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The Dormouse Reintroduction Programme: A review

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

The common or hazel dormouse (*Muscardinus avellanarius*) was once widespread in the UK, but now has a restricted range and is vulnerable to local extinction. It is unlikely to return to many areas without some assistance.

The dormouse reintroduction programme is part of Natural England's Species Recovery Programme and was initiated in order to restore dormice to areas of England from which they had been lost and where natural re-colonisation was unlikely.

The first re-introduction took place in 1993 and since then 18 re-introductions have taken place throughout England.

This review was commissioned by Natural England to help identify the best approach to the long term conservation of dormice. It will be used to inform decisions about future action taken under the Dormouse Species Recovery Programme and to deliver the aims of Biodiversity 2020.

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Further information
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The Dormouse Reintroduction Programme: A review

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Executive Summary

Although Britain's only native species of dormouse, the Common or Hazel Dormouse (*Muscardinus avellanarius*), was once widespread in the UK, it is now more restricted in range, is vulnerable to local extinction and is unlikely to return to many areas without some assistance. The dormouse re-introduction programme is part of Natural England's Species Recovery Programme and was initiated in order to restore dormice to areas of England from which they had been lost and where natural re-colonisation was unlikely. The first re-introduction took place in 1993 and since this time 18 re-introductions have taken place throughout England.

This review of the dormouse reintroduction programme was commissioned by Natural England to help identify the best approach to long term conservation of dormice, to inform decisions about future action taken under the Dormouse Species Recovery Programme and to achieve the aims of Biodiversity 2020.

The report reviews the procedures involved in selecting sites, breeding dormice, preparing them for release and the actual reintroduction process. An attempt is made to assess the success of the reintroduction programme, first in terms of criteria set out in Bright & Morris (2002) and then by looking at longer term outcomes. The principal conclusions drawn from this review are that the reintroduction programme should not continue in its present form and the strategy should change from one of expansion to consolidation; sites should be clustered in small groups as opposed to being widely dispersed so that viable metapopulations can be established; a Project Coordinator should be appointed from outside the existing participating organisation and a small Advisory Group formed; and in addition to ongoing monitoring of progress by the Coordinator and Advisory Group, there should be more formal reviews after three and ten years.

Introduction

The Common or Hazel Dormouse (*Muscardinus avellanarius*) is Britain's only native species of dormouse. Dormice were once widespread in the UK, but they are now more restricted in range and are vulnerable to local extinction. They are now mostly found in the southern counties of England and Wales, with some scattered populations in the midlands and the north of England.

There are likely to be several reasons why the range of dormice in England has become restricted, including fragmentation, deterioration and loss of habitat as well as wider climatic factors (Bright & Morris, 1996). The inappropriate management of woodlands in the past has meant that dormice have been lost from many counties and although these areas may now be more appropriately managed and the habitat may be suitable for dormice, they are unlikely to return without some assistance (Bright & Morris, 2002).

The dormouse re-introduction programme is part of Natural England's Species Recovery Programme and was initiated in order to restore dormice to areas of England from which they had been lost and where natural re-colonisation was unlikely. The first re-introduction took place in 1993 and since this time 18 re-introductions have taken place throughout England. Although reviews have been undertaken since the start of this programme, an updated review of these reintroductions now needs to be undertaken in order to re-evaluate the programme.

This review of the dormouse reintroduction programme was commissioned by Natural England to help identify the best approach to long term conservation of dormice, to inform decisions about future action taken under the Dormouse Species Recovery Programme and to achieve the aims of Biodiversity 2020. The review specifications are shown in Appendix A.

Scope
This review covers 18 sites where dormice were released between 1993 and 2012. Less attention is paid to the two most recent sites, Alne Woods and Windmill Naps (both in Warwickshire). Dormice have only been released at these for one and three years respectively and it is too soon to detect any outcomes. At all other sites dormice were released four or more years ago.

The project aims to answer the following questions:

- Were dormice released into appropriate locations, at the right time, with the correct sex ratio and suitable habitat management procedures being put in place to conserve the population for the long-term and promote its natural expansion? If not, what could have been done differently?
- Were pre-release procedures such as captive breeding, veterinary checks and PIT-tagging justified and cost-effective? Could anything have been improved?
- Have dormice been restored to their former range?

- *Have dormice been re-established in at least five self-sustaining populations, from which they have been lost?*
- *Have dormice populations which were isolated been strengthened to a viable level?*
- *Have scattered populations expanded to a viable level?*

- Have each of the 18 re-introductions been a success? Success criteria were defined by Paul Bright and Pat Morris (Bright & Morris, 2002) and these can be used to assess each release.

(See appendix A for the project's original specification).

The author

Paul Chanin is an independent mammal ecologist with over 40 years' experience. He has been an ecological consultant for fifteen years and during that time has worked mainly with otters, badgers and dormice. He has undertaken small scale research projects on dormice with various colleagues as follows:

- With the late Michael Woods, an investigation into the use of nest tubes to detect dormice in 'unconventional' habitats (i.e. other than deciduous woodland. This work was used as the basis for devising a protocol for using nest tubes in surveys for development;
- With Leonardo Gubert, a four year study of dormouse movements and ecology in an area fragmented by roads;
- With colleagues from the UK and the Irish Republic, a study of insects in the diet of dormice using molecular methods.

Outline of report

The first part of this report deals with the procedures involved in selecting sites, breeding dormice, preparing them for release and the actual reintroduction process. It is based primarily on interviews with staff from the main organisations involved in the programme (see below). In addition, views were obtained from volunteers taking part in reintroductions at the site level, while Dr Pat Morris, kindly provided useful background on the early days of the project together with his views on current practices.

In the second part of the report an attempt is made to assess the success of the reintroduction programme, first in terms of criteria set out in (Bright & Morris, 2002) and then by looking at longer term outcomes. This is followed by a section in which conclusions are drawn and concerns about existing processes summarised. Recommendations are made for future work under the programme, together with suggestions as to how the project might be focussed in the future, its progress kept under review and its success measured.

Finally the role of the reintroduction programme is discussed in relation to other conservation work on dormice.

Abbreviations

A number of abbreviations will be used regularly throughout this report, not least because some of the organisations use them for branding. These are:

CDCBG	Common Dormouse Captive Breeders Group
DCH	Dormouse Conservation Handbook
GNH	Great Nut Hunt
NDD	National Dormouse Database
NDMP	National Dormouse Monitoring Programme
NE	Natural England
PTES	People's Trust for Endangered Species
PZEP	Paignton Zoo Environmental Park
ZSL	Zoological Society of London

Abbreviations which occur infrequently are given in full at first use.

Methods

December 6th 2012	Initial set up meeting with NE (conference call)
	Literature review conducted (no formal literature review requested or carried out)
January 9th – February 14th 2013	Interviews with those historically and currently involved in the dormouse re-introduction programme
January 9th – 10th 2013	Site visits conducted to gain an understanding of habitat management processes
January to March 2013	Review of NDD, NDMP databases and other relevant information
	Conclusions

Sources of information

People

The following people were interviewed, either face to face[1] or by telephone[2] or by an informal, tailored questionnaire[3] (please see appendix B). Several interviewees kindly responded to additional questions and requests by phone or email. These people were seen as important to interview due to their involvement with the project, either in the past or as it stands today.

Ian White[1]	PTES
Nida Al-Fulaij[2]	PTES
LaurenAlexander[1]	PTES
Susan Sharfi[1]	PTES
Tony Sainsbury[2]	ZSL
Neil Bemment[3]	CDCBG, PZEP
Pat Morris[2]	Royal Holloway, University of London (RHUL)
Sarah Bird[2]	Chester Zoo and North West Dormouse Partnership, carrying out research at Bontuchel Wood (natural population) and Stockton Dingle (reintroduced population)
Simone Bullion[2]	Suffolk Wildlife Trust, coordinator of Suffolk and Essex Dormouse Group and volunteer at Bradfield Wood.

In addition, I spoke informally to several volunteers at the Treswell Wood and Little Linford Wood reintroduction sites and at greater length to Sue Raven, volunteer at Maulden Wood while in the field. Ghislaine Sayers (Head of Veterinary Services at PZEP) provided some additional information during a telephone conversation.

Publications

There have been a number of reports and reviews of the programme or related matters and these are briefly described in Appendix D.

The three organisations participating in the reintroduction programme (PTES, ZSL and CDCBG) produce annual reports to the UK Dormouse Steering Group as well as other unpublished reports relevant to the programme. Where these are not in the public domain they will be cited in a descriptive form (e.g. unpubl. annual report, 2009; Caddick, 2005, unpubl. review).

Databases

Staff at PTES kindly made available copies of the NDD and NDMP in December 2012. Unless otherwise stated, data on distributions, dormouse numbers at individual sites and tagging returns have been extracted from these databases, with permission.

Maps
All maps were created with DMAP (**www.dmap.co.uk/**).

Historical background to reintroduction programme

Decline of the dormouse
In 1993 the first Great Nut Hunt (GNH) was carried out, based on the technique pioneered by Hurrell & Mackintosh (1984) and using 6,500 volunteers to search for hazel nuts eaten by dormice. Over 1700 sites were searched and signs of dormice recorded at 334 (19%) of these (Bright et al 1996). Using historic records of dormouse distribution, Bright & Morris (1996) showed that there had been a decline in the range of dormice and that they were probably extinct in seven counties where they were known to be present in the late nineteenth century (Cheshire, Derbyshire, Lincolnshire, Norfolk, Staffordshire, Warwickshire and Yorkshire). Further evidence was presented from other sources to lend support to the view that there had been a '*considerable decline'* in numbers even though '*the Dormouse remains widespread and relatively numerous in some counties*.'

In the second edition of the Dormouse Conservation Handbook, Bright et al. (2006) claimed that the distributional range had contracted by 50% since a hundred years previously and that the causes of this decline were believed to be mainly due to changes in land management practices, particularly the decline in coppicing but also to habitat fragmentation and deterioration. Bright et al also considered climatic factors to be involved due to the species specialised feeding requirements.

Subsequent GNHs (2001, 2009/10) have involved fewer surveyors and sites, but 108 new sites were identified in the first and a further 69 in the second. The difficulties of using the technique for long term monitoring have been recognised and no conclusions could be drawn about population changes from these data. However, the National Dormouse Monitoring Programme which also started in the early 1990s is designed for population monitoring.

In more recent years the known range of dormice has not changed markedly (except as a result of reintroductions). However, it is now known that dormice exploit a wider range of habitats and do not depend on hazel nuts as a food source as much as had been previously thought (Bright et al, 2006; Juškaitis & Büchner,2013). As interest in dormice has widened and new methods of detecting them have become available, the number of places where they have been recorded has increased dramatically having a consequent effect on the data and therefore knowledge of the species. The National Dormouse Database (NDD) shows that in the period 1990 to 1993 inclusive (i.e. including results of the first GNH), dormice were recorded in 340 one kilometre squares. Since the Millennium, they have been recorded in 1270 one kilometre squares. Not all sites where dormice are found are monitored; therefore this information is based on a proportion of the population from which inferences can be drawn about the population as a whole.

Maps, based on data in the NDD, showing the known distribution at various times are presented in Appendix F. This also provides information on the accumulation of dormouse records over the past two decades.

Origins of the programme
The dormouse re-introduction programme was initiated in the early 1990s through two contracts issued to Royal Holloway, University of London (RHUL). The first was issued by the Nature Conservancy Council and the second by English Nature, its successor organisation, responsible for wildlife conservation in England.

Under the terms of the first contract, Drs Pat Morris and Paul Bright carried out investigations into the feasibility of reintroducing dormice to parts of their former range where they were then believed to be absent. These involved trial introductions to test the benefits of different approaches to release and also the merits of using captive bred

dormice versus wild bred animals. Work carried out under this contract is reported in (Bright & Morris 1994) and there is an overview in a popular article in British Wildlife (Bright & Morris, 2002).

The second contract built upon the first and was the basis for all future releases of dormice under the reintroduction programme. Carried out initially by Pat Morris and Paul Bright, together with their students and colleagues at Royal Holloway, it was subsequently taken over by a small group of organisations, co-ordinated by PTES. Currently, the programme is carried out under contract to Natural England.

PTES also manages the NDMP and the NDD under the same contract. The NDMP and NDD were set up by Bright and Morris during the 1990s alongside the reintroduction programme. The NDMP is a means of monitoring long term changes in dormouse population in the UK using a network of volunteers who monitor dormice at more than 300 sites using protocols devised by Bright and Morris. The NDD is a record of the current distribution of dormice. Initially it was composed mainly of records from the first national GNH, organised by Morris and Bright (in 1993 and subsequently by PTES in 2001& 2009/10). However, records from all sources are accepted and mutual exchanges of data with both local and national biological recording schemes have been implemented. The effect of the first GNH on recording is illustrated by figure F.5, Appendix F.

Biodiversity and Species Action Plans.

The UK Biodiversity Action Plan (BAP) was the UK Government's response to the Convention on Biological Diversity, which the UK signed up to in 1992 in Rio de Janeiro. The plans were set out to aid recovery of the UK's most threatened species, including the dormouse. The dormouse has been a BAP species since the 1990s and successive Biodiversity (or Species) Action Plans have described its current status, perceived threats and proposed actions to mitigate them. The first BAP for dormice was published in 1995 as part of '*Biodiversity: The UK Steering Group Report'.* This corresponded closely in time with the start of the re-introduction programme and is included in Appendix C of this report, together with the proposed 'Actions' from the most recent iteration, dated 2010.

Present management of project

At present there are three organisations participating in the programme in a professional capacity (PTES, PZEP and ZSL) aided by a large number of volunteers coordinated by PTES and several individuals and institutions involved in captive breeding, co-ordinated by Neil Bemment of PZEP. RHUL is no longer directly involved.

Since 2000, a number of PTES staff have been involved in the reintroduction and other programmes. At present, Susan Sharafi manages the NDMP, Lauren Alexander manages the NDMP and NDD databases, Nida Al Fulaij oversees dormouse conservation programmes and Ian White's principal role is to oversee reintroductions and training. All were interviewed as part of this review.

The captive breeding programme is carried out primarily by a small group of zoological collections, aided by private breeders and other wildlife centres. The Wildwood Trust of Kent, PZEP, the City of London (at the Burnham Beeches National Nature Reserve) and the British Wildlife Centre have held the largest stocks over the last three years. Some breeding stock is on view to the public, but the majority is 'off exhibit'. The CDCBG is chaired by Neil Bemment, Director of Operations at PZEP, a professional zoo curator with many years' animal husbandry experience.

Responsibility for veterinary inspection of dormice prior to release is held by ZSL. Dr Tony Sainsbury (Senior Lecturer in Wild Animal Health at the Institute of Zoology, ZSL) devised the protocol which is annually reviewed. This work is carried out under the terms of a cross-taxon project with Natural England which oversees disease risk analysis and health surveillance for all the species that are being released under NE's Species Recovery

Programme. These strict protocols are in place to ensure that such projects comply with the IUCN guidelines for the re-introduction of species.

ZSL and PZEP each clinically examine half of the animals nominated for release. PZEP's Head of Veterinary Services, Ghislaine Sayers, follows the protocols devised at ZSL with all dormice being kept under quarantine conditions during the screening period (usually about six weeks) right up until the day of delivery to the release site.

Once released, day to day work in connection with the dormice is undertaken by volunteers supported by PTES staff. Initially this consists of providing food for the animals in the release cages, later they take responsibility for monitoring the population, following NDMP protocols. Post-release health surveillance is included in the ZSL protocol but carried out by volunteers who check dormice for a microchip, weigh them and (from 2013 onwards) assess their body condition. Dead dormice are sent to PZEP for post mortem examination, carried out according to standard procedures. Faecal samples are also collected and sent to PZEP to assess endoparasites.

Participating organisations submit annual reports to the UK Dormouse Steering Group (previously Dormouse BAP Steering Group) and projects are overseen by Natural England's Senior Specialist, Mammals, Katherine Walsh.

Current processes and procedures and the views of participants

Intro

There are six main processes involved in the reintroduction programme

1. Site selection (PTES)
2. Captive breeding (CDCBG)
3. Veterinary procedures (ZSL)
4. Release of dormice (PTES)
5. Short term care of dormice (Volunteers, overseen by PTES)
6. Long term monitoring of dormouse population (Volunteers, overseen by PTES)

In addition, at some sites, management plans for the woodlands are agreed and implemented, usually by the land owner.

These processes are described more fully in the following subsections. Issues which have been raised as matters of concern by participants or considered to be so by the reviewer are discussed at the end of each subsection.

Site selection

In the contract between English Nature and RHUL (and continuing in today's contract between NE and PTES) the priorities were to release dormice a) in counties where they had become extinct; b) in peripheral counties at the edge of current distribution and c) anywhere else deemed appropriate (Pat Morris, pers. comm.). In essence this makes it possible to release dormice anywhere within their current and historic range. In practice, most releases have taken place in the northern half of the species current distribution from Bedfordshire to Yorkshire and from Suffolk to Cheshire.

The current Species Recovery Plan for dormice has a requirement to:

"*Carry out one reintroduction a year in either a county with no known natural populations, which are adjacent to counties within the core range and are within the known historical range of the dormouse, a county with isolated populations, which require strengthening or with a county with scattered populations, where some gaps may exist* ..."

Today, individual sites are brought to the attention of PTES largely by word of mouth, though in the past efforts have been made to pro-actively search for sites in suitable areas. Criteria for selection include:

- Suitable ownership;

- Appropriate size (>20ha);
- Appropriate management.

Matters of concern

Site selection is a central issue in this programme and it is clear from comments by Nida Al-Fulaij, Ian White and Tony Mitchell-Jones as well as MacPherson & Bright's report (2003) that finding suitable sites is not easy.

Many of the reintroduction sites are rather small, half being no more than 25ha and two are less than the recommended minimum of 20ha (Bright & Morris, 1994b). This may be a concern in the long-term survival of reintroduced populations, unless there is good connectivity to other areas of suitable habitat. It is also evident that, apart from Heslett and Peter Woods, sites have been selected independently of one another with no apparent attempt to group them, either with each other or with sites where dormice are extant. Such a strategy would add considerably to long term viability if it were possible to create more robust metapopulations.

There is also a clear need to ensure that long term management agreements are in place and in the past, this has not always been achieved.

It would appear that site selection needs to be much more rigorous in several ways which are outlined in *Recommendations*. However, this may have the adverse consequence of making it even more difficult to find suitable sites.

Captive breeding

In 2010 and 2011 combined, 120 animals were involved in the captive breeding programme of which 47% were male. Thirty four were carried forward from the previous year and 36 were wild caught animals, the remainder were born in captivity to these animals. No reintroduction took place in 2011 because there were insufficient animals to release. As a consequence the 2012 population included a large number of animals which had overwintered twice. During 2012, 42 dormice were released at Alne Woods, Warwickshire, 22 wild-caught animals were received and 61 born in captivity. This leaves a sufficient stock for a release in 2013.

Neil Bemment expressed the view that the protocols involved in the programme do not compromise good husbandry for dormice. He had determined that the minimum size for veterinary screening (post hibernation) and breeding cages should be no less than $1m^3$ and that this was appropriate, with no evidence of stereotypic behaviours being observed. He also took the view that the small holding cages used for quarantined dormice, though not ideal, were not obviously detrimental to dormice which were held in them in the six week period prior to release.

The captive breeders group includes a dozen or so individuals and organisations. Half of these are private individuals, the remainder zoos and wildlife centres. Private individuals tend to keep fewer dormice (mean 3.1; maximum 9: held between 2010 and 2011) than the institutions (mean 11.5; maximum 26). In 2010 and 2011 the largest holder of dormice was Wildwood in Kent responsible for just over 25% of the dormice available for release over that period. Private individuals in total made a similar contribution. It is Neil Bemment's view that there are a number of benefits in having so many participants, partly in spreading the load and sharing knowledge, also because some institutions are involved in education and could accommodate animals which were not needed for release. He noted that a number of the private breeders had been involved in the programme for several years and that he is content with current arrangements.

At present there is no lack of support for the captive breeding programme and new offers are received regularly. Most are turned down as unsuitable and many withdrawn when they realise that animals may not be kept on show.

Relationships between the captive breeders and other participants are good and it was noted that Neil Bemment had done much to achieve this situation. Breeders were aware of the needs of other participants and had adequate advanced warning of the requirements each year. The only pressures perceived were matters of dormouse biology, particularly the time between dormice awakening from hibernation and being prepared for release and the numbers received and born each year. In 2012 it was agreed that dormice may be forwarded to ZSL and PZEP while still in the process of emerging from hibernation thus saving on transport time/costs. This means that the animals are received in timely fashion to ensure that adequate checks can be made in time for a June release. The procedure is to be reviewed in 2013.

Matters of concern

On the whole, the captive breeding programme functions very well and all participants are pleased with its management. However, genetic diversity is not very high and although suggestions have been made for remedying this, and even for bypassing the need for captive breeding altogether, these have not been adequately discussed or evaluated and a forum for such discussions is needed.

Although all breeding stock ultimately comes from wild animals, there is some concern that new animals need to be brought into the programme to maintain adequate genetic diversity. The Chairman of the Captive Breeders Group applies for a licence to permit this under prescribed circumstances. A proportion of new animals are brought in as 'rescued' animals by well-meaning members of the public. These maybe transferred into the captive breeding programme, where NE licences permit. Others have been supplied on request, for example by CDCBG Accredited Agents carrying out dormouse surveys who are aware of the need. However the supply from these sources is not reliable or sufficient at present. Note that the 'taking' of any dormouse requires a licence from Natural England and only those that satisfy the requirements of the licence held by Neil Bemment may be used for reintroductions.

The wild caught animals were captured in autumn when they were considered to be underweight and therefore likely to have a lower probability of surviving hibernation. This policy seems to have been devised to reduce the impact of removing animals from existing populations. It is not clear that the implications of this have been considered in terms of using potentially maladapted animals as the source population for reintroductions.

Two suggestions to improve the situation have been put forward by Neil Bemment and his colleague Julian Chapman and although there has been some discussion of these at the UK Dormouse Steering Group, no decision has been made. The first is to take a total of 20 dormice into captivity each year, ideally four or five animals from each of four or five sites. There would be a need to 'commission' these captures in advance in order to ensure that a reliable supply was obtained and probably to 'over-order' to allow for poor breeding years. Any such arrangements would require the approval of Natural England and the issuing of an appropriate licence.

The second approach that has been suggested is to simply translocate dormice from one area to another without an intervening period in captivity. This would reduce the risk of animals acquiring infections from the sites where they are held in captivity and quarantine, but increase the risk of transferring disease from one natural site to another. Clearly a risk assessment would be needed and such work would also require a licence from Natural England.

A likely problem with these approaches is that suppliers may be difficult to find. Sources are likely to be volunteers taking part in the NDMP who may be concerned that removing dormice from 'their' population could have an adverse effect on dormouse numbers and also compromise the results of their surveys. There is no evidence for this and the

problem may be one of perception. On the other hand, an increasing number of professional ecologists are taking part in these surveys and they might have a more pragmatic approach.

An alternative approach might be to obtain dormice from development sites where dormice could be caught instead of displaced and either translocated to a release site or taken into captivity for breeding. While this approach has some attractions, there are problems of predictability – time frames would have to fit in with the development cycle rather than the most desirable timings for translocation. In addition there are significant legal issues since, in order to obtain a licence for development it is a requirement that in the long term, the conservation status of dormice in the area should not be compromised. Natural England considers moving dormice away from the site of a development to be a last resort and it is unlikely that this view would be modified in order to provide stock for the reintroduction programme.

It has also been noted that late changes in plans, particularly postponements of releases are problematic since more dormice have to be kept over the ensuing winter with consequent problems of providing sufficient accommodation. In addition, a proportion of the animals released will be two years old rather than one.

Pre-release veterinary checks

ZSL has taken the lead in this and Tony Sainsbury and his team have devised protocols which they consider appropriate for the circumstances. Dormice held at PZEP are checked by the Zoo's vet Ghislaine Sayers, other dormice are delivered to ZSL for checking.

Dormice are sent to ZSL or PZEP in mid-April and kept there until release in the third week of June. During this period they are held in standard plastic rodent cages and fed an appropriate zoo diet. While in quarantine, dormice are subject to a clinical examination under anaesthesia, are prophylactically treated for cestodes and nematodes, undergo faecal screening for parasites and bacteria and their condition is monitored. Dormice which show signs of infection, injury, deformities (loss of tail, overgrown incisor teeth) or are in poor condition are not used in the release programme.

The objectives of this screening are to ensure that released dormice are in good condition, have the best chance of survival and that the risk of infectious diseases being introduced into the wild are minimised. Tony Sainsbury explained that the protocol is updated annually and that perceived risks are constantly re-evaluated as part of their ongoing contract with Natural England.

One matter of concern had been the finding of a cestode (*Rodentolepis sp*) in the captive bred population. Screening of faecal samples from wild animals (some of which had been released as part of the re-introduction programme) is being carried out and in a report to the UK Dormouse Steering Group (January 2013) Peniche and Sainsbury disclosed that *Rodentolepis* cestodes have now been found in dormice from two wild populations. This work continues.

Tony Sainsbury also pointed out that the release programme had started in 1993 but veterinary screening only took place from 1998/9. He expressed the view that a formal risk assessment of health issues should have been undertaken at an earlier stage.

Matters of concern

Concerns over the screening programme have been expressed by staff at PTES and Pat Morris. One of these is that the screening programme is onerous and consequently adds expense to the programme and stress to the dormice. The other is that the conditions in which dormice are kept prior to release are not ideal and may in some way reduce the survival of released animals. Particular concern was expressed that animals are kept indoors individually in small cages in the period immediately before release. This is

different from the conditions in which they have previously been kept and from those they will meet in the wild. It also means that there is no opportunity for breeding to take place prior to release. It was suggested that this might make them more vulnerable and that their survival might be poorer as a result.

In order to address the first of these issues I sent a copy of the protocol to Vic Simpson BVSc, DTVM, FIBiol, HonFRCVS (Director Wildlife Veterinary Investigation Centre, Truro), a highly respected veterinary pathologist who has specialised in wildlife issues throughout his career. His view was that the screening programme is appropriate to the risk. He pointed out that the risk of disseminating disease by moving animals from one place to another was frequently under-estimated by non-veterinarians. He noted that apart from the fact that dormice are being moved from one part of the country to another, they are also potentially exposed to a range of diseases, including exotic ones while kept in captivity, particularly those animals kept in zoological collections where non-native species are present.

At present, there is no evidence to support the concern about cages and I see no reason to recommend changes to the protocol. At a meeting held to discuss the captive breeding programme at the end of March 2013, approaches to assessing the impacts on dormice were considered, including analysis of faecal corticosteroids to assess stress levels in dormice. If practical and cost effective this should certainly be explored.

Despite the reservations of some, my view is that the measures being taken are appropriate to the risk. In addition, the need for NE to adhere to IUCN guidelines on re-introductions cannot be ignored.

The question of dormouse housing arrangements prior to release should not be dismissed, but in my opinion, urgent action is not required. Careful monitoring of dormice released in recent years should inform future action and the possibility of assessing levels of corticosteroids should be investigated.

Release

Following a period of six weeks in quarantine, dormice are taken to the site and placed in release cages. These are ca 1m high and 450mm x 300mm, as described by Bright & Morris (1994). Originally constructed with wooden frames they are now built to fold flat for easier transport and re-use. Cages are placed at intervals of approximately 100m throughout the wood. Dormice are introduced to these cages and kept confined in them for a period of 10-14 days before being released.

Initially dormice were released in pairs or trios (one male to two females) but more recently pairs have been the norm. The spacing is designed to mimic the natural spacing of dormouse home ranges and reduce the risk of territorial conflicts. This ‘soft release’ method of confining the dormice to the release cages for a period is intended to give them an opportunity to acclimatise to the locality before release. This was shown to be more effective than allowing them to leave the cage immediately (‘hard release’: Bright & Morris, 1994).

Dormice are fed *ad lib* throughout the period of confinement and then for as long as they continue to return to the release cages to take the food provided, typically a further 6-10 weeks. Feeding is carried out by volunteers who also carry out the monitoring of dormice post release.

Prior to the release, 200 nest boxes are installed in the area around it with the expectation that dormice will use these for nesting following emergence from the release cages. These boxes then form the basis for future monitoring of the population following the protocols of the NDMP. In practice, the full number is not put out at all sites in the first instance and at most sites the number increases with time as dormice are assumed to

spread. At Little Linford the number of boxes rose from 300 to 400 and at Bubbenhall it increased from 100 at release to 150 after two years.

Matters of concern

The basic procedure appears to work well and there have been no suggestions that it should be altered. However the number of animals currently being released at each site is quite small.

Given that both males and females appear to take part in multiple matings there is a moderate benefit in having a preponderance of females since that will increase the number of litters born in early years when the population is low. On the other hand, this creates a problem of 'surplus males' in the captive population. This interacts with the issue of numbers of animals released. If 30 animals are released in a ratio of two females per male the breeding potential, in terms of litters, is the same as for 40 animals in a ratio of 1:1.

Discussions with one of the volunteers (at Maulden Wood) suggest that it is important to give adequate support during this period and that this should be done pro-actively. It would appear that in the past, help and advice was provided when asked for but that some volunteers have been reluctant to make an approach to the coordinators.

No nest box checking is carried out until October by which time dormice will have been living free for a minimum of 3 months. This appears to be designed to ensure that dormice are not disturbed during the period immediately after release. However, it has been suggested (Tony Sainsbury) that there would be benefit in carrying out earlier checks to monitor the condition of dormice in the period immediately following release. In his view this might help elucidate the reasons for the lack of success of the programme (see below).

Post-release monitoring and interactions with volunteers

Following a successful release, volunteers are expected to continue monitoring the released population using the NDMP protocols and checking boxes at least twice a year between May to October - once pre-breeding and once post breeding. Results are returned to PTES and incorporated into the NDMP database. Ian White uses these data to show changes in numbers over time at each release site and graphs are incorporated into his annual reports to the UK Dormouse Steering Group.

Although all dormice are micro-chipped prior to release, scanning for these tags has only taken place since 2003 and only on a large scale since 2006, following the introduction of scanners which are more sensitive and easier to use. To date 51 tagged dormice have been recaptured of which 19 were recorded at Bradfield Wood and the same number at Freeholders Wood. Smaller numbers of recaptures (maximum 4) have been recorded at Leashaw Wood, Heslett & Peter Wood, Monsal Dale, and Windmill Naps.

The exception to this is at Stockton Dingle in Cheshire where dormice were released in 1996. This site is monitored by the North West Dormouse Partnership alongside a larger site nearby at Bontuchel Woods in Denbighshire. Dormice are intensively monitored at both these sites and all animals caught at Stockton Dingle since 2005 have been micro-chipped, as have those at Bontuchel. These sites are discussed further in the next section (*Success of the reintroduction programme*).

In addition to monitoring the dormouse population in the nest box grid, volunteers are encouraged to try and record the presence of dormice away from the reintroduction site as the population increases in size and expands in range. In some cases this has worked well, for example at Little Linford Wood (see below), where an extension in range over 3-4km of linear habitat has been recorded by systematically increasing the area covered by nest boxes. This has taken 14 years to achieve, during the first ten of which dormice were

only recorded inside the wood. Elsewhere monitoring is more *ad hoc* and patchy and insufficiently pro-active to reliably track changes in distribution.

Interactions with volunteers seem to work well with no major problems identified. The proactive approach of PTES seems to be appreciated and productive.

Matters of concern

One concern is that as more releases occur, the number of volunteers or volunteer groups which need to be sustained increases and there is a risk of this placing too great a burden on PTES staff. The offering of incentives in the form of courses and meetings might help to compensate for less frequent site visits. Prioritisation of these visits may be needed whereby larger groups and older sites are visited less frequently than smaller and newer ones.

Management of sites

The importance of securing agreements on appropriate management has been increasingly recognised and is included in criteria for site selection. In the past, some sites were taken on without satisfactory arrangements being made. Both Treswell and Bubbenhall underwent habitat management changes, which although thought to be suitable at the time, had the potential to be detrimental to dormice after they were released and neither have a population at present.

My impression is that it is easier to persuade conservation organisations of the need to formulate an appropriate management plan and carry it out than private landowners. One strategy that has been successful in the latter case is to encourage participation in a dormouse habitat management training course and the possibility of expanding this could be considered.

Interactions with land managers, like volunteers, are potentially very time-consuming but it is also an essential part of the process. Again, as the number of sites increases so, potentially, does the commitment.

Matters of concern

Despite increasing attention being paid to this issue, there are still concerns about the extent to which landowners can be encouraged to manage their woodlands appropriately for dormice once they have been released.

Other matters of significant concern

Two further matters merit consideration. First, although the remit for the reintroduction programme and the Species Action Plans indicate where reintroductions should take place at the county level, there is no guidance given on the distribution of sites below that level and it is my opinion that this issue needs to be addressed. I also feel that there is some scope for improvement in the way the project is managed.

Distribution of reintroduction sites

At present, the overall distribution of sites is considered at the county level and while this has some merit in terms of administration (local record centres, wildlife trusts and mammal groups tend to be organised at this level) it has no biological meaning and other geographical divisions might have more validity and be more practical when setting priorities (e.g. National Character Areas).

Of greater concern however is the fact that the current sites are very scattered. The closest pairs of sites are Windmill Naps and Alne woods in Warwickshire which are 11km apart and Priestly and Bradfield in Suffolk which are 15km apart. In both cases there are other woods and a network of hedges between them and for the first two some of these are of comparable size and not very far apart (gaps of 1 - 1.5km). In Suffolk however the

gaps are larger (2 - 2.5km), the woods smaller and there is a substantial area midway between where hedge connectivity is very poor.

Dormice have been shown to cross distances of up to 500m across open farmland (Keckel et al, 2012) and male dormice have been observed moving over 300m in a single night (Bright & Morris, 1992), but adult dormice are sedentary and have permanent home ranges. Dispersing juveniles will travel, on average, between 127m and 363m from the natal site (Juškaitis & Büchner, 2013).

At Little Linford Wood it took dormice 10 years to move beyond the boundaries of the wood and a further four years to colonise 4km of hedge and motorway verge. It can be seen that the prospect of these sites linking up is not very high, particularly at a time when the dormouse population may be declining in number and range.

The most distant sites (from other reintroductions or from wild populations) are in Yorkshire, Lincolnshire, Nottinghamshire and Derbyshire, all towards the northern end of the range of dormice. Amongst these, only Nottinghamshire has existing populations. Between the release sites in these counties the closest proximity is 24km and the greatest isolation for a single site is 38km.

We have in effect created over a dozen small isolated populations which are likely to remain so for some time to come. This carries the risk of all small populations which are susceptible to stochastic processes, particularly of climate (Bright & Morris 1996) and low genetic diversity.

In his report on enhancing dormouse populations, White (2011) states that:

> *"…it may now be appropriate to actively promote the acquisition of new sites that are relatively near to existing sites. This would potentially allow future reintroduced dormouse populations to link with the existing population to form a more robust metapopulation."*

It is essential that any future re-introductions of dormice should either be based on this principle, or be at new sites where a cluster of reintroductions may be carried out. Suggestions for the sizes of woods, their proximity and connectivity and for the number of animals to be released are provided in *Recommendations for the reintroduction programme*, below.

Management of project

In carrying out this review I had a strong sense of a small group of organisations working in parallel on the same project, for the most part very successfully, but not that it was a team effort or that there was an individual in charge of it. In addition, I do not feel that there is an appropriate opportunity for participants to take part in ongoing discussions about the project where possible changes can be discussed and agreement sought on ways forward.

In practice, there has always been a clear line of management responsibility with Senior Mammal Specialists in English Nature and Natural England being Project Officers on behalf of these organisations. However participating organisations do not seem to have taken advantage of this as a means for resolving issues which have arisen. Where there have been divergences of view among participants no-one has acted as arbiter or ensured that differences are satisfactorily aired and resolved. This may be due to reticence in involving people who clearly have many responsibilities and busy time tables, or to the fact that it has not been made sufficiently clear that this should be done.

Opportunities for discussion are available at the annual UK Dormouse Steering Group meetings. However these meetings cover a wide range of topics which means that opportunities for in-depth discussion of the reintroduction programme are limited. At the last meeting, reintroductions amounted to three out of 16 substantive items on the agenda and accounted for 14% of the minutes. Although reports about reintroductions are

received and some issues discussed it is not clear whether these meetings have the power to make decisions about the programme or that they do so.

Success of the reintroduction programme

In his report on enhancing the programme Ian White (2011) says;

The Dormouse reintroduction programme which is part of the Natural England Recovery programme has been successful in a number of ways:

- *It has achieved, and exceeded the 1995 BAP target to re-establish dormice in five counties*
- *It has promoted the engagement of individuals and local groups to become involved in dormouse surveying, monitoring and conservation.*
- *A dormouse reintroduction involves the close co-ordination and co-operation of a number Government and non-government organisations such as PTES, Natural England, ZSL, CDCBG, private and public landowners, local dormouse groups, local mammal groups, local Wildlife Trusts,*
- *A dormouse release will promote sympathetic, long term woodland and hedgerow management.*

This is undoubtedly true and a number of other interviewees stressed the value of the programme in promoting dormouse conservation generally and involving a range of organisations and individuals. Nevertheless the programme is not an unqualified success, with certainly three and possibly five populations failing to survive in the long term and others failing to expand into nearby habitat.

Tony Sainsbury expressed some concern that the programme was not more successful, and felt that insufficient attention was being paid to investigating the causes of this which might then lead to improvements in protocols and procedures.

A significant problem in assessing the success of this project is that the original target, to carry out one reintroduction per year within the dormouse's current or recent range, does not specify outcomes in terms of viable populations. Later objectives which use words like re-establish (see above) or self-sustaining populations (Dormouse BAP 1995 - see Appendix C) are either difficult to define or need to be qualified by a time scale.

Here, two approaches are used to assess the programme. The first is based on the stages which Bright and Morris (2002) originally recommended as measures of success. The second adopts a longitudinal approach to investigate progress in sites a) in the first three years after release b) sites where dormice where released more than 5 years ago (2006 or earlier) c) sites where dormice have been released more than 10 years ago.

Success at reaching the seven 'stages'

From the start, there has been a list of stages which the dormouse population should reach. Originally there were six, to which one more was added by Ian White. White expressed these as follows:

The success of the reintroductions can be measured by identifying if, and when, the following stages having been reached (Bright & Morris 2002):

Stage 1 *Release accomplished by July, with animals returning to feed in the cages, even if they do not live in them all the time.*

Stage 2 *Young born at the new site, preferably by September of the first year.*

Stage 3 *Some animals survive the first winter, being present in nest boxes in Year 2.*

Stage 4 *Birth of second generation young (i.e. born to females who themselves were born at the site). This is difficult to demonstrate unless members of the original release cohort are permanently marked.* [Note: It is assumed, in PTES reports and below, that this stage has been reached if young are born in the third year after

release.]

Stage 5 *More adults present than were originally released (i.e. survival now exceeds losses).*

Stage 6 *Evidence of dispersal found.*

Stage 7 *Evidence of dispersal from the original reintroduction woodland.*

(Stage 7 was added by White to differentiate between dispersal within the release site woodland and dispersal beyond the release site woodland).

In his report to the UK Dormouse Working Group of January 2013, White added a further stage - 8 ... *to indicate when a reintroduced population has a high probability of mixing with a native or another reintroduced population so creating a local metapopulation.* This recognises an important point in the history of a re-introduction but to date no evidence has been presented which shows that it has been reached.

The problem with this approach is that it gives a multiplicity of success points, some over a very short timescale, which makes it very difficult to make simple comparisons between sites at which dormice have been released at the rate of one per year between 1994 and 2012. Note also that:

a) to date stage 4 has only been inferred, not proven;

b) it is almost impossible to achieve a realistic assessment of numbers (stage 5) owing to the fact that not all dormice are recorded during nest box checks;

c) assessment at stage 5 could be made in spring, prior to breeding or in the autumn after breeding has taken place - the former would seem to be more appropriate but no site has achieved this;

d) detection of stages 6 and 7 is dependent on adequate monitoring being carried out beyond the release area which has not always been done;

e) it can take several years (up to at least 10) to reach stage 7 and dormice have only been at 11 sites for that length of time.

Given that stages 1 - 3 occur over a very short timescale (two years) and that assessment of stage 5 is very difficult one may simplify this by reducing to three key stages: 4, 6 & 7.

Stage 4: At all sites where it is more than three years since the release, dormouse populations have reached stage 4 and one may state that there is 100% success in reaching that stage.

Stage 6: The time taken to reach stage 6 is not predetermined but may be assessed by looking at the length of time those sites which have reached that stage took to do so. Of the nine sites for which dates are available, the time taken ranged from 1 year to 10 with a mean of 4.4 and a median of three years.

Taking a very conservative time period, of the nine sites where dormice were released more than 10 years ago, six reached stage 6. Using a less conservative value of those sites where dormice were released more than five years ago the sample increases to fifteen, of which ten have reached stage 6. One may reasonably conclude that two thirds of the sites successfully reached that stage.

Note on dates: The baseline for this review is 2012 (when dormice were last active), so ten years ago is 2002 and more than ten years ago is 2001 or earlier. Similarly, more than five years ago is 2006 or earlier.

Stage 7: Of the six sites where the time taken to reach stage 7 is known, the average was 5.7 years (median 5), range 1 to 10 years. Of the nine sites where dormice were released in 2001 or earlier (i.e. more than the maximum value of 10 years), five have reached stage

7 and three are now believed to be extinct. Thus the success rate for these sites is 56%. For the 14 sites where dormice have been present for more than 6 years (equivalent to the mean value), the success rate is 43%.

Assessing success in the short, medium and long term

Using the approaches above one may assess the progress of the reintroductions in the short and medium term, answering the questions:

a) Short term: did dormice survive the first two winters and breed in the third year (i.e. reach stage 4)?

b) Medium term: did the dormouse population at the release site, remain stable over a period of 5-10 years and disperse from there into adjacent areas outside the original wood?

In the long term what is required is for the dormouse population to increase in size and expand its range to reach a level where the probability of long term survival of the population is high. Determining criteria for this is not easy but one approach would be to aim for the dormouse population to be found in an area of sufficient size to substantially reduce the risk of extinction due to stochastic processes (see below). In the following section, the long term success is assessed by only considering sites where dormice were released more than10 years ago.

Short term success:

Taking the criterion for short term success as reaching stage 4 (when young are born in the third year after release), all sites where releases took place prior to 2010 (sixteen) may be considered successful in the short term. Of the two sites since then, Windmill Naps (released 2010/11) has reached stage 3 (surviving the first winter) and Alne Wood (released 2012) stage 1 (animals released from cages and returning to feed from them).

At one site (Freeholders) dormice were recorded outside the wood within a year of release. Whether this is a reflection of a very rapid rise in population or the small size of the wood (16ha) is unclear.

Medium term success:

Considering only sites where dormice were released in 2006 or earlier (15), populations have failed to survive at three (Treswell, Bubbenhall and Leashaw Woods) and are probably no longer present at Rievaulx Wood and Hamps Valley. Numbers appear to be declining at Stockton Dingle and Monsal Woods. Populations are stable at five sites (Brampton, Priestley, Maulden, Chambers Farm and Heslett & Peter Woods.

They are known to have spread beyond the boundaries of the release woodlands (stage 7) at five sites (Stockton Dingle, Little Linford, Priestley, Chambers and Bradfield Woods). Times recorded for this range from 3 years (Stockton Dingle) to 10 years (Little Linford and Chambers Farm).

Long term success:

Of the nine sites where dormice were released more than 10 years ago, only two (Priestly Wood and Linford Wood) may be judged successful in that populations have spread from the original release wood and are stable within it. Dormice are probably extinct at three of these sites (Treswell, Bubbenhall, and Rievaulx) and possibly declining at one other (Stockton Dingle). At Brampton and Maulden the populations are stable but have not spread and at Bedford Purlieus the population is increasing, but has not yet spread.

<u>Summary</u>

- All sites were successful in the short term (up to stage 4).
- Two thirds of sites were successful in the medium term (5-10 years) and by this time one third had spread beyond the release wood.

- In the long term, four of the nine sites failed (extinct or declining populations) and dormice have only dispersed from the release wood at two sites.

The information may also be used to answer questions raised in the specification for this review as follows:

- *Have dormice been restored to their former range?*
  No.
- *Have dormice been re-established in at least five self-sustaining populations, from which they have been lost?*
  Yes, in the short to medium term.
- *Have dormice populations which were isolated been strengthened to a viable level?*
  No.
- *Have scattered populations expanded to a viable level?*
  No.

Individual sites

Sites are not discussed individually as there are brief descriptions in Ian White's annual reports and Jenny Caddick's review (unpubl. 2005). However some do merit further attention either individually or as a category.

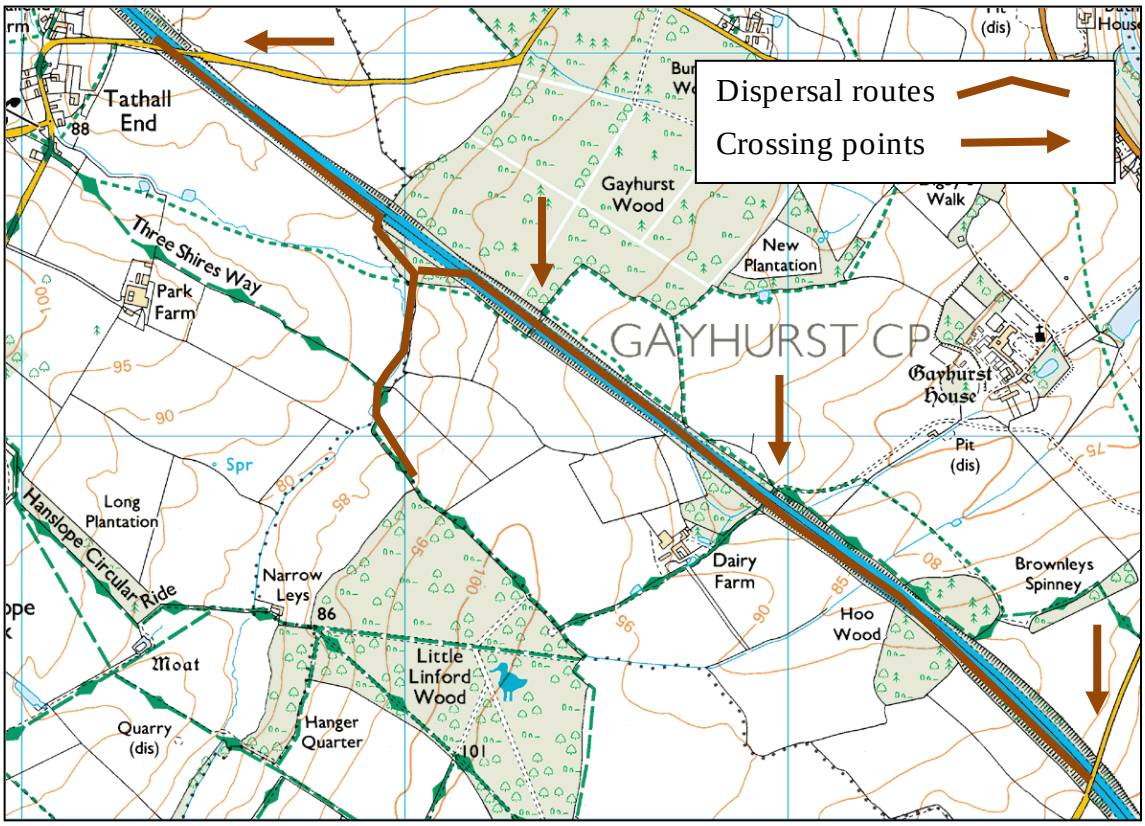
At the sites where dormice are extinct or probably so, Ian White has identified lack of appropriate management as a common factor (although other factors have also contributed – for example, see Black, 2004). At Treswell, the existing, agreed management proved to be less suitable for dormice than had originally been thought and at other sites, promised management did not happen or was not adequate. Subsequently, the habitat in Treswell Wood, under continuing coppice management by Nottinghamshire Wildlife Trust, has improved sufficiently enough for a further release to be planned for 2013.

Stockton Dingle is an interesting site because it has been monitored by the Northwest Dormouse Partnership and additional micro-chipping has been carried out since 2006. The Partnership has been carrying out a parallel (and larger) study at a site some 40km to the North West (Bontuchel, Denbighshire). In a recent paper (Bird et al., 2012) the reintroduction site was characterised as 'fragile' in contrast with the natural site which is stable. I have classed it as unsuccessful because of this assessment and because the population appears to be declining (based on Ian White's assessment). However results for 2012 suggest that the situation may be changing (Sarah Bird, pers comm.)

The two most successful sites are Little Linford and Priestly Woods which, at 14 and 12 years since introduction, have populations which are both spreading and increasing. At Bradfield Wood dormice are also increasing in number and spreading, though it is only six years since the introduction.

Little Linford Wood is particularly interesting since dormice have dispersed approximately 800m along a hedge to an isolated fragment of Gayhurst Wood south of the M1. They have also dispersed along the edge of the motorway using the planted woodlands beside it and are now known to be present along a minimum distance of 3km. Unfortunately Little Linford is somewhat isolated from other woods. To the south of the M1 the nearest other woodlands of suitable size are 9km away. However, north of the M1 lies the remainder of Gayhurst Wood (approximately 70ha) and there are four crossing points along the motorway in the area already colonised - two road bridges, a footbridge and an underpass. In my opinion, continued monitoring of this site, including the northern part of Gayhurst Wood would be very valuable in order to see whether this happens. If it does, the possibility of introducing more dormice in Gayhurst Wood in order to increase genetic diversity should be considered as well as in other woodlands to the north of the M1.

Figure 1. Relationship between Little Linford Wood, Gayhurst Wood and the M1



Priestley and Bradfield woods are both close to other woodlands which appear to have potential for dormice and dormice have spread from Priestly Wood to Bonny Wood, which is separated by approximately 100m of hedge. There is clearly scope for augmenting these sites by further releases in other nearby woodlands, provided they are not already occupied and this should be considered.

Factors which might lead to a lack of success

Several factors might be involved in a reintroduction not succeeding and these are addressed briefly here. Where relevant data were available it was investigated in a preliminary manner to determine whether or not there were obvious relationships. Given the very small number of samples over a relatively short period of time, relationships were suggestive rather than conclusive and more data over a longer period of time will be needed to fully explore them. Unless otherwise stated the data from which comparisons are drawn are in Appendix E, table E.2.

As an interim approach to measuring success, those sites where populations are stable or increasing are considered to be *successful* and those where populations are extinct or declining as *unsuccessful*. This does not take into account the possibility that some of the successful sites are relatively recent and circumstances may change or that this decision is being made after a temporary period of decline at some sites. Nevertheless, this does divide the sites into two groups of roughly equal numbers 9 successful and 7 unsuccessful which are used in the discussion below. Windmill Naps and Alne Wood are excluded as being too recent for a judgement to be made.

Habitat:

The decline of dormice has been attributed mainly to destruction and deterioration of habitat. Studies by Bright and Morris in the 1990s support this view (Bright, 1996; Bright et al., 1994; Bright & Morris, 1996) as do analyses carried out by Fiona Sanderson. Ian White and Nida Al-Fulaij are clearly persuaded that this is a significant factor in

determining the success of reintroductions and the observations reported above support that view. However it has not been possible to systematically explore this owing to the small number of sites, the time period over which releases have occurred and the difficulties of assessing both habitat quality and the extent and suitability of management.

Climate:

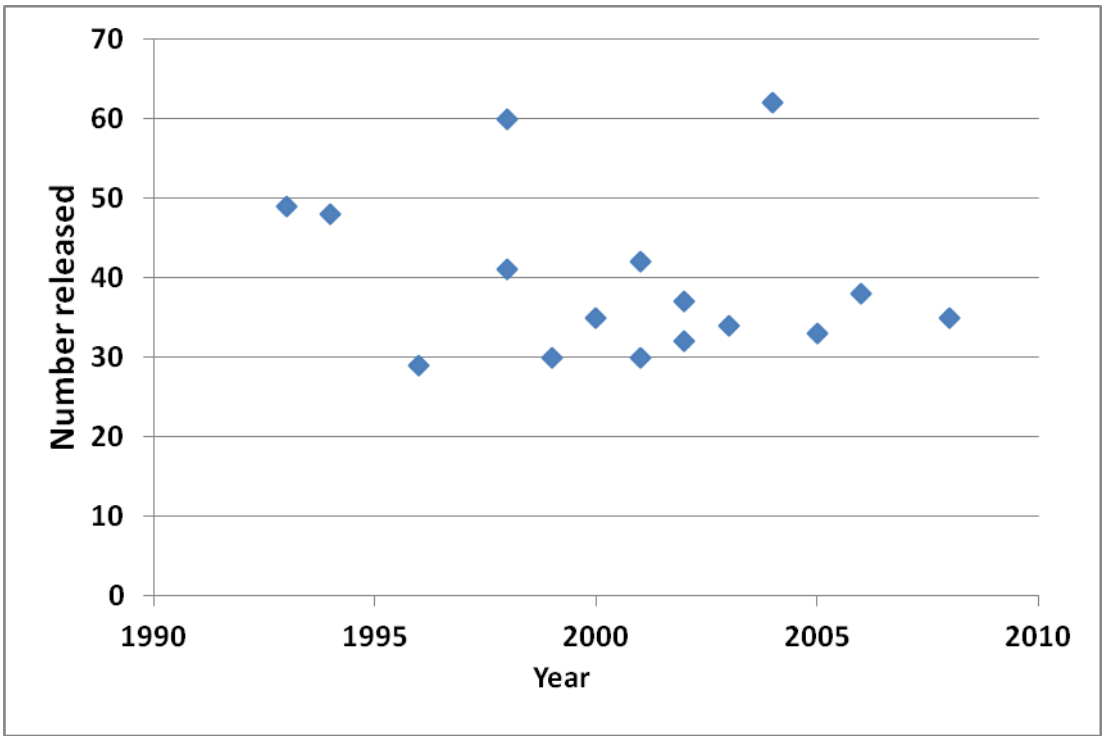
Fiona Sanderson found that weather patterns had an influence on annual changes in dormouse numbers and that these varied between habitat types. She was able to detect a relationship between the North Atlantic Oscillation index and dormouse populations. Given that dormice are found further north in mainland European countries than the UK and that the populations in northern England appear to have declined more than those in the south, one approach to investigating this is to compare the success of reintroductions in the northern part of their range to those carried out further south. This was done and although there appears to be a tendency for reintroductions further north to be less successful, this is not statistically significant.

Number of animals released:

Nida Al-Fulaij suggested that the number of dormice being released had declined since the start of the programme and that 30 animals per site was becoming the norm rather than a minimum. She was concerned that this might decrease the probability of success.

This tendency to release fewer animals can be confirmed, only one of the first 5 releases involved less than 40 animals but only 2 of the subsequent releases involved more than 40. Sites which are extinct or declining tend to have had fewer dormice released but the difference is small and not significant. Median for unsuccessful sites is 34 and for successful, 38. At the two sites with the largest releases (Bubbenhall (60) and Heslett and Peter Wood (62) dormice are extinct at the first and stable at the second. Of the six sites where fewer than 35 animals were released, two are extinct, two declining and two stable.

Figure 2. The number of dormice released against time



The DCH points out that the average density of dormice across the country is estimated at 2.2ha^{-1}. Based on this, the oft quoted figure of 20ha (Bright et al. 1994) as being the minimum area of woodland for long term viability of isolated dormouse populations implies

a need for 40 or more animals to ensure a viable population. Given that the source of animals is largely captive bred individuals which already have a lower genetic diversity, there would seem to be significant benefits in releasing more animals per site, or more animals in one area, dispersed over a cluster of sites.

Size of release site:

The recommended minimum size for a release site is 20ha, but two sites were smaller than this (Stockton Dingle, 8ha; Freeholders Wood, 16ha). The largest site was Chambers Farm Wood (347ha) but half the first 16 sites were 25ha or less in area.

Successful sites (median 72ha) tended to be larger than unsuccessful (median = 22ha) but the difference was not significant, being precisely on the threshold (p=0.05).

Treatment of animals prior to release:

Staff at PTES expressed concern over the fact that during quarantine, dormice are now kept in separate cages which are very small and are indoors, whereas previously they were in much larger outdoor cages in pairs. They felt that this might have a detrimental effect on the behaviour of the dormice leading them to be more vulnerable on release, to predation for example.

There is no evidence to support this, but it is a serious concern and in theory it could be addressed by looking for a detectable decline in survival overall when comparing releases before the change in protocol took place.

Using returns from micro-chipped dormice it may be possible to gain some information on survival but numbers are small. Eight and ten tagged dormice were recovered at each of Freeholders and Bradfield woods, 23% and 26% of those released respectively.

Table 1. Recaptures of tagged dormice

Site	Released	Recap.	Dormice	%	Year
Leashaw Wood	34	3	2	6%	2003
Heslett & Peter Wood	62	4	4	6%	2004
Monsal Dale	33	2	2	6%	2005
Bradfield Wood	38	19	10	26%	2006
Freeholders	35	19	8	23%	2008
Windmill Naps	25	4	4	16%	2010

Released = total number released
Recap. = total recaptures of tagged dormice
Dormice = number of tagged dormice recaptured
% = percentage of released animal recaptured
Year = year of release

Of the 30 tagged animals that were recaptured, 12 were caught in the year following release indicating a minimum overwinter survival of 40% and four of these were caught after a second winter in the wild. Note that each of these animals had also survived at least a single winter in captivity, having been released after emerging from hibernation.

Recommendations for the reintroduction programme

Changes to existing protocols and procedures

Before discussing the details of how sites are selected, captive animals sourced and maintained and the procedures for veterinary inspections and release, I have included a section on dispersion of release sites. The scattered approach that has been adopted to date has a number of flaws and I strongly recommend that it be reconsidered.

Dispersion of sites

Bright et al. (1994) suggested that 20ha is the minimum area needed for dormice to survive in the medium term where woodlands are isolated. For long term viability a substantially larger area would seem more appropriate. Ideally this would consist of a network of woods and hedges where links are robust, secure and managed sympathetically. To date dormice have only been released at one site in any one area (apart from at the two small woods of Heslett and Peter Wood, 200m apart and totalling only 24ha) and there are considerable gaps between released populations as well as between released and existing populations. No attempt has been made to build up a viable network of metapopulations to further increase viability and in future this should be the first priority.

Future releases should focus on building up such a network rather than waiting for the dormice to do so from a single reintroduction site. This would have the benefit of increasing the size of the gene pool and also ensuring that populations more quickly reach a stage where risks to small populations are significantly reduced.

The more prescriptive the criteria for doing this, the more difficult it will be to find suitable sites so the following suggestions should be seen as such. They should be discussed by those with direct experience in the field before implementation and should be taken as guidelines, not as rigid requirements.

In order to avoid confusion it is important to distinguish between a release site (normally one wood but it could be two places within one very large wood) and a cluster of sites (normally separate woods) which are sufficiently close together for animals to disperse between them. It is envisaged that such a cluster would form a viable self-sustaining population which might be distant from existing natural populations but could be close to them in some circumstances. Clusters could be formed *de novo* or be based on existing release sites or on existing natural populations.

Nature of a cluster

An ideal cluster would consist of 4 - 6 woodlands each of 20ha or more in extent and totalling more than 150ha. Distances between would depend on connectivity but the aim should be for them to be within a radius of no more than 5km.

Connectivity would be defined in two ways, a) based on maximum dispersal distances depending on intervening habitat, see table 2 below, and b) absence of barriers (see below).

Table 2.

Habitat	Max dispersal dist.
Arable land with no hedges	500m
'Dispersal' hedges: heavily managed or moderately gappy	2km
Habitable hedges: 3-4m high or wide, lightly managed, few gaps	5km

Greater distances would be acceptable where there are intervening 'stepping stones' in the form of woodland and/or scrub >1ha in extent.

Barriers

No roads > 12m wide; no rivers unless canopies connect or small (<10m wide) with bridges present.

Releases

Within a cluster, a minimum of 150 animals should be released. This could take place over a few years in order not to overstretch captive breeding resources or source populations. At any one site within a cluster, there should be an absolute minimum of 30 animals released, preferably 50 where the sites are 30ha or larger.

Site selection

Two of the factors which might lead to a lack of success (management and size) are determined at this stage and criteria for these should, in future, be more rigorously applied. I recognise that Don MacPherson's project (MacPerson et al, 2003) showed how difficult it can be to find suitable sites, but feel that this should have a much higher priority in future. In particular, no sites should be taken on until firm commitments to management have been formally agreed.

There is a need to ensure that dormice are not released into isolated woods unless they are very large. I would suggest a minimum of 250ha but this could be discussed further. Sites which are less than 20ha may be taken on if they can form part of a network where there is scope to develop a metapopulation (see above).

Further thought must be given to ways of finding sites. Ian White has suggested that the Ministry of Justice has large, potentially suitable holdings and I feel that this and other large land-holding organisations should be approached, again, if this has been tried before. Other potential originations include large conservation NGOs (Woodland Trust, National Trust, Wildlife Trusts, the National Forest and the RSPB) as well other government bodies and departments such as the Forestry Commission and the Ministry of Defence.

On the whole, it seems likely that the long term assurances needed about ownership and management are less likely to be available for privately owned woodland. However, where there are other secure sites in the vicinity, these should not be overlooked as part of a cluster. This is particularly the case with large estates which may have an interest in nature conservation or are carrying out sympathetic (often traditional) habitat management. They are also likely to consider long-term management plans.

Captive breeding

The captive breeding programme is functioning well and there is no need to change the procedures currently in place.

However, the difficulties of obtaining new stock need to be given greater consideration and the issues raised by Neil Bemment properly addressed. Restrictions on the taking of young should be reviewed. There is no ecological or conservation reason to confine the take to light, late-born young. Consideration should also be given to making direct approaches to suitable contributors to the NDMP (such as professional ecologists) rather than making generalised requests.

In addition, the suggestion of translocating dormice directly from an existing site to a release site should be fully considered. Risk assessments would need to consider matters of health, genetics, availability and impact on source populations. Again, directly approaching professional ecologists who are monitoring sites may prove to be an effective approach.

Veterinary procedures

Current protocols are an appropriate balance between the risk of spreading disease and the welfare needs of dormice. Nevertheless, both of these should be kept under review, not least to address the concerns of some participants.

Data obtained from the returns of micro-chipped dormice should be monitored to assess survivorship. The potential for investigating stress using corticosteroid assays should be investigated.

Health surveillance of wild and released populations should continue.

Release protocol and monitoring

The original release protocol (Bright & Morris, 2002) is still followed to a large degree and continues to work well. There is no evidence to suggest that this needs modifying. However consideration should be given to both sex ratios and total numbers of animals released. This is considered in the discussion of clusters of sites above.

The presence of a volunteer, or preferably a group of volunteers, to undertake daily feeding visits immediately after dormice are put in release cages and then regular but less frequent ones in ensuing weeks is essential. In addition, such people normally continue to carry out monitoring according to NDMP protocols in succeeding years.

In practice, where the dormouse population persists, it is not normally difficult to maintain this level of interest but it would be beneficial to encourage volunteers to sign up for a minimum period of, say, five years. I recommend agreeing in advance the minimum requirements for monitoring, which should be a minimum of twice per year and ideally always in the same month. Also it is important to thoroughly emphasise the great importance of always checking for microchips during the first three years after release. This might be difficult where working with individuals but some counties (e.g. Suffolk) have active dormouse groups which undertake training and monitoring. It would be beneficial to invest time in encouraging the formation of these in areas where none exist but conditions are otherwise suitable for reintroducing dormice.

It would clearly be beneficial to continue monitoring for a period sufficiently long to find out how the population develops, but the benefits of requiring a commitment to this have to be weighed against the likelihood that volunteers would be unwilling to make one, even though they are likely to do the work.

It has been suggested that monitoring could start sooner after release (August and September) in order to assess the condition of dormice at an earlier stage. There is some reluctance to do this in case it disturbs the dormice. In my opinion this anxiety is probably misplaced, since at present all animals have been held in captivity for some time. It would however create an additional burden for volunteers. I recommend that this be discussed further with a view to assessing the benefits against the costs.

Interactions with volunteers (monitors and managers)

I made no attempt to contact individuals or organisations managing the woodlands where reintroductions have taken place, but did meet staff of the Nottinghamshire Wildlife Trust at Treswell Wood. It is clear that since the original problems there, significant habitat improvements have occurred and there is a good working relationship between staff of the NWT and PTES. It is obvious that this level of co-operation and mutual understanding is essential for a successful reintroduction and therefore a matter of considerable importance in selecting future sites.

Relationships with the volunteers that I met were also very good and at present a considerable amount of effort is put into maintaining these. This should continue and the proactive approach currently adopted is also important.

Note however that there are significant resource implications in doing this since the number of sites, and therefore contributors, increases each year. PTES are at present considering ways of maintaining the contact and enthusiasm by organising meetings specifically for volunteers and this approach should continue to be developed. They have also encouraged land managers to attend appropriate courses, including those which they put on themselves, and this too should be continued. Consideration could also be given to subsidising attendance at such courses by paying expenses and reducing or waiving fees.

Notwithstanding the need to maintain these relationships, it may be appropriate to prioritise efforts towards sites which are clearly successful or have greater scope for forming clusters and away from those where the reintroduction appears to be failing and sites are very isolated.

Other issues

Where to reintroduce dormice geographically?

As pointed out above, at present, sites are scattered widely at both the national and local level. The need to build up clusters of sites at local level has already been discussed. However there is also a need to determine in what parts of the country efforts should be focussed.

One significant factor in this is the issue of climate change. The Environment Agency (press release, 4th March 2013) has pointed out that 2012 was a record year for both floods and drought, and the principal message about the impact of climate changes is one of uncertainty. Weather has been shown to influence dormouse population ecology (Sanderson 2004), but it is not at all clear whether changes over the next few decades will be beneficial to dormice or detrimental. It is conceivable that the range of dormice in the UK could expand northwards if suitable habitat is available but also possible that it may contract.

Concern has been expressed about various impacts, including changes in habitat structure and composition and phenological effects whereby the physiological adaptations of dormice which determine when they go into and emerge from hibernation may not synchronise with food supplies. In addition, the impact of climate on farming and land management practices may be influential.

Adopting the precautionary principle and preparing for contraction in range due to adverse climate conditions suggests that future efforts should not be concentrated on isolated populations at the northern end of the current dormouse range but in those more centrally placed. Nevertheless over time the predictions from climate change may become clearer and if there is evidence that dormice (like some other species) might be better able to exploit northern England than at present, this policy should be reviewed.

Counties versus squares

To date reintroductions have been targeted on a county basis. This is partly because some of the evidence for a decline in dormouse populations is based on these but also because it has the benefit of potential links with wildlife trusts, and local mammal or dormouse groups which tend to be county-based. Nevertheless, counties are no more ecologically determined than the boundaries of 100km squares. A more natural way of considering this would be to base it on the current known distribution of dormice - figure 3 shows that dormouse records can be seen to stratify along four latitudinal bands.

Geographical regions

South: south of the river Thames, 10km squares SS to TR. Dormice widespread throughout with few exceptions (Wiltshire, west Cornwall).

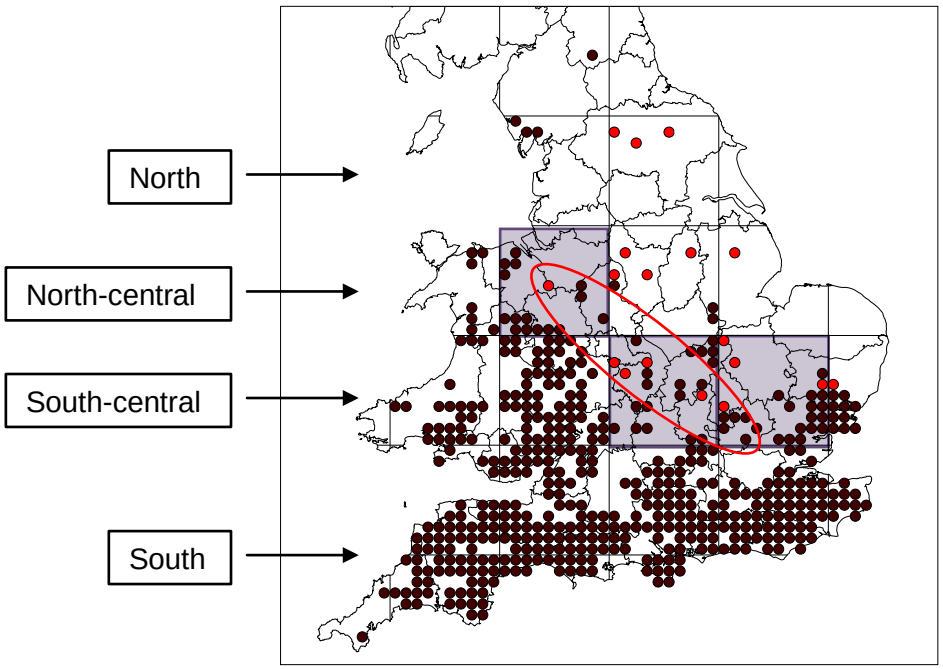
South-central: squares SO to TM (Worcestershire to Suffolk). Dormice more widespread at east and western ends (SO and TM) than in between (SP and TL). This could be due to under-recording.

North-central: squares SJ to TF. Dormouse populations scattered. Only reintroduction sites present in northern half (six). Nine natural localities in southern half.

North: Squares SD and SE. Few isolated records, 3 natural localities in Cumbria, one in Northumberland and three introduced ones in Yorkshire.

It is recommended that future activity should be focussed on the two central areas above, either on 100km squares SJ, SP and TL (shaded purple) or on the counties Hertfordshire, Bedfordshire, Buckinghamshire, Northamptonshire, Oxfordshire, Warwickshire, Staffordshire, Shropshire (north), Cheshire (south). These are roughly enclosed by the red oval.

Figure 3. Distribution records from the NDD at a resolution of 10km squares. Squares containing reintroduction sites in red. Purple squares and red oval indicate areas recommended for future reintroductions



Genetics

Two recent PhD projects investigated genetics in dormice (Naim 2010; Mills, 2012). The first of these identified three phylogenetic clusters on the basis of mitochondrial DNA. Using microsatellites, Mills reported "*high levels of population differentiation and genetic isolation across the southwest UK* ". To date no consideration has been given to the implications of these findings for the reintroduction programme and this should be done.

It is only recently that techniques for monitoring genetic diversity in wild populations have become readily available and there is only a single study comparing a reintroduced and wild population, those at Stockton Dingle and Bontuchel, respectively. Naim (2010) found evidence for reduced genetic diversity in the reintroduced population, but no significant bottleneck. Allelic richness was greater at Bontuchel and there were also more alleles per locus (6 - 14, compared to 5- 11).

Under the circumstances the differences between these are not great and give some reassurance. Nevertheless, the present difficulties in sourcing animals from the wild may

mean that greater reliance is placed on lineages of captive bred animals than is desirable and this should be kept under review.

Management of project

In my view there should be two changes. First, while Natural England will continue to hold overall responsibility for the project, one person should be designated as Project Co-ordinator (or *convener, director, organiser).* This could be a member of NE staff or an outsider but should not be drawn from one of the participating organisations.

Second, there should be a forum for discussion of the project either annually or every other year. There are several places in this report where I have recommended consideration or discussion of recommendations and this is where that should happen. It should be chaired by the Project Co-ordinator and involve an appropriate number of staff from each of the participating organisations (PTES, ZSL, CDCBG) as well, perhaps, as one or two representatives of the volunteers. It would also be beneficial to involve one or two outsiders, at least one of whom should be a scientist with experience in mammal ecology, making this in effect a project advisory panel.

The Project Co-ordinator could report to the UK Dormouse Steering Group to reduce the number of meetings attended by other participants as well as the number of attendees at Steering Group meetings.

Treatment of existing sites:

Several existing sites lie outside the area where priority should be focussed for future releases and decisions must be made about how to treat these. Given the pressures on resources there is a need to ensure that efforts are directed to sites which offer the greatest benefits. A simple list of priorities is outlined below but no attempt has been made to classify individual sites into them at this stage since account should also be taken of the input and enthusiasm of volunteers.

Priorities

a) Abandon: Sites where dormice are extinct except where there is a strong likelihood of recovery and potential for a cluster.
b) Minimal input: Existing sites which are in continued and long-term decline or very isolated.
c) Maintenance: Existing sites which are stable or increasing but isolated.
d) High input: New sites and existing sites which can form basis of a cluster.

Review of progress

Given the significant changes proposed, the project should be reviewed at an early stage to ensure that the recommendations can be satisfactorily implemented and again after a longer period to determine whether or not they have led to an improvement in the success of the programme.

Clearly the Advisory Panel will to some extent review these on an annual basis but there is a need for a more formal report to be prepared (possibly by members of the panel who are not from participating organisations) after three years to assess practicality. A review at ten years to assess effectiveness should be carried out by someone not directly connected with the project or a member of the advisory panel.

Criteria for success at the first report should be that:

- two areas should have been identified for reintroductions under the new protocols (i.e. potential to create two metapopulations);
- suitable and formally agreed management plans are in place at sites where reintroductions have already taken place under this protocol and are planned for the following year;
- at least two releases have taken place;

- there is no evidence that it is not practical to extend this approach elsewhere.

Criteria for success at the second report should be that:

- at least two metapopulations have been formed and at least one further area identified;
- dormouse populations in these areas are stable or increasing in numbers;
- there is evidence of expansion within the release wood (stage 6) in at least half the sites where dormice were released three or more years ago;
- there is evidence of expansion outside the release woods and into connecting countryside (stage 7) in at least half of the sites where dormice were released five or more years ago.

The place of reintroductions in dormouse conservation

The reintroduction programme is not the only technique being used in the conservation of dormouse populations as recommended in the Biodiversity/Species Action Plans. The monitoring of dormouse populations by means of the NDMP and promoting appropriate management practices are also seen as important. Habitat management includes the enhancement and maintenance of hedgerows and other connecting features as well as woodlands, recognising the importance of mitigating the fragmentation of habitats by ensuring the maintenance of suitable connections between them.

These practices are not mutually exclusive but clearly, when resources are limiting, the question must be asked as to how much to invest in each. This question may become more acute if the methods used for selecting sites for reintroductions or the techniques employed make it more difficult to find appropriate sites or add significantly to the resources required to fulfil them.

The approaches recommended above may be characterised as concentrating on consolidation and long term security by the creation of (meta)populations which are substantially larger than at present. If carried out as described it will create fewer dormouse populations but these should have a greater probability of long term survival and be more robust in the face of an uncertain climatic future. Previously the focus has been on restoration to a previous range which has led to a large number of populations being created but with lower probabilities of individual survival.

If the recommendations made above are adopted and either the additional costs or the impracticality of the approach make it clear that it is not viable then the question which has to be asked is: ‘Should the reintroduction programme continue as at present or should resources be devoted to other approaches to dormouse conservation?’

The answer to this depends very much on what objectives Natural England has for the dormouse population in England and whether or not the reintroduction programme can help to achieve them. In the specification for this contract four questions are asked and these are addressed in the following sections:

In the light of conclusions being drawn from the questions posed above, a suitable way forward would need to be adopted around the questions posed below.

- *Should dormouse conservation concentrate on habitat management, enhancement and creation schemes?*
- *Is there a need to top-up populations in some areas (existing re-introduction sites for example)? If so, how far from an existing site should a new site be located so that it might appropriately enhance the population?*
- *Is there a need to re-introduce dormice in failed counties or in additional targeted areas/counties based on their former range?*
- *If dormice have been restored to their former range, what is the reason for continuing with re-introductions?*

Habitat management, enhancement and creation

Bright et al (1994) showed that management of woodland has a significant impact on dormouse populations. Although it has not been possible to formally assess this, there was a very clear message from PTES staff that they believe that having an appropriate management programme will strongly affect the likelihood of a reintroduction being successful. Many conservation organisations are concerned with the management of dormouse habitat including various NGOs such as Hedgelink and the Woodland Trust at a national level and the County Wildlife Trusts more locally. The following initiatives are concerned wholly or partly with dormice:

1. PTES organises courses on woodland management for dormice and other conservation organisations offer courses which, while not directed specifically at dormice, have the potential to benefit them.
2. A national project, Hedgerows for Dormice, was undertaken over the period 2009 to 2011 during which over 2,000km of hedgerow was surveyed by volunteers trained at regional workshops. 10km of hedges were planted and 180 land managers took part in hedge management workshops. Four of these entered stewardship schemes as a result.
   The survey revealed that only 14% of hedges were in 'favourable condition' but this assessment was based on criteria used by Defra which may not be relevant to dormice. Excluding nutrient enrichment as a criterion increased the value to 28%. Efforts were directed at so called 'hotspots' based on the extent of dormouse recording taking place, rather than the density or distribution of dormice. No formal report is available and it is too soon to assess the long term impact of this work.
3. I was informed that local efforts to improve hedgerow connections are being made in Cheshire and Suffolk and while these are not solely aimed at dormice there is potential benefit to them.
   In Suffolk, the goal of the Wildlife Trust's Stour Valley Woodlands project is to "*reconnect these fragmented patches of habitat and link key sites to create an extensive woodland landscape which reunites isolated groups of dormouse and other woodland species*". While the Tracking Down Suffolk's Dormice Project is intended to "*expand knowledge of the distribution of dormice in known clusters, [and] to see if there are any remaining hitherto unknown populations in the County. This project also funds the planting of new hedgerows where this will help reconnect populations*".
   In Cheshire the British Association for Shooting and Conservation's Green Shoots project aims to "*recognise, build upon and co-ordinate the shooting community's considerable contribution to wildlife and biodiversity conservation*". The dormouse is one of their priority species for action and links have been established between the project and PTES.

The evidence from Little Linford Wood is that it took four years from the time that dormice were first recorded outside the wood for them to colonise 3-4km of linear habitat (broad hedge and roadside verge). Natural spread is clearly a slow process, but so is the building up of a population within a wood, it having taken ten years from release for the dormice to move outside a 40ha wood.

The implications of this are that habitat management is more likely to be effective as part of a consolidation than an expansion strategy. Thus, if the recommendations made here prove impractical or too costly it would be appropriate to divert resources into it. It should be noted that there are many potential objectives for woodland management. Not all of these are ideal for dormice and some may be detrimental. Given the need to maintain biodiversity as a whole, rather than a single species, it would be unreasonable and impractical to expect the management of woodland to be devoted entirely to maximising

dormouse populations. Nevertheless there could be considerable value in working with woodland managers and other woodland specialists to aim for the best compromises in methods.

Topping up existing populations

It has been suggested above that it would have been beneficial to release larger groups of dormice at many sites, both from the point of view of increasing the genetic diversity and ensuring that the population was sufficiently large to withstand stochastic events.

'Topping up' i.e. releasing more dormice at a site which appears to be 'failing' raises other sets of issues. In particular, one would need to understand why the site/population is failing. Clearly if the habitat is unsuitable or not being managed properly there is little point in releasing more animals until these problems have been resolved. In addition, there are questions about releasing new captive-born animals in an environment where they may end up competing with the descendants of earlier releases.

This could only be considered on a case by case basis, but it should only be considered for sites which comply with the revised criteria for selection recommended here. These would be classified as High input in the priorities list for existing sites above.

Further introductions in failed counties or additional areas

Table 3 below lists the counties where released populations are either extinct or declining. Dormice are now absent (as far as is known) from Nottinghamshire, despite attempts to reintroduce them. In Cheshire the population is declining at the single release site and in Derbyshire they are declining at the sole remaining release site in the county.

Table 3. Counties where released populations are either extinct (2nd column) or declining (3rd column). Fourth column shows number of sites in the county where dormice are known to be present (natural + released)

	Extinct	Decl.	Present
Cheshire	0	1	1
Derbyshire	1	1	1
Nottinghamshire	1	0	0
Staffordshire	1	0	5
Warwickshire	1	0	6
Yorkshire	1	0	2

A further attempt to release dormice at Treswell (Nottinghamshire) is to be made in 2013. Preparations are well advanced and it would be very disruptive to change them, as well as risking bad feeling amongst the volunteers and the local Wildlife Trust. On these grounds this should go ahead and consideration be given to creating a cluster of sites here. Elsewhere I recommend that sites are treated according to the new criteria for reintroductions described above and only in areas where there is likely to be a high probability of success.

Dormice restored to their former range?

Dormice have clearly not been restored to their former range since they were once present in Nottinghamshire and are no longer present there (Bright & Morris, 2002). There are undoubtedly other places where they were present in the past but have since become extinct.

Whether restoring the population to its former range is an appropriate ambition must be decided elsewhere, but given the major changes in landscape that took place in the last century and the risks associated with climate change it is possible that it is not achievable. In my opinion resources should not be allocated to attempting to create isolated

populations in remote areas. It would be better to consolidate the existing range rather than expand into areas where dormice are now very scarce or absent.

Summary of principle conclusions

1. The reintroduction programme should not continue in its present form. The strategy should change from one of expansion to consolidation.
2. Rather than disperse sites widely they should be clustered in small groups in order to create viable metapopulations.
3. A Project Coordinator should be appointed from outside the existing participating organisations and a small Advisory Group formed.
4. In addition to ongoing monitoring of progress by the Coordinator and Advisory Group there should be more formal reviews after three and ten years.

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Sarah Bird, Simone Bullion and Sue Raven kindly provided information from the volunteer and researcher viewpoints as did several members of the groups involved in management and monitoring at Treswell and Little Linford Woods.

The contribution of Vic Simpson who reviewed veterinary procedures for me, was of considerable value and I am very grateful to him for taking the time to do this.

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Appendix A: Project Specifications

Specification of works to undertake a review of the dormouse re-introduction programme in England

1. The dormouse re-introduction programme

The Common or Hazel Dormouse *Muscardinus avellanarius* is Britain's only native species of dormouse. Dormice were once widespread in the UK, but they are now more restricted in range and are vulnerable to local extinction. They are now mostly found in the southern counties of England and Wales, with some scattered populations in the midlands and the north of England.

There are likely to be several reasons why the range of dormice in England has become restricted, including fragmentation, deterioration and loss of habitat as well as wider climatic factors (Bright & Morris, 1996). The inappropriate management of woodlands in the past has meant that dormice have been lost from many counties and although these areas may now be more appropriately managed and the habitat may be suitable for dormice, they are unlikely to return without some assistance (Bright & Morris, 2002).

The dormouse re-introduction programme is part of Natural England's Species Recovery Programme and was initiated in order to restore dormice to areas of England from which they had been lost and where natural re-colonisation was unlikely. The first re-introduction took place in 1993 and since this time 18 re-introductions have taken place throughout England. Although reviews have been undertaken since the start of this programme, an updated review of these reintroductions now needs to be undertaken in order to re-evaluate the programme.

2. Project Objectives

The aim of the project is to undertake a review of the re-introduction programme for dormice through a review of the 18 releases that have taken place so far.

The project will answer the following questions:

- Were dormice released into appropriate locations, at the right time, with the correct sex ratio and suitable habitat management procedures being put in place to conserve the population for the long-term and promote its natural expansion? If not, what could have been done differently?
- Were pre-release procedures such as captive breeding, veterinary checks and PIT-tagging justified and cost-effective? Could anything have been improved?
- Have dormice been restored to their former range?

- *Have dormice been re-established in at least five self-sustaining populations, from which they have been lost?*
- *Have dormice populations which were isolated been strengthened to a viable level?*
- *Have scattered populations expanded to a viable level?*

- Have each of the 18 re-introductions been a success? Success criteria were defined by Paul Bright and Pat Morris (Bright & Morris, 2002) and these can be used to assess each release.

- ***Stage 1:*** *Release accomplished by July, with animals returning to feed in the cages, even if they do not live in them all the time.*

- ***Stage 2:*** *Young born at the new site, preferably by September of the first year.*

- ***Stage3:*** *Some animals survive the first winter, being present in nest boxes in year 2.*

- ***Stage 4:*** *Birth of second-generation young (i.e. born to females who themselves were born at the site). This is difficult to demonstrate unless members of the original release cohort are permanently marked.*

- ***Stage 5:*** *More adults present than were originally released (i.e. survival by now exceeds losses).*

- ***Stage 6:*** *Evidence of dispersal found.*

- ***Stage 7:*** *Evidence of dispersal from the release woodland.*

- Where re-introductions have failed, can the reason for failure be identified?

In the light of conclusions being drawn from the questions posed above a suitable way forward would need to be adopted around the questions posed below.

- Should dormouse conservation concentrate on habitat management, enhancement and creation schemes?

- Is there a need to top-up populations in some areas (existing re-introduction sites for example)? If so, how far from an existing site should a new site be located so that it might appropriately enhance the population?

- Is there a need to re-introduce dormice in failed counties or in additional targeted areas/counties based on their former range?

- If dormice have been restored to their former range, what is the reason for continuing with re-introductions?

3. Methodology

The contractor will review all 18 of the dormouse re-introduction projects, assessing the programme as a whole and addressing the objectives detailed in section 2. The contractor will need to work closely with the People's Trust for Endangered Species (PTES) who administer the National Dormouse Monitoring Programme (NDMP) and the National Dormouse Database (NDD). PTES have developed important relationships with the landowners at these re-introduction sites and it is imperative that

the contractor works closely with the project officer when reviewing each site. The contractor will also need to contact the Captive Breeders Group to discuss this review.

Given the timing of this contract, it is expected that this will mainly be a desk-based review, but if contractors feel that there is a need for field work then they may include this in their tender. Any contractor that chooses to undertake field work must be appropriately licensed to do so. Close contact will need to be maintained with Ian White of PTES who knows each re-introduction site and the associated management.

The contractor will produce a comprehensive report drawing on the findings of this project, with input from members of the project steering group and other key specialists within Natural England.

Appendix B: Questionnaire

Review of dormouse re-introductions

CDCBG - Questions

Please write as much or as little as you feel necessary, cells will expand. If there are matters you would like to be kept confidential, please mark them clearly. Eg using a highlight.

Bringing in new animals 1. Are there problems in obtaining new stock? If so can you outline them and let me know if you have any suggestions for overcoming them? 2. In a letter to TMJ in August 2009, you raised the issue of translocation. Is there a reason why this suggestion seems not to have been pursued?
1. 2.
Are husbandry guidelines/protocols appropriate? Do they accord with normal Zoo standards? Are there any concerns about using non-professional breeders?
It has been suggested that the way that dormice are held prior to release at ZSL (small plastic cages) may be detrimental. Do you have any views on this in terms of either welfare of the animals or the impact it may have on their chances of survival? Are dormice at Paignton similarly confined prior to release?
Prep for release 1. Do you get adequate notification of requirements? 2. Are there any problems with vet screening? 3. Are there any problems delivering stock to sites?
1. 2. 3.
There are two main breeders and several ‘smallholders’. Is this OK? Would it be better to have few breeders holding more stock?
Any other comments?
Costs. Would you be willing/able to provide an estimate of the cost of this project - either in financial terms or in terms of person/days per annum? An approximation only.

Appendix C: Biodiversity Action Plans

1. Biodiversity Action Plan of 1995
Dormouse section extracted from *Biodiversity: The UK Steering Group Report; Volume 2: Action Plans (Annex F and Annex G); 1995*

DORMOUSE (*MUSCARDINUS AVELLANARIUS*)

1. CURRENT STATUS

1.1 The dormouse does not occur in Scotland or Northern Ireland. In Wales, there are few known populations and in England it has become extinct in up to 7 counties (comprising half its former range) in the past 100 years. It is absent from the north, except for small populations in Cumbria and Northumberland, and although dormice are still widespread in southern counties (Devon to Kent), they are patchily distributed. Population densities everywhere are less than 10 adults per hectare, even in good habitats.

1.2 The dormouse is listed on Appendix 3 of the Bonn Convention and Annex IVa of the EC Habitats Directive. It is protected under Schedule 2 of the Conservation (Natural Habitats. etc.) Regulations, 1994 (Regulation 38) and Schedule 5 of the WCA 1981.

2. CURRENT FACTORS CAUSING LOSS OR

DECLINE

2.1 Changes in woodland management practice, notably cessation of hazel coppicing and stock incursion into woodland.

2.2 Fragmentation of woodland, leaving isolated, non-viable populations. (Short distances, possibly as little as 100m, form absolute barriers to dispersal, unless arboreal routes are available).

3. CURRENT ACTION

3.1 Ecological research has led to practical proposals for conservation management. A nestbox scheme has been established, aimed at collating data on breeding and population density from sites throughout the present range.

3.2 *A Practical Guide to Dormouse Conservation* was published by the Mammal Society in 1989, and EN are preparing manual of dormouse conservation management.

3.3 In 1992 the dormouse was added to English Nature's Species Recovery Programme, with the aim of protecting and consolidating the species at selected sites where it still occurs, and developing methods to re-establish dormice in counties from which they have been lost. Trial re-introductions have been undertaken in Cambridgeshire and Nottinghamshire.

3.4 A major public participation exercise - the Great Nut Hunt of 1993 - aroused considerable interest and prompted many local surveys which improved knowledge of dormouse conservation status.

3.5 Developments which fragment habitats and break up natural features which link wildlife sites (notably road building) have a significant impact on dormouse populations. The importance of retaining and managing natural features linking wildlife sites was emphasised in DoE's Planning Policy Guidance Note on Nature Conservation (PPG9), published in October 1994, which covers England.

4. ACTION PLAN OBJECTIVES AND TARGETS

4.1 Maintain and enhance dormouse populations in all the counties where they still occur.

4.2 Re-establish self-sustaining populations in at least 5 counties where they have been lost.

5. PROPOSED ACTION WITH LEAD AGENCIES

5.1 Policy and legislation

5.1.1 Seek to ensure that PPG9 guidance issued by DoE and the WO is taken into account by Highway Authorities and LAs. (ACTION: DoT, LAs, WO)

5.2 Site safeguard and management

5.2.1 Sites supporting dormice should be identified and advice provided to land managers on appropriate management. (ACTION: CCW, EN)

5.2.2 Grant-aid and incentive schemes (such as the Woodland Grant Scheme) should be used to encourage owners to manage suitable habitat sensitively. (ACTION: FA)

5.2.3 Manage woodlands and hedgerows to maintain current populations and prevent further habitat fragmentation. (ACTION: FA, MAFF)

5.3 Species management and protection

5.3.1 Continue the programme to re-introduce dormice in 5 counties (Cambridgeshire, Nottinghamshire and 3 others yet to be selected) where they are currently absent. Reinforce populations in at least 3 other counties where they are scattered (e.g.: Bedfordshire, Northamptonshire and Berkshire). (ACTION: EN)

5.3.2 Establish by 1996 a co-ordinated programme of captive breeding to support the re-introduction programme, including research into the long term survival of captive bred individuals. (ACTION: EN)

5.4 Advisory

5.4.1 A new manual on dormouse conservation will be published in 1995. (ACTION: EN)

5.4.2 Support training in conservation of dormice both for land managers and advisers. (ACTION: MAFF, FA, WOAD, CCW, EN)

5.5 Future research and monitoring

5.5.1 Continue research into dormouse ecology, with particular emphasis on the ecology of dormice in hedgerows or conifer sites, the analysis of existing population data, hibernation requirements, and the effects on populations of isolation. (ACTION: EN)

5.5.2 Promote research on methods of conserving dormice which are consistent with various silviculture systems. (ACTION: EN, FA)

5.5.3 The National Dormouse Monitoring Scheme should be maintained and extended to 25 counties. Methods of survey or monitoring should be further developed and standardised to obtain sufficient long-term data on which to assess the effects of site management and successional development. (ACTION: CCW, EN)

5.5.4 Surveys of sites identified in the Great Nut Hunt of 1993 should be repeated at 5-10 year intervals to provide data on changes in distribution and abundance. (ACTION: EN)

5.5.5 Carry out a survey of dormice in Wales to assess the range and habitat use and identify necessary conservation measures. (ACTION: CCW)

5.5.6 Encourage research on the ecology and conservation of this species in an international context. (ACTION: CCW, EN, JNCC)

5.5.7 Pass information gathered during survey and monitoring of this species to JNCC in order that it can be incorporated in a national database and contribute to the maintenance of an up-to-date Red List. (ACTION: CCW, EN)

5.6 Communications and publicity

5.6.1 Ensure that landowners, agencies and local authorities are aware of the requirements of the dormouse, especially the impact woodland and hedgerow management may have, and the effects of habitat fragmentation. (ACTION: CCW, EN)

5.6.2 Ensure continued public awareness of this species as a key indicator of desirable woodland and hedge

2. Extract from UK priority species pages – Version 2; dated 2010
Muscardinus avellanarius (Linnaeus, 1758) Dormouse
Actions identified by experts

Action number	Action text	Reporting category
1	Habitat management and fragmentation issues. Encourage appropriate habitat management (of woodlands and of hedgerow connectivity) including protecting, maintaining and enhancing current habitat by planting and retaining woodland edge, dense shrubbery and overgrown clearings. Offer advice and good practice information on a) habitat management, b) on relevant grants schemes (e.g. Woodland Grants Scheme, ELS/HLF/Tir Gofal), and c) on relevant legislation, current & new. Promote better consideration by Highways Agency and Local planning authorities when considering development or roads proposals to ensure fragmentation of populations does not occur.	Species-specific prescriptive habitat action
2	Carry out one reintroduction a year in either a county with no known natural populations, which are adjacent to counties within the core range and are within the known historical range of the dormouse, a county with isolated populations, which require strengthening or with a county with scattered populations, where some gaps may exist (subject to suitable sites being identified and suitable captive bred dormouse availability).	Species-specific management action
3	Maintain and enhance the National Dormouse Monitoring Programme, ensuring that the data collected are representative of a range of sites in England and Wales and that there is sufficient data collected to produce population trends for each country.	Monitoring/survey
4	Related to priority action 1 - encourage appropriate habitat management in priority BAP habitats, but note that dormice are found in a wider range of habitats and thus action should not be restricted to these BAP habitats.	Priority habitat action
5	Related to priority action 1 - increase the extent of suitably managed woodland and connective hedgerows by encouraging appropriate habitat management in priority BAP habitats, but note that dormice are found in a wider range of habitats and thus action should not be restricted to these BAP habitats.	Priority habitat action

Appendix D: Publications

Previous reviews and reports

There have been a number of reports and reviews of the programme or related matters and these are briefly described here.

Bright, P & Morris, P (2002). A review of the work carried out to test methods used in the reintroduction programme and report on the first seven sites where releases were carried out.

MacPherson, D & Bright, P (2003). The aim of the project was to locate 20 suitable sites for dormice reintroductions over the following decade, in counties already identified in the dormouse Species Action Plan. MacPherson and Bright noted that prior to this report, suitable sites had been sought mainly by contacting appropriate organisations such as English Nature Regional Offices, Forest Enterprise, Wildlife Trusts and the Woodland Trust. They noted that 85% of woodland was in private ownership and suggested that greater efforts should be made to approach private owners. Of the 33 sites visited in 2003, only five were from the organisations listed above. Two of these were considered suitable or potentially suitable in terms of habitat and management. Ten other sites which were considered suitable or potentially suitable were all in private ownership. Subsequently dormice were released at only two of the sites, Heslett and Peter Woods in Yorkshire which are adjacent to one another and treated as a single unit. Criteria for suitability were not spelled out in detail but size, nature of habitat and potential for appropriate management seem to have been the principal factors.

The report has a recording form appended which was designed to collect information about potential sites and this is still used for this purpose by PTES.

Sanderson, F J (2004). In her abstract, Sanderson states that:

> *This thesis comprises an investigation into various aspects of the population ecology and monitoring of the dormouse* Muscardinus avellanarius*, with the aims of evaluating dormouse population monitoring in Britain, assessing factors which influence dormouse abundance, and evaluating management options for increasing abundance.*

Significant relevant conclusions were that "*Abundance was strongly influenced by habitat and weather, but responded differently to weather in different habitats*" and that "*habitat quality and connectivity are vital to the success of dormouse reintroductions.*"

Caddick, J (2005). Caddick visited 12 of the 13 sites where dormice were reintroduced before 2005 and summarised the main features of each site including management and land ownership. She also set out the management work that would be needed at each site in terms of both short term and long term requirements and set priorities between the sites for carrying this work out. No formal report was available but the site documentaries and summary tables were seen.

Mitchell-Jones, A J and White, I (2009). A formal paper reviewing the project up to 2008.

A b s t r a c t. The dormouse Muscardinus avellanarius has disappeared from a large part of its range in England, probably because of habitat fragmentation and deterioration. Reintroductions, mainly using captive-bred animals, have been generally successful at re-establishing populations within this lost part of the species' range, with only 2, perhaps 3, out of 15 known to have failed. However, the establishment of new isolated populations is not seen as an end point to the project and attention is now focused on improving habitat connectivity around the reintroduction sites, to enable the founder populations to spread to nearby woods.

Appendix E: Table of sites

Table E.1. Basic information about sites

Site name	Grid Ref.	County	Area (ha)	Date Released	Status
Brampton Wood	TL185700	Cambridgeshire	134	1994	Stable
Treswell	SK762796	Nottinghamshire	48	1994	Extinct
Stockton Dingle	SJ483449	Cheshire	8	1997	Declining
Little Linford Wood	SP832455	Buckinghamshire	40	1998	Increasing
Bubbenhall	SP368716	Warwickshire	23	1998	Extinct
Rievaulx	SE570850	Yorkshire	22	1999	Extinct
Priestley Wood	TM080530	Suffolk	25	2000	Stable
Maulden Wood	TL068390	Bedfordshire	161	2001	Stable
Bedford Purlieus	TL040995	Cambridgeshire	207	2001	Increasing
Chambers Farm Wood	TF144744	Lincolnshire	347	2002	Stable
Hamps Valley	SK095528	Staffordshire	84	2002	Extinct
Leashaw Wood	SK331555	Derbyshire	21	2003	Extinct
Heslett & Peter Wood	SE249784	Yorkshire	24	2004	Stable
Monsal Dale	SK178715	Derbyshire	22	2005	Declining
Bradfield Wood	TL935581	Suffolk	72	2006	Increasing
Freeholders	SE013888	Yorkshire	16	2008	Stable
Windmill Naps	SP093724	Warwickshire	38	2010	
Alne Woods	SP103610	Warwickshire	19	2012	

Status based on most recent report to UK Dormouse Working Group by Ian White (2013)

Table E.2. Basic statistics about each site

Site name	Number Released	Area (ha)	Date Released	Date at Stage6	Date at Stage7
Brampton Wood	49	134	1994	2002	No
Treswell	48	48	1994	No	No
Stockton Dingle	29	8	1997	Yes	2000
Little Linford Wood	41	40	1998	Yes	2008
Bubbenhall	60	23	1998	No	No
Rievaulx	30	22	1999	No	Yes
Priestley Wood	35	25	2000	2002	2004
Maulden Wood	30	161	2001	2011/12	Yes
Bedford Purlieus	42	207	2001	2009	No
Chambers Farm Wood	32	347	2002	2006	2012
Hamps Valley	37	84	2002	2005	No
Leashaw Wood	34	21	2003	No	No
Heslett & Peter Wood	62	24	2004	2005	No
Monsal Dale	33	22	2005	No	No
Bradfield Wood	38	72	2006	2009	2012
Freeholders	35	16	2008	2009	2009
Windmill Naps	25	38	2010	No	No
Alne Woods		19	2012	No	No

Appendix F

Distribution Maps

These are included to show how knowledge of dormouse distribution has changed a) before and after the first GNH (F.1 v F.2) and b) between the start of the reintroduction programme and the present (F.2 v F.3). The fourth map is at the 1km scale, to show finer detail of the current distribution.

Figure F.1. Distribution of 88 10km squares from which dormice were known in 1992, before the first GNH

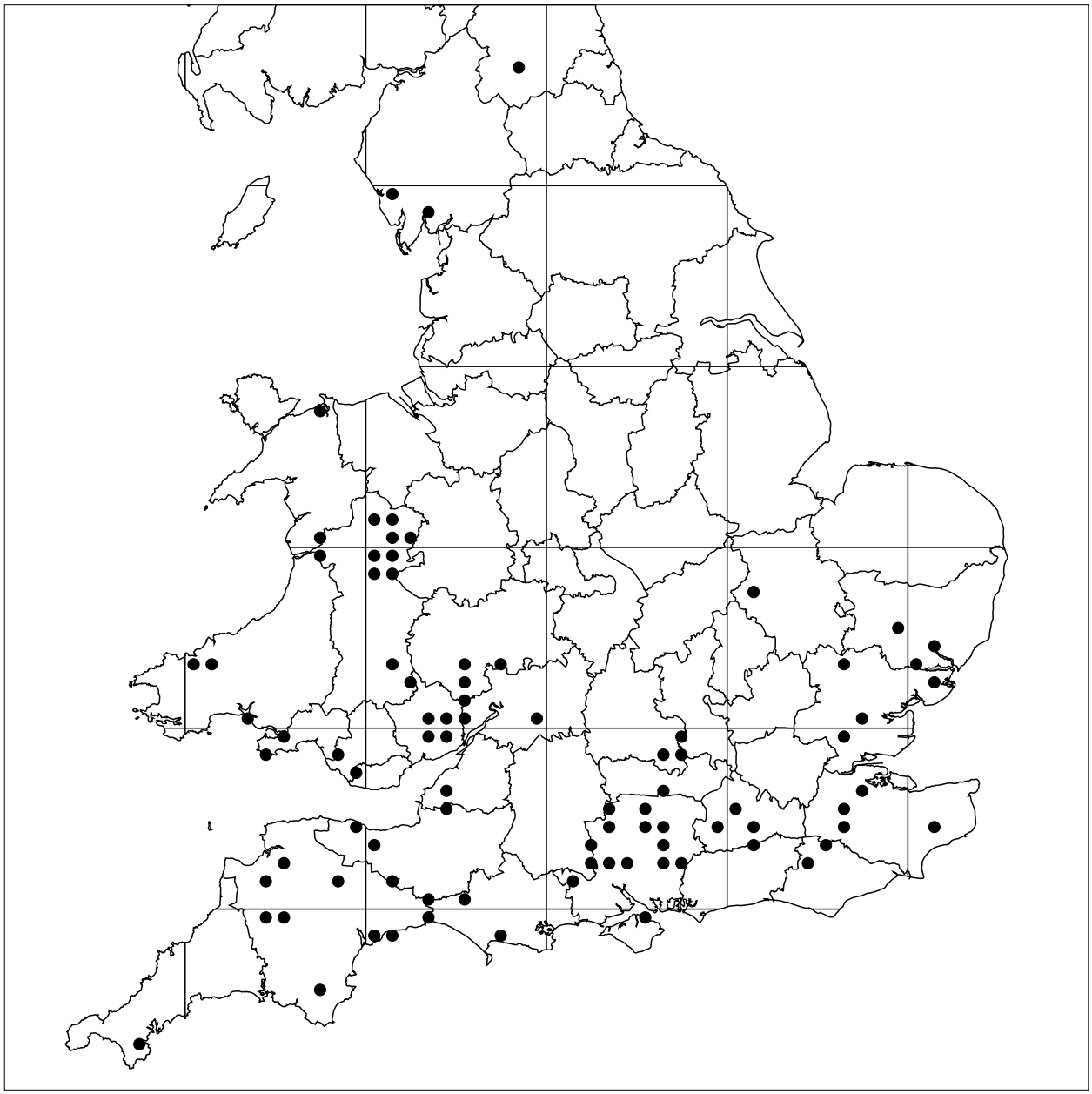


Figure F.2. Distribution of 277 10 km squares from which dormice were known in 1996, shortly after the first GNH. Includes two reintroduction sites, Treswell Wood in Nottinghamshire and Brampton Woods in Cambridgeshire

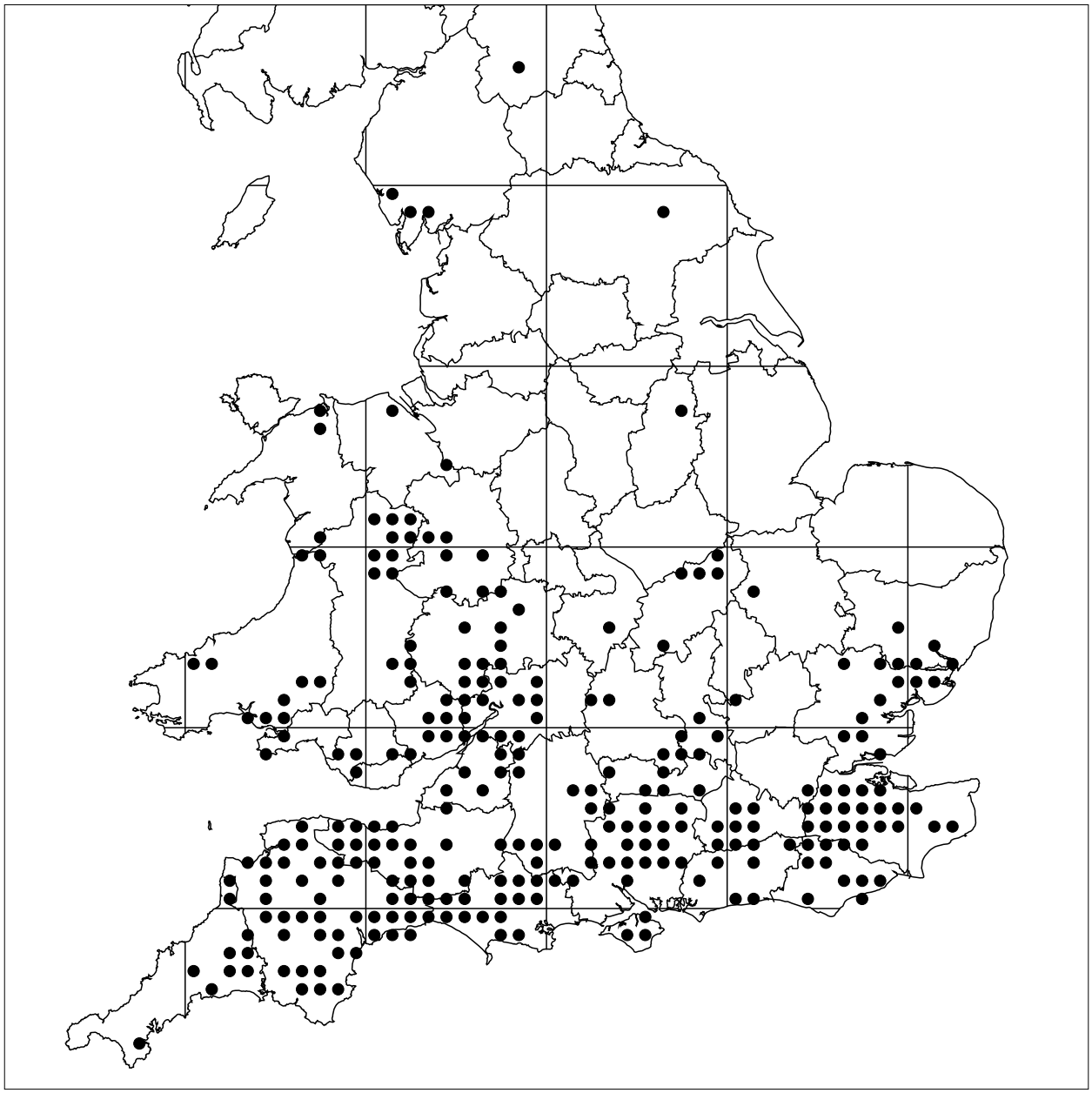


Figure F.3. Distribution of 477 10 km squares in which dormice were known to be present by 2011. Reintroduction sites shown as red

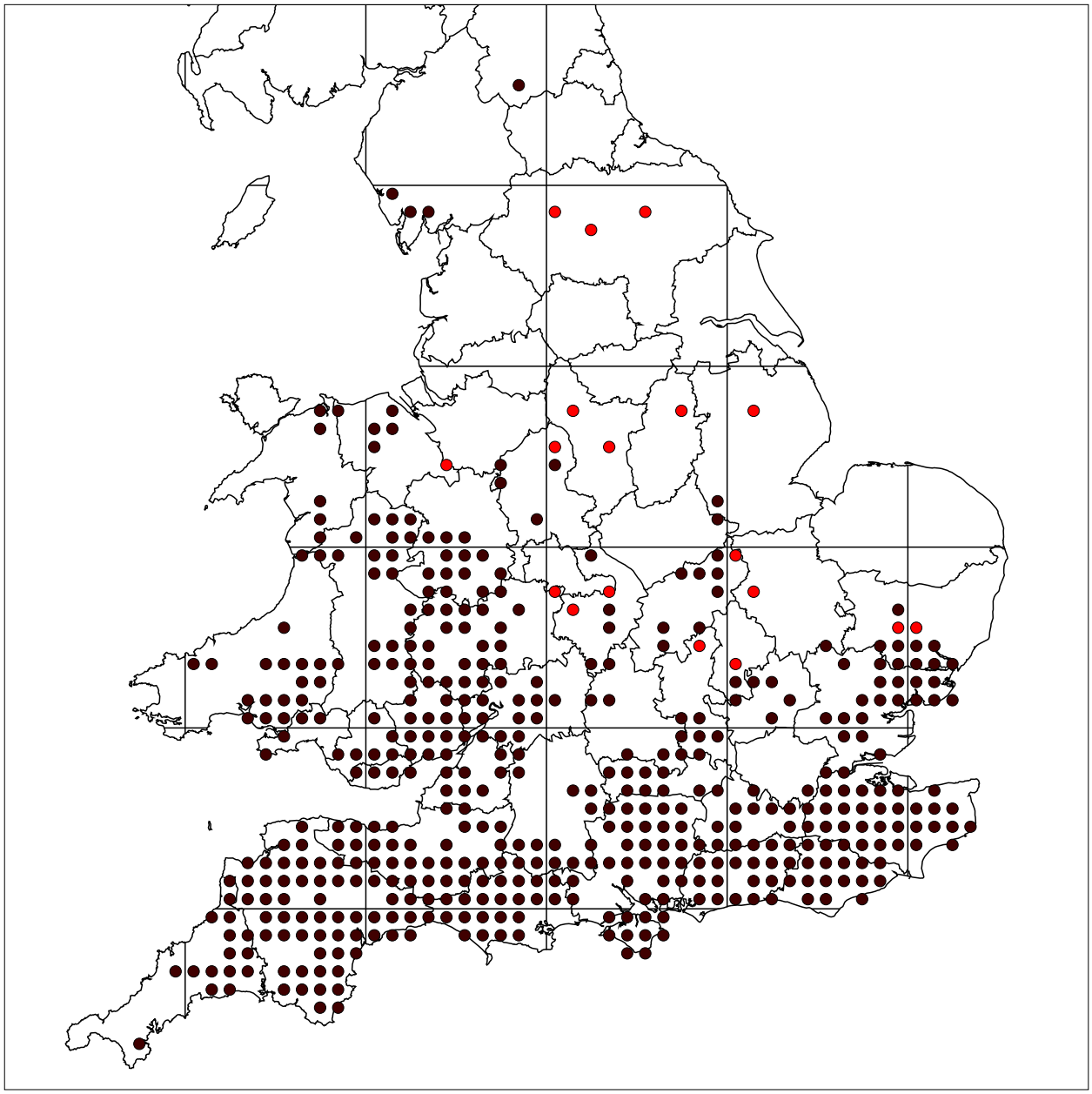
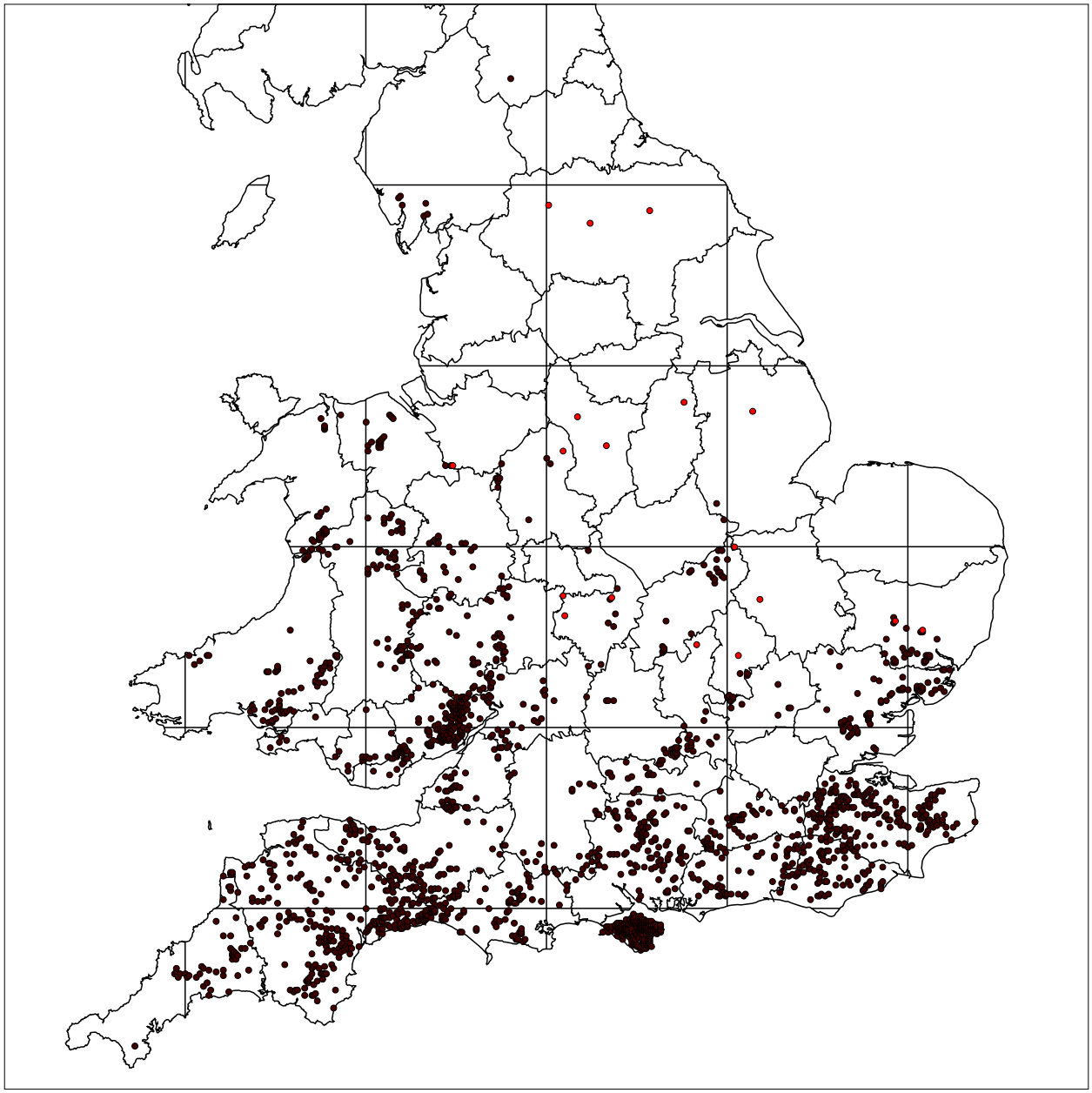


Figure F.4. Distribution of 1876 1km squares from which dormice have been recorded by 2011. Individual dots scaled at 4km diameter. Reintroduction sites in red

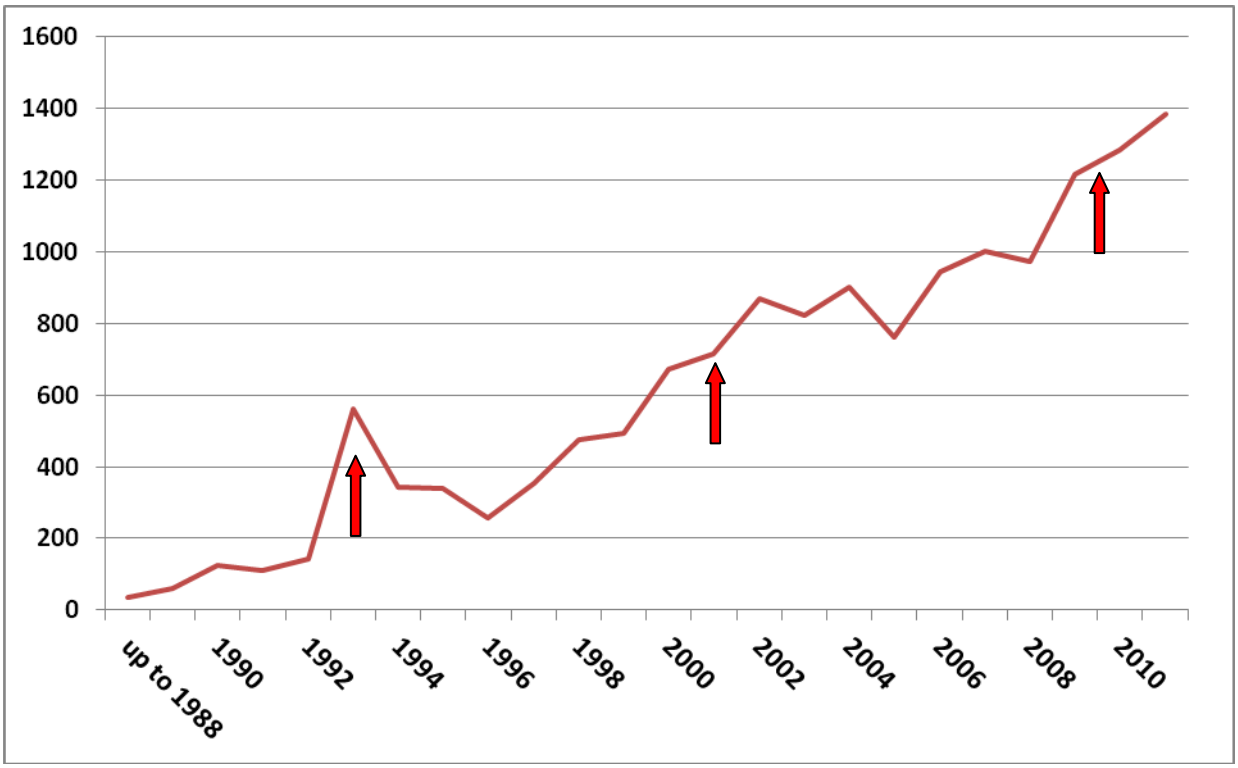


This provides an indication of where records are concentrated (e.g. Isle of Wight, West Dorset, East Monmouthshire) and where they are sparse.

Accumulation of records

The graph and table below illustrate the rates of accumulation of dormouse records over the past two decades.

Figure F.5. Number of dormouse records submitted each year. Arrows indicate dates of nut hunts



The effect of the first GNH on the accumulation of records is very clear. However from 1996 onwards there has been a fairly consistent annual increase in the number submitted and the effects of the GNH are not so clearly discernible.

Table F.1. Increase in our knowledge of dormouse distribution. The values shown are the total number of squares (10km or 1km) from which dormice had been recorded by the date given

Up to Year	10km squares	1km squares
1992	88	143
1996	277	640
2001	379	1036
2006	435	1506
2011	477	1876

1992 is used as the baseline year as it immediately precedes the first GNH. Subsequent years are at 5 year intervals working back from the most recent year for which results are available. 10km squares provide an overview of the known range of dormice whereas 1km squares are the nearest approximation to dormouse 'sites' - used in early descriptions of dormouse distribution (e.g. Bright & Morris, 1996). At that time, these were roughly equivalent to woods known to be occupied by dormice.