The Vincent Wildlife Trust

A Strategy for Restoring the Pine Marten to England and Wales

To restore self-sustaining populations of pine martens to England and Wales

May 2011

Prepared by The Vincent Wildlife Trust in collaboration with other stakeholders

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This document was prepared in collaboration with other stakeholders in 2010 including (alphabetically):

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- Forestry Commission Wales (Chris Tucker)
- Game and Wildlife Conservation Trust (Stephen Tapper)
- Natural England (Kat Walsh)
- People's Trust for Endangered Species (Nida Al Fulaij)
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- Swift Ecology (Johnny Birks)
- The Mammal Society (Johnny Birks, Marina Pacheco)
- The Vincent Wildlife Trust (Natalie Buttriss, Lizzie Croose, Hilary Macmillan, John Messenger, Henry Schofield)
- Wales Mammal Biodiversity Action Forum (Kate Williamson)
- Waterford Institute of Technology (Peter Turner)

Aim of the strategy
To restore self-sustaining populations of pine martens to England and Wales.

Implementation of the strategy:

Reviews
This strategy should be reviewed and updated every two years, with minor amendments made following strategy group meetings.

Geographical Scope
The strategy is targeted at England and Wales, where pine martens are faring poorly in comparison with other areas of Britain and Europe in general. Common issues are addressed for pine marten conservation in both England and Wales, but the strategy flags up region-specific issues where appropriate with actions usually implemented at either a country-wide or regional level through a number of different partners.

Contents

Acknowledgements

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Executive Summary

Although sightings reports and occasional genetic evidence confirm the presence of the pine marten, *Martes martes,* in parts of England and Wales, limited success in their detection despite concerted efforts suggest that they are not abundant and that populations have failed to recover from their historical decline.

This situation contrasts markedly with populations in Scotland and Ireland which have seen significant recovery, and has resulted in the pine marten being added to national Biodiversity Action Plan lists in England and Wales as a priority species in urgent need of conservation action.

At present, data from different sources paint a potentially confusing picture of the recent method of population persistence (breeding or restocking) in England and Wales. Sightings reports (including potential evidence of breeding) and occasional unequivocal records support the impression of long-term persistence of populations in areas of northern England and parts of Wales. However, more recent genetic data has so far found no evidence of the persistence of ancient/relict populations. This limited genetic evidence suggests that populations consist at least partially of individuals or their descendents that have escaped from captivity and/or were translocated from elsewhere.

From this starting point - where the pine marten is still present in England and Wales but populations do not appear to contain ancient genetic types of special conservation value - this strategy sets out a framework for the restoration of viable pine marten populations to England and Wales. The current presence of pine martens that appear not to be directly descended from ancient relict populations leaves two potential routes open to achieve this aim: (1) natural recovery with intervention; (2) restocking/reintroduction. Both of these potential routes will be explored and developed within the framework of this strategy.

Because population recovery has not occurred, the overriding current priority is therefore to determine the factor(s) that have prevented natural population recovery. These limiting factor(s) studies are the critical next step in population restoration, whether by an assisted natural recovery or restocking/reintroduction route.

While adopting a 'natural' recovery approach precludes the release of animals to England and Wales, intervention of some sort would still be necessary. This would likely occur *via* the management of habitats and other factors as determined by the limiting factor(s) studies and associated research proposed in this strategy.

Although genetic data mean that the potential survival of an indigenous relict population with unique genetic characteristics can no longer be used as an argument against a potential reintroduction, this does not automatically mean that reintroduction should be attempted. Any restocking/reintroduction programme will only be undertaken should future work outlined in this strategy deem it to be both necessary and desirable, and any such future programme would strictly adhere to the guidelines set out by the International Union for Conservation of Nature (IUCN 1987, 1995).

The success of this strategy in restoring self-sustaining populations of the pine marten to England and Wales can only be assessed by monitoring. The development of effective monitoring techniques is therefore a key stage in this strategy, and continued monitoring of populations - particularly their genetic composition – is supported.

This strategy has been led by and compiled by The Vincent Wildlife Trust as part of a core strategy stakeholder network (listed on page 2). A wider network still will be consulted on specific issues and periodically informed of progress. The strategy will be reviewed and revised by members of the stakeholder network every two years.

1. Background

A preliminary framework is outlined in this document for the practical work and research required to restore and secure the future of self-sustaining populations of the pine marten in England and Wales. Rather than being a prescriptive manual of solutions, the strategy instead focuses on identifying the relevant gaps in our knowledge, and highlights the critical research and practical conservation action required to achieve this aim.

Following both a series of detection efforts across historically occupied areas which failed to provide generally accepted evidence of a viable population (Velander 1983; Bright & Harris 1994; Strachan *et al.*, 1996; Messenger *et al.*, 2010), and recent genetic work suggesting that relict populations may have gone extinct at some point in the twentieth century (Jordan *et al.*, In prep.), this strategy starts from the premise that relict populations are probably no longer present, and that current populations are mostly if not wholly composed of released or translocated animals or their descendents. From such a starting point, two main potential routes remain available to achieve our stated aim: (1) natural recovery with intervention; (2) restocking/reintroduction[1]. Both will be explored and developed within this strategy document.

Having gained a reputation as an organisation opposed to reintroduction, mainly as a result of a critique (Birks & Messenger 2000) of an earlier plan to reintroduce the pine marten to England in the late 1990s (Bright *et al.*, 2000), it is worth pointing out that this apparent change in position does not represent a U-turn in The Vincent Wildlife Trust's (VWT) policy. As Birks and Messenger (2000) pointed out, among other concerns, the original consultation had dismissed the possibility that populations of England and Wales might be genetically distinct from those of Scotland. Recent genetic analysis of early 20th century specimens from England and Wales has showed this to be of valid concern, with English and Welsh specimens being of a different haplotype[2] to populations elsewhere in Britain (Jordan *et al.*, In prep.). However, this 'southern' haplotype has not been found in samples from England and Wales for over sixty years and, as such populations no longer appear to consist of surviving relicts, protecting these from dilution by animals from outside is no longer a legitimate conservation concern. Reintroduction may now be considered as a potential route for population restoration, and so is considered here alongside the alternative route of natural recovery.

1.1. Implementation and scope

A cross-border Wales/England focus is emphasised, which brings with it potential logistical and administrative challenges. However, this strategy will address issues believed to be common to both England and Wales, as well as more specific issues should they arise in particular locations. Both common and specific issues will, in practice, be implemented on

[1] 'Reintroduction' is defined as an attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct. In contrast, 'supplementation' is the addition of individuals to an existing population of conspecifics.

[2] A haplotype is a group of alleles of different genes on a single chromosome that tend to be inherited as a unit and are relatively conserved. The species *Martes martes* contains individuals of many different haplotypes, and because particular pine marten haplotypes are often associated with specific geographic areas, determining an individual pine marten's haplotype can provide some clues as to its origin.

a regional level whilst being overseen by the core strategy stakeholder network (listed on page 2).

Implementation of the strategy will be coordinated through a virtual forum, which will bring together all key stakeholders (listed on page 2) committed to moving this strategy forward. The VWT will be the lead organisation for coordinating actions within the strategy and will provide a secretariat role for the strategy group. A wider stakeholder network will need to be consulted periodically in planning and implementation phases, and particular issues may require and benefit from the input of particular specialist groups or individuals from within this network. For example, stakeholders from countries beyond England and Wales with extant pine marten populations are also included in this wider network and may be in unique positions to input on current issues in their areas which may be of future relevance to England and/or Wales.

1.2. Why do we need to restore the pine marten to England and Wales?

1.2.1. Populations have failed to recover naturally, and may be locally extinct

Around 6,000 years ago, the pine marten population was estimated to be almost 150,000 across Britain and was thought to be more abundant than any other carnivore except the weasel (Birks, J & Messenger, J. 2010).Today, after extensive deforestation particularly in the late 19th century, along with trapping and persecution, the pine marten is now the rarest carnivore in England and Wales.

Unlike their counterparts in Scotland and Ireland, pine marten populations in England and Wales have failed to recover naturally from this decline. Although the status, and indeed existence, of relict populations of the pine marten has been disputed for some time, all parties seem to agree that there is little evidence of natural population recovery.

The pine marten appears to be extinct in large parts of its former range in England and Wales and, even in locations where individuals have been unequivocally detected such as Staffordshire, Snowdonia, Cumbria, North Yorkshire, Derbyshire, Northumberland and Hampshire, the origins of these individuals is uncertain. Sightings data collected over a considerable time period suggest the long term persistence of populations in core areas (North Yorkshire, Cumbria, Northumberland, Snowdonia and Carmarthenshire), and include occasions where two or more individuals were seen together which may be interpreted as indicating successful or attempted breeding in this solitary species (Birks & Messenger 2010). While not necessarily contradicting these sightings data, genetic data casts doubt on the notion that relict populations have persisted without direct human intervention to the present day, and suggest that current populations consist at least partially of individuals translocated from elsewhere and/or their descendents. Genetic haplotypes not previously detected in England and Wales (including some in northern England providing evidence of introgression with the American marten, *Martes americana*) have been found in locations across England and Wales in recent years (>1990), whereas the original or relict haplotype has not been detected since 1924 in England and 1950 in Wales respectively (Jordan *et al.*, In prep.). However, regardless of their origins, current pine marten populations appear to be clinging on below or around the detection threshold. This contrasts markedly with the situation in Ireland (O'Mahony *et al.*, 2006; O'Sullivan 1983), and in Scotland (Balharry *et al.* 1996) where populations appear to be expanding. This failure of populations to recover naturally south of the Scottish border deserves attention, and highlights the need for urgent conservation action in England and Wales.

1.2.2. Pine martens are a woodland icon

The pine marten's preference for 'old growth' woodland in which standing deadwood is abundant qualifies it as an icon for those interested in truly natural woodland, which has been completely lost from Britain as a result of human intervention. As Birks and Messenger (2010) point out, what better benchmark could there be for judging the quality of modern woodlands than the frequent presence of breeding pine martens in arboreal cavities? Landscape-scale initiatives could benefit from the use of the pine marten as an indicator species to help inform the long-term biodiversity success of woodland enhancements.

1.2.3. Pine martens are a UK BAP Species for priority conservation action

The pine marten is listed as a protected species in Appendix III of the 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats, and is listed as a species 'of community interest whose taking in the wild and exploitation may be subject to management measures' in Annex V of the European Community's Habitat and Species Directive of 1992. In the UK, the pine marten and its dens are protected under the Wildlife and Countryside Act 1981 under which the species was added to Schedule 5 in 1988; pine martens cannot be trapped, disturbed at a den site or sold without licence from the relevant government conservation agency. In 2007 the pine marten was added to the list of UK BAP species in urgent need of conservation action.

2. Conservation of pine martens in England and Wales

An important part of this strategy is identifying work that will attempt to understand the reasons for the pine marten's decline and the suppression of natural recovery (these factors need not be the same). This will allow action to be proposed that will ensure effective conservation and recovery. Therefore it is important to consider the causes of pine marten population decline in Britain and Ireland, but as these are discussed in detail elsewhere (e.g. Langley & Yalden 1977; Birks & Messenger 2010), we will introduce them only briefly in this document to set the scene for appropriate research and action. In contrast to the reasons for historical population decline, the key factors potentially limiting current recovery are relatively poorly understood, and determining these will form a major part of this strategy.

2.1. Causes of decline

The pine marten's decline in Britain to a distributional nadir in the early 1900s is generally attributed to persecution associated with game preservation in the late 19th century (Langley & Yalden 1977). This assertion is rooted in the suggestion that their decline occurred too late to be explained by habitat loss, and that their demise coincided more closely with the increase in gamekeeping. Anthropogenic mortality was clearly an important and relatively well-documented pressure, but it has also recently been suggested that the role of deforestation in the pine marten's decline might have been

underplayed (Birks & Messenger 2010). The extent of woodland clearance in the Neolithic and Bronze Age appears to have been enormous. By Doomsday, woodland cover had already been reduced to 15%, and estimates suggest this reduction continued by about 20 acres each day (Rackham 1990). The potential effect on a forest specialist requiring a large foraging range is clear, and the closely related American marten, showed a strong response to habitat loss and fragmentation, being virtually absent from areas with less than 75% forest cover (Hargis *et al.,* 1999). However, it is important to note that the pine marten's ability to persist in the Burren area of Ireland (albeit at low density) and in woodland patches of only 90ha or so contrasts with this perception. Nonetheless, dwindling populations as a result of large-scale habitat loss would likely have been hit hard by even low levels of anthropogenic mortality.

2.2. Possible limits to recovery

Historical causes of decline are not necessarily the factors limiting the recovery or survival of extant populations. It is therefore important to consider how the landscape has changed since factors forced them into decline, and to identify the current limits to recovery. There are a number of factors which potentially impact upon a population's ability to recover. These are considered briefly below in four main categories, although the distinction between these categories is blurred in some cases, and is not intended as a comprehensive list. This list should, however, provide a basis for work on comparative factors assessing those most important in limiting survival and/or recovery of the pine marten in England and Wales; work that represents a key component of this strategy.

2.2.1. Populations are functionally extinct[3]

First and foremost, it is possible that the pine marten is functionally extinct in England and Wales, which would clearly make natural population recovery impossible. Records, mainly in the form of third-party sightings (e.g. Birks & Messenger 2010), continue to trickle in from parts of England and Wales suggesting individuals or populations that are living at or near to the detection threshold. Difficulties in detecting these martens have made it almost impossible to estimate population sizes with any degree of accuracy, but it is unlikely that these populations are large enough to be viable in the long term without intervention. Soberingly, theoretical population modelling work suggests that as marten populations fall to between 75 and 125 females, extinction becomes the most likely outcome (Schneider & Yodzis 1994). This suggests that populations in England and Wales may have slipped below the minimal viable population (MVP) size, meaning that stochastic events such as predation of only a few animals will exert a heavy toll on the population's ability to recover.

[3] Functionally extinct is used to describe a nonviable population: either there are no individuals able to reproduce, or the small population of breeding individuals will not be able to sustain itself due to inbreeding depression and genetic drift, which leads to a loss of fitness.

2.2.2. Genetic effects

The potential deleterious effects of close inbreeding are well known, and since populations were reduced so significantly, natural recovery would likely involve the population passing through a genetic bottleneck. Inbreeding depression[4] and the consequences of an accumulation and expression of potentially deleterious alleles[5] are potential factors that may seriously limit population recovery.

2.2.3. Social effects

Aside from their potentially negative genetic effects, low population densities may also result in a breakdown in the 'natural' social system of the species, particularly with regard to territory occupancy and defence. Martens that never or rarely encounter other individuals or their signs may be unlikely to invest in the significant costs of patrolling and defending a territory, and this could have potential knock-on effects on the mating system and its efficacy. In a solitary species with breeding season restricted as it is (females have a short oestrous period), roaming animals, particularly living at the extremely low densities we suspect, may simply not meet up at the right times in order to breed. As Bright and Harris (1994) point out, the chances of reproductive failure are probably high due to a rigidly time-structured breeding system. Here, as in functionally extinct populations, a simple lack of numbers may explain a failure to recover even in an otherwise suitable environment.

2.2.4. Environmental/habitat factors

Habitat coverage, quality and connectivity are likely to have a profound influence on marten distribution and the ability of populations to recover. David Balharry's work (1993) in Scotland suggests that woodland distribution is key, with each animal in his particular study requiring a minimum of 126 ha of wooded habitat. Fragmentation of this area is also likely to be important, as for the American marten, where the population was absent in areas of less than 75% woodland cover (Hargis *et al.,* 1999). Most British woodlands are much too small to support even a single pine marten home range (>70% of woodland are <10 ha), and given that hedgerows have also been lost at an alarming rate during the late 20th century, pine martens moving between these isolated blocks may be at much greater risk of predation.

Of course it is not only quantity and connectivity that count, but the quality of woodland is also an important issue. Home ranges must include an adequate year-round food supply, and at least one elevated and well-insulated site suitable for breeding. Managing habitats for food availability is an important consideration, as the abundance of voles and other prey species may have important impacts on population recovery and persistence. Den boxes can provide a short-term solution to the possible lack of natural den cavities, and rocky outcrops within and adjacent to forest blocks may provide alternative den and shelter sites, but the long-term solution can only be achieved by

[4] A decrease in fitness and vigour as a result of inbreeding.

[5] Breeding between close relatives may produce offspring with two recessive genes, which are therefore expressed. Where these genes result in maladaptive traits, the offspring may suffer from reduced survival.

adapting woodland management to ensure that suitable volumes of standing deadwood are available as a source of elevated tree hole dens (Birks and Messenger 2010).

The abundance of foxes is also a potential limiting factor - even in well-wooded areas with an abundance of potential escape routes elsewhere in Europe, fox predation appears to be a significant limiting factor (Lindström *et al.,* 1995; Helldin 1998). The impact of fox predation is also likely to be exacerbated by a series of anthropogenic activities resulting in increased fox abundance and distribution (principally wolf eradication and changes in land-use), and reduced escape opportunities (principally reductions in the quality, quantity and connectivity of woodland described above).

2.2.5. Anthropogenic factors

Despite changes in the legal status of the pine marten, persecution is likely to continue on an unknown scale by accidental trapping or shooting (e.g. during fox control), secondary poisoning, and in some cases perhaps even targeted persecution. Ironically, if perhaps predictably, information on any instances of such is now much less likely to be recorded and particularly shared, due to the legal implications, but these causes of mortality may still be a limiting factor for some populations.

Roads too, both in terms of their effect on habitat fragmentation and direct mortality, may also have a current or future impact. The efficacy of wildlife bridges and tunnels, and in particular the use of these by martens, is being evaluated in the Iberian peninsula. We, however, have so far failed to embrace this in the UK.

Changes in land use too are likely to have a big impact on population recovery. The past fragmentation and large-scale clearance of much woodland habitat as described above will have had a negative impact on martens, while foxes, as a more generalist carnivore, are thriving within new man-made matrix habitats, and they have increased in both density and range throughout the 20th century. Such increases in predator range and numbers will undoubtedly have an impact on a struggling marten population through intra-guild effects, especially in fragmented landscapes. However, it may be important to point out here that a degree of temporary woodland clearance may be beneficial for pine martens due to the increased prey abundance and foraging opportunities provided in such areas (assuming they are well connected to each other by trees and that vertical escape routes from predators are common enough). Social perceptions too are important. Although unlikely to be affecting their recovery, public support will influence the efficacy of any recovery programme, and so public engagement is essential. This will be particularly true for sectors of the community that may be directly influenced by pine martens, including gamekeepers, farmers and other land managers, whose support it will be particularly important to garner. Political perceptions and support are key too, and so we must also consider that the pine marten is listed as 'least concern' on the IUCN red data list (Kranz *et al.*, 2008), so that it may not be realistic to expect English and Welsh populations to be a high priority for funding and conservation effort, especially during times of economic uncertainty.

As mentioned above, effective conservation management should be based on a thorough assessment of the key factors affecting pine marten recovery, and these factors may differ in the different populations or population areas. For example, roads are perhaps unlikely to have a large impact on populations in rural Wales, and persecution may prove to be a more important limiting factor in North Yorkshire than elsewhere.

3. Conservation challenges

3.1. Pine martens in a changing environment

It is important to consider here pine marten conservation in terms of a changing political and climatic landscape. Although we are focused on our goal of restoring self-sustaining populations to England and Wales, we do so within a wider political landscape which may accordingly embrace a different perspective. As we are part of the European Union for example, it is worth considering whether wildlife law in England and Wales is likely to be adapted in the future to a more European slant, where pine marten populations are more prevalent. Given also that the pine marten is listed as 'least concern' on the IUCN red data list, can we expect English and Welsh populations to be a high priority for funding and conservation effort, especially if, as we suspect, unique relict populations have been lost?

In contrast, climate change scenarios, and our response to them, may have a profound if unknown impact on pine martens. For example, the retention of beech trees, and their slow damage and death in areas of reduced rainfall may be good for den sites, while the potential development of wind farms in rural upland areas may have negative impacts. These are real considerations that we need to think about and be prepared to respond to. In addition, recent budget cuts and the government's prior intention to privatise substantial areas of public forests may have a significant impact on the prospects for co-ordinated pine marten conservation, despite recent trends and pledges promoting reforestation for carbon capture. How these recent cuts will affect the government's stated aims of creating 10,000 hectares per year of new woodlands in England (Dept. of Energy and Climate Change, 2009) and a gradual increase in Welsh woodland cover (Welsh Assembly Government, 2009), remains to be seen, but we must be informed and ready to respond to such threats and opportunities as they occur.

3.2. Funding and value for money

As mentioned above, the pine marten is not endangered across its European range, which means that conservation budgets for work in isolated pockets are. Thus it is important to consider and make a robust case for money spent on England and Wales. It is important to consider how important, both economically and culturally, is it to achieve the aim of restoring pine marten populations to individual countries within Great Britain. These are the questions this strategy will need to answer. There needs to be a logical, reasoned and convincing response, and one that ideally stands up to economic, as well as idealistic, scrutiny. How much money does Scotland make through pine marten tourism? How much do gamekeepers and others lose to marten predation? How much will restoring populations cost and who will pay for it? Can the pine marten be economically as well as ecologically self-sustaining? This is a real challenge, and this strategy must embrace the economic realities, be flexible enough to respond to fundraising opportunities as they arise, and to the changing priorities of governments and the SNCOs.

4. Conservation objectives

4.1. Overall aim

As mentioned above, the overall aim of this strategy is to provide a framework or road map 'to restore and secure self-sustaining populations of pine martens in England and Wales'.

4.2. Options for population recovery

In practice, there are two main potential mechanisms for delivering pine marten population recovery: (ii) indirect intervention (fixing limiting environmental and/or anthropogenic factors); (iii) direct intervention (reintroduction or supplementation of populations).

As the pine marten is included as a priority UK BAP species, non-intervention is not a desired option and so is not promoted within this strategy. This is particularly so because, in contrast to populations elsewhere, the pine marten has failed to recover naturally and without intervention in England and Wales and the projected timescale for 'natural' recolonisation from Scotland is considered too long. Despite a general consensus that intervention of some sort is necessary, views have differed historically on the scale required to achieve viable self-sustaining populations. Most notably, a number of studies declared the pine marten to be functionally extinct, non-viable, or incapable of expansion in England and Wales (Bright & Harris 1994; McDonald *et al.*, 1994; Bright & Smithson 1997; Bright & Halliwell 1998), and a feasibility study was completed for the reintroduction of the pine marten to England (Bright & Harris 1994). At the time, the VWT publicly questioned this conclusion, citing, amongst other concerns, their unease regarding extrapolation from inadequate field surveys and concerns for the potential swamping of possibly unique relict populations with genes from elsewhere (Birks & Messenger 2000). Additionally, they argued, there was simply no need to rush: pine martens as a species were doing well elsewhere in their range, and this afforded us the luxury of taking our time to properly assess their status in England and Wales, particularly in relation to their genetic makeup and possible uniqueness. Recent genetic evidence has now emerged which suggests that, although once unique, relict populations appear to have gone extinct in the early to mid 20th century and have been replaced by a mixture of individuals of non-native or non-relict Scottish stock (Jordan *et al.* In prep.). Thus, the need to protect potentially unique relict populations has been removed, and we are left with two main and not mutually exclusive options for population restoration/recovery, either or both of which may be appropriate in different parts of England and Wales.

First, current populations may be encouraged and allowed to recover semi-naturally via intervention (such as habitat management *etcetera*) that does not require restocking. Alternatively, populations of pine martens may be restored to parts of England and Wales by direct restocking. Both of these interventionist options and their various intermediate stages are included in this strategy and should be decided upon on the basis of solid research-derived information on the limiting factors. This factor analysis is briefly outlined below, and its development and output form a crucial part of this strategy.

5. A conservation framework

A flow diagram, illustrating the main stages and logical potential routes from the pine marten's current position in England and Wales to the stated aim of self-sustained populations, is proposed below (Fig. 1). This is not meant to serve as a prescriptive conservation route map, but rather as a broad framework through which the relevant stakeholders and conservation practitioners can navigate in a logical, goal-driven manner. However, there are certain routes through this scheme that may be more appropriate than others. For example, while it is theoretically possible to 'reintroduce/restock' immediately, it is legally, ethically and scientifically sound to first follow a path which passes through assessing the limiting factors stage proposed in the diagram. Further details of each of the potential steps, and suggested current conservation and research priorities that should be completed as action progresses through them are outlined below.

Timings and especially completion dates for each step are difficult to outline with accuracy, particularly as the route or routes taken towards the objective will depend on the results of each of the prior steps. The appropriate action may also vary between different sites. However, a broad time scale is proposed, along with a range of priorities and a targeted completion date for the smaller identified priority objectives involved in each step (see section 6).

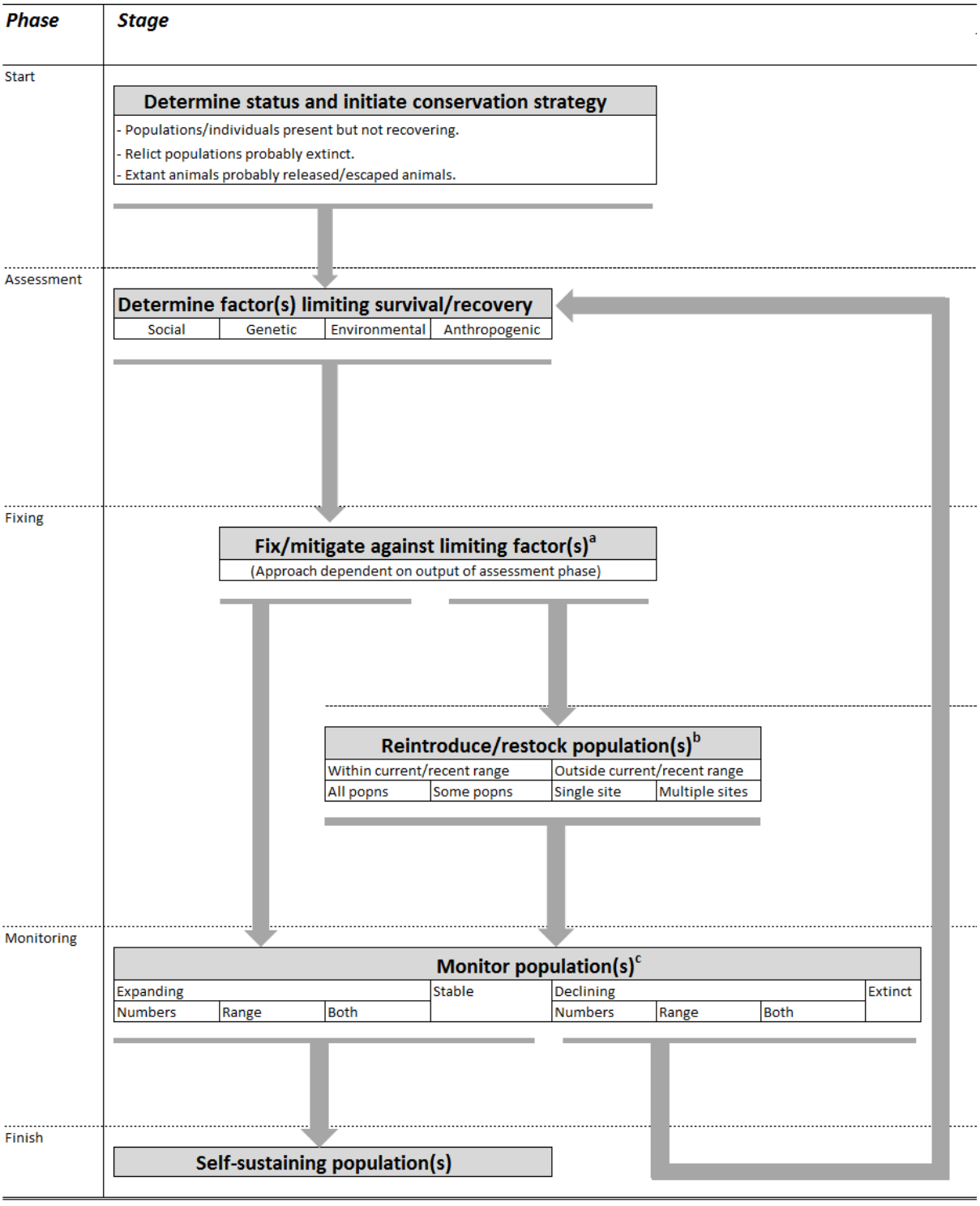
5.1. Proposed steps in a pine marten conservation framework

Further details for each of the recommended steps in the above proposed conservation framework are given below, and in more detail in section 6 further on.

5.1.1. Determine the factors limiting survival/recovery

Determining the key factors limiting population survival and/or recovery is an essential step in putting them right. These factors may vary in different areas. A key part of this strategy will therefore be to undertake a GIS-based comparative habitat and environmental factors study or studies (see section 6.1.i), to determine the key differences between Scotland, Ireland, England and Wales. This should include all factors likely to affect recovery and survival, and should not be limited to a habitat assessment. It is also suggested that further work monitoring the recovery of the Scottish and Irish pine marten populations (see section 6.1.ii) may also allow the identification of the key factors that might be suppressing this expansion in particular areas. It may also be important to document any human-marten conflicts arising as part of this expansion (see section 6.2.v), as these may be a future limiting factor.

Fig.1 Flow chart of conservation actions to restore and conserve self-sustaining populations of pine martens in England and Wales.



a) Mitigation against limiting factors might include, but not be limited to: Den box/site provision; habitat management for prey base; anti-predator management; habitat expansion; increase habitat connectivity; human-marten conflict alleviation measures.

b) Careful consideration must be given to the origin (perhaps indicated by the haplotype) of released stock.

c) To guard against false negatives, validation of detection techniques is urgently required in areas where pine martens are known to be present (particularly in areas where they are at low density).

Fig.1 (cont.)

Main methods

Strategy section	*Brief project description*	*Target completion date* [d]
	DNA project comparing extant & historical genetics[e]	Apr 2011
	Field based surveys[f]	ongoing/annually reviewed
6.1.v	Third party sightings reports[g]	ongoing/annually reviewed
6.2.ii	Implement and review a strategy for pine martens in England and Wales	Apr 2011/two-year reviews
6.2.iii	Establish and run virtual strategy group	Jan 2011/two meetings/year
6.1.i	GIS desktop study to determine limiting factors	2015
6.1.ii	Pine marten surveys of Scotland	2012
6.1.ii	Pine marten surveys of Ireland	2015
6.1.iv	Study investigating marten behaviour in England & Wales	TBC
6.1.vii	Desktop review of pine marten critical needs	2013
6.1.viii	Habitat suitability/selection modelling	2015
6.1.vi	Investigate methods of increasing number of den sites	2015
not yet proposed	Design and implement habitat restoration programme (based on outputs of 6.1.i)	TBD
6.2.i	Promote targeted expansion and creation of suitable habitat	ongoing
6.2.iv	Produce habitat management guidelines (based on outputs of 6.1.i & 6.1.vii)	2015
6.2.v	Document human-marten conflict across current range and develop solutions	ongoing from 2011
6.2.vi	Develop conservation education programme	2013
6.1.ix	Socioeconomic studies & public consultation exercise	2016
not yet proposed	Select suitable areas for reintroduction (*via* habitat viability assessments)	c. 2017 (if feasible & desirable)
not yet proposed	Population modelling study	c. 2018 (if feasible & desirable)
not yet proposed	Genetic/health screening of source population & selection of founder animals	c. 2019 (if feasible & desirable)
not yet proposed	Genetic/health screening of related species in/around release area	c. 2019 (if feasible & desirable)
not yet proposed	Release of animals	c. 2020 (if feasible & desirable)
6.1.iii	Develop effective monitoring methodology	2013
6.1.v	Continued assessment of distribution and status	ongoing/annually reviewed

d) Dates assume pre-requisite work is both completed on schedule and indicates that work is deemed desirable/necessary.

e) Jordan *et al*. In prep.

f) Strachan *et al. 1996*

g) Birks and Messenger 2010

5.1.2. Fix/mitigate-against limiting factor(s)

There are two main options here: (1) employ 'best-guess' remedies on current (and probably insufficient) knowledge, or (2) await results of 'factors' research (see sections 5.1.1. and 6.1.i) and attempt to change these factors (see section 5.2.3.ii.a). A fixing approach may be taken in an area outside the current range (but within the historical range) or within the current range.

Effective conservation management should ideally focus on correcting/altering factors that are deemed, by the research suggested above, to be restricting pine marten population recovery. Potential solutions are listed below, but these are not necessarily suggested for immediate action, as their importance (if any) is not yet known. It is also important to note that different areas might face different limiting factors, and so a national directed local focus might be most appropriate.

To ensure good cost-benefit, intervention is only recommended as the factors most likely to affect recovery are identified, but there are some areas of action that can be promoted prior to the outcome of this research.

i) Habitat creation and expansion of existing woodlands

Compared with the rest of Europe, Britain has an extremely low percentage of forest cover, which is probably suboptimal for a woodland specialist, such as the pine marten, that requires large foraging areas. The re-establishment of large tracts of suitable woodland may therefore prove to be our highest priority, and we should be ready to respond to any such opportunities presented by re-wilding initiatives and our collective response to global climate change (see section 3.1). In particular, suitable opportunities may present themselves where reforestation is promoted as a means of carbon capture, and allow us to achieve great gains for pine marten conservation. Although reforestation initiatives will be beneficial in all areas, our particular focus should be directed towards the hot-spots and adjoining/connecting areas of pine marten evidence (see section 6.3). Efforts must be made to establish formal partnerships with key stakeholders in this endeavour, including the Woodland Trust, Forestry Commission, National Parks and major private land-owners.

ii) Habitat management

A high priority is the production of a comprehensive document/leaflet on habitat and forestry management recommendations for pine marten conservation, fed by knowledge from elsewhere. At present however, it is felt that we have insufficient knowledge to produce such a document based on anything other than a 'best-guess' interim basis. As such, gaining this crucial information must be incorporated into the limiting factors study (see sections 5.1.1., 6.1.i & 6.1.vii).

Once complete these recommendations should be circulated widely and be known by and accessible to national and private landowners. Efforts need to be invested in inserting these recommendations into policy at the national and organisational levels, and ensuring their practical implementation on the ground.

It is suggested that management recommendations should focus on the conservation of current and potential future den and rest sites, and that these might include the provision of den boxes, the retention of standing deadwood and the promotion of practical research into methods of artificially accelerating cavity formation in trees or other suitable den sites. A similar focus should be put on managing forests and woodlands on a landscape scale, such as conserving and restoring hedgerow links, and ensuring that selective harvesting policy is turned into practice. These good woodland management practices should be built into guidance from the respective country's Forest Estate

departments and woven into forestry grant schemes where possible (Forestry Commission Wales, 2011).

iii) Predator management

If predator abundance appears to be a limiting factor, then predation mitigation or predator management should be considered. Red foxes are likely to have the most impact in this regard, and it is possible that culls or increased control might be an option. However, due to the fast breeding rate of this species, and the huge resources that would likely be required to keep fox numbers in check, mitigation against foxes might be a more sustainable, cost-effective and less politically-charged option. Such mitigation would include the increased connectivity (with vertical escape routes for martens) of utilised habitat within the home range.

iv) Management of anthropogenic factors

Many anthropogenic factors may be important in limiting population recovery, including road casualties, public perceptions, and incidental or deliberate trapping/killing. Depending on the outcome of limiting factor assessments (see sections 5.1.1. and 6.1.i), a number of mitigation measures may be appropriate and will likely include much human-marten conflict resolution work on many levels (see section 6.2.v). For example, the development of wildlife bridges/tunnels over/under roads may be appropriate in key locations. Clearly, responses will vary depending on the factors identified as limiting, and these may vary in different locations.

v) Genetic and social management of populations

Restocking and/or reintroduction may be one option available for the genetic management of pine marten populations, and/or to extract them from an extinction vortex, and is considered in detail below.

5.1.3. Restock/reintroduce population(s)

The IUCN has produced clear guidelines for the reintroduction of species (IUCN 1995). Many points raised in that document are particularly pertinent to developing a strategy for the pine marten in England and Wales, and are briefly highlighted here. In addition many authors have provided specific recommendations and cautions for reintroducing carnivores (e.g. Reading & Clark 1996; Miller *et al.,* 1999; Breitenmoser *et al.,* 2001), and the literature includes some useful examples of planning and implementing reintroductions which may be relevant (Lewis & Hayes 2004; Lewis 2006; Callas & Figura 2008).

Depending on the outcome of surveys and background work, the pine marten may be reintroduced to an area within the species' historical but outside its current range; alternatively a surviving population may be supplemented with individuals from another population. Reintroductions/supplementations have the aim of re-establishing viable populations and as such are merely one potential tool in our strategy armoury, and such intervention should by no means be considered an end in itself.

Should reintroduction/supplementation be deemed necessary and desirable there are a number of research questions that would need to be addressed prior to the actual release(s). The main stages in this process, with relevance to potential marten releases, are outlined briefly below. It is worth, when reading these stages, to consider that many of these are not only relevant when considering releases, but are also potentially useful steps in promoting natural recovery.

i) Feasibility assessment & background research

Prior to the reintroduction of animals, a thorough feasibility study and relevant background research should be completed. The key aspects of this work would include:

(a) Assessment of the taxonomic status of individuals to be reintroduced

As per IUCN guidelines, it is desirable that source animals come from wild populations, and that founder stock should be supplied from a population that is closely related genetically to the original native stock and shows similar ecological characteristics (i.e. morphology, physiology, behaviour, habitat preference) to the original sub-population. The results of molecular work by the VWT, The Waterford Institute of Technology and various museums and collections (Jordan *et al.,* In prep.) are key in this respect and highlight three main points. First, the 'original native stock' of England and Wales were of haplotype *i*; currently this haplotype has only been found in extant Iberian populations (Davison *et al.,* 2001) and on the tiny Isle of Erisca on the west coast of Scotland. Second, aside from what must be only a small number of individuals on Erisca, the most closely related individuals to the original native stock of England and Wales are found in Ireland. The extant Irish population consists of animals of haplotype *p*, which are closely related to - and almost certainly directly descended from - a population of haplotype *i* individuals. Third, current captive stock in the United Kingdom does not include animals of original English and Welsh origin. This latter result rules out the use of current captive stock as a source population, but not necessarily the possibility of establishing a specific captive breeding programme for the relevant genetic type. However, this is unlikely to be the most cost-effective or indeed effective solution. (But see work on stone martens showing that released captive-reared animals fared better than translocated wild-caught individuals; Herr *et al.,* 2008).

Despite the logistical complexity that sourcing animals from Ireland would no doubt pose, similarities in genetics between current Irish and historical English and Welsh populations make Ireland (and not Scotland or current captive stock) a logical and suitable source population for any restocking programme in England and Wales. However, prior to such a step, it is recommended that a cost-benefit analysis of the possibility of establishing a captive breeding programme for the relevant genetic type will need to be assessed, as will the impact that harvesting from Ireland would have on the current Irish population(s) (see section 5.1.3.b below).

(b) Assessment of the status and biology of wild populations in other parts of their range

Should a particular wild population be earmarked for the capture of founder/supplementary stock it will be important to demonstrate that removing animals for reintroduction/supplementation elsewhere is not detrimental to the donor population. Once source populations have been identified, surveys should be conducted to determine their status. It is recommended that surveys be conducted at appropriate intervals on all populations in the UK to assess their status, as recommended in the UK BAP for the species (see section 6.1.ii).

Detailed studies should also be made of the biology of wild populations, particularly to determine the species' critical needs. Previous work has been conducted on these issues including: habitat preferences, social behaviour, group composition, home range size, shelter and food requirements, foraging and feeding behaviour, predators and

diseases. It would be useful to collate this knowledge as a review document, which will highlight any notable gaps in our knowledge (see section 6.1.vii).

(c) Habitat selection/suitability models

This work focuses on habitat suitability, and as such will form a smaller part of the comparative factor study described above in the context of investigating potentially limiting factors (see sections 5.1.1. and 6.1.i for further details).

(d) Investigation into the behavioural ecology of extant pine martens in England and Wales

Due to the possibility of intraspecific variation and adaptations to local ecological conditions, it is crucial to understand the behavioural ecology of the pine marten in England and Wales. Use of the habitat, den sites, home range size and patterns of use, are of particular importance, and could perhaps be best addressed by a radio-tracking study. Forest Research (through Roger Trout) and an independent forestry consultant (Tom Fairfield) are currently conducting a study in an area where evidence of pine marten presence has been collected. This project will involve live-trapping and radio-collaring, and although this is likely to be limited to one or two animals at most, its value is greatly enhanced by the current absence of information on marten ecology in England and Wales. Although care clearly needs to be taken when extrapolating from a small number of individuals, with this caveat in mind every bit of data is of great value.

Similar studies in Ireland and Scotland would also produce valuable data, bearing in mind the caveat that martens in other locations may behave significantly differently to those in England and Wales. Owing to their use of den boxes and resulting 'trapability', the reintroduced population in Galloway perhaps offers a particularly appealing opportunity to study seasonal and individual patterns of den box use (via micro-chipping/readers for example) and habitat use (via radio-tagging), and as the population is the result of a historical reintroduction, its spread should also be closely monitored.

(e) Population modelling study

IUCN guidelines (IUCN 1995) state that, prior to reintroduction/supplementation, the expansion of the released population should be modelled under various sets of conditions in order to specify the optimal number and composition of individuals to be released per year and the numbers of years necessary to promote establishment of a viable population. Previous work by Bright and Harris suggests that large founder sizes will be required to establish populations due to low rates of population growth (Bright & Harris 1994) but, as they point out, population growth will be affected by mortality which is likely to vary at different sites and needs to be accounted for in any models. Furthermore, because of the varied use of habitat types throughout the pine marten's European range, the opportunistic nature of this species needs to be also accounted for. The type of model used therefore will be key and will not be a straightforward exercise. Although a population modelling study is not a priority at this stage, it will however form a necessary part of any reintroduction scheme, should that be instigated.

(f) Assessment of success of previous re-introductions of the same or similar species

Because martens are important components of their natural ecological communities and because some can be valuable furbearers, they have often been reintroduced to re-establish extirpated populations (e.g. see Slough 1994). Much can be learned from an

assessment of the success of marten reintroductions at other sites, and work by Roger Powell of North Carolina State University is underway to assess the factors affecting reintroduction/translocation[6] success for marten species worldwide using empirical (field) data and theoretical models (Powell *et al.*, In prep.). There is a particular wealth of information on American martens, which have been translocated at least 51 times (Powell *et al.*, In prep.).

(g) Socioeconomic assessments

Socio-economic studies must be made to assess impacts, costs and benefits of the reintroduction programme to local human populations. Such studies and the development of a conservation education programme are discussed in section 6.1.ix.

ii) Pre-release management

a) Habitat restoration programme

Where the chosen release site(s) has undergone substantial degradation caused by human activity, a habitat restoration programme should be initiated before the reintroduction is carried out. Such restorative work will be completed within the varied and substantial 'fixing' section described above (section 5.1.2) - following work to determine the important limiting factors (see sections 5.1.1. and 6.1.i), and is potentially an important prerequisite of both a reintroduction/supplementation programme and any efforts to promote natural population recovery.

In addition, IUCN guidelines (IUCN 1995) clearly state that previous causes of decline should be identified and eliminated/reduced to a sufficient level. To these factors should be added any additional potentially-limiting factors that have arisen following eradication/decline, and this work is also covered under the relevant stages above (see sections 5.1.1 and 5.1.2). It is neither legal nor considered ethical to release animals into an area when these issues have not been reasonably addressed, and such a move is not promoted in this strategy.

b) Health and genetic screening

Appropriate health and genetic screening of release stock is required. Genetically, stock should be of the same or a similar race to the relict population, and opposite-sex individuals should not be closely related. If release stock is wild-caught, as is likely in this case, care must be taken to ensure that: a) the stock is free from infectious or contagious pathogens and parasites before shipment and b) the stock will not be exposed to vectors of disease agents which may be present at the release site (and absent at the source site) and to which it may have no acquired immunity. To this end, health screening of closely related species in the re-introduction/supplementation area is required. Such screening would have to be carefully planned, but would likely include other mustelids such as the polecat, *Mustela putorius*. Post-reintroduction monitoring of the health of individuals, as well as their survival, is important, and intervention may be necessary if the situation proves unforeseeably favourable.

[6] Translocation is the intentional release of animals to the wild in an attempt to establish, re-establish or augment a population (IUCN 1987).

iii)Monitoring

Monitoring (see also 5.1.4 below) forms a key part of post-release management and all other parts of this pine marten strategy. Design of pre- and post- release monitoring programmes is essential so that each re-introduction is a carefully designed experiment, with the capability to test methodology with scientifically collected data. Research into the efficacy of detection and monitoring methods at different but particularly low densities is a key area ear-marked for research, and is noted in more detail below.

5.1.4. Monitor population(s) in England and Wales

This is a key step in the strategy, with many recommended stages of the framework passing through this 'hub' at one or more points. Although standard monitoring techniques such as scat and hair-tube surveys are known to work at relatively high population densities, their efficacy in the early stages of population recovery are unknown, and suspected to be rather limited/ineffective. This is unfortunate, as the key stages of recovery where monitoring is arguably most vital are those at low population density, and current techniques are not robust enough to detect the likely and key fine-scale changes in population densities and distribution. Developing and evaluating monitoring techniques that produce robust results for a highly mobile carnivore living at low density are a research priority, and some potential ideas are discussed in sections 6.1.iii & 6.1.v.

Monitoring reintroduced or supplemented populations will be somewhat easier, as all should be genotyped and fitted with tags prior to release so that their movements and that of their genes can be tracked.

5.1.5. Monitor populations in Scotland and Ireland

It is important to keep track of the recovery of the Scottish and Irish pine marten populations (by monitoring via repeated surveys) as this will highlight where they have spread, where they are struggling, and will potentially assist in identifying the factors that might be suppressing this expansion in particular areas. In addition, if either of these countries are determined to be suitable for source of animals for restocking, it will be important to understand and assess the population impact that their removal will have on the source population and in particular its ability to bear such a removal or removals.

6. Current research and conservation priorities

Outlined below are what have been identified as the current research and conservation priorities. These are generally discrete pieces of work that are crucial to the transition between steps on the overall framework outlined above. Some are relevant to more than one step in the framework.

Each of the actions has been given a priority (1=highest, 2=high, 3=medium priority; note that low priority work is not suggested). Where possible the time scale or duration of the project is estimated, and a target completion date given.

6.1. Research priorities

i) Determine factors limiting survival/recovery

Priority: 1; Time scale: 3 years; Target completion date: October 2015.
Suggested lead organisation/individual: VWT and a university collaborator.

As outlined above, a key part of this strategy will be to undertake a GIS-based comparative habitat and environmental factors study, to determine the key differences between Scotland, Ireland, England and Wales and therefore the factors most likely to be limiting recovery. The VWT has a commitment to instigate such a study, and intends to have identified a partner institution and passed on the study to them by April 2012. This will likely be a three year PhD or post-doctoral position.

ii) Conduct pine marten surveys in Scotland and Ireland

Priority: 2; Time scale: variable; Target completion date: Periodic surveys at 10 year intervals in Scotland ASAP; Ireland 2015.
Suggested lead organisation/individual: SNH (with VWT and WIT) in Scotland; WIT in Ireland.

As part of the UK BAP process, regular surveys at appropriate intervals (suggested every 10 years) should be conducted on the distribution and expansion of the pine marten throughout their range. In particular, keeping track of the extent and rate of recovery of these populations in different habitats and on exposure to potential limiting factors may be of great value. These data will be useful both in predicting expansion patterns and extents in England and Wales (a prerequisite for reintroductions/supplementations) and in identifying potential limiting factors that should be mitigated against.

Of particular importance is a thorough genetic assessment of the distribution of pine marten haplotypes present in Scotland. Since Angus Davison's genetic work (Davison *et al.* 2001), it has been assumed that all pine martens from Scotland are of a single haplotype (hap *a*). However, of the 52 samples tested in that paper, over half were of captive origin, and only nine wild samples have so far been assigned to particular locations and dates (loosely clustered around Oban & Inverness and collected in 1994 and 1995). This limited geographical and temporal spread make it possible that the Scottish population has a more diverse haplotype structure than previously thought, and the recent discovery of pine martens of haplotype *i* (the relict haplotype from England and Wales) on an island off the west coast of Oban supports this (VWT/WIT unpublished data). It is possible that haplotype *i* may be present in small geographical localities (exclusively or including an island or islands), or is present in low numbers throughout the whole population. Determining the fine-scale haplotype distribution across Scotland is important in determining the origin of Scottish populations, determining the potential source of animals should reintroduction to England and/or Wales be deemed appropriate and, potentially, focusing conservation efforts on appropriate areas containing rare/relict

haplotypes. For these reasons, it is strongly recommended that the next pine marten survey of Scotland includes the collection and DNA-analysis of sufficient scats and bodies from across their current range to allow a fine scale haplotype distribution map to be compiled.

The success of population recovery elsewhere in Europe, and particularly other parts of Britain and Ireland, will generate challenging issues for pine marten conservation there, and although these are quite different to those faced and outlined at this stage of the strategy for England and Wales, it is worth remembering that we can learn much from these issues. If we're successful in restoring self-sustaining populations to England and Wales, any issues that potentially crop up now and in the future in these other populations will likely be similar to those faced over time in England and Wales. Monitoring, surveying and generally keeping abreast of issues in those populations will be invaluable in avoiding future conflicts and hurdles for recovering English and Welsh populations. The most recent pine marten survey in Ireland was conducted in 2005 (O'Mahony *et al.*, 2006), and in Scotland in 1996 (Balharry *et al.*, 1996). A pine marten survey in Scotland is therefore overdue and should be prioritised.

iii) Develop effective monitoring methodology

Priority: 1; Time scale: 2 years; Target completion date: 2013
Suggested lead organisation/individual: VWT and a university collaborator.

A key priority will be developing and evaluating monitoring techniques that work across the range of population densities including martens living at low densities. The efficacy of scat surveys along tracks and rides is questionable, especially given the possibility that pine martens may not be territorial at low density and may avoid regular use of tracks to avoid contact with foxes. The results of the recent two-year WIT/VWT pine marten scat survey (Messenger *et al.*, 2010) illustrate the difficulties of using such a technique; Are pine martens not detected because they are not there or is the technique producing false negatives? Sightings records suggest the latter, and it is important that this and other potential techniques are tested in areas of known presence but at low/comparable density.

The use of olfactory and vocal lures might be effective in increasing the catchment area for detection, and so increase the encounter rates with widely roaming animals. Playbacks of kit calls, adult 'rut' calls, and prey (blackbird) distress calls have been trialled in areas of northern England without success, but the response of pine martens to these sounds is not known and they may even have a repellent effect. The same is true of scats placed out to induce counter-marking (where one animal responds to the scat/scent of another by leaving its own), or commercial hunting lures apparently used effectively in the United States. The response of various captive mustelids to commercial marten lure was observed recently, with a male pine marten described to "emit low grunting sounds, with the occasional huff and chuckle" and to "salivate and produce saliva bubbles of considerable size" (T. Fairfield, personal communication). Such methods offer potential, but must be evaluated in areas of known marten presence. This study would form the basis of a Master's degree project, and should be promoted as such.

The use of sniffer dogs to detect rare carnivores is increasingly common throughout the world, and with companies now operating from the UK, this method could be used as an effective detection/monitoring tool for the pine marten in England and Wales and should be investigated further.

To monitor reintroduced or supplemented pine marten populations, the animals should be fitted with tags prior to release so that their movements, survival and other data can be recorded.

iv) Investigate marten behaviour in England and Wales

Priority: 1; Time scale: TBC years; Target completion date: TBC
Suggested lead organisation/individual: Forest Research/Roger Trout.

Empirical questions remain to be addressed on even the basic behavioural ecology of the pine marten in England and Wales, as it is plausible that this may differ substantially to what we know from animals living elsewhere, where populations defend contiguous territories. For example, it is important to understand: how they are using and moving through the environment; whether they are territorial or semi-nomadic; what they are eating; where they are denning.

Roger Trout (previously with Forest Research) has obtained permits and funding to trap and collar a marten in Wales, and any data collected from such a study will be of great value (including a hair sample to feed into the study above). Similar studies in other populations are recommended as a research priority, but are unlikely to attract interest from academic institutions due to the almost inevitable small sample sizes.

It has been suggested that reintroducing a small (and possibly neutered) study population into one area for intensive study would be of benefit, but as this would not conform with IUCN guidelines it is not recommended here.

v) Continued assessment of distribution and status

Priority: 2; Time scale: continuous; Target completion date: Ongoing, with periodic (annual) reviews. Suggested lead organisation/individual: VWT.

Despite their questionable origin and, arguably, their reduced conservation value as a result, there is a need for continued monitoring of extant populations of the pine marten in England and Wales. This information will be useful not only in predicting patterns of re-colonisation but will also be valuable in assessing the attitudes of the public and landowners to pine martens. Collection and analysis of genetic material from known pine martens should also continue.

Sightings: The cost-effectiveness of collecting and evaluating third-party sightings is well-known (Poulton *et al.*, 2006); however, such data include an inherent element of doubt. Third-party sightings data do, however, provide a useful if broad-brush approach to determining the distribution of low density, elusive animals, although there is always an element of doubt as to whether the observer is describing accurately, and in some cases truthfully, the animal they saw. A small number of recent sightings interviews have concluded with comments about the location of the sighting having been ear-marked for development. However, the VWT's cautious approach in evaluating and scoring sightings records has produced geographically consistent results, which, along with the cost-effectiveness of the approach, supports its continued use.

Unequivocal records: Unequivocal records, in the form of scats, skulls, hair samples, live-trapped animals, bodies and photographs are required for unequivocal distribution to be determined, and (with the exception of photographs) have the added bonus of allowing further genetic investigation/information. Efforts have been made, via the VWT's three-year (2008-2011) 'Prospects for Pine Martens' project, to ensure that

fixed hotspot detection techniques continue to be employed by volunteers and overseen by the VWT beyond the life of that project, although this will assume a lower priority and will no longer be the focus of future work.

It should be noted that validation of field detection techniques, such as hair-tubes and scat surveys, is urgently required to guard against false negatives. Ideally such a study should compare the efficacy of detection techniques in multiple areas of known and varying abundance. This would ideally allow extrapolation to density estimates.

vi) Investigate methods of artificially creating den sites

Priority: 3; Time scale: 5 years; Target completion date: 2015.
Suggested lead organisation/individual: PTES

A lack of natural den sites is a potential limiting factor for population recovery, and while den boxes represent a short-term stop-gap a sustainable long-term solution needs to be found. One area that has potential is the creation of artificial cavities in large standing deadwood, or the artificial acceleration of natural cavity formation, for example, by fungal or microbial injection. Such may also need to include an assessment of the public's perception of this 'environmental engineering'. A survey or assessment of the abundance of alternative den sites - such as in snags of windblown trees or the roof spaces of abandoned buildings in or on the edge of woodland- would also be beneficial, and may need to be included in habitat suitability assessments and modelling (see 6.1.viii).

vii) Desktop review for critical needs assessment

Priority: 3; Time scale: 1 year; Target completion date: 2013.
Suggested lead organisation/individual: VWT with university collaborator

Detailed studies have been made of the biology of wild populations, but there is a need to assimilate this information with regard to determining the species' critical needs. Such work needs to review the biology of pine martens living in as a wide range of habitats across the species' range as possible. It is suggested that such a review could be conducted by a Master's student.

viii) Habitat selection/suitability modelling

Priority: 3; Time scale: 3 years; Target completion date: 2015.
Suggested lead organisation/individual: VWT with university collaborator (part of this study may be conducted by WIT and partners with Interreg funding between 2011 and 2014).

This work will form a smaller part of the comparative factor(s) study described above in the context of investigating potentially limiting factors (see section 6.1.i). Using GIS modelling, factors affecting site selection/suitability will be determined in areas of existing marten occupancy, and feed into a Habitat Viability Analysis that will identify and assess the suitability of sites in England and Wales. This work will build on previous work conducted on habitat suitability as part of English Nature's (now Natural England) species recovery programme for the pine marten in England (Bright & Smithson 1997).

In addition to this work, pine marten habitat comparisons will be made in Ireland and Wales as part of a collaborative *Mammals in a Sustainable Environment* project led by Catherine O'Reilly of Waterford Institute of Technology. These data will be used to identify good potential habitats for pine marten in Wales and may identify issues limiting pine marten expansion in current sites with very low population density.

ix) Socioeconomic studies on impacts costs and benefits of pine marten presence

Priority: 3; Time scale: 1 year; Target completion date: 2016.
Suggested lead organisation/individual: VWT with university collaborator

A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long-term protection of the reintroduced population, especially if the cause of any species' decline was due to human factors, as is the case for the pine marten (see section 2.1). The programme should be fully understood, accepted and supported by local communities, and have been developed to include foreseeable potential conflict issues highlighted by prior monitoring of the situation in Scotland and Ireland. It will be important to identify key stakeholders in any reintroduction programme, offer solutions to potential conflicts and ensure there is sufficient time and expertise to communicate with and involve the necessary audiences. Ultimately the England and Wales statutory bodies for nature conservation will be required to sign off a species introduction plan.

6.2. Conservation priorities

As for the research priorities above, each of the actions has been given a priority (1=highest, 2=high, 3=medium priority; note that low priority work is not suggested). Where possible the time scale or duration of the project is estimated, and a target completion date given.

i) Promote targeted creation and expansion of woodland

Priority: 1; Time scale: Long-term; Target completion date: Ongoing but periodically reviewed. Suggested lead organisation/individual: TBD.

The pine marten strategy group must play a key role in promoting afforestation and landscape connectivity in appropriate areas, particularly but not exclusively in key pine marten hotspots. Efforts must be made to establish formal partnerships with key stakeholders, including the Woodland Trust, Forestry Commission, National Parks and major private landowners.

ii) Implement and review a strategy for pine martens in England and Wales

Priority: 1; Time scale: ongoing; Target completion date: First draft April 2011 (revised on two-yearly basis).
Suggested lead organisation/individual: VWT/Neil Jordan

Clearly this document is the first draft in this process, and will be revised and developed by the virtual strategy group (above). The strategy should be reviewed at regular intervals, and it is suggested that two-year reviews and revisions should be completed. More minor reviews may be conducted more frequently.

iii) Establish and run virtual strategy group

Priority: 2; Time scale: ongoing; Target completion date: First meeting held early 2011; two meetings per year thereafter.
Suggested lead organisation/individual: VWT/Natalie Buttriss

In order to develop and discuss this document, and the actions resulting from it, a virtual strategy group has been established. The key purposes of this group are:

1. To develop strategies for the conservation of the pine marten in England and Wales
2. To facilitate any necessary strategic alliances with conservation partners
3. To promote the agreed plan to conservation networks and partners
4. To collaborate on resources where possible with other group members

Meetings will occur twice a year (or more frequently if deemed necessary). The VWT will organise dates, agendas, papers and minutes and will chair the discussions.

iv) Produce habitat management guidelines

a) INTERIM GUIDELINES:

Priority: 1; Time scale: 10 months; Target completion date: End of 2012
Suggested lead organisation/individual: FCm/WIT

Already the Forestry Commission are receiving requests for guidelines on management of woodland for pine martens. It is important to produce some preliminary, interim woodland management guidelines based on the information we have already (our best guess). This publication would also be a good opportunity to make the case for dedicating resources to pine marten conservation. This would then progress to the full guidelines in due course as detailed below.

b) FULL GUIDELINES:

Priority: 2; Time scale: 10 months (additional to initial 10 months of preparation for Interim guidelines); Target completion date: Dependent on results of limiting factor (6.1.i) and critical needs (6.1.vii) assessments.
Suggested lead organisation/individual: TBD

As outlined in section 4.1.5.ii above, the production of a comprehensive document/leaflet on habitat and forestry expansion and management recommendations is a high priority. However, this work will be dependent on the results of research to determine the factors

limiting survival and recovery (see 6.1.i) and a review of the species critical needs (see 6.1.vii), particularly as it would not be appropriate to draw up full habitat management guidelines in the absence of sufficient data on habitat requirements.

Additionally, following the compilation of these guidelines, an effective follow-up that ensures that these recommendations are put into both policy and practice must also be conducted.

v) Document human-marten conflict across current range and develop prevention/alleviation techniques

Priority: 2; Time scale: ongoing; Target completion date: process up and running by 2012, ongoing thereafter. Suggested lead organisation/individual: VWT/SNH/National Parks and Wildlife Service

It will be important to document any human-marten conflicts occurring in other parts of the species range in order to predict the potential conflicts that might arise in areas of population recovery in England and Wales. In particular, expanding populations in Scotland and Ireland should be monitored particularly closely due to the similarities in species, habitats and human cultures between these countries and England and Wales (see section 6.1.ii). The development of conflict prevention or alleviation strategies in advance of conflicts occurring here will be of immense public relations benefit prior to restocking, should that be deemed necessary and desirable, and will also be of immediate conservation value in areas of current conflict.

vi) Develop a conservation education programme

Priority: 3; Time scale: 1 year; Target completion date: 2013.
Suggested lead organisation/individual: TBD

Development of a conservation education programme, particularly in the local communities, is essential for long-term support, and involvement of local people throughout the programme should be a key criterion. This is true for natural recovery and restocking/reintroduction, but should reintroduction or restocking be deemed necessary and appropriate detailed assessments of this nature will need to be undertaken at the site(s) of release(s) and also in the surrounding areas that population expansion models predict will form part of the population's expansion. The results of attitude surveys will also be an important consideration when selecting the potential release site(s).

6.3. Possible specific country actions

Birks and Messenger (2010) promote a Vice County (VC) approach to determining priorities and to guide strategic conservation action. We will follow that approach here, and the below leans heavily on that report's main conclusions. In addition to these areas however,

it will be important to consider areas not currently occupied by pine martens (or not providing evidence of being so).

6.3.1. England

In northern England, where pine marten evidence is most abundant, the solid block of three adjacent VCs with abundant and persistent evidence (Cumberland, Westmorland and Northumberland South) offers a 'coast to coast' focus for high priority conservation action. In particular, this northern block's proximity to Scotland, where the pine marten is established and appears to be expanding in the south-west, adds to its conservation value. Further, the presence of two national parks and substantial areas of land devoted to forestry offer special opportunities to improve habitat conditions for pine martens. Work that can be prioritised and completed before or in tandem with the 'limiting factors assessment' suggested above (section 6.1.1) includes the provision of den boxes and promoting increases in woodland connectivity. North-east York has the highest occupancy index (a measure of the abundance and persistence of records) and is linked to the above block by two VCs with abundant evidence of pine marten presence (Durham and North-west York). Birks and Messenger (2010) suggest that this VC must be regarded as a top priority for conservation action, and that sustained efforts should be made to reduce mortality associated with predator control on the moorland fringe, and to reinforce habitat links between it and adjacent counties, particularly to the north. This VC contains a large number of den boxes put up by Forest Enterprise staff, and efforts should be made to increase the number and distribution of these boxes throughout the vice county, together with annual monitoring of occupancy.
Crucial to the function of any link between England and Wales will be improvements to conditions for pine martens along the Pennine chain and in the English West Midland VCs of Stafford and Salop.

6.3.2. Wales

A bipolar distribution of marten evidence is apparent in Wales (Birks and Messenger 2010), with the two Primary[7] VCs with the highest abundance and persistence (Merioneth and Carmarthen) 'cushioned' by adjacent Secondary[7] and/or Tertiary[7] VCs and by a ring of VCs with occasional evidence. A logical target for conservation action is to improve the extent and quality of habitat links between these two 'population poles'. Again, work that can be prioritised and completed here before or in tandem with the 'limiting factors assessment' includes the provision of den boxes and promoting increases in woodland connectivity, with the aim of elevating the occupancy status of Cardigan, Montgomery, Radnor and Brecon and to maximize gene-flow between the poles.

[7] Vice counties (VC's) were classified by Birks and Messenger (2010). VC's with a high 'occupancy index', reflecting an abundance and persistence of high-scoring sightings reports received by the VWT (1996-2007), were classified as Primary VC's, with Secondary and Tertiary VC's having lower occupancy indices respectively.

7. Collaborators and resources

7.1. Potential collaborators

Table 1 below identifies the collaborators and resource(s) that they may be able to contribute to the development and execution of this strategy. A key next step will be identifying resource gaps and needs, and this may be best achieved as part of the first Virtual Strategy Group meeting.

***Table 1*. Key collaborators and resources**

Collaborators	**Resource**
Department for Environment, Food and Rural Affairs Welsh Assembly Government	Funding
Forestry Commission	Land and habitat, funding, policy development
Funders	Funding
Game and Wildlife Conservations Trust British Association for Shooting and Conservation	Information, expertise
The Mammal Society	Volunteers, expertise
National Parks	Expertise, volunteers, funding, land and habitat
Non-governmental organisations (e.g. Wildlife Trusts)	Support, funding, land, project management, volunteers
Private Land Managers	Expertise, land and habitat, licences
Statutory Nature Conservation Organisations (Countryside Council for Wales / Natural England / Scottish Natural Heritage / National Parks and Wildlife Service / Northern Ireland Environment Agency)	Expertise, funding, licences
Universities	Research
The Vincent Wildlife Trust	Expertise, volunteers, core staff time, secretariat role, species champion, fundraising, project management
Waterford Institute of Technology	DNA expertise, DNA lab, field/test site(s).

7.2. Funding and value for money

As mentioned above, the pine marten is not endangered across its range, which means that conservation budgets for work in isolated pockets are! Thus it's important to consider and make a robust case for money spent on England and Wales, which will be considerably easier if it was demonstrated that genetically unique relict populations are surviving. If this is not the case however, it is important to consider how important, both economically and culturally, is it to achieve the aim of restoring pine marten populations to the provinces of Great Britain? These are the questions this strategy will need to answer. There needs to be a logical, reasoned and convincing response, and one that ideally stands up to economic, as well as idealistic, scrutiny. How much money does Scotland make through pine marten tourism? How much do gamekeepers and others lose to marten predation? How much will restoring populations cost and who will pay for it? Can the pine marten be economically as well as ecologically self-sustaining? This is a real challenge, and this strategy must embrace the economic realities, be flexible enough to respond to fundraising opportunities as they arise, and to the changing priorities of governments and the SNCOs.

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