WATER VOLE
CONSERVATION HANDBOOK
THIRD EDITION

WILDCRU
Wildlife Conservation Research Unit

WATER VOLE CONSERVATION HANDBOOK

THIRD EDITION

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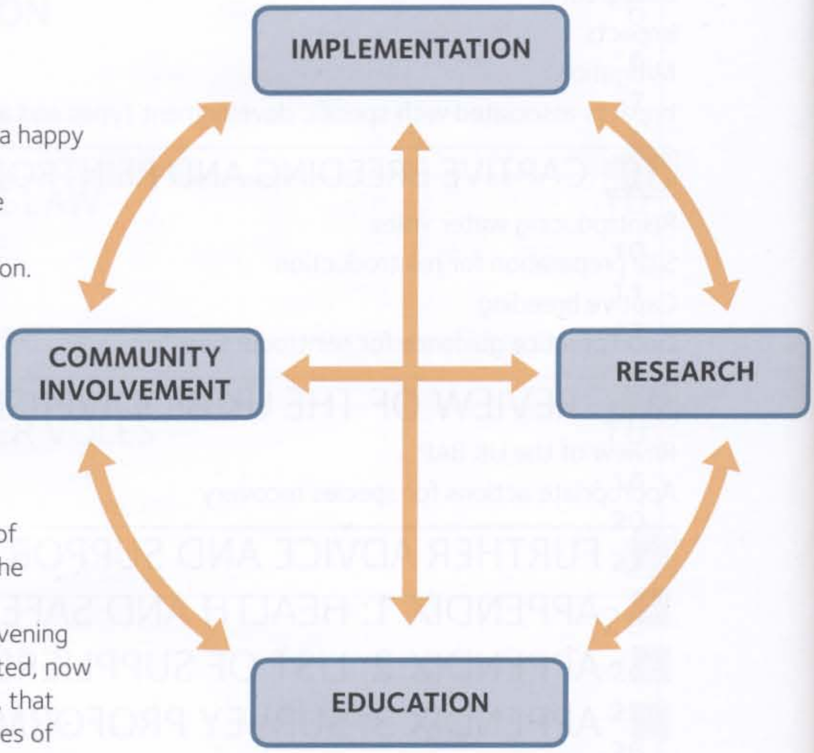
CONTENTS

FOREWORD



The Water Vole Conservation Handbook provides a happy example of real progress in wildlife conservation. Together, the scientists and the practitioners have delivered, and are continuing to do so ever-more effectively from a more and more robust foundation. In the Foreword to the Second Edition - the comprehensive overhaul, published in 2006, of the original Water Vole Conservation Handbook - I reflected on the early research on water voles, and took pride in the WildCRU's contribution to insights from radio-tracking, habitat manipulation, attempts at development mitigation and captive breeding, all of which had been assembled by Rob Strachan into the 1998 original. At that point I was astonished and excited by how far research had come in the intervening decade or so. Once again I am shocked and delighted, now writing in 2011 the Foreword to the Third Edition, that this newest stock-taking reveals yet again advances of far-reaching practical importance.

Much of the information in the Second Edition has withstood the tests of time, despite critical scrutiny by a new generation of researchers and on-the-ground conservation practice; nonetheless, this Third Edition represents a radical up-date and provides the practitioner with a greatly renewed resource. One detail is the change in the Latin binomial of water voles, from the previous *Arvicola terrestris* to *Arvicola amphibius*. This does not represent any novel thinking on the taxonomic relationships or evolutionary provenance of the water vole, but merely a clarification of the naming priority in the original work by Linneaus, in which water voles were first recorded. More than a detail, 2008 saw a change in the law, granting the water vole full protection under the Wildlife and Countryside Act. This milestone – itself a major stimulus for producing this Third Edition - has had wide-ranging implications for conservation practitioners and consultants alike, and the ramifications are fully incorporated in the pages that follow.

The Water Vole Conservation Handbook provides the practical advice - underpinned now by over fifteen years of collaboration between parties as disparate as academic researchers, the Water Vole Steering Group, NGOs, consultancy firms, statutory bodies and government departments, as well as hoards of interested citizens – required to implement the conservation actions which water voles still so acutely need. Conservation plans and actions should be evidence-based, conceptually sound and practically useful; they should also embrace diverse communities of interest and equally diverse skills and disciplines. With this in mind, in the WildCRU we measure our projects against what we call the Conservation Quartet – the four ingredients of an ideal project being a) research to gather the evidence needed to solve the problem, b) education to explain the problem and the solutions to all concerned, c) community involvement to seek the support of all those involved and d) implementation to put the solution into effect. Plans solidly supported on these four pillars provide a foundation for action, and successive iterations of monitoring, evaluation and refinement can doggedly nudge the conservation problem towards a solution. This Third Edition represents one such nudge. The fact that it is a smaller – but still robust – nudge than the hefty shove represented by the Second Edition is encouraging evidence that knowledge of the water vole has progressed to a point where a large majority of the necessary research work has been tackled and the insights delivered. Of course, more remains to be discovered, and important ongoing research projects around Britain are striving to fill the gaps, but the emphasis has shifted towards the practical application of the solid knowledge base represented by the text and numerous diagrams housed within these covers. It might be a cliché to say that this Third Edition provides an armoury of knowledge with which the battle to implement conservation action for the water vole can be fought, but the fact is that this starts to look like a battle than can be won, and this is possible only because of the meticulous evidence base on which these actions are founded.

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Andrew Parkinson

GENERAL INTRODUCTION

1 WATER VOLES AND THE ISSUES THEY RAISE

In the introduction to the first handbook we wrote *"Ideally this handbook should have been written after 10 years of solid practical and scientific research into the detailed habitat requirements, population processes and tried and tested conservation methods for preserving the species".*

In fact it has now been 13 years since the publication of the first handbook and five years since the second edition. The combined research and conservation activities over these 13 years has given us given us a great deal of insight into the water vole's ecology and conservation needs, and the steps needed for an effective species recovery plan. At the heart of such a plan is a reversal of those factors that have driven the species decline, particularly the compounding effects of habitat loss and degradation, population fragmentation and predation by feral American mink (*Neovison vison*) (Barreto et al., 1998; Bonesi et al., 2002; Woodroffe et al., 1990a). It remains the case that much of the conservation effort has been directed at halting the decline, fire-fighting tactics to protect individual water vole colonies from losses due to unsympathetic management or new development. While such action is essential to retain the species in extant colonies, it does not address the steps needed to restore the species to the wider countryside.

To underpin an effective recovery programme it is essential to address the issues of both habitat restoration and mink management simultaneously. Where pilot studies of this twin-track approach have been tried we have observed that local populations of water voles respond well and rapidly increase in numbers (as many rodent species do under favourable conditions). The recovery of the water vole is not an impossible pipe-dream but a goal which is achievable with properly targeted resources and focused conservation effort (see Figure 1:1).

This handbook has been designed to tell you about water voles' ecology, what their main conservation issues are, and how to rectify them. One thing is certain: water voles need conservation action and they need it now!

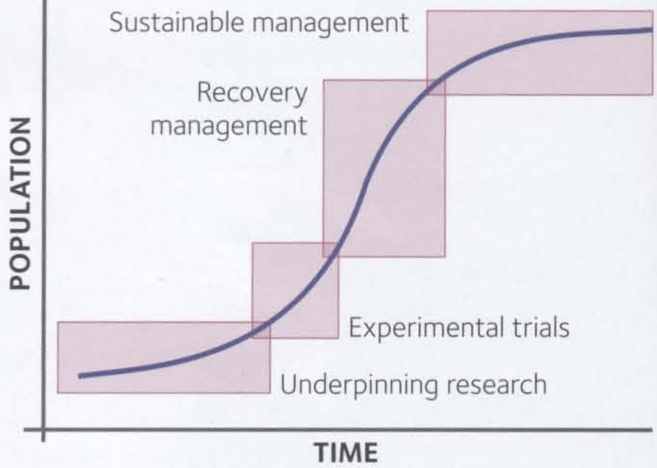


Figure 1:1
Theoretical species recovery curve for the water vole.

2 HISTORICAL PERSPECTIVE

The water vole was formerly common along the banks of rivers, streams, canals, ditches, dykes, lakes and ponds throughout mainland Britain.

A review of the published distribution data gathered by the Wildlife Trusts, the Environment Agency, the Statutory Nature Conservation Organisations, together with the results of two nationwide systematic surveys, carried out by the Vincent Wildlife Trust from 1989–1998 (sampling 2,970 sites), demonstrated that the water vole population in Britain had suffered a long-term decline since 1900. Populations are scarce and fragmented across their former range but have strongholds in southern and eastern Britain, on certain islands such as Anglesey and the Isle of Wight and parts of upland Britain such as Snowdonia, the Peak District, the Cairngorms and Assynt mountain range in Scotland (see Figure 1:2).

Changes in both land-use and riparian habitat management have resulted in habitat loss and degradation, causing fragmentation and isolation of water vole populations. This has led to an increased vulnerability to predation, especially by American mink, which have coincidentally been spreading and consolidating their range throughout Britain. However, during the 1980s there was a period of accelerated site loss and this appears to have continued very steeply through the 1990s. For instance, the results of a resurvey of the River Thames catchment sites during 1995 showed a dramatic regional decline from 72% to 23% site occupancy in a mere five years (from 1990 to 1995). In nearly all cases the loss of water vole populations has resulted from one – or a combination – of habitat loss, population fragmentation, leading to isolation of colonies (see Chapter 3), predation by American mink, and to a lesser extent environmental factors such as droughts and flooding. Therefore, restoration and re-creation of extensive areas of riparian vegetation, together with effective mink control are required to arrest the water vole's decline, and allow it to recover over its former range.

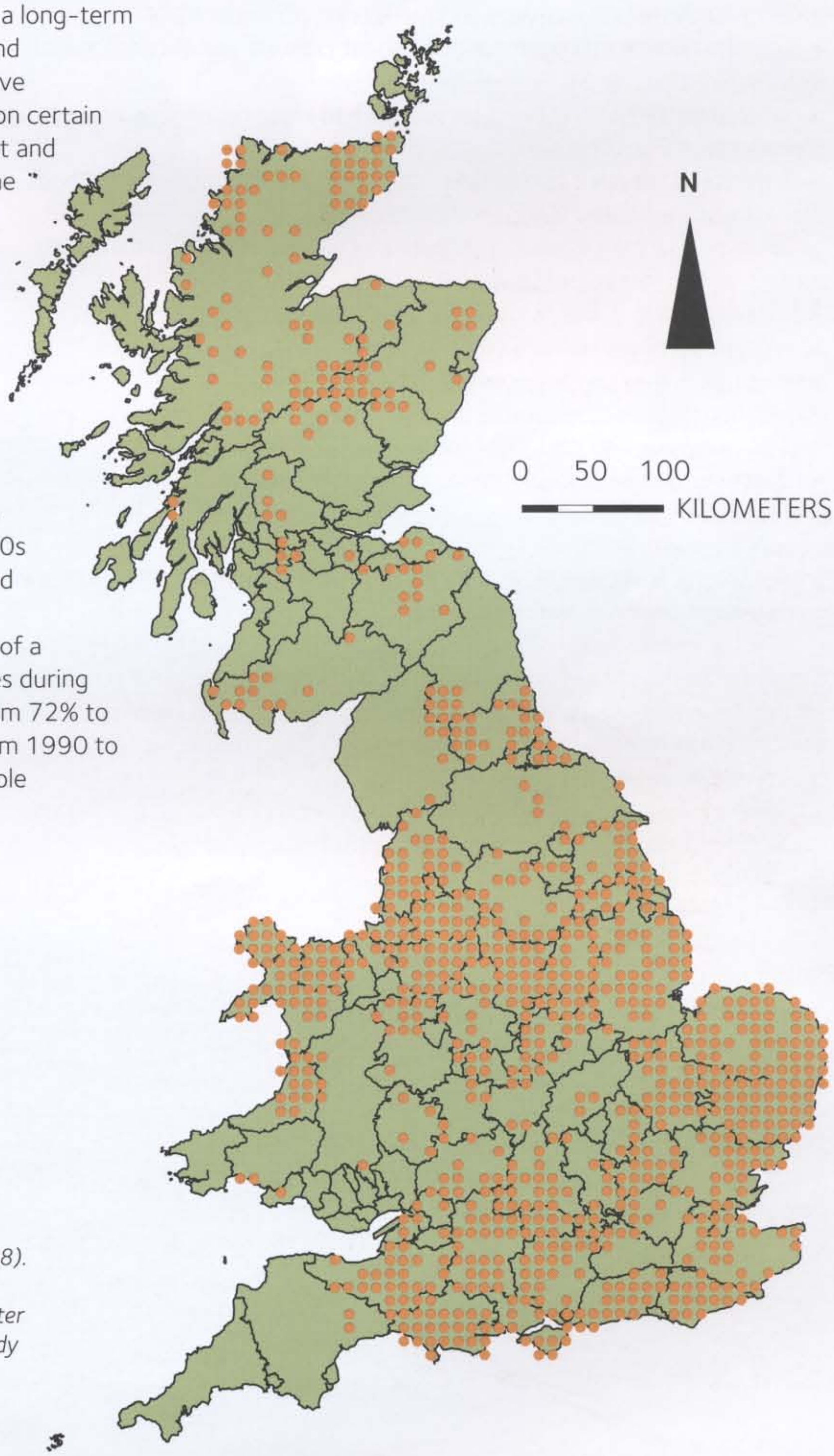


Figure 1:2

Present known water vole presence (2004 – 2008). The extent is shown as a total of 874 occupied 10km squares. Map courtesy of The National Water Vole Database and Mapping Project (see case study in Chapter 11).

3 PURPOSE OF THIS HANDBOOK

The water vole is one of 11 Priority Species of British terrestrial mammals identified in the Biodiversity Steering Group Report as needing conservation action (HMSO, 1995). Both that report and the ensuing Species Action Plan (WVSG, 1997) identified the provision of management advice, primarily through the production of a conservation handbook, as a high priority for action.

This handbook is intended to provide information to:

- Understand the issues that water voles raise within the current legal framework (Chapter 2).
- Better understand water voles, their ecology, habitat requirements and threats (Chapter 3).
- Carry out water vole surveys and monitoring (Chapter 4).
- Describe riparian management and habitat creation and enhancement for water voles (Chapter 5).
- Understand the National Key Sites approach to implementing the Water Vole Species Action Plan (Chapter 6).
- Understand the need for humane mink control, and how these methods should be implemented (Chapter 7).
- Describe how management for species other than American mink may conflict with water voles (Chapter 8).
- Understand the issues, with respect to water voles, that arise from developments of riparian and wetland habitats, and how the impacts from such developments may be mitigated (Chapter 9).
- Describe the role that captive breeding and reintroductions play in the species' recovery, and guidelines for successful reintroduction (Chapter 10).
- Describe the role of local Action through the Biodiversity Action Plan process (Chapter 11).

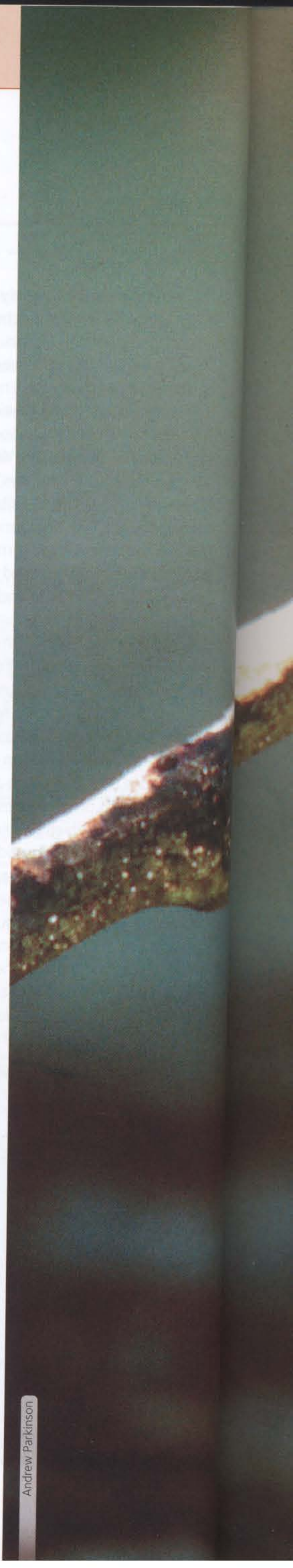
The Handbook is liberally illustrated by Case Studies that describe the various management methods and materials that can be used.

For the conservation of the water vole to be effective it is essential to raise the profile of the species and stimulate public interest. We make no apologies for promoting the water vole as an emblem of a healthy and diverse riparian habitat, in much the same way as the otter is a flagship species for good water quality and a healthy riverine environment.

Among those strongly recommended to consult this handbook are the following organizations (guided by their conservation staff):

- Environment Agency
- Scottish Environment Protection Agency
- British Waterways
- Internal Drainage Boards
- Statutory Nature Conservation Organizations
- The Wildlife Trusts
- Local Planning Authorities

Organizations with riparian land holdings (such as the RSPB, Forest Enterprise and Ministry of Defence), other land owners and farmers, and environmental consultants will also find this handbook invaluable.



Andrew Parkinson

WATER VOLES AND THE LAW

1 LEGAL PROTECTION

Full legal protection for the water vole was granted on 6th April 2008 in England and Wales by the provisions under Section 9 of Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). Prior to this time water voles had only received limited legal protection under section 9(4). The water vole remains protected at this level in Scotland. The increase in protection in England and Wales to include the animal itself in addition to the its places of shelter or protection reflects of the significant decline the water vole has undergone in recent decades, while recognising that habitat loss and destruction have played a much greater part in this decline than direct persecution.

The increased level of protection therefore now makes it an offence to:

- Intentionally kill, injure or take wild water voles. Section 9(1);
- Possess or control live or dead wild water voles or any derivative part of a water vole. Section 9(2);
- Intentionally or recklessly damage, destroy or obstruct access to any structure or place used for shelter or protection. Section 9(4);
- Intentionally or recklessly disturb wild water voles whilst occupying a structure or place used for that purpose. Section 9(4b);
- Intentionally or recklessly obstruct access to any structure or place which any wild water vole uses for shelter or protection. Section 9(4c);
- Sell wild water voles or offer or expose for sale or transport for sale. Section 9(5a);
- Publish or cause to be published any advertisement which conveys the buying or selling of wild water voles. Section 9(5b).

As an exception to the above it is, however, legal to tend to a sick or injured wild water vole with the intention to release it back into the wild, or to kill a water vole which is unable to recover. Section 10(3a, b).

Offences under Section 9 carry a maximum penalty of a fine not exceeding Level 5 on the standard scale (currently £5000), and / or a custodial sentence of up to six months. In addition, the courts may order the forfeiture of any vehicle or other item that was used to commit the offence.

A defence is available permitting the possession of specimens which were not taken illegally (e.g. wild water voles which were found dead). The law only applies to wild water voles; therefore captive-bred animals may legally be possessed but the duty falls on the possessor to prove their case.

Licences may be issued under Section 16 by the SNCO's to permit activities which would otherwise be classed as offences including:

- For scientific or educational purposes;
- For the purposes of ringing or marking;
- For conserving wild animals or introducing them into a particular area;
- Preserving public health or public safety;
- Preventing the spread of disease;
- Preventing serious damage to any form of property or to fisheries.

There remains no provision for licensing the intentional destruction of water vole burrows for development activities or any activities associated with the improvement or maintenance operations of waterways.

2 | THE LAW IN PRACTICE - AN INTERPRETATION

2.1 INTERPRETATIONS

Intentional: it is the actor's purpose or the actor knows that it is a virtually certain consequence of the act.
Reckless: act creates a risk that is obvious to the ordinary and prudent person and not given thought to the possibility of risk or has recognised the risk and done the act anyway.
Disturbance: any activity which affects the survival chances, the breeding success or the reproductive ability of one or more individuals or which leads to a reduction in the quantity of occupied habitat.

A case-by-case approach means that the competent authorities will have to reflect carefully on the level of disturbance as to whether it is harmful to water voles. Short-term disturbance which allows the species to flee then later return within a short time period (e.g. the same day) will not normally be considered problematical.

It is clearly not the intention of the law to prevent all development or maintenance works in areas used by water voles. However, legal protection does require that due attention is paid to the presence of water voles and appropriate actions taken to safeguard the places they use for shelter or protection.

In England or Wales if it can be demonstrated that any action which would otherwise have been an offence was the *"incidental result of an otherwise lawful operation and could not reasonably have been avoided"*, this constitutes a defence against prosecution under the Wildlife and Countryside Act 1981 (as amended) Section 10(3)c. This defence thus provides for the carrying out of works that intentionally but unavoidably damage, destroy or obstruct water vole burrows, but requires that reasonable steps must be taken to avoid any unnecessary damage. Only a court can decide what was "reasonable" in any set of circumstances, but, clearly, agreement between the conservation agencies (such as Natural England and the Environment Agency), planners and developers would be important. There is, therefore, an obligation on those who maintain waterways to ensure that appropriate systems are in place to minimise damage and that all reasonable ways of avoiding that damage are used. As this defence is open to interpretation by the courts in any specific situation, it may not be advisable to rely solely upon this defence.

Following enhanced protection to the Wildlife and Countryside Act 1981 (as amended) from the Nature Conservation (Scotland) Act 2004, the defence against prosecution differs in Scotland from that in England and Wales. In Scotland there is a statutory defence against prosecution if it can be demonstrated that:

- "the unlawful act was the incidental result of a lawful operation or other activity" and that:
- "the person who carried out the lawful operation or other activity took reasonable precautions for the purpose of avoiding carrying out the unlawful act" or that the person:
- "did not foresee, and could not reasonably have foreseen, that the unlawful act would be an incidental result of the carrying out of the lawful operation or other activity".

This defence only applies if the person stops causing any further illegal actions as soon as practically possible once he or she realises they are occurring.

Whether in England, Scotland or Wales the law in practice requires that developers, or other riparian owners, who may wish to maintain, build on or alter areas used by water voles must ensure that there is no unnecessary damage to their place of shelter. To this end all reasonable steps must be taken to minimise damage to water vole burrows (see Box 2 regarding breaking the law). This can be best achieved by undertaking an Environmental Assessment, including a water vole survey, prior to planning any work and ensuring that appropriate mitigation measures are included in the proposals (see Chapter 9 for more detail).

The above only constitutes a general guide to the main provisions of the law, not a definitive interpretation. The Wildlife and Countryside Act 1981 (and subsequent amendments), CRoW 2000, and the Nature Conservation (Scotland) Act 2004 should be consulted for further details.

In addition to prohibiting potentially destructive actions, the Natural Environment and Rural Communities Act (NERC) 2006 places a duty on every Public Authority to deliver the UK biodiversity Action Plan (BAP). As a BAP priority species this places a strong emphasis on the development of local community-based strategies (LBAPs) for the conservation of the water vole. To this end the water vole is recognised in 187 LBAPs at the District, Borough, County, Regional and organisational level (such as the Water Utility Companies and the Environment Agency).

3 WATER VOLES, PLANNING AND POLICY GUIDANCE

As a protected species, the water vole is highlighted under planning policy guidance. In England, the Department of the Office of the Deputy Prime Minister has produced a Planning Policy Statement on Biodiversity and Geological Conservation (PPS9 – 2005) and associated circulars (ODPM Circular 06/2005 + Defra Circular 01/2005 – Biodiversity and geological conservation – statutory obligations and their impacts within the planning system). These state that local authorities should take measures to protect the habitats of species of principal importance for the conservation of Biodiversity (such as the water vole) from further declines through policies in local development documents. Planning authorities should refuse permission where harm to the species or its habitat would result, unless the need for, and benefits of, the development clearly outweigh that harm. When considering proposals, local planning authorities should maximise the opportunities for building-in beneficial biodiversity features in and around developments as part of good design.

Andrew Harrington

Similar guidance is available in Wales and Scotland. Planning Policy Wales has a Technical Advice Note (TAN5) on Nature Conservation and Planning 2009 and Scottish Planning Policy (National Planning Policy Guidelines 14: Natural Heritage) supported by Planning Advice Notes (PAN 60: Species and habitats and development opportunities to improve environment by design) for full details see the Welsh Assembly Government and Scottish Executive Development Department websites.

Planning authorities in England, Scotland and Wales should, in accordance with the above legislation, take appropriate steps to check for the presence of water voles and ensure that their habitats are protected through the planning process.

Environment Assessment is a statutory requirement for certain classes of development but is recommended for all cases that affect protected species. It provides an appropriate mechanism for gathering data on the presence of water voles and the development of appropriate mitigation. The output from this process, an Environmental Statement, should include the following elements:

- A description of the development.
- Data necessary to identify the main effects of the development.
- An assessment of the likely significant effects of the development on the environment (including fauna).
- Measures to avoid, reduce or remedy the impacts of adverse effects.

In the case of developments involving riparian habitats, those preparing Environmental Assessments should check for the presence of water voles through a combination of field survey and consultation with local record centres or other holders of environmental data, and ensue that appropriate mitigation is included in the Environmental Statement. Appropriate field survey methods are described in Chapter 4 and suggestions for mitigation methods can be found in Chapter 9.

Andrew Parkinson

4 | WATER VOLES AND DEVELOPMENT

It is not possible to obtain a license from the SNCO's which covers development or waterway maintenance activities. Therefore the following course of action is recommended in situations where the impact on water voles cannot reasonably be avoided:

Firstly, establish presence or absence of water voles in the area(s) to be affected by the proposed development or maintenance works following survey guidelines in Chapter 4. If water voles are present, consider whether the scope of the works might be amended or altered to exclude areas occupied by water voles, and thereby avoid committing an offence under the Wildlife and Countryside Act 1981 (as amended). If avoidance of the occupied water vole habitat is unavoidable, then the developer must rely on the incidental result defence. It is up to the developer to evaluate whether his or her actions are covered by that defence provision.

PLANNING DECISIONS

In England and Wales, if planning permission is required for development or maintenance works there is a requirement under the Natural Environment and Rural Communities Act 2006, section 40, for local planning authorities to consider the need to conserve water voles when making their planning decision. Due to their status as a protected species, water voles are in PPS9/TAN5 as a material planning consideration and planning authorities must accordingly ensure that adequate information pertaining to water voles at the site is available prior to determining a planning application.

USE OF THE *INCIDENTAL RESULT* DEFENCE

This defence is available for the carrying out of otherwise lawful operations from which some harm to a protected species, which would otherwise be an offence, is caused as an incidental result which could not reasonably be avoided. In order for this defence to be viable, it is necessary to be mindful of the presence of water voles and, as far as is reasonable, ensure appropriate action is taken to safeguard both the animals themselves, and places they use for shelter and protection. The statutory conservation authorities cannot provide legal advice on specific circumstances, and ultimately it is up to a court to determine what is reasonable and to what extent any adverse impacts might have been reasonably avoided in any specific situation.

TRAPPING AND REMOVING WATER VOLES: CONSERVATION LICENSES (APPROPRIATE FOR ENGLAND & WALES)

In situations where a developer considers that the best approach to ensure the protection of water voles is capture and translocation to a different location, Natural England are unlikely to view intentional capture as an *incidental* outcome of the development or maintenance activity, thereby rendering the incidental defence unusable.

Under some conditions there may be a genuine reason to issue a translocation license for the purpose of conservation. Examples of such circumstances might include situations where, despite efforts to minimise the risk, the potential of killing or injuring water voles cannot be reasonably avoided. Although all applications will be judged by Natural England on their individual merits, licenses to trap and remove water voles from a site for the purposes of conservation where the application can demonstrate that:

- The proposed activity is lawful, i.e. appropriate planning permission or other lawful authorities have been granted.
- The development and subsequent likely impacts on water voles could not reasonably have been avoided. For this to be applicable it will be necessary for the applicant to demonstrate that all reasonable efforts had been made to carry out the lawful development in a way that minimised any risk of committing offences under the Wildlife and Countryside Act. All reasonable efforts should have been made to retain water voles on site, with consideration given to alternative options which might have a reduced impact on the voles. Suggestions as to how this might be achieved are outlined in Chapter 9.
- For a conservation licence to be issued, the translocation of water voles must be shown to have a conservation benefit. Guidance on appropriate methodologies can be found in Chapter 10.

NATURAL ENGLAND / COUNTRYSIDE COUNCIL FOR WALES LICENSE APPLICATIONS FOR TRAPPING WATER VOLES

The following documents must be submitted to apply for a license to trap and translocate water voles for the purposes of conservation, and all works must be overseen by a suitably qualified ecologist:

- A completed license application form (For Natural England this is form WML A29)
- Detailed methodology of the proposed works, to consider and stipulate where appropriate;
- Details of relevant planning permissions for the proposed works if applicable, or justification as to why the works must commence and why alternative options are not suitable.
- Details of baseline water vole surveys in the area to be affected by the development or maintenance proposals.
- Statement outlining why trapping and translocation of water voles is considered to be the most appropriate course of action, and why water voles cannot be maintained on site.
- A detailed and scaled map(s) depicting the area which

will be affected by the development or maintenance proposal, and relevant phases as appropriate.

- The impact of connectivity with other water vole populations within the wider metapopulation across the site.
- A proposed timescale for trapping and releasing water voles, including details of the phasing of operations over a number of years where appropriate.
- Details of displacement or exclusion techniques to be employed to ensure water voles are not present at the time of the works, and contingency plans to be employed should water be found on site.
- Details of new areas of riparian habitat to be created or restored *in situ* as mitigation for the loss of original habitat, including planting regime of suitable vegetation. This should be timed to be available prior to the commencement of works to existing habitat.
- A methodology for trapping and holding the water voles prior to release.
- Details of the site into which water voles will be released, including results of water vole surveys undertaken in the area.
- A post-operation management plan for both the development and release sites, including when (short and long term), and by whom.

This summary is intended for guidance only, and we recommend referral to the relevant sections of legislation for further information.

BOX 2 WATER VOLE CONVICTION 2005

Following a trial at St. Helens Magistrates Court on 8th November 2005, a housing development company was convicted of two offences against the Wildlife and Countryside Act 1981 (WCA81). N.B. this conviction took place before full legal protection of water voles was granted in 2008.

- Reckless disturbance of a Schedule 5 protected species (water voles);
- Reckless destruction of shelters and places of safety of a Schedule 5 species.

The company was fined £2,500 on each charge and ordered to pay £500 costs (total £5,500).

The case was brought as a result of an incident in September 2004, where the company had a large housing development of over 200 houses.

On land adjacent to the development there is a nature reserve, which has been allowed to develop for its biodiversity and is managed accordingly. The area is an important site for water voles, whose habitat is protected by the Wildlife and Countryside Act 1981 because of their vulnerable status.

In October 2004 an ecologist for the Environment Agency surveyed the site and found that a ditch had been dredged and re-profiled. They concluded that water vole burrows and places of shelter had been destroyed and the species must have been disturbed. The matter was reported to the Merseyside Police Wildlife Crime Officer.

The court heard that the work on the ditch had been carried out to allow water to drain freely from the housing development, but was done without the knowledge of the landowners and against the land management plan. It was alleged that the work also contravened the WCA because of the damage to the water vole habitat.

The company denied they were responsible for the damage to the ditch and blamed subcontractors who they said had carried out the work without their knowledge or consent. The court was told by one witness that the work had been carried out on the instructions of the company as the result of a site meeting after a problem with the drainage had been identified.

The District Judge concluded that she was satisfied that a representative of the company had instructed subcontractors to carry out the work and that the work was carried out on the assumption that the company had acquired the appropriate consent and permission of the landowner. She said that the company had not consulted with the landowners and had they done so they would have been made aware of the presence of the water voles. She said that by failing to do so they had been reckless in their actions. The District Judge accepted that the company had not 'intentionally' disturbed or destroyed the water vole habitat.

Following the case the Merseyside Police Wildlife Crime Officer stated that, "Companies must realise they have a responsibility to work within the law. These are criminal offences and offenders will be dealt with by the criminal courts. Offenders run the risk of being sent to prison".

This was the third prosecution nationally for this type of offence.

UNDERSTANDING WATER VOLES

1 BACKGROUND BIOLOGY

1.1 TAXONOMY

The water vole, *Arvicola amphibius* (formerly *terrestris*) (Linnaeus, 1758), is a rodent of the subfamily Arvicolinae, along with all other voles, lemmings and muskrats. Currently two species are recognized (Wilson and Reeder, 1993): the northern water vole *A. amphibius* (Britain and throughout Europe to Russia) and the southern water vole *A. sapidus* (south-west Europe).

Arvicola amphibius has a number of local common names. In Britain it is generally referred to as just the 'water vole' due to the absence of *A. sapidus*, but it is also frequently called the water rat ('Ratty') and occasionally known as the earth hound or water dog.

1.2 GENERAL CHARACTERISTICS

The water vole is the largest of the British voles, adults weighing between 140–350g (with males normally slightly larger than females). It is typically vole-like in its morphology with a rounded body, blunt muzzle and short round ears almost hidden in its thick fur of the head and nape.

Although it swims and dives well, the water vole is not particularly adapted to water insofar as it does not have webbed feet like an otter, nor does it use its tail as a rudder but simply swims in a doggy-paddle style, the fur becoming water-logged with prolonged submergence. Young water voles buoyantly ride much higher in the water than adults.

When disturbed from feeding on the bank, water voles purposefully splash dive into the water with a loud 'plop' which serves as a warning to other voles. The plop may be a first indication that water voles are present on a site, warranting further investigation for the distinctive fieldsigns (burrows, feeding remains and latrines).

Water vole swimming buoyantly, high in the water.

1.3 PELAGE VARIATION

Its rich silky coat is variable in colour, although most southern England populations are typically reddish, medium to dark brown colour grading to a paler ventral fur. Black colour forms may occur in any population, but are more common at the higher latitudes in Scotland, and some areas of Norfolk. Partial albinism, with white patches of hair on the tail tip, forehead, chest or paws also occurs in most populations.

Black colour forms occur commonly in Scotland.

1.4 DETERMINATION FROM SIMILAR SPECIES

Water voles are most frequently mistaken for brown rats (*Rattus norvegicus*) which frequently inhabit waterside habitats and are also excellent swimmers. However, brown rats are generally larger, weighing up to 500g (Corbet and Harris, 1991) and have a pointed muzzle, larger eyes and more obvious ears. The water vole's tail is a little longer than about half the body length and is well furred, whereas the longer tail of the rat, being sparsely furred, looks naked or scaly.

Confusion can also exist between newly weaned water voles and adult field voles (*Microtus agrestis*). The former leave the nest weighing as little as 30g, which overlaps with the upper end of the field vole range. However, juvenile water voles are generally darker with large heads and much larger hind feet (around 30mm as opposed to only 17.5mm in adult field voles).

1.5 DISTRIBUTION WORLDWIDE

The type locality for the species is Uppsala, Sweden.

The current distribution extends across Europe (except central and south Spain, western France and south-west Italy), from mountains of the Mediterranean region to the

Arctic coast, east through Siberia almost to the Pacific, south to Israel, Iran, Lake Baikal and the North Tien Shan mountains of north-west China (Corbet, 1978; Wilson and Reeder, 1993).

1.6 BRITISH DISTRIBUTION

Water voles were formerly widespread and common in the British Isles, ranging from the toe of Cornwall to the extreme north-east of Scotland. It is absent from Ireland, Isle of Man and the Scottish Islands, but occurs on Anglesey and the Isle of Wight (Corbet and Harris, 1991).

In Britain water voles have generally adopted a semi-aquatic lifestyle. In this respect they behave somewhat differently from the smaller, continental water voles which often live away from fresh water, becoming highly fossorial (that is, living a largely underground existence like a mole, throwing up frequent molehill-like spoil heaps in the damp meadows). The fossorial form can occur at huge densities of between 200 and 500 per hectare, where it becomes a significant pest in orchards, bulb and rice fields in France, Austria, Switzerland, Germany, former Yugoslavia and the Netherlands.

Recent evidence suggests that the British distribution of water voles stemmed from separate colonization events following the last ice age. One colonization resulted in the water voles that now inhabit England and Wales, and a separate colonization in the water voles that now inhabit Scotland. This resulted in Scottish voles, whilst remaining the same species, being genetically dissimilar to English and Welsh voles (Piertney *et al.*, 2004) – see Box 3:A.

BOX 3:A GENETIC VARIATION IN WATER VOLES: IMPLICATIONS FOR CONSERVATION

Piertney et al. (2005) examined genetic variation amongst water vole population in the UK. Their results indicate that the current UK water vole population resulted from two separate colonization events, originating from different locations following the last glaciation. Contemporary Scottish populations derived from water voles which colonized from an Iberian glacial refugium (basically, an area that escaped being buried under tonnes of ice during the last ice age, and in which animals were able to survive) whereas the populations which currently inhabit England and Wales most likely derived from a different refugium in eastern Europe. Whilst British water voles are still all the same species, these results indicate that there are considerable genetic differences between Scottish water voles and those present in England and Wales. Piertney et al. (2005) also found genetic variation between regions within these two main groupings (e.g. water voles from different regions within England are also genetically different from each other, but more similar to each other than to Scottish voles), and also between populations within each region.

In practical terms, the implications of this are that any conservation plan for water voles which involves the movement of animals between geographic locations must take into account the amount of genetic divergence between

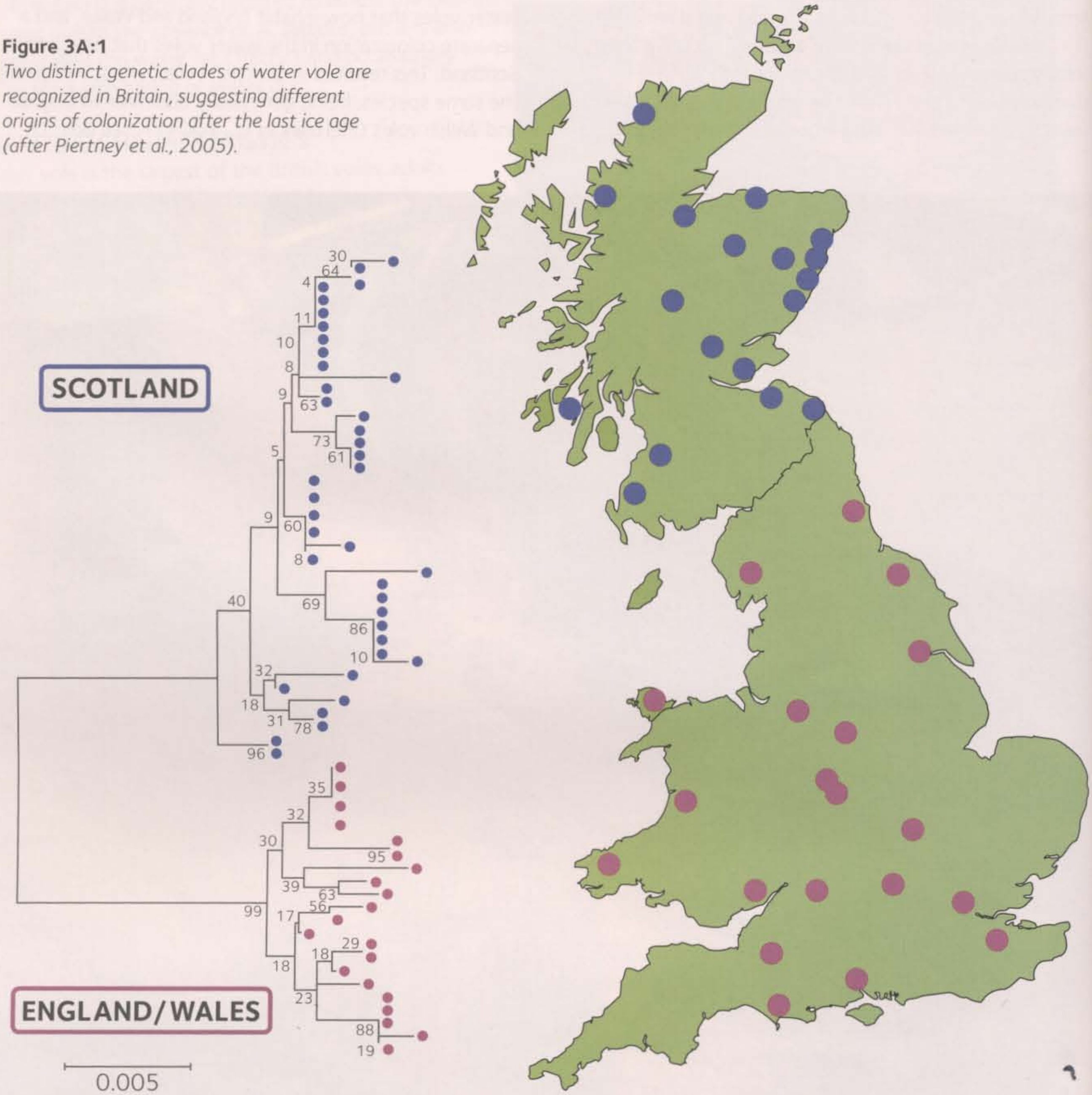
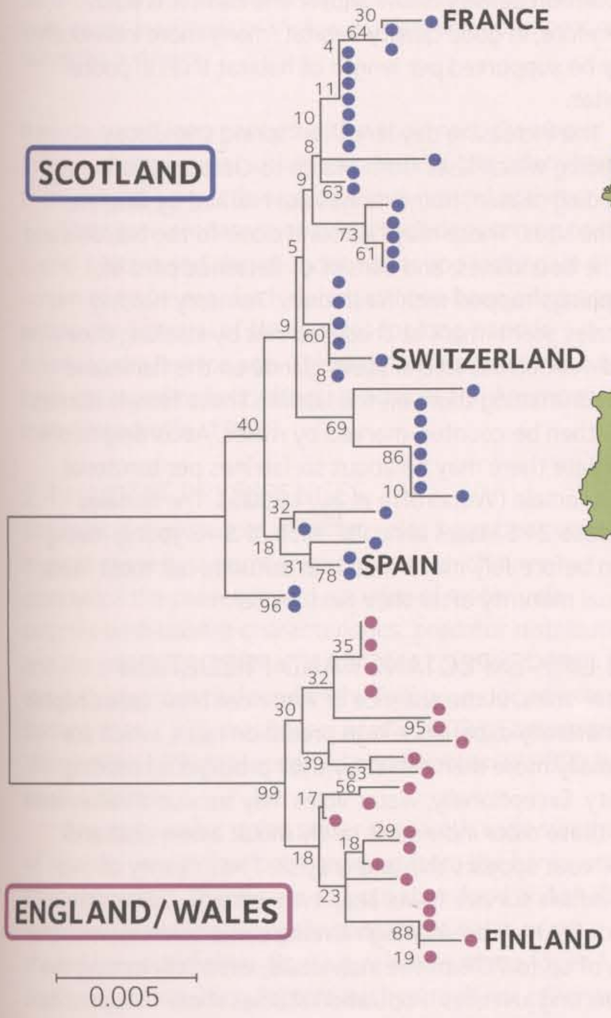


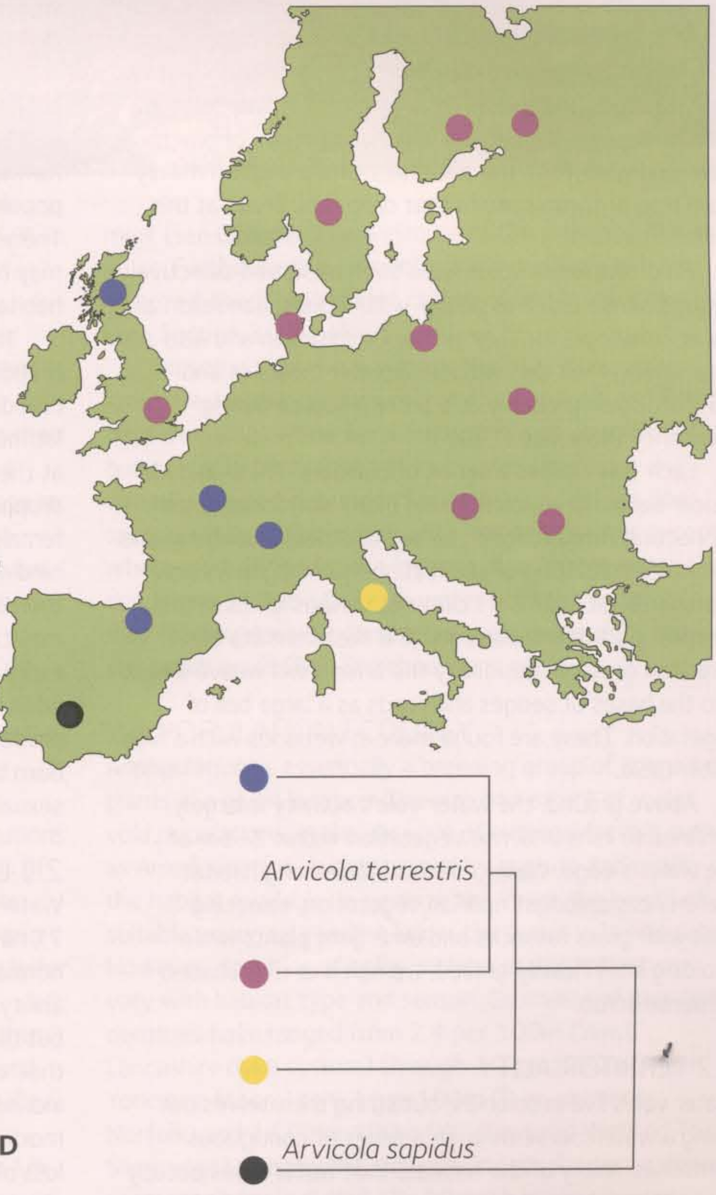
Figure 3A:1
Two distinct genetic clades of water vole are recognized in Britain, suggesting different origins of colonization after the last ice age (after Piertney et al., 2005).

those locations. This is to ensure that lineages are not mixed and evolutionary heritage lost, and also to ensure that other possible complications (such as outbreeding depression – whereby young of very different genetic lineages may have reduced fitness) are avoided. For these reasons, later in this Handbook we recommend that populations are never translocated between Scotland and England/Wales, and that in any case the distance that populations are moved – whether for reintroduction or as part of mitigation for development – should be kept to an absolute minimum (see Chapter 9 and Chapter 10).

Figure 3A:2

Genetic relationship with counterparts in Europe. The water voles in Scotland are more closely related to voles from western Europe than those from England and Wales. The latter are closely related to water voles now found in eastern and northern Europe (after Piertney et al., 2005).





2 HABITS AND LIFESTYLE

2.1 GENERAL

Water voles are herbivorous, primarily feeding on the lush aerial stems and leaves of waterside plants. From the remains found at feeding stations, the nation-wide survey was able to identify 227 species of plant eaten by the water vole in Britain (Strachan and Jefferies, 1993). This surprisingly large list has been compiled from the diverse number of habitats sampled and the wide geographic range for the species in Britain. The best sites show a highly layered bank-side vegetation with tall grasses and stands of willowherb, loosestrife, meadowsweet or nettles, often fringed with thick stands of rushes, sedges or reed.

Over the winter period, the roots and bark of woody species such as willow or sallow are eaten, together with rhizomes, bulbs and roots of herbaceous species. At some sites water voles may even climb into the branches of low growing trees and shrubs (to a height of 2.5m) to strip bark or consume the young leaves, especially of hawthorn, elder and willows. In the autumn, fruits are eaten mainly from tree or shrub species that drop their fruits at this time.

Pregnant water voles have been observed selectively eating flowers (such as pussy-willow buds, dandelion and water crowfoot) for their protein-rich pollen and also augmenting their diet with freshwater molluscs and crayfish, again probably as a protein source during pregnancy (Strachan, 1997).

Each vole utilizes a series of burrows. These include residential burrows, comprising many entrances, inter-connecting tunnels, food storage and nest chambers, and bolt holes consisting of short tunnels ending in a single chamber. Nest chambers occur at various levels in the steepest part of the bank and the nest consists of shredded grass. Occasionally the animal will weave a nest into the bases of sedges and reeds as a large ball of vegetation. These are found more in wetlands with a high water table.

Above ground, the water vole's activity is largely confined to runs in dense vegetation within 2–5m of the water's edge. Water voles exhibit strong habitat preferences amongst riparian vegetation, selecting sites with grass tussocks and emergent plants while avoiding sites heavily grazed, trampled or overshaded by dense scrub.

2.2 TERRITORIALITY

Water voles live in colonies, but string themselves out along a watercourse through a series of contiguous territories. Many of the habitats that water voles occupy in the UK are linear (streams, rivers, ditch systems) and in these habitats, water voles' ranges also tend to be linear. It is therefore appropriate to measure territory sizes in terms of 'length' in most UK habitats. Exceptions to this are habitats such as large reedbeds, where water voles' ranges tend to be more two-dimensional, and therefore are best described as having an 'area'.

Breeding female water voles are territorial. Female territories represent the appropriate 'breeding unit' for water voles, since it is territory size that will influence the number of breeding females that a given length of habitat can contain. Frequent interactions, and the presence of latrines (see below) determine the boundaries of the territory which generally exclude other adult females. Females may, however, share territories with their female offspring. Males are not territorial as such, but have ranges which overlap with the ranges of many females and other males. Males compete for access to females.

Depending on overall population density, season and habitat quality, the length of territory varies between 30m to 150m for females and home-range from 60m to 300m for males. The larger range sizes occur when the population density is low and/or the habitat is poor. Therefore, in good quality habitat, many more individuals may be supported per length of habitat than in poorer habitat.

The increasing day length of spring stimulates breeding which lasts from March to October. During the breeding season, home ranges are marked by discrete latrine sites. These may be found close to the burrows and at the boundaries, and consist of flattened piles of droppings topped with fresh ones. Territory holding females scent-mark at these latrines by stroking their hind-feet across lateral scent glands on the flanks and then drumming them on the latrine. These female latrines may then be counter-marked by males. According to one estimate there may be about six latrines per territorial adult female (Woodroffe et al., 1990b). The females produce 2–5 litters annually, each of 5–8 young. Young born before July may breed that autumn, but most reach sexual maturity after their first winter.

2.3 LIFE-EXPECTANCY AND PREDATION

Water voles, in the absence of American mink (see Chapter 7), naturally experience high predation rates, which are normally more than offset by their prodigious breeding ability. Exceptionally, water voles may survive three winters but these older individuals rarely moult a new coat and their coat appears thin and greyish. The majority of individuals survive fewer than two winters. Over-winter mortality may be very high among some colonies, with the loss of up to 70% of the individuals, especially among the dispersing juveniles. Population studies show that juvenile water voles probably need to attain a weight of 170g in order to survive the winter. Although they do not hibernate

Spate rivers with rocky banks are generally avoided by water voles except in sections of shallow gradient and where peat or soil allows burrowing.

they do spend long periods within their nest chambers (often cohabiting with other members of the colony) and there may be very little sign of above ground activity.

Their anti-predator behaviour includes running to their tunnel system and diving under water and kicking up a screen of sediment. Such defences have been adequate to ensure the survival of the species for long periods following the last ice age. These defences, however, have been observed to be ineffective against the American mink (Woodroffe, 1988).

2.4 HABITAT PREFERENCES

The habitat preferences of water voles have been covered in great detail by a number of studies, which have associated the presence and absence of water vole colonies with habitat characteristics, predator distributions and the proximity of other water vole colonies. Details of these studies can be found in the following documents: Barreto *et al.* (1998b); Bonesi *et al.* (2002); Lawton and Woodroffe (1991); Macdonald and Strachan (1999);Telfer *et al.*, (2001).

Generally water voles prefer sites with wide swathes of riparian vegetation, both growing from the banks and from the water. This serves as both their food and shelter. Water voles also prefer easily penetrable earth or silt-shored banks and slow-flowing, relatively deep (over 1m depth) water courses. Factors such as rocky or otherwise impenetrable substrates, over-shading by trees, fast flowing or shallow water, and the presence of American mink (see Chapter 7) are inimical to the presence of water voles. Furthermore water voles are more likely to inhabit an area if there is an extant colony of water voles nearby (see Section 3:2.5 below).

On some tidal rivers water voles may occupy the lower freshwater reaches even if the daily ebb and flood of the tide causes water level fluctuations of up to 6m. Here burrows may be exposed at low water conditions and virtually flooded out under Spring tide conditions. The species rarely occupies estuaries and saltmarshes except where reed-fringed saline lagoons offer stable water conditions. In these brackish water sites the water vole may feed extensively on species such as sea club-rush and sea couch grass (Rob Strachan, pers. obs).

2.5 POPULATION ECOLOGY

A 'population' is essentially a breeding group of animals or plants in a given location. The size and extent of water vole populations, in the absence of external factors such as American mink, is determined by the size and quality of the habitat available. In general, the larger the length of suitable water course, the larger the water vole population. However, densities of voles within suitable habitat can vary with habitat type and season. Estimates of population densities have ranged from 2.4 per 100m (West Lancashire dyke system) through 3.3 per 100m (North Yorkshire Moors) to 6.1 per 100m (Bure marshes, Norfolk) and 14.0 per 100m (Wildfowl and Wetland Trust, Slimbridge). Among the wet carr and reedbed sites density estimates have included 40–50 per hectare (Brownsea Island, Dorset) and 25–30 per hectare (Redgrave Fen, Suffolk). The width of the vegetation fringing water courses may affect population densities by altering water voles' survival rates (by making them harder for predators to catch) and potentially growth rates (by giving them access to more food). In general, wider swathes of bankside and emergent vegetation are expected to be able to support more water voles per length of water course than thinner habitats.

Populations in lowland Britain can be very large, often containing hundreds of individuals. In upland areas, however, populations of water voles are often subdivided into colonies consisting of a small number of individuals, occasionally as few as a single male-female pair (Aars *et al.*, 2001; Telfer *et al.*, 2001; Telfer *et al.*, 2003).

The probability of a population going extinct (local extinction of a particular population) is related to the numbers of individuals present. Very small populations are extremely vulnerable to fluctuations in breeding or predation rates, or environmental catastrophes such as flooding. A bad breeding year, or a good year for predators could easily reduce the numbers down to such low levels that the population goes extinct. Conversely large populations are far less affected by such fluctuations. For example, if conditions during a breeding season promoted low birth rates and high mortality, it could be that a population could experience a 70% loss of numbers by the following year. From a population of 10, this would leave only three individuals whereas from a population of 100, it would leave 30. Another one or two deaths could end the smaller population, even if the following breeding season was excellent.

A useful concept is that of the minimum viable population (MVP). This is the smallest isolated population which has a high chance (e.g. 90–95%) of surviving for a long time (e.g. 100–150 years), despite the foreseeable effects of fluctuations in the environment, natural catastrophes and variations in breeding and mortality rates. It is currently unclear exactly what the MVP for water voles is, but it is likely to be in excess of 100 individuals at peak breeding season (30–50 individuals at the beginning of the breeding season), occupying an approximately 1.5–2km length of good quality habitat. Generally speaking, however, the larger the amount of habitat available, and the larger the population, the better its chances of survival.

If populations are not spatially isolated, this can mean that smaller population sizes can be viable. If an isolated population goes extinct, then it cannot be recolonized from surrounding populations, and the habitat will remain permanently unoccupied thereafter. If the same population was surrounded by other populations, within dispersal distance, then the empty habitat would be very likely to be quickly recolonized, and so the proximity of other colonies promotes stability in terms of habitat occupation over the long term.

Whether or not a given location is occupied by water voles is determined by a number of factors:

1) The presence of suitable habitat;

2) The absence of American mink (see below);

3) The degree of isolation from other water vole colonies (Barreto *et al.*, 1998b; Bonesi *et al.*, 2002; Macdonald and Strachan, 1999).

Water voles can be absent from good quality lowland habitats if conspecifics are absent from the immediate vicinity, but if neighbouring colonies were present, water voles can persist in suboptimal habitat (Bonesi *et al.*, 2002). For example, although upland populations can be extremely small, and each subpopulation is not viable in its own right in the long term, the population as a whole is stable because the distances between the subpopulations are small enough to allow dispersal to recolonize empty habitats. Such large overall populations, comprising many smaller subpopulations linked by dispersal, are called 'meta-populations'.

3 THREATS TO WATER VOLES

The principle threats to water voles stem from habitat loss, degradation and fragmentation, and from predation by American mink. The presence of mink and absence of the correct quantities of suitable habitat are inimical to water voles. In the vast majority of cases, populations can only exist if the habitat is correct and mink are absent. In cases where some coexistence between mink and water voles has been observed, this has been because the habitat was extremely extensive and not optimal for mink (Carter and Bright 2003; see Chapter 6). Other threats to water voles, such as flooding and persecution, are less severe on a national basis but can have large effects at a given location.

3.1 HABITAT LOSS AND DEGRADATION

Following the Second World War, Britain followed a policy of agricultural intensification. This generally resulted in the loss of floodplain habitat, 'radical linearalization' of the remaining riparian habitat, loss of hedgerows and ditches, drainage of semi-natural grassland and canalization and dredging of water ways to produce heavily regulated channels (Barreto *et al.*, 1998a). Riparian maintenance works and unsympathetic agricultural management practices have frequently been implicated in the loss of water vole colonies (Barreto *et al.*, 1998a; Macdonald and Strachan, 1999; Strachan, 1998; Strachan *et al.*, 2003), and have commonly resulted in suitable, occupied habitats being reduced in size and spatially isolated from

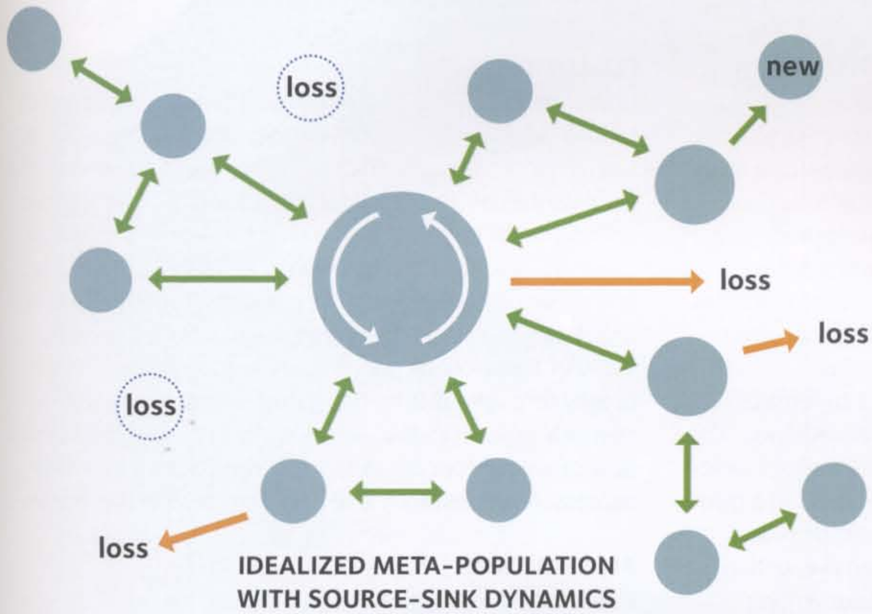


Figure 3:2
Schematic representation of interchange of water voles between individual colonies and their local persistence based on observational data.

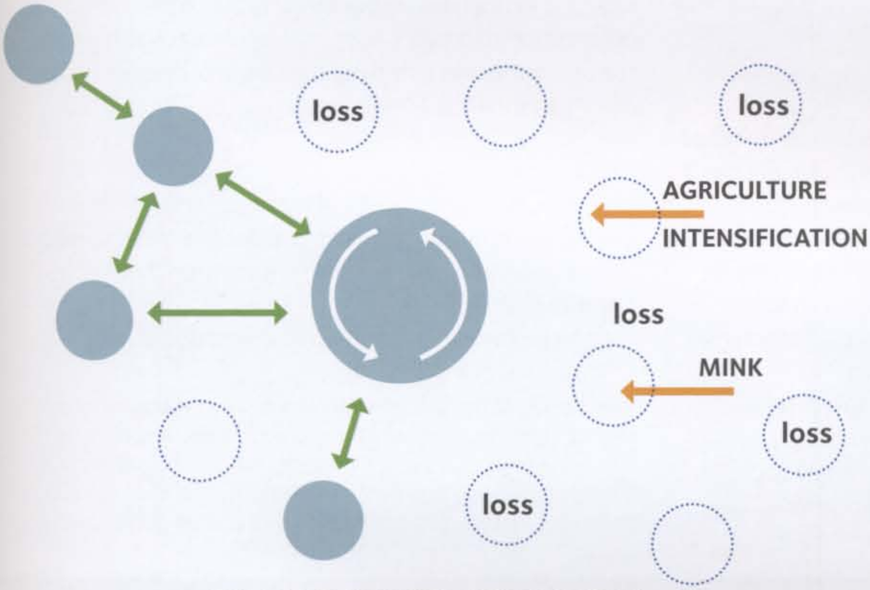


Figure 3:3
Water vole metapopulations have been found to collapse in the face of habitat loss and degradation due to agricultural intensification, and the arrival and spread of American mink throughout Britain.

other such habitats. In particular:

• A wide, luxuriant fringe of waterside vegetation is essential for water voles and this can be drastically reduced through inappropriate management (such as overzealous mowing or strimming of the banks where there are footpaths). Bank mowing and vegetation clearance may also put the water voles at risk to being more easily hunted by predators.

• Insensitive river engineering, bank protection and maintenance works (e.g. de-silting operations) can damage habitats.

• Urbanization of the floodplain has lead to direct habitat loss and containment of the river channel with sparse vegetation along the margins.

• Heavy grazing pressure from domestic livestock not only denudes riparian vegetation but may make sites untenable for water voles by poaching and trampling the banks.

• Cessation of historical management patterns can lead to the degradation of a site through silting up, drying out or scrubbing over.

Survival of water vole populations can only be ensured through increased connectivity between the various colonies, allowing range expansion and dispersal of the water voles. This is best achieved through habitat enhancement and restoration projects adjacent to the present colonies (see Chapter 5).

3.2 PREDATION BY AMERICAN MINK (SEE ALSO CHAPTER 7)

Water voles in Britain coevolved with a suite of predators, and were widespread before the arrival of American mink. American mink are able to counter the water voles' anti-predator behaviours, because they swim well, hunt efficiently and the females can fit down water voles' burrows. American mink can disperse very large distances (20–40km has been recorded), and so are easily able to colonize new areas.

Water voles are particularly vulnerable to female American mink once they have colonized a waterway. The regular foraging of a nursing female mink is likely to locate all local water vole colonies and most individuals in a given habitat. However, where the riparian habitat provides dense cover for water voles (such as expansive wetlands of inter-connecting waterways and ponds or among reedbeds), the impact of mink predation appears to be lessened (Carter and Bright, 2003).

3.3 OTHER THREATS

FLUCTUATIONS IN WATER LEVEL

Food, cover and burrows along waterways will be affected by fluctuations in water level. Land drainage, development of hydroelectric dams, flood control and abstraction policies can all increase impacts. Refuge areas for water voles during flood events are essential and these may be backwater pools or high banks. This may be a limiting factor at a number of waterway stretches that otherwise offer favourable water vole habitat.

Drought conditions may be just as detrimental as severe flooding when channels dry out completely. Exposed burrows may be particularly vulnerable to terrestrial predators such as stoats and weasels.

POLLUTION

Contaminants of the freshwater and riparian environment include organo-chlorine insecticides and their metabolites, alkyl-phenols, polychlorinated bi-phenyls, heavy metals and farm waste pollution. Their effects on water voles remain unknown and may have had a direct effect in the past. However, improved environmental legislation, monitoring and enforcement of discharge consents, together with pollution prevention advice and the diminished use of many of these contaminants have led to improved water quality throughout Britain in recent years. A new suite of chemical pollutants that act as endocrine disruptors may be a cause for concern as this could impact on breeding success. More research is required to confirm these fears.

PERSECUTION

Poisoning by rodenticides either directly or indirectly when used for brown rat control may be responsible for some localized extinctions, especially in urban areas. Direct persecution to protect bank erosion or leakage may also still present a risk, as indeed may control operations for rabbits or moles in floodbanks.

RATS

The occurrence and effects of leptospirosis and other diseases recorded in brown rat populations and their possible transmission to water voles are presently unknown. The rats themselves may also pose a risk to water voles by either acting as a competitor or even as a predator of young voles.

Fighting is common among water voles, but rarely captured on film. Disputes may result in overt fighting with boxing and biting until the vanquished is chased away. Deep bites may sometimes be fatal. Usually aggresive encounters are avoided by individual voles defining their territory through scent marking – this is my patch, keep out!

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Andrew Parkinson

WATER VOLE SURVEYS

1 WHY SURVEY?

As with many mammals, a direct sighting of the water vole is not always possible. The presence or absence of water voles, therefore, has largely to be determined by survey for the species' characteristic fieldsigns as described in Box 4:A below.

To implement the Biodiversity Action Plan for the water vole, we need to find out where they occur and how

BOX 4:A WATER VOLE FIELDSIGNS

FAECES

Droppings are the most distinctive fieldsign. These are about 8–12mm long and 4–5mm wide, cylindrical with blunt ends and symmetrical (**1**). The colour varies from green, brown, black and even purple, depending on what food has been eaten and its water content. They have the texture of putty when fresh but when dry may show green concentric rings of fine plant material if broken open. Rat droppings are always larger than water vole droppings and have an unpleasant odour.

1

LATRINES

Although a few droppings may be found scattered along runways, most are usually deposited at discrete latrine sites near the nest, at range boundaries and where they leave or enter the water (**2,3**). Latrines are established and maintained from February to November. Scent from the lateral flank glands is deposited on the latrine when the vole drum-marks with its hind feet, so that many latrines often show a flattened mass of old droppings, topped with fresh ones (**6**). Rat droppings on the other hand tend to be scattered along their runs, or deposited in latrine sites away from the water's edge, often in dark corners under bridges.

2

3

FEEDING STATIONS

Food items are often brought to favoured feeding stations along voles' pathways or at haul-out platforms along the waters edge. These show feeding remains as a neat pile of chewed lengths of vegetation (**4**). The sections are typically up to 10cm long showing the marks of the two large incisors and are quite good fieldsigns of presence of water voles (**5**). These chopped sections of vegetation are often taken into the burrow entrances by the voles (and laid up as stores along the tunnels or in chambers). By matching the pieces with the local plants growing on the bank the water vole diet can be determined.

Rat feeding stations may show collected and chewed tubers, piles of snail shells or fruits or even skinned frogs (during the frog spawning season).

4

5

BURROWS

Water vole burrow entrances are typically wider than high with a diameter of between 4–8cm (**6,7**). At the water's edge the entrances may occasionally appear larger due to erosion but the tunnel soon contracts down to the size of two fingers. Be aware that mole tunnels may be revealed by bank erosion and these can lead to confusion. Also sandmartin and kingfisher nest holes may resemble vole burrows, but these are largely constructed in the upper portion of an earth cliff rather than close to the water. Field vole, bank vole and woodmouse dig smaller burrows of 2–3cm across. Rat burrows are slightly larger in size (8–10cm) than those of water voles but are best told by a fan-shaped spoil heap outside the entrances and well trodden runs that link them up. Rat burrows are usually dug higher up the bank than those of water voles, although some vole colonies have been taken

6

abundant they are. The Action Plan aims to protect existing populations and ultimately restore them from where they have been lost. Distribution surveys of water voles are essential to describe the present distribution at the national, regional and local levels (Figure 4:1). Surveys for these purposes are necessary to maintain up-to-date

7

over by rats (the holes getting enlarged in the process). Externally, the burrow system appears as a series of holes along the waters edge, some at or just above the water level on steep banks, some opening below the water line and others occurring within the vegetation up to five metres from the water (for access to food and for ventilation (**8**)). At the water's edge spoil excavated from the burrows tends to be washed away while those burrows opening high on the bank are probably dug from underground as no spoil can normally be found around them.

LAWNS

Around land holes, grazed 'lawns' can be found (**8**). These frequently occur when the female is nursing young and time away from the nest is kept to a minimum. The female grazes the vegetation short to the ground within easy reach of the hole; often by not fully leaving the hole and being wary to dart back should danger threaten.

8

NESTS

Both males and females take bedding underground to line nest chambers in the burrow system. Nurseries consist of a large ball of finely shredded grasses or reed and the chamber entrance may be plugged by the female with loose soil or grass. Where vegetation cover is dense and the water table is high, nests roughly the size and shape of a rugby ball can sometimes be found above ground, often woven into the bases of rushes, sedges or reed (**9**).

FOOTPRINTS

Although footprints may be readily found along the soft margin of a water course (of many species besides water voles) they are not the easiest fieldsign to use. Large adult water vole tracks will appear very similar to those of juvenile rats. As with all rodents, the imprints show four toes in a star arrangement from the fore foot and five toes of the hind foot with the outer ones splayed, but often the tracks of the hind feet partially overlap those of the fore (**10**). The hind foot typically measures between 26–34mm and is noticeably smaller than that of the common rat at 40–45mm (heel to claw measurements). The brown rat is also heavier and so leaves a deeper impression.

9

The hind feet also show a pad arrangement that may allow distinction from brown rats (see illustration). Right and left tracks lie about 45mm apart and the stride averages 120mm.

Typically water vole tracks occur at the water's edge and lead into vegetation cover; rats on the other hand are more nocturnal and travel over more open ground under the cover of darkness.

RUNWAYS IN VEGETATION

These are most often found within two metres of the water's edge and take the form of low tunnels pushed through the vegetation. Pathway width may be 5–9cm broad and often branch many times, leading to the water's edge or burrow entrances or favoured feeding areas. Rat runs on the other hand are usually very obvious, as clear or bare pathways linking burrows and often running along the bank away from the water's edge.

10

All photos by Rob Strachan

records and to monitor the overall effect of water vole conservation actions in the UK.

Environmental Assessment surveys are reactive surveys which must occur prior to any work that may affect riparian habitat. These surveys provide data for assessing the impacts of developments, designing appropriate mitigation, and provide a baseline for monitoring (see Chapter 9).

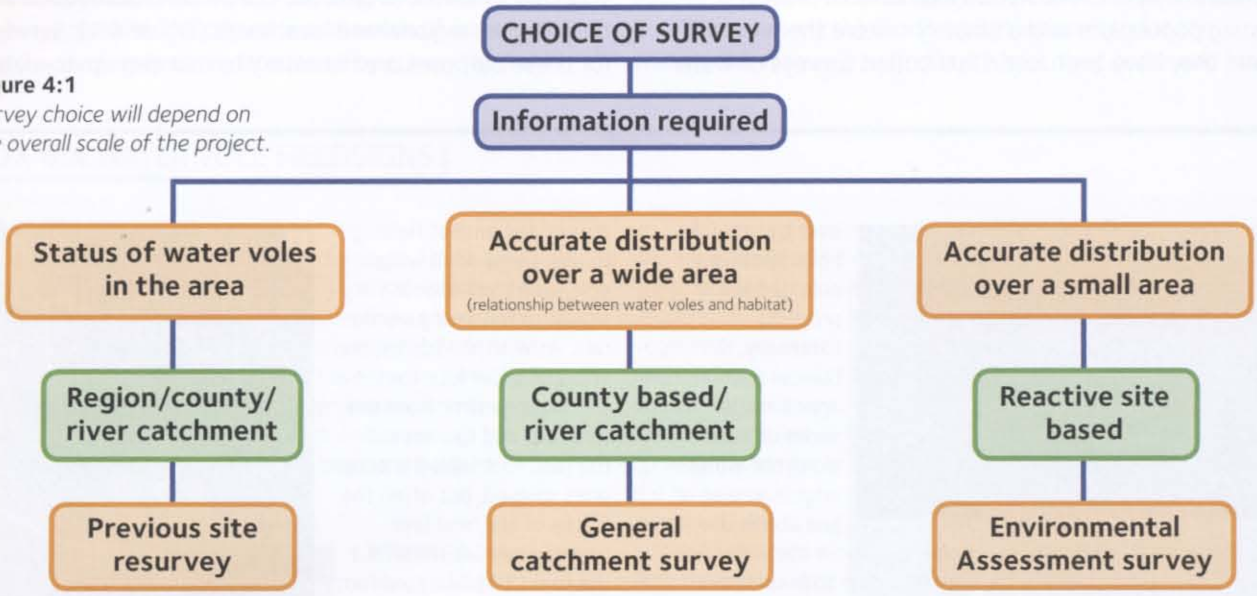


Figure 4:1
Survey choice will depend on the overall scale of the project.

2 DISTRIBUTION SURVEYS

To monitor changing population and distribution trends a national sampling survey is in place, designed by the Vincent Wildlife Trust, that covers 2,970 survey sites throughout England, Scotland and Wales, from which future repeat surveys could measure any declines, increases or stability in the population (at both national and regional levels) as well as any changes in distribution. Such a survey is not designed to find every, or even most, water vole colonies, but to provide an overview of the trends affecting the national population. The interval between the first two National Surveys was seven years (the baseline was carried out in 1989–90 and repeated in 1997–98). Further details of the methodology used in the National Survey are given by Jefferies (2003) and Strachan and Jefferies (1993).

More detailed local surveys can be nested within the National Survey structure. Local surveys can incorporate a greater frequency of sites along each watercourse, at 2km or 1km intervals or, better still, examine the entire system metre by metre. Water vole surveys can be overlaid onto River Corridor Survey maps where possible allowing habitat features to be examined in relation to water vole distribution. Local surveys identify gaps in the habitat and the level of fragmentation of the water vole population – and ultimately direct the focus of conservation effort.

The act of surveying for water voles does not require licensing in England or Scotland; however it is the view of the Countryside Council for Wales that the surveyor may trample water vole habitat and burrows and thereby cause disturbance. Each case will be need to be examined separately by CCW to see whether they require a survey licence to be issued.

3 REVISITING HISTORICAL SITES

One important starting point in determining the present whereabouts of water voles is to examine all the sites where the species had been previously recorded.

For a complement of previously known sites for water voles, old records and reports can be searched in order to extract accurately referenced and dated sightings of water voles. These include National Biological Network Records (usually based at local Biological Record Centres), Vincent Wildlife Trust survey sites (National Survey – lodged with JNCC), Environment Agency biodiversity records, The Wildlife Trusts, BTO Waterways Survey, Local Mammal Reports and information from local naturalists.

Not only would this help focus survey effort, but the proportion of sites still supporting water voles would indicate the severity of any local decline.

Each site should be surveyed according to the field techniques described below, recording data on standard recording sheets for each 500m searched. Where water voles are found to survive, the extent of the colony upstream and downstream of the site should be determined where possible.

The UK Biodiversity Action Plan process has required that national aims and objectives are met through local initiatives that arise out of local Biodiversity Action Plans. These focus their delivery to specific areas, such as whole Counties, defined administrative areas, whole or part river catchments or specific conservation sites. Published actions and target dates for their implementation, have given the impetus for much detailed survey work to be carried out for the water vole, establishing local baseline surveys through which to monitor the success of the various local conservation initiatives.

Many County-based or river catchment-based surveys have now been completed, often in great detail (such as contiguous 500m stretches along a waterway). Collectively, this detailed survey effort has been immense involving several hundred thousand mapped and recorded sites across the UK mainland together with the whole island surveys of Anglesey and Isle of Wight. Much of this survey work has been commissioned or co-funded by the Environment Agency, English Nature, Countryside Council for Wales, Scottish Natural Heritage, British Waterways and the public Water Utilities (such as Thames Water, Wessex Water, Severn-Trent Water etc.). The Wildlife Trusts in each County, together with a few professional survey teams have carried out the work.

4 GENERALIZED CATCHMENT SURVEY

Catchment-based surveys provide a regional overview, which ignore the artificial constraints of political boundaries but are determined by local geography and hydrology – more natural systems that have a direct bearing on riparian mammal species.

Hydrometric areas may be surveyed in their entirety, metre by metre, to give a complete and accurate picture of a species' distribution and so demonstrate the integrity of the riparian habitat corridor. It is important that the survey includes ditches and small backwaters off the main river channel, as well as ponds, lakes, flooded gravel pits, reservoirs and lochs. Where they occur, canal sites should also be included as they can provide ideal habitat for the species.

The approach to carrying out a generalized catchment-based survey is one of attempting to cover as much of the catchment as possible in a systematic way. Where possible the main watercourse, its tributaries and headwaters should be surveyed with additional sampling of a series of adjacent 1km squares to provide information on field boundary ditches and static water bodies. Urban watercourses may be particularly fruitful for locating water voles since they may provide a refuge area from many predators of the wider countryside. Information on riparian habitat as well as information on the presence of riparian mammals should be gathered simultaneously.

The steps involved in selecting which areas to survey are as follows:

- Establish the broad outline of the catchment from Environment Agency catchment maps.
- Overlay the catchment area on to Ordnance Survey 1:25,000 maps (Pathfinder series).
- Mark areas on the map which may contain possible water vole habitat, progressing through each of the catchment 1km squares by:

(i) Delineating all water courses, water bodies and wetland areas within parcels of land that suggest flat or gently sloping gradient (interpolates between the drawn 10m contour lines should be greater than 4mm apart on the map).

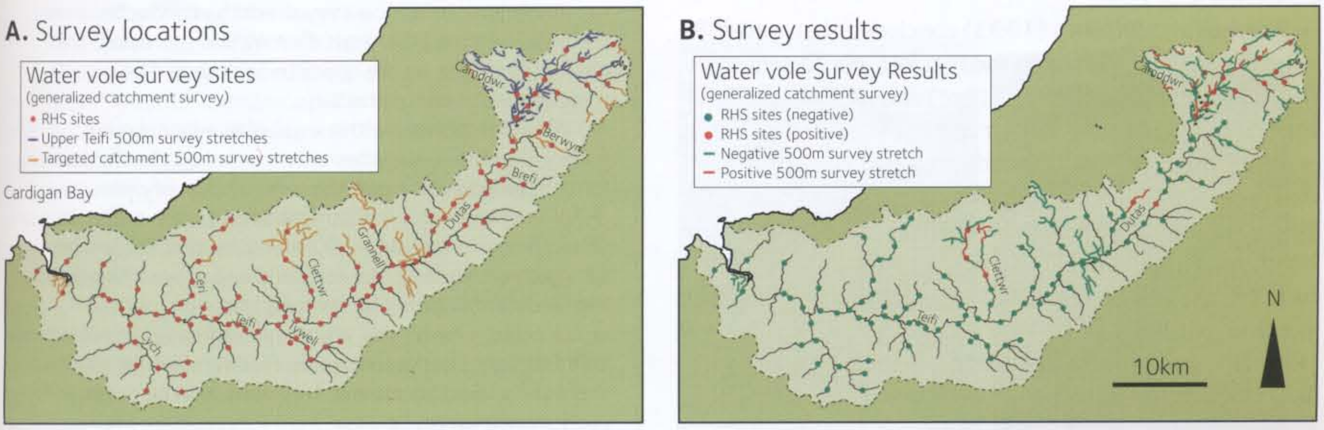


Figure 4:2

Generalized catchment survey of the River Teifi, Wales: ***A.*** *location of survey sites showing complete systematic search ofthe upper catchment and river habitat survey sites in the remaining part;* ***B.*** *results indicating the fragmented distribution of watervoles surviving in 1998 (source: Macdonald and Strachan, 1999).*

(ii) Where the gradient of the landform is very steep (with water falls, etc.) or the water course is very rocky by nature, then survey sites may be best sampled at a frequency of 2km intervals rather than intensively searched.
(iii) Exclude water courses with mature forest (broad-leaved woodland and conifer plantation) on both banks.
(iv) Exclude salt marsh, tidal estuaries and coast.
(v) Include isolated large ponds, lakes, moats and other static water bodies that may support water vole populations.

- Number the 1km squares which contain more than 1000m total length of possible water vole habitat and record their grid references.
- Designate 500m sections of waterway for field survey within each 1km squares by the following methods:

(i) Select approximately one third of the upper catchment for the complete systematic search of contiguous 500m sections to provide continuous metre by metre information along all the suitable waterways and the isolated water bodies and wetlands out-with the river course. This approach allows for the majority of the uppermost water vole colonies to be identified and allow for any patterns of fragmentation to be interpreted. If possible the water vole distribution should be overlaid on to any existing River Corridor Survey habitat maps where appropriate and so help to interpret any relationship with available habitat, riparian management and adjacent land-use.
(ii) For the remaining catchment, sample the statutory main river and tributaries according to River Habitat Survey site selection recommendations. Starting from the tidal reaches, mid-point grid references are identified at 2km intervals (using a map-wheel), each site being the standard 500m length.
(iii) Using the results found in both (i) and (ii) above, target a random sample of the remaining 1km squares with over 1000m length of possible water vole habitat (this method should be used where time constraints or resources preclude a more detailed investigation).
(NB: where 1km squares may contain a large amount of possible water vole habitat and distinct differences in available water body types, the sampling intensity in those squares should not exceed 2000m of riparian bank length, but never the less be proportional to availability of waterway types).

- For each 500m section searched, standard field survey techniques should be followed as described in Box 4:B.
- Ponds and still waters may act as refuges for water voles where riparian habitat has been degraded. Where these sites can be surveyed the total perimeter should be searched and the distance recorded on the survey form.
- For each 500m section, survey data should be recorded on the standard survey recording sheets as described in Box 4:B below.
- Each site should be searched for water voles over a distance of 500 metres along the watercourse bank (one bank only). The field survey can usually be divided into 250m upstream and 250m downstream of the mid-point grid reference. Approximately 45–60 minutes should be spent at each site.

5 UPLAND SURVEY STRATEGY

Due to the additional difficulties of working within the terrain of uplands areas in the UK, the lowland survey strategy described would be inefficient in these habitats. In these cases a simple selection strategy makes the most efficient use of time.

- Strachan and Jefferies (1993) concluded that water voles are not to be found on the rockiest, nor fastest flowing streams (i.e. steep gradient) and these areas should be omitted from the survey.
- Identify the parts of the study area that consist of mainly peatland, and with gently sloping or level ground (less than three percent gradient). These areas are those in which water voles were most likely to be found and thus form the basis of the survey. Maps can be easily generated in GIS to help focus the survey effort.
- Within this patchwork of 'suitable' habitat, randomly select 500 metre stretches of waterway for survey in the same manner as for lowland habitats.

BOX 4:B GENERAL METHODOLOGY FOR

- Field work should be confined to the optimal period of finding water vole breeding territories, marked by latrines (late April through to early October).
- Survey only needs be conducted from one bank of a given length of waterway. If, however, one bank has unsuitable or extremely poor habitat, survey should be conducted from the bank with the best vegetation. Whilst surveying, any obvious fieldsigns on the opposite bank should be noted, through binoculars if necessary.
- For 500m sections within a generalized catchment survey, signs of water voles are recorded on standard survey forms (see Figure 4:3 and Appendix 3) at every site.
- For Environmental Assessment surveys, the entire site should be split into 50m–100m lengths, preferably with a GPS grid reference for the start and end of each length, and the fieldsigns recorded for each section.
- For either survey type, the number of each type of water vole fieldsigns (latrines, burrows, feeding signs etc., below) should be ranked **abundant**, **frequent**, **scarce** or **none** for each section surveyed.
- Fieldsigns to record include (in approximate order of usefulness as an indication of occupation and for

6 ENVIRONMENTAL ASSESSMENT SURVEY

Environmental Assessment is a process to ensure that the environmental impacts of potentially damaging schemes are identified before a decision is taken on whether a proposal should proceed. This is discussed in more detail in Chapter 9. This allows the best practical environmental option to be selected at an early stage in the planning process. Projects can then be designed or modified to avoid or minimize potentially adverse impacts on habitats or species.

Information on water voles should be collated through both a desk-based review of existing data, for the site and surrounding area, and a field survey. The study area for both types of survey, and the level of detail required will be dependent upon the type and scale of any potential impacts.

6.1 DESK STUDY

Any existing information on water voles within a 2km radius of the site should be collated and assessed through a desk study, by contacting relevant organizations and individuals, as described under 'Revisiting historical sites' above. This information will assist the assessment of the level of 'importance' or 'value' of any water vole populations affected, and inform the identification of impacts beyond the proposed development site, such as population fragmentation (see Chapter 9). In addition, data relating to water vole populations in the local area may also assist in the selection of mitigation options. In certain cases, for example for large schemes with a major impact on water voles, or for schemes requiring the translocation of individual animals, it is likely that the study area would need to be extended to a 5km radius.

6.2 FIELD STUDY

A field survey will always be required for any proposed development affecting habitat potentially suitable for water voles. Such surveys should include all areas of habitat suitable for water voles which could be directly affected by the proposals, and should extend some distance from the site boundaries to inform impact assessment and mitigation (see Chapter 9). The distance from the site which will need to be surveyed in detail will be dependent upon the nature and magnitude of potential impacts. For a small-scale development affecting a 50m length of habitat, it would be appropriate to extend the survey 50m upstream and downstream of the site boundaries. For large scale developments affecting several hundred metres of habitat, and which could result in population fragmentation as well as habitat loss, it would be appropriate to extend the survey for up to 500m upstream and downstream of the site.

Field surveys for development projects should initially aim to confirm the presence or absence of water voles from the site and the surrounding area. If water voles are present, the survey will have several further aims:
1) To assess the status of the population and the

SITE-BASED WATER VOLE SURVEY

density estimates):
- Latrines, showing discrete piles of droppings;
- Feeding stations or chopped vegetation;
- Tunnel entrances above and below water with a cropped 'garden' or 'lawn' around the tunnel entrance;
- Paths and runs at the water's edge, runs in the vegetation and footprints in the mud;
- Sightings, sounds of entering water.

• The best index of abundance is the number of latrines counted. This provides an indication of relative density of water voles, based on the presence of breeding individuals (visiting and maintaining latrines) at that site and is useful for comparison between sites and future surveys. Very approximately six latrines equate to one female territory, and therefore one 'breeding unit', although this may vary markedly between habitats (see *Interpreting the survey results*, below).

• For either survey type, habitat for the site as a whole should be recorded on the standard survey forms (see Figure 4:3 and Appendix 3).

• The presence/absence of mink, otter and brown rat signs at each site should also be recorded, noting the relative abundance of footprints and droppings located along the 500m distance. These should be marked on the sketch map together with the position of the water vole signs.

• Supply your survey records (positive and negative) to the local records centre, local Wildlife Trust, Environment Agency and SNCO.

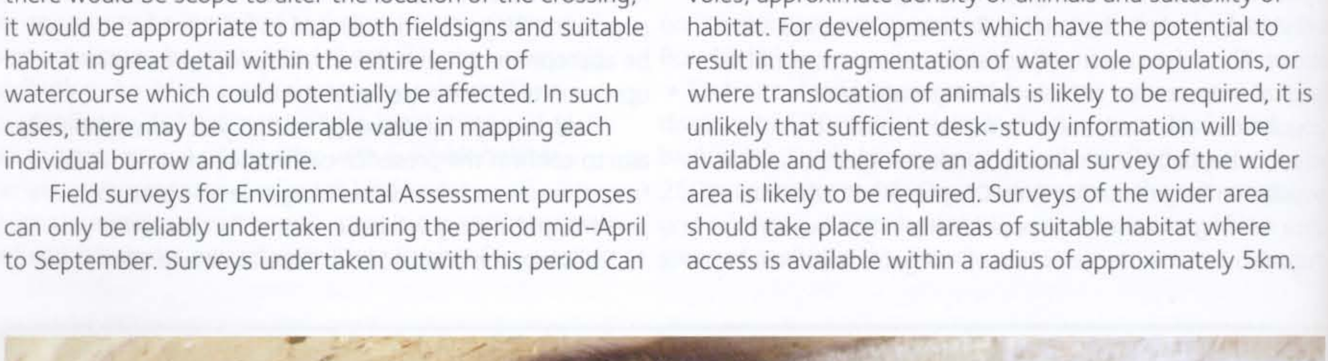
Water vole surveyors at work in contrasting habitats.

proportion of the population likely to be affected;
2) To assess the value of the habitat that would be affected, as well as that adjacent to the site, and provide a comparison between the two;
3) To map the relative value of the habitat and the relative density of water voles at a scale which could inform either the location of the development to minimize impacts; and
4) To provide a baseline for monitoring the success of any mitigation measures implemented.

The scale at which habitat suitability and water vole fieldsigns need to be mapped will therefore be dependent upon the potential value of this information. For example, a development which would require the diversion of several hundred metres of a watercourse, and where there is no scope to alter the location of the proposals, should assess the value of the habitat and the density of fieldsigns within the affected section and adjacent sections (of a similar length to the affected area). In such cases, there would be little point in mapping each individual burrow or latrine. However, for a pipeline crossing of a watercourse, where there would be scope to alter the location of the crossing, it would be appropriate to map both fieldsigns and suitable habitat in great detail within the entire length of watercourse which could potentially be affected. In such cases, there may be considerable value in mapping each individual burrow and latrine.

Field surveys for Environmental Assessment purposes can only be reliably undertaken during the period mid-April to September. Surveys undertaken outwith this period can only confirm the presence of water voles and not absence; they should also not be used as a means of informing impact assessment or mitigation options except in very straightforward cases (such as where the affected habitat is clearly unsuitable or very poor in comparison with adjacent areas). Water voles can react quickly to slight changes in habitat suitability, such as drying out of a wetland area or watercourse, management works, or vegetation growth. It is therefore advisable that any Environmental Assessment is based on field surveys conducted at either end of the season (i.e. one visit in mid-April, May or June, and a second visit in July, August or September). Surveys undertaken immediately following management works can be misleading and should be avoided.

Where insufficient desk-study information is available on water voles in the surrounding area to inform the assessment of impacts or the appropriate mitigation, it may be necessary to undertake surveys of the wider area around the site. These surveys are likely to comprise only a 'spot-check' to record the presence or absence of water voles, approximate density of animals and suitability of habitat. For developments which have the potential to result in the fragmentation of water vole populations, or where translocation of animals is likely to be required, it is unlikely that sufficient desk-study information will be available and therefore an additional survey of the wider area is likely to be required. Surveys of the wider area should take place in all areas of suitable habitat where access is available within a radius of approximately 5km.


Tom Moorhouse

7 RECORDING WATER VOLE HABITAT INFORMATION

This can be recorded in two ways: by filling a series of tick-boxes on a simple pro-forma that summarizes the habitat features over the length surveyed, and by drawing an annotated map of the site (a simplified version of the River Corridor Survey and its associated symbols; Figure 4:3 shows a completed recording form). Where copies of River Corridor Survey maps are available depicting each 500m section of the waterway, the precise location of the fieldsigns of the riparian mammals can be marked directly onto them.

- ***Site details:*** it is essential to provide accurate Ordnance Survey grid reference coordinates for the mid-point of the survey. Each site should be named, with that of the watercourse and any other local landmark (such as a farm or village).
- ***Habitat:*** tick the relevant box that best describes the watercourse or water-body.
- ***Shore/bank:*** tick more than one box if required, that best describes the predominant bank substrate.
- ***Bordering land-use:*** tick more than one box if required and mark symbols on the accompanying map. Note whether the banks are fenced or not and whether the site is grazed by horses, cattle or sheep. Record where banks show extensive poaching and trampling.
- ***Vegetation cover:*** for each of the vegetation types, estimate the overall amount of cover provided for the 500m section. Record them using the following DAFORN categories:

Dominant	81–100%
Abundant	61–80%
Frequent	41–60%
Occasional	21–40%
Rare	1–20%
None	0%

- ***Disturbance:*** note disturbance at the site from human recreation (boating, angling, dog-walking etc.) and any recent river engineering or bank maintenance work.
- ***Bank profile:*** estimate the overall angle of the bank from the river (mark any cliffs or undercut sections on the map). If possible determine any previous channel realignment, resectioning or bank reprofiling.
- ***Depth:*** estimate the overall average midstream depth, but note any deep pools on the map.
- ***Width:*** estimate the width of the watercourse in metres. A useful guide is to imagine how many tall people (2m) could lie across the river head to toe.
- ***Current:*** how fast is the watercourse flowing? Estimate the speed by watching the midstream passage of a small stick floating on the surface.
- ***Wildlife information:*** tick the relevant boxes of the fieldsigns found and provide counts of latrines, burrows and feeding stations over the 500m length.
- ***Sketch map of site:*** draw a representation of the watercourse and mark on important features such as pollarded trees, extensive areas of emergent vegetation and areas of scrub. Select symbols from the sketch map prompt on the sheet and use the appropriate codes to describe adjacent land-use. Mark important areas of water vole activity with target notes (mink and otter signs can be similarly marked).
- ***Additional comments:*** describe any evidence of pollution at the site and information on water level management. Note whether any known water abstraction occurs that may affect the site. Note level of flood debris position from winter flooding (trash line above current water level) and any signs of summer drought/drying out entirely. If water voles are present note whether the colony extends further upstream or downstream.

WATER VOLE SURVEY FORM

BACKGROUND INFORMATION

Site name/river: **Eastern Yar, Alverston, I.O.W.**

Site number: **105** 10km square: **SZ58** Grid ref: **SZ 577855**

County: **Isle of Wight** Water Authority: **Southern**

Recorder: **Rob Strachan** Date: **30 / 03 / 1997**

HABITAT INFORMATION (mark features on map)

Survey distance: **0.5** km

Habitat
- ☐ Ditch
- ☐ Dyke
- ☐ Gravel pit
- ☐ Pond
- ☐ Lowland lake
- ☐ Upland loch
- ☐ Reservoir
- ☑ Running water
- ☐ Marsh/bog
- ☐ Canal

Shore/bank
- ☐ Boulders
- ☐ Stones
- ☐ Gravel
- ☐ Sand
- ☐ Silt
- ☑ Earth
- ☐ Rock cliffs
- ☐ Earth cliffs
- ☐ Canalized
- ☐ Poached
- ☑ Reinforced (man-made)

Bordering land use
- ☐ Upland grass
- ☑ Permanent/temporary grass
- ☑ Mixed broadleaf woodland
- ☐ Conifer wood
- ☐ Peat bog
- ☐ Arable crop
- ☐ Salt marsh
- ☐ Urban/industrial
- ☐ Park/garden
- ☐ Heath
- ☐ Fen
- ☐ Cattle/grazing
- ☐ Bank fenced?

Vegetation (DAFORN)
- **F** Bankside trees
- **O** Bushes
- **F** Herbs
- **F** Submerged weed
- **A** Reeds/sedges
- **F** Tall grass
- **R** Short grass

Disturbance: **2**
Footpath & anglers

Bank profile
- ☐ Flat < 10°
- ☐ Shallow < 45°
- ☑ Steep > 45°
- ☐ Vertical/undercut

Depth
- ☐ < 0.5m
- ☑ 0.5–1m
- ☐ 1–2m
- ☐ > 2m

Width
- ☐ 1m
- ☐ 1–2m
- ☑ 2–5m
- ☐ 5–10m
- ☐ 10–20m
- ☐ 20–40m
- ☐ > 40m

Current
- ☐ Rapid
- ☐ Fast
- ☑ Slow
- ☐ Sluggish
- ☐ Static

WILDLIFE INFORMATION

Water voles
- **2** Sightings (count)
- **22** Latrines (count)
- **36** Burrows (count)
- ☑ Footprints
- ☑ Pathway in vegetation
- ☑ Feeding remains
- ☐ Cropped grass around tunnel entrance

Rat **None**
- ☐ Sightings
- ☐ Droppings
- ☐ Footprints/runs

Otter **None**
- ☐ Sightings
- ☐ Droppings
- ☐ Footprints/runs

Mink **None**
- ☐ Sightings
- ☐ Droppings
- ☐ Footprints/runs

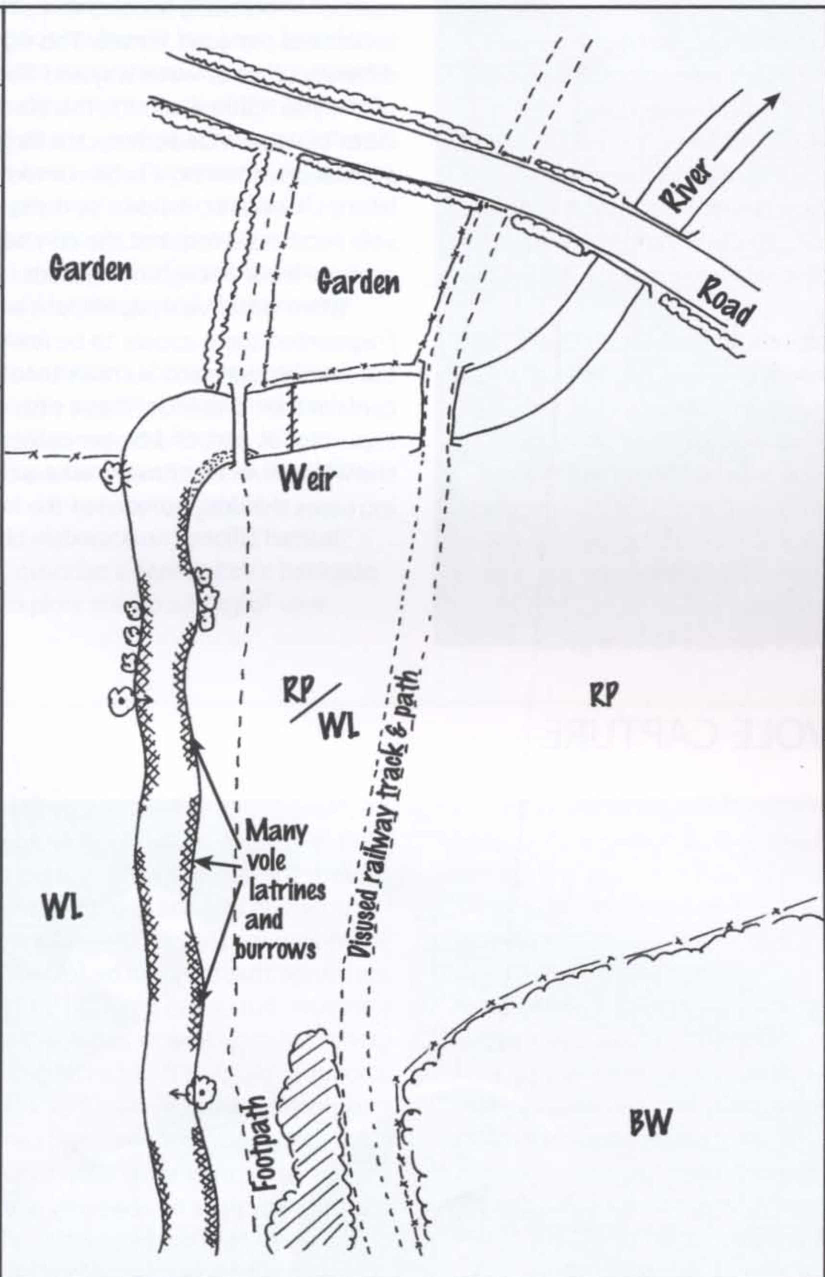
Other wildlife
- ☑ Coot
- ☑ Moorhen
- ☐ Kingfisher
- ☐ Heron
- ☑ Waterfowl
- ☐ Dipper

Identified plants from feeding remains: Carex paniculata, Glyceria, Ranunculus, Salix spp (flower buds)

SKETCH OF SITE – vole activity indicated (if any)

KEY TO SYMBOLS
(mark route surveyed and direction of flow)

- Mature trees
- Over-hanging branches
- Fallen tree
- Exposed roots
- Pollarded tree
- Sapling
- Scrub
- Hedgerow
- Fence —×—×—×—
- Reed/sedge bed
- Flood bank
- Artificial bank
- Earth cliff



ADJACENT LAND-USE CODES

Broadleaved wood	BW
Conifer plantation	CP
Moorland/ heath	MH
Rough pasture	RP
Wetland	WL
Improved grass	IG
Tilled land (crop)	TL
Suburban/ urban devel. (inc. gardens)	URB

OTHER FEATURES

Roadbridge	
Footbridge	
Weir	
Culvert	
Ford	
Outfall	
Dredgings/ spoil	
Silt bars	
Islands	mark position and size

ADDITIONAL COMMENTS:

Water level management
Signs of drying out
Flood debris position
Evidence of pollution

Weir allows for stable water condition throughout the year.

Adjacent wetland has pool and greater tussock sedge - many signs of water voles.

Water voles eating, greater tussock sedge, reed sweet grass, water crowfoot, water cress, willow.

Figure 4:3
An example survey form completed during a survey of the Isle of Wight.

8 INTERPRETING THE SURVEY RESULTS

Survey results need to be put into context. Background information on relative status and distribution is therefore paramount in determining the importance of a particular site and the extent of the water vole colony it supports. The two National Surveys (published by the Vincent Wildlife Trust in 1993 and 2003 respectively) provide an overview at both national and regional levels.

On current information (suggesting a catastrophic national loss of water vole sites in Britain) there are strong conservation arguments to retain every large water vole colony located.

The number of water vole latrines counted at a site (during the breeding season) gives an indication of the strength of the water vole colony. Morris *et al.* (1998) published a predictive equation that describes the relationship between water voles and latrine numbers (based on intensive water vole trapping along stretches of two Yorkshire rivers), $y = 1.48 + 0.683x$, where y = water vole numbers and x = number of latrines. This equation is unlikely to provide a robust estimate in all habitat types. This notwithstanding, there appears to be a good correlation between maintained large latrines and the number of breeding females at a site: very approximately six latrines per adult female. This figure too may vary for differing types of waterway and also for different months of the year. Latrine counts, therefore, provide a very useful index of water vole activity, the larger and more robust populations showing a large number of closely packed latrines. However, if a precise numerical estimate of water vole numbers is required the only accurate method is via capture-mark-recapture methods.

When water vole populations are small and fragmented there appear to be fewer maintained latrines, but feeding signs and burrows (and even sightings) confirm their presence. These sites may be equally important as part of a bigger collective population over the whole river catchment, where the survival of each site increases the likely survival of the neighbouring site.

10 WATER VOLE CAPTURE

The provision of full protection for water voles under Section 9 of Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) in 2008 means that any attempts at catching this species will require licencing from the appropriate Statutory Nature Conservation Organization (see Chapter 2).

In any live-capture procedure, there is a potential to compromise the welfare of trapped animals. Live trapping should therefore only be conducted by experienced personnel. Capture of water voles may be necessary for detailed scientific study, for an accurate population census, or in extreme cases, if the population requires removal from a site threatened with destruction (see also Chapter 9). For scientific studies and population censusing, the capture will most likely be part of a Capture Mark Recapture (CMR) study, in which individuals are captured, marked and then released over a period of some days. For water vole relocation or translocation, individuals will be removed from the site on capture.

Water voles are relatively easy to capture, especially during the breeding season when they are frequently patrolling their home range. The key to a successful trapping exercise is the location in which the traps are placed and the use of a suitable bait. It is important that any water vole capture is conducted by experienced personnel, since the potential for compromising the welfare of many individuals is high if live-capture is not conducted in an appropriate manner.

Many types of traps are available for capturing water voles, and some of these are listed in Appendix 1. In general, the larger the trap the better since this will allow the provision of good quantities of food and bedding. Sherman traps (*http://www.shermantraps.com*) have the advantage that they can be folded flat for ease of transport, but unless the XLF15 (15 inches long, with galvanized steel treadle and door) are used, may limit the amount of bedding that can be provided. Other designs incorporate a separate nest box which allows plenty of room for bedding and food, and can make transport of animals easier over short distances. The disadvantages are that these designs can be bulky and fiddly to set. In general designs with nest boxes or which allow the addition of lots of bedding and food are preferable, but logistical factors for a given project may limit trap choice to those which are easy to transport and handle in numbers.

10.1 WHERE AND HOW TO PLACE AND SET THE TRAPS

Between April and October, latrines are regularly visited by resident water voles, and by placing a trap immediately beside a latrine, success is almost guaranteed.

- Trapping should only be conducted by experienced personnel. Trapping has large potential to compromise the welfare of individual animals and to lead to mortality. Moreover, incorrect trapping will result in a lowered capture success which will give biased survey results, or,

9 | SITE SPECIFIC RECOMMENDATION

The basic premise for the conservation of water voles in the particular catchment, as anywhere else in the UK, is one of protecting the species where it has been found to occur and encouraging it to expand into adjacent suitable habitat. Throughout the catchment much of the former wet margins, backwater ditches and adjacent areas of wet rough pasture may have been lost. The restoration of large swathes of bankside vegetation and the creation of additional wetland habitats (pools, ponds and interconnecting ditches) within and adjacent to where water voles survive should be the goal of the recovery programme for the species.

Site specific recommendations should be used to provide linkage between the fragmented and isolated colonies at the various tributaries and ditches. Where necessary, mink control as a conservation tool should be included (see Chapter 7). Where appropriate the recommendations should elaborate on specific habitat enhancement schemes, describe where suitable bankside fencing is required and explore the possibility of new habitat creation.

Pringles tubes are handy devices for handling voles with minimum stress.

if trapping for mitigation purposes, lead to a partial failure of mitigation.

- Brand new traps are unlikely to successfully capture water voles if they smell unfamiliar. It is advisable to scrub traps out and soak them in river-water overnight before the first use.
- Traps should be set with **at least** half an apple and one carrot placed in the back of the trap, behind the treadle. The apple keeps the water voles hydrated and the carrot provides more solid nutrition. The apple should be placed flat against the back of the trap, and the carrot arranged so that it holds the apple in place (usually in an inverted 'L' shape, with half of the carrot above the apple and half down the side). If, on checking, you find that the majority of captured individuals have no food left, increase the quantities when setting traps. The food can be held in place with hay for bedding to prevent it interfering with the treadle. It is necessary, however, to leave at least some clear path to the food through the bedding, or the door is likely to be jammed open by bedding removed by water voles attempting to get to the food. Apple and carrot should be replaced after four days in any trap.
- Placing a small (1/16th of an apple) slice of apple on, or near the door encourages water voles to discover the trap. It is common for the apple to be taken, but the trap not sprung on the first day of trapping.
- Traps should be set at 15m intervals along the length of the water course(s). Longer intervals will increasingly result in individuals remaining untrapped.
- When setting traps it is very important that the treadle works efficiently. Each trap should be checked to ensure that it will close with slight pressure on the treadle. If it does not, it needs adjusting until it does. Malfunctioning traps could, for instance, allow one individual to remove the food, and then capture another individual which would have no food for an extended time. This can result in water voles dying.
- Traps should be positioned perpendicular to the water course so that the open end is nearest the water.
- Traps should be placed so that they are on a slight slope, such that the rear is higher than the front, high enough so that rapidly changing water levels would not risk drowning any captured animals.
- Traps should be thoroughly secured to the bank so that they do not tumble into the water when a vole is caught. This can be achieved by two methods:

1) A small channel dug into the bank at right angles to the watercourse may provide a long-term capture site, but if you intend to dig the trap into the bank permission must be sought from the landowner.

2) Otherwise, traps should placed in a heeled-in groove in the bank and pegged out with a short cane at each side, with a larger, flagged cane in front of the entrance, to prevent the trap slipping down the bank into the water. Water voles can easily fit into the trap past the cane.

- The entrance cane should be visibly flagged to prevent traps being missed during trap-checking. Traps must not be missed during checking, as any animal not released after 16 hours is likely to run out of food. A useful tip is to have three colours of flag and alternate the colours when setting the traps, so that, when checking, you know what colour the next cane should be, and can therefore identify if you have missed any traps. Numbering the traps is, however, the best method for ensuring none are missed.
- Traps should be covered with plenty of vegetation so that no metal is visible from the outside. During summer this keeps the traps cool. Later in the year, it keeps them warm.
- Trapping overnight is the most effective period, and most captures will be found in the morning. Traps should be checked at least twice a day (start checking before 8:00am and after 5:00pm on any given day), and preferably every four to six hours.
- Traps may be found by predators such as foxes which can destroy traps attempting to get to the contents. If this occurs, it is advisable to stop trapping for a number of days.
- Traps need resetting following a capture. They require thoroughly cleaning out, with anything that could obstruct the treadle being removed from the trap, if necessary taking it apart to ensure good operation of the treadle.
- Following a period of trapping, especially if traps are being moved between sites, they require thorough cleaning to prevent the transfer of disease. Traps should be dismantled and scrubbed out with odourless TriGene Virucidal Disinfectant (*http://www.medichem.co.uk/acatalog/Online_Catalogue_ Veterinary_Products_2.html*) or a similar disinfectant. It is very important that the product used does not have a strong odour as this will deter water voles from entering traps.

10.2 HANDLING THE CAPTURES

Water voles are easily stressed and have a very strong bite. They will need to be handled with care and with leather gloves for your own protection.

If water voles are being captured for Capture Mark Recapture purposes, they will usually require marking, sexing and weighing before release. Marking for CMR requires the use of a net. Handling for other reasons does not.

HANDLING WITH A NET

This is performed by running the water vole from the trap into a long bag of constructed of poly-mesh (such as landing-nets from fishing or keep nets), wide enough to fit over the entrance to the trap, and tying it shut behind the vole. It is important that the net fits over the trap with considerable overlap, and is held tight around the trap to prevent the vole escaping up the sides. Once in the bag the vole can be handled and tagged through the mesh.

Weighing can be achieved by weighing the vole in the bag, and then weighing the empty bag following release. Tagging is conducted using Passive Interrogation Transponders which are injected into the scruff of the neck and read by scanning the vole with a compatible reader. If performed correctly, this process is harmless, and can be performed on individuals as little at 50g in weight. However, due to the potential for inflicting harm on a water vole, transponder injection should only be performed by experienced personnel. Many companies supplying veterinary practises retail pre-packaged transponders mounted in sterile needles and dedicated readers.

HANDLING WITHOUT A NET

Water voles can be handled by gently emptying them from the trap into a pop-up garden waste container, such as those available from garden centres. These are cylindrical with an approx. 60cm diameter, constructed of tough synthetic cloth, and held upright by a coil of wire. Water voles can be removed from these containers for weighing and sexing by offering them the open end of an empty 'Pringles' tube (the potato-based snack food – these make excellent handling devices if thoroughly cleaned). As the water vole climbs into the tube (which can occasionally take some encouragement) it is relatively easy to gently grasp the base of the tail to allow the vole to be sexed. Water voles can be weighed in the tube and then gently shaken out to release them.

RADIO-COLLARING

Radio-tracking is a technique employed to track animals where an indication of ranging activities or dispersal rates of individuals is required. Radio-tracking, therefore, is generally only used for the purposes of scientific study of water voles' movements. Radio-tracking is not appropriate for deriving population estimates, or assessing the occupation of habitat. These goals can be more simply, and accurately, achieved by sign survey and/or CMR methods. The attachment of radio-collars to water voles can be very stressful for the individuals and recently doubts have been raised as to whether radio-tracking may have undesirable impacts upon water vole populations (Moorhouse and Macdonald, 2005).

HABITAT MANAGEMENT

In managing flood risks, many watercourses have in the past been modified to increase their capacity to store and carry flood water. This has typically involved techniques such as deepening and widening the channel by dredging, removal of fallen trees and other obstructions, straightening of the channel to remove meanders and channel realignment/re-profiling to remove the roughness of the banks. These changes to the channel have reduced the diversity of habitats and food availability for species such as water voles. In some instances the increased grass cover has been beneficial but the routine maintenance can directly impact on water voles and make them more vulnerable to predators.

Waterway channel, bankside, water level and vegetation management all have consequences for water voles. Thorough appraisal is essential well in advance of any work to ensure that any potential damage to water vole habitat is mitigated.

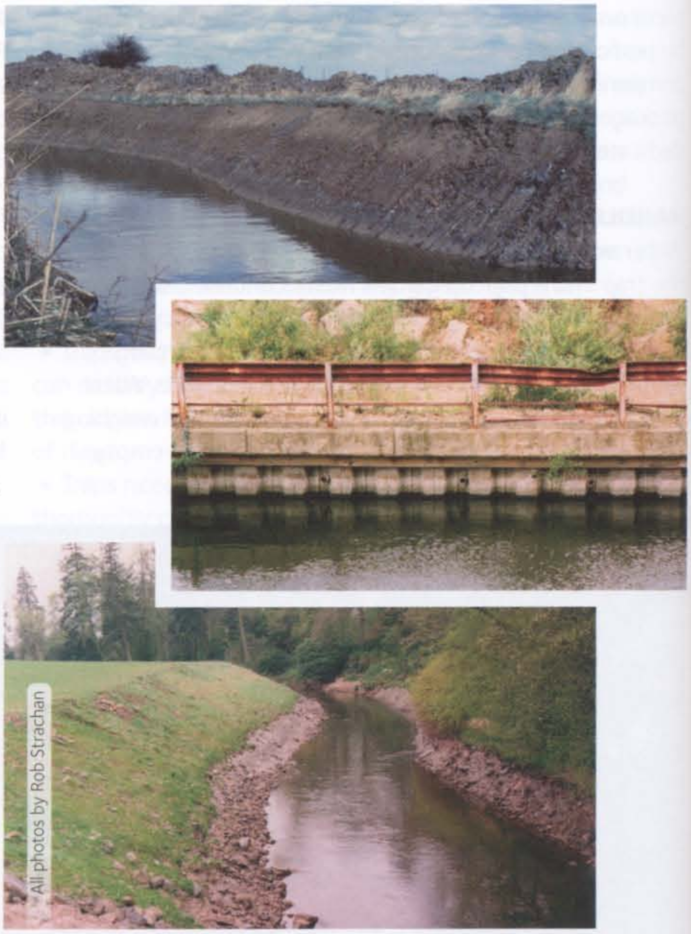
Canals are mainly artificial channels imposed on the landscape but they can provide important habitat for water voles, even on those waterways well used by boats. Though having maintenance and management operations in common with river channels, canals present some particular problems.

This chapter describes the best practice guidelines for water voles in the five areas of:

- River and canal engineering work.
- Water level management.
- Channel, marginal and bank vegetation management.
- Sustainable urban drainage systems
- Restoring water voles to farmland

Management advice is also essential to maintain existing water vole populations, encourage their spread and restore them where they have been lost.

The input of conservation specialists should be a requirement whenever the Environmental Assessment of a site reveals the presence of water voles, so that guidance on a site by site basis is given. Where possible, an alternative to the physical destruction of burrow systems should be sought when planning capital works.



Examples of over-engineered waterways and unsympathetic management.

1 | RIVER AND CANAL ENGINEERING WORK

Disturbance should be minimized by phasing engineering works. The length affected at any one time should be minimized with at least one year elapsing between action on adjacent lengths to allow recolonization.

Dredging and canalization are engineering processes that physically change the channel bed or banks through realignment, regrading or resectioning. Dredging and bank protection are regular maintenance activities on operational canals. Such work through good water vole areas should only be carried out where essential, and if possible small sections or nearby waterways or lateral channels left untouched to allow a refuge for survivors from which a new local population can be regenerated.

RETENTION OF FEATURES WITH WATER VOLE CONSERVATION VALUE

Where river channel management is required, as part of a Flood Defence improvement scheme or to increase flood water storage capacity, then working from one bank only is recommended, in line with current good practice. In most instances, it should be possible to leave stands and/or marginal fringes of emergent vegetation during the physical modification of the channel bed and banks to retain valuable habitat for water voles. This is particularly vital where there are voles present and there are no other nearby water features which may act as refuges.

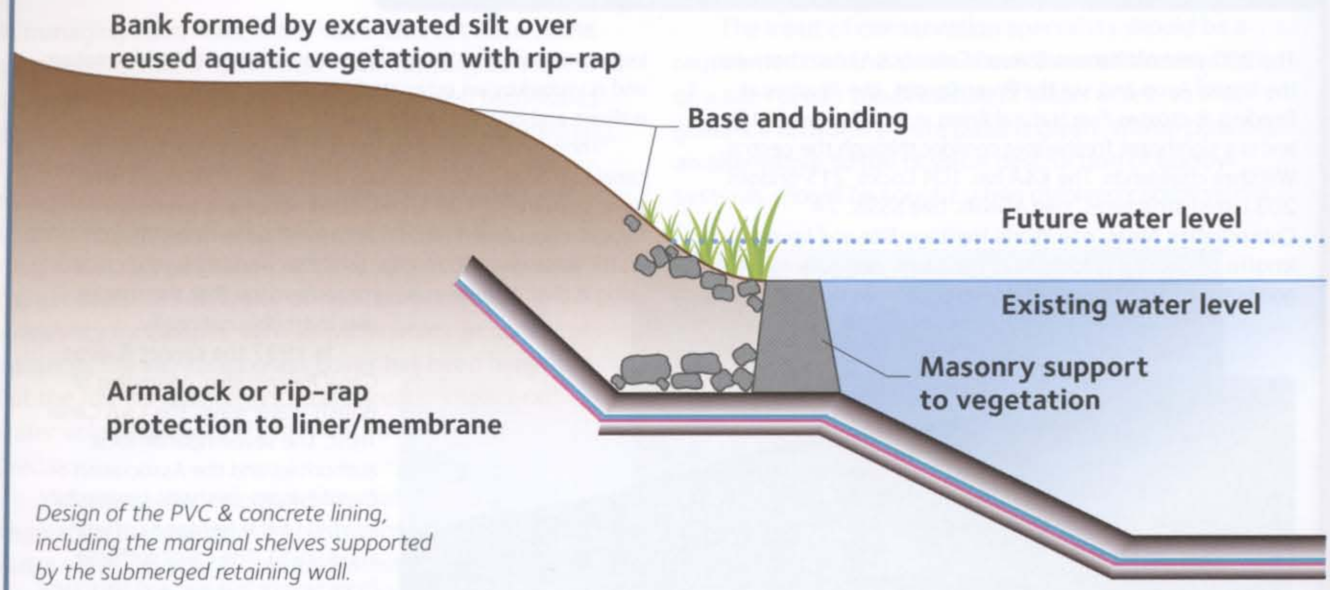
CASE STUDY RESTORATION OF THE KENNET AND AVON CANAL – I

The 200 year old Kennet & Avon Canal (K&A) runs between the Bristol Avon and, via the River Kennet, the Thames at Reading. It crosses five Natural Areas in its 87 miles (140km) and is a significant freshwater corridor through the central Wiltshire chalklands. The K&A has 104 Locks, 215 bridges, 203 Listed structures, two AONBs, five SSSIs, 24 Conservation Areas, one World Heritage Site and several lengths of County Wildlife Site. The canal, originally built for goods transported by horse drawn boats, has become a major leisure resource for both local communities and holidaymakers and is visited by an estimated 10 million cyclists, anglers, walkers and boaters every year.

Though re-opened to through navigation in 1990, the canal had been largely disused and funds for management were scarce until 1997. Low disturbance and extensive habitat encouraged good numbers of water voles. In fact, water voles were so familiar to those working on the canal or using it that it came as a surprise to many that the species was in trouble nationally.

In 1997 the Kennet & Avon Canal Partnership, consisting of British Waterways, the K&A Canal Trust, the seven riparian local authorities and the Association of Canal Enterprises, was successful in a bid to the Heritage Lottery Fund (HLF). The canal suffered from severe leakage and structural problems as well as an irretrievable backlog of maintenance,

Canal repaired (top left) with a concrete liner incorporating marginal shelves for water voles (left bank); these are clearly seen as the site regenerates (top right). Marginal shelves on both sides of the canal can be seen. The lower three photos close-ups of towpath side marginal shelf showing aquatic and emergent plant colonization.



Design of the PVC & concrete lining, including the marginal shelves supported by the submerged retaining wall.

Photographs taken during (left) and two years after (right) the construction of the PVC and concrete lining in the Bath Valley.

threatening the canal's future. The partnership was awarded £25 million to undertake urgently required repairs, smaller scale operations such as bank protection and environmental improvements like path construction and tree planting.

One of HLF's first requirements was for the development of a conservation plan, to guide the five-year programme of works and to protect the K&A Canal's unique environment & heritage beyond the life of the HLF Project.

PVC AND CONCRETE CHANNEL RELINING IN THE BATH VALLEY

Aim of the works

The biggest single engineering project funded by the HLF Award was dedicated to addressing the long history of failure and canal leakage in the Bath Valley. Travelling east from the outskirts of Bath the canal contours along the River Avon Valley, high above the river and the Bristol to London railway line, on a hillside destabilized by spring water flow. The canal was typified by broad marginal fringes of *Glyceria maxima*, soft offside banks and tumbled down washwalls with strong water vole colonies and attractive towpath verges with good plant diversity.

The 6km of relining required, undertaken in three phases, was effectively equivalent to digging a new canal on the line of the old, such was the unavoidable level of destructive preparation. Planning the project needed integration of complex engineering design and measures to save and restore important habitats and species, and to build a suitable basis for establishing sustainable habitats.

Engineering solution/design selected

The diagram above shows the successful design for the relined channel. The choice of PVC liner protected by concrete was dictated by the constraints of the site, especially the working room available. Shallow marginal shelves within the lined area were crucial to developing good channel habitats, protected by a submerged retaining wall. These were built continuously along the offside and on both sides where practical. Aquatic emergent plants removed from the original channel and stored during the construction period (over winter) were replanted along the shelves. Earth banks were included on the offside margins to provide water vole burrowing habitat which keyed into natural bank above the liner. There were some problems in creating stable slopes to the earth banks in phase 1, resolved in later phases by extending the banks over the whole width of the shelf. Burrowing conditions in the earth banks in phase 1 were hindered by use of stone riprap to anchor the marginal plants, in later phases stone was replaced with clay-rich soil and the plants rooted without problem. The underwater entrances to the stony shelf habitat were improved by using flexible ridged plastic pipes, but as backfill became more burrowable in later phases there was no need for pipes.

Verge topsoil was stored and reused along the new towpath verges, adjacent habitats were protected from damage, and stream inflows were incorporated into the lined channel.

Water vole mitigation and methodology – before and during the works

Measures to protect water voles were a key focus for the project; the techniques and designs were adapted as the phases progressed but essentially the initial process remained in place. Pre-works survey was followed by trapping and removal of either all or a proportion of the animals immediately prior to the works as de-watering began. Each phase of construction took about five months, with the canal reopened to navigation each year for Easter. Recovered water plants placed in the new marginal shelves showed immediate growth with a surprising apparent increase in species diversity, as *Glyceria* domination was set back and other species were able to flourish. Colonization of the earth banks was slower, but had about 50% cover at the end of the first growing season.

Recovery and development

Despite minor problems noted above, the habitat in phase 1 was suitable for reintroduction of water voles in the second summer after construction. Twenty animals were released using a soft technique in which the water voles burrow out of safe holding cages in their own time. The animals carried individual microchips and half were radio-collared. Surveys have shown that the population expanded successfully.

In phase 3, adjacent habitat had been judged to be able to accommodate at least a proportion of the population. Consequently half of the population was trapped and the remainder left *in situ*. When assessing the readiness of the habitat over one year later, this strategy proved effective and a thriving water vole population was present on the restored canal.

The dispersal of released animals and the population dynamics of the water voles on the full length of the restored Bath Valley continue to be monitored. Although initial signs are positive, only time will tell whether this busy section of canal can continue to support water voles.

The sensitive design of the canal refurbishment along the K&A Canal has ensured that water voles remain a common sight for narrowboat users.

ISSUES TO BE CONSIDERED FOR PROPOSED REGRADING AND RESECTIONING WORK

- Use suitable machinery for the size of river to minimize impact and enable enhancement.
- Leave a minimum percentage of river channel untouched in marginal strips or patches centred on the core of the water vole population.
- Where banks are re-formed, new profiles should provide a gradual transition at the bank toe to create marginal habitat. A stepped profile may allow for a rapid recolonization by water voles.
- Regrading will create a variety of habitats suitable for water voles in both long and cross-sections.
- Selection of working bank to avoid damage to water vole habitat and other ecologically important sites.
- Execution of works in an upstream direction enabling recolonization downstream.
- Any spoil and channel vegetation material should be sensitively disposed of.
- Existing marginals can be lifted and restored to site immediately after completion of work.

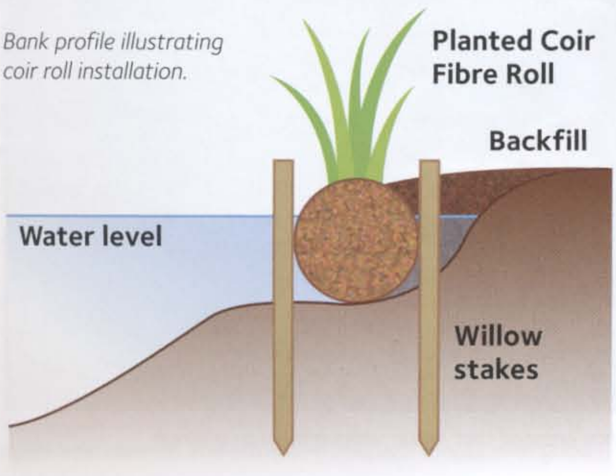
CASE STUDY OXFORD CANAL, SUSTAINABLE BANK REINFORCEMENT

In 1998 the BBOWT Water Vole Recovery Project was alerted by a member of the public to the presence of water vole in an area of new development on the banks of the Oxford Canal at Kidlington. The site was on flat ground above the canal level and the site had already been cleared to the canal edge, resulting in the loss of all water vole habitat along one bank for a 500m stretch. An inspection revealed burrows and feeding signs on the towpath bank opposite.

Half of the bank adjacent to the development comprised soft earth, while the remainder was reinforced with vertical concrete piles. These protruded about 30cm above the mean water level. The towpath bank opposite had been repaired in the past with concrete sand bagging over much of its length, but within this were areas of soft bank where water voles had created burrows.

A bank protection scheme and vegetation management prescription was agreed between the Water Vole Recovery Project, British Waterways and the developer, which would allow water voles to recolonize the site while simultaneously safeguarding the canal bank from erosion. Coir (coconut fibre) rolls, pre-planted with rush, sedge and other aquatic margins, were installed against the toe of the canal bank in March 2000. The rolls were staked to the bed at 1m intervals on both sides and cords between the stakes held the rolls firmly in place. As vegetation grows on the coir rolls, roots extend into the bank behind the rolls, protecting the bank from erosion and re-creating water vole habitat. A 2m wide strip of vegetation at the edge of the bank is being managed by the developer to provide additional cover and food supply for water voles, with phased management in short sections to prevent excessive scrub growth. Monitoring surveys have been completed each year since the work and have revealed abundant water vole fieldsigns on the coir rolls.

Bank profile illustrating coir roll installation.



Coir can be pre-planted with rushes and sedges for instant cover (see top image). This will provide suitable food for the water voles that also may take the coir itself as bedding. Installation of pre-planted coir fibre rolls therefore acts as 'water vole friendly' bank protection (see bottom image).

1.1 CANAL RELINING AND CANAL BANK REPAIRS

Canal leakage sometimes requires drastic engineering solutions such as draining and relining the affected section. Relining should be undertaken when there is no other viable option and the integrity of the canal may be at risk. Canal relining can have damaging consequences for water voles with the need to make the bed and sides of the canal impermeable through the use of plastic membranes, cement, brickwork or sheet metal piling. Relining is effectively equivalent to building a new canal in the old line with consequent disruption of all plant and animal communities. Hard engineering such as relining can increase fragmentation of suitable water vole habitat unless mitigation measures are incorporated.

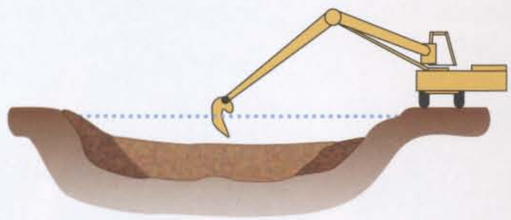
Provision of water vole burrowing opportunities through brickwork gaps, use of geo-textile materials or earth embankment during construction could be considered as ways to retain habitat. However, the preferred options would be retain as much of the original earth banks and associated vegetation as possible, or a means found to reinstate them. New channel profiles with incorporating new water vole habitat ('vole banks') on marginal shelves linked into adjacent natural banking are being trialled by British Waterways in a major relining scheme on the Kennet and Avon Canal. Existing marginal vegetation can be lifted and stored before relining work commences and subsequently reinstated on completion. This will not only provide the correct local water plant species for the site but also soften the appearance of the new canal sides and provide rapid cover to maintain water vole presence immediately after completion of the works. Further enhancement can be achieved by the planting of marginal vegetation (commercially available preplanted coir fibre rolls provide an instant solution).

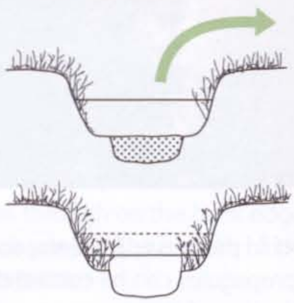
Under some exceptional circumstances water voles may need to be captured and taken off-site to a holding facility while engineering work is taking place. The animals can then be restored to the site on completion of the work. Consult with the Water Vole Technical Group for further information (see Chapter 9 for further details).

1.2 DE-SILTING OPERATIONS

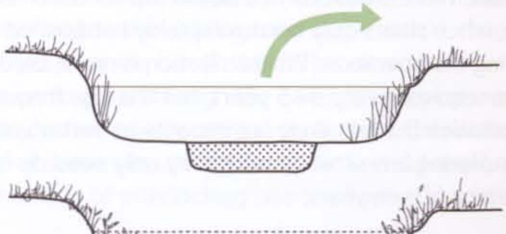
Wherever possible, channel de-silting should only be partial to retain as much of the aquatic and emergent vegetation for water vole conservation (Figure 5:1). In many canals, and other shallow navigated waterways, dredging (de-silting) can be a beneficial maintenance operation which (by removal of excessive loose silt, which is constantly resuspended by boat propellers) increases water clarity to the benefit of aquatic plants and dependant wildlife. Dredging is unlikely, however, to improve water clarity to a point where water voles are more vulnerable to predation; most navigated waterways remain turbid. During de-silting, in line with current Environment Agency best practice, marginal vegetation should be left untouched and the operation should be carried out from one bank only. At least one third of the channel should remain untouched, but in very narrow watercourses this may not be either possible or acceptable.

Dredging of canals may take place with equipment in mid-channel (excavated material being placed in floating hoppers), in which case the disruption to the banks and marginal habitats can be minimal.

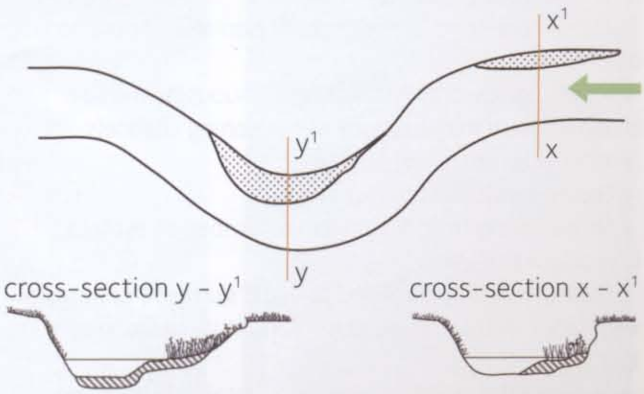




Retaining small margins on narrow watercourse



Retaining wide margins on wider watercourse



Reprofiling to retain habitats created by point bars (y) and bankslips (x)

Figure 5:1
Various options for re-forming and desilting river channels.

Dredging should progress upstream, so that any dislodged plant propagules can be carried downstream to aid rapid recolonization of the de-silted and disturbed substrate. Work is best carried out in the winter or early spring, when plants may become quickly established following the operation. Where siltation is rapid, dredging may be required every 3–5 years, but the less frequent the operation the less likely are impacts on water voles. Sites suffering low siltation rates may only need de-silting once every fifteen years.

BEST PRACTICE

- Access, selection of working bank, and choice of suitable machinery are all important considerations to minimize impact.
- At least one third of the channel plan area should be left untouched.
- Asymmetric working, creating a sinuous de-silted channel should mimic natural self-cleaning channels.
- Work in an upstream direction.
- Ensure sensitive spoil disposal.
- No de-silting from March to September, to protect breeding water voles.
- Careful working is needed to avoid slumping of marginal vegetation into the channel resulting in its detachment and loss.
- In canals the marginal vegetation retained should be at least 1m in width on the offside and minimum 0.5m on the towpath side, except at moorings and locks. Here, the aim is to create a navigable central channel where two boats can pass.

1.3 SPOIL DISPOSAL

Spoil disposal is subject to Waste Management Regulations and the disposal route is dependent on the amount and quality of the spoil. Often localized riverine desilting or reprofiling is simply incorporated into the soil of adjacent land by thinly spreading it on the surface, restoring the land to pre-management conditions (and never spread into hollows unless working to specific client instructions). In other cases the spoil may be utilized to improve habitats, such as widening the margins.

BEST PRACTICE

- Where material is largely vegetation, dredge channel and temporarily store material overnight on top of the bank to de-water and enable mobile animals to crawl back to the river (do not heap high above vertical banks or the latter may collapse).
- When spoil is of suitable consistency, strip topsoil from land adjacent and store alongside, place spoil in stripped area and replace the original soil over it.
- Look for habitat creation possibilities in reinstatement.

When large volumes are removed, as frequently occurs in canals, spoil may be tipped in adjacent designated sites or spread on farmland as a 'benefit to agricultural land'. This requires silt analysis to establish suitability and investigation of receptor site. Designated dredging tips beside canals can be allowed to vegetate naturally, often forming damp willow scrub, of value to water voles.

- Avoid disposal to land of existing nature conservation value, particularly unimproved grassland, rough herbage or naturally occurring damp or marshy ground.
- Safeguard adjacent watercourses and ditches from run-off.

1.4 BANKSIDE MAINTENANCE

River maintenance operations should normally leave banks untouched, but where bank regrading is deemed necessary, such as when part of a habitat enhancement scheme or during 'reforming' operations (where the physical modification of slumping banks is required to regain a previous design standard), this should be of a profile which maximizes the width of marginal vegetation that can re-establish.

A survey for water vole signs prior to work will be necessary to establish the extent and location of the local population (see Chapters 4 and 9), and as much as possible of the fringing vegetation should be retained in occupied areas.

BEST PRACTICE

- Access, selection of working bank, and choice of suitable machinery are all important considerations to minimize impact.
- Where banks are reformed, new profiles should contain

cross sectional variety and always provide a gradual transition at the bank toe to create marginal habitat.

- The bank profile could be stepped, or with a steeper incline on the upper half of the bank, to facilitate burrowing.
- Any bank regrading should be restricted to the smallest sections possible. It is preferable to retain existing bank profiles, particularly if well vegetated.
- One third of the existing habitat around the determined water vole 'centre' must be retained.
- Cross-sections should encompass features which reflect the need for a low-flow channel with self-cleansing ability as well as features enabling performance during the design flood.
- Two-stage channel creation may be a suitable option for encouraging the regrowth of a fringe of tall emergent vegetation.
- Work in an upstream direction to enable downstream recolonization by vegetation.
- Nearby waterways or lateral channels should be left untouched as a refuge site for the water voles from which they can recolonize these temporarily disturbed habitats once the bankside vegetation has regenerated.
- On the very rare occasions when adjacent ditches, small streams or lateral channels require excavating and redredging, conservation advice should be sought from Environment Agency staff. Particular care should be taken on site, as these are important features for the local water vole population.
- Ensure sensitive spoil disposal.
- No regrading/resectioning operations should be performed from March to September, to protect breeding water voles.

1.5 EROSION CONTROL AND REVETMENT

Where bank erosion requires bank reinforcement, the use of sheet metal piling, rock gabions or masonry should be avoided at water vole sites. Sympathetic bank maintenance should be encouraged by way of small-scale repairs or through the use of living willow withies, coir fibre bundles or other natural materials which will allow the bank to be used by water voles following repair (see photos right).

As a general guide for these bio-engineering solutions, coir fibre rolls or even willow logs may be best for shallow banks, while faggots and spiling are valuable for higher banks. Work is best carried out between November and February, to encourage rapid establishment of the willows and minimize disturbance to the water voles.

WHAT TO USE?

Trees: where appropriate plant small groups of willows as these will root very quickly. Tree guards will protect them against rabbits (or even water vole damage). Do not plant alders (unless planted from existing stock) as there is risk of transmission of the spreading alder disease *Phytophthora*.

Faggots: usually these are osier willow, poplar or hazel canes of 25mm diameter, to provide bundles of up to 40cm across. Each bundle is bound with wire or rope and can be held in place by poles and buried beneath surface soil.

Poles: green (live) willow poles can be driven in for toe protection, the poles shooting and rooting to stabilize the bank. The growing shoots reinforce the surface and the poles are back filled with earth. Stakes and galvanized wire are used to secure the poles until rooted. Cut poles can also be laid horizontally, or used to face a gabion basket core, but this technique is unlikely to be sympathetic to the needs of water voles.

Spiling: 75mm diameter poles are driven in and green (live) osier woven through on the bank edge. The bank is then made up by back-fill. The growth of the osiers provides reinforcement.

Hurdles: hazel wattle hurdles, of the dimension 1.8m x 1.8m are fixed to the eroding bank slope with U-shaped lightweight retaining bar or stake. This allows for vegetation to grow through the panels as they rot away and provides temporary erosion protection. Crib walls can be used at some sites to create a near vertical reinforced wall consisting of interlocking beams of wood in a lattice

Installing spiling in March (left) and view of bank by June (right), after work had been completed.

Willow spiling can make effective bank protection to meandering rivers that have a wide floodplain. The spiling will need to be protected from livestock as it establishes and the erection of fencing at least 2m back is recommended.

which is back-filled. Although liable to scour, vegetation may establish between the lattice and provide cover for water voles as well as access to burrows.

If water vole tunnels are present in the old face it is important to ensure that the backfill between that face and the new bio-engineering face is not so heavily compacted that it entombs the water voles and prevents them from burrowing out. Where the backfill is likely to be clay the careful laying of field drain pipes between the vole tunnel and the new bankface during the infilling process will allow the voles to remain in their existing tunnel system. This method had been put into practice during restoration work along the Oxford Canal.

Protection at the toe of a bank to prevent slumping can be done through the use of coir rolls.

Other hard engineering bank protection techniques potentially suitable for retaining water voles on site include the use of geo-textile meshes (made from natural bio-degradable yarns or synthetic fibre). The man-made banks of canals were originally built using locally available materials. Typically the vertical towpath-side bank would be a masonry wall and the offside (opposite) was often a natural earth bank. Over the years water vole habitat has been gained (by disrepair and collapse of the towpath walls) and also lost (increasing use of solid bank protection against erosion and leaks). Repair of most canal banks presents particular difficulties because of the artificial nature of the channel and lack of width (precluding the use of willow spiling/hurdles etc.) and the constraints imposed by boat traffic (causing erosion etc.). Maintaining a healthy fringe of emergent aquatic vegetation at least 0.5m deep is probably the most effective bank protection for canals.

The standard use of sheet metal piling as bank protection on navigable waterways effectively excludes water voles. Where leakage is a problem, burying long sheet steel piling behind the first 23m of waterway bank (i.e. in the trodden or surfaced towpath itself or the crest of an embankment) can be effective whilst leaving marginal habitats intact. This solution is dependant on finding suitable geological strata to form a seal with the piling. Where such conditions are not suitable or where erosion is the problem, use of geo-textile protection combined with a dense fringe of emergent plants is the favoured option. Stoning and rip-rap can restrict burrowing but do allow vegetation to establish and therefore may be useful in combination with other methods. Interlocking preformed blocks (e.g. Armalock)

CASE STUDY RESTORATION OF THE KENNET AND AVON CANAL – II

BANK WORKS FOR VISITOR MOORINGS AND BRIDGE AND LOCK LANDING STAGES

Another part of the K&A Restoration Project involved improving facilities for canal customers, including the construction of safe and easy-to-use visitor moorings, permanent moorings and bridge and lock landing stages. The British Waterways standard for such moorings and landings is a vertical, hard, often piled edge. Without the hard edge the canal banks erode away rapidly due to the wash created by repeated boat movements. This creates unsafe conditions for boat users, washes away the towpath and in some cases can cause instabilities within the canal bank as the clay liner of the canal is washed away. This has the potential to lead to breaching of the bank.

The locations of the landings and moorings were long established and often associated with facilities such as locks and bridges, water points, town centres, cafés and pubs and so could not be reasonably relocated. As a consequence, design of moorings and landings had to be reviewed, and a strategy to compensate for the inevitable loss of habitat developed.

Mitigation was achieved by using the three designs shown below:

1. THE HAZEL FAGGOT VEGETATION SHELF

Aim of the works

Hazel faggots were used to protect collapsing canal banks with water vole habitat from further erosion, while at the same time improving the habitat by re-establishing the marginal vegetation fringe.

Photgraphs taken before and six months after the construction of a hazel faggot vegitation shelf.

It was applied to over 1km of canal, with or adjacent to existing water vole habitat and on riverine sections of the canal, set in relatively rural locations and outside major centres of boat and visitor activity.

Engineering solution/design selected

Hazel faggot vegetation shelves are a technique widely used on rivers for hundreds of years. The established design was adapted for use on canals with the help of the Cain Consultancy. The basic structure is made up of reinforced hazel faggot bundles staked in front the canal bank behind a woven hazel hurdle. This is then filled with soil and planted with fringe vegetation of local provenance. The shelves finish just below normal water level and provide a secure medium for plants to root in, so dissipating the wave action from boats and preventing the marginal fringe from washing away.

Water vole mitigation and methodology – before and during the works

This technique leaves existing water vole habitat undisturbed, as the structure sits in front of the canal bank and installation is done by hand with the canal in water. Water voles have been seen sitting on the unfinished shelf while work was going on.

2. THE STEEL SHEET PILED VEGETATION SHELF

Aim of the works

The principle of this technique is the same as the hazel faggot vegetation shelf, and although it is less environmentally friendly it is much more robust, has a longer life and can cope with a much higher boat impact rate.

This technique was used on or adjacent to existing water vole habitat on sections of canal that suffered from bank erosion, in areas with high boat use and visitor numbers or on sections of canal with banks in an extremely poor condition. This method was applied on more than 500m of canal bank.

Engineering solution/design selected

This method involves piling a line of steel sheets to below normal water level, in front of the existing bank. The piles are fixed with a fender, to protect boats from damage and back-filled with soil. Coir rolls (coconut fibre roll) are tied down directly behind it, parallel to the bank. Both the coir roll and the soil backfill were subsequently planted with marginal species of local provenance.

Water vole mitigation and methodology – before and during the works

This installation method is more invasive than the hazel faggots method as heavy machinery is required to drive the steel sheet piles down to the desired level. To minimize compaction of the bank, water-based machinery was used where possible. In most cases this type of steel piling has to be tied back in to the bank at regular intervals to keep it from tilting. To achieve this, 1m sections of bank need to be dug out every 4m, so that tie-rods can be installed.

As the installation process may damage water vole habitat, all bank-side and canal verge vegetation on these sites was strimmed as described earlier.

Photographs taken before and immediately after the construction of a piled vegetation shelf. NB the water level on the 2nd photograph is low; the shelf is normally submerged as shown on the illustration.

3. CASTELLATED PERMANENT MOORINGS

Aim of the works

Permanent moorings are mostly used by experienced navigators and are not subject to the large number of boat movements that visitor moorings have to cope with, and so this design could be developed to include water vole habitat, erosion protection as well as safe mooring conditions.

The Project applied this design in two locations. Both were situated in locations with water vole habitat, within the centre of a smaller town, in very close vicinity to sections of hard edge bank protection and on the offside of the canal.

Engineering solution/design selected

This design combines moorings with water vole habitat, by alternating sections of below water level piled vegetation shelf with sections of higher piled hard edge. It provides safe platforms for boats to moor against with bays of reed fringes and soft bank, protected from erosion by the line of submerged piles.

Water vole mitigation and methodology – before and during the works

As for the steel sheet piled vegetation shelf.

with central open cavities might allow water voles to burrow if the cavity is sufficiently wide. Timber facing is preferable to steel piling as it allows the transfer of moisture and it would be easier to incorporate artificial access holes to the natural bank behind. If no alternative to sheet piling along the waterway margin is found then areas of piling should be adapted to provide somewhat more environmentally friendly habitat at intervals. Reducing short lengths of piling to water level, supported by geotextile protection on the bank above and behind has been shown to be beneficial (this has the added advantage of providing escape ramps for badgers and deer). Groups of access/exit holes of suitable size for voles could be drilled in the piles to lie just above and below water level but as yet there is no evidence that these are used.

1.6 HABITAT ENHANCEMENT RESTORATION

Restoring geomorphological and hydraulic features to the natural dynamic system of a water course has tremendous benefits to the whole aquatic ecosystem. Water voles benefit in particular from the restored connectivity of the river system and its floodplain habitats such as backwaters, ponds, wet grassland, marshes/reedbeds and a network of ditches. Reprofiling of banks can restore wet ledges, berms, steeper faces for burrowing and a meandering plan form.

With the intensification of agriculture and the building of properties within the floodplain, rivers have to meet flood defence standards and so have been engineered for flood storage, excessively over-widened and deepened. Trapezoidal bank profiles had become the norm in the recent history of many river systems (although many are now showing signs of recovery) with a management that prevents dense in-channel vegetation and thick stands of marginal cover becoming established as these are potential obstructions to flow conveyance.

Opportunities for river restoration are wide and varied. Habitat can be enhanced for water voles by the creation of suitable banks in which to burrow and the establishment of a broad band of emergent and bankside cover. At its simplest this may just involve fencing and allowing the vegetation to regenerate itself naturally. Bank regrading or two stage channelling may be enhanced by the planting of *Phragmites, Carex, Sparganium, Glyceria, Scirpus, Phalaris*

Recovery and development
Water vole habitat is developing at the sites using these solutions. Establishment of the emergent fringe, in particular on the hazel faggot shelf, has been spectacular and water voles as well as other wildlife are benefiting from the protection it provides. Overall, the available habitat has increased as well as been given long-term protection.

In conclusion
The water vole habitat improvements made are not only beneficial for water voles, but also provide suitable conditions for other wildlife such as dragonflies, various canal side birds and amphibians. The methods used provide eco-friendly, functional and durable alternatives. Apart from improving water vole habitat, they help to maintain the canal's 'green' character for the benefit of canal visitors.

In recognition, the Project has been given the 2001 Award for Engineering in the Natural Environment by the Engineering Council. The Conservation Plan received the Landscape Institute's 2001 Strategic Landscape Planning Award.

Photographs taken before and six months after the construction of the castellated permanent moorings.

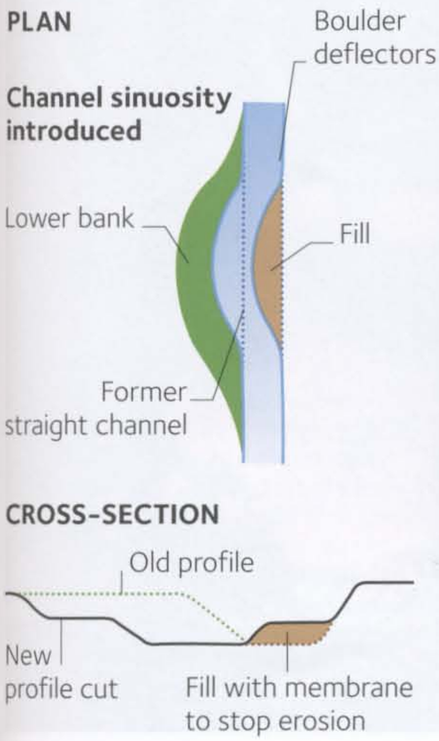


Figure 5:2
Bear Brook, Aylesbury: a channel remeandered to create berms on alternating banks. The photographs show the site during (inset) and after work (main photo).

CASE STUDY BAYSWATER BROOK, BARTON

In December 1998 the BBOWT Water Vole Recovery Project gave a presentation to a local community group in Barton, north Oxford City, on the potential habitat improvements on the Bayswater Brook. Community representatives agreed that £10,000 (topped up with £2000 from Oxford City Council) would be spent on improving the environment of Bayswater Brook for the local community and water voles.

Designs were drawn up by Oxford City Council with input from the Water Vole Recovery Project, and in December 1999, work began on the ground. Two large bays with steep banks and wet shelves were created off the brook, and a new ditch parallel to the brook was dug to provide additional habitat. Local schools and community groups organized re-planting of the site with native marginal species.

Bayswater Brook was surveyed by volunteers involved in the Water Vole Recovery Project in 2003 and 2004 and the highest density of fieldsigns located along the watercourse was adjacent to the newly created bays.


Cengiz Philcox

Creation of a backwater on Bayswater Brook, Barton.

and *Juncus*. Bare banks could be seeded with a mix of tall wild grasses such as *Phalaris, Dactylis, Arrhenatherum, Holcus, Phleum, Alopecurus* and *Agrostis* (see boxed feature on page 70).

Wet berm creation improves the aquatic margin suitable for colonization by water voles, but a steep or stepped bank face opening to deep water may be necessary for burrow construction (see Figure 5:2).

Ponds, old oxbows, backwater channels and a network of floodplain ditches are extremely valuable for water voles and should be reinstated if possible (such as where marginal farmland permits them). New creation or restoration of wetlands with these features is also desirable, and care should be taken in the site design to maximize the amount of riparian frontage (overall bank length) so as to provide sufficient area that can support a self-sustaining water vole population.

A rule of thumb guide is that one breeding territory requires 30–50m of waterway bank (with individual female voles using both banks on waterways less than 2m wide). A minimal over-wintering population of female water voles may be as low as 10 individuals. The overall length of suitable waterway, showing a dense fringe of emergent vegetation should not be less than 500m and probably in excess of 1000m. The greater the amount and length of suitable habitat, the greater the possibility of maintaining a viable population of water voles.

Conservation advice from Environment Agency staff should be sought before any habitat enhancement work, such as wet berm creation, is carried out.

1.7 WETLAND CREATION MANAGEMENT

Ponds and wetlands can be managed to create as wide a range of habitats as possible. This might include leaving some completely alone while giving consideration to creating new pond features in adjacent areas.


Andrew Parkinson

PONDS

Off-stream ponds along a waterway may be particularly valuable to water voles as refuge areas during flood conditions or as strategic colonization sites to provide linkage between isolated colonies. Pond creation or restoration may be used as a conservation tool for the species and may be especially valuable on rivers known to spate.

Recommendations for the design and management of ponds for water voles include:

- Provide a steep bank face to at least a third of the bank edge.
- Retain or create a dense fringe of marginal vegetation (sedges and rushes).
- Avoid use of invasive plants such as common reed (*Phragmites spp.*) or reedmace (*Typha spp.*).
- Prevent summer drying by ensuring a depth of at least 1 m.
- De-silt without interfering with banks.
- Islands within the ponds increase the bank-face for water voles to burrow into.
- A number of small ponds in close proximity are better for water voles than a single large pond of the same surface area.

POND RESTORATION

In many areas unmanaged ponds have become overgrown, with the surrounding vegetation increasingly drying out the pond through falling debris and siltation. Tall dense vegetation may overshade the pond to reduce light levels and affect aquatic plant growth.

If the pond is to be restored the following points should be considered:

- If overgrown, at least part of the surrounding scrub can be coppiced to reduce shading and leaf fall, and increase light and access. If possible this should be on the south side of the pond to maximize sunlight.
- If de-silting, the pond's potential can be maximized by creating spits, bays and a shallow sloping bank to allow for vegetation development.
- Buffer strips and good farm practises can be utilized to ensure that only clean water enters the pond.

CREATION OF NEW PONDS

When a new pond is to be created the following points are worth considering:

- Location of the pond can be prioritized to any existing areas of low wildlife value or adjacent to existing ponds to allow natural colonization to take place.

CASE STUDY RESTORATION OF THE KENNET AND AVON CANAL – III

AIM OF THE WORKS

At Sells Green on the Kennet and Avon Canal, a 0.5km section of canal embanked on both sides was in urgent need of attention to prevent serious leakage. The traditional engineering solution to this problem would have been to drive steel piling at the interface between water and bank, but this was ruled out because of the presence of thriving water vole colonies in both banks. Sheer numbers of burrows in the offside bank were leading to rapid erosion of the habitat. The project secured the colony's long-term future.

ENGINEERING SOLUTION/DESIGN SELECTED

Instead of bank face piling, the towpath bank was sealed against leakage by driving deep piles through the surfaced central section of towpath into the underlying impermeable clay, thereby retaining undisturbed soft bank habitat at the water's edge.

On the offside the embankment's condition was too fragile to use deep piling without re-building which would have been destructive and expensive. However, investigations showed that the land adjoining the canal was underlain by impermeable clay. An area of this land was purchased and the canal allowed to flood into it, via two breaches created in the offside bank, to form shallow lakes designed to attract a wide range of wetland wildlife. This elegant solution simultaneously solves the leakage problem (with no leakage beyond the lake) whilst creating a valuable wetland habitat.

WATER VOLE MITIGATION AND METHODOLOGY – BEFORE AND DURING THE WORKS

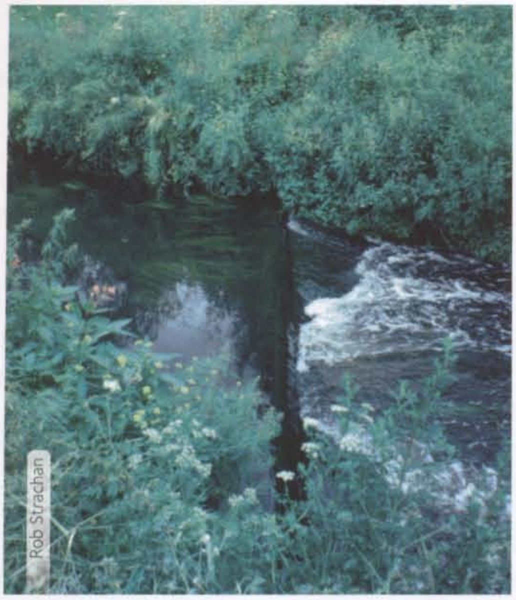
For engineering reasons the canal had to be de-watered during the works, but the banks and marginal fringes were largely undisturbed. On the towpath side the deep piling line was outside the active burrowing area. The offside bank breaches were only 4m wide.

RECOVERY AND DEVELOPMENT

Water voles were found to quickly colonize the new lake, in addition to maintaining their territories along both banks of the canal and so the local habitat has increased significantly.

Photograph taken six months after the construction of the new offside lake and piling works at Sells Green.

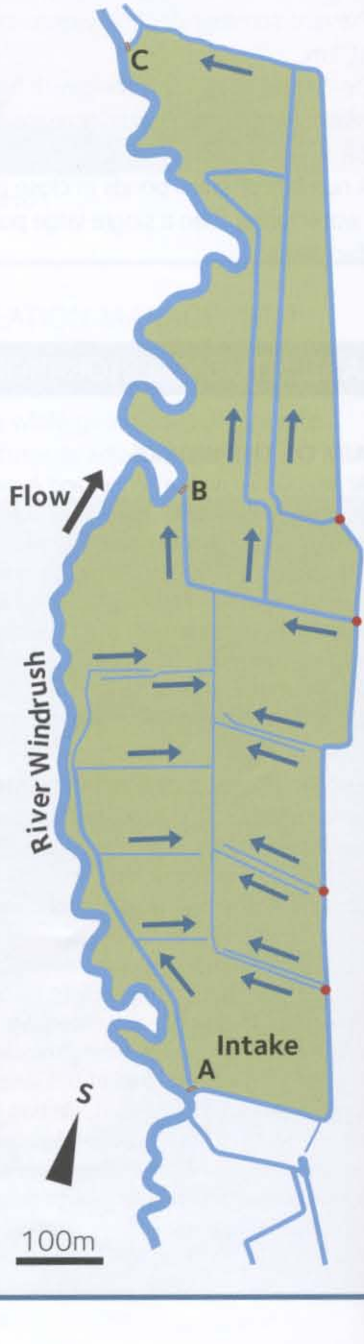
CASE STUDY RIVER WINDRUSH – SHERBORNE WATER MEADOWS



Low weirs and boulder weirs on the feed system and River Windrush main channel help retain water across the site.

Traditionally, the creation of water meadows was simply a system that produced a large area of good quality grass for the grazing of sheep and cattle, through the intentional flooding of riverside fields by using a series of sluices, carriers and drains. At Sherborne such meadows were created in 1844, but these fell into disuse in the early 1930s due to changes in farming practices. The grassland was improved by ploughing, reseeding and the application of artificial fertilizers. From 1965 the land was used for cereal production until 1992, when under the ownership and management of the National Trust, the land was put into Countryside Stewardship Scheme to restore 57 hectares back to a water meadows system. 10,000 metres of ditches were redug using original plans and former aerial photographs (EA - Thames Region). These were to carry water onto the meadows from the River Windrush and back into the main channel again. Original stone sluices that had remained intact but buried in the meadows were located and restored and the whole site was refenced to control grazing pressure (8,000 metres of fencing).

Features important to water voles included the restoration of 10,000m of water meadow ditches as functional water feeders, drainers and habitat in its own right. Assessment of the project had showed that the ditches had been colonized naturally with aquatic and wetland flora. The grassland had established well and the planned grazing and hay cutting regimes implemented successfully. A sheet of flood water cannot drown the whole site due to the lower bed level in the Windrush and slight land raising due to ditch excavations. However, as yet water voles have not been recorded on site, probably due to the large distance to the nearest colony on the Windrush. The restoration of Sherborne water meadows is a good example of countryside stewardship in practice.



Water level management in the restored water meadow system is maintained through the use of sluices. Historical maps were used to identify the previous sluice gate locations, and these were re-created in situ.

CASE STUDY NEW POND CREATION: RIVER DON, CRIMPSALL, DONCASTER

The trapping and relocation of water voles at Crimpsall took place as part of an award-winning Environment Agency Flood Defence project to replace the old Crimpsall Sluice on the River Don.

The Crimpsall Sluice was built in the 1950s to allow flood flows through Doncaster while maintaining navigable river levels upstream. By the late 1990s the sluice needed to be replaced. A new structure was required to maintain water levels upstream and allow up-river migration of both game and coarse fish. A rock-chute was designed as an innovative solution previously untried on this scale in this country.

The rock-chute was constructed in an Oxbow Pond, previously isolated in the 1950s by river straightening. This old channel was then reconnected so the river now flows back on its original course, resulting in important benefits to the ecology of the river.

Since the 1950s, the Oxbow Pond had established as a locally valuable still-water habitat and is designated by Doncaster Metropolitan Borough Council as a Site of Scientific Interest in their Unitary Development Plan. Most importantly the pond supported a water vole population which is particularly vulnerable to habitat changes, such as the new rock-chute and main river flows.

Detailed mitigation proposals and a formal Environmental Statement were drawn up in 1999 in agreement with English Nature, Water Vole Technical Group, Doncaster Metropolitan Borough Council's Countryside Officer and Doncaster Naturalists' Society. Creation of new water vole habitat and translocation of individuals was accepted because of the other significant benefits of the rock-chute weir and other new habitats to the long-term ecological recovery of the River Don system.

Water voles were trapped and relocated in the Spring and Summer of 2000. Release of further captive-bred water voles took place as a second phase of the water vole work in 2002. The Crimpsall Sluice Scheme has won The Institution of Civil Engineers Yorkshire Association Award 2001.

MITIGATION PONDS

As part of the scheme design two ponds were established:

- A new pond isolated from the river but connected to the spring fed Black Pond;
- A back-water pond on the new 'island' connected to the River Don.

The new pond was created to provide water vole habitat, with shallow margins to provide extensive emergent vegetation, extending to open water up to 1.8m deep. Bank slopes of 45° were created to allow water voles to burrow at various heights. The length of pond bank was maximized by creating large islands within the pond, and including a spit. The final bank length equates to the length that was available to voles within the Oxbow Pond. Excavation was into naturally occurring clays, and a connection was made to an adjacent spring-fed pond to ensure stable water levels.

New water vole habitat was quickly and successfully established within seven months of pond excavation by transferring aquatic plants, bank-side vegetation, soil, water and silt from the Oxbow Pond. Spreading of soil and vegetation including grass rhizomes from the Oxbow banks was particularly effective at providing good bank-side cover which could not have been achieved by seeding alone.

The need for this mitigation scheme has meant that great efforts were made to relocate only nine water voles. Predictably, this number was unable to re-establish a

Above: Crimpsall Sluice, River Don and Oxbow Pond before scheme. The oxbow pond supported a population of water voles.

Left: Rock-chute weir, reconnected river course and new ponds on completion August 2000.

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New Pond at Crimpsall December 1999 (left); and again in August 2000 (below). Compare the treated banks on the left and right, and the island tops, with the untreated island bank.

sustainable population. It is likely that the original population was already vulnerable due to low numbers and isolation from other populations. So although the original mitigation fully replaced habitats, it was possibly never likely to be successful due to low numbers and isolation. The mitigation effort may have been better spent on establishing a robust network of water vole habitat rather than rescuing individuals.

The project has been augmented by the captive-bred release of a larger numbers of water voles and this appears to have had more success, with individuals gaining weight and evidence that the population has over-wintered successfully in their first year since release in 2002. The appearance of mink on site in 2003 highlighted the need for resources for long-term management of mitigation projects well beyond any initial habitat replacement phase. A survey in 2005 confirmed that water voles remain on site.

• Any water entering the pond should be sourced as clean and minimum and maximum levels may be maintained through use of sluices and culverts.

New pond design can also consider the creation of a varied shoreline with spits and bays to attract more wildlife. Gently shelving edges from the banks in to the water allows easy access for young waterfowl and amphibians, and encourages waterside vegetation. The middle part of the pond should have a design depth of around 2m to prevent encroachment of bankside vegetation and maintain the desired mix of open water and pond plant life.

REEDBEDS

On a number of sites there may be an opportunity to restore and extend existing areas of common reed as well as to create new reedbeds. Such features may be designed to act as filtration systems to collect waste-water from agricultural sites, such as vegetable processing units or dairy units.

When reedbeds are to be created, the following points should be considered:

• The design should involve a flooded shallow depression with a network of ditch channels. Where possible hard engineering or geo-textiles should be avoided (although coir matting can be used).

• Minimum and maximum water levels can be maintained through the use of sluices and culverts.

2 WATER LEVEL MANAGEMANT

Excessive flooding or drying of a site can make it untenable for water voles. Long-term stability of water levels is an important prerequisite for their survival at a site. The practice of lowering water levels in rivers and drainage systems during winter is detrimental to aquatic margins, particularly during dry winters when they may be exposed to severe frosting. This practice occurs mostly on Internal Drainage Board systems and may be further compounded by the use of herbicides or short mowing which leaves no surface cover.

Excessive abstraction at headwater sites on some rivers has lead to the complete drying of groundwater aquifers and springs, resulting in loss of flow at these uppermost sites during the summer months. Dried out sites are quickly vacated by the local water vole population. The restoration of river flows (particularly on chalk streams) may be essential to retain a thriving water vole population at headwater sites.

2.1 USE OF SLUICES AND WEIRS

The introduction of sluices and weirs regulates natural hydrological processes in rivers and is generally regarded as environmentally degrading and therefore best avoided. However, the upstream retention of water and control of water level can be of great benefit to water voles by creating ponded habitat with features similar to backwaters (i.e. luxuriant marginal and in-channel vegetation growth). Minor sluices and weirs can enhance degraded in-channel habitats and floodplain wetlands, especially by diverting flows into secondary channels or ditches (Figure 5:3). In general, land drainage canals and ditches provide satisfactory habitats for water voles, as they are characterized by good growth of emergent vegetation, slow flow rates and relatively constant water levels.

Although there are no studies which have looked directly at weirs and water level management with reference to water voles, it is clear that provided some attention is paid to the habitat requirements of the water vole, weirs can improve conditions upstream for these animals. The following is a list of guidelines for the construction and upgrading of weirs and sluices to benefit water voles:

- Construction of weirs or sluices should only be considered as a last resort.
- Boulder weirs and artificial riffles provide ponded habitat and allow the natural characteristics of the watercourse to be retained.
- Where in-stream work is carried out, the channel substrate should be left as mud or silt, not paved or otherwise 'improved'.
- Weirs allow the depth of water to increase upstream. This is to be encouraged, as water voles show a strong preference for deeper water up to 2m in depth.
- Avoid the use of stony or reinforced banks, unless a form of woven mat is used. This both impedes the burrowing of voles, and restricts vegetation growth.
- Encourage the growth of emergent and aquatic vegetation (particularly *Carex paniculata*, *C. riparia*, *Sparganium erectum* and *Phalaris arundinacea*) both in the channel and along its fringes.
- Water should not be allowed to brim the channel ahead of the weir. Voles prefer steep, high banks above the water.
- Stream velocity could be kept low.
- Where water voles already exist in the vicinity of a newly constructed weir, the water level should be allowed to reach its new level progressively, over the course of a few days allowing time for the resident voles to excavate new tunnels and entrances.

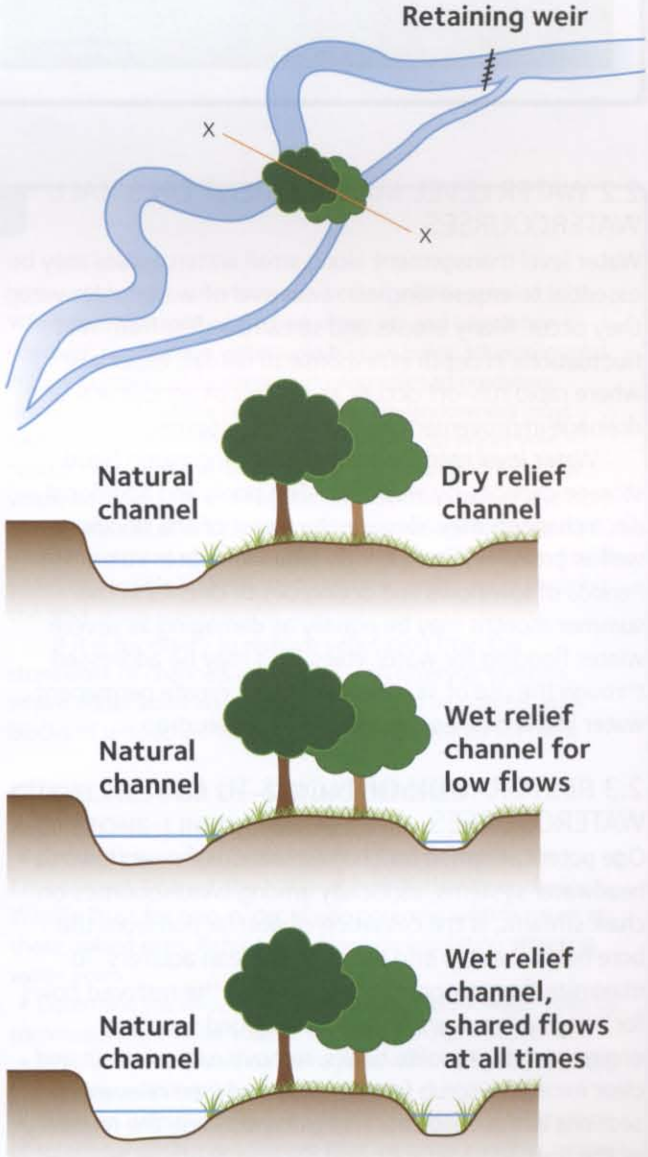
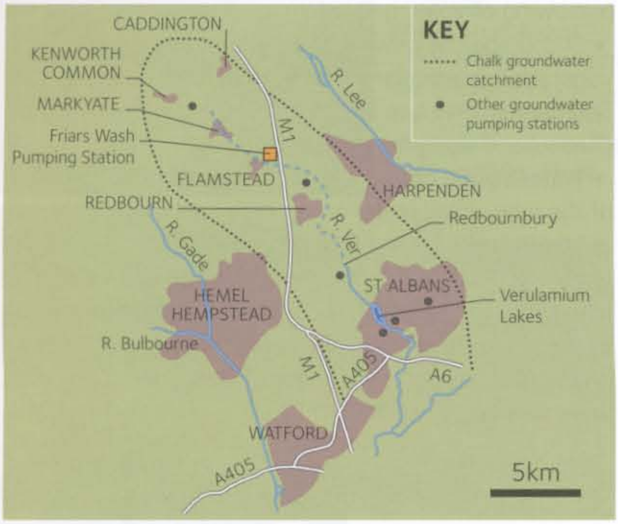


Figure 5:3

Three basic bypass scenarios to create a relief channel to the main river. Option 3 shares river flow at all times and creates a backwater habitat for water voles.

CASE STUDY RIVER VER



Groundwater over abstractions had created a lack of winterbourne flow of the River Ver above Redbourne, Hertfordshire. An investigation during 1986–87 showed that abstraction from aquifers had risen sharply since the 1950s, to intercept nearly 70% of the rainfall. The Ver Society, Three Valleys Water and the Environment Agency worked to close down (but retain its operational use for emergencies) the bore hole at Friars Wash (the primary cause of the lack of flows). New supplies were to be from a nearby reservoir (Grafham Water), requiring £2.5M of engineering works to pump and pipe water. Sensitive engineering works to Flood Defence standard were carried out along the upper Ver.

Features important to water voles included the restoration of maintained water flow, depth and channel resectioning work with design to maximize marginal vegetation. Sensitive engineering work on extensive length of river to Flood Defence standard created self-sustaining riffles and runs with coarse sediments, benefiting a wide variety of wildlife.

2.2 WATER LEVEL MANAGEMENT ON SMALL WATERCOURSES

Water level management along small watercourses may be essential to ensure long-term survival of water voles when they occur. Many brooks and streams suffer from wild fluctuations in depth in response to rainfall, especially where rapid run-off occurs as a result of agricultural land drainage improvement and urban development.

Water level management through increased flood storage capacity by way of on-line pools and additional ditch channels may alleviate the worst of the flooding as well as providing flood refuge areas for water voles. Periods of low flows and drying out of ditches in the summer months may be equally as damaging as severe winter flooding for water voles. This may be addressed through the use of sluices or bunds to create permanent water in the ditches when the river levels drop.

2.3 RESTORATION OF FLOWS TO DRY WATERCOURSES

One potential option for the restoration of river flows to headwater systems, especially among winterbournes on chalk streams, is the cessation of abstraction from the bore holes that tap into the subterranean aquifers. To maximize the environmental benefit of the restored flows for water voles, there should be included sensitive engineering to reprofile banks, remove excessive silt and clear excessive scrub from the dry bed (see relevant sections in this chapter). This will encourage the recovery of the riparian vegetation and a water depth to be maintained that is suitable for water voles.

Consultation with the Environment Agency and Water Companies is required at every stage in this procedure (see case study above).

CASE STUDY MANAGING DITCHES AND STONE-

Upland drainage ditches can provide good quality habitat for water voles, with soft banks for burrowing into and slow flowing water. Some may support abundant marginal vegetation with plants such as soft rush, bottle sedge and branched bur reed that provide food and cover. Floating plants such as water starwort are additional food sources. The ideal ditch profile has a shelf or berm at the bottom of the bank to encourage marginal vegetation and a deeper central channel to facilitate water flow. For water voles, stepped or relatively steep sides above the berm will allow burrow systems to be constructed at different levels.

In some upland areas, water voles are able to utilize stone-lined channels or leats associated with reservoirs, both for dispersal and, when conditions are suitable, for breeding. Holes in the stonework which may be incorporated below the water line can provide entrances to burrow systems, and vegetation that colonizes

A typical stone-lined leat at Torside Reservoir in the Dark Peak.

Appraisal of the scheme demonstated that the effects of ceasing abstraction were dramatic, with springs breaking out in the middle and upper river. Within 18 months flow was restored and many typical winterbourne aquatic and emergent water plants had returned to the previously dry channel above Redbourne. A water vole survey along the River Ver during 1997 found evidence that the species had recolonized this upper part of the river (while disappearing from many former sites below St. Albans – probably due to mink predation). Subsequent mink management has further encouraged the species on the system.

Environment Agency

Environment Agency

Photographs before and after flows were restored to the upper reaches of the River Ver.

LINED CHANNELS FOR WATER VOLES IN THE UPLANDS

stonework can facilitate the movement of water voles up and down the bank side, provide cover, food and latrine sites. Water flows in such channels are variable, but where flow is generally slow such sites may provide ideal habitat for water voles.

Silt accumulation in ditches and leats reduces water depth over time, slows water flow and causes channels to become densely vegetated. Maintenance works to remove silt and restore areas of open water by removing marginal and in-channel vegetation can benefit water voles in the long term. Ditches with low water levels and dense vegetation may make water voles more vulnerable to terrestrial predators such as stoats. However, in the short term, ditch maintenance operations can have a devastating impact on water voles and other wildlife species. Traditionally, de-silting of ditches was undertaken little and often using spades or chains dragged along the bottom of the ditch. The current use of mechanical excavators poses a greater threat to water voles and other wildlife species. Wholesale clearance of ditches where silt and vegetation is removed can destroy water vole burrow holes, kill water voles in their burrows and expose surviving voles to predators. Under current wildlife legislation riparian landowners must take steps to minimize this kind of damage to water vole habitat. Where stone-lined channels are occupied by water voles, removing silt and vegetation from the channel and from stone banks all at once can eradicate cover and food sources, make movement of water voles up and down the stone-lined banks impossible and is likely to result in water voles vacating the area.

Helen Perkins

Ditch occupied by water voles at Leash Fen, Eastern Peak District moors.

If it is necessary to remove vegetation from the stonework of channels associated with reservoir systems where water voles are present, this should be phased, with blocks of untouched vegetation between cleared sections.

GUIDELINES FOR DE-SILTING DITCHES AND STONE-LINED CHANNELS

- Contact relevant agencies such as English Nature, the Environment Agency, the National Park Authority or the local Wildlife Trust for help in identifying potential wildlife issues at these upland sites. Refer to guidance on legislation affecting water voles.
- Determine the value of the ditch or channel for water voles by commissioning a water vole survey between April-September.
- Seek advice on avoiding damage to water vole habitat from the surveyor and appropriate agencies.
- In liaison with the relevant agencies, establish a programme of rotational ditch management that, as far as possible, retains a fringe of marginal plants and ensures that the banks of the ditch are undamaged. The frequency of maintenance works will depend on the function of the ditches or channels and the rate of vegetation growth.

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- Determine the exact timing of the maintenance works. To avoid the water vole breeding season work should be carried out between November and January.
- Use machinery that is appropriate to the size of the task and carry out works from one bank only to minimize damage.
- Try to confine de-silting operations to the central areas of the ditch, enabling banks and a good fringe of marginal vegetation to be left untouched. If the central channel of the ditch is slightly deeper, leaving a fringe of plants at the edges need not result in slowing the water flow, as rooted vegetation is unlikely to choke the whole channel and water flow need not be significantly impeded.
- If this is not possible, clearing shorter sections of ditch at a time is an alternative option, with gaps of un-touched ditch of around 30m between cleared sections.
- Whichever method is chosen, ideally clearance should only ever be partial with no more than 20–30% of the ditch cleared in one year. Where there is some flow in the ditch, work upstream; this will help the vegetation to recover from the operations and help to restore water vole habitat.
- Determine the site for spoil deposition. Ensure that it is deposited in an area of low wildlife interest and that it will not block water vole burrow entrances, which may occasionally be located several metres from the water's edge.

ENHANCING EXISTING DITCHES

Some deep ditches may have steep vertical sides that do not enable marginal plants to establish along the ditch edges. It may be possible to create a berm or shelf along one or both banks in order to stimulate marginal vegetation growth. Berms need not be continuous but could be cut as scallop shaped hollows at intervals along the bank.

Re-profiling of existing ditches should be done in alternative 100m stretches and if possible on one side of the ditch at a time. However this work should not be undertaken without first seeking advice from relevant agencies such as English Nature.

Ditches and channels that dry out in summer could be enhanced through the erection of sluices. Fencing of ditches prone to damage by grazing livestock can benefit water voles, as has been demonstrated at sites owned by the National Trust near Castleton in the Peak District. Selective coppicing of trees and shrubs along shaded ditches and channels may increase their suitability for water voles by increasing light levels, encouraging the growth of marginal and in-channel vegetation and reducing leaf fall into the channel.

Odin Sitch: managed by the National Trust to benefit water voles.

3 | VEGETATION MANAGEMENT

3.1 ENVIRONMENTAL OPTIONS FOR FLOOD RISK MAINTENANCE WORKS

The Environment Agency has developed a series of Environmental Options that provide generic best practice advice for 'routine' flood risk maintenance operations, which include desilting, grasscutting, weedcutting and bush/tree management. These ensure that all main river, tidal and sea defences meet defined flood risk management standards but are also carried out sensitively to the Biodiversity interest of the sites. The Options allow the Flood Risk Management teams to specify the conservation requirements in the instructions for work on individual jobs within a consistent framework. Emergency works, other *ad hoc* work and work near or in a designated site (conservation or archaeological) or where protected species are known to be present is outside the scope of these options and specific advice must be sought from conservation advisors such as the Environment Agencies Fisheries and Biodiversity Team.

In practice a good working relationship should develop between those managing flood risk and the conservation staff within the Environment Agency and external environmental organizations. The Environmental Options must be used in conjunction with training to ensure that the various works teams are aware of habitats and species of importance that could be affected or enhanced by flood risk maintenance works. Generally, the higher the conservation value of the watercourse, the option with the least environmental impact should be chosen, unless there are justifiable reasons for using a high design standard, such as where there is a high risk of property flooding and risk to human life.

3.2 RETENTION OF FEATURES WITH CONSERVATION VALUE

As a general rule, the more diverse the structure of a river channel, (for example, riffles, pools, wet berms, cliffs, debris dams, marginal vegetation) the more opportunities

Checking weir in place to create a linear pond. Such a feature does not interfere with the drainage function under flood conditions.

BOX 5:A MANAGING DITCHES FOR WATER VOLES

As water voles become increasingly rare along main rivers and streams, their occurrence and survival along backwaters and ditches has very high conservation value. The large network of ditches that occur across many coastal areas and floodplains allow many colonies of water voles to establish. The interchange of individuals between colonies buffers individual sites from local losses, making the metapopulation more robust.

Management is a key factor in realizing the potential of a ditch system for water voles and other wildlife. Management is necessary to maintain the drainage function of the ditch by the removal of silt and dense vegetation, to prevent adverse water level fluctuation and prevent redundancy leading to the ditch scrubbing over or being filled-in.

Preferred best practice techniques are:

- De-silting without interfering with the banks and use appropriate sized machinery;
- Working from one bank only and progress upstream, working short stretches;
- Leaving gaps of 10–20m as untouched refuge areas for water voles;
- At least one third of the ditch should remain untouched.

Timber boards were inserted into a number of ditches to retain water at the time of summer drought.

When there is some flow it is important to move upstream when slubbing-out the ditches (de-silting). This will enable dislodged plant propagules (as well as invertebrates) to float downstream onto the disturbed substrate to readily recolonize it. The quicker the vegetation recovers after a de-silting operation the better the recolonization of the water vole colony. Where siltation is rapid, such as in the Fenland peat drains dredging may be necessary every 3–5 years. On higher ground de-silting may be only necessary every 7–15 years. Frequent de-silting of ditches is detrimental to water vole survival.

As with de-silting operations, vegetation removal or cutting should be minimized, perhaps best cut along different ditch lengths on a 3–5 year rotation. For bank vegetation a late autumn cut every one or two years would stimulate a rich grass sward providing plenty of food and cover for water voles, without effecting the drainage function of the ditch. A more regular mowing regime is unnecessary.

Many farm ditches have tended to be over managed in the past, leading to steep-sided, over-deepened features, which often tend to hold water only during flood events. Various options can be considered for altering the vegetation management, the retention of water in the summer months and the creation of pond features within the ditches.

VEGETATION MANAGEMENT IN DITCHES

Bankside vegetation cutting is best undertaken in late summer (mid-July to mid-September) with the flail cutters set high to retain 10–15cm of vegetation. Cutting options might include the cut of both banks, the cut of only one bank in any year or cuts to leave at least some ditch vegetation at intervals along one side. Where possible the removal of dense over-shading scrub cover will encourage better bankside grass cover for water voles. The overall effect of this management of the ditches is to create as many different habitats as possible from reed dominated ditches to open ditches.

CREATION OF LINEAR PONDS WITHIN DITCHES

Where ditches have been over deepened by past maintenance work, retention of water throughout the year in at least part of the ditch system can be achieved by creating a series of linear ponds along the ditch length. This can be done by either putting bund features within the ditch to hold water back, or if the soil type allowed, creating deeper and wider pools along the ditch length.

At a number of sites linear ponds can be created by inserting timber boards along the length of the ditch. Distances between boards will depend on the slope of the ditch but in general boards should be placed at 50m intervals. The bunds are created so as to maintain a water depth of at least 25cm without impeding flow along the ditch. As a rule of thumb, the bunds should be designed to be less than a third of the depth of the ditch and not impede flow when the channel was at bank full capacity. Consent must be sought from the Environment Agency for all checking weirs or bunds.

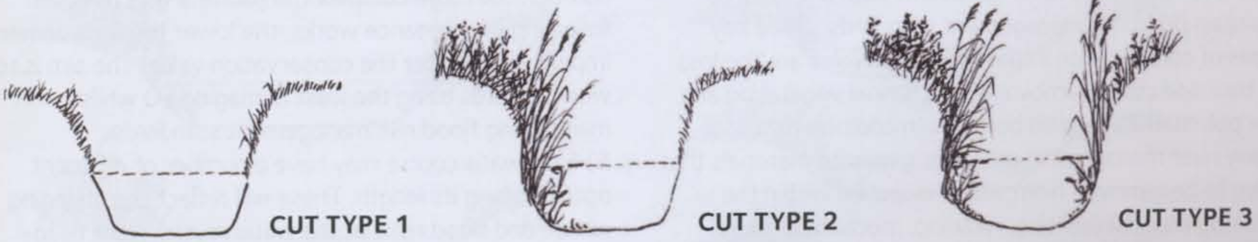


Figure 5A:1
Schematic cross-sections of the various vegetation cut types, within ditches.

there are for diverse plant and animal communities. These features and habitats, in whole or in some part, must survive throughout the year to maintain the plants and animals they support. Linear feature,s such as marginal standing vegetation, provide habitat and refuges from which animals and plants can repopulate into areas where maintenance work has occurred. The quantity and location of features that should be retained will be largely dependent upon the nature of the river and the flood risk management standard required.

3.3 KEY ENVIRONMENTAL IMPACTS AND BEST PRACTICE

All maintenance operations have some impact upon the environment. The options below have been assessed against best practice for water voles.

The aim must always be to use best practice options whenever this is possible, consistent with the need to maintain flood risk management standards. Three key areas of conservation impact on water voles are the loss of bankside cover, removal of in-channel vegetation and the potential damage to burrows. In addition to these many river management activities generate materials that have to be removed from site or disposed within the working area. All desilting, mowing, mechanical weed control and tree/shrub management produce materials that are potentially damaging to water vole habitat unless disposed of sensitively.

3.4 USING ENVIRONMENTAL OPTIONS TO BENEFIT WATER VOLES

1) Environmental Options (EOs) are a series of cross-section and long-section drawings, which provide a visual picture of the desired environmental outcome required of maintenance works (see Figure 5:4).

2) The objective of EOs is to provide a minimum environmental specification for maintenance works. Opportunities to enhance the river environment should always be sought.

3) The choice of each EO must be balanced with the flood risk management needs of the watercourse, including health and safety issues. The Environment Agency and other waterway managers should decide the design standards required and then agree the appropriate EO to meet these standards with the appropriate conservation advisors.

4) EOs are generally hierarchical; that is the higher the number, the more complex the habitats which remain following maintenance works, the lower the environmental impact and greater the conservation value. The aim is to work towards using the least damaging EO whilst maintaining flood risk management standards.

5) Each watercourse may have a number of different options along its length. These will reflect the changing nature and flood risks of the watercourse, from head-streams to lowland river and open floodplain to urban bottlenecks. It should be possible to 'colour code' the relevant sections of watercourse in relation to flood risk

and allocate the EOs in a series of reference maps (see Case Study: Water courses and flood risk management).

6) EOs are an idealized environmental minimum. They are not intended to define every facet of each watercourse. A common sense approach is required when river and option do not match exactly:

a) Do not 'expand' maintenance works to where existing margins/habitats already exceed minimum specification and do not affect flood risk management standards.

b) If the existing margins/habitats are smaller than those specified in the chosen options, take care not to disturb the 'retained' margin/habitat, e.g. do not run a weedrake through. This 'retained' zone must be undisturbed to allow recolonization and regeneration.

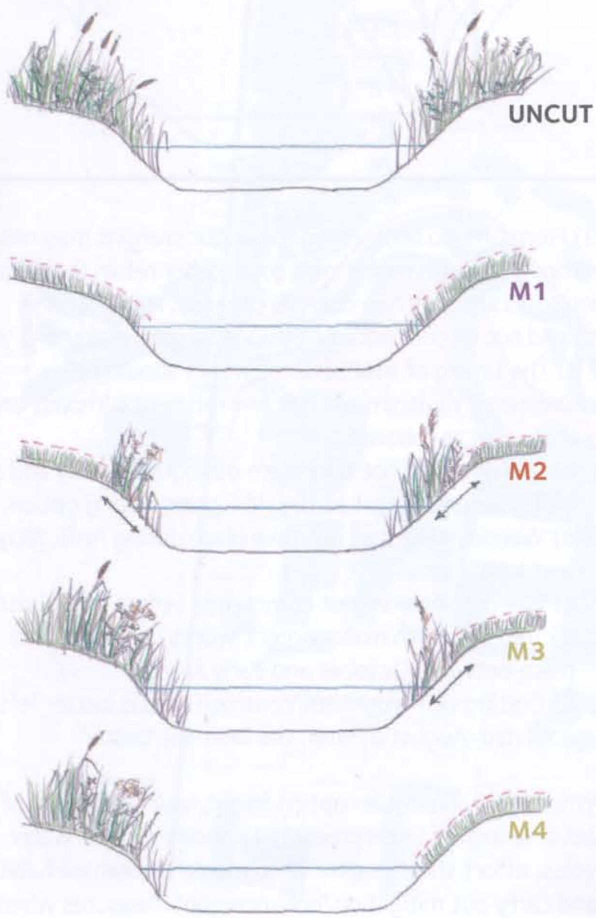
7) Weed cuttings, dredged silt, etc. must not be dumped on retained margins/habitats. Arisings should either be removed from the working area or placed in a specified place within the working area.

8) During weedcutting works take care to avoid baring the toe of the river bank as this can have adverse impacts on both flood water capacity and conservation interests, potentially damaging water vole burrows.

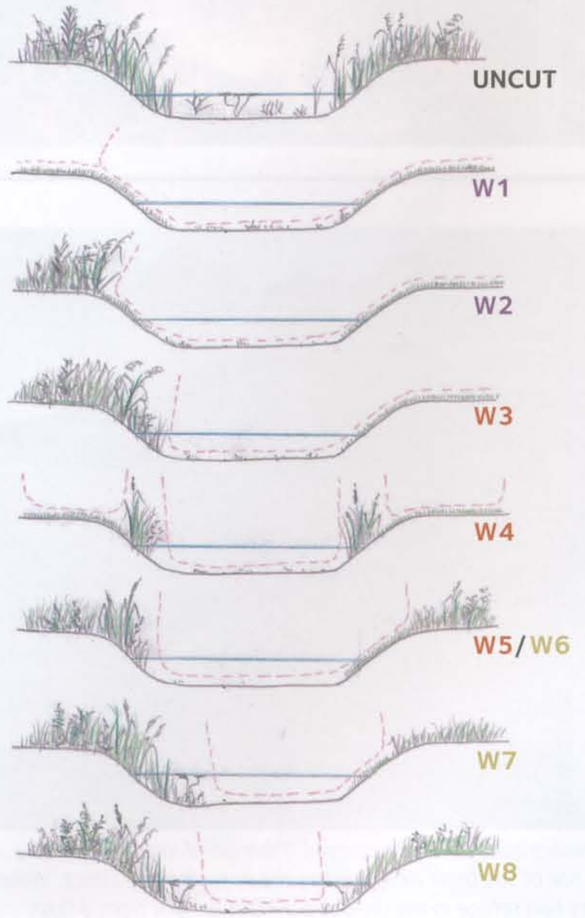
FIGURE 5:4 CONSERVATION VALUE OF OPTIONS

OPERATION	ENVIRONMENTAL OPTIONS – INCREASING CONSERVATION VALUE →		
Mowing	M1	M2	M3 M4
Mowing raised banks	ME1	ME2	ME3
Mowing tidal/sea banks	MS1	MS2	MS3
Weedcutting	W1 W2	W3 W4 W5	W6 W7 W8
Weedcutting by boat		WB1 WB2	
Weedraking		WR1 WR2	
Pollarding			P1
Tree and brush management	B1	B2 B3	

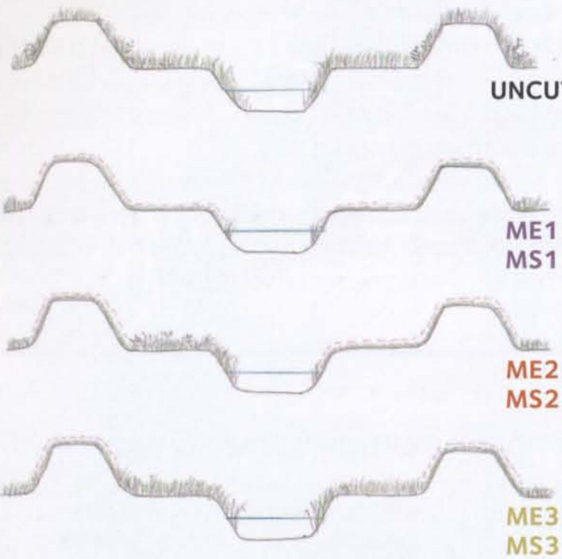
MOWING



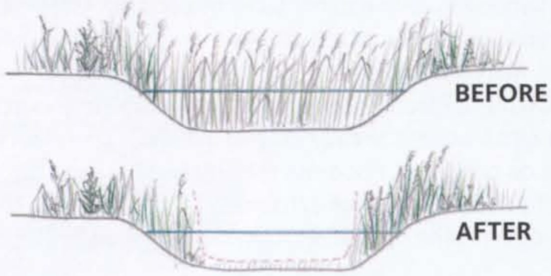
WEEDCUTTING



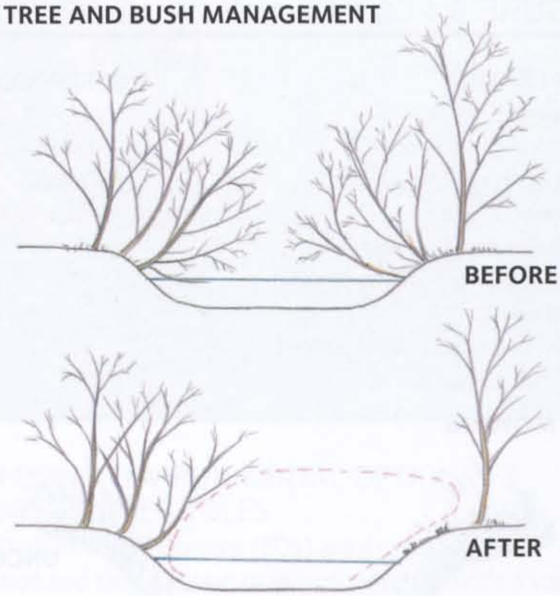
MOWING RAISED BANKS/SEA BANKS



WEEDCUTTING BY BOAT (WB)
WEEDRAKING (WR)



TREE AND BUSH MANAGEMENT



Sensitive bank mowing retaining a margin of vegetation along the toe of the bank while leaving the opposite side intact. Water voles find refuge in the un-cut bank but benefit from a flush of fresh grass growth following mowing.

9) From time to time, retained aquatic margins may need removal through a rotational cut in order retain their aquatic interests and maintain channel capacity. However, this should not be continuous over long lengths in any one year.

10) The timing of maintenance works should be coordinated to minimize their environmental impact on water voles as follows:

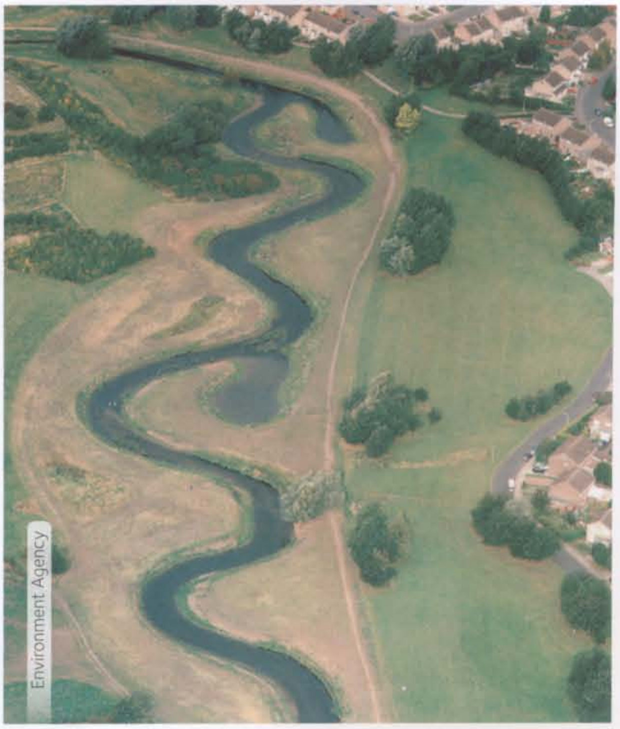
- a) Mowing shall not take place during April, May and June inclusive, unless part of the H&S grasscutting option.
- b) Weedcutting shall not take place during April, May and June.
- c) Weedraking shall not commence before 1st August.
- d) Tree and bush management works shall only take place between October and early March.
- e) Cutting of *Phragmites*/common reed is better left until mid-August or later, the later the better.

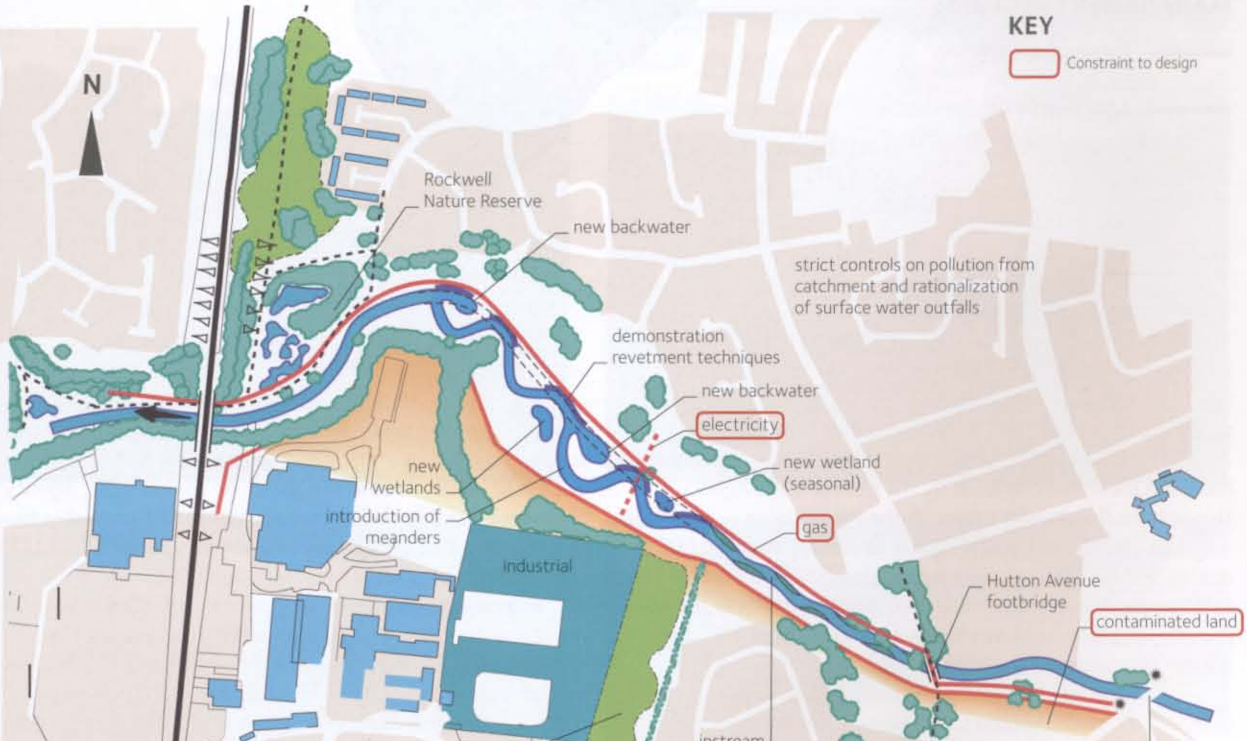
Where carrying out an option might have a high risk of adverse impact upon protected species such as water voles, effort should be made to identify potential habitat and carry out mitigation/enhancement measures where present to minimize impact.

CASE STUDY RIVER SKERNE RESTORATION PROJECT

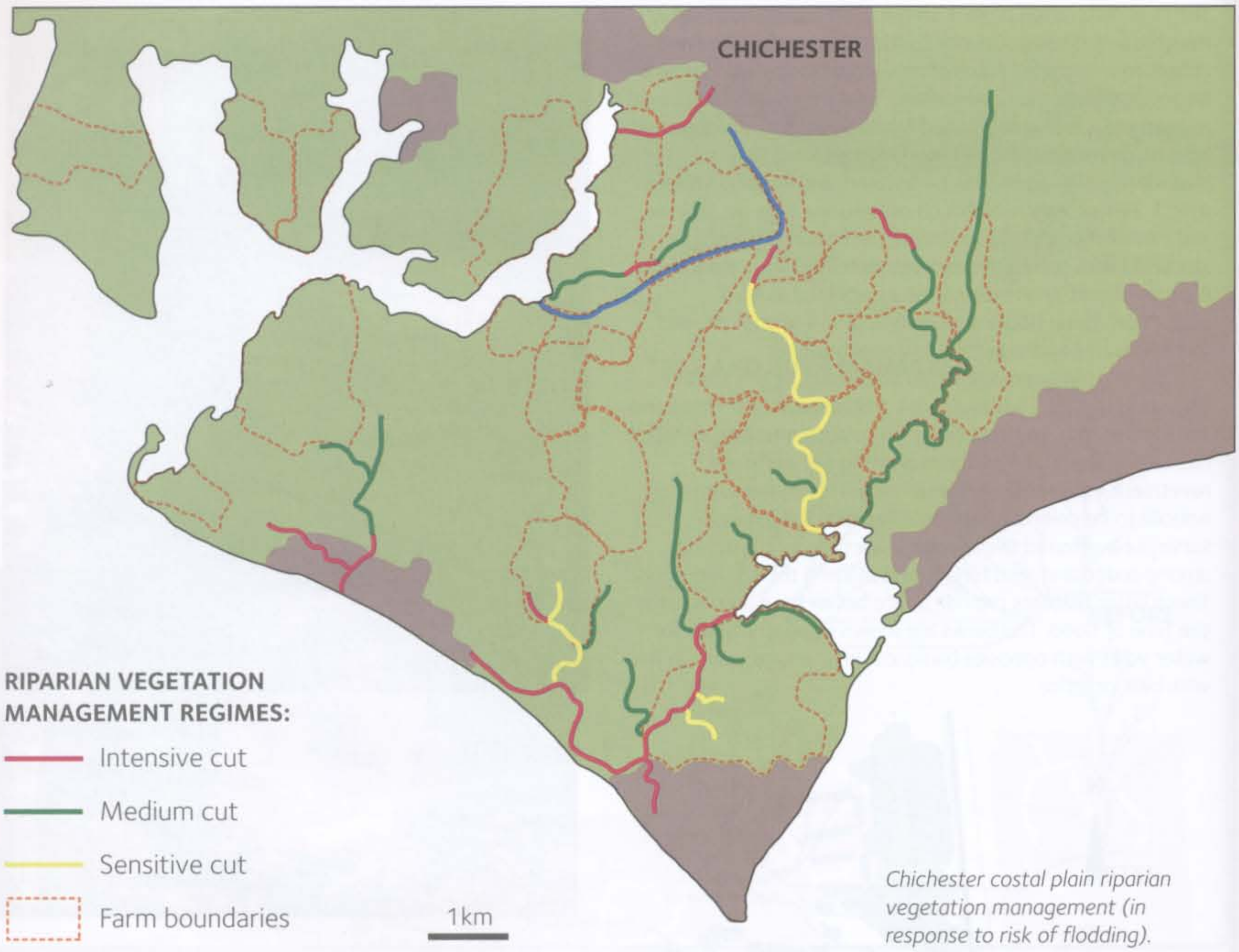
The river restoration project on the River Skerne at Haughton-le-Skerne, County Durham has rehabilitated and enhanced a degraded reach of urban, lowland river in terms of its physical features, flood storage, bankside habitat and visual appearance. Once straightened for flood control, drainage and housing development it has now been restored to a meandering plan-form with backwaters and wetland scrapes over 1.3km of length. Although constrained by a gas pipeline and electricity cables, a section of the floodplain was identified with sufficient room to create four large meanders. A series of soft revetments were established as bank protection during flooding using willow spiling and coir, and the whole area had extensive marginal planting.

Water voles were known to be present at the start of the works in 1995 (although not protected at that time) and the bank re-profiling was designed to accommodate suitable habitat for them. The marginal planting and soft bank revetment established well and water voles were soon noticed to be colonizing the new habitat. Subsequent surveys have found the species in sections of the spiling, among sedge and reed fringes and utilizing the on-line pools. These latter features provide a safe haven for water voles at the time of flood. The banks are mown sympathetically for water voles with opposite banks cut in alternate years, in line with best practice.





CASE STUDY WATER COURSES AND FLOOD RISK MANAGEMENT



Chichester costal plain riparian vegetation management (in response to risk of flodding).

The Chichester Coastal Plain is a flat lowland floodplain prone to flooding, mainly from groundwater after prolonged and heavy rainfall. Concerns over flooding in the area have a high public profile as the city of Chichester flooded significantly in 1994 and 2000. In response to this a flood defence scheme has been recently completed by the Environment Agency and this siphons flood waters through the project area.

The Chichester Coastal Plain is also of high agricultural quality and is intensively farmed, predominantly for arable and salad crops. Therefore, pressures to alleviate flooding and to provide land drainage have led to watercourses being intensively managed with little consideration for wildlife.

There are two types of watercourse within the coastal plain: natural rivers/streams and man-made drainage ditches. Ditches are the commonest type of watercourse. Many have little gradient or flow and are regulated by tidal flaps or pumping stations. They are characteristically trapezoidal in cross-section and have been re-sectioned and deepened to maximise their capacity to store water. Historic vegetation maintenance regimes have been intensive and have aimed to prevent in-channel vegetation and thick stands of marginal cover from reducing flow conveyance.

The Environment Agency maintains 83km of watercourses within the coastal plain area. In order to conserve water voles in the area it was crucial that the watercourses received sensitive management as the loss of suitable riparian habitats was a contributing factor in the decline of water voles in the area. The Environment Agency's biodiversity and flood risk management staff were able to target a sensitive vegetation maintenance scheme across the coastal plain (see map).

In assessing the flood risk posed by changes in vegetation maintenance it was essential to understand the flooding history of the catchment, its land-use and how the drainage system operates. With this in mind each watercourse was carefully considered and assigned one of three categories of flood risk, 'high', 'medium' and 'low', depending on the following simple criteria:

- How crucial is the watercourse (or stretch of) in draining built property? (have there been reported incidents of flooding by the watercourse, does it flow through a town, are there structures that cause flooding, etc?);
- What is the conservation value of the watercourse (protected or rare species, important corridor etc)?

This information was transferred graphically to maps and cab cards. Each cut type was assigned an individual colour in order to help staff identify them in the field. This exercise identified 26km stretches of high risk watercourse and promoted changes in the vegetation maintenance of all 83km, most notably to those in the medium and low categories.

Training and education was also an important part of this exercise. A number of workshops and practical exercises were undertaken that explained the rationale behind the changes and practically demonstrated each cut type. This helped make the transition between the historical and the new approach more rapid.

The map above depicts the various colour coded cut options as they were used on the watercourses of the coastal plain 2002–03.

The various vegetation cutting regimes were assessed in terms of their impact on the marginal, emergent and aquatic plants and various biodiversity indicator species (such as water voles and nesting reed warblers).

Options for the vegetation cuts were:

- *Cut type 1 (high flood risk)*: Intensive cut along one or both banks (cutting blades set 10–15cm), vegetation removed from the majority of the river channel with a Bradshaw bucket. 20% of vegetation retained as a small margin.
- *Cut type 2 (medium level of flood risk)*: Intensive cut much like type 1 on one bank only but retaining a narrow fringe of vegetation at the toe of the bank. 30% of vegetation retained. Opposite bank left uncut and 50–75% of the in-channel vegetation removed.
- *Cut type 3 (low level of flood risk)*: Both banks left intact (or one bank cut on a two year rotation). 50% of vegetation retained and just centre of channel removed, creating a sinuous meandering course to encourage self-cleansing of any silt.

These figures were assessed as a percentage of the cross-sectional area from top of left hand bank to top of right hand bank (for example, in cut type 1 this does not mean a cut of 80% of the vegetation present but leave 20% of cross sectional area un-cut). Water voles benefited from the proactive management as reflected in the case study on page 74.

Mid-channel and bank-side vegetation cut to three levels of Flood Risk Management specifications. Cut type 1 retains 20% of marginal vegetation; Cut type 2 retains 30% of marginal vegetation while Cut type 3 retains 50% of the bank and channel vegetation.

Pre-cut

4 WATER VOLES IN THE URBAN ENVIRONMENT

4.1 THE ROLE OF SUSTAINABLE URBAN DRAINAGE SYSTEMS

While Sustainable Urban Drainage Systems have been extensively analysed and tested in terms of their hydrological function, their implications for wildlife have not received the same attention. SUDS offer a network of diverse and contiguous habitats and corridors, connecting in many cases to existing habitats, their value for wildlife holds great potential (see Table 5:1). For water voles these include:

- Extension of existing habitat;
- Creation of feeding habitat;
- Creation of breeding habitat;
- Creation of linkages and suitable corridors between existing fragmented habitat.

The management regime will be critical in the performance of any implemented SUDS. An existing baseline ecological survey together with a clearly worked management and monitoring regime should therefore be part of any SUDS proposals.

Where waterbodies are to be created and managed for their wildlife value, consideration should be given to separating different sources of water, e.g., roof top and highway, with, perhaps, reedbed systems installed to help ameliorate the quality of water from the latter. Reedbeds in particular are favoured as a refuge habitat by water voles which may occur in them at high densities.

TABLE 5:1 SUMMARY OF POTENTIAL WATER VOLE HABITATS WITHIN A SUSTAINABLE DRAINAGE SYSTEM

SUDS	DESCRIPTION	HABITAT	ECOLOGICAL SIGNIFICANCE
Retention pond	Storage facility with permanent water	Pond/small lake	Wide range of habitats
Wetland	A retention basin with significant numbers of water-purifying plants	Marsh/bog/reedbed	Wide range of habitats. Improved water quality
Infiltration trench	Trench filled with a media having a large void ratio allowing water storage	Seasonally-wet ditch	Valuable habitat/corridor
Infiltration basin	Similar to a pond but all water stored is exfiltrated from the basin into the underlying soil	Seasonally-wet grassland/ wet woodland/carr	Valuable habitat
Grassed swale	Shallow, grassed ditch allowing limited amount of storage typically two year return period events	Ditch with grassland and temporary running water	Valuable habitat/corridor

SUD features associated with new housing development. Protected watercourse for water storage and habitat corridor. Reed fringed retention pond provides ideal habitat for water voles.

5 WATER VOLE HABITAT ON FARMLAND

5.1 THE ROLE OF AGRI-ENVIRONMENT SCHEMES

Intensification of agricultural practices in the UK over the last 50 years has revolutionized the countryside. Changes include increased use of pesticides, intensification of grassland management, the decline of traditional rotations and changes in sowing and harvesting times. As a result, 88% of English farmland is now intensively managed. Some consequences for wildlife have been drastic, others remain unknown. Intensification has contributed to major declines in formerly common farmland birds, as well as those of some plant and insect species. Less is known about mammals, but agricultural intensification is implicated in the decline of mammals ranging from brown hares to bats – and the suspicion is that other insectivores may have been particularly hard hit. A broad aim of Agri-environment Schemes is to seek to promote more extensive, lower-input agriculture, reversing many of the recent changes that are perceived as being damaging to wildlife, and Stewardship Schemes offer landowners and managers financial rewards for implementing action on the ground.

In the wider countryside a 'whole farm' approach to sensitive management of riparian habitats with options to restore or create new wetlands favourable to water voles should be promoted through Agri-environment Schemes.

The importance of Agri-environment Schemes in meeting BAP conservation targets is illustrated by the frequency of actions referring to them within individual BAPs. For example, of the 112 species BAPs originally produced in 1995, over one third specifically referred to Agri-environment Schemes as mechanisms for achieving targets. *A review of biodiversity conservation in Britain by the House of Commons Select Committee (HMSO, 2000)* judged that Agri-environment Schemes were crucially important in delivering action. These schemes provide many opportunities and financial incentives for managing, protecting, and creating wetlands, riparian corridors, arable margins, buffer strips and fenced off watercourses. No single scheme has been designed specifically to meet biodiversity targets, but all can be used to expand, link or buffer existing habitats or create new ones suitable for the various species of conservation concern.

5.2 EXISTING SCHEMES

The Environmentally Sensitive Areas Scheme was introduced in 1987, and aimed to maintain and enhance the landscape, wildlife and historic interest of designated areas by encouraging appropriate agricultural practices. There are 43 designated ESAs in the UK as a whole, administrated by the four Agricultural Departments, each identified as a discrete area of national environmental significance. A number of these specifically encompass wetlands including the upper Thames tributaries, Somerset Levels, the Broads, Avon valley, Test valley, Suffolk river valleys, Pennine dales and the north Kent marshes. The conservation interest of these areas is dependent upon *the adoption, maintenance or extension of particular* farming practices which have or are likely to change, or which could, if modified, result in a significant improvement in that interest. Each ESA had its own specific objectives as appropriate to the area. The ESA scheme provided farmers with 50–80% capital grant funding in order to facilitate beneficial works on the farm; land management agreements run for ten years and are based on a tiered structure of management prescriptions. Options include management of existing habitats, restoration of degraded habitats and reversion of arable land to grassland.

In 1991, the Countryside Commission launched the Countryside Stewardship Scheme as a pilot. The CCS was a multi-objective scheme that aims to provide landscape, wildlife, historical and public access benefits. It was transferred to DEFRA in 1996 and expanded to become the main Agri-environment Scheme outside of the ESAs.

As an example, in areas where waterside land is a targeted habitat, farmers could enrol with the Countryside Stewardship Scheme and apply for grant aid to:

CASE STUDY OXFORD SCIENCE PARK

In November 1998 the BBOWT Water Vole Recovery Project was invited to advise on incorporating water vole habitats in the balancing pools of the Oxford Science Park. This site borders Littlemore and Northfield Brooks in South Oxford, where water voles had been previously recorded.

A series of interconnected balancing pools were designed to balance flows and partially treat rainfall run-off by filtering water through a reedbed before discharging into Northfield Brook. The banks of the balancing pools were designed with alternating steep and shallow slopes with wet shelves at the margins to provide burrowing opportunities and feeding areas for water voles. The pools were lined with a butyl membrane which was placed well beneath any water vole burrowing areas for its own protection.

During the extensive site clearance, the banks of Northfield brook were fenced off to protect burrows and marginal habitat from damage. Additional water vole habitat was created on site in the form of a small wetland surrounded by steep banks next to the brook. Wetland plants from around the site were collected and stored by the developer to be incorporated later in the wetland area. A section 106 agreement was formulated by the Water Vole Recovery Project in conjunction with Oxford City Council for the developer to manage habitats favourably for water voles along Northfield Brook and pond edges. The Oxford Science Park development is ongoing and water voles on site are being monitored. The first signs of water vole using the balancing lakes were recorded in November 2004.

BOX 5:B PROVIDING PLANTS FOR WATER VOLES

Below is a list of common species that may be considered important for water voles, providing both food and cover. Most aquatic plants are best transplanted rather than seeded. Mixes containing a selection of the list species may be sown in any restoration or habitat creation projects.

REEDS:
Reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), reed sweet grass (*Glyceria maxima*).

GRASSES:
Meadow grasses (*Poa trivalis, P. pratensis*) cocksfoot (*Dactylis glomerata*), sweet grasses (*Glyceria fluitans, G. notata*), false oat-grass (*Arrhenatherum elatius*), tufted hair-grass (*Deschampsia caespitosa*), sweet vernal-grass (*Anthoxanthum odoratum*), Yorkshire fog (*Holcus lanatus*), creeping soft-grass (*H. mollis*), creeping bent (*Agrostis stolonifera*), Timothy (*Phleum pratense*), marsh foxtail (*Alopecurus geniculatus*), meadow foxtail (*A. pratensis*), purple moor-grass (*Molinia caerulea*).

RUSHES:
Hard rush (*Juncus inflexus*), soft rush (*J. effusus*), conglomerated rush (*J. conglomeratus*), sharp-flowered rush (*J. acutiflorus*), jointed rush (*J. articulatus*).

SEDGES:
Greater tussock sedge (*Carex paniculata*), false fox-sedge (*C. otrubae*), hairy sedge (*C. hirta*), bottle sedges (*C. rostrata*), bladder sedge (*C. vesicaria*), pendulous sedge (*C. pendula*), black sedge (*C. nigra*), lesser pond-sedge (*C. acutiformis*), greater pond-sedge (*C. riparia*).

Greater tussock sedge (Carex paniculata).

WATER PLANTS:
Branched bur-reed (*Sparganium erectum*), unbranched bur-reed (*S. emersum*), arrowhead (*Sagittaria sagittifolia*), common water-plantain (*Alisma plantago-aquatica*), flowering rush (*Butomus umbellatus*), broad-leaved pondweed (*Potamogetum natans*), hornwort (*Ceratophyllum demersum*), water-milfoil (*Myriophyllum spicatum*), yellow flag (*Iris pseudacorus*), bogbean (*Menyanthes trifoliata*), pond lilies (*Nymphoides peltata, Nuphar lutea, Nymphaea alba*), bulrush (*Schoenoplectus lacustris*), water crowfoots (*Ranunculus peltatus, R. aquatilis, R. penicillatus, R. fluitans*), water dropwort (*Oenanthe aquatica*), watercress (*Nasturtium officinale*).

Willow bark is an important winter food.

WETLAND/EDGE PLANTS:
Bistort (*Polygonum amphibium*), marsh marigold (*Caltha palustris*), celery-leaved buttercup (*Ranunculus sceleratus*), lesser spearwort (*R. flammula*), greater spearwort (*R. lingua*), cuckoo flower (*Cardamine pratensis*), meadowsweet (*Filipendula ulmaria*), water avens (*Geum rivale*), marsh cinquefoil (*Potentilla palustris*), purple loosestrife (*Lythrum salicaria*), fool's watercress (*Apium nodiflorum*), angelica (*Angelica sylvestris*), marsh bedstraw (*Galium palustre*), Water forget-me-not (*Myosotis scorpioides*), water mint (*Mentha aquatica*), brooklime (*Veronica beccabunga*), marsh valerian (*Valeriana officinalis*), marsh sowthistle (*Sonchus palustris*), water figwort (*Scrophularia auriculata*), gypsywort (*Lycopus europaeus*).

DRYLAND/BANK PLANTS:
Garlic mustard (*Alliaria petiolata*), rosebay willowherb (*Chamerion angustifolium*), greater willowherb (*Epilobium hirsutum*), cow parsley (*Anthriscus sylvestris*), sweet cicely (*Myrrhis odorata*), ground elder (*Aegopodium podagraria*), common comfrey (*Symphytum officinale*), hemp agrimony (*Eupatorium cannibinum*), dandelion (*Taraxacum officinale*).

WOODY SHRUBS AND TREES:
Crack willow (*Salix fragilis*), white willow (*S. alba*), purple willow (*S. purpurea*), bay willow (*S. pentandra*), ossier (*S. viminalis*), goat willow (*S. caprea*), grey willow (*S. cinerea*), aspen (*Populus tremula*), black polar (*P. nigra*), alder (*Alnus glutinosa**), hazel (*Corylus avellana*), field maple (*Acer campestre*), rowan (*Sorbus aucuparia*), hawthorn (*Crataegus monogyna*), crab apple (*Malus sylvestris*), bird cherry (*Prunus padus*), buckthorn (*Rhamnus carthartica*), elder (*Sambucus nigra*).
(* be careful to check against alder disease before planting).

Not all the species listed above are going to be suitable or acceptable at all locations, but as a rule of thumb native species of local provenance suitable to local geographic, hydrological, shade and soil chemistry factors should be chosen. Providing tall and dense cover in which the voles can hide from predators as well as providing diet should not be forgotten.

• Restore and create waterside features such as ponds, fens and reedbeds;

• Improve habitats for wildlife, both in the water and alongside streams, by restoring waterside vegetation, where necessary protecting banks from erosion by livestock, or by buffering them from the effects of herbicides, pesticides and fertilizer applications;

• Receive payments for the restoration and management of ditches and dykes by rotational cutting and raising water levels.

Modern farming has undergone a major revolution through the Common Agricultural Policy Reform. Cross compliance (the process whereby receipt of subsidy for production is conditional on meeting environmental standards) and modulation (the process whereby subsidies are transferred from production to environmental goals) are the new buzzwords for agricultural production with environmental benefits. Grant aid opportunities are now to be delivered with a 'broad and shallow' Entry Level Scheme (ELS) – open to all farmers. The Higher Tier Scheme (HTS) will reap greater financial rewards for those farmers who really focus on nature.

5.3 NEW SCHEMES

The Entry Level Scheme has been simplified to reduce the paperwork and increase uptake and coverage throughout the UK. With a larger proportion of land entered into stewardship these schemes are likely to contribute significantly to restoring the biodiversity of the wider countryside.

ENTRY LEVEL SCHEME (ELS)

Entry Level Stewardship was introduced in England in 2004. For information see *www.defra.gov.uk*. The basic characteristics of the Entry Level scheme are as follows:

CASE STUDY HABITAT ENHANCEMENT FOR WATER VOLES

The following are examples of work carried out during 2001–2004 as part of the YWT Water Vole Recovery Project. The project focussed on the River Hull catchment in the East Riding of Yorkshire, primarily because there was reliable information indicating that water voles were still present in good numbers, particularly in the River Hull headwater streams. The river is the most northerly chalk stream in the UK with the streams being spring fed off the chalk-based Yorkshire Wolds. It is an isolated catchment flowing north-south from the streams around the market town of Driffield, south to the city of Kingston-upon-Hull, where it enters the Humber estuary.

Various schemes have been undertaken, with fencing off of water courses the most cost effective. Bank repair using willow spiling and hazel fagots has also been carried out, often to compliment fencing work. New ponds and restoration of old neglected ponds has also been beneficial, often providing refuges for water voles, or perhaps more importantly, creating links between habitat enabling water voles to migrate between colonies that may otherwise have remained isolated.

One particular farm, The Beeches at Skerne near Driffield, has seen a lot of positive work undertaken. As part of a diversification to develop a fly fishing enterprise on one of the main River Hull chalk headwater streams, the West Beck, that flows through the farmland. The aim of the work was to enhance the whole area not only for the fishing enterprise but also for the benefit of the wildlife, integral to the overall success of the venture. Much of the area was designated a SSSI, due to its chalk stream characteristics. Water vole surveys were carried out prior to any major work being carried out and a programme of monitoring instigated to see how things developed. The project has been an ongoing working partnership between the farmer, the YWT Water Vole project, the EA and EN.


Andrew Parkinson

During the three years, over 3000m of stock fencing has been erected to manage the cattle and prevent bankside trampling. Around 700m of hazel fagots have been installed along five different sections of bank. Two new ponds have been dug adjacent to the West Beck and scattered tree planting and two new sections of hedge planted to provide some extra cover in one or two exposed areas.

Across the whole of the headwater streams a programme of mink control has been ongoing, starting in February 2002. Mink monitoring rafts have started to be used in the area to back up earlier work. A total of 54 mink had been removed from the catchment by September 2004.

MONITORING RESULTS: THE BEECHES, WEST BECK, OTTER ISLAND (WHINHILL)

SURVEY SEASON	GRID REF (START)	GRID REF (FINISH)	LATRINE COUNT	NO. WATER VOLE SEEN	MINK SIGNS
2002–August	TA04905685	TA03905675	23	03	No
2003–July	TA04905685	TA03905675	38	06	No
2004–June	TA04905685	TA03905675	46	11	No

NOTE: The length of bank surveyed was approx. 1200m

• There is a flat rate payment of about £30 per hectare over the whole holding, paid annually (the contract being for five years). For land parcels of 15ha or more within Less Favoured Areas (LFA) different rates apply, however. See ELS Handbook for details.

• ELS will be open to all farmers and land managers. Providing they can fulfill the requirements, entry and payment is guaranteed.

• Acceptance will be based on the farmer making a commitment to carry out environmental management activities. Each action will be worth a certain number of points. If you achieve a target number of points, you will be guaranteed entry to the scheme and payment.

• Points will be awarded for existing good stewardship as well as for introducing new management. The target number of points will vary depending on farm size.

If there are watercourses or ponds on the land, choosing options to protect and/or manage them will easily give the valuable points.

Below are listed some of the Options which will help water voles (see *'The ELS Handbook'* for full details of the scheme and the points):

• EB6 Ditch management *24 points/100m*

• EB7 Half ditch management *8 points/100m*

• EB8, EB9, EB10 Combined hedge and ditch management *28, 38 or 56 points/100m*

• EE1-EE6 Buffer strips *300–400 points/ha* (useful where *beside watercourses*)

• EE7-EE8 Buffering in-field ponds *400 points/ha*

Options which, if located by watercourses or ponds, may help provide habitat for water voles:

On arable land:

• EF1 Field corner management, e.g. the inside of a river bend *400 points/ha*

• EF9 Conservation headlands in cereal fields *100 points/ha*

• EF10 as for EF9 with no fertilizers or manure *330 points/ha*

• EF11 Uncropped, cultivated margins on arable land *400 points/ha*

On grassland:

• EK1 Take field corners out of management *400 points/ha*

MANAGEMENT PLAN OPTION

The EM2 Nutrient Management Plan and EM3 Manure Management Plan will reduce nutrients in buffer strips. This will help reduce the risk of harmful weeds and non-native plants from dominating buffer strips, reducing the need for weed control and letting native plants favoured by water voles flourish.

Fencing schemes to protect watercourses from livestock are particularly important to encourage a more luxuriant swathe of bankside vegetation.

Higher Tier Scheme (HTS) – available from 2005

This offers a structure where land managers are encouraged to manage, restore and sometimes create important features and habitats with the highest payments for sites in good condition.

CASE STUDY LINKING WATER VOLE COLONIES TOGETHER

Clayfields Farm near Brandesburton (approx 10 miles south east of Driffield) East Yorkshire has a network of agricultural ditches criss-crossing the land. Land use is predominantly livestock (cattle and sheep) with some arable fodder crop.

A site visit in 2002 confirmed water voles in a number of the ditches. Two ditches in particular had good levels of activity (Hall's drain and Mickley Dike). A small cross field drain that once linked these two larger drains had become almost lost through the actions of cattle poaching. Only the southern-most end of the drain, closest to Mickley dike was still in reasonable condition (due to steeper banks gradient and mature hawthorn bushes). It was agreed with the landowner to reinstate this small ditch and erect sheep proof stock fencing along both sides to create a link between the two water vole colonies using Mickley Dike and Hall's drain.

The work was carried out in winter 2002 as a special project under the CS scheme and directed by the Yorkshire Wildlife Trust water vole recovery project. Surveys in summer 2003 showed that water voles had begun to colonize this newly restored ditch and by 2004 the full length of ditch had water vole activity. More importantly it now provides a connecting link between two other ditches containing water voles.

Further fencing work has followed on other ditches, to protect them from stock and a new ditch created nearby. Mink are not active on the farm and monitoring occurs to ensure reactive action should any be found.

Brambles provide water voles with seasonal fruit. Leaves and young shoots will be taken in Spring and roots in the winter months.

A 6m-wide grass margin established either side of a farm ditch provides extensive foraging opportunities for water voles.

There is a need to stand back and think about what it is that produces the greatest benefits for wildlife. Certainly low intensity, extensive systems are valued, but this does not mean that we ignore the intensive systems. Giving these systems a softer edge with targeted measures to maximize and diversify habitats at the farm level will go a long way to restoring water voles and a lot more besides.

Further information and administration
For more information contact your local FWAG office or DEFRA Rural Development Service team (see also *www.defra.gov.uk*).

Scottish Countryside Premium Scheme
The scheme aims to support environmentally sensitive farming across Scotland. It provides payments for farmers to undertake positive conservation management measures and capital works in association with conservation management. This includes an incentive to extensify grazing through payments for stock disposal. It also requires participants to protect existing features of conservation value on the farm or croft.

Eligibility:
It is available to Scottish farmers and crofters outside ESAs. Each Department Area has its own set of local conservation priorities against which the merit of individual applications are assessed.

Incentives and payments:
Annual area payments are available for the management of grasslands, wetlands, water margins and flood plain habitat. Payments are also available for the creation of wetland and the creation of conservation headlands around arable fields. A payment will also be made for every ewe removed from the flock to reduce grazing pressure on heather moorland.

Capital Works payments are available for the erection of stock-proof fences and the creation/restoration of ponds.

Potential benefits for water voles:
- Retains and enhances inbye wetland areas such as lowland raised bogs, ponds and reedbeds and protects them from damage by livestock and farming operations.
- Management of water margins to protect from erosion and permit the development of tall waterside vegetation.
- Creation or restoration of permanent ponds.
- Creation of uncropped wildlife margins to arable fields as streamside corridors.
- Reduction of sheep numbers on moorland which, while it achieves the primary aim of heather regeneration, also allows tussock grasses to predominate in wetter areas and along streamsides as excellent water vole habitat.
- Water voles could be included in the annual priorities for conservation measures and habitat enhancement targeted in each administration area.

For further information and administration:
Applications to the Agriculture, Environment and Fisheries Department, the Scottish Office. A conservation audit is required to identify features and habitats of conservation on the farm. Individual applications will be considered in the context of conservation priorities agreed locally by a range of groups and interests including NUFS, Scottish Crofters Union, Scottish Agricultural College, FWAG, SNH and others.

TIR GOFAL (WALES)
Tir Gofal is a whole farm scheme, managed by the Countryside Council for Wales (CCW)/Welsh Assembly Government.

Tir Gofal comprises four elements:
1) Land management of Whole Farm and key habitats with additional habitat restoration and creation options.
2) Creating new permissive access as voluntary options.
3) Capital works payments to protect and manage habitats and features.
4) Training for farmers including courses on managing specific habitats and practical skills.

Agreements will run for 10 years (with a break clause at five years). Available throughout Wales to farmers or others who have responsibility for and control over farmed land.

Incentives and payments:
All farms entering the scheme receive a whole farm annual payment (for information on maximum payment ceiling contact CCW).

Additional payments include the following land and features: woodland and scrub; heathland; unimproved

CASE STUDY RESTORING WATER VOLES TO THE CHICHESTER COASTAL PLAIN, WEST SUSSEX

Chichester costal plain. Insert (right) shows the location of the study site in the UK. The aerial photo (left) shows the three rivers of Pagham Harbour draining the farmland of the costal plain.

The Chichester Coastal Plain is one of the most productive farming areas in the UK due to a combination of very fertile free-draining soils, favourable climate and long periods of sunshine. This has encouraged the development of a very progressive farming community, using new ideas and technology to produce high yields of predominantly vegetable, salad and arable crops. With such intensive agriculture, can there ever be room for wildlife?

In 2000 the Chichester Coastal Plain Sustainable Farming Partnership was formed between WildCRU, Sussex FWAG, Sussex Wildlife Trust, Environment Agency and West Sussex County Council to work directly with the farming community and focus on restoring biodiversity to farmland. In particular, Sussex FWAG and WildCRU made joint farm visits and co-authored Whole Farm Conservation Plans for each site visited that highlighted best practice, emphasizing the benefits not only to the environment but also to the farmers themselves. Assistance was also given to farmers to help with applications for agri-environment funding. Sponsorship allowed this service to be offered free within the project area.

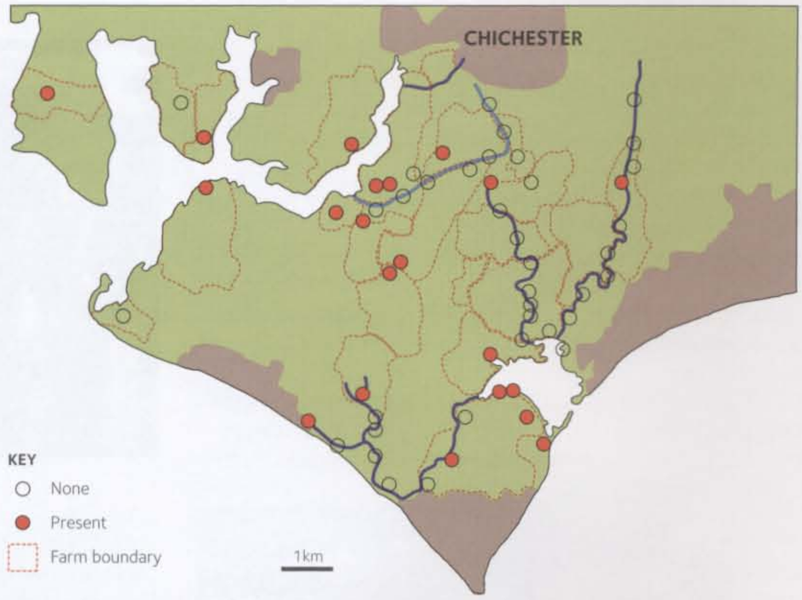
Each Whole Farm Conservation Plan described the existing farm habitats and farm management practices, but also made baseline surveys for key species of conservation concern. The plans included advice on a whole range of issues such as livestock and grassland management, arable margins and buffer strips, ditches, hedges and wetlands as well as advice on farm operation and resource management issues.

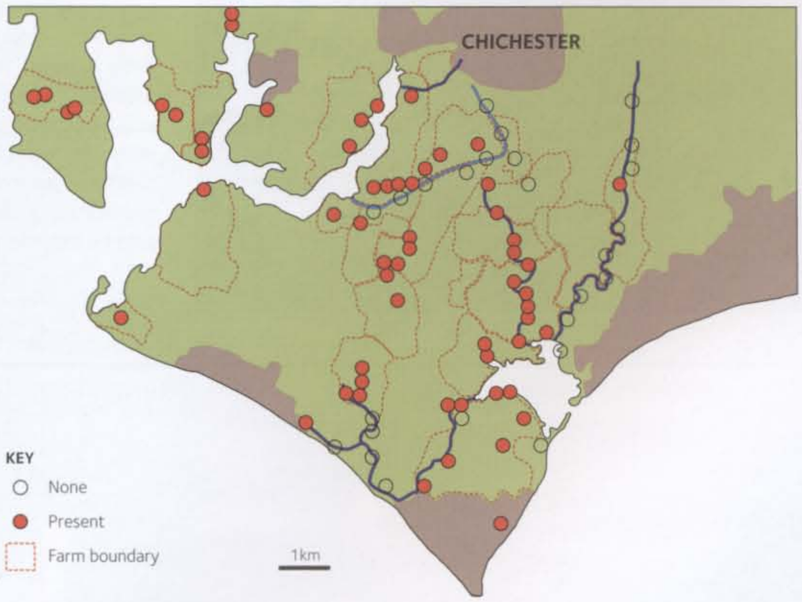
Through the delivery of these plans the project has been able to create linked habitat corridors across and between neighbouring farms. By 2003, 42 contiguous farm holdings, totalling 8,400ha (approximately 20,750 acres) have been visited and conservation plans written. Key farms in the area abutted the three major watercourses that feed the Pagham Harbour Nature Reserve. 4,556ha of this land has been entered into Countryside Stewardship as a direct result of the project (advice on grant funding played a pivotal role within each of the Whole Farm Conservation Plans, helping farmers to both achieve benefits and help maintain a sustainable farm). A further 1,328ha of land was already in Countryside Stewardship, but the project was able to develop beneficial amendments. This meant that 70% of the farmland visited has been directly impacted by agri-environment funding.

Collectively, these stewardship agreements have created over 61km of six-metre wide grass margins, which equates to 36.6ha of rough grass buffer-strips. As many of these margins were targeted beside ditches and watercourses they have directly linked across farms and benefited the riparian corridor for species such as the water vole. 27 farm ponds have been restored, 28 ditch ponds have been created and water levels in over 42km of ditches have been maintained. 7,200m of new fencing have been erected as part of the project to protect watercourses from the trampling of livestock. On some of the farms, habitat improvement has also included the restoration of ancient hedgerows, the creation of scrapes, arable reversion and the extensive management of waterside pasture.

Although it is still early days, it is a real credit to the project that the water vole responded well to the various habitat enhancements on the farmland, so that by 2003 the population had more than tripled in total size. In particular a number of the new ponds and ditches were quickly colonized, together with those watercourses protected from cattle trampling by fencing. Measured increases were also made for brown hare numbers and field voles where new grass margins had been established around arable fields. Corn buntings, turtle doves, skylarks and barn owls have all benefited as have many butterflies and dragonflies. Where rare arable flowering plants were identified, their future conservation has also been assured through targeted management prescriptions as outlined in the Whole Farm Conservation Plans.

The success of the working partnership has shown us not only what can be done but, how to do it on the ground. To this end WildCRU produced a report on the project *'Restoring water voles and other biodiversity to the wider countryside'* together with an information pack of technical sheets aimed at farmers to ensure best practice management of watercourses, ditches and wetlands.





Relative distribution of water voles across the costal plain farms: 2000 (top) and 2003 (bottom).

Insects, such as this damselfly, and birds have also benefited from the habitat enhancements on the Chichester Costal Plain farmland.

grassland; semi-improved grassland; wetlands; unimproved coastal habitat; restoration or creation of new environmental features.

Potential benefits for water voles:

- Retain and avoid damage to all existing wildlife habitats on the farm. The special requirements of known water vole colonies could be considered in the scheme.
- Safeguard ponds, rivers and streams and protect them from damage by livestock and farming operations. This may encourage the recovery of existing water vole populations.
- Creation of streamside corridors would encourage water vole dispersal and colonization.
- Creation of uncropped wildlife margins to arable fields adjacent to watercourses.
- Reversion of improved/semi-improved grassland to rough pasture beside watercourses.
- Creation of new wetland habitat features such as reedbeds.

Further information and administration:
Further information is available from CCW and Welsh Assembly Government.

BOX 5:C LIVESTOCK MANAGEMENT BESIDE WATERCOURSES

Livestock can have both a direct and indirect impact on waterside vegetation and water quality. Where animals have direct access to bankside vegetation their feeding and trampling can greatly reduce the habitat quality by removing food sources and reducing the quality of cover. Their impact on the banks may also cause erosion, and increased siltation of the watercourse, while their dung may also affect water quality. Indirectly poor livestock management may lead to increased runoff through poaching and compaction of fields and where livestock are regularly moved, their pathways may also become channels for nutrients and soil to enter watercourses.

In a number of studies that have monitored the effects of bankside fencing clear differences have been observed in the ability for the watercourses to maintain a high density of water voles. Unfenced banks were largely untenable by water voles if heavily trampled by cattle. Intensively sheep grazed banks were also found to support far fewer voles than un-grazed banks. However, fencing can lead to the banks becoming scrubbed over by woody species such as bramble, hawthorn, blackthorn and gorse. These will ultimately lead to a reduction in grass cover and have the potential to harbour predators. Long-term maintenance of fenced banks should include either periodic grazing or mechanical flail mowing to stimulate grass cover. The siting of the fenceline should therefore incorporate an opportunity for flail mowing or provide stock access via a gate. Cattle drinking bays could also be incorporated.


Rob Strachan


Rob Strachan

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KEY AREAS FOR WATER VOLES

The 1997 Species Action Plan for the water vole recommended that a number of large viable breeding populations of water voles were given special status as Nationally Important Key Sites. Such sites could be expected to maintain the species in the long term through appropriate management, and act as source populations for the recovery of the species into adjacent areas. Modelling and observational studies on the dynamics of water vole meta-populations have suggested that long-term viability is a function of the immigration and emigration of individuals between different colonies. Such interchange can improve both colony breeding vigour and numbers, and so can increase the likelihood of persistence at the site. The designation of key areas for water voles should ensure that limited resources are focused on the proactive management of the species and its habitat at the most important sites and at the appropriate landscape scale.

Three tiers of Water Vole Key Area have been suggested, and the first of these, National Key Sites, is already in place:

- National Key Sites – populations of water voles of National importance and priority sites for conservation resources.
- Regional Key Areas – populations of water voles of Regional significance. These should be recognized as strategic areas for conservation effort and resource allocation.
- Local Key Areas – populations of water voles of local importance to be incorporated into Alert Maps for local planning authorities and conservation agencies.

Ideally a bottom up approach should be used so that clusters of the best Local Key Areas are put forward as candidate Regional Key Areas. A list of the most important Regional Key Areas are then used to select the next tranche of National Key Sites. This process would then allow for the Key Site selection criteria to be widened to include water vole populations across the geographic range of the species in the UK.

Populations of water voles that occupy the upper watersheds, such as on the Elan and Wye catchments, may make ideal candidate Regional Key Areas.

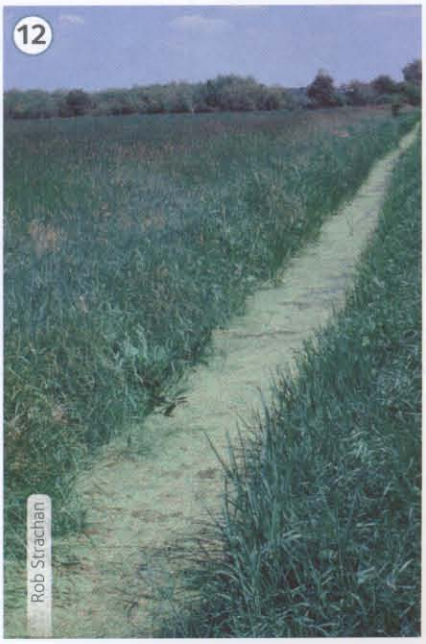
1 NATIONAL KEY SITES FOR WATER VOLES

A scientific study by Bright and Carter (2000) discovered that large reedbed sites could provide a refuge for water voles from predation by mink. The research showed that, although mink were responsible for high levels of mortality on the fringes of reedbeds, predation rate declined sharply with the distance water voles nested within reedbeds, away from main channels. As a result, reedbeds still support large populations of water voles, even in areas where mink have been present for several decades. The authors suggested that reedbeds are made one focus of landscape-scale conservation, from which water voles might disperse to recolonize surrounding areas.

Based on the original recommendations of the UK BAP Water Vole Steering Group in 2000, a small number of sites have been recognized as being of *national* importance for water voles in the lowlands, and designated as National Key Sites. These are sites with

1. TITCHWELL
2. HICKLING BROAD
3. BURE MARSHES
4. MINSMERE
5. SIZEWELL
6. NORTH WARREN
7. BLACKWATER ESTUARY
8. INNER THAMES MARSHES
9. ELMLEY
10. NORTH KENT MARSHES
11. STODMARSH
12. WEST SEDGEMOOR
13. SHAPWICK HEATH & HAM WALL
14. LLANELLI
15. MALLTRAETH

Figure 6:1
First tranche of National Key Sites 2000–05 as endorsed by the UK Water Vole Steering Group. Photos show Bure Marshes, Malltraeth, West Sedgemoor, and North Kent Marshes.



BOX 6:A LOCAL KEY AREAS FOR WATER VOLES IN BERKSHIRE, BUCKINGHAMSHIRE AND OXFORDSHIRE

A list of water vole Key Areas has been compiled by the BBOWT Water Vole Recovery Project to enable the preparation of alert maps for use in the planning process. The Local Key Areas enable the Water Vole Recovery Project to direct conservation action to those areas where the water vole requires protection.

Key Areas have been allocated following seven years of field surveys by the Project Officer and other trained surveyors, and the collation of other water vole records from Oxford University, Environment Agency, amateur naturalists and Local Records Centres.

The boundary of a Key Area is taken to be 10m from the bank-top each side of a watercourse surrounding the water vole colony (as this is ideally the area in which no unavoidable physical work should be undertaken, e.g. ground excavations, hard engineering, or unnecessary development etc). A buffer zone of 2.5km is added to either end of the colony to allow for dispersal of individuals and population expansion, and a buffer width of 0.5km each side of the watercourse is added to allow for water vole dispersal across land. This may be along connecting watercourses, through high vegetation or by using ponds as stepping stones to reach other favourable riparian habitat. Within the area of a major population, some un-sampled minor waterways may be included in a Key Area based on the presence of suitable habitat. Suitable habitat is defined as a river bank substrate suitable for burrowing with a plant species composition which provides suitable food plants for water voles. Suitable habitat on one or both banks of a watercourse may be sufficient to fulfil the criteria.

Key Areas are regularly monitored to determine the status of the water vole colony and determine suitable limits to the key area so that the entire riparian habitat inhabited by water voles is identified. Previously unknown water vole populations which are identified may be added to the Key Areas list if they meet the criteria listed above. Local Authorities will be notified of any additional Key Areas by the Water Vole Recovery Project on an annual basis.

Denotification of a Key Area requires a series of three negative surveys (from a reliable source, i.e. those completed by the Water Vole Project Officer or by an informed ecological consultant) that are completed within a six year time frame of alternate years to allow for metapopulation dynamics.

Figure 6A:1

Water Vole Key Areas as designated April 2005 by the BBOWT Water Vole Recovery Project.

A radio-collared water vole. Radio-collaring has been vital for research on this species, but its use is generally limited to scientific research. See Chapter 4.

probably highly viable water vole populations, which are likely to be defensible in the long term from the dual threats of habitat loss/degradation and mink predation.

To date fifteen wetlands have been designated as National Key Sites in England and Wales (see Figure 6:1). The following criteria were used in their selection:
a) Sites with large water vole populations where current habitat quality is optimal for water voles or where a minor adjustment in management would make it so.
b) Sites that provide a known and probably sustainable refuge from mink.
c) Sites that are most likely to be major sources of re-colonists for a wider area.
d) Sites where land tenure and habitat management are assured in the long term.

Landowners and managers of National Key Sites have adopted habitat management plans to ensure favourable conditions for water voles. Water vole survey information for each site has been reviewed and, where necessary, baseline population surveys carried out. Annual monitoring is carried out using a standardized protocol in May and September to provide a comparative index of activity at each site. Proactive management of the adjacent habitats surrounding each Key Site will encourage natural expansion of water vole populations and enhanced buffering of the sites themselves.

The first tranche of sites have concentrated on reedbed habitats and coastal grazing marsh. It is expected that the series of designated sites will be expanded in future years and should include a wider geographic spread, particularly from Northern England, Scotland and upland Wales.

2 REGIONAL KEY AREAS

The second tier of importance includes those areas for water voles that are likely to play a strategic role in the recovery of the species and encompass a significant proportion of the total water vole population at a regional level. Such populations may occur at upland sites and link across watersheds or occur along floodplains and coastal plains in the network of associated backwaters and ditches. Such areas may involve a multitude of different landowners but may be brought into favourable management through the targeting of agri-environment funding or special project funding. A twin track approach of habitat restoration and mink management may be required to safeguard these populations.

The selection of these areas has yet to be confirmed but it is recommended that conservation organizations in each of the various UK Regions identify candidate areas suitable for inclusion. Example Key Areas might include the central Cairngorms in eastern Scotland, areas of the Pennines in Northern England, the River Itchen and its floodplain ditches in Southern England and the Abergele marshes in North Wales.

3 LOCAL KEY AREAS

Local Biodiversity Action Plans recognize the importance of local populations of water voles and the measures required to ensure their future safeguard. The knowledge of the whereabouts of the various local water vole colonies is paramount in their local protection. Aggregations of colonies should be depicted as important local areas on planning Alert Maps by local authorities and those that screen development plans. The recognition of the local Key Area status can also focus local conservation initiatives aimed at linking together the colonies through proactive management of their habitat. A good example of Local Key Areas being used to influence local authority planning is given in Box 6:A.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MINK CONTROL FOR WATER VOLE CONSERVATION

UK WATER VOLE STEERING GROUP GUIDANCE ON MINK CONTROL FOR WATER VOLE CONSERVATION: POSITION STATEMENT.

- The UK Water Vole Steering Group considers that unless action is taken to reduce the impact of mink it is possible that the water vole will become extinct over much of Britain in a few years.

- The UK Water Vole Steering Group supports in principle the humane control of mink as part of a national plan endorsed by the UK WVSG for the purposes of water vole conservation. Mink control should follow the UK WVSG guidelines to ensure maximum benefit for water voles. Any mink control project must be properly researched, carried out and monitored by people with the relevant experience and competence. It must have a stated objective and be for a defined period and should be reviewed, altered or terminated at specified intervals in the light of the monitoring results.

- The UK Water Vole Steering Group does not consider mink hunting with hounds to be an effective method of reducing mink numbers. This activity may also disturb habitats and wildlife including otters.

- The UK Water Vole Steering Group will only support mink control where it is accompanied by habitat restoration and management to provide long-term protection for water voles.

- This mink control position statement will be reviewed in the light of any new research or information on control methods or changes in best practice.

1 BACKGROUND

Many studies have demonstrated losses of extant populations of water voles due to predation by mink (e.g. Barreto and Macdonald, 2000), and such losses often occur in habitats which had previously supported a healthy population of water voles. Given the extremely large distances that dispersing mink can cover (20–40km), nearly all extant water vole populations face a high likelihood of mink eventually dispersing into their habitat. Dramatic declines can result from overwinter predation of water voles by mink. The main predation pressure on a local water vole colony arises when a female mink is nursing her young and needs to provision the litter with fresh meat. From the breeding/nursery den (for example, in an old hollow willow pollard or riverside rabbit warren), females have been observed to hunt the river margin for approximately 1.5km upstream and 1.5km downstream every night. This hunting strategy not only locates the local water vole colonies, but the regular visits over the four months the female is nursing are likely to successfully hunt out every water vole in the colony. Female and juvenile mink are slim enough to enter the water vole burrows and catch them underground.

A good example of the adverse effects that mink can have, and how unexpectedly these impacts can occur is the loss of the population on the Wendover Arm of the Grand Union Canal, Buckinghamshire. In 2001, the Wendover Canal supported a population of over 120 water voles on a 4km stretch. This population had been in existence for at least 80 years and was being monitored during the water voles' breeding season. The population suffered mink predation between September 2001 and April 2002, resulting in only one individual surviving to the following spring. Needless to say this resulted in the complete destruction of this population.

In order to ensure the survival of water vole populations, mink control, at least in the immediate locale of populations, is necessary. If new populations are being created, by reintroduction or translocation, then permanent mink control in the surrounding locale is mandatory.

That mink control is an essential tool in water vole conservation is recognized by its inclusion in the National Species Action Plan (SAP, 1997). Non-lethal control methods are under review (Macdonald and Strachan, 1999) although none appear to be directly applicable to the mink at present.

It should be stressed that the existence and establishment of well-connected, good quality habitat is vital to water vole recovery in the long term. Any intervention to control mink should be seen as an interim measure while habitat measures come into effect.

2 PLANNING A MINK CONTROL PROJECT

The approach that should be taken is one of careful planning and proper justification.

It should be considered that there is a good chance that mink control will be effective in reducing mink numbers and that it would make a significant contribution to the conservation of an existing population of water voles in a defined area.

By starting with a written proposal and justification, the different elements of this can be discussed, and if necessary defended, and the cost in both time and money can be assessed and justified. A convincing case must be made, after adequate research, that the proposed mink control programme will benefit the water vole in the context of the site/s in question. The proposal should be sent to the UK WVSG for endorsement.

Any mink control project must be properly researched, carried out, and monitored by people with the relevant experience and competence. It must have a stated objective and be for a defined period and should be reviewed, altered or terminated at specified intervals in the light of the monitoring results.

An average mink territory size along a linear waterway may be 5km (male) and 3km (female), so trapping in only one locality (e.g. a Nature Reserve) may simply create a territorial vacuum which will quickly be filled. Only the wider view (stream or river catchment) is likely to have a long-term benefit for water voles. This has been demonstrated on the Rivers Test and Itchen in Hampshire where both rivers are kept relatively free of mink. The cooperation and involvement of neighbouring landowners and managers in the area will be a key factor in determining the effectiveness of the mink control programme.

Trapping should only be considered as a part of an overall strategy to help water voles locally. Positive habitat management should also be undertaken or encouraged to increase the amount and variety of suitable habitat available. Even simple measures can help, such as fencing a section of river to prevent excessive poaching by livestock (see Chapter 5).

If a decision is taken that the trapping of mink is to go ahead then it must be carried out strictly in accordance with the Best Practice Guidelines for Mink Trapping (see below).

CASE STUDY MINK CONTROL ALONG THE RIVER DEBEN CATCHMENT, SUFFOLK

Three surveys funded by the Environment Agency have been undertaken and managed by the Water for Wildlife Project, Suffolk Wildlife Trust.

The baseline survey was carried out in 1997 and showed 78.5% of sites occupied by water voles. A repeat survey in 2003 showed a dramatic and serious change in water vole distribution along the River Deben. Only 46.8% of the sites showed signs of voles and mink evidence was widely recorded.

A mink control programme was initiated and co-ordinated by the Water for Wildlife Project.

Landowners have been trapping mink along the Deben for three years. As a result there were approximately 15km within the catchment covered by 10 landowners borrowing 20 traps. In 2004 a total of 31 mink were trapped. In 2003 42 mink were trapped and in 2002 29 mink were trapped. That brings the total number of mink trapped over a three year period to 101. Mink rafts were deployed at 1.5km intervals throughout the Deben catchment. The work undertaken by a project officer who could liaise with landowners, deploy the rafts, monitor the rafts and set and check mink traps when necessary. This avoided the necessity to rely wholly on the commitment of landowners and ensured continuous trapping throughout the catchment.

Simultaneously to the mink removal has been habitat enhancement work so that all main channel of the Deben now supports suitable habitat for water voles. The 2004 water vole survey found a rapid recolonisation of water voles. Eighty percent of survey sites were occupied.

The mink control programme has been extended to six other river catchments and a total of 139 mink were trapped in Suffolk in the period June to December 2004.

3 BEST PRACTICE GUIDELINES FOR MINK TRAPPING

Water voles undergo a high winter mortality (around 70% in two recent studies) and the mink's early breeding ensures that, to feed her kits, the female mink will be taking the winter-surviving water voles before they have had a chance to breed. Consequently, the best time to trap the mink is prior to their breeding season in the early Spring (February–April). Obviously mink will take water voles at other times of the year but the Spring is when the trapping effort is likely to be the most effective. However, trapping should be continued throughout the year if resources allow except where welfare issues may prevent trapping between mid-April and July (see Section 3:3). Trapping in August to November would intercept dispersing juveniles.

The use of the Game and Wildlife Conservation Trust mink raft has revolutionized the approach and efficiency of mink management.

3.1 THE GAME AND WILDLIFE CONSERVATION TRUST MINK RAFTS – DESIGN

Until recently, mink trapping relied upon targeted bank-side trapping. Problems associated with this approach were that mink may only visit areas within their home range at two to three week intervals (Reynolds *et al.*, 1994), during which time a live capture trap would have to be checked on a daily basis with no guarantee of a quick capture. The GWCT mink rafts allow mink traps to be placed only in areas where mink are known to be present and in locations which they are known to use.

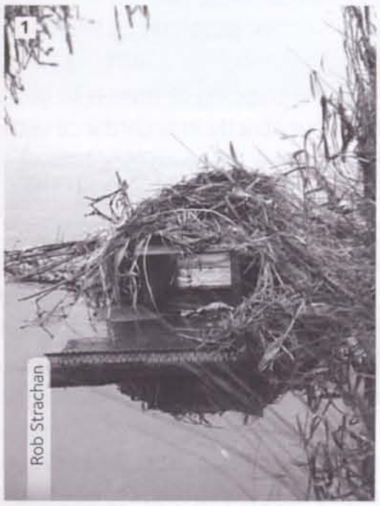
The GWCT mink raft has proved an extremely effective tool for mink control. The raft comprises three elements: a buoyant raft base, a removable tracking cartridge and a wooden tunnel. In brief, the raft measures approximately 2.4 x 1.2 x 0.6m, and floats in the channel of the water-course to be monitored, tethered to the bank. The tracking cartridge sits in a hole in the centre of the raft, in contact with the water. The cartridge comprises a perforated basket containing Oasis® flower arranging foam supporting a thin, smooth, layer of mixed clay and sand on the top. The clay-sand mixture takes clear footprints of mammals when stepped on, and is kept moist by water wicked-up through the Oasis®. The wooden tunnel covers the cartridge, and:

1) Provides a dark cavity that is attractive to mink;
2) Keeps debris off the clay surface;
3) Can house a trap if required;
4) Provides a closed off area whose entrances could be made to exclude non-target species larger than mink.

See Reynolds *et al.* (1994) and the GWCT leaflet for further details of construction (see *http://www.gwct.org.uk/research__surveys/predation/predation_control/mink/2734.asp*).

3.2 DEPLOYMENT

In deployment, rafts are placed at approximately 1km intervals along the water course, and the clay plate is checked for mink footprints at weekly intervals, being re-smoothed if none are found. If the mink prints are found on the clay, a live-capture trap is placed in the tunnel over the tracking cartridge. Trapping generally continues for two weeks, or until a mink is caught. Mink may be captured extremely quickly following the start of trapping. Experience suggests that leaving the trap open



*Mink raft in action. The clay pad reveals the presence of mink (photos **1** & **2**) and the raft is converted from its monitoring mode to trapping mode by inserting a cage trap in the wooden tunnel (photo **3**). Once a mink is caught the raft returns to monitoring mode (photo **4**).*

CASE STUDY CATCHMENT SCALE MINK CONTROL – RIVER HULL HEADWATERS

The Yorkshire Wildlife Trust water vole recovery project initiated a catchment scale mink management scheme in 2004. Twenty-eight mink monitoring rafts (as developed by GWCT) were deployed across the River Hull headwaters, covering not only the main chalk streams but also off line features such as ponds, agricultural drainage ditches, fish farms and the Driffield Canal (which runs adjacent to one of the chalk streams – West Beck, and flows into the River Hull further downstream).

The rafts were particularly useful where trapping had been underway for the previous three years as they helped improve efficiency by not trapping unless mink signs were found on the rafts. A total of five mink (all male) were caught during the first winter (2004), all from the rafts. Two of these were caught on a section of chalk stream thought to be mink free (no evident fieldsigns, no sightings by the YWT officer, river keeper, anglers or landowners) proving the worth of the rafts. Conventional trapping was still in place in some locations, complimenting the rafts.

Water vole signs have been found on 24 of the 28 mink rafts, when a survey was carried out in May 2005. Across the headwater catchment streams, water voles have increased on all streams where a programme of mink control has been in place for the last three years, with an increase in latrine density as well as an expansion of overall colony size. This is backed up by anglers, river keepers and landowners, all reporting an increase in numbers of water voles seen.

for another few nights after the first capture may increase the likelihood of capturing another mink soon after. Following the end of trapping, the raft can be returned to the tracking mode to detect mink dispersing in to fill the gap left or mink that were missed during trapping.

The GWCT raft, has considerable benefits in comparison to a bank-side trapping programme. These are:

- Reduced manpower required. Fewer traps are put out and the period for which traps must be checked every day is minimized because the rafts pre-define where and when to put in the trapping effort.
- Increased trapping efficiency. Traps are only put out at rafts that are in current use by mink, and so captures are expected to occur quickly.
- Reduced capture of non-target species. Fewer traps are put out and for shorter periods, which necessarily reduced by-catch. By situating the traps on the water, terrestrial animals are also unlikely to be captured.
- Reduced number of traps required for larger length of trapped waterway.
- Remaining or replacement mink are able to be quickly detected following removal of the original mink.

Mink control projects can operate at a variety of spatial scales, from protection of localized populations, requiring only two or three rafts, to the monitoring and trapping on a catchment-wide basis. The latter option requires a large number of rafts, which will usually represent too great a commitment for any one person to maintain and check: projects of this size require substantial landowner involvement, and a mechanism by which the results of monitoring and trapping can be regularly fed back to the project coordinator. It is advisable that the coordinator keeps each participant informed on a six monthly basis of the successes of the project to maintain interest.

Some notes on the deployment of mink rafts (full details available in the GWCT leaflet):

- Rafts should be sited at approximately 1km intervals along water courses.
- Otters may spraint on rafts as a territorial marking. Similarly mink may scat on rafts. In either case the presence of sign should be noted, and the faeces removed, since the presence of otter or other mink may discourage all of the mink in the area from using the raft.
- Placement of rafts at places where two water courses join may increase the chances of capturing a mink.
- Rafts should be situated in areas where they are unlikely to be encountered by members of the public, or where they can be well hidden, since rafts may be vandalized, and the welfare of captured mink potentially compromised. Such positioning will generally also increase their effectiveness, since these are areas likely to be favoured by mink.


Andrew Harrington

CASE STUDY SOMERSET LEVELS MINK AND WATER VOLE PROJECT

PROJECT IN COLLABORATION WITH:

BASC Wildlife Habitat Trust

In 2001 the British Association for Shooting and Conservation (BASC) published its 'Green Shoots' Biodiversity Action Plan for the shooting community. Following a pilot in Cheshire, the scheme was launched on the Somerset Levels by the appointment of a Conservation Officer in autumn 2002, a post now jointly funded by BASC, English Nature, and the Environment Agency.

In Spring 2003 the Environment Agency's 'Cordon Sanitaire' strategy – of creating a mink control 'firewall' from the Bristol Channel to the South coast – was adopted as part of the local Green Shoots programme and a series of 'Mink and Water Vole Workshops' were held across the Somerset Levels. The main theme of these events were mink control techniques and water vole habitat conservation. The workshops recruited a volunteer trapping team crossing the Levels in a broad band from the Gordano Valley and Clevedon on the Severn Estuary to Martock and Chard on the Dorset border.

Though BASC led, with a number of wildfowling clubs, shoot syndicates, gamekeepers and individual members actively involved, the trapping team also included fishery owners, National Nature Reserve wardens, RSPB staff, university researchers and the local Wildlife Trusts.

By autumn 2003 the team consisted of seventy trappers, and a grant from the Wildlife Habitat Trust (WHT) supplied live-catch cage traps shared between the Somerset Levels and Wiltshire Wildlife Trust's Water Vole Recovery Project. Speculative trapping began on the Levels in September 2003.

By February 2006 the number of mink caught and disposed of exceeded 260 animals, but this figure should be viewed in the context of trapping effort, which varied considerably between individuals within the team, and the 5000km of watercourses on the Somerset Levels! However, there are also encouraging new records of water voles recolonizing areas where they have hitherto been absent, particularly around Wells, March, Wedmore, Long Sutton, and Langport.

Water vole-friendly rhyne clearance on the Somerset Levels.

In 2004 a further grant from WHT provided ten Game Conservancy Trust 'mink rafts' for use on the Levels and these have been deployed on a rotating basis in a strategic monitoring role at selected sites.

Funded by the Environment Agency, in January 2006 a further 'Mink and Water Vole Workshop' was held on the Exminster Marshes in order to recruit a trapping team through the Exe catchment. A similar event will take place in the summer of 2006 in West Dorset in order to develop the mink 'firewall' and water vole monitoring activities from the southern edge of the Somerset Levels to the south coast. The 'Cordon Sanitaire' will be completed by autumn 2006.

Throughout all these activities, it has become apparent that BASC membership, and the shooting community at large is a willing and enthusiastic volunteer workforce for this project. In addition, the fact that the mink has been identified as a 'common enemy' by a wide range of conservation stakeholders has generated a spirit of cooperation and understanding that has led to several joint projects involving BASC members and other conservation organizations.

Pam Marshall-Ball demonstrates 'mink raft management' at the Exminster Mink and Water vole Day (right), and a WHT-funded mink raft (above) monitoring riparian mammals at Shapwick Heath NNR, Somerset Levels.

• Rafts appear quite bright when new, but rapidly begin to blend-into the background. Covering the raft with loose vegetation when new helps to camouflage the raft.

• If running a large, coordinated mink raft programme, it is important not only that feedback from participating land owners is gathered and acted upon, but that the participants themselves receive regular feedback on the overall effectiveness of the project, probably at six-monthly intervals. This maintains interest in the project, and therefore ensures efficient monitoring and trapping.

• If you are thinking of starting a mink control programme, please contact the Game Conservancy Trust for advice.

3.3 BEST PRACTISE MINK TRAPPING GUIDANCE

USE OF TRAPS

• Mink trapping should be conducted using live-capture traps. Although the welfare benefits of spring traps (which kill individuals on contact) versus live-capture traps are debateable, spring traps have a high probability of killing non-target species, in particular juvenile otters, polecats and even water voles. All equipment must be used and maintained so as to avoid injury to captured animals.

• Mink trapping should be conducted by people sufficiently experienced to positively identify mink, and who are able to distinguish a mink from related species that may be captured (i.e. stoat, weasel, polecat or otter). These animals, if captured, should be released unharmed.

• Local projects should decide upon a policy to adopt with respect to brown rats and grey squirrels which are occasionally captured on mink rafts.

• All mink traps should have otter-guards to prevent capture of otters. In addition, otter excluders can be positioned at the entrance to the mink raft tunnel. Traps and rafts should be set away from any known otter holt.

• Live-trapping between mid-April and July risks separating nursing female mink from dependent young. Mink trapping should be avoided at this time of year, to minimize welfare concerns associated with mink trapping. The rafts can be maintained as tracking devices during this period to identify the presence of mink for trapping after July.

• Bankside traps must be placed above any normal rise in water level and secured to prevent any trapped animal rolling them into the water.

• Bankside traps must be covered with hay which a trapped animal can pull into the cage as bedding material helping to reduce the stress of capture. The hay may be covered with sticks or branches or other material to disguise the trap, to make it more likely that a mink will investigate it as a tunnel and to prevent the hay from blowing away or being eaten by livestock. Traps may be baited with fish, eggs or day old chicks (dead), providing the trapped animal with food.

• The period during which mink control is most effective is from October until March, especially during November to January. This is the time of year when mink disperse and when the females come into breeding condition. A thorough trapping effort conducted during this period should mean that trapping need not be conducted from April to July.

• Traps must be checked at least once, preferably twice, in every 24 hour period.

DISPATCH OF LIVE-TRAPPED MINK

• Once a mink has been trapped it is illegal to release it back into the wild.

• To despatch mink humanely, the only recommended method is shooting. They must not be drowned and there are no approved methods of killing them by gassing.

• The GWCT recommend that mink are disposed of using a high powered air-pistol or air-rifle rather than a firearm, since this is less conspicuous in both form and noise. See GWCT leaflet for further advice.

CONFLICTS WITH WATER VOLES AND THE MANAGEMENT OF OTHER SPECIES

Pest control may lead to the unnecessary destruction of water voles or their colonies. This chapter describes how to manage brown rat infestations, harvest non–native crayfish and manage problem water voles without damaging the voles themselves.

1 RAT CONTROL AND WATER VOLE CONSERVATION

Water voles can be easily confused with brown rats and there is a risk the methods used to control rats may lead to the accidental destruction of water vole colonies, particularly in towns and other urban areas.

If pest control operations need to be carried out near water it is essential that a proper assessment of the rodent fieldsigns is carried out. Both water voles and brown rats burrow into the banks of most types of waterway and their signs can lead to confusion (see Chapter 4). Blocking water vole burrows is illegal as is the killing (accidental or otherwise) of water voles (see Chapter 2). Placing scatterpacks, traps or bait boxes into or in the way of water vole burrows could lead to prosecution.

How to control pests when water voles are present:

- Always check for water voles before controlling rats along watercourses, ditches, lakes or ponds.
- If correct identification is in doubt seek advice of a professional ecologist before taking further action.
- Live-capture cage traps are the only safe option – check twice a day to release animals that you do not intend to catch. Site traps in the open rather than in dense vegetation (cut back the vegetation if necessary). Water voles are less likely to cross open ground than brown rats. Avoid placing traps along the water's edge.
- Avoid the use of Break-back/Snap traps. If used place these traps at least 5m from the water.
- Avoid the use of poison baits to control rats where water voles are known to occur. Do not place poison in burrows. It is illegal to block or obstruct water vole burrows.
- Where no alternative is feasible, poison should be covered or enclosed in a bait box. This should be placed at least 5m from a waterway. Avoid the use of poison grain


Andrew Parkinson

Brown rats may pose a direct threat to water voles as predators, competitors and carriers of disease. Accidental poisoning through rat control operations may also be a problem to water voles when the two species occur together.

or pellets. Use wax or soap blocks instead. If possible site the bait off the ground, as rats are more likely to climb than water voles. Poison bait is also best dispensed around buildings or litter bins where rats are more likely to be attracted to the food sources.

- Regularly inspect and monitor the control site, clearing away poisoned corpses. If any dead water voles are found, review the control method in use.
- Report any water vole sites to the local Wildlife Trust, Environment Agency or Biological Records Centre.

Done carefully, rat control may be beneficial to the local water vole population as they sometimes prey on young water voles or may be a vector of disease.

2 CRAYFISH TRAPPING AND WATER VOLE CONSERVATION

In recent years there as been an increase in the applications to trap non-native crayfish. The most common method used is either a Windermere fish trap, or baited pot. Incidents have been recorded where the use of traps has resulted in the accidental drowning of water voles. There are no known effective guards that can be fitted. To reduce the risk of such incidents occurring, the Environment Agency suggest the use of Fishery Byelaws to determine fishery methodologies which will minimize the risk to water voles.

2.1 FISHERY BYELAWS

Regional Byelaws can be created by the regulatory authorities such as the Environment Agency with regard to the removal of crayfish from rivers, streams and static waterbodies. Such a byelaw might be worded as follows; "Except with the previous consent of the Authority no person shall remove crayfish from non–tidal waters.". Guidance on methods for best practice crayfish trapping and considerations for water voles, might then be issued with every licence.

2.2 GUIDELINES TO PREVENT ACCIDENTAL DROWNINGS

When a proposal for the trapping of non-native crayfish is intended, the following steps should be taken:

- Check the proposed trapping sites for the presence of water voles by survey for their fieldsigns (burrows, feeding remains and latrines/droppings) before the commencement of trapping.
- Areas of strong water vole populations should be avoided (it is likely that crayfish will prefer those areas of a waterway that have fewer voles anyway – that is, stony riffles or heavily shaded by tree cover, extensive tree roots along bank etc.).
- Traps should be positioned along a waterway away from areas where there is evidence of extensive burrowing activity by water voles. It would be illegal to site traps in

BOX 8:A CRAYFISH AND THE LAW

The native white-clawed crayfish (*Austropotamobius pallipes*) is listed on Schedule 5 of the Wildlife and Countryside Act 1981, which makes it illegal either to take it from the wild or sell it without a licence from the appropriate nature conservation agency. Protection is also afforded to the place where it can be found dwelling.

It is also included in the IUCN Red Data List, Appendix III of the Bern Convention and Annexes II and V of the European Habitats Directive. This directive requires the designation of protected areas (Special Areas of Conservation) for the species in Annex II.

NON-NATIVE CRAYFISH SPECIES

It is illegal under the W&C Act to release, or to allow to escape to the wild, signal and other non-native crayfish species and strict regulations (the Prohibition of Keeping of Live Fish (Crayfish) Order 1996) govern the farming, ranching and wild harvesting of these species.

Despite these controls, five non-native species are known to have escaped or have been deliberately released into the wild. The commonest is the signal crayfish, which has a widespread distribution, and this has been shown to pose a threat to the native species due to competition for food, predation, and the spread of the disease 'crayfish plague'.


Andrew Parkinson

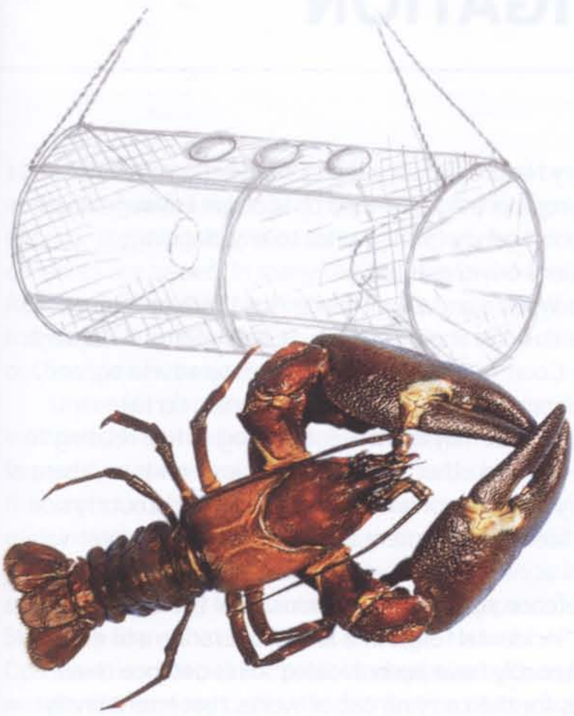


Photo of signal crayfish, and sketch of crayfish trap with dorsal exit holes for water voles.

the entrances to water vole tunnels – *no traps must block water vole burrow entrances.*

- Mid-channel sited traps are likely to catch fewer voles than those tucked under the banks (it may even be that water voles deliberately seek out the trapped crayfish as a food source and enter the traps in the same way otters seek eels in fyke nets).
- If Windermere traps or baited pots are used and voles are accidentally caught then it should be a condition that the trapping ceases or the method changed in favour of baited drop nets.
- Traps and pots can be modified to release accidentally trapped voles through escape holes cut into the roof of the trap (see sketch). Up to three circular holes each with a diameter of 6–8cm should be cut along the dorsal spine of the trap. It should be noted, however that such holes might substantially reduce the effectivness of the trap at retaining crayfish.
- Where the site has been identified as containing a large water vole population with continuous sign along the banks, then the method of fishing should be restricted to the use of baited drop nets or rod and line only.
- No consent will be given if native crayfish are known to be present.
- All crayfish traps and nets should be treated to prevent the risk of the spread of plague.

Further information and advice should be sought from the Environment Agency and their booklet *Freshwater Crayfish in Britain and Ireland.* (Environment Agency 1999).

3 PROBLEM WATER VOLES

Under exceptional circumstances water voles can cause problems, through both their burrowing and foraging activity. In some areas vole burrows have been known to weaken the banks and cause leakage to fish farm ponds, cause damage to plants in aquatic nurseries and cause the loss of young apple trees in orchards by ring-barking the stems. To solve these types of problem adequately there may be a need to exclude or displace the water voles. Advice must be sought from the Statutory Nature Conservation Organizations, in order to stay within the letter of the law (see Chapter 9 for full details).

DEVELOPMENT AND MITIGATION

1 BACKGROUND

1.1 POTENTIAL IMPACTS OF DEVELOPMENT ON WATER VOLES

Any construction work, such as the construction of housing developments or new business parks, the widening or realignment of roads, or the building of other infrastructure may involve land-take and the loss or alteration of potentially suitable water vole habitats. Many developments will have works associated with them in addition to land-take, such as outfall construction and the re-profiling or regrading of watercourses to meet flood defence standards (see Chapter 5). These operations can have major implications for water voles, and can extend some distance from the footprint of the built development. Impacts associated with development upon water voles vary in scale and permanence, but even temporary developments taking place in the short term and on the smallest scale have the potential to cause modification or loss of the riparian habitat suitable for water voles. This can lead to adverse effects on water vole populations. For any development it will also be important to consider indirect effects, such as changes in the hydrological regime of adjacent wetlands.

Many impacts on water voles can be avoided or minimized through consideration of the location of works and careful design of the layout of the development. It is therefore essential that potential negative impacts are assessed as early as possible in the planning process. Key to the success of this assessment is detailed knowledge of the location of water voles both within the footprint of a proposed scheme and in the wider area which could be affected.

1.2 ROLES AND RESPONSIBILITIES

Developers and environmental consultants must ensure that they hold up-to-date survey information on any protected species within the footprint of the development site, and undertake an assessment of how the development may impact on those species. Local Environmental Record Centres should be contacted for existing information as the first stage of any assessment. In many cases adequate survey information for a proposed development site will not be available, and professional ecological surveys will be required. However, information relating to the distribution of water voles in the local area can be of particular value in assessing the impacts of a proposal on the wider population and in determining the most appropriate mitigation strategy. This information should therefore be sought in addition to undertaking surveys.

Any mitigation strategy for a proposed scheme needs to be developed in consultation with the appropriate Statutory Nature Conservation Organizations (SNCO) and the Environment Agency (EA) or Scottish Environmental Protection Agency (SEPA), prior to any planning permissions being granted.

The Wildlife and Countryside Act 1981 (as amended) places a duty on English Nature, Scottish Natural Heritage and the Countryside Council for Wales to advise on, and, where appropriate, consent under licence, certain operations that may contravene the legislation relating to water voles and other protected species. However, there is currently no provision under the Wildlife and Countryside Act for licensing the intentional destruction of water vole burrows or nests for development purposes (see Chapter 2). A defence against prosecution under the WCA is the phrase "incidental result of a lawful operation and could not reasonably have been avoided". This defence thus provides for the carrying out of works that intentionally but unavoidably damage, destroy or obstruct water vole burrows, and possibly even kills, injures or harms water voles. However, it also requires that reasonable steps must be taken to avoid any unnecessary damage. Only a court can decide what was "reasonable" in any set of circumstances, but, clearly, agreement between the conservation agencies (such as English Nature and the Environment Agency), planners and developers would be important. Developers, or other riparian owners, who may wish to maintain, build on or alter areas used by water voles must also ensure that unnecessary damage is avoided and all reasonable steps are taken to minimize damage to water vole burrows. This can be best achieved by undertaking an Environmental Assessment, including a water vole survey, prior to planning any work and ensuring that appropriate mitigation measures are included in the proposals. This is only a general guide to the main provisions of the Law, not a definitive interpretation. The Wildlife and Countryside Act 1981 (as ammended) should be consulted for further details. The developer (or consultant acting on his behalf) will need to agree the methods used to mitigate the effects on water voles with the relevant SNCO.

The legislation protecting water voles also applies to organizations undertaking management works on watercourses, such as the EA, SEPA or local Internal Drainage Boards. There is, therefore, an obligation on those who maintain waterways to ensure that appropriate systems are in place to protect water voles during such works.

The Environment Agency (and SEPA in Scotland) has advisory, operational and regulatory roles in all riparian environmental assessments. Through their role in the screening of planning proposals, they may request that surveys are undertaken to confirm the presence or absence of water voles, and may review the design of appropriate mitigation measures before any land drainage consents are issued. In many regions the Environment Agency may hold current data on water vole distributions, but may still request reactive survey work to be carried out for specific projects.

Under UK planning regulations (PPS9 in England; TAN5 in Wales; PPG14 in Scotland – see Chapter 2) a duty is imposed on the various local planning authorities to ensure that *water voles (as both a protected species and a species of principal importance for biodiversity conservation) should be a material consideration in determining planning applications*. Many local authorities have adopted Structure Plans that recognize Strategic Nature Conservation Policies for protected species such as the water vole. In many cases the distribution of key water vole colonies has been marked onto alert maps and flagged for planning issues.

The local Wildlife Trusts may carry out and hold survey information on the current status and distribution of the water vole within each County. They are often a lead partner in the local Biodiversity Action Plan with the aim to ensure proactive management to assist the recovery of the water vole at the County level. The local Wildlife Trust may also act as a consultee in the screening of planning proposals to ensure that any wildlife interest affected by the proposal is taken into account.

1.3 QUALIFICATIONS AND EXPERIENCE

It cannot be the place of this handbook to describe in detail every aspect of the processes required, and so it is strongly recommended that personnel involved should have a proven track-record of working successfully with the species. This is particularly important due to the seasonal constraints associated with undertaking surveys and implementing mitigation for water voles, and the consequences for development programmes if survey information is inadequate or mitigation measures are inappropriate. The Institute of Ecology and Environmental Management has run courses on water vole survey and mitigation in recent years (see *http://www.ieem.org.uk*).

The amount of experience that operatives have of any aspect of the mitigation process, from assessing mitigation options to handling, trapping and transporting animals, is a critical factor in determining the success of the project. 'Experience' relates to both the design of the layout of development to avoid/minimize impacts, as well as the design and implementation of the appropriate mitigation options. These two issues are interlinked and it is important that there is continuity of advice between them. Poor advice on designing a scheme can lead to greater costs at the mitigation stage, both in terms of impacts upon water voles and financially. A particular concern is that failure to attend to the welfare requirements of any animals during the mitigation process may leave operators liable to prosecution under current legislation concerning the abandonment and mistreatment of animals.


Amy Ishwewood

2 IMPACTS

2.1 HOW DEVELOPMENTS CAN AFFECT WATER VOLES

Development may affect water voles on a variety of scales, from direct mortality of individual animals within a colony, to the loss of one or many colonies of water voles. It is important to realize that impacts of works may extend beyond the water vole habitat that is directly affected by a development, and beyond the period during which any works are taking place. The majority of impacts upon water voles from unmitigated development result from habitat loss and deterioration operating at a variety of scales.

A well planned road scheme design running beside a watercourse that incorporates new habitat features such as floodwater balancing lakes suitable for water voles.

HABITAT LOSS AND DETERIORATION

Any habitat permanently lost and not compensated for represents a reduction of the total available habitat for a given colony. This will result in a reduction in the maximum population size that the habitat can support. Depending upon the initial size of the habitat, and the amount lost to development, permanent loss of part of the habitat on-site has the potential to reduce numbers to below the minimum viable population size (see Chapter 3). Therefore, loss of only part of the habitat can, in some cases, result in the loss of the colony. Consideration also needs to be given to any deterioration in the quality of the habitat or the temporary loss of habitat, for example where re-profiling of the banks of a watercourse is required.

In addition, it will also be important to assess the impacts of habitat loss and deterioration on water voles, where the species is absent but suitable habitat is affected. This can be important in allowing water voles to recolonize areas from which they are absent. Water voles often move between different sections of a watercourse at different times of year to take advantage of more favourable conditions. Therefore habitats which are unoccupied at a given time of year may still be relevant if they are occupied at other times (e.g. overwintering habitat, or habitat into which the population may expand at peak breeding season).

Works on a given length of habitat may have effects on occupied habitat not directly under the scheme footprint. For example, disruption to the hydrology of an area may affect animals occupying habitat in neighbouring wetlands, and water run-off may affect downstream or adjacent habitats.

FRAGMENTATION

Habitat fragmentation has played a large role in the decline of water voles, and is likely to restrict the recolonization of areas from which the species is absent. The fragmentation of water vole colonies or populations is a secondary consequence of permanent habitat loss or deterioration at a given scale. Habitats which are unoccupied by water voles may function as a dispersal route between occupied patches of better habitat. Destruction of this connecting habitat may result in colony isolation and therefore raised extinction risks in those colonies. Large lengths of unsuitable terrain (more than approximately 1km) between two occupied habitats are likely to effectively isolate these colonies with respect to the dispersal of individuals between the two. Colonies of water voles can act as 'stepping stones' in maintaining dispersal within a landscape level population (e.g. a river catchment). The loss of a colony of water voles, through habitat loss or deterioration of occupied habitat, can have an effect on the wider water vole population by increasing the distance that animals need to travel to disperse between unaffected colonies. Dispersal rates will vary with the distance between colonies. Any increase in the distances that water voles must travel between occupied habitats is likely to increase dispersal mortality and decrease the numbers of individuals exchanged. Developments which permanently remove either colonies or habitat (or temporarily remove habitat over a long period) from, or around populations that are linked by dispersal, may therefore decrease the rates of interchange of individuals. Any reduction in dispersal rates will have knock-on effects in increasing the extinction risk of small colonies that are linked by dispersal (see Chapter 3).

The magnitude of the impact of fragmentation will be dependent upon the amount of habitat affected, the relative importance of that habitat/colony in providing a link between other colonies, and the value to water voles of the habitat post-development. For example, the culverting of a short section of watercourse may result in a small amount of habitat loss. Where such a development takes place within a large and robust population of water voles, with a relatively large amount of available habitat, the fragmentation effects would be expected to be low, as the animals would be likely to disperse through the culvert. However, should the works be affecting a small and isolated colony, and the amount of habitat lost to the development is relatively large in comparison with the amount of habitat available to the colony, the impact of fragmentation would be expected to be high; this impact would affect adjacent colonies and the population as a whole, as well as the colony within the footprint of the works. Clearly in each case the impact of fragmentation would be expected to increase as the amount of habitat loss increases.

INCIDENTAL MORTALITY OF ANIMALS ASSOCIATED WITH WORKS

Individuals may be killed or injured if still resident in their territories when destructive development commences. Any individuals that leave habitat which is subsequently destroyed (even if only for a temporary period) can face increased mortality rates, especially if there is insufficient habitat left to accommodate all of the individuals at the site. In this situation, even if there is no direct mortality it is likely that an approximately equivalent number of individuals will die due to a lack of sufficient habitat to support the entire colony or population affected.

INCREASED PREDATION OF WATER VOLES BY DOMESTIC ANIMALS

For large housing developments within close proximity (within 500m) of habitat occupied by water voles, the potential exists for the proposals to significantly increase the risk of predation by introducing large numbers of additional predators. This may result in the loss of small colonies. The risk of increased predation having an impact on the colony will be dependent upon the proximity of the development to the colony, the size of the development, the size of the water vole colony potentially affected, and the likely levels of predation by domestic animals experienced by the colony prior to the development.

2.2 ASSESSMENT OF THE IMPACTS OF DEVELOPMENT

The Institute of Ecology and Environmental Management (IEEM) has developed a set of guidelines for ecological impact assessment (*http://www.ieem.net/ecia/impact-assess.html*). The framework, which should be followed by any project likely to affect a population of water voles, is summarized below.

The assessment of ecological impacts is required at the following stages:

1) A screening exercise may be undertaken in certain cases to establish the need for an Environmental Impact Assessment; the potential impact on water voles should be considered at this stage.

2) A scoping assessment is needed as the basis for determining whether water voles are likely to suffer significant impacts. If the potential for impacts on water voles exist, then they should be subject to a detailed assessment.

3) The detailed assessment should inform the location and layout of the proposal, and identify the need and options for impact avoidance, mitigation measures for unavoidable impacts, and opportunities for enhancement.

4) After the mitigation strategies have been fully devised and their likely success considered, the residual impacts should be assessed.

5) Finally, if significant impacts are still likely, it may be necessary to consider the need for, and value of, ecological compensation.

Consultation with the relevant SNCO should underpin each stage of the process set out above. The IEEM guidelines also state that ecological implications for important ecological resources or features should be clearly identified before the legal, policy, social or economic implications are considered.

Impacts of specific developments should be assessed with respect to the following criteria (*see http://www.ieem.org.uk/ECIA.htm for full description*):

- Confidence in predictions (levels of uncertainty);
- Extent;
- Magnitude;
- Duration;
- Reversibility;
- Timing and frequency;
- Cumulative effects.

As part of any detailed assessment of impacts on water voles, it is important to consider the likelihood of significant effects in terms of habitat loss and impacts on individual animals, and the effect on the conservation status of the species within a given geographical area. This assessment will determine the scope of the mitigation required, which will also have to address the legal implications of effects on water voles.

Clearly the impacts on water voles of a given development will need to be assessed on a case-by-case basis. Many developments will have several types of impacts on water voles, and may impact in more than one location. Generalized examples of applying the guidelines on impact assessment for different types of development are provided in Section 9:4.

2.3 SURVEYS TO INFORM IMPACT ASSESSMENT

The survey requirements will vary for each scheme. At the scoping stage an assessment of the suitability of any potentially affected habitat and, if appropriate, an initial survey for fieldsigns to confirm the presence or likely absence of water voles should be undertaken. Water vole surveys are discussed in more detail in Chapter 4. In addition to carrying out field surveys, desk study information should be collated and reviewed to inform the assessment of impacts outside the scheme footprint, and enable the relative value of any potentially affected colonies or populations to be assessed in a geographical context.

Where potential effects on water voles are identified more information will be needed. In order to avoid impacts on water voles, and select the most appropriate mitigation option, detailed survey information will be required. Field surveys should be undertaken to map both the habitat within the affected area in terms of its quality for water voles, and any fieldsigns present. It is important that such surveys are undertaken at an appropriate time of year, by an experienced ecologist and during suitable weather conditions (see Chapter 4 for further details). The relative density of water vole latrines will inform an assessment of the relative value of parts of a given site for the species. At this stage, field surveys should extend to include all areas potentially affected, including those outside the footprint of the build development, and any habitats or features which may be indirectly affected. For large developments, where desk study information is not available for the wider area, it may be appropriate to undertake brief 'spot-check' surveys to inform the impact assessment and mitigation proposals.

A negative survey result does not necessarily mean that a site will remain unoccupied, especially if there are water voles in the surrounding area, and if the suitability of habitat fluctuates during the year (e.g. if ditches dry up in summer or habitat floods in winter). The reliability of survey information can also be affected if habitat management works have recently been undertaken, and if surveys are conducted early or late in the season, or during adverse weather conditions (high water levels or following heavy rain). In certain cases, therefore, repeat visits to undertake surveys at more than one time of year may be required. This will be particularly important where the initial survey did not record signs of water voles but the habitat was suitable and water voles are present in the local area. A follow-up survey immediately prior to the commencement of works is advised.

3 MITIGATION

3.1 PRINCIPLES OF MITIGATION

Mitigation should represent an iterative process during the design stage of a proposed development. The first step should be to avoid the conflict entirely by designing the layout of the proposed works to avoid any potential impact on water voles. For this approach to be realistic, potential conflicts need to be identified at the earliest possible stage to allow time for plans to be altered.

If it is impossible to avoid a given impact, then the extent of any effects should be minimized. If the location of a development must conflict with a water vole colony, then it still may be possible to relocate part of the development to reduce direct impacts to an absolute minimum.

Once the likelihood of impacts has been minimized as far as possible, and where there would be a direct impact on water voles, the need to 'rescue' animals should be considered. Although the translocation of a colony of water voles should always be seen as a last resort option, the requirement to relocate or translocate water voles should be considered at this stage. N.B. both translocation and relocation will require licensing if water voles become fully protected.

The fourth stage of mitigation is to rectify any impacts through repair, reinstatement or restoration.

Where significant effects are likely to occur following the implementation of the mitigation steps described above, the significance of any such residual impacts will need to be assessed, and this will determine the need for compensation. Any compensation measures would need to be proportional to the scale and type of residual effect. In addition, consideration should be given at this stage to the potential for enhancement opportunities to deliver beneficial effects. In any case, the quantity of suitable habitat for water voles which is provided following mitigation and compensation should be at least equivalent to that lost, in terms of its carrying capacity. There should be no net decrease in the amount of habitat available, in terms of both quantity and quality, and ideally there should be a net increase. Where there is a degree of uncertainty regarding the quality of newly-created habitat, it will be appropriate to 'over-size' the compensation habitat respectively.

Due to their inherent expense, complexity, and lack of guaranteed success, translocations into compensation habitat should only be considered as the very last option of mitigation, when all of the previous approaches have been shown to be unavailable or inappropriate.

3.2 CONSULTATION WITH THE RELEVANT SNCO

Consultation with the relevant SNCO (see Section 9:1.2 above) should be undertaken to inform the design of any development and the selection of mitigation options (see

Section 9:3.3 below). Any works affecting water voles should be guided by the production of a detailed method statement, which would need to be agreed with the relevant SNCO, or the Environment Agency/SEPA.

3.3 MITIGATION OPTIONS

This section details the options available for water vole mitigation. The mitigation measures for a given project should have precise aims, and be targeted to address impacts at a given level based on the potential impacts of the proposals, to ensure that the effectiveness of the mitigation can be judged. For example, if a proposed development has the potential to have a significant effect on the conservation status of water voles within the local area, the mitigation measures should be designed to address this effect. If a scheme is predicted to have an impact on small numbers of individual water voles, but not have a significant effect on conservation status, then clearly different mitigation measures would be appropriate.

Any given development will affect water voles in different ways, and it is therefore important that the most appropriate option is determined on a case-by-case basis by a suitably experienced ecologist. In particular, the mitigation options for avoiding incidental mortality of water voles will be dependent upon a number of factors, including the magnitude of the impact, the timing of the works, the habitat type, the number of animals likely to be affected, and the duration of the works.

The impacts discussed below often act in combination, and a combined approach to mitigation is therefore appropriate. Furthermore, careful consideration of all of the various mitigation requirements during the design of the proposed development can facilitate the implementation of effective mitigation. For example, habitat created to compensate for that lost can be used to act as a 'receptor' site for animals which need to be removed from the footprint of the works to avoid their incidental mortality. Careful consideration of the location of this habitat can mitigate the effects of fragmentation and allow more straightforward (and cheaper) techniques to be used to relocate the animals. The description of the mitigation options below is illustrated by example scenarios provided in Section 9:4.

AVOIDING/MINIMIZING HABITAT LOSS AND DETERIORATION

For large schemes that would have a significant impact on water voles, it would be appropriate to consider re-siting the development to an alternative location, where it will not affect habitat used by (or suitable for) water voles. Other environmental constraints will need to be considered in the light of their relative importance and magnitude of impacts when determining whether or not an alternative location is more appropriate. Clearly if it is possible to avoid impacts on habitat used by water voles, then the need to avoid incidental mortality of animals will also be removed. Increased costs involved with avoiding impacts on water voles should be balanced against the saving in not having to implement mitigation.

In many cases it will not be possible to avoid impacts on all habitat used by water voles. However, it may be possible to minimize such impacts through careful scheme design. For example, where a pipeline or road would need to cross a watercourse which supports a water vole colony, it may be possible to select a crossing location where lower quality habitat, and therefore fewer animals, would be affected. Similarly, the layout of housing developments can be designed to minimize the impact on suitable habitat for water voles, particularly those areas occupied by water voles at the highest density.

Sustainable Urban Drainage System within new build housing schemes can create excellent pond habitats for water voles.

In avoiding/minimizing impacts on habitat used by water voles, it will be important to ensure that consideration is given to all habitats on site which may be used by the species, such as areas of higher ground that may provide important refuges from flood during the winter months. It will also be necessary to consider the need to mitigate impacts on other habitats occupied by water voles, which are not directly affected by the proposals. For example, changes to the hydrology of a waterbody could result in the loss or deterioration of such habitat and this potential effect should be avoided or minimized wherever possible.

The potential for any development to result in deterioration of retained habitats will also need to be minimized. For example, careful site practices and appropriate use of fencing to avoid accidental damage to unaffected habitats will be an important part of the mitigation during construction (see Box 9:A). All works close to watercourses will need to be undertaken with appropriate measures in place to minimize the risk of pollutants or increased sediment entering the watercourse.

The loss of habitat occupied by water voles will need to be compensated for by the creation of replacement habitat of similar quantity and quality, and ideally there should be a long-term net increase in the amount of habitat available for water voles. For works which would only temporarily affect habitat used by water voles, such as a pipeline crossing a ditch, restoration of the habitat should take place as soon as possible to minimize the time during which the habitat is unavailable for use by water voles. In addition, it will be appropriate to design the restoration of any affected areas to provide habitat of higher quality for water voles than that lost. Where there will be a permanent loss of habitat, particularly where this would have a significant effect on water voles, it will generally be appropriate to provide the replacement habitat in advance of removal of the affected habitat. In many cases the replacement habitat will be required to act as a 'receptor' site for the translocation or relocation of water voles from the footprint of the proposed development, to avoid incidental mortality of animals during the works, and will therefore need to be designed and constructed to perform this function as well (see below for further details). For small-scale permanent habitat loss, it may be possible to compensate for this impact by enhancing existing adjacent habitat, as opposed to creating new habitat. This will be dependent upon the size and quality of the habitat lost in comparison with that retained.

For works affecting habitats which are only used by water voles at certain times of year, it would be appropriate to carry out the works whilst the habitat is unoccupied and reinstate it or replace it prior to the period of use.

Works affecting habitat suitable for water voles, but where the surveys have revealed that water voles are not present, will not require mitigation for this species.

BOX 9:A MITIGATING DISRUPTION DURING CONSTRUCTION

Ideally the development works should be planned to avoid any water vole habitats which fall outside of the footprint of the scheme, leaving buffer zones of undisturbed vegetation along ditches or undeveloped areas around ponds. The width of the buffer zone would be dependent upon the likely distance at which burrows would be affected. Water voles may have burrows and subterranean nests that extend up to 5m from the water's edge and therefore in many cases a buffer zone of more than 5m from the bank-top would be appropriate. However, in certain cases, a smaller buffer zone may be appropriate. For example, on watercourses where the top of the bank is significantly higher than the toe of the bank, and therefore burrows extending 5m from the water's edge would be a much shorter horizontal distance from the top of the bank, or where the existing habitat adjacent to the watercourse is such that extensive burrowing away from the watercourse is unlikely.

Each development will need to be carefully considered as to its potential impact on the water voles and to ensure that adequate safeguards are put in place. In many cases it will be appropriate to install fencing to protect watercourses and retained vegetation from construction traffic and personnel, site materials and daily disturbances. Careful consideration will need to be given to the location of any stored material, such as topsoil or subsoil mounds, to avoid the potential for these to affect water voles. All developments adjacent to watercourses will need to provide adequate protection against pollutants or sediment entering the water during the construction programme.

However, replacement habitat for that lost will be necessary in any case, and it is good practice to design this for the benefit of water voles where it would assist in the recolonization of the species, or in strengthening the local water vole population, provided that this does not conflict with habitat requirements for other species. It would not, however, be necessary to provide compensation habitat for water voles in advance of the loss of affected habitat if water voles are absent from the site.

Details on creating habitat for water voles are provided in Chapter 5.

AVOIDING/MINIMIZING HABITAT FRAGMENTATION

As discussed in Section 9:2.1 above, fragmentation is a secondary consequence of habitat loss and deterioration, and therefore minimizing these impacts (see above) will clearly minimize the impact of fragmentation. However, in certain situations mitigation for this impact would be required in addition to mitigation for the loss of habitat. For example, where a proposed development would result in the loss of an entire colony of water voles, it will be necessary to consider the effect on the water vole population in the wider area. Should the removal of the colony create a significant risk of fragmentation for the population, it would be necessary to relocate the colony to a location which allows it to continue performing its function of linking adjacent colonies. The most appropriate location would be as close as possible to the affected area, either on the same watercourse, or linked to that watercourse. For large scale temporary impacts, such as regrading of a watercourse, it is therefore appropriate to ensure that the animals return to their original location following completion of the works and restoration of the habitat. Ideally this would be achieved by introducing the animals into nearby compensation habitat and allowing them to naturally recolonize the affected area following completion of the works.

The issue of fragmentation should also be considered in determining the location of compensation habitat for schemes which would result in large scale permanent habitat loss, whether or not the affected habitat is occupied by water voles. Once again, it will be important to locate such habitat as close as possible to the affected area.

In certain situations a development may act as an impermeable barrier to water voles, for example where long lengths of watercourse need to be culverted. Clearly it is good practice to minimize the length of culverts, to avoid large scale habitat loss as well as to minimize fragmentation. There is little available information relating to the length and design of culverts which act as barriers to water voles movement. However, relatively short culverts, under single carriageway roads for example, are known to be regularly used by water voles. In addition, culvert design which includes a ledge linking the banks of the watercourse on either side of the structure, and culverts which are 'over-sized' and box-shaped in cross-section are also thought to be beneficial in facilitating the movement of water voles, as well as other species, such as otters. A development may result in the unavoidable isolation of a small colony of voles, which is smaller than the minimum viable population size for the species. In such situations it may be appropriate to translocate or relocate the animals into compensation habitat within the local area, where the colony would not be isolated. Further details on translocation and relocation are provided below.

AVOIDING/MINIMIZING INCIDENTAL MORTALITY OF WATER VOLES

Wherever works would result in a direct effect on habitat occupied by water voles, it will be necessary to move the animals in advance of works taking place, using the most appropriate method. The various methods available are described in more detail below, and the most appropriate option will need to be determined by a suitably experienced ecologist on a case-by-case basis, and agreed

with the relevant SNCO. A number of factors will influence the selection of the most appropriate option(s), including the amount of habitat and likely number of animals affected, the timing of the works, and the availability of suitable alternative habitat. There are two main options for mitigating the potential for incidental mortality of animals: relocation and translocation. Both options are discussed in more detail below, with relocation preferred over translocation due to the inherent difficulties in successfully translocating a population of water voles, and the additional impacts that this mitigation option can have (see below for further details). There are also two methods for relocating water voles: displacement and relocation by trapping. More than one technique may be appropriate for different situations associated with a single development.

To assist with the selection of the correct mitigation option(s) to avoid/minimize incidental mortality, broad guidelines for typical developments are provided in Section 9:4.

CASE STUDY WATER VOLE DISPLACEMENT – CHANNEL TUNNEL RAIL LINK, SWANSCOMBE

A number of drains within reedbed habitat were due to be infilled as part of the rail link crossing. Habitat enhancement and water vole displacement was the agreed mitigation methodology for those drains directly affected by the development.

The available adjacent habitat for these animals to move into was identified within a number of watercourses. However, this was not ideal because there was already water vole activity there (noted during site visits). Therefore the best option was to carry out habitat improvement works later in the year in order to increase the long-term suitability of habitat for the voles. This improvement would take the form of selective scrub clearance over intermittent lengths of the watercourse, once the bird breeding season ended.

Strimming of the stretch to be infilled continued in accordance with the protocol and best practice guidance, to ensure that no animals were present when the work took place.

Despite strimming, water vole activity was observed during site visits for monitoring, possibly because the length of displacement was particularly long (500m). It was essential that the animals were successfully displaced prior to the construction of a lagoon habitat. By phasing the strimming, from one end to the other, water voles were encouraged to move north from ditch into the reed bed. An additional compensatory ditch was then created as soon as the voles had moved away from the area.

Water vole activity was noted on the southern section of another drain, which was also due to be infilled. The concern here was that there was no adjacent available habitat for displaced voles to move to. In order to improve the chances of success of the displacement, the northern section of the drain (which was currently choked up with reed) was desilted in the Autumn, creating higher quality habitat for the voles in the long term. It was also necessary to install exclusion fencing to prevent displaced voles returning back into the ditch to be infilled.

In this case study it was essential that the timetable for water vole mitigation measures was set out in conjunction with the timetable for construction work. It was the timing and phasing of mitigation work on the site that caused the majority of the concerns, not the mitigation techniques themselves. It was particularly disappointing to resort to the 'fire-fighting' measures during the work programme, in order to try to ensure that proper account was taken of the presence of water voles at Swanscombe marshes.

With guidance from Environment Agency staff a sensitive programme of ditch maintenance was carried out throughout the site, throughout the construction period to ensure that the water vole habitat remained suitable. Water voles remain a feature of this site now that the Rail link crossing is in place. Similar methods were used throughout the Rail link construction where ditches and streams were crossed and culverts were inserted.

Compensatory ditch and reedbed habitat at Swanscombe after construction of Channel Tunnel Rail Link. Water voles remain an important feature of the site.

Relocation

For most developments, the most appropriate method of avoiding the incidental mortality of water voles is relocation of the animals in advance of the works. This requires suitable habitat to be available for the animals to be relocated to. There are two techniques which can be used in different circumstances: relocation by displacement; and relocation by trapping and release.

Displacement

Displacement is the movement of one or a few individuals from a location where their presence conflicts with a development to a location where they do not. Displacement differs from 'relocation by trapping' in that it attempts to remove a relatively small number of individuals from short stretches of habitat by passive means, allowing the water voles to disperse away from the footprint of the scheme and into available alternative habitat. Water voles are encouraged to move by making their habitat unsuitable via a process of vegetation removal (see Box 9:B for further details). This should always be followed by a destructive search (see Box 9:C for further details) to ensure that all animals have been moved from the footprint of the works, and the habitat is subsequently destroyed to prevent the animals from returning.

Displacement is only likely to be effective where the footprint of the works and the number of animals affected is relatively small. Sufficient suitable alternative habitat must be available for the water voles to move into, and this habitat must be directly adjacent to the affected area. In the case of linear watercourses, suitable habitat must be available to either side of the affected section. *In most cases displacement should only be used to relocate animals from a section of linear habitat which is less than 50m in length, or equivalent. This is likely to require the relocation of one or two animals only.* For small colonies, where the number of animals likely to be affected represents a significant percentage of the number of animals within the colony (more than 20%) this technique should not be used. Where animals need to be relocated from a longer stretch of habitat (50–100m) this technique should only be considered where the number of animals to be moved represents a very small percentage of the colony (less than 5%). Displacement should not be used for relocating water voles from affected habitat which is more than 200m in length (or equivalent).

Water voles exhibit a high degree of fidelity to their burrows, and are only likely to be displaced by vegetation removal during the very early part of the breeding season (late-February to early-April). At this time of year the animals are active, but young animals are unlikely to have been born. Similarly, population densities at this time are low and there is inherent flexibility in water voles' ranges, meaning that displaced animals can settle outside of their

BOX 9:B DISPLACEMENT

Displacement is the passive relocation of water voles from a short section of affected habitat into suitable adjacent habitat. Further details on the situations in which it is appropriate to use this technique are discussed on page 108. This includes consideration of the timing of works, as displacement is only likely to be successful at certain times of year (late February to early April).

Displacement is undertaken by removing vegetation from the working width of a development operation, by strimming to bare earth. In order to be effective all standing vegetation both on the bank and in the water needs to be cut and all arisings need to be removed. The various steps of the process are outlined below:

1) Before vegetation removal, identify and mark the position of all burrows in the working area so that these can be located later to ensure that they are not blocked.
2) Remove vegetation from the working width and a suitable buffer zone (up to 5m either side) with a strimmer until only bare earth remains. The strimmed area needs to extend to at least the top of the bank and, where suitable vegetation exists adjacent to the bank-top this will need to be strimmed as well.
3) Rake off and remove any arisings from the strimmed area.
4) Check that burrow entrances have not become blocked.
5) Monitor the strimmed area on a daily basis for fieldsigns of water voles. Where fieldsigns are recorded the need to repeat or extend the strimming should be reviewed. Draining water from the affected area, if possible, can encourage water voles to move, so long as this does not affect water voles in adjoining habitats.
6) Undertake a destructive search of the affected area (but not the buffer zone) after a period of three days following strimming (see Box 9:C for details of how to undertake a destructive search).
7) Ideally the works should proceed immediately following the destructive search. However, in certain cases it may be necessary to maintain the affected area for a period of time until works can take place. In such cases the need to install vole-resistant fencing (see Box 9:D), or continually strim and remove any regrowth should be reviewed. In all cases it is advisable to monitor the affected area to confirm the continued absence of water voles at least weekly (during spring) and in some cases daily (from late-May onwards).

CASE STUDY RELOCATION: RIVER LEEN VOLE FACILITY, PAPPLEWICK, NOTTINGHAM

The River Leen is a small lowland watercourse that extends just over 24 kilometres from its source to the north of Newstead Abbey to its confluence with the River Trent at Wilford within the City of Nottingham.

The River Leen catchment has been subject to extensive subsidence over the past 20 years as a result of coal extraction by the Annesley Colliery. On one particular section of the River Leen near the village of Papplewick, the river has been affected by mining subsidence on three occasions in recent years, initially in the 1993 and latterly in 1996 and 1998. On all of these occasions the subsidence resulted in an increased risk of flooding to nearby property and the Environment Agency duly served notice on the mining company to address the problem.

Following the first subsidence event the river and the adjacent land dropped by approximately 300mm. The river was subsequently subject to limited regrading to reduce the risk of flooding. However, the cumulative effects of the 1996 and 1998 subsidence events meant that the impact on the river was a lot more severe, and following the final event it was found that the river had dropped by up to 1000mm compared with pre-subsidence levels. This time in order to address the flooding problem it became necessary to carry out significant bed regrading and bank re-profiling over a 400 metre length of river.

Both water vole and white clawed crayfish were known to be present in this section of the river and this immediately raised concerns about the impact of the works on what are two nationally rare and protected species. The scale of the engineering work required meant that the only option available was to translocate the water vole and crayfish to temporary receptor sites for the duration of the project. In the case of the white clawed crayfish the solution was relatively straightforward. As the population in this section of the river was relatively small all animals were trapped and moved to a suitable site on the river about 200 metres upstream. In time this would allow the crayfish to move downstream and recolonize the section of river that they had been removed from.

However, in the case of the water vole the population was known to be large, thereby presenting a far greater challenge for relocating them. In the end it was decided to construct a receptor site as close to the river as possible of sufficient size to accommodate all of the water vole present. The chosen area was an old dried up mill pond approximately 30 metres from the river at the bottom end of the impacted reach.

WATER VOLE RECEPTOR SITE

The design of the receptor site was critical if it was to function effectively. It needed to have a constant water supply and needed to be vegetated to provide the voles with cover and a food source. The site also needed to be fenced to prevent voles from returning to the river whilst the works were in progress.

The site was constructed by carefully digging a single ditch that zig-zagged back and forth to create the maximum length of watercourse possible in the available area. The ditch was cut using a long reach excavator to avoid damaging the

Receptor site showing channel design and vegetation replacement.

Water vole burrows found one week after the introduction of the first animals.

original range. After the end of the first week in April displacement by vegetation removal is unlikely to be effective and should not be attempted. However, the technique of vegetation removal can be used to discourage animals from colonizing suitable but unoccupied habitat.

Displacement should only be attempted during mild weather conditions and when evidence suggests that sufficient forage is available to support the displaced individuals. Displacing animals during, or immediately following, hard frosts or snow should not be attempted. Displacement should also not be attempted where the removal of vegetation would not significantly affect the habitat within the affected area. For example, where watercourse banks are regularly mown short, such as in urban areas, water voles are considerably less likely to be displaced in response to vegetation removal. Likewise, where the structure of a watercourse is such that there is little vegetation on the face of the bank, or water voles are occupying burrows in stonework (such as on canals), displacement is also unlikely to be effective.

Where displacement is not likely to be an effective option, relocation by trapping should be considered (see below). In a number of previous cases, vole-resistant fencing has been installed following vegetation removal to prevent animals recolonizing, and traps set within the fence to capture remaining animals. However, trapping following vegetation removal is unlikely to be successful,

Receptor site one month after completion.

vegetation on either side of the new channel. The vegetation long the line of the ditch itself was carefully stripped off as a series of turves and these were carefully placed along the finished channel so that they overhung the sides. The upstream end of the ditch was linked to the River Leen by a pipe to provide an inflow of water to the site and a piped outlet was installed at the bottom end. Water levels within the arms of the ditches were adjusted by placing spare turves in the channel to create mini dams.

The end result was a long flowing ditch with established vegetation on the bank tops and overhanging vegetation along the sides of the ditch. The site was completed in March when the vegetation was starting to grow vigorously with the result that the site matured rapidly following its completion. The finished receptor site took two days to complete and received its first water vole the following week. More than 20 water voles were moved to the receptor site over the next two weeks. However, an accurate final estimate of the total number moved was not possible because of escapes during the first few days of the exercise.

Regular surveys of the receptor site revealed that water vole readily adapted to the new habitat by creating burrows and runs underneath the turves. Within two weeks of the relocation process being completed, surveys also revealed many new signs of water vole activity including burrows, runs, droppings, latrines and feeding stations.

The regrading of the River Leen was carried out using a similar technique to that used to create the receptor site. Marginal vegetation was carefully removed and stored until the bed regrading and bank re-profiling had been finished. The bank re-profiling included the creation of a berm on both sides of the watercourse onto which the marginal vegetation was replaced. This had the effect of re-establishing vegetated banks straight away, and within a couple of months of completion the engineering works were virtually undetectable. Once the regrading work had been completed the fencing around the water vole receptor site was removed to allow the animals to return to the river. Within a week of this happening fresh signs of water vole activity were observed on the section of river nearest to the receptor site.

Rock and gravel removed during the regrading work was saved and stockpiled, later being returned to the river to create new riffles and to improve habitat for crayfish. Future surveys will assess whether or not these improvements have been successful.

Water vole surveys carried out during late summer 2000 showed that water vole were still present within the receptor site and had recolonized the regraded section of the river. The results of a trapping exercise carried out at the same time suggested that only juvenile animals remained within the receptor site, the only adults trapped being found along the river itself. Further surveys in Spring 2001 and beyond demonstrated that there was good water vole distribution throughout the site.

RIver Leen immediately after regrading.

and this approach is generally not necessary. In certain situations, where the development cannot take place immediately following displacement, it may be appropriate to consider the installation of vole-proof fencing (See Box 9:D) to minimize the likelihood of animals recolonizing the area during the intervening period. However, it is very difficult to fence an area to effectively exclude water voles, especially when population densities are high, and removal of the vegetation (through a destructive search) followed by regular removal of any vegetation that re-grows is more likely to be effective. The shorter the period between displacement and development the lower the likelihood that voles will recolonize the area and, in the case of temporary relocations, this will also reduce the timeframe during which the habitat is not available to the colony.

Further details on the methods used to effectively displace water voles, where the technique is appropriate, are provided in Boxes 9:B and 9:C.

Relocation by trapping

Where it is not considered appropriate to attempt to relocate water voles by displacement, relocation by trapping is the most favourable option (See Chapter 4 for trapping guidelines). This involves the removal of the proportion of the colony affected by the footprint of the development from their original home ranges into unoccupied, suitable habitat on the same site. Relocation by trapping differs from displacement in that it requires

BOX 9:C UNDERTAKING A DESTRUCTIVE SEARCH

A careful destructive search should be the last stage of **any** chosen mitigation option that involves removal of habitat occupied by water voles, and is the minimum requirement in those situations where suitable habitat would be affected, and water voles are present nearby but have not been recorded within the development footprint. The aim of a destructive search is to render the habitat and bank structure unsuitable for water voles following reasonable effort to relocate or translocate the animals. The various steps of the process are described below:

1) Undertake strimming of the vegetation within the affected area (if this has not already been undertaken as part of a 'relocation by displacement' operation – see Box 9:B).
2) Wherever possible, drain the water from the affected section. For watercourses this will only be possible where a diversion channel has been created, or the water can be over-pumped for the duration of the works. This will increase the likelihood of the animals leaving of their own accord and make the capture of any remaining animals by hand easier.
3) Excavate all burrows using hand tools under the direct supervision of a suitably experienced ecologist. It will be important to have gloves, nets and pre-prepared suitable animal containers containing food (apples, carrots and dried rabbit food) and bedding (hay) available for the capture and temporary storage of any animals found.
4) Any remaining vegetation, including roots, should be stripped (under direct supervision of an ecologist) from the affected section by a machine, and any animals discovered should be directed towards areas of bare ground where they can be captured.
5) The destructive search should continue until all vegetation has been stripped and all individuals present captured.
6) The affected habitat should be carefully monitored for any remaining animals for a period of 2–4 hours, and the works should then proceed as soon as possible.
7) Any animals captured should be released into 'receptor' sites (where one has been created), or released in suitable adjacent habitat (using a soft-release technique – see Box 9:E) following destruction of all affected habitat.

the active removal of water voles by live-capture and release. Relocation by trapping, if it can be achieved effectively, is preferable to translocation (see below), as the animals are moved a shorter distance and spend less time in captivity. It will, therefore, be less stressful for the individual animals concerned, and the relocated colony will be sufficiently close to the site to recolonize newly created or restored habitats following the works. This will minimize the impact of fragmentation on the wider population. Relocation also represents significantly fewer risks to the colony than those posed by translocation (as explained in more detail below), and therefore an increase in the likelihood of successful mitigation.

The major constraint associated with relocation by trapping is the need to provide a 'receptor' site for the animals. This will need to be an area of suitable habitat of sufficient size to accommodate the number of animals which need to be moved, close to the affected area (within approximately 250–500m) and should not already be occupied by water voles. Clearly there are likely to be relatively few situations in which a suitable site already exists and therefore, in the majority of cases, one will need to be created. As discussed above, this can also act as compensation habitat for any areas permanently lost. For temporary relocations it is appropriate to ensure that the 'receptor' habitat is retained in the long term, wherever possible.

In general the creation of a 'receptor' site can require works up to 12 months in advance of relocation, although this period can be reduced through careful construction and planting methods (see Chapter 5). For example, already established vegetation can be transplanted to the 'receptor' site or pre-planted coir fibre rolls can be used. It is sometimes also possible to enhance an area of existing vegetation, which is unsuitable for water voles and therefore not occupied. For example, areas of wetland habitat that have dried out, such as silted-up mill ponds or stands of reed sweet-grass (*Glyceria maxima*) adjacent to a watercourse, can be carefully excavated to provide a series of narrow wet ditches in well-established habitat. For phased developments of larger sites it may be possible to create sufficient habitat to accommodate a proportion of the animals in advance, followed by the creation of further 'receptor' sites utilizing suitable vegetation from the areas from which animals have already been moved.

The location of a 'receptor' site needs to be carefully considered. Ideally it will be as close as possible to the affected areas but within land controlled by the developer, or through legal agreement with a third party for adjacent land. It will also need to be situated to minimize the likelihood of flooding or vandalism by the public.

Fencing will always be required with projects that involve relocation by trapping, to prevent relocated animals from returning to the affected areas, even when the 'receptor' site is several hundred metres away. A vole-

BOX 9:D INSTALLING WATER VOLE-RESISTANT FENCING

Water vole-resistant fencing comprises sheets of thick plywood or similar (25mm thickness), installed to a minimum above-ground height of 1.2m and buried to a minimum depth of 0.5m. The fence will need to be installed to form a continuous and effective barrier. Ideally the fence will be set back from any suitable water vole habitat by more than 2m, and this area maintained as short mown vegetation to reduce the likelihood of voles approaching the fence. Where the fence is installed on significantly higher ground than the habitat used by the water voles, it would be appropriate to consider increasing the depth of the fence appropriately and/or increasing the distance between the fence and the habitat to up to 5m.

The fencing needs to be supported by regular posts to ensure stability, and should be vertical to minimize the likelihood of animals climbing in or out. The positioning of the posts on the inside or outside of the fence will need to be reviewed dependent upon the purpose of the fence, as the posts will aid any animals attempting to climb it. For example, a fence installed around an area from which water voles have been displaced to prevent animals returning, should have posts on the inside of the fence. Conversely, a fence installed around a 'receptor' site as part of a translocation should have posts on the outside of the fence. The positioning of posts for a fence installed around a 'receptor' site for a relocation would need to balance the likelihood of animals colonizing the site prior to the relocation and the risk of animals climbing out and returning to the affected area during the works. Where there is a high likelihood of animals attempting to climb the fence, boards can be fitted to the top of the fence to create an overhang of at least 30cm. The height of a fence should not be reduced below 1.2m, even with an overhang fitted, as the animals are capable of jumping up to 1m, and the presence of an overhang may actually aid their ability to climb over the fence.

In certain cases, particularly where there is a high likelihood of animals attempting to burrow out, due to factors such as topography and proximity to the 'donor' site, it may be appropriate to consider burying the fence to a greater depth, back-filling the fencing trench with gravel and/or fitting an outward return of wire mesh at the base of the fence prior to back-filling.

The need to install a fence within a watercourse should ideally be avoided when designing the mitigation, as it can be difficult to achieve effective installation and can result in an increased likelihood of pollutants of sediment entering the water. If it is unavoidable, the fencing must be strong to account for water wash. Fencing parallel to the bank within the channel should comprise sheet metal piling sunk to a depth of 2.4m by a machine. Careful installation will be required to create an effective barrier. Installing fences across a channel is particularly problematic as they can interfere with the functioning of the watercourse. Where it is possible, sheets of heavy gauge 2.5cm square weld mesh should be sunk to a depth of 1m across the channel, with a height above water level of more than 0.75m, and topped with overhanging boards to prevent climbing.

In all cases it will be important for a suitably experienced ecologist to oversee the installation of the fencing to ensure that it is correctly installed.

Water vole fencing needs to be well maintained and buried to a depth of 0.5m to form a continuous and effective barrier.

resistant fence (see Box 9:D for further details) should be installed around the 'receptor' site as soon as possible following its creation; this will help to prevent animals from colonizing the new habitat and reducing its carrying capacity prior to the relocation operation. 'Receptor' sites should therefore ideally be discrete habitats, such as ponds or inter-linked drains, as opposed to being a section of new watercourse, which would be difficult to effectively fence. The 'receptor' site should, however, be as close as possible to the affected area and any other compensation habitat created. It may also be considered necessary to install vole-proof fencing around the affected area, to prevent the influx of animals from any unaffected, adjacent habitat during the trapping. Such an influx would result in larger numbers of animals being relocated than necessary, and a reduction in numbers on the surrounding habitat. However, in certain cases, particularly where the number of animals likely to be affected represents a significant proportion of the colony (such that the remaining population will be too small to be viable in its own right – see Chapter 3), it will be more appropriate to relocate all of the animals associated with the colony.

Trapping of water voles will need to be undertaken during spring and early summer (mid- March to mid-June) to ensure that the animals are released into the 'receptor' site prior to the end of June. Relocation operations later in the year will generally be considered inappropriate, as this will allow too little time for the animals to raise sufficient offspring by the end of the breeding season to mitigate the large over-winter loss of individuals that this species experiences (see Chapter 3). Ideally, trapping would take place during the early part of this period, to minimize the likelihood of capturing lactating females (which would need to be released immediately and trapping suspended

CASE STUDY EXCLUSION VIA THE DISPLACEMENT TECHNIQUE: SOME CONSIDERATIONS

The Exclusion Technique is a method of mitigation that attempts to persuade water voles to leave a stretch of water and allow development or land management to go ahead. These guidelines are intended for small-scale projects (those that do not exceed 100m of constant impact). Projects for which this technique may be appropriate include:

- Sewage outfall installation or repair;
- Pipeline or road crossings;
- Bridge developments/modifications/repairs;
- Bank repairs/modifications;
- Installation of gauging stations.

Where such small developments are necessary and impacts cannot be avoided, this method of mitigation appears to be the most beneficial to water vole population conservation and welfare. For larger developments, where the impact is considered to be significantly greater, more substantial mitigation measures will be required, which will take longer to plan and implement, such as habitat creation in advance of development.

The open-cut method for installing pipelines across watercourses is significantly cheaper than other, less destructive methods and is therefore widely used. However, this method may result in the temporary loss of habitat for any water vole populations encountered within the working width of the crossing, and significant disturbance during construction. Vegetation removal is sometimes followed up with fencing off the working width and a trapping programme to exclude voles from it.

The technique of vegetation removal has been implemented in a number of cases and considered successful based on surveys of fieldsigns and/or a trapping programme within a fenced area (Arnott, 2001; Bennet et al., 2001; Strachan, 1998), and is recommended as a suitable mitigation technique by English Nature (English Nature, 1998).

Despite the number of projects where 'displacement' of water voles has been attempted, there have been few studies that have involved detailed monitoring of the reaction of water voles to vegetation removal, and much of the evidence that this technique is effective is based on observations at specific sites, and not on experimental manipulations.

The fact that water vole fieldsigns are generally absent within areas where vegetation has been removed (Arnott, 2001), and that animals are not captured within such fenced-off areas (Arnott, 2001) may be a direct result of the habitat being made suboptimal for water voles, rather than an indication that they are no longer present.

It is still largely unknown how water voles react to 'displacement', what consequences it has for the reproductive success of the colony, exactly what level of disturbance and vegetation removal actually causes them to move, and whether or not they actually move at all. It is also not known whether or not fencing and trapping are required and in which situations they work. Furthermore, there have been no studies carried out on the long-term effects of this mitigation technique.

Water vole populations tend to suffer high mortality over the winter, and therefore a significant decrease in a population's breeding potential, through the temporary loss of habitat during the summer months, may significantly increase the likelihood of local extinction.

The wide acceptance of the use of 'displacement' as a mitigation technique is therefore based on the belief that it is a successful and cost-effective option, without many scientific trials to support this assumption.

Amy Ishwewood


Vakuumikuivattua perunaa,
riisijauho,
E471, suolaa,
kovetettua kasviöljyä, maitojauhe,

CASE STUDY WATER VOLE DISPLACEMENT – PIPELINE CROSSING OF HOOBOROUGH BROOK

Following strimming and indication that burrows are no longer occupied, all vegetation can be carefully stripped to create bare ground unsuitable for water voles.

The study area was a length of the Hooborough brook, which flows along the Derbyshire/Leicestershire border near Swadlincote, Derbyshire. The brook was found to support an extensive water vole colony. However, the proposed crossing point for the pipeline was through a section of less optimal water vole habitat, where water voles were present at a relatively low density compared with elsewhere on the same watercourse.

The mitigation was designed to replicate that generally employed where a pipeline crosses a watercourse using an open-cut method. Two 15 metre sections of watercourse were selected for the study: Sites A and B. The bankside and in-channel vegetation on both banks was cut throughout the two sites using a petrol strimmer. The vegetation was cut to ground level, with the strimmer cord angled into the ground to ensure that all vegetation had been removed and bare earth remained. The 'displacement' area extended from the channel to the top of the bank, and further where burrows were present high up the bank-face (vegetation within two metres of burrow entrances was removed). The arisings were then removed from each 'displacement' area.

Along the Hooborough brook water voles were caught and fitted with radio-collars prior to works so that their response to works could be closely observed.

Site A: the banks within this area varied from shallow to vertical. Site A was originally intended as the working width for a proposed pipeline crossing. However, the route of the pipeline was altered as a result of a foul sewer being located within this width, and the pipeline was instead laid across an adjacent footbridge.

Site B: the left bank within this section was flat and supported a sedge bed within which extensive signs of foraging were recorded. The right bank was a steeply-sloping grassy bank containing numerous burrows at the toe.

Both areas were re-strimmed three weeks after the initial vegetation removal operations, as the vegetation was beginning to recover at this stage. The 'displacement' area was extended further back from the water's edge on the right bank within Site B, as a result of fresh burrows on the strimmed bank-face being recorded during post-mitigation monitoring.

Burrow systems in Site A were excavated by hand and topsoil scraped from the banks to ensure that all voles had moved from this location, as this was originally intended to form the working width of a pipeline crossing. The banks were then smoothed to make them as unsuitable for re-occupation by water voles as possible. Work was carried out in the summer months.

POST-MITIGATION MONITORING

Regular site visits were carried out following mitigation works, to determine the effect on the territories of the radio-collared animals. The frequency of visits was approximately daily at the start of the post-mitigation monitoring, and this decreased to

The displacement technique is most effective early in the year (late February to early April) and over short lengths of bank.

twice weekly after the first two weeks. The locations, level of activity and position (above/below ground) of radio-collared animals were recorded on each visit. Surveys of the 'displacement' areas for fieldsigns were also carried out on each visit.

Site A

The male water vole which occupied a burrow system within Site A was also recorded in other burrow systems further downstream. However, it was most often recorded within the burrow in Site A, and this continued for at least 17 days after the vegetation removal had been carried out. No fieldsigns of water voles were recorded at Site A during post-mitigation monitoring. However, fresh droppings were recorded within a burrow when it was excavated by hand. An animal was observed attempting to burrow back into the bank at Site A after the banks had been scraped of topsoil and smoothed to make them 'unsuitable'. This animal was not fitted with a radio-collar, and could not be captured to enable to determine identification as a previously recorded individual.

Site B

The radio-tracking data showed that the two study animals within Site B occupied directly adjacent burrows, and this location was favoured by both animals, although both were recorded in other burrows within their respective territories. After the vegetation removal, both animals continued to favour the same burrow systems as before, despite the fact that this location was in the centre of the 'displacement' area.

The following table summarizes the various problems and limitations with 'displacement' which were identified in this study, and provides possible solutions.

PROBLEM	LIMITATION	SOLUTION
Increased vulnerability to predation.	'Displacement' in winter or mid-summer may increase chances of local extinctions.	Avoid use of 'displacement' at this time of year until further research is carried out.
High burrow fidelity.	'Displacement' unlikely to be effective over long stretches.	Do not use 'displacement' in these circumstances. Fencing and trapout is a more effective option.
	'Displacement' unlikely to be effective in late summer/autumn.	Careful timing, or use an alternative to 'displacement', such as fencing and trap-out.
	'Displacement' may be ineffective in all cases.	Carry out research into alternative solutions.
	'Displacement' may be ineffective in all cases.	Where 'displacement' is used, excavate burrows by hand and carry out supervised bank destruction prior to development.
Lack of fieldsigns within 'displacement' areas.	Fieldsigns/trapping are not reliable indicators of the effectiveness of mitigation.	Carry out further research through radio-tracking to gauge the effectiveness of mitigation techniques.
Voles attempt to burrow out of 'displacement' areas.	'Displacement' may be ineffective.	Where 'displacement' is used, extend strimming well away from burrows and monitor regularly to ensure that underground connections to retained habitat are not excavated.
Voles attempt to dig back into banks which have been made 'unsuitable'.	Impossible to make banks completely unsuitable for animals which have high burrow fidelity.	Careful timing to ensure that the period between mitigation and development is as short as possible, with regular monitoring for new burrowing in the interim period.

for up to four weeks), and releases during April and May should always be encouraged. Animals should always be 'soft-released' into pens within the 'receptor' site (see Box 9:E for further details), and marked using a micro-transponder (see Chapter 4).

A destructive search of the affected habitat should always be undertaken following completion of the trapping (see Box 9:C for further details). Trapping should be considered complete when there have been at least three consecutive days with no captures.

For developments which will restore the affected habitat following the works, it will only be necessary to relocate animals temporarily. Ideally the 'receptor' site will be retained permanently, as discussed above, and recolonization of the restored habitat can be allowed to take place naturally; removal of the fence around the 'receptor' site is all that will be required. In certain cases it may not be possible to retain the 'receptor' site in the long term, and the relocated voles will need to be actively returned to the restored habitat. Given the length of time required to undertake successful restoration, and the need to relocate the animals back to their original site before the end of June, this is likely to take place in the year following the initial relocation. In such cases it will be important to ensure that the 'receptor' site is sufficiently large to accommodate the natural increase in the colony size towards the end of the summer and contains suitable over-wintering habitat (e.g. on-site habitat that will not flood during the winter months). The methods used to relocate the animals back to their original location should follow those for the initial relocation operation.

Where fencing needs to be removed following the completion of a relocation operation, this should be done under the supervision of a suitably experienced ecologist.

In cases where there is no scope to create sufficient mature habitat on-site prior to the works it may be possible to house water voles in large, well-constructed individual enclosures on-site. This option would only be appropriate where the loss of the original habitat will be temporary and the habitat will be restored sufficiently quickly so that all of the animals can be returned to it before mid-June. Clearly this would require the capture of the animals, destructive searches of the banks, development and restoration to all proceed according to a very strict programme, commencing at the end of March. Habitat restoration would also need to be done quickly by planting well-established vegetation, and by the use of pre-planted coir fibre rolls. The enclosures must contain a hay bale, covered to keep the rain off, and the water voles given daily food and water changes. Such pens should be constructed and provisioned with the collaboration of an organization experienced in this method or with captive breeding of water voles. This option cannot be used to house water voles for more than a three month period or

BOX 9:E RELEASE PEN CONSTRUCTION AND USE

If water voles are required to be released into new habitat, whether as a result of mitigation work or as part of a reintroduction programme, they should always be released using a 'soft-release', or release pen method. This method allows the animals to acclimatize to their new surroundings whilst being protected from predation and supplied with food and water. There are many designs of release pen, but all allow the water voles to make their own way into the habitat, and allow territorial females to be properly spaced at the outset to reduce aggression. Release pens should have a minimum floor area of 1m^2, and a minimum height of 45cm. Each pen should house only one adult individual, and individuals of the same sex should be spaced evenly throughout the receptor site and at intervals which reflect the spacing at which the animals are present in the donor site. Release pens should be buried into the ground to a depth of 15–20cm to prevent immediate escape of the released animals, but to allow them to construct a burrow system and dig-out in their own time. The pens should be sited as close to the water as possible, in (or near) tall vegetation.

SUGGESTED CONSTRUCTION METHOD

Release pens should be constructed on-site at least 2–3 weeks in advance of the release date to allow the vegetation to grow up following construction. A good release pen can be constructed using four sheets of plywood 120 x 60 x 0.6cm and a square of chicken wire of approx. 120 x 125cm. The long-side of the plywood should be inserted into slots dug into the ground with a spade and firmly tapped into the ground to a depth of 15–20cm using a rubber mallet. The plywood should form a square pen: it is very important that no gaps are left at the corners since the water voles will escape through these. To avoid gaps, leave up to 5cm of overlap between sheets, so that the corners form a slight 'T' shape. The plywood should be of approximately the same height above the ground at the corners (this can be difficult on sloping ground). The corners can be held together using two large (15–20cm) cable ties at each corner. The cable ties are inserted into holes drilled opposite each other on the edge of each plywood sheet. The holes can be drilled after the sheets have been sunk into the ground, using a cordless drill.

A sheet of chicken-wire is used to form a predator-proof lid, which is held on using cable ties secured at four points on each sheet, taking particular care to ensure that the corners are secure. The cable ties should be inserted through the chicken wire 5–10cm from the edge and pulled tight enough to ensure the lid overlaps the plywood. It is very important that the lid is tight, and that the edges are folded down over the plywood to prevent injury to any passers-by and to make the lid secure. It is a good idea to leave one corner of the lid after the mid-June period. Thereafter the population will not have time to increase before winter, and runs a high risk of extinction. Any slip in the programme of such works would reduce the effectiveness of the mitigation, and it should therefore only be attempted where there is no feasible alternative, and where there is a high likelihood that works would proceed according to the programme. This technique will therefore be inappropriate in the vast majority of cases.

Translocation

Translocation requires the active removal of water voles by live-capture and release, and is therefore similar to relocation by trapping (see above). The methods described above for relocation by trapping would therefore also be used to translocate water voles. However, translocation differs from relocation in that the proportion of the colony affected by the footprint of the development is removed from the original location into a site that is outside of the normal dispersal distance of water voles (at a distance of approximately 1km or more from the 'donor' site). There are therefore several additional factors which need to be considered, and these make it a more costly option than relocation, with a lower likelihood of success.

As explained above, the process involves removing a colony, or part of a colony from its original context into a location that is beyond water voles' normal dispersal distance (approximately 1km or greater). Any colonies which were linked to this colony by dispersal would have an increased chance of extinction (see 'Fragmentation' in Section 9:2.1 above) and this impact would need to be mitigated. It is important to ensure that the 'receptor' site is not isolated from existing water vole colonies, as this could result in the loss of the translocated individuals and a failure of mitigation. The degree of isolation will be a particularly critical factor when translocating small colonies (less than 30 individuals). Similarly, if only part of the colony is to be translocated, it will be necessary to ensure that both new colonies are sufficiently large to be self-sustaining (see Chapter 3); in this scenario both colonies would be more at risk from extinction as a result of the translocation. When multiple colonies which are within dispersal distance of one another will be translocated, it is appropriate to attempt to replicate the existing spatial juxtaposition of the colonies when creating new 'receptor' sites.

Translocation is sometimes viewed as a more favourable option by developers, as it may avoid the need to create a 'receptor' site in advance of the works commencing. However, in reality there are likely to be relatively few suitable existing locations to act as 'receptor' sites for a translocation, and therefore creation of a 'receptor' site may still be required. In all cases, the distance between the 'receptor' site and the 'donor' site will need to be minimized; this distance should generally be less than 10km.

For an area of existing habitat to be suitable for use as a 'receptor' site it must be unoccupied by water voles, and the reasons for their absence need to be established and rectified prior to translocation taking place. One of the factors responsible for the absence of water voles may be the presence of mink and, in any case, translocation will require consideration of the risk of mink predation at the 'receptor' site. The site must have an established management plan incorporating mink control both pre- and post-release (see Box 9:F and Chapter 5), with the absence of mink confirmed for at least six months on all watercourses within a 1km radius of the site.

A further complication is the need to consider the potential for the spread of disease from the translocated animals to existing colonies in the local area. The chances of novel diseases being spread by translocated animals are smaller if the 'receptor' site is relatively close to the area from which the animals were captured, as the animals are likely to form part of the same meta-population. However, where the 'receptor' site is sufficiently distant that translocated animals could encounter new populations, screening for diseases will be required prior to the release of the animals by a suitably licensed and experienced person.

Translocation is not only less likely to be successful than relocation it also necessitates the consideration of a series of onerous requirements. It should therefore only be considered as a last resort option.

undone prior to use of the pen, to aid the release of captured water voles. The lid should be fully fastened when the animal is in the pen. Extremely hard ground or dry/hot weather can hamper water voles digging. In such cases it is advisable to thoroughly wet the ground around the edges of the pen (inside and outside) with river/pond water before releasing animals (but not so much that there is standing water).

Pens must be situated sufficiently distant from public access to reduce the likelihood of vandalism and interference.

PROVISIONING

Release pens should be supplied with a straw-bale-section (1/6 of a bale) to provide immediate cover. The straw bale must not be high enough to allow a water vole standing upright to reach the lid as this can lead to voles injuring themselves. Each vole will require 4–5 apples (apples are very important as they provide a lot of energy and moisture for water voles), 4–5 carrots and a few handfuls of dried hamster or guinea-pig food, all of which should be provided on the day of release. Water should be provided as a large trough (approximately 60 x 30 x 15cm) into, and out of which the water voles can climb without spilling the water. The trough can be filled with river water. Pens should be removed when signs indicate that the majority of individuals have escaped, or after three weeks following release.

CASE STUDY TRANSLOCATION OF WATER VOLES FROM READING SEWAGE TREATMENT WORKS

Redevelopment of the Thames Water Sewage Treatment works at Reading required the draining and infilling of derelict sludge lagoons. Survey immediately prior to the scheduled dewatering in March 2001 identified the presence of water voles. No adjacent habitat was available nearby and no provision had been made for the presence of water voles, or, therefore for mitigation strategies or compensation habitat within the scheduled redevelopment plans. Under these

The London Wetland Centre has created 44ha of mink-free habitat suitable for water voles.

circumstances the only available option was the 'last-resort' option of translocation to a suitable receiving site. N.B. this option would not be considered for cases were sufficient lead-in time exists for alternative mitigation strategies. In this case, due to the necessarily short lead-in time, and lack of provision for the presence of water voles in the works plans, it was desirable quickly to find a receptor site of sufficient size which did not have a water vole population but which supported mature habitat suitable for occupation.

The newly created London Wetland Centre, at Barnes, provided ideal habitat for the translocation of the water voles from this development. The site was large enough to accommodate the entire population, was mink-free, had no existing population of water voles and was situated in the same river catchment as the donor site.

The translocation work was conducted by the Wildlife Conservation Research Unit as part of the ongoing programme of research into water vole conservation and the R&D project on translocation and reintroduction.

CONSIDERATIONS

Where translocation of water voles has been proposed for planned works that will ultimately destroy their habitat, it is essential to gauge the size of population that would be affected. A detailed survey that mapped out water vole signs was conducted over the entire effected area before any traps can be set down.

It was expected that any trapping and removal of animals would potentially draw individuals from neighbouring populations into the trapped area. However, in this case, because the sludge lagoon was an isolated system, the removal process did not require vole-proof fencing to prevent immigration.

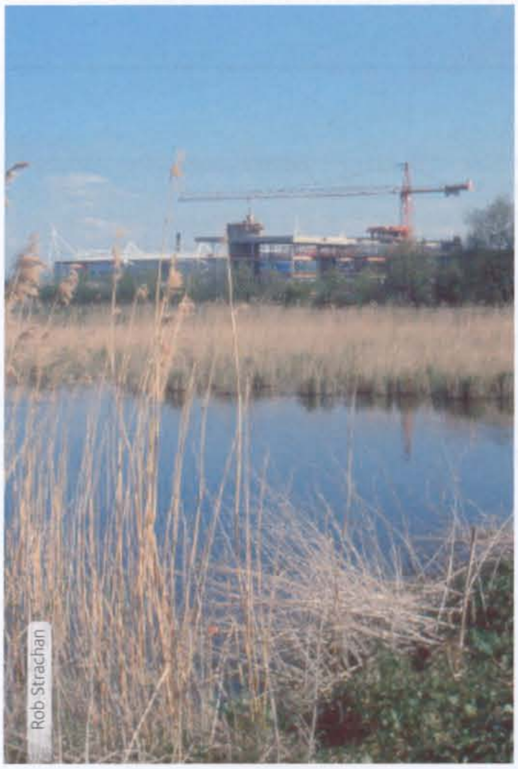
TRAPPING PROCEDURE

Trapping aimed to catch water voles for a 3–4 week minimum period (traps were left in place until no animals had been caught for at least three consecutive days). All traps were sited at water vole latrines and provisioned with hay and food. Each trap was set in an appropriate place and checked before 8am each day, and again in the evening (as the trap-out extended into the breeding season there was an increasing risk of pregnant females being caught and the checking was increased to every four hours).

Each capture was weighed, sexed and given a unique micro-transponder tag for identification purposes. All animals (except one lactating female, which was re-released and left to return to her nest for four weeks before re-trapping with her young) were immediately transferred to carrying pens and taken to a holding facility.

HOLDING FACILITY

Forty-five animals were captured and were placed in a temporary holding facility at Wildwood in Kent, and given a health check. At Wildwood each animal was housed in a separate pen where their husbandry requirements were met by dedicated staff.



Flooded sludge lagoon at Reading due to be destroyed during redevelopment.

Water vole trap being used as a latrine site during the trap-out.

TRANSLOCATION

Translocation to the receiving wetland site (reedbed, ponds and ditches) took place following a health screening quarantine period of four weeks, during which time the receptor site was prepared by digging in soft-release pens. These allowed the animals to acclimatize to their new environment prior to emergence into the waiting habitat. During this time the London Wetland Centre was 'risk assessed' in terms of future survival of the voles, and favourable management practises were put in place.

The translocation was conducted following the IUCN Guidelines regarding reintroduction procedure. All the animals were released before mid-June and many bred within their first month post-release. Monitoring post-release revealed an estimated population of 180 individuals at the end of the second breeding season. Monitoring continued for five years and water voles appear to have established well throughout the 44ha site.

Water vole release pen at the London Wetland Centre.

CASE STUDY DOES STRIMMING ALWAYS WORK?

The Yorkshire Wildlife Trust have been involved with several development schemes where water voles have needed to be 'moved' from the working area. The following example highlights the potential for problems when following standardized methods:

ROAD BRIDGE REPLACEMENT WORK

- A road bridge crossing a water course needed replacing and water voles were active either side of the bridge.
- It was decided to strim off vegetation down to bare earth, followed by erection of plywood boarding to create an exclusion zone.
- Traps were placed inside the boarded off area to ensure all water voles had vacated their burrows.
- There was plenty of available habitat both up and down stream from the working area.
- Trapping commenced and on day seven a subadult male water vole (190g) in good physical condition was caught inside the boarded area.
- A total of 22 days had elapsed between the first strim of grass (grass was kept cut back and not allowed to regrow) through to the capture of the water vole. Disturbance levels around the bridge area were high in an attempt to discourage water voles from the area.
- This highlights the potential for water voles to display high site fidelity and either travel back and forwards to find a suitable food supply or remain in the burrow system, relying on food stores within the burrow.

At three further bridge replacement schemes where water voles have needed to be moved, the YWT project officer left all habitat intact and carried out a trapping programme. This resulted in resident water voles continuing to display normal behaviour patterns and remaining active (rather than disappearing into their burrow systems) in the trapping areas. Once set, the traps have successfully caught any resident voles (on all three sites, all within a week), and once the site is declared 'clear', construction work could begin with removal of the now unoccupied habitat.

In certain cases it may prove necessary to translocate water voles to a 'receptor' site some distance from the 'donor' site, but the affected habitat will be restored following the works. The need to actively 're-stock' the 'donor' site using animals from the translocated population should be reviewed, dependent upon the likelihood of passive recolonization of the restored habitat.

MINIMIZING THE IMPACT OF INCREASED PREDATION OF WATER VOLES BY DOMESTIC ANIMALS

Where a development would result in a significant increase in the risk of predation by domestic animals, such as where a large residential development would take place close to a water vole colony, thereby increasing the number of cats in an area, it may be considered necessary to provide some form of mitigation for this impact. The extent to which mitigation is required will be dependent upon the scale of the impact (see Section 9:2 above). In all cases it would be appropriate to consider the options for educating the new (and any existing) residents through leaflets, talks and interpretation boards. For developments which would require the creation of compensation habitat and/or 'receptor' sites, these should be designed to provide the maximum protection from predation, through the provision of islands and extensive areas of marginal vegetation. In certain cases, where no habitat would be directly affected and no animals would need to be relocated or translocated, it may be considered necessary to provide additional habitat, as discussed above, to encourage an increase in the number of water voles, and therefore buffer the colony against the impact of predation.

3.4 MONITORING

All developments which have impacts on water voles should be monitored to gauge the success of the mitigation. The monitoring should be designed to feedback in the short term to enable the project being monitored to be improved, where necessary, and also in the long term to inform future mitigation operations. What constitutes a 'success' should be determined in advance of any translocation/relocation taking place and requires pre-defined practical measures by which the outcome of the project can be determined.

MONITORING DURING IMPLEMENTATION OF THE MITIGATION

The successful implementation of mitigation should be monitored continually during the early stages of any mitigation works to ensure that any problems can be rectified. This would include (where appropriate): monitoring of the development of compensation habitat, particularly where such areas will be used as 'receptor' sites for relocation or translocation; the continued effectiveness of water vole-resistant fencing (based on recaptures of marked individuals and structural integrity of the fence); and the continued presence or absence of water voles (based on fieldsigns) from 'receptor' sites and 'donor' sites respectively. A monitoring programme should form part of the method statement agreed with the relevant SNCO, and should be tailored to the mitigation proposed. The amount of survey effort required will be dependent upon the nature and duration of the impact and the type of mitigation implemented. For example, relocation by displacement is likely to require more intensive monitoring during the works than relocation by trapping, due to the reliance of this method on the passive movement of animals. However, the period of monitoring is likely to be shorter for displacement, as it should be possible to complete the process more quickly.

POST-CONSTRUCTION MONITORING

This will normally require a comparison between the status of any affected water vole populations or colonies pre-construction and their status post-construction. The impacts associated with each individual development scenario will determine the monitoring requirements, and a scheme-specific monitoring programme should be agreed with the relevant SNCO as part of the method statement for the mitigation. For example, developments which affected habitat suitable for use by water voles, which was

BOX 9:F SITE MANAGEMENT AND OPPORTUNITIES FOR HABITAT ENHANCEMENT – SEE ALSO CHAPTER 5

The management of any 'receptor' site should be sufficient to ensure the future survival of the relocated/translocated colony. This will require consideration of both mink control (for translocations) and habitat management, which must remain in place thereafter. A written habitat management plan should be produced that is designed to maintain the site in a favourable condition for water voles. Such a plan might consider rotational cutting of vegetation to encourage fresh grass growth and the prevention of the site turning to scrub. To ensure that any plan takes the presence of water voles into account, site managers should consider the impact of the presence of the voles on their ability to manage the site.

Translocated colonies must be protected against mink predation, either by providing large (greater than 20ha in area) reed-beds or by instituting a permanent programme of mink control. Such mink monitoring and control should take place from September to April. In the lowlands, monitoring and control of mink is best managed via the Game and Wildlife Conservation Trust mink raft technique (see Chapter 7).

It will be particularly important to consider the management of habitat at sites where the development would result in increased numbers of domestic predators, such as cats. In such cases management will need to ensure that a sufficient amount of habitat which provides the water voles with protection against such predation is retained at any given time.

not occupied at the time of the works, will require only a low level of monitoring to assess the suitability for water voles of any compensation habitat created as mitigation for habitat lost. Developments which resulted in the loss of suitable habitat and the need to relocate or translocate animals in advance of the works, will require considerably more extensive monitoring. In this situation the monitoring would need to assess the success of the relocation/translocation operations as well as the suitability and level of occupation of newly-created compensation habitat post-construction. The aim of monitoring will generally be to determine whether or not there has been a net loss of habitat or long-term effects on colony size. Colony size does not need to be absolutely quantified, but can be assessed in relative terms based on latrine counts pre-construction and post-construction (which will need to be undertaken at the same time of year – see Chapter 4). Monitoring reports should be made available to the relevant SNCO, EA/SEPA conservation team, and local Wildlife Trust.

Monitoring of any mitigation will generally take place for up to five years following the completion of works. For low level impacts this does not necessarily need to take place annually. However, any projects requiring relocation of water voles by trapping, or translocation, should be monitored annually. In certain cases, should the mitigation be shown to be successful prior to the end of the monitoring period, it may not be necessary to continue monitoring for five years. For example, where water voles were temporarily relocated by trapping from an area of occupied habitat, and the reinstated habitat was shown to be occupied by water voles at an equal or higher density post-construction than pre-construction, there would be no value in continuing monitoring. Any further changes in status experienced by the affected water vole colony would be significantly less likely to be due to the mitigation operation.

Where a mitigation project is considered to have failed (for example, where there has been an overall decrease in the relative numbers of animals or the amount of habitat occupied by water voles) the causes should be identified and rectified wherever possible. Any information gained from monitoring should be made widely available to inform any future mitigation projects.

4 IMPACTS ASSOCIATED WITH SPECIFIC DEVELOPMENT TYPES AND APPROPRIATE MITIGATION OPTIONS

Some of the common impacts associated with development types and the most appropriate mitigation option in each case are outlined below. This is **not** intended as an exhaustive list of all of the potential impacts, and conversely, not all of the impacts listed here will apply in each case. For development projects where it is not considered possible to implement the recommended mitigation, or where the likely impacts are outwith the scope of those discussed in this chapter, the relevant SNCO should be consulted for further guidance at an early stage.

These guidelines concern only habitats occupied by water voles. There is no legal requirement to mitigate impacts on habitat which is suitable for water voles but is not occupied (at any time of year), although it is good practice to do so. Given the rate at which water voles are capable of colonizing suitable habitat and the timeframe between a planning application being submitted and construction works commencing, it is advisable to consider mitigating impacts on unoccupied habitats at the planning stage, particularly where the risk of colonization is high. The need to implement mitigation at a late stage, which has not been carefully considered, will be expensive, can potentially cause lengthy delays to construction programmes, and is less likely to be successful; it should therefore be avoided.

The distances given in the examples in Box 9:G below are approximations only and the impacts of a given development will depend upon colony/population sizes and the degree of isolation of each colony. Impacts should always be assessed on a case by case basis.

BOX 9:G GENERAL EXAMPLES OF IMPACTS RESULTING FROM, AND MITIGATING FOR, DIFFERENT

1. TEMPORARY SMALL SCALE HABITAT LOSS AND MODIFICATION

Typical works: Pipeline or cable crossing a ditch.

Extent: Footprint of works typically smaller than one female territory or less than 50m of bankside habitat.

Magnitude: Direct impacts upon one or a few individual animals under the footprint of the scheme during works, potentially including:

- Minor short-term loss of habitat (the degree of impact will be dependent upon the quantity and quality of the affected habitat relative to that available to the colony);
- Minor increase in risk of mortality of one or a few individuals due to movement to new location;
- Mortality of one or a few individuals during the works.

Duration: Up to several weeks for works and several months for regrowth of habitat.

Reversibility: Habitat loss is fully reversible.

Timing/frequency: Impact can be reduced by correct timing of works (see Section 9:3.2) as the occupancy of surrounding habitat will affect the ability of resident individuals to move/be moved from under the scheme footprint. Incorrect timing of works will increase the likelihood of incidental mortality of animals.

Cumulative effects: Low probability of cumulative effects.

Beneficial effects: Appropriate restoration of habitat can have a long-term beneficial effect and any such opportunities should be taken.

Mitigation:
1) Careful selection of location and timing of works to avoid/minimize impacts on water voles (select the lowest quality habitat, or area where fieldsigns are at their lowest density).
2) Relocate water voles from affected area, ideally by displacement (if appropriate, see above), or alternatively by trapping (which will require the creation of a 'receptor' site in advance of relocation).
3) Consider the need for vole-resistant fencing.
4) Undertake a destructive search of the affected area.
5) Carry out the works and reinstate the habitat as soon as possible.
6) Allow relocated animals to recolonize the restored habitat (if relocated by trapping).
7) Monitor during the works and post-construction.

2. PERMANENT, SMALL SCALE HABITAT LOSS

Typical works: Installation of gauging station, hydrological telemetry station, access bridge or small footbridge; above-ground pipeline or outfall construction.

Extent: Footprint of works typically smaller than one female territory or less than 50m of bankside habitat.

Magnitude: Direct impacts upon one or a few individual animals under the footprint of the scheme during works, potentially including:

- Minor permanent loss of habitat (the degree of impact will be dependent upon the quantity and quality of the affected habitat relative to that available to the colony);
- Minor increase in risk of mortality of one or a few individuals due to movement to new location;
- Mortality of one or a few individuals during the works;
- Minor long-term reduction in population carrying capacity.

Potential for minor fragmentation effects.

Duration: Up to several weeks for works; thereafter permanent habitat loss.

Reversibility: Habitat loss is permanent.

Timing/frequency: Impact can be reduced by correct timing of works (see Section 9:3.2) as the occupancy of surrounding habitat will affect the ability of resident individuals to move/be moved from under the scheme footprint. Incorrect timing of works will increase the likelihood of incidental mortality of animals.

Cumulative effects: Low probability of cumulative effects.

Beneficial effects: Creation of compensation habitat (see mitigation, below) will be required. This would have beneficial effects if created to provide habitat of improved quality for water voles compared with that lost.

Mitigation:
1) Careful selection of location and timing of works to avoid/minimize impacts on water voles (select the lowest quality habitat, or area where fieldsigns are at their lowest density).
2) Relocate water voles from affected area, ideally by displacement (if appropriate, see above), or alternatively by trapping (which will require the creation of a 'receptor' site in advance of relocation).
3) Consider the need for vole-resistant fencing.
4) Undertake a destructive search of the affected area.
5) Carry out the works and provide compensation habitat (if not already created as a 'receptor' site). For such small scale habitat loss compensation habitat could be provided through enhancement of existing habitat, thereby avoiding the need to create new habitat (although this is unlikely to be appropriate for creation of a 'receptor' site).
6) Monitor during the works and post-construction.

DEVELOPMENT TYPES

3. LARGE FOOTPRINT SCHEME RESULTING IN TEMPORARY LOSS OF HABITAT

Typical works:	Widening, resectioning or re-profiling of watercourses; drainage of water bodies for restoration work; watercourse diversions.
Extent:	Footprint of works typically 50–500m length of habitat; Footprint of works affects up to 10 female territories, and potentially entire colonies of water voles; Habitat loss can be extensive, although temporary.
Magnitude:	Direct impacts upon several individual animals under the footprint of the scheme during works, potentially including: • Major short-term loss of habitat (the degree of impact will be dependent upon the quantity and quality of the affected habitat relative to that available to the colony); • Raised mortality risk of several individuals due to movement to new location, potentially resulting in the loss of the colony; • Mortality of several individuals during the works, potentially resulting in the loss of the colony. Potential for significant fragmentation effects in the short-term.
Duration:	Works (including both mitigation and development itself) likely to take at least several months, and up to several years; Restoration likely to take at least 12 months.
Reversibility:	Habitat loss is fully reversible.
Timing/frequency:	Unmitigated works will have a large impact upon occupied habitat irrespective of timing; Successful mitigation will, however, require careful consideration of timing (see Section 9:3.2)
Cumulative effects:	Any water vole colonies affected by the works, either directly or indirectly, would be more vulnerable to cumulative effects resulting from other developments (or other impacts on water voles associated with the same development) in the short-term.
Beneficial effects:	Appropriate restoration of habitat can have a long-term beneficial effect and any such opportunities should be taken.
Mitigation:	1) Careful selection of location and timing of works to avoid/minimize impacts on water voles. 2) Create a 'receptor' site close to the affected area and enclose it with vole-resistant fencing. 3) Relocate water voles from affected area by trapping (displacement will not generally be appropriate over distances greater than 50m). In certain cases it may be necessary to translocate animals to a 'receptor' site some distance from the works, due to lack of availability of a suitable location closer to the development. 4) Undertake a destructive search of the affected area. 5) Carry out the works and reinstatement as soon as possible. 6) Allow relocated animals to recolonize the restored habitat. If it has been necessary to translocate animals some distance from the site, review the need to actively move animals back to the 'donor' site, dependent upon the likelihood of passive recolonization by animals within the surrounding area. 7) Monitor during the works and post-construction.

4. LARGE FOOTPRINT SCHEME RESULTING IN PERMANENT LOSS OF HABITAT

Typical works:	Culverting of watercourses for road widening or housing developments (see Box 9:H); construction of bridges for road schemes; permanent in-filling of small waterbodies.
Extent:	Footprint of works typically 50–500m length of habitat; Footprint of works affects up to 10 female territories, and potentially entire colonies of water voles; Habitat loss can be extensive.
Magnitude:	Direct impacts upon several individual animals under the footprint of the scheme during works, potentially including: • Major loss of habitat (the degree of impact will be dependent upon the quantity and quality of the affected habitat relative to that available to the colony); • Raised mortality risk of several individuals due to movement to new location, potentially resulting in the loss of the colony; • Mortality of several individuals during the works, potentially resulting in the loss of the colony. Potential for significant long-term fragmentation effects.
Duration:	Works can take several months or years to complete; Habitat loss and fragmentation effects are permanent.
Reversibility:	Works result in permanent loss of habitat.
Timing/frequency:	Unmitigated works will have a large impact upon occupied habitat irrespective of timing; Successful mitigation will, however, require careful consideration of timing (see Section 9:3.2).
Cumulative effects:	Any water vole colonies affected by the works, either directly or indirectly, would be more vulnerable to

cumulative effects resulting from other developments (or other impacts on water voles associated with the same development). The potential for cumulative effects would be relatively high.

Beneficial effects: Creation of compensation habitat (see mitigation below) would be required. This would have beneficial effects if it provides habitat of improved quality for water voles compared with that lost.

Mitigation: 1) Careful selection of location and timing of works to avoid/minimize impacts on water voles.
2) Create a 'receptor' site close to the affected area and enclose it with vole-resistant fencing.
3) Relocate water voles from affected area by trapping (displacement will not generally be appropriate over distances greater than 50m). In certain cases it may be necessary to translocate animals to a 'receptor' site some distance from the works, due to lack of availability of a suitable location closer to the development.
4) Undertake a destructive search of the affected area.
5) Carry out the works and provide compensation habitat (if not already created as a 'receptor' site).
6) Allow relocated animals to recolonize the compensation habitat. If it has been necessary to translocate animals some distance from the site, review the need to actively move animals into the compensation habitat, dependent upon the likelihood of passive recolonization by animals within the surrounding area.
7) Monitor during the works and post-construction.

5. MAJOR CONSTRUCTION WORKS RESULTING IN A RANGE OF IMPACT TYPES AND CHARACTERISTICS

Typical works: Improved infrastructure such as new motorways or rail-links; large scale development such as large housing estates, business parks/airports; new reservoirs constructed on existing water courses; open cast mining/mineral extractions/gravel pits; in-filling of large water-bodies; costal re-alignment (see Box 9:I).

Extent: Footprint of scheme affects more than a total of 500m of occupied habitat;
Works will affect one or many colonies of water voles;
Extensive loss of habitat;
Potentially severe effects of habitat fragmentation;
High likelihood of in-combination effects. For example, attempts to displace water voles from the footprint of one part of a scheme may result in water voles utilizing previously unoccupied habitat n another part of the scheme. It will be important to consider the mitigation strategy on a scheme-wide basis.

Magnitude: Direct impacts upon one or more colonies under the footprint of the scheme during works, potentially including:
• Major loss of habitat (the degree of impact will be dependent upon the quantity and quality of the affected habitat relative to that available to the colony);
• Raised mortality risk of many individuals due to movement to new location, potentially resulting in the loss of one or more colonies;
• Mortality of many individuals during the works, potentially resulting in the loss of one or more colonies.
Potential for highly significant long-term fragmentation effects.

Duration: Up to one or several years for works to be completed;
Habitat loss and fragmentation effects are permanent.

Reversibility: Works result in permanent habitat loss.

Timing/frequency: Unmitigated works will have a large impact upon occupied habitat irrespective of timing; Successful mitigation will, however, require careful consideration of timing (see Section 9:3.2).

Cumulative effects: Any water vole colonies affected by the works, either directly or indirectly, would be more vulnerable to cumulative effects resulting from other developments (or other impacts on water voles associated with the same development). In the majority of cases the potential for cumulative effects would be very high.

Beneficial effects: Creation of compensation habitat (see mitigation below) would be required. This would have beneficial effects if created to provide habitat of improved quality for water voles compared with that lost.

Mitigation: 1) Careful selection of location and timing of works to avoid/minimize impacts on water voles.
2) Create one or more 'receptor' sites close as close as possible to the affected area and enclose with vole-resistant fencing.
3) Relocate or translocate water voles from affected area by trapping (displacement will not generally be appropriate over distances greater than 50m or where there are such extensive works). It is also likely to be necessary to relocate water voles from areas not directly affected by the footprint of the scheme to minimize indirect effects and to improve the effectiveness of the mitigation, particularly

where works will take place in a phased manner in numerous locations. In certain cases it may be necessary to consider relocation or translocation of entire colonies or populations.
4) Undertake destructive searches of the affected areas.
5) Carry out the works and provide any additional compensation habitat required.
6) Allow relocated animals to recolonize any restored habitat. If it has been necessary to translocate animals some distance from the site, review the need to actively move animals back to the restored habitat or compensation habitat, dependent upon the likelihood of passive recolonization by animals within the surrounding area.
7) Monitor during the works and post-construction.

BOX 9:H BOX CULVERTS AND WATER VOLES

The act of culverting a watercourse may have an impact on both habitat and water vole population fragmentation. However, from a water vole point of view they do not seem provide a major problem to their movements or dispersal.

There are basic principles that should be observed – the more headroom above the water and the more light entering the culvert the better to encourage the through movement of water voles. Box culverts are better than pipe culverts in this respect and do not suffer from a diminishing air space as the watercourse floods.

Ledges within the culvert may be useful as these allow the upstream movement of animals at times of high flows (provided they are not submerged). One possible option is the construction of a ledge using stone filled gabion baskets that is then turved to encourage plant growth within the culvert tunnel.

Diameter of culvert may also be an important consideration – for instance where a standard design specification is for a diameter of 1400mm culvert, a 2000mm diameter of culvert with berm would be better for water voles.

The total length of culvert may present a problem to water voles in their daily movements and/or dispersal movements. For instance, an 18m culvert under a standard B-road carriageway is unlikely to prohibit the connectivity of habitat for voles. The typical home range for a vole is about 50m linear length.

Where there is a new road construction that crosses a watercourse(s) that harbour water voles, a mitigation procedure will need to be put in place. If water voles are occupying burrows within the road footprint they will need to be displaced (through exclusion or capture) prior to any construction works. Timing of works is paramount to the success of this action. The animals are best displaced in March and April before they breed on the site. Each site should be treated under its own merits and have a specific plan agreed before works commence.

If the site tends to flood more as a result of culvert construction it may cause the voles to vacate the watercourse – at least in the short term. To allow for such an event it may be possible to construct suitable high banks to part of the watercourse to act as a refugia for water voles at time of flooding as adequate mitigation.

BOX 9:I COSTAL RE-ALIGNMENT AND

Coastal re-alignment, also known as "managed retreat" is a mechanism where the coastal sea defences are set back and the eroding energy of the sea dissipated across the new intertidal zone. This usually requires the loss of previously farmed low-lying coastal land in favour of recreating intertidal habitat such as saltmarsh, mudflat and creek. The new embankments of the sea defences are constructed to accommodate the predicted sea level rise within the next 100 years and may be set back hundreds of metres from their existing location.

In the first instance, such a scheme would require detailed surveys of all watercourses and ditches that may be affected by coastal re-alignment (water voles are known to be tolerant of saline conditions provided that the water levels do not fluctuate too drastically. Borrow ditches behind sea wall coastal defences provide ideal habitat for the species especially when fringed with emergent plants (common reed and sea club rush). Once surveyed an assessment of the ecological impacts can be made.

Water voles are reasonably mobile animals and can colonize sites rapidly from source populations nearby, even if surveys find no evidence on site. In light of this, using the 'Precautionary Principle', it is strongly recommended that any mitigation works assume no net loss – that all available habitat for notable and protected species could be occupied. For water voles, this would mean ensuring that an equivalent length and quality of ditch habitat is created to that lost from the proposed sea wall re-alignment.

Proposals for tidal walls set-back have the potential to significantly impact the populations of water voles that live within the area seaward of the proposed new walls. There may be a need to move these voles to alternative habitat within the remaining freshwater grazing marsh of the site (behind the new sea wall defences).

If alternative sites for water voles already exist on site, they must be unoccupied in order to be effective receptor sites. However, such sites may be unoccupied because some environmental or predation constraint exists. Unless these constraints are identified and eliminated, these sites will not


Andrew Parkinson

WATER VOLES

be appropriate receptor sites. Existing watercourses within the site may be enhanced to provide better habitat for water voles. If this 'enhancement' involves excavation and re-profiling of the watercourses, then the ecological impacts of this operation also need to be assessed.

Any proposed newly-created waterbodies will need time to mature ecologically before they are suitable for water voles. At least one year's vegetation growth may be necessary before translocation to the new habitats can take place. Whilst these areas are 'maturing', they may become occupied by other water voles from nearby ditches, thus reducing their suitability as receptor sites. Water vole secure fencing should be installed and maintained until the translocated voles have been released into the new ditch habitats.

Timing of works is a critical issue. The ideal scenario would be to create new ditches in the receptor areas in winter/early spring and allow them to vegetate over the course of the spring/summer growing season. During this time, the new ditches would need some method of preventing in-migration by nearby water vole populations. Trapping and translocation from the impacted area could then take place in the following spring.

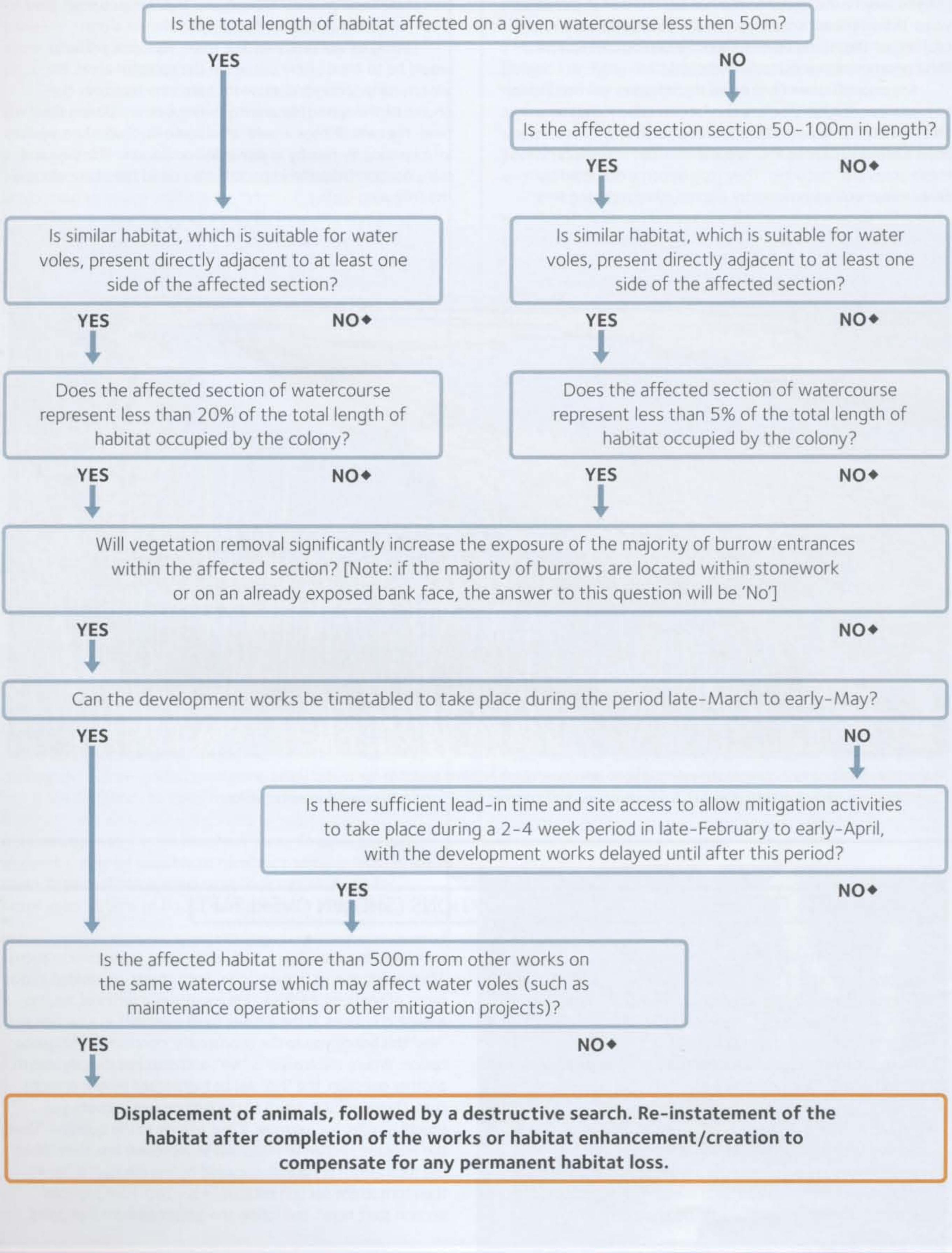
Managed re-alignment can create saline lagoon and new ditch habitat suitable for water voles. Common reed, sea club rush and salt tolerant grasses all provide ideal food and cover for water voles.

FLOW CHARTS FOR SELECTING MITIGATION OPTIONS (SHOWN OVERLEAF)

These flow charts are intended to guide the reader to the mitigation option(s) that are likely to be appropriate for a given situation: the full details concerning the suitability of, and methods for, each option are listed in Section 9:3.2. It is important to realize that many developments will have more than one type of impact and therefore will require a number of different mitigation options to be used consecutively or in tandem. The final course of action must be decided after taking into account all of the details listed under the description of each mitigation option in Section 9:3.2.

The first chart (Chart A) is a general guide to the most appropriate mitigation option(s) available. The second (Chart B) is relevant only when it has been determined that a translocation is necessary, and outlines the main considerations when conducting a translocation. Both charts are divided into a series of sections. Each section comprises a series of Yes/No answer questions. If the answer to all questions in a section is "Yes" this brings you to the appropriate, concluding, mitigation option. Where the answer is "No", and does not directly lead to another question, the "No" will be highlighted by one or more dots; these indicate which of the subsequent sections you should turn to. For example, if the answer to the question "Does the affected section of watercourse represent less than 5% of the total length of habitat occupied by the colony?" is "No◆", then turn to the section entitled "◆8 x 'No's from previous section start here", and follow the questions from that point.

CHART A FLOWCHART TO ALLOW DETERMINATION OF THE MOST APPROPRIATE MITIGATION OPTION



◆ 8 X 'NO'S FROM PREVIOUS SECTION START HERE

Is there a site available, which contains sufficient suitable habitat to accommodate the water voles present within the affected section, is currently unoccupied by water voles, and is located within 250-500m of the works? [Note: the reason for the absence of water voles needs to be considered in determining whether or not the site was suitable for water voles]

YES ↓ (to lead-in time question)

NO ↓

Can a suitable site, of an appropriate size, be created within 250-500m of the affected section, and sufficiently far in advance of works taking place to allow it to be used as a receptor site? [Note: such sites would need to be created sufficiently far in advance to ensure that vegetation is mature and well-established and therefore able to support water voles]

YES ↓

NO◆◆

Is there sufficient lead-in time and site access to allow mitigation activities to take place during a 2-4 week period in late-March to early-June, with the development works delayed until after this period?

YES ↓

NO◆◆◆

Relocation of animals by trapping and soft-release into the receptor site, followed by a destructive search of the affected habitat; habitat re-instatement (for temporary works) or habitat enhancement / creation as compensation for any permanently lost habitat (if new habitat is created to act as a receptor site, this may provide a proportion of the compensation habitat required). Vole-resistant fencing is likely to be required.

◆◆ 1 X 'NO' FROM PREVIOUS SECTION START HERE

Can the works be programmed to take place after a 2-4 week trapping period in late-March to early-June?

YES ↓

NO◆◆◆

Identify or create a suitable off-site receptor site (see Translocation Considerations flowchart). Translocation of animals by trapping and soft-release into the receptor site, followed by a destructive search of the affected habitat; habitat re-instatement (for temporary works) or habitat enhancement / creation as compensation for any permanently lost habitat (if new habitat is created to act as a receptor site, this may provide a proportion of the compensation habitat required). Vole-resistant fencing is likely to be required.

◆◆◆ 2 X 'NO'S FROM PREVIOUS SECTIONS START HERE

There is no obvious mitigation solution. Re-consider programme and design options. A combination of different mitigation solutions may offer a possible approach. Consult relevant SNCO for further advice.

CHART B FLOWCHART DESCRIBING CONSIDERATIONS WHEN TRANSLOCATION IS NECESSARY

[Note: check mitigation strategy truly necessitates moving water voles to an off-site location]
Is off-site compensation habitat available which is of a sufficient size and habitat quality to support all of the translocated individuals and allow for population expansion?

YES ↓ NO◆

Are water voles completely absent from the compensation habitat and likely to remain absent until translocation can occur? [note: for compensation habitat which is close to an existing population of water voles, it is possible that the compensation habitat will be colonised - and therefore become unsuitable for translocation - before translocation can occur. This can be avoided by vole resistant fencing, if appropriate.]

YES ↓ NO◆

Have the reasons why the site is unoccupied by water voles been ascertained and remedied?
[note: this is likely to require some habitat restoration and / or mink control in most cases]

YES ↓ NO◆◆

Is there a management plan for the site, suitable for maintaining a water vole population in the long-term?
[i.e. mink control measures, any necessary livestock management, bankside cutting regimen.]

YES ↓ NO◆◆

Translocation of animals by trapping and soft-release into the receptor site, accompanied by a suitable monitoring and feedback programme.

◆ 2 X 'NO' FROM PREVIOUS SECTION START HERE

Can suitable, unoccupied off-site compensation habitat be created within a reasonable time-frame?

YES ↓ NO ↓

Can work programme be altered to accommodate sufficient lead-in time for creation of suitable habitat?

NO◆◆

Is there a management plan for the site, suitable for maintaining a water vole population in the long-term?
[e.g. mink control measures, any necessary livestock management, bankside cutting regimen.]

YES ↓ NO◆◆

Translocation of animals by trapping and soft-release into the receptor site, accompanied by a suitable monitoring and feedback programme.

◆◆ 4 X 'NO' FROM PREVIOUS SECTION START HERE

Translocation should not be attempted until these factors have been considered and rectified. Where there is insufficient lead-in time for habitat creation, there is no obvious mitigation solution. Re-consider programme and design options. A combination of different mitigation solutions may offer a possible approach. Consult relevant SNCO for further advice.

Andrew Harrington

CAPTIVE BREEDING AND REINTRODUCTIONS

1 REINTRODUCING WATER VOLES

In many areas the degree of fragmentation of the national populations of water voles has become such that although good quality water vole habitat may exist, it is likely to remain unoccupied simply because it is too far from an existing population to be recolonized by natural dispersal. Restoring water voles to the wider countryside in these cases is likely to require reintroduction of individuals from captive bred populations. Reintroductions may potentially have great benefits in recolonizing an area with water voles if conducted in a systematic fashion with large-scale mink control.

Reintroduction is not an easy option, and success is by no means guaranteed. In areas where some populations of water voles still remain, a far more effective, less expensive and less complicated conservation strategy is to preserve the remaining populations via an integrated mink-control and habitat enhancement programme, to encourage existing populations and recolonization of empty habitat (see Chichester Coastal Plain case study, chapter 5). For this reason reintroduction is only appropriate in areas where natural recolonization is extremely unlikely.

In this chapter we consider only reintroduction of captive-bred, not translocated individuals. Although for many species it is possible to translocate individuals from wild populations for the purposes of conservation reintroduction (IUCN, 1998), the scarcity of sufficiently robust wild populations of water voles, and the ease with which they breed in captivity mean that this is not recommended for water voles. Nevertheless, if a translocation is deemed necessary as part of a mitigation strategy, much of the advice in this chapter will also be relevant and should be considered, particularly if animals are to be held in captivity mid-translocation.

Andrew Parkinson

2 SITE PREPARATION FOR REINTRODUCTION

The success or failure of a reintroduction is most likely to depend on the conditions at the receptor site, how many animals are released and the standards of husbandry pre-release.

It is inappropriate to consider reintroduction until the causes of the decline of water voles at the release site have been both understood and remedied. The principal concern is summarised by the question 'Why is the habitat currently unoccupied?' For water voles, this is usually because the habitat itself is unsuitable or due to the presence of American mink. Reintroduction of water vole will always, therefore, require setting up adequate, permanent mink control, and usually some habitat restoration before any release. To neglect this risks the re-established population quickly being lost under easily preventable circumstances. Sufficient time should therefore be allocated prior to any reintroduction to ensure habitat restoration and / or mink control has been satisfactorily undertaken prior to water voles being released.

Balmford *et al* (1996) state that "by far the strongest determinant of reintroduction success is the availability of suitable habitat", and Griffith et al (1989) that "without high habitat quality, [reintroductions] have low chances of success regardless of how many organisms are released or how well that are prepared for the release". It is essential, therefore, that the habitat is correct both in terms of quality and quantity.

Almost inevitably, reintroduced / translocated populations start small, but the released population should be as large as possible. Similarly, large release cohorts are likely to retain more of their original genetic diversity than do smaller cohorts. Higher levels of genetic variation in a population could influence its ability to adapt to new environmental conditions. It is therefore important that the release cohort is of a sufficiently large size and is able to breed quickly enough to a) minimise the period during which it is vulnerable due to small population size and; b) to retain as much genetic diversity as possible.

The above points are summarised in the (by no means exhaustive) list of questions in Box 10: A which should be addressed before release during any reintroduction project. Failure to satisfactorily answer any of these questions should call into doubt the validity of the proposed reintroduction. Only when the habitat quality, habitat quantity, surveys of the surrounding area, release cohort size, health screening, mink control and monitoring have been accounted for should the reintroduction proceed, following the good practice guidelines in Section 10.4.

BOX 10:A CONSIDERATIONS BEFORE REINTRODUCING WATER VOLES

- Why is there no population present at the receptor site already?
  - Are there historical records of water voles being present at this site? If so, why are they no longer present? If not does this suggest that the site is unsuitable?
  - Is the habitat of a suitable quality to support a population of water voles?
- Are management practices at the release site sufficient to ensure the long-term viability of the population?
- Is sufficient habitat available to support a viable population? This will generally require at least a 1.6-2km length of good quality habitat.
- Will habitat need to be restored or created?
- Are sufficient animals available for release in order to be reasonably assured of 'success'?
- Is there a population of water voles within dispersal distance (or within 3km) of the release site? If so, could the objectives of the reintroduction be better achieved by natural recolonization couples with habitat restoration and mink control?
- Has the release population been health screened to prevent:
  - Disease in the released population, potentially brought on by release stress?
  - Spread of disease to other species / other populations of water voles?
- Is the site management, including ongoing mink control, sufficient to guarantee the survival of the released population in the long term?
- Are the resources available for the necessary post-release monitoring and reporting?
- Have the IUCN guidelines on reintroduction been followed? (*http://www.iucnsscrsg.org/policy_guidelines.php*)

3 CAPTIVE BREEDING

Captive breeding of water voles for reintroduction is best achieved by dedicated institutions which are able to comply with the husbandry, record-keeping and health monitoring requirements of a captive breeding programme. Considerations for captive breeding programmes are as follows.

3.1 SOURCING ANIMALS AND STUDBOOK

Individuals for captive breeding should not be directly captured from wild populations, unless as part of a last resort mitigation exercise which has been deemed necessary by an appropriate SNCO (See Chapter 9 for mitigation details). Accurate records of the genetic origin / geographical location of capture of each individual, and their descendants need to be maintained in a studbook. In general, genetic lines should be kept separate for release into their original geographical area unless there is no alternative. Cross breeding between different stocks may be appropriate if they derive from similar areas, but it is likely that a large geographical distance between sources will equate to genetic dissimilarities, and water voles from very different locations should not be interbred. In particular voles from upland habitats and voles from lowland habitats should never be interbred, due to evidence that they are of different genetic provenance. Animals should be sourced from organisations that are members of the Zoo Federation.

3.2 HUSBANDRY CONSIDERATIONS

Water voles should not be housed in communal pens, since this will lead to violent conflicts and injuries. Water voles need housing in large, separate outdoor enclosures, containing one individual each (unless the additional occupants are a females' offspring). For breeding purposes, one individual of each sex should be introduced to a new breeding outdoor pen simultaneously to avoid issues of territoriality.

Water voles should only be housed in lab cages if:

- They are individually-housed wild voles awaiting release back to the wild or pairing up for captive-breeding within one month;
- They are individually-housed captive-bred voles awaiting release within one month;
- They are being transported or held temporarily for short periods of time;
- They are recovering, injured individuals.

If water voles have to be maintained in lab cages, the time spent in cages should be kept to a minimum and strict husbandry best practice adhered to. Water voles require:

- Cleaning out at least once weekly;
- Half an apple to be fed daily;
- A handful of rabbit food daily;
- Weighing once weekly (combined with cage cleaning to reduce interference which might induce stress) to monitor condition loss / gain;
- Access to fresh water bottles;
- Access to wood for chewing, especially if animals are showing stereotypical 'bar-chewing' behaviours when in lab cages.

Water voles can be easily bred in outside enclosures almost to a farm scale. The cages are constructed so that the animals do not burrow out and provisioned with a hay bale in which to create nests. Fresh water and food is provisioned daily and weaned littermates can be caught for reintroduction projects.

Water voles in outside pens require access to a large container of water for both swimming and drinking, and plenty of food. Both need changing on a daily basis. A rough platform placed beside the water (either wood, bricks or stones) will be used as a latrine, and may therefore improve the voles' captive experience. When handling animals for cleaning or any other purpose, it is occasionally convenient to grip them by the base of the tail. If this is performed great care should be taken not to damage the tail; preferable handling techniques involve the use of a clean 'Pringles' tube or similar to reduce the need to handle the animal wherever possible.

Water voles should not be permanently housed in lab cages since recent work suggests that lab cage housing may compromise their welfare. Water voles kept in lab cages for any length of time may become stressed, dehydrated and lose weight. Nevertheless, lab cages remain the most practical means of transporting water voles, but both the number of individuals in each cage, and the length of time that they are housed in lab cages should be kept to a minimum. See case study: Overcrowding and captive water vole welfare.

3.3 RELEASE CONSIDERATIONS

When reintroducing animals it is highly desirable that the individuals are from stock that derives from the geographical area of the reintroduction. In particular, upland water voles should never be released into lowland sites and vice versa. Water voles must never be transferred between Scotland and England.

The optimal age for release of individuals is recently overwintered young adults, or young of breeding weights (e.g. over approximately 110g) which have matured in the year of release. Individuals that have overwintered twice are inappropriate for release. The length of time in captivity for any individual should be minimized. It is important, therefore, that captive breeding serves demand from planned reintroduction projects, rather than driving the need for reintroductions. Supply-driven reintroductions are likely to be hastily planned and have low chance of success. Animals bred to excess usually have either to be maintained in captivity or put-down.

3.4 HEALTH AND DISEASE ISSUES ARISING FROM CAPTIVE BREEDING AND RELEASE

Keeping a large number of animals requires adequate veterinary support, and routine monitoring of individual water voles' health. In previous editions of this handbook we have advised that health screening be conducted prior to release to identify any pathogens which could compromise the release stock or other wildlife surrounding the release site. The reasons for this were implicit; water voles, in common with all other wild animals, naturally harbour reservoirs of parasites and pathogens. Wild animals retained for captive breeding, or individuals born directly into captivity can also harbour parasites and pathogens. In both cases these diseases may not directly cause mortality but may persist at low levels within individuals in the captive population. The effects of the changes encountered during a translocation or reintroduction programme may have negative effects upon both the individuals released, and individuals of other species living in the same habitat. However, while it remains imperative that health is monitored closely in all captive water voles and veterinary advice sought if any concerns arise, research into parasites and pathogens harboured by both wild water voles, and captive bred water voles throughout a reintroduction, indicate that the likelihood of encountering a highly pathogenic disease is very small (see case study below). It is vital that the health of captive animals is routinely monitored, particularly prior to release, both to maintain welfare and to prevent the introduction of parasites and pathogens carried by the host animals into new areas. When maintained in captivity, housing for water voles should be of a high standard to ensure the best levels of health and welfare are maintained for each individual; involvement of organisations with a good reputation for captive water vole husbandry is recommended. Access to fresh water for both drinking and swimming (if possible) should be provided, along with a regular supply of fresh greens and dried food. Enclosures and bedding should be regularly cleaned (at least weekly) and fresh bedding supplied. However, we caution against cleaning out lab cages too frequently, as this could potentially compromise an individual's immune system, disturb olfactory cues associated with latrines and bedding, and cause interference with the animals, thereby inducing unnecessary stress.

Any animal behaving in an atypical manner or with an obvious ailment should be isolated, and veterinary assistance sought if deemed necessary.

Symptoms to be aware of include (amongst others):

- Being unresponsive to stimuli (noticeable during normal husbandry cleaning).
- Atypical wheezing without provocation (some animals wheeze when disturbed and upset).
- Pink bald patches around the eyes (indicative of mites).
- Sudden weight loss (individuals can be weighed regularly for monitoring purposes).
- Emaciation (possibly due to malocclusions, or over-grown teeth preventing proper eating). Provision of wood for chewing in enclosures can help to prevent this problem.
- Excessive ectoparasite burdens (noticeable during normal husbandry cleaning). Do remain mindful that some ectoparasite infection is normal in wild animals and should not be a cause for concern. However high infestations can be treated using veterinary preparations, under specific advice from a vet prior to application.

There are direct effects associates with releasing animals in poor health:

- Individuals already stressed by the release process may have a depressed immune system. Encountering novel pathogens which are present in the new environment but to which their immune system has little defence may result in direct mortality of individuals. Similarly, stress initiated by release into new environments may make individuals more susceptible to subclinical pathogens already present within the release population.
- Diseases present within the population of released animals may not already be present in the new environment, thereby posing a risk of a novel infection being passed to other species living in and around the release habitat.
- In cases where reintroductions or translocations occur within dispersal distance (e.g. 1km) of an existing population of water voles, there is the potential to transmit novel pathogens between the existing and introduced animals which may have a negative impact on both populations.
- Chronic diseases which do not cause immediate mortality of individuals may impose long-term effects, including reduced fecundity which may in turn influence the population by reducing breeding rates.

4 GOOD PRACTICE GUIDANCE FOR REINTRODUCTIONS

4.1 DEFINITIONS

Following the IUCN (*http://www.iucnsscrsg.org/policy_guidelines.php*), "Reintroduction" is an attempt to establish a species in an area which was once part of its historical range, but from which it has become extirpated or become extinct ("Re-establishment" is a synonym, but implies that the reintroduction has been successful). "Translocation" is the deliberate and mediated movement of wild individuals or populations from one part of their range to another. These guidelines are currently in the process of being revised to reflect findings of recent reintroduction science.

Reintroduction is a conservation measure for water voles, distinct from translocations which are a last-resort mitigation option. Reintroduction seeks to re-establish populations in areas which are unlikely to be recolonized by natural dispersal. Such reintroductions may contribute to reversing the national decline, but require careful planning and monitoring to be achieved successfully.

4.2 PRINCIPLES

1) Follow IUCN guidelines on translocations and reintroductions. See website (*http://www.iucnsscrsg.org/policy_guidelines.php*).

2) Never move water voles between England and Scotland as there is evidence that there are distinct genetic differences between these populations. Animals for reintroductions should be of local provenance if possible, and translocated individuals should be moved as short a distance as possible. Animals should be sourced within 50 kilometres of the receptor site in both cases.

3) The principal aim of any reintroduction should be to establish a viable, self-sustaining population in the wild. It is likely that population sizes in excess of 100 individuals at peak breeding season (30-50 individuals at the beginning of the breeding season) occupying an approximately 1.5-2kn length of good quality habitat (see Section 3:2.5) will be viable, and this should be regarded as a minimum requirement. Sizes of non-isolated populations may be lower, since local extinctions can be balanced by recolonization.

4) Generally, a 40-50m length of good-quality habitat should be sufficient to accommodate one adult male and one adult female during peak breeding season. Ideally sufficient animals should be released for one male and one female per 50m of release habitat. For a 1.5km stretch of suitable habitat, therefore this would indicate 30 males and 30 females would be required. Current evidence suggests that no fewer than 44 individuals should be considered for release and into no less than 1.5km of habitat, unless further habitat patches are available within easy dispersal distance: 0.5-1km maximum separation. Release pens containing females should not be positioned closer than 40m apart.

5) Habitat in receptor sites should have a minimum width of 2m per side of the water course (therefore 4m total width for each meter of bank length). This should comprise at least 1m but preferably 2m or more, of riparian vegetation with high percentage cover growing from the bank itself, and the rest of the width comprising emergent vegetation such as water cress (*Rorippa nasturtium-aquaticum*), reed canary grass (*Phalaris arundinacea*) or reed sweet grass (*Glyceria maxima*) with a high percentage cover. Ideally both bank and emergent vegetation should be present, and ideally at greater than the 2m minimum width.

6) The reintroduced population must be protected against mink predation, either by providing large (20ha) reed-beds, or by instituting a permanent programme of mink control, or both. Such mink monitoring and control should take place from September to April. In the lowlands, monitoring and control of mink is best managed via the Game and Wildlife Conservation Trust mink raft technique; (See Chapter 7).

7) All reintroductions should be monitored to gauge how successful they have been (See Section 9:3.3 'Monitoring') and such monitoring should feed-back to not only the current project, but also to future projects. The reasons for any failure must be addressed before any further reintroductions can be permitted.

4.3 PREPARATION

1) Carry out detailed surveys of latrines, feeding signs and burrows to demonstrate that water voles are not present on the receptor site. Brief sign surveys should record presence and absence of water voles in all habitat within a 2km radius of the site, in order to establish the context of the receptor site. Reintroductions should not take place into occupied habitat.

Release pens are sited at 50m intervals to replicate typical territory sizes of individual voles. Voles are either released as single adults or in sibling groups.

2) Check for evidence of the historical occurrence of water voles in the area of the receptor site. If water voles were present, investigate why they no longer are. If it is because the habitat is of insufficient quantity or quality, habitat restoration will be required before any reintroduction or translocation.
3) Check whether mink are present on, or near, the receptor site. Mink monitoring and control are essential for any reintroduction or translocation attempt. Once established, mink monitoring and control should be performed on an annual basis between September and April.
4) Ensure any site management plans will take the presence of water voles into account and ensure continuity of the habitat. Site managers should consider the impact of the presence of water voles on their ability to manage the site.

4.4 RELEASE METHODS AND POST-RELEASE MONITORING

1) Releases should take place no earlier than early April, to ensure that there is sufficient cover, and no later than mid-June, to allow sufficient time for the population to increase in numbers before the overwinter period (late September to late March).
2) Water voles should be released using release pens with a minimum floor area of 1m^2, approximately 50-75cm in height. Each pen should house only one individual (if adults, although family groups may be released together), and individuals of the same sex should be separated by at least 40m intervals along the waterway (two pens, one male, one female, per 40m length). See Box 9:E for full information on release pen construction.
3) Post-release monitoring is essential and should take the form of a full sign survey one month after the release cohort have been placed in the pens, followed by survey before and immediately after the overwinter period (in late September and early April). Survey should initially seek to establish whether the voles have escaped the pens and established on-site. Thereafter survey should establish:

a) Whether the site is occupied;
b) How many kilometres of water course are occupied;
c) Whether the signs indicate that a high population density has established.

The results should be assessed against pre-defined criteria for success (see Section 9:3.3 'Monitoring'). Any failures to meet the criteria require rectifying. After the first year, monitoring should take place on an annual basis for a minimum of five years.
4) Mink monitoring and control, and habitat management for water voles should continue as part of the wider site management following release.

CASE STUDY OVERCROWDING AND CAPTIVE WATER VOLE WELFARE

Water voles captive bred for reintroduction purposes are often housed under conditions which are not representative of their preferred social structure. Given that an average water vole territory is a 50 m stretch of linear habitat, and that in general individuals are solitary, it would be very difficult to re-create these conditions in a captive environment. Nevertheless, the degree of stress encountered by individuals may negatively impact upon an individual's immunocompetence. Therefore optimising the housing set-up wherever possible is vitally important to help ensure healthy voles, and a successful introduction.

In a recent study, the amount of physiological stress encountered by captive-bred water voles housed at different densities - whilst in transit from their captive-breeding establishment - was investigated by measuring *in vitro* their ability to combat an immunological challenge using a technique called the Leucocyte Coping Capacity.

The voles studied had been bred in outside pens the previous summer, and overwintered in family groups. Prior to the planned reintroduction date in May 2007, the animals were captured from their outside pens and split into same-sibling groups in laboratory cages, of the same types as routinely used throughout the country to transport water voles between locations. The voles had been housed in these cages for one week prior to transportation to Oxford for health monitoring and reintroduction.

Results from this study indicated that those individuals which were housed at lower densities (down to the ideal individual housing) were more able to combat a bacteriological challenge. Those water voles housed in larger groups were more stressed than water voles housed in cages containing fewer animals. Chronic stress is known adversely to affect growth rates and general health. Therefore routinely transporting water voles in smaller groups, or preferably individually - where possible - even if only for short periods of time, is highly recommended.

Some final considerations when deciding upon an optimum housing strategy are that wild water voles which are trapped for the purposes of translocation should always be housed separately as it is impossible to know the relationship between two individuals trapped in different traps, and it is likely that fighting will occur if they are housed together. In addition, captive-bred animals which have been separated are unlikely to be successfully re-housed in groups without fighting occurring. Therefore once they have been separated, water voles must remain that way whilst in captivity.

For further information, please see Gelling, M., Montes, I., Moorhouse, T. P. & Macdonald, D. W. 2010. Captive housing during water vole (Arvicola terrestris) reintroduction: Does short-term social stress impact on animal welfare? PLoS ONE 5(3): e9791. doi:10.1371/journal.pone.0009791.

CASE STUDY PARASITES AND PATHOGENS IN WATER VOLES

Both wild-caught and captive-bred water voles have been screened for a number of parasites and pathogens to investigate which were of most relevance to the species. A number of common environmental parasites and pathogens were identified, including *Leptospira, Cryptosporidium, Giardia,* and *Toxoplasma.* There were no findings to suggest that water voles harbour unusual pathogens or diseases which might compromise their ability to survive. As a direct result of these findings we recommend that vigilance is used in respect of monitoring water voles which are either captive bred, or are held in captivity for any reason, rather than specific health screening. When following best practice, individuals originating from different sites should be kept separately to preclude cross-transmission of pathogens from different areas to individuals which may not have a natural immunity.

Water voles have now been confirmed as reservoirs for *Leptospira*, the pathogen which gives rise to Weil's disease in humans and which, in extreme cases and if left undiagnosed, can be fatal. The potential risk to humans of contracting leptospirosis or Weil's disease from infected water voles should always be considered when developing survey, trapping or handling protocols. Nevertheless, it is important that this consideration is not disproportionate as this confirmation that water voles are a host for leptospirosis does not worsen the long-established recognition that people working near water are at risk of contracting Weil's disease. Simple precautions, including wearing gloves while handling voles or equipment, covering cuts and abrasions and ensuring hands are thoroughly washed afterwards, should be followed by anyone working near water. These precautions will help prevent the transmission of not only leptospirosis, but also other environmental pathogens.

For further information see Gelling, M., Macdonald, D.W., Telfer, S., Jones, T., Bown, K., Birtles, R. and Mathews, F. (in press). Parasites and pathogens in wild populations of water voles (Arvicola amphibius) in the UK. European Journal of Wildlife Research. DOI: 10.1007/s10344-011-0584-0

CASE STUDY WATER VOLE RESTORATION IN THE UPPER THAMES

Between 2005 and 2007, twelve discrete populations of water voles were reintroduced to sites in the Upper Thames catchment area experimentally, in a bid to establish the optimum width of riparian habitat (perpendicular to the watercourse) which was required for water voles successfully to establish themselves.

Prior to each reintroduction, mink control was implemented in conjunction with local landowners for a minimum of 4 km either side of the release site, and along any tributaries within these areas. Each 800 m release site was prepared by constructing 20-22 soft-release pens on site in advance of the reintroduction occurring, spaced at 40m intervals. These open-floored predator-proof pens were dug into river banks at each site, and covered with chicken mesh. On the day of release, each pen was provisioned with some straw for shelter, sufficient food for several days (apples, carrots and dried food), and a water bowl. The design of these pens allowed the water voles to acclimatise to the release location, create a burrow system in the pen and eventually burrow their way to freedom. As the released animals explored the site, they were still able to return to a pre-constructed, familiar burrow system.

In total, 532 water voles were released, with 44 or 45 individuals per site. Most individuals burrowed out of their pens within three days. This research was conducted by the Wildlife Conservation Research Unit as part of an ongoing programme of research into water vole conservation.

WATER VOLE FATES

STAGE OF REINTRODUCTION	END OF MONTH	NUMBER OF EXTANT POPULATIONS	REASON FOR LOSS OF POPULATION(S)
Initial release	May	12	/
Establishment	June	9	Flooding post release (1) Failure of mink control (2)
Survival to end of breeding season	October	8	Failure of mink control (1)
Successful overwintering of population	April	7	Failure of mink control (1)

From Moorhouse, T. P., Gelling, M. & Macdonald, D. W. 2009. Effects of habitat quality upon reintroduction success in water voles: Evidence from a replicated experiment. Biological Conservation 142: 53-60.

POPULATION ESTABLISHMENT, SURVIVAL AND DENSITY

Each reintroduced individual was marked with a passive integrated transponder (PIT tag) prior to release for subsequent capture-mark-recapture monitoring, and all juveniles subsequently captured during monitoring sessions were also PIT-tagged on their first capture for monitoring purposes. Vegetation abundance on site was measured during each monitoring session.

At the nine sites where populations initially established successfully, monitoring suggested that females had a 57% and males a 40% probability of recapture post-release, the difference in figures likely to be attributable to males having larger range-sizes than females in wild populations, and therefore potentially being more susceptible to predation. There was a clear effect of vegetation abundance influencing the probability of recapturing water voles from the release cohort and the survival rates and population densities of the established populations: the greater the width of riparian vegetation bordering the water course (up to 6m in the experiment), the greater the survival rates and densities of the resulting populations.

At sites which had relatively thin margins (1-3m) of riparian vegetation both males and females initially ranged significantly further from their point of release that at those sites with higher initial recapture rates. This suggests that water voles reintroduced into poorer quality habitat ranged further in a bid to find a better quality home range, and were therefore more likely to experience early mortality than those in better habitats which stayed closer to their release points. Whilst it is not possible to establish cause and effect between habitat quality, post-release ranging and survival from the data, these results suggest that voles reintroduced into better quality habitat initially had better survival rates.

CONCLUSIONS

The primary reason for failed reintroductions in this study was ineffective mink control; nonetheless, it has now been shown that water voles released into sites with a greater abundance of vegetation had a greater chance of long-term survival and thus population establishment. Both reintroductions and translocations have limited resources available, therefore it is vital that the release habitat chosen for water voles is the best obtainable, and that effective and ongoing mink control is implemented.

This project was deemed a success by establishing seven new populations of water voles and reversing their local decline within the Upper Thames area. It demonstrated that the quantity and quality of the habitat at the release site has a substantial impact on the resultant population density and survival rates, and therefore reintroduction success. On this basis we recommend that the width of habitat bordering the water course selected to host a reintroduced or translocated population should be maximised wherever possible (ideally six metres in width or more).

For further details please see: Moorhouse, T. P., Gelling, M. & Macdonald, D. W. 2009. Effects of habitat quality upon reintroduction success in water voles: Evidence from a replicated experiment. Biological Conservation 142: 53-60.

REVIEW OF THE UK BIODIVERSITY ACTION PLAN

1 REVIEW OF THE UK BAP

The UK BAP for the water vole helps coordinate and drive conservation work at national and local levels (187 Local BAPs include actions for the water vole) through identifying priorities for action and setting biological targets to aid the recovery of the species. The initial plan was drafted in 1995 and adopted by the UK Water Vole Steering Group in 1997. At that time, the goals of the Action Plan were to defend water voles where they still occurred in the United Kingdom, focussing on the need to create sanctuaries among core populations, provide the incentive to restore riparian habitat, reinstate them where possible in areas where they have been lost, create a mechanism for continued scientific monitoring of local populations, and raise the profile of the species and stimulate public interest.

The UK BAP targets were updated in 2006 to reflect new research, survey and monitoring information. These targets were:

T1: Maintain the current range (730 occupied 10km squares) of the water vole in the UK.

T2: Achieve an increase in range by 50 new occupied 10km squares in the UK by 2010.

The targets were based on the species' known distributional range (number of occupied 10km squares) rather than population size, which is very difficult to assess with any accuracy.

The Targets are scheduled to be reviewed every five years post 2006 and have been set for the UK and its component Countries of England, Scotland and Wales (there are no water voles in Northern Ireland) – see Table 11:1 below.

To achieve the targeted range expansion of the water vole, the continued delivery and implementation of local action on the ground is required. The network of LBAPs and Organization BAPs promote partnership working and targeted local action. This should directly benefit water vole populations through habitat enhancement schemes, species protection work and local mink control projects. Resources are limited but Regional and local forums can effectively develop local strategies to safeguard water vole populations and their habitat. The 'Water Vole Conservation Handbook: Third Edition' has been designed to set out best practice management advice and guidance based on sound science to underpin these strategies.

The 2008 review of the BAP targets (see *http://webarchive.nationalarchives.gov.uk/20110303145213/http://www.ukbap-reporting.org.uk/default.asp*) demonstrated that the majority of the 2010 targets had already been exceeded. This was largely, however, due to more extensive survey data being available. Nonetheless the review concluded that "...the signs are that, even if we discount the fact that there is a large amount of additional survey information available...the species is slowly expanding its range overall. This is due to concerted habitat creation, enhancement and management, in combination with sustained catchment-scale mink control which has led to localised range expansions. Continued fragmentation of populations is continuing due to mink predation, catastrophic flood events, etc, especially in South Wales, Northern England and Scotland, but at a national scale, the positive range expansions are now just about outweighing the declines."

This conclusion, while broadly positive, underlines the fact that threats to water voles are still ongoing and that further conservation action is required for the species.

TABLE 11:1 TARGETS FOR THE NUMBER OF 10KM SQUARES OCCUPIED BY WATER VOLES IN ENGLAND (E), SCOTLAND (S) AND WALES (W) FOR 2010 AND 2015 COMPARED TO THE 2005 BASELINE

TARGET UNITS	2005 BASELINE				2010 TARGET				2015 TARGET			
	UK	E	S	W	UK	E	S	W	UK	E	S	W
Number of occupied 10km squares	730	582	79	69	780	605	95	80	835	635	110	90

2 APPROPRIATE ACTIONS FOR SPECIES RECOVERY

There are a number of key actions that should be adopted in every local BAP that will halt the decline of the water vole and encourage its recovery.

Action 1: Ensure species protection and site safeguard in the local authority planning process
As a protected species the water vole should be recognized as a material consideration in the planning process. A preliminary to any planning decision will be the need for survey information on the presence of protected species such as the water vole. In addition to ensuring that surveys have been carried out, an appropriate assessment must be made of any adverse impact (see Chapter 2). Where mitigation is required best practice procedure is essential (see Chapter 9).

Action 2: Ensure species protection and site safeguard in the repair and maintenance of watercourses, canals, lakes, ponds and ditches
Appropriate habitat management should ensure no loss of banks for burrowing, nest sites and continuous vegetation cover for foraging (see Chapter 5).

Action 3: Establish a series of Key Areas for water voles
National, regional and local populations of water voles should be identified as containing a significant proportion of the overall population of water voles. This recognition will allow for the effective targeting of the limited conservation resources (see Chapter 6).

Action 4: Encourage existing water vole populations to recover and expand
Habitat restoration and enhancement schemes should be coupled to mink control and targeted to existing water vole populations. This will only be effective if delivered at the appropriate landscape scale such as river catchments, coastal plains and upland areas across watersheds. A targeted approach to the allocation of Agri-environment scheme funding would restore habitat within and between neighbouring farmland (see Chapters 5 and 7).

Action 5: Ensure the management of rats and other pest species does not affect water voles
Best practice guidance should be carried out during pest control operations to avoid the accidental trapping or poisoning of water voles (see Chapter 8).

CASE STUDY THE NATIONAL WATER VOLE DATABASE AND MAPPING PROJECT

The National Water Vole Database and Mapping Project was established in 2008. The project is managed by The Wildlife Trusts and delivered by a Water Vole Information Officer based at the Hampshire and Isle of Wight Wildlife Trust. Funding for the work has been provided by the Environment Agency, People's Trust for Endangered Species, Royal Society of Wildlife Trusts and Scottish Natural Heritage. The project aims to collate and map water vole and American mink data to assist with species monitoring and the development of conservation priorities.

Alert and Key Area maps have been produced to identify areas known to support water vole populations and to suggest where some of the more robust populations are to be found. This mapping work aims to complement the outputs of the National Key Sites Project, which developed from a study by Bright and Carter (2000).

The methodology for producing alert maps is based on work undertaken by the Berkshire Buckinghamshire and Oxfordshire Wildlife Trust, summarised in Box 6:A. Mapping is produced by buffering water vole records to capture some of the potential surrounding habitat and areas within average water vole dispersal distance. A figure of 0.5m (measured from occupied watercourses) is used to capture some of the surrounding habitat and a figure of 2km, as measured from water vole records, is used to capture dispersal distance.

Local Key Areas are identified by selecting areas of 6 km^2 and over from the alert maps. These areas are important for maintaining the sustainability of local water vole populations, Regional Key Areas are identified by selecting areas of 35 km^2 and over. Selection of areas of this size and over could help identify those places where water vole populations are more likely to survive the impacts of stochastic events and more likely to persist for more than 40 years.

The mapping produced to date is intended as a tool to assist water vole conservation in the future. Identification of local and regional key areas using the methodology described above does not confer any statutory or non-statutory designation and further work is now needed to refine methods and explore the potential for producing time series and coincidence mapping. There is also the potential for using the data to develop landscape scale working to benefit the species and to prioritise areas where investment in mink control is likely to be most cost effective.

Further information and a copy of the guide to the project outputs can be obtained from The Wildlife Trusts (enquiry@wildlifetrusts.org).

Regional Key Water Vole alert areas. England Scotland and Wales (2004 – 2008).
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Andrew Harrington

FURTHER ADVICE AND SUPPORT

UK WATER VOLE STEERING GROUP ORGANIZATIONS

LEAD AGENCY: ENVIRONMENT AGENCY (EA)
National Customer Contact Centre
PO Box 544
Rotherham S60 1BY
General enquiries - Tel: 08708 506 506
Email: enquiries@environment-agency.gov.uk

SCOTTISH ENVIRONMENT PROTECTION AGENCY (SEPA)
Irskine Court
Castle Business Park
Stirling SK9 4TR
Tel: 01786 457 700

STATUTORY NATURE CONSERVATION ORGANIZATIONS (SNCOS)

FOR ENGLAND: NATURAL ENGLAND
Head Office
Foundry House
3 Millsands
Riverside Exchange
Sheffield S3 8NH
Tel: 0845 600 3078
Email: enquiries@naturalengland.org.uk

FOR SCOTLAND: SCOTTISH NATURAL HERITAGE (SNH)
Head Office
Great Glen House
Leachkin Road
Inverness IV3 8NW
Tel: 01463 725 000
Email: enquiries@snh.gov.uk

FOR WALES: COUNTRYSIDE COUNCIL FOR WALES (CCW)
The CCW office team
C/O Enquiries
CCW
Maes-y-Ffynnon
Penrhosgarnedd
Bangor
Gwynedd LL57 2DW
Tel: 0845 130 6229
Email: Enquiries@ccw.gov.uk

NON GOVERNMENT ORGANIZATIONS

THE WILDLIFE TRUSTS
The Kiln
Waterside
Mather Road
Newark
Nottinghamshire NG24 1WT
Tel: 01636 677 711
Email: enquiry@wildlifetrusts.org

PEOPLE'S TRUST FOR ENDANGERED SPECIES
15 Cloisters House
8 Battersea Park Road
London SW8 4BG
Tel: 020 7498 4533
Email: enquiries@ptes.org

OTHER ORGANIZATIONS

BRITISH WATERWAYS (BW)
64 Clarendon Road
Watford
Hertforshire WD17 1DA
Tel: 01923 201 120
Email: enquiries.hq@britishwaterways.co.uk

APPENDIX 1: HEALTH AND SAFETY

PREVENTION OF LEPTOSPIROSIS

Incidences of Leptospirosis in the UK (also known as Weils Disease) are very rare, but can be caught by fieldworkers from contaminated water systems or possibly handling water voles and rats or their faeces (although normally occurring in urine).

Mild infection leads to a flu-like illness but in more severe cases infection can cause damage to the liver and kidney failure, and may even prove fatal.

PREVENTION

- Always wear waterproof footwear and gloves when in contact with potentially contaminated water, soil or animal droppings.
- Make sure any broken skin or cuts are covered with waterproof plasters.
- Ensure water is not ingested and avoid splashing eyes or nose.
- Always wash your hands and forearms with anti-septic/anti-bacterial soap, particularly before eating, drinking or smoking. Do not bite your nails or rub your eyes before washing.
- Avoid contact with rat or water vole urine.

DIAGNOSIS AND TREATMENT

Flu-like symptoms including high temperature and muscle pain occur within 3–19 days of being exposed to the bacteria. In a few cases conjunctivitis and jaundice may also occur.

If you suffer from any of the above symptoms and have possibly been exposed to Weils disease contact your doctor immediately. Ask for an ELISA blood test to check for the presence of the disease. Early diagnosis and treatment are vital for recovery.

> From your doctor obtain a copy of the HSE leaflet **'LEPTOSPIROSIS – ARE YOU AT RISK?'** (INDG84) and keep it with you for reference (also free from the HSE offices).

APPENDIX 2: LIST OF SUPPLIERS

Suggested suppliers: this list represents suppliers of which we have experience and does not in any way represent an exhaustive list of suitable suppliers for a given commodity.

WATER VOLE TRAPS:
H.B. SHERMAN TRAPS
3731 Peddie Drive
Tallahassee, FL. 32303
USA
Tel: 850 575 8727
Fax: 850 575 4864
Website: http://www.shermantraps.com/

WE RECOMMEND THE XLF15 TRAPS.

MINK TRAPS:
RHEMO PRODUCTS LTD
Unit 26, Wick 2 Industrial Estate
Gore Road
New Milton
Hampshire BH25 6TJ
Tel: 01425 621 283
Fax: 01425 619 860

WE RECOMMEND THAT ANY MINK TRAPS ORDERED SHOULD INCLUDE OTTER-GUARDS TO PREVENT TRAPPING OF NON-TARGET SPECIES.

TAGGING:
(A) IDENTICHIP TAGS:
ANIMALCARE LTD
Common Road
Dunnington
York, YO19 5RU
Tel: 01904 487687
Fax: 01904 487611
Email: office@animalcare.co.uk
Website: http://www.animalcare.co.uk/ident.html

(B) TROVAN TAGS:
MID FINGERPRINT
PO Box 4505
Weymouth
Dorset, DT3 6YH
Tel: 01279 757943
Fax: 01279 501434
Website: http://www.midfingerprint.com/

RADIO-TAGS:
BIOTRACK LTD
52 Furzebrook Road
Wareham
Dorset, BH20 5AX
United Kingdom
Tel: 01929 552 992
Fax: 01929 554 948
Email: info@biotrack.co.uk
Website: http://www.biotrack.co.uk/

N.B. PLEASE BE AWARE THAT RADIO-TRACKING MAY HAVE DETRIMENTAL CONSEQUENCES FOR THE POPULATIONS MONITORED

RADIO-TRACKING RECEIVERS:
COMMUNICATIONS SPECIALISTS, INC.
426 West Taft Ave.
Orange, California 92865
Tel: (800) 854 0547
Fax: (800) 850 0547
USA
Email: sales@com-spec.com

WE RECOMMEND THE R-1000 RECEIVER

MARINER RADAR LTD.
Bridleway, Campsheath
Lowestoft, Suffolk NR32 5DN
England
Tel: 01502 567 195
Fax: 01502 567 762

APPENDIX 3: SURVEY PROFORMA

Overleaf is a blank water vole survey proforma for copying freely for use in the field. An example of a completed form, for guidance, can be seen on pages 34–35.

WATER VOLE SURVEY FORM

BACKGROUND INFORMATION

Site name/river: ____________

Site number: ______ 10km square: ______ Grid ref: ______

County: ______ Water Authority: ______

Recorder: ______ Date: ______

HABITAT INFORMATION (mark features on map)

Survey distance: ______ km

Habitat
- Ditch
- Dyke
- Gravel pit
- Pond
- Lowland lake
- Upland loch
- Reservoir
- Running water
- Marsh/bog
- Canal

Shore/bank
- Boulders
- Stones
- Gravel
- Sand
- Silt
- Earth
- Rock cliffs
- Earth cliffs
- Canalized
- Poached
- Reinforced (man-made)

Bordering land use
- Upland grass
- Permanent/temporary grass
- Mixed broadleaf woodland
- Conifer wood
- Peat bog
- Arable crop
- Salt marsh
- Urban/industrial
- Park/garden
- Heath
- Fen
- Cattle/grazing
- Bank fenced?

Vegetation (DAFORN)
- Bankside trees
- Bushes
- Herbs
- Submerged weed
- Reeds/sedges
- Tall grass
- Short grass

Disturbance:

Bank profile
- Flat < 10°
- Shallow < 45°
- Steep > 45°
- Vertical/undercut

Depth
- < 0.5m
- 0.5–1m
- 1–2m
- > 2m

Width
- 1m
- 1–2m
- 2–5m
- 5–10m
- 10–20m
- 20–40m
- > 40m

Current
- Rapid
- Fast
- Slow
- Sluggish
- Static

WILDLIFE INFORMATION

Water voles
- Sightings (count)
- Latrines (count)
- Burrows (count)
- Footprints
- Pathway in vegetation
- Feeding remains
- Cropped grass around tunnel entrance

Rat
- Sightings
- Droppings
- Footprints/runs

Otter
- Sightings
- Droppings
- Footprints/runs

Mink
- Sightings
- Droppings
- Footprints/runs

Other wildlife
- Coot
- Moorhen
- Kingfisher
- Heron
- Waterfowl
- Dipper

Identified plants from feeding remains:

SKETCH OF SITE – vole activity indicated (if any)

KEY TO SYMBOLS
(mark route surveyed and direction of flow)

Mature trees	
Over-hanging branches	
Fallen tree	
Exposed roots	
Pollarded tree	P
Sapling	
Scrub	
Hedgerow	
Fence	—×—×—×—
Reed/sedge bed	
Flood bank	
Artificial bank	
Earth cliff	

ADJACENT LAND-USE CODES

Broadleaved wood	BW
Conifer plantation	CP
Moorland/ heath	MH
Rough pasture	RP
Wetland	WL
Improved grass	IG
Tilled land (crop)	TL
Suburban/ urban devel. (inc. gardens)	URB

OTHER FEATURES

Roadbridge	
Footbridge	
Weir	
Culvert	
Ford	
Outfall	
Dredgings/ spoil	
Silt bars	
Islands	mark position and size

ADDITIONAL COMMENTS:

water level management
signs of drying out
flood debris position
evidence of pollution

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The mission of the Wildlife Conservation Research Unit (WildCRU) is to achieve practical solutions to conservation problems through original scientific research.

The Environment Agency is the leading public body protecting and improving the environment in England and Wales. It is our job to make sure that air, land and water are looked after by everyone in today's society, so that tomorrow's generations inherit a cleaner, healthier world. Our work includes tackling flooding and pollution incidents, reducing industry's impact on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats. A key element of the latter remit is the implementation of our national and local Biodiversity Action Plans and other work programmes to secure increases in biodiversity priority species such as water voles.

Natural England is the Government's statutory adviser on nature conservation in England. Our Species Recovery Programme is the main mechanism by which we contribute to the delivery of Species Action Plans under the UK BAP. Natural England is a member of the UK Steering Group for the water vole.

The Countryside Council for Wales champions the environment and landscapes of Wales and its coastal waters as sources of natural and cultural riches, as a foundation for economic and social activity, and as a place for leisure and learning opportunities. We aim to make the environment a valued part of everyone's life in Wales.
Mae'r Cyngor Cefn Gwlad yn hyrwyddo amgylchedd a thirluniau Cymru, yn ogystal â dyfroedd ei glannau, fel ffynonellau o gyfoeth naturiol a diwylliannol, fel sail i weithgarwch economaidd a chymdeithasol, ac fel man ar gyfer hamddena a chyfleoedd dysgu. Nod y Cyngor yw gwneud yr amgylchedd yn rhan hanfodol a phwysig o fywydau pawb yng Nghymru.

Scottish Natural Heritage is the Government's statutory advisor on nature conservation in Scotland. Our mission is to work with Scotland's people to care for our natural heritage. Our task is to secure the conservation and enhancement of the wildlife, the habitats and the landscapes which have evolved in Scotland through the long partnership between people and nature.

SEPA's main aims are to be an effective regulator and respected authority on the environment in Scotland. Our broad objectives are to achieve good water, air and land quality; help minimise, recover and manage waste; protect, inform and engage communities and promote economic well-being. SEPA supports the co-operative efforts to halt the decline of the water vole and welcomes this handbook as a mechanism for improving the understanding and awareness of the species.

There are 47 local Wildlife Trusts across whole of the UK, the Isle of Man and Alderney. We are working for an environment rich in wildlife for everyone. With 670,000 members, we are the largest UK charity dedicated to conserving the full range of the UK's habitats and species whether they be in the countryside, in cities or at sea. We manage 2,200 nature reserves covering more than 80,000 hectares; we stand up for wildlife; we inspire people about the natural world and we foster sustainable living.

PTES was formed with the aim of ensuring a future for endangered species both in the UK and abroad. The Trust pursues this aim by funding scientific research, which forms the basis of conservation strategies for endangered species. PTES also funds conservation work in the field to support specific populations of endangered species faced with immediate dangers.