying the entire shore, if time allows.

7.11 It is important to identify potential otter populations and habitat when different routes are still being considered. When the preferred route is finally selected then detailed surveys should be conducted and repeated on a regular basis before and during construction. If the project is delayed then the area will need to be re-surveyed as in 7.12. On smaller design projects such as improvement works the survey should be started at the outset of the design process.

7.12 **The timing of any surveys to establish the presence or absence of otters is crucial to the accurate identification of a new or expanding otter population.** The survey should be conducted at 3 month intervals over a period of one year to account for seasonal variations within otter activity. Otters may use different areas at different times of year and this must be taken into account. If the survey is conducted

in the early stages of the project, it may be out of date when construction is due to commence. It is especially important to re-survey the area immediately prior to construction to update the original surveys and adjust the proposed mitigation if necessary. If a project is temporarily shelved, then the area should be re-surveyed as soon as the project recommences to make allowances for any change in conditions. Surveys should be postponed after periods of heavy rainfall and/or flooding to allow time for signs to re-appear.

7.13 Minor works that do not require an environmental assessment will still need to include mitigation to reduce their effects. This is particularly true for the construction of new bridges on an existing road (Chapter 9). A survey will also be needed when improvements or maintenance work on existing roads involves crossings of water courses in otter territory and where mitigation for existing effects might be provided. Records of otter casualties will help to pinpoint those areas where mitigation can provide the greatest benefits.

8. POSSIBLE EFFECTS ON OTTERS

8.1 The effects of roads and road construction on otters includes direct mortality where otters attempt to cross both new and existing roads and no safe passage is available; the severance of home range and dispersion routes, the destruction and degradation of habitat, the loss of holts, couches and food resources, disturbance to otters in the vicinity of construction works, and the indirect effects of construction and of the use of roads on water quality.

Severance

8.2 Where the line of a new or improved road crosses some part of an otter home range, it is inevitable that otters will attempt to cross the road. This is of particular importance on coastal roads where otters will need to make frequent trips inland to find fresh water, or in areas where the road separates different types of habitats which provide different resources for the otter, such as food and shelter. In these circumstances, it is essential that otters are discouraged from crossing the road at

uncontrolled points and are steered towards safe crossing points as described in Chapter 10.

8.3 Fencing creates a barrier to otters and other forms of wildlife. It should not be used in isolation, but should be incorporated as part of an overall scheme to prevent otters from gaining access to the road while diverting them to an alternative route. The otter will try to find an alternative route if one is not supplied and so may try crossing the road after the fence has stopped, or may increase its efforts to climb or dig, or may be forced to cross a different road elsewhere. Separation from part of its home range could compromise the animal's survival by depriving it of valuable resources and so alternatives as described in Chapter 9 should be used.

8.4 Deliberate severance of an otter's home range may also place it in increased competition with other individuals, so increasing stress on the population as a whole. It may also prevent migration of individuals to new areas, again increasing competition in stable populations and decreasing genetic variety. Otters are aggressive animals and are quite capable of inflicting fatal injuries on each other during disputes. Increased competition, therefore, could be damaging to the population, removing animals that might have successfully colonised new catchment areas.

8.5 New roads and improvements to, or increasing traffic on, existing roads can cause the fragmentation of suitable habitats which can reduce the breeding potential by separating different populations and reducing the chances of successful dispersion to new areas.

Habitat destruction

8.6 The construction of new roads usually requires the crossing of the various rivers and streams that lie along the proposed route as well as their possible realignment. The development process may result in the destruction of riverbank or floodplain habitat, which in turn reduces the amount of cover available to otters. Bridge and culvert design which canalise water creating faster flows reduce the opportunities for the otter to swim.

8.7 It is important to recognise the river as an important habitat, a wildlife corridor that provides shelter for some species and a migration route for many others, including otters. The use of viaducts allows contiguous habitat and does not reduce resource availability. Cost Benefit Analysis could be useful in assessing the environmental benefits as opposed to the costs of viaducts rather than embankments with mitigation installed. An unbroken strip of habitat that passes under the road can provide passage for otters and other animals; in other cases it may be possible to design an agricultural underpass which can provide suitable cover and passage which are attractive to otters. The ideal is therefore to design river crossings that allow a wide margin on both banks which can allow for high water flows so that a safe route under the road is always available.

8.8 Good riparian habitat may also include holts and couches where otters may rest and where a female otter may raise her young (as described in Chapter 5). It must be remembered that as otters have no fixed breeding season a holt or couch could be occupied by young at any time. The otter is a secretive mammal and so the provision of holts and couches is essential. Each animal will be familiar with its home range, knowing each site where shelter is available. The loss of such sites will place more stress on the animal requiring it to move further in order to find suitable cover. This in turn may place it in conflict with other otters or put it at risk to other hazards.

8.9 Any work which may destroy or affect an otter holt should be discussed with the relevant statutory body. Where a holt or suitable habitat for couches may be affected, expert advice should be sought in the context of the surrounding habitat, the availability of other sites and the possible construction of an artificial holt.

8.10 The loss of habitat may also restrict the otters' movements, because they will not favour crossing open territory. This may force animals to pass through new areas away from the new road, possibly crossing roads where no mitigation is present, so that they may remain under cover.

8.11 In coastal areas the habitat will include small streams or fresh water pools which may be frequented by otters for bathing. Otters foraging in the sea require

fresh water resources to remove excess salt from their fur. Deprived of these, the otter will become stressed and succumb to pneumonia. It is therefore important that these, or access to them, is not removed. Coastal areas can also include holts and other suitable features for shelter, such as scrub, cavities amongst rocks and even man made structures such as old buildings or abandoned boats.

8.12 The effects on habitat can be summarised as those which are permanent or temporary. There are permanent effects such as the destruction and segregation of habitat, severing the otters' territory and removing valuable resources, such as shelter and food. There are the temporary effects created by the disturbance to the river bed which may also cause problems affecting fish productivity, so damaging the otters' main supply of food as well as interfering with drainage and causing possible contamination of water supplies. This is particularly important in marginal areas as a poor food supply will reduce the potential for otters to survive in the area. A variety of other food sources such as amphibians and small mammals may also be affected as a result of the destruction of wetland and riparian habitat. This will restrict the otters' ability to forage and may lead to territorial disputes in areas of high population density. The Environment Agency can provide advice on the potential impacts of a scheme on riparian and flood plain habitats and on their mitigation.

Pollution

8.13 Pollution of the water course can cause long term damage to the productivity and diversity of a habitat, adversely affecting otters and their food supply. Being a large carnivore, they are vulnerable to changes in food availability at all levels in the food chain and suffer the most through the bio-accumulation of contaminants and the loss of prey. Certain compounds, such as heavy metals or pesticides, that enter the water course may affect otters directly, through lethal levels of toxicity and sub-lethal effects on reproduction and fitness, as well as indirectly, through degradation and contamination of the food chain. Pollutants such as oil or petrol will reduce the waterproofing properties of the otter's fur which will affect its ability to control its body temperature whilst swimming.

8.14 Pollution from roads is limited, but should be managed. DMRB 11.3.10 details the aspects in assessing pollution risks and the designs for drainage systems are detailed in Advice Note: HD 33/96 Surface and Sub-surface Drainage Systems for Highways.

8.15 Rubble and other building waste and rubbish should also be prevented from entering the water course, or damaging potential habitat during the construction period.

Disturbance

8.16 The disturbance caused by increases in people and traffic at the site during construction and maintenance operations will also affect the otters' behaviour. Personnel and equipment should be excluded from areas where otters may reside and provision should be made to allow otters to pass by the site safely. Being inquisitive animals, they may investigate the work site, or conversely, they may be alarmed and be diverted from their normal paths on to a more dangerous route to avoid the construction site. As a result there are many possible hazards that could be fatal to animals such as being hit by works vehicles or by being caught in machinery.

8.17 Consideration should also be given to the location of laybys and other parking areas so that they are not located near holts or other areas of shelter. The close proximity of people could disturb the animals and litter could create a hazard.

9. EXISTING ROADS

9.1 The 180 otters killed in South West England between 1986 and 1996 were all killed on existing roads where no mitigation was present. As a result some sites have had mitigation installed. In one example an underpass was installed in 1987 at a site where a number of deaths had been reported. Since its installation no more otter casualties have been recorded at this site.

9.2 Due to the impacts on existing and possible future otter populations caused by otter deaths on existing roads, where the upgrading or improvement of existing roads

is planned or where major maintenance work is to be carried out, in areas of known otter habitat or in areas where otter populations can be expected to spread during the life of the improvements, the provision for mitigation should be considered. A protocol is described below setting out the extent of assessment that may be required. The same principles outlined in Chapter 10 should be used.

- Wherever water courses of any size are involved in proposed improvements or maintenance works on existing roads, the possibility of their being used by otters or of their being potential otter habitat should be investigated;
- It will be necessary first to establish if otter habitat exists or if the otters are likely to spread into the area during the life of the scheme and if this is the case whether the scheme will allow safe passage for otters moving around that habitat and using water courses;
- If otters already use the area then it should be surveyed in detail and records checked for previous casualties;
- The results of the assessment, the mitigation proposals and an assessment of any potential residual effects should be included in the environmental assessment for the scheme;
- Post construction monitoring of mitigation works should be carried out in all areas where otters already exist.

9.3 In areas where otters are known to have been killed, then it is important that remedial work should be undertaken at the first opportunity. Again, the techniques described in Chapter 10 should be followed. Bolt-on ledges can be added to the bridge or culvert where the water levels allow. Where this is not possible an underpass located above water level can be installed without requiring modifications to the river crossing. In all cases fencing should be used to guide the otter to the safe passage.

9.4 Some operations on existing roads may be small and so will not require a full environmental assessment. However these projects can still have detrimental effects and so mitigation may be required. The area should be surveyed for any evidence of otters. This survey should include 2 km either side of the road in question and spot checks on bridges within 5 km of the site. If evidence is found then action will be

required to ensure that the otters' route is not blocked and that there are no hazards for them to deal with. It is also important to check for existing otter road casualties in this area. The local Wildlife Trust and Environment Agency office or the Vincent Wildlife Trust should be able to provide information on otter habitats and casualties.

9.5 Any maintenance operation on an existing road may create a disturbance to habitats where otters are present and maintenance works must be designed and timed to ensure that habitat disturbance is kept to a minimum and that otters can access existing crossing points. Otters may try to investigate the site or they may be deterred from using their usual routes because of the construction or maintenance work. It may be necessary to consider the use of mitigation to ameliorate these effects especially where the work is expected to last longer than two weeks. These operations include any construction or maintenance operation affecting a crossing of a water course. The effects of construction are detailed in chapter 11.

10. MITIGATION MEASURES

Environmental Assessment

10.1 Mitigation to reduce the impacts of roads on otters starts with a thorough and rigorous Environmental Impact Survey. DMRB Volume 11 Section 3, Chapter 7 describes the ecological assessment in detail. **It is essential that an expert in otter ecology and surveys be employed to confirm the presence or absence of otters in an area of likely otter habitat that may be affected by a new road scheme and to advise on and design mitigation at each site.**

Mitigation during planning

10.2 Care must be taken that space is always retained between the road and river where they run parallel through a valley and that wherever possible, 50 metres is a suitable width to allow. Different areas of potential habitat should not be bisected without allowing safe passage for otters. Where possible, the road should be kept on one side of the river, reducing the number of crossing points.

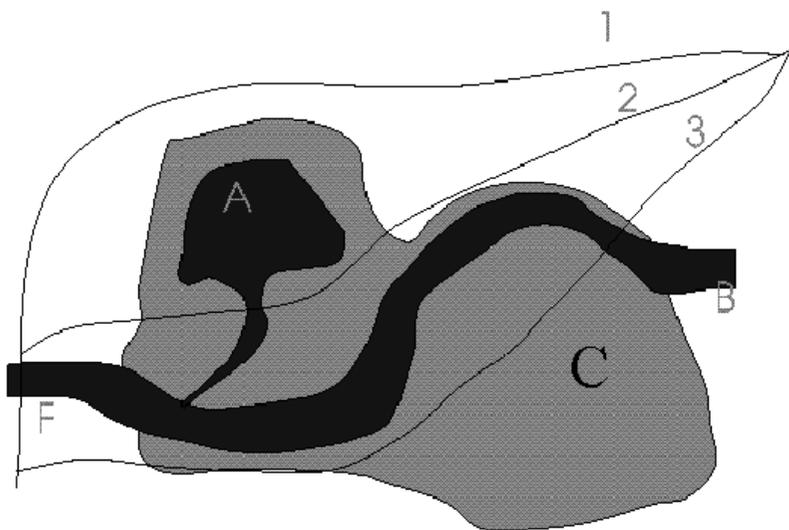
10.3 River realignment should be avoided where this will reduce the available habitat. If realignment is unavoidable hardened margins should be kept to a minimum and a dry passage for otters should be provided as described in paragraph 10.10; as many natural habitat features as possible should be retained, eg mature vegetation; existing habitat which is lost should be restored and suitable new habitat should be created along the banks, adjacent to the new channel. Wherever possible sections of the redundant channel should be retained in a natural state and managed for otters with safe passage provided between these areas and the new channel. The New Rivers and Wildlife Handbook (RSPB *et al*, 1994) gives a list of considerations for such work as well as more information on channel improvements and habitat restoration.

10.4 River crossings should be treated with care so the river corridor is not compromised. Viaducts should be used wherever possible to avoid fragmentation of the valley habitat especially where there are a number of related water courses and wetlands to be crossed. Where viaducts cannot be used the road should be designed to provide as little obstruction and disturbance as possible to the river corridor by using bridges with sufficiently wide span to allow animals dry passage in preference to culverts and by avoiding running parallel with, or close to, the river.

10.5 The identification of holts or couches, or other potential shelters, at the earliest stages of the design process can prevent their destruction by selecting a route that avoids these areas. Holts and couches are difficult to identify, as otters tend to make use of existing features and so a cautionary approach should be used by the surveyor particularly in areas where there is a scarcity of suitable sites. The destruction of holts should always be considered as a last resort, as such sites may be rare in that locality.

It is essential therefore, that the location of such sites is determined before final route is chosen, in order that alternative alignments can be considered. If destruction is unavoidable, confirmation must be obtained from the otter consultant that the holt is not occupied before any work is carried out in the area. In all cases where the holt shows signs of current use, the methodology for evacuation and mitigation must be agreed with English Nature or the equivalent statutory body.

Figure 1.



This outlines three possible routes for a new road. This is prime otter habitat, with a wooded lake (A), river (B) and wet woodland (C). Of the three routes, 1 is the preferred option, as it avoids all these habitats, with the exception of a well designed bridge crossing at F. Route 2 should be rejected, as it requires the destruction and severance of a large section of woodland, removes holt sites and other possible areas of shelter. Otters may cross the road at any point between the river and lake and so several underpasses would be required along with a few kilometres of fencing. Route 3 should also be rejected as it also requires the destruction of a large area of habitat.

Crossing water courses

10.6 The otter has rather particular requirements for survival in its habitat, and specialised solutions are required in mitigating against the impact of a proposed or existing road. Although other species can benefit from mitigation designed for otters, mitigation designed for other species may not be adequate. The otter's use of the landscape and preferred routes for travel can vary a great deal from other mammals. Thus the exact specifications of design should only be amended after consultation with the otter expert.

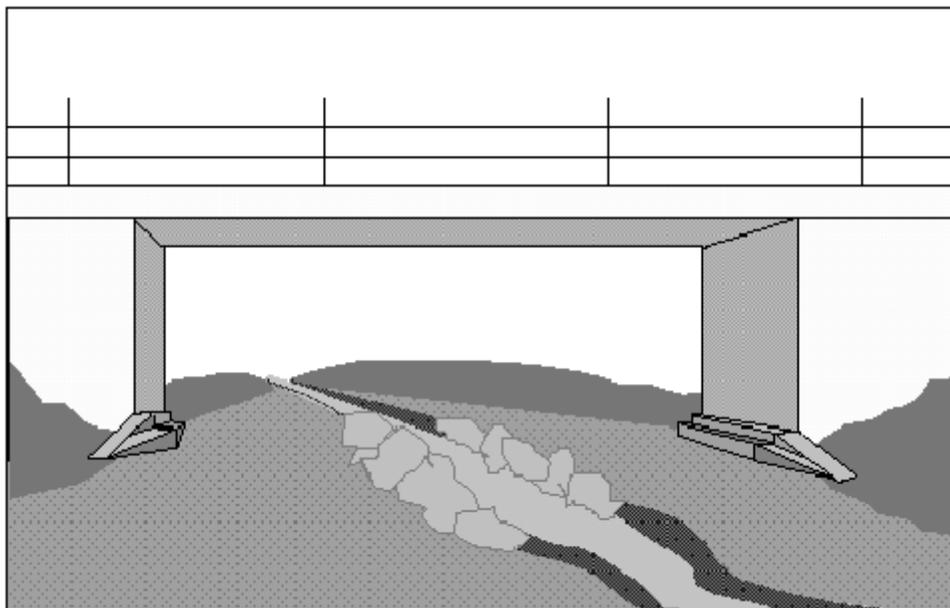
10.7 Three options for allowing safe passage for otters are described. **The construction of a viaduct or bridge is the preferred option in all cases.**

Bridge and Viaduct design

10.8 Where a road crosses a river valley the use of a viaduct will provide the least disruption to the habitat and a safe environment for otters will be retained. These viaducts need not be tall, but the principle of using stilts to carry the road rather than an embankment allowing the habitat below to remain relatively intact. This design has many advantages:

- The area below the road can be used for the construction of artificial holts and other habitat improvements.
- Reduces the need for river diversion.
- It will remove the necessity for many small crossings on smaller water courses and other linear features such as railways.
- Viaducts allow free passage of all species through the habitat and reduce the need for fencing to guide animals to safe crossing points.

Figure 2.



This shows a wide span bridge with space between the river banks and abutments allowing continuation of the river corridor. Ledges are also provided.

Figure 3.



This picture shows the use of embankments and a wide span bridge crossing the River Wolf on the A30, near Okehampton, Devon.

10.9 Bridge design should allow space between the abutments of the bridge and the river bank to enable otters to pass at times of high water flow. The abutments should be set back far enough to allow the natural riverbank and riverbed to be retained. The bank should be softened using bio-engineering techniques such as log piling, willow hurdles or hazel faggots wherever possible. If hard protection is necessary, this could be softened with gabions and boulders in preference to concrete and softer treatments above the waterline, for easy access in and out of the river. These materials will also provide sprainting sites for otters, so encouraging the animals to

use the safe passage provided. The base of the embankments should then be fenced to guide the otters to this passage.

Sluice gates and weirs

10.10 The use of sluice gates, weirs and other possible obstructions under bridges, or near roads increases the risk to otters unless an alternative route can be provided. These can consist of ledges and/or steps as described below, allowing the otter to pass round the obstruction and which can easily be accommodated in designs for fish passes, or an underpass located nearby.

Figure 4.



Steps as shown in this picture can be used to allow otters to pass obstructions such as weirs or sluice gates. (Environment Agency).

Figure 5.



Ideal mitigation. The M5 crossing Exminster Marshes, near Exeter, Devon.

Figure 6.



M6 Cumbria. Each crossing point has retained both the river bed and its margins unaltered. The viaducts provide sufficient clearance to retain something of the original vegetation and micro-climate and avoid interference with the channels.

Culverts

10.11 The use of cylindrical culverts in road construction is well established as the quickest and most cost efficient way of spanning most water courses. Cylindrical culverts represent a danger to otters because their design causes problems in times of flood. They are installed on smaller water courses which can flood rapidly in heavy rain. **It is important to note that otters will use any water course, no matter how**

small, especially when dispersing to new areas. Cylindrical culverts fill rapidly so reducing the air space available at the top of the pipe and making swimming more difficult. The channelling of water through the pipe increases its speed dramatically and some animals, especially young, could be drowned. Some designs also allow for water to collect on the upstream side of the road, so increasing the water flow. This also creates difficulties for otters. If the watercourse is flooded, then otters are more likely to avoid swimming due to the increased risk and so will cross the road when they encounter a river crossing. One of the main causes for otter road casualties is the need to cross the road because the culvert design does not allow an otter to pass through it. The design of any culvert should allow for plenty of air space above the water during times of flood or if this is not possible an alternative route should be provided. **It is vital that any bridge or culvert has provision for otters to walk under the road during spate levels.**

10.12 However culverts have many damaging affects, not just on otters, but on the riparian ecosystem as a whole. They can cause long term damage to the site by removing the river bed and cause irreparable damage to bankside habitat. The loss of habitat is detrimental, removing areas of cover for otters and other animals many of which may also feed on bankside vegetation, such as the water vole. The damage to the river bed results in disturbed water flows, increased silting and possible reductions in fish populations due to damage to spawning grounds. This can be avoided by using box culverts which would be larger than required for purely engineering reasons. The base of the culvert should be at least 150 mm below the height of the river bed, to allow the bed to reform. Planting on the banks by the culvert will help to re-establish cover.

10.13 **It is not in the interests of the conservation of riparian habitats and species or good practice to install cylindrical culverts if other possibilities exist.** The use of box culverts, or cylindrical culverts that are larger than normal, can be considered if a bridge is not a practicable option. Any culvert should be large enough to allow the incorporation of a dry passage that is accessible during floods. if this is not possible then an underpass should be installed above flood levels nearby.

Figure 7.



A 40 Haverfordwest, Wales. A typical cylindrical culvert. An underpass was installed nearby after the death of an otter on this stretch of road (figure 13).

Figure 8.

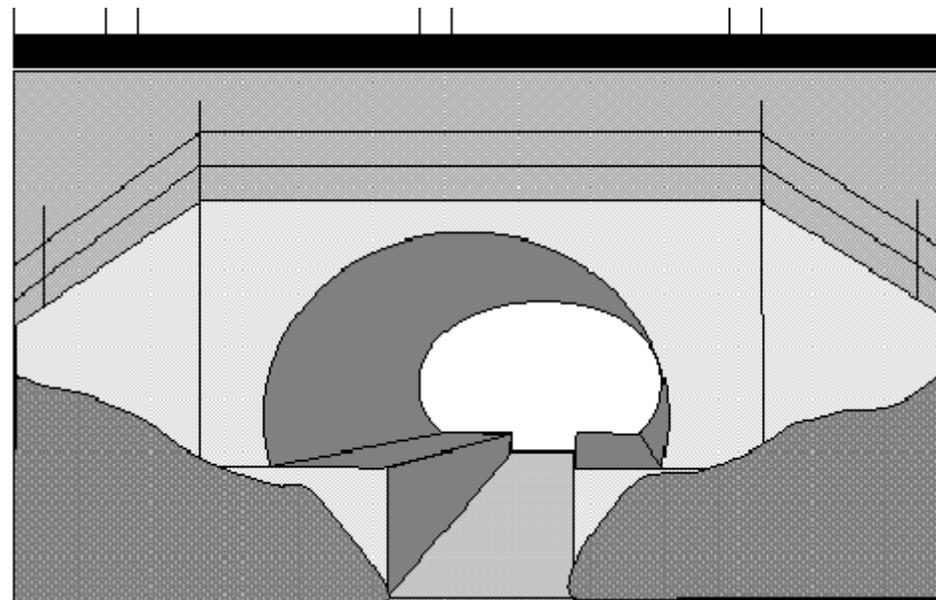


Another culvert, this time near Alresford, Hampshire, and the probable cause of death of two animals. An underpass has since been installed (figure 14).

Ledges

10.14 Where it is not possible to allow a gap between the bridge abutments and the edge of the river then ledges should be incorporated in the design. These ledges can be used in bridges and culverts and can be built of solid concrete, or with a bolt on design using metal brackets and wooden planks or mezzanine flooring sections. All ledges should be at least 500 mm wide and must be accessible from the bank by ramps. There must also be provision for the otter to gain access to the ledge from the water, either via the bank, or by use of a ramp sloping down to below the water level. The ledge should be sited at least 150 mm above the highest water level and allow for 600 mm headroom. This will allow otters to pass through at all times and will also be a landmark, encouraging individual animals to spraint and will encourage other otters to use this route. If an obstacle, such as a weir, is located under the bridge, then steps should be provided to allow the otter to climb over the obstruction or onto the ledge. As otters tend to use the bank for travelling, the ledge should be installed on the preferred bank as identified by the surveys. If such a preference does not exist, then otters should be guided to the crossing by planting dense scrub on the opposite bank to the ledge.

Figure 9.



An oversized cylindrical culvert with ledges to provide safe access for otters.

This figure is indicative only. The advice and approval of the appropriate Structures Group in Highways Agency, Quality Services Division or other overseeing department should be sought for the design and installation of culverts and ledges.

Figure 10



Bishopstoke, Hampshire. A ledge constructed of galvanised steel has been bolted on to this structure. (Environment Agency).

Figure 11.



Hole Bridge, Bovey Tracey, Devon. A ledge was incorporated into the bridge design during construction.

Underpasses

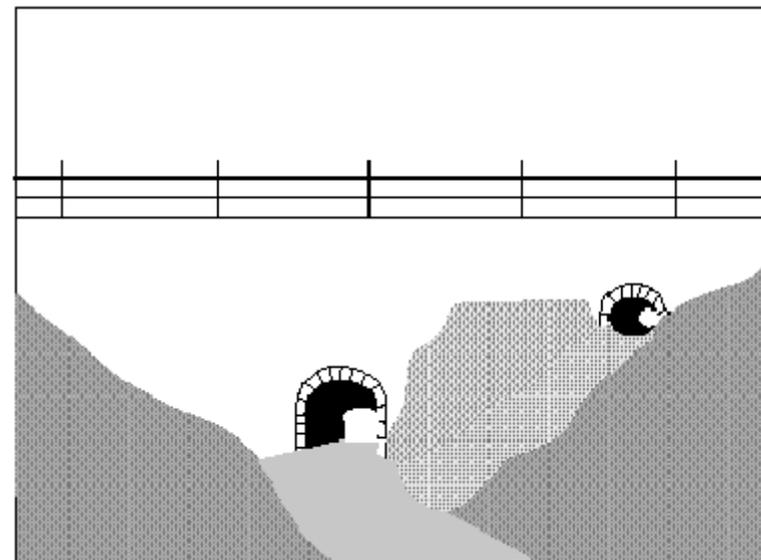
10.15 In some circumstances there may not be room available to install a bridge with enough room for a ledge of the correct dimensions. In this instance, an underpass should be constructed alongside, parallel to the river. The underpass should be located within 50 metres of the riverbank and above possible flood levels. The entrance also needs to be located near the road so the otter associates the underpass

with crossing the road. Otters can be guided to the passage by means of a channel running from the riverbank to the entrance of the underpass. Fencing can also be used for this purpose although it will be more intrusive. Fencing should be installed along the road. The use of rocks and other features will also encourage otters to spraint which can be used to judge the effectiveness of the mitigation.

10.16 Underpasses should be installed in areas where the road passes between different types of habitat resource, such as a lake or reservoir and a water course, or between the sea and other potential otter habitats, or where areas of habitat will be bisected. This will allow otters to fully utilise the resources within their home range so that they will not be disadvantaged. Again they will need to be guided to the crossing by means of fencing and/or channels.

10.17 The underpass should be constructed to a similar design of an underpass for badgers, using a 600 mm cylindrical pipe to a length of 20 m. In crossings over 20 m in length, the width of the pipe should increase to 900 mm, so that the otters will not be deterred from entering. It is important that the underpass does not become water-logged. The pipes should be laid to falls and the joints between pipes should be sealed to prevent water seepage. The entrance to the crossing can be softened by the use of appropriate planting. Underpasses should be kept as short as possible but do not need to be straight although this is preferable.

Figure 12.



Culvert with underpass installed with a path leading from the stream to the entrance.

Figure 13.



A 40, Haverfordwest, Wales. this underpass was installed near the culvert in figure 7 with a dry ditch cut to lead animals from the stream.

Figure 14.



Alresford, Hampshire. Underpass installed near the culvert shown in figure 8. (Environment Agency).

Fencing

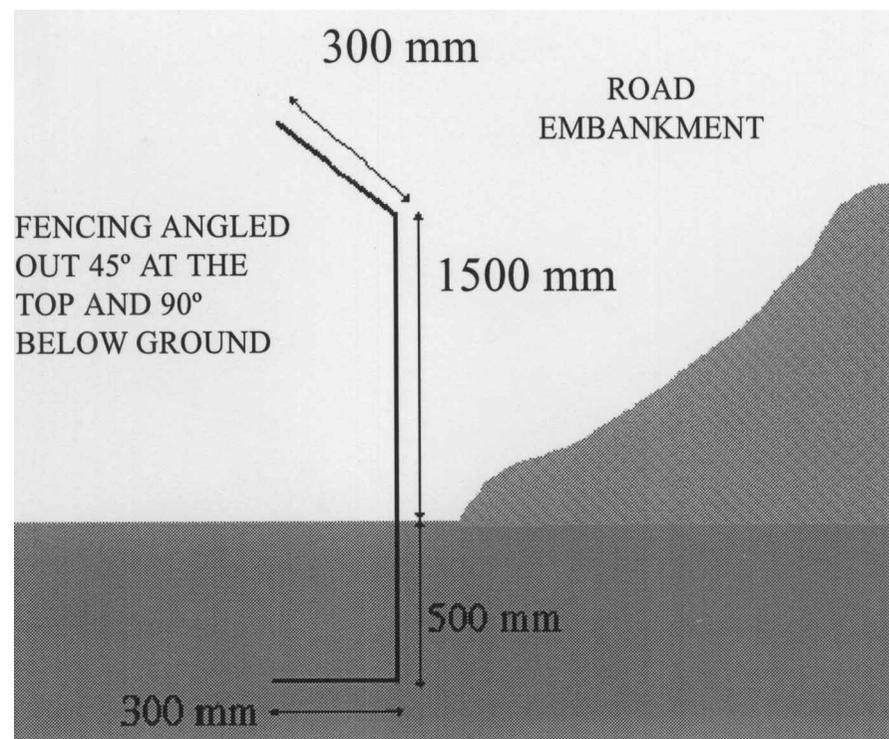
10.18 Fencing is an important part of any scheme, but will not be successful if applied in isolation. It should be used to guide animals to safe crossing points and prevent them from gaining access to the road. Fencing without the use of safe crossing points will not be effective in reducing casualties. A variety of different types of fencing has been used in the past, but many, such as dry stone walls or chain link can be easily scaled or damaged. Where possible, the installation of badger fencing, as described in the DMRB (Volume 10, Section 1, Part 5, Chapter 9) is the

most effective option using 50 mm mesh. This type of fencing is essential if badgers or rabbits are present in the locality to prevent the fence being undermined. Otters will also try to excavate underneath a fence, although with less determination. The addition of a mesh overhang at the top of 300 mm, angled away from the road. (fig 13) is essential to prevent otters from climbing. Where the fence abuts bridge rails, gate posts or a different type of fence, there should be no gaps greater than 50 mm. The fence must be installed on both sides of the road for at least 100 m from the watercourse or underpass. This fencing can also be combined with deer fencing if an overhang is provided 1 m off the ground and mesh of 50 mm or less is used below this point.

10.19 Gates should also be made otter proof by attaching the correct size mesh to the inside of the gate, and by installing concrete slab underneath. The gate should close to leave a gap of about 10 mm between the slab and the bottom rail and sprung so they close automatically. Otter proof stiles should be provided for footpaths crossing through otter fencing where there is public access to river banks or shores and for access to planting plots bounded by otter fencing.

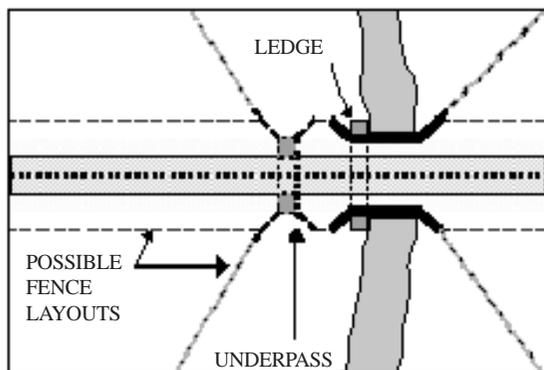
10.20 Guard rails on bridges should also be covered with mesh and where fencing abuts these rails, care should be taken that no gap is left between the two. If the fence crosses a ditch, a grille should be located under the fence to prevent the otter passing through the gap. It is important that no such gaps occur that might allow an otter to gain access to the carriageway and that regular maintenance is carried out to ensure that no blockages to the drainage system occur at such points. Drain outfalls beyond the line of the fence, on the non-road side, should be designed so as to prevent otters entering and becoming trapped.

Figure 15.



A design for otter proof fencing.

Figure 16.



Otter fencing layouts to direct otters towards an underpass or ledge.

10.21 Where possible the duplication of different fences for different purposes should be avoided and that where an otter fence is combined with the boundary fence, the fence should remain the property of the highway authority. Also in such cases, arrangements should be made with the neighbouring landowner to allow for the fence to be set into the ground and for maintenance to be conducted. If another feature marks the boundary, eg a stream, the fence should run parallel with the road and the area between the fence and stream can be used for habitat improvements (see 9.26 to 9.30). In some instances, fencing can be used to funnel the animals to the underpass as illustrated in figure 17. This will require a more significant area of land, but could be more efficient requiring less fencing to be installed.

10.22 Fencing can be visually intrusive and so this needs to be taken into account in the design. It is possible to reduce the height of the fence to a minimum of 0.75m but the overhang should be retained. Care should be taken that changes made to the fence for aesthetic reasons do not negate the efficacy of the design, making the fence redundant. The fence design must be approved by the otter expert so that it will remain effective. In sensitive areas it may be easier to re-align rather than re-design the fence for it to be more in keeping with the landscape.

10.23 Permanent fencing must be complete with no gaps present before the road is opened to traffic.

Temporary fencing

10.24 In some areas fencing may only be required on a temporary basis during construction or maintenance operations, eg while repairs are undertaken on an existing fence, or for bridge repair works. Chestnut paling, with stakes at 25 mm gaps, has proven effective as a temporary measure for otters in areas where badgers or rabbits may not be present to undermine the fence. It is also cheaper and can be installed relatively easily, especially on undulating ground.

Deterrents and warnings

10.25 Reflectors are currently used in many areas for deer and badgers, but unfortunately there is very little evidence to suggest that they reduce casualties in either species. This also applies to otters. Fencing, although more expensive, is a far more effective method of preventing animals from crossing the road. Reflectors require constant maintenance to keep vegetation from obscuring them and they also need frequent replacement as many are stolen or vandalised. Reflectors are not recommended as a suitable mitigation design for otters and should not be relied upon.

10.26 Hazard signs, warning drivers that otters may be in the vicinity could be considered, although their effectiveness is unproved.

Siting of mitigations

10.27 The accurate siting of mitigation measures is essential. Ledges and underpasses should be placed in line with the natural paths of the otter along the river bank. To avoid having an underpass on both banks, planting on the opposite side of the river may encourage the otter to travel along the correct bank. It is important for the otter to associate the underpass with a road crossing and so the entrance should not be located at a distance from the road. Fencing should be used to guide the otter to the tunnel entrance and should be continued in both directions **on both sides of the road**. This is essential, or animals may cross the road and find themselves trapped, forcing them back on to the carriageway. The length of the

fencing is difficult to define as it will be dependant on the topography of the site and the number of water courses, although most casualties occur within 100 m of the water course. Fencing should also be used where the road bisects or passes between areas of otter habitat if an alternative route can be provided.

Figure 17.



River Itchen, Hampshire. For this underpass, a wet channel has been cut to guide otters from the main river.

Figure 18.



An underpass for badgers using fencing to guide animals to the entrance. This is located within 20 m of a culvert on a minor stream in Kent and would be a suitable crossing point for otters as well.

Protection and restoration of habitat

10.28 Where habitat destruction cannot be avoided, then habitat restoration should be undertaken as part of the scheme. The enhancement of existing habitat can also assist in mitigating the effects of the road. Opportunities for additional habitat enhancement may occur on severed land or where land has to be acquired but is not needed for construction purposes and in flood storage compensation areas.

Restoration work should be designed to return disturbed habitat to at least its former quality and where possible improve it. This applies particularly to rivers and wetlands, the degradation of which will adversely effect a wide variety of wildlife. Where a section of river has been re-aligned, it should be returned to as near a natural state as possible. If bank reinforcement is required, hard vertical surfaces should be avoided as far as possible, while the use of gabions should be limited to small stretches of river. Alternatives for bank revetment include the use of log piling, woven hurdles, or faggoting. Trees such as willows, ash and oak should be planted on the river banks to provide shelter in the future. Emergent vegetation and dense scrub such as bramble should be encouraged to provide cover for otters. This may require livestock to be excluded from the river bank by fencing except at discrete points where access to drinking water is required. Emergent vegetation is also important and so reeds and rushes should be encouraged. The restored vegetation should have a species composition that is comparable with the local riparian flora.

10.29 If the disturbed river banks include bends or meanders, opportunities exist for fencing off the inside of the bend and planting up this area with trees and scrub. Fencing and underpasses should be provided so otters can utilise this area without being at risk from traffic. The aim should be to repair damage to the habitat and encourage animals to pass the potentially dangerous area of the road in safety.

10.30 The restoration of scrub and reedbed habitats is desirable for the siting of holts and couches. If old trees need to be removed the root systems could be retained as possible holts. Any other wood can be stacked by the river then used for log pile holts or bank revetments. Boulders and stone filled gabions, although not always ideal, can produce cavities which will also provide shelter.

Artificial holts

10.31 The building of artificial holts is sometimes suggested in areas of poor vegetation cover, particularly if the vegetation has been removed or damaged as a result of road construction. However, unless the safety of otters can be assured, it is unwise to place an artificial holt in the vicinity of a road scheme. If land is acquired that is away from the road, or if the road is to be fenced, then artificial holts could be used. A consultant with experience in otter conservation will have designs of holts

which can be adapted to suit conditions. Artificial holts normally consist of one or two chambered structures built from breeze blocks or log piles with at least two entrances. One entrance should lead into the river, sloping down to reduce the chances of flooding. Another entrance should provide an exit onto the river bank. Both entrances need to be well concealed.

10.32 The local Wildlife Trusts are usually experienced in, and may welcome involvement in, habitat restoration schemes. Further information on habitat enhancement and restoration is available in the NRA booklet "Otters and River Habitat Management"(NRA, 1993), currently being updated by the Environment Agency and in the New Rivers and Wildlife Handbook (RSPB *et al*, 1994).

Drainage systems

10.33 Drainage systems used to divert water from the road should be designed so as to prevent otters entering and becoming trapped.

Maintenance of mitigation measures

10.34 Fencing is prone to damage, either by vandalism, corrosion, traffic accidents or animals. Any breach in the fence negates the effectiveness of all other measures, therefore fences must be maintained intact. The fence should be checked every 6 months to ensure no breaches have occurred. Roadside fences should also be checked after any reported accidents on the stretch of road concerned. Grilles that are used to prevent access to drainage systems should also be checked regularly and cleared of debris.

10.35 If reflectors are used, they will need to be kept free of vegetation and cleaned every 3 months, or more frequently in the summer.

10.36 Underpasses and ledges should be checked every 6 months for obstructions or damage.

10.37 Maintenance staff and managers should be made aware of the existence and location of mitigation measures for maintenance and repair schedules.

11. DISRUPTION DURING CONSTRUCTION

11.1 The physical disturbance created by the construction of a new road can seriously affect the activities of an otter if no mitigation measures are enforced. Noise, lights for night working, the use of machinery, the obstruction of holts and paths and the presence of a large number of human beings can all have detrimental effects.

11.2 Site compounds and storage or waste dumping facilities should be located away from potential otter habitat. This will avoid disturbance to the otters' routine and also minimise pollution risks. If there are a number of different contractors and subcontractors on site, it is essential to inform each contractor of mitigation schemes present and any obligations they may have regarding such schemes. All personnel working on site should also be aware of the mitigation in place and of the obligations. Night working should be suspended in areas where otters are thought to be active. Areas of scrub should be retained with as little disturbance as possible during construction and fenced with signs to clearly mark areas that contractors should not enter.

11.3 Otters are inquisitive animals and may be attracted onto the road to investigate new machinery or spoil heaps and so measures must be taken to prevent this. Some existing casualty records are believed to be as a result of this trait. This could increase the risk of an accident, either on the road or on site. Where otters are known to be active, they should be excluded from the area by fencing and an alternative route provided to allow them to pass the site safely. This may include underpasses for site access roads. The fence should be positioned to guide otters to these safe crossing points. Temporary fencing can be used; either a stiff plastic mesh that otters cannot scale, but does not entangle them, or a chestnut paling fence with 25 mm spacing.

11.4 Conversely, some otters may be deterred by such activity, so care must be taken to keep equipment, materials and portacabins from obstructing the otters'

preferred path. Also night working is not encouraged as this is the most likely time for an otter to be at risk. An otter could be diverted and forced to cross the road where no safe crossing point exists, so care must be taken that this does not occur. This may also require the installation of temporary fencing.

11.5 By the time work on site commences, all possible holts should have been identified. The clearance of the site must be preceded by a thorough survey of the area for holts, couches and otters. Upon completion of this survey, the working area should be fenced to prevent animals returning. Site clearance should then proceed with caution. If a holt or couch is located during construction, an exclusion zone of 30 m should be established, and all works therein suspended. Expert advice must be sought to ascertain the status of any holt. If a breeding site is found during construction, all work should cease while advice is sought from English Nature (or equivalent). This may lead to a cessation of work for 10 weeks until the cubs are mobile and able to leave the area. Thorough assessment work is essential before commencement of operations is important to avoid delays.

11.6 The construction of bridges and other crossings may cause obstructions which the otter must pass. Otters diverted from the river may be driven to cross another road outside of the scheme. Where possible one bank of the river or stream being bridged should be retained intact for as long as possible to provide safe access. An alternative route using fencing and underpasses if necessary should be provided if a safe passage along the river bank is not feasible.

11.7 The construction of artificial holts can be used to mitigate against a loss of cover during the construction of the road. However such holts require careful siting so that otters are not encouraged to spend time on or near the construction site. The consultant can advise on the best holt design and its position.

11.8 Maintenance work on existing roads must be conducted with this in mind and mitigation provided. Temporary fencing can be used, providing an alternative route for the otter is made available. Areas of scrub or other resources utilised by otters should remain accessible.

11.9 If the scheme is to improve a road that will remain open to traffic during construction, temporary mitigation measures must be in place before work commences and be retained until permanent mitigation designs are completed.

12. CONTRACT IMPLEMENTATION

12.1 All mitigation methods employed must be installed and checked by a competent person with experience in this type of work. If incorrectly implemented, any weakness could be exploited, invalidating the entire exercise. If specialist contractors are not used, the work should be supervised by a person with experience in this field.

12.2 The implementation of otter mitigation suffers from similar faults to badger mitigation. Fencing may not be buried correctly, gaps can be left between bridge guard rails and mesh, the wrong sized mesh is used and so on. Most of these problems occur due to a breakdown in communication between the contracted expert and the design and construction team. It must be made apparent that any alterations to the design of the mitigation measures recommended by the consultant, should not be implemented without the approval of the consultant. Changes made for aesthetic or economic reasons can negate the effectiveness of all other measures.

12.3 Other works must also be inspected to ensure that they do not interfere with the mitigation measures already installed. It is important that all mitigation measures are completed satisfactorily before the road is open to traffic.

12.4 Two Golden Rules.

AN EXPERT IN OTTER ECOLOGY SHOULD BE EMPLOYED IN THE DESIGN AND CONSTRUCTION OF ALL OTTER MITIGATION MEASURES.

ALL OTTER MITIGATION MEASURES MUST BE IN PLACE AND COMPLETED BEFORE THE ROAD IS OPEN TO TRAFFIC.

13. POST-CONSTRUCTION MONITORING

13.1 Following the completion of each project the measures installed should be monitored by an otter consultant to ensure their effectiveness. In areas where otters are known to be present, spot checks should be conducted on the different bridges, culverts and underpasses, looking for spraint. This survey should be conducted every week for a month after completion and then again after six months and after 1 year. This allows a measure of success to be recorded. If no signs are found, the consultant may need to expand the survey to see if otters are still using the area and to ensure they are not crossing the road elsewhere. The consultant should also look for other evidence, such as holes in fences, or otter casualties. Post construction monitoring provides feedback about the effectiveness of a scheme and the particular mitigation designs which may be used elsewhere.

13.2 Other checks should include an inspection of the mitigation design to see if any defects are apparent. This could include holes, gaps in or under fencing, bolt on ledges coming loose, underpasses obstructed by stones, debris or flooding, gates closing properly, etc... Any defects should be made good immediately.

13.3 Members of the public and maintenance staff should also be made aware of the importance of recording all otter casualties in England and Wales and that they will be collected by the Environment Agency. In Scotland, casualties are collected by the Institute of Terrestrial Ecology. These addresses are given in Annex C.

ANNEX A SUMMARY OF LEGISLATION REGARDING OTTERS

Wildlife and Countryside Act 1981

The otter is currently protected under schedules 5 and 6 of the Wildlife and Countryside Act of 1981 which covers the UK with the exception of Northern Ireland where the otter is protected under the Wildlife (NI) Order 1985.

Being listed under schedules 5 and 6, it is now an offence:

- Intentionally to kill, injure, take or sell an otter or parts of it without a licence.
- To intentionally damage, destroy or obstruct access to their place of shelter or protection, or to disturb the animal whilst occupying such a place of shelter or protection.
- To set in position for the intention of causing bodily injury any trap or snare, any electrical or poisonous substance, or use any of these articles for the purpose of killing or taking the animal, whether or not it is of such a nature or is positioned in such a way with this intention.

It is, however, a defence to show that a trap was set for the purpose of killing or taking a wild animal which is not protected under the Act, and all reasonable precautions were taken to prevent injury to protected species.

The EC Directive 92/43 and Conservation (Natural Habitats &c.) Regulations 1994.

The otter is protected under European Law, being listed in Annexes IIa and IVa of the EC Directive 92/43, Conservation of Natural Habitats and Wild Fauna and Flora (the 'Habitats Directive') which requires the conservation of habitats, fauna and flora of community interest. Designated sites will form a 'coherent European ecological network' called Natura 2000. These sites will consist of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) as listed in the EC Birds

Directive. The importance of improving the coherence of this network is impressed upon the member states who may develop further measures in the wider countryside aimed at conserving key landscape features.

Articles 3,4 and 6 require the designation and conservation of habitats for species listed under Annex IIa.

Article 10 requires the management of linear features which help in the migration and dispersal of species, rivers being one such example.

Article 11 requires the surveillance of species on Annex IIa and IVa.

Article 12 requires strict protection of species on Annex IVa, prohibiting deliberate killing, keeping and transport, and requires monitoring of such killing and capture. It also includes an obligation to take steps to prohibit the deterioration and destruction of breeding sites or resting places.

These Regulations are implemented in England, Scotland and Wales under the Conservation (Natural Habitats) Regulations 1994, Statutory Instrument 2716. For Northern Ireland implementation is under the Statutory Rules (NI) 380, 1995.

Sections 7 *et seq.* & 39 *et seq.* cover the designation of Special Areas of Conservation (SACs) and protection of listed species of animals respectively. Section 39 (1) makes it an offence to deliberately capture, kill or disturb a wild otter, or to damage or destroy an otter's breeding site or resting place.

The Bern Convention

The otter is listed in Appendix II of the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats), to which the UK is a signatory.

Article 2 requires measures taken to maintain populations of wild flora and fauna, while taking account of economic and recreational requirements.

Article 6 seeks to ensure special protection for species listed in Appendix II of the Convention.

Article 8 prevents the indiscriminate means of capture.

These articles are implemented in the UK by the Wildlife and Countryside Act 1981 and Wildlife (Northern Ireland) Order 1985.

Wild Mammals Protection Bill 1996

This law makes it an offence for any person to mutilate, kick, beat, nail or otherwise impale, stab, burn, stone, crush, drown, drag or asphyxiate any wild mammal with intent to inflict unnecessary suffering.

Exceptions are;

- mercy killings to end suffering;
- any animal taken during hunting, shooting coursing or pest control.
- Anything authorised by enactment.

In Northern Ireland similar provisions are served by the Welfare of Animals Act (Northern Ireland) 1972.

ANNEX B HABITATS LISTED IN THE BIODIVERSITY STEERING GROUP REPORT (1995) DIRECTLY AFFECTING OTTERS

Broad Habitats. As numbered in the Biodiversity Steering Group Report.

1. Broadleaved and yew woodland.
12. Grazing marsh.
13. Fens, carr, marsh swamp and reedbeds.
14. Lowland raised bog.
15. Standing open water.
16. Rivers and streams.
17. Canals.
20. Blanket bog.
21. Maritime cliff and slope.
22. Shingle above high tide mark.
23. Boulders and rock above high tide.
24. Coastal, strandline.
25. Machair.
26. Saltmarsh.
27. Sand dune.
28. Estuaries.
29. Saline lagoons.
30. Islands and archipelagos.
31. Inlets and enclosed bays (inc sea lochs, rias and voes).
32. Open coast.
35. Offshore seabed.

Key Habitats. Numbers relate to broad habitats listed above.

- Wet woodlands (1)
- Coastal and floodplain grazing marsh. (12)
- Fens and reedbeds (13)
- Raised bog (14)
- Mesotrophic standing water (15)
- Eutrophic standing water (15)
- Aquifer fed naturally fluctuating water bodies (15)
- Chalk rivers (16)
- Blanket bog (20)
- Maritime cliff and slope (21)
- Coastal vegetated shingle structure (22)
- Machair (25)
- Coastal: saltmarsh (26)
- Coastal sand dune including dune grass, dune heath, dune scrub and strandline vegetation. (27)
- Estuaries (28)
- Saline lagoons (29)
- Ascophyllum nodosum mackii* beds (31)
- Maerl beds (31)
- Sea grass beds (31)
- Maerl beds (32)
- Chalk coasts (littoral and sublittoral) (32)

ANNEX C GOVERNMENT AND STATUTORY ORGANISATIONS

Environment Agency

Each region has its own Conservation Officer, with a team of experienced personnel who can give advice on otters and riparian habitats in general.

Head Office:

Rivers House,
Waterside Drive,
Aztec West,
Almondsbury,
Bristol,
BS12 4UD.

Anglian:

Kingfisher House,
Goldhay Way,
Orton Goldhay,
Peterborough,
PE2 5ZR

Northumbria and Yorkshire:

21 Park Square South,
Leeds,
LS1 2QG.

North West:

Richard Fairclough House,
Knutsford Road,
Warrington,
WA4 1HG.

Severn Trent:

Sapphire East,
550 Streetsbrook Road,
Solihull,
B91 1QT

Southern:

Guildbourne House,
Chatsworth Road,
Worthing,
West Sussex,
BN21 1LD.

South Western:

Manley House,
Kestrel Way,
Exeter,
EX2 7LQ

Thames:

Kings Meadow House,
Kings Meadow Road,
Reading,
RG1 8DQ.

Wales:

Rivers House/Plas-yr-Afon,
St Mellons Business Park,
St Mellons,
Cardiff,
CF3 0LT.

Northern Ireland:

Environment and Heritage Service,
Commonwealth House,
35 Castle Street,
Belfast,
BT1 1SU

Institute of Terrestrial Ecology

Although there are several stations throughout the UK, the following address is the only address for otter casualties.

Hill of Brathens,
Banchory,
Kincardineshire,
Scotland,
AB3 4BY.

The Wildlife Trusts (WT) and Vincent Wildlife Trust

Most counties have their own Trust, but not all have an Otters and Rivers Project Officer. However, the officers listed below should be able to provide advice for counties neighbouring their own. Geoff Liles can be consulted for work throughout Wales and the Greens for any development in Scotland.

Head Office:
UK National Office,
The Green,
Witham Park,
Waterside South,
Lincoln,
LN5 7JA

The WT for Bristol, Bath and Avon,
The Wildlife Centre,
32 Jacob's Wells Road,
Bristol,
BS8 1DR

The WT for Bedfordshire, Cambridgeshire, Northamptonshire and Peterborough,
Enterprise House,
Maris Lane,
Trumpington,
Cambridge,
CB2 2LE.

Buckinghamshire, Berkshire and Oxfordshire Naturalists Trust:
BBONT,
3 Church Cowley Road,
Rose Hill,
Oxford,
OX4 3JR.

Birmingham and Black Country Urban WT,
Unit 310,
Jubilee Trade Centre,
130 Pershore Street,
Birmingham,
B5 6ND.

Brecknock WT,
First Floor Office,
2 The Struet,
Brecon,
Powys,
LD3 7LH.

Cheshire WT,
Grebe House,
Reaseheath,
Nantwich,
Cheshire,
CW5 6DA.

Cleveland WT,
Bellamy Pavillion,
Kirkleatham Old Hall,
Kirkleatham,
Redcar,
Cleveland,
TS 10 5NW.

Cornwall WT,
Five Acres,
Allet,
Truro,
Cornwall,
TR4 9DJ.

Cumbria WT,
Brockhole,
Windermere,
Cumbria,
LA23 1LJ.

Derbyshire WT,
Elvaston Castle,
Derby,
DE27 3EP.

Devon WT,
Shirehampton House,
35-37 St. Davids Hill,
Exeter,
EX4 4DA.

Dorset WT,
Brooklands Farm,
Forstan,
Dorchester,
DT2 7AA.

Durham WT,
Low Barns Nature Reserve,
Witton-le-Wear,
Bishop Auckland,
DL14 0AG.

Dyfed WT,
7 Market Street,
Haverfordwest,
Dyfed,
SA61 1NF.

Essex WT,
Fingringhoe Wick Nature Reserve,
Fingringhoe,
Colchester,
Essex,
CO5 7DN.

Glamorgan WT,
Nature Centre,
Fountain Road,
Tondu,
Mid Glamorgan,
CF32 0EH.

Gloucestershire WT,
Dulverton Building,
Robinswoodhill Country Park,
Reservoir Road,
Gloucester,
GL4 9SX.

Gwent WT,
16 White Swan Court,
Church Street,
Monmouth,
Gwent,
NP5 3BR.

Hampshire and the Isle of Wight WT,
8 Romsey Road,
Eastleigh,
Hampshire,
SO50 9AL

Herefordshire Nature Trust,
Community House,
25 Castle Street,
Hereford,
HR1 2NW

Hertfordshire and Middlesex WT,
Grebe House,
St Michael's Street,
St Albans,
Hertfordshire,
AL3 4SN.

Kent WT,
Tyland Barn,
Sandling,
Maidstone,
Kent,
ME14 3BD.

Lancashire WT,
Cuerden Park Wildlife Centre,
Shady Lane,
Bamber Bridge,
Preston,
Lancashire,
PR5 6AU.

Leicestershire and Rutland Trust for Nature Conservation,
1 West Street,
Leicester,
LE1 6UU.

The Lincolnshire Trust,
Banovallum House,
Manor House Street,
Horncastle,
Lincolnshire,
LN9 5HF.

London WT,
80 York Way,
London,
N1 9AG.

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Montgomeryshire WT,
Collott House,
20 Severn Street,
Welshpool,
Powys,
SY21 7AD.

Norfolk WT,
72 Cathedral Close,
Norwich,
Norfolk,
NR1 4DF.

Northumberland WT,
Carter Side Farm Cottage,
Whitton,
Morpeth,
NE65 7RT.

North Wales WT,
379 High Street,
Bangor,
Gwynedd,
LL57 1YE

Nottinghamshire WT,
310 Sneinton Dale,
Nottingham,
NG3 7DN.

Radnorshire WT,
Warwick House,
High Street,
Llandrindod Wells,
Powys,
LD1 6AG.

Scottish WT,
Cramond House,
Kirk Cramond,
Cramond Glebe Road,
Edinburgh,
EH4 6NS.

Shropshire WT,
167 Frankwell,
Shrewsbury,
Shropshire,
SY3 8LG.

Sheffield WT,
Wood Lane House,
52 Wood Lane,
Sheffield,
S6 5HE.

Somerset WT,
Fyne Court,
Broomfield,
Bridgwater,
Somerset,
TA5 2EQ.

Staffordshire WT,
Courts House,
Sandon,
Staffordshire,
ST18 0DN.

Suffolk WT,
Brooke House,
The Green,
Ashbocking,
Nr Ipswich,
Suffolk,
IP6 9JY.

Surrey WT,
School Lane,
Pirbright,
Woking,
Surrey,
GU24 0JN

Sussex WT,
Woods Mill,
Shoreham Road,
Henfield,
West Sussex,
BN5 9SD.

Ulster WT,
3 New Line,
Crossgar,
County Down,
BT30 9EP.

Warwickshire WT,
Brandon Marsh Nature Centre,
Brandon Lane,
Coventry,
CV3 3GW.

Wiltshire WT,
19 High Street,
Devizes,
Wiltshire,
SN10 1AT.

Worcestershire WT,
Lower Smite Farm,
Smite Hill,
Hindlip,
Worcester,
WR3 8SZ.

Yorkshire WT,
10 Toft Green,
York,
YO1 1JT.

Other otter projects and information may be obtained from:

Vincent Wildlife Trust,
10 Lovat Lane,
London,
EC3R 8DT.

Jim and Rosie Green,
Vincent Wildlife Trust,
Barrjarg,
Barrhill,
Girvan,
Ayrshire,
KA28 0RB.

Tyne Otter Project:
Tim Thom,
c/o Department of Biological Science,
University of Durham,
South Road,
Durham,
DH1 3AL.

Otters in Wales:
Geoff Liles,
Capel Dewi WTW,
Capel Dewi,
Camarthen,
Dyfed,
SA23 8AY.

Wiltshire Wildlife Trust:
Mark Satiney,
19 High Street,
Devizes,
SN10 1AT.

Worcestershire Wildlife Trust,
Andy Graham,
Lower Smite Farm,
Hindlip,
Worcestershire,
WR3 8SZ.

Yorkshire Otters and Rivers Project:
Sylvia Jay,
15 Newport Road,
Headingley,
Leeds,
LS6 3BZ

The Vincent Wildlife Trust,
10 Lovat Lane,
London,
EC3R 8DT
(Otter surveys for England, Scotland and Wales.)

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Further Reading.

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