Three potential methods of reducing the non-native Uist hedgehog population to conserve breeding waders: animal welfare and conservation considerations.

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Uist Wader Project

The Uist Wader Project is a partnership between SNH, RSPB Scotland and the Scottish Executive.

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THREE POTENTIAL METHODS OF REDUCING THE NON-NATIVE UIST HEDGEHOG POPULATION TO CONSERVE BREEDING WADERS: ANIMAL WELFARE AND CONSERVATION CONSIDERATIONS.

Contractor : Uist Wader Project

BACKGROUND

This report examines the animal welfare issues involved in the removal of hedgehogs from the Uists and Benbecula.

MAIN FINDINGS

- Timing considerations for catching Uist hedgehogs throw into question the practical potential for effective, legal and humane programmes of Uist hedgehog translocation, or holding in long-term captivity. If these methods are to be achieved without inducing significant suffering and death, they would have to be attempted very early on in the season. At such a time the life-cycle stage of hedgehogs is sub-optimal for capture resulting in an impractically short time-window of ten days for capture.

- To achieve immediate and effective population reduction of Uist hedgehogs, as a means to achieving wader conservation the Uists, a choice has to be made between killing hedgehogs whilst minimising suffering, and allowing some survival of Uist hedgehogs but considerable concomitant suffering of both individuals that die and those that survive.

- Even if serious practical considerations are overlooked, this review suggests that there is little justification in terms of animal welfare (as assessed by both mortality and suffering) for proceeding with programmes of translocation or long-term captive holding of Uist hedgehogs. The only clear advantage that these techniques appear to have over humane lethal control is that they may at first sight appear to be more palatable. Judged from the perspective of animal welfare, however, trialing translocation would be misguided.

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1. INTRODUCTION

North Uist, Benbecula and South Uist in the Western Isles of Scotland support some of the most important populations of breeding waders (dunlin, ringed plover, redshank, snipe, lapwing and oystercatcher) in the British Isles. In recognition of this, many of the nesting areas have been designated as Sites of Special Scientific Interest under UK law and Special Protection Areas under the EU Birds Directive.

A baseline survey carried out in 1983 showed that the Uists held at least 17,000 pairs of nesting waders, making it one of the best areas in Europe. It also supported 25% of the total UK breeding populations of both dunlin and ringed plover. Indeed the densities in some areas for these two species were the highest recorded anywhere in the world. A repeat survey carried out in 1995 found that numbers of dunlin, ringed plover, snipe and redshank had declined severely in South Uist and Benbecula. Subsequent research revealed that high levels of egg predation by hedgehogs was by far the most significant problem (Jackson & Green, 2000). People introduced hedgehogs to the Uists in 1974, since then, they have spread north to the southern part of North Uist. The population is currently estimated to be in the order of 5000 adults, with around 10,000 young born per year.

The latest survey of breeding waders on the Uists, carried out in 2000, reveals further dramatic population declines in some areas for five species since the 1980s (Jackson *In prep*). In areas with hedgehogs, wader numbers have been halved (Table 1a). In contrast, in North Uist where hedgehogs remain very rare or absent, the estimated numbers of three species - lapwing, redshank and oystercatcher increased (Table 1b). Although dunlin declined by 30%, this was approximately half the decline observed in the areas where hedgehogs were present. Ringed plover declined by approximately 50% across all the islands (North and South) and research indicate that egg predation by hedgehogs is less severe in this species. Oystercatcher is the only species which has not been affected by hedgehogs - their eggs are too big to be routinely tackled.

To date, there is no evidence that hedgehogs have successfully established themselves in the machair areas of North Uist, a key nesting area for waders. In the absence of population control, hedgehogs are very likely to spread further in North Uist causing further severe population declines in several wader species in the near future. Therefore, it is a conservation priority to keep this area free of hedgehogs. Furthermore, in areas where hedgehogs are already present, no recovery of the existing depressed wader populations can be expected unless the hedgehog population is significantly reduced.

Hedgehog-proof fencing has been investigated experimentally as a non-lethal means of reducing predation of wader eggs. Results demonstrate that although this method can be effective it, only offers a short-term solution for relatively small areas. The main problem is that the fences are constantly degraded on dry machair habitats, by burrowing rabbits. Hedgehog-proof fencing therefore has the capacity to protect only a tiny proportion of the islands' wader populations which is spread over 200km squares (Jackson 2000).

Table 1: A comparison of estimated numbers of six species of nesting waders in the Uists surveyed across the same areas in 1983 and 2000. Table 1a shows the data for the area surveyed on South Uist and Benbecula. Since 1983 this areas has become colonised by introduced hedgehogs. Table 1b shows the data for areas surveyed on North Uist, which remains hedgehog free.[1]

1a) South Uist & Benbecula

	Total No Pairs in 1983 and 2000		**% Change**
Species	**1983**	**2000**	**1983-2000**
Lapwing	1869	1287	-31
Redshank	1288	760	-41
Dunlin	2016	884	-56
Snipe	655	280	-57
Ringed plover	1287	569	-56
Oystercatcher	928	1122	+21

1b) North Uist

	Total No Pairs in 1983 and 2000		**% Change**
Species	**1983**	**2000**	**1983-2000**
Lapwing	1104	1364	+24
Redshank	486	733	+51
Dunlin	803	558	-31
Snipe	172	154	-10
Ringed plover	760	385	-50
Oystercatcher	907	1403	+55

Other novel, non-lethal control methods, for example contraception, have been investigated through discussions with experts. There is currently no chemical available for use on hedgehogs. Most contraceptives in use for other mammals work for only a short time, perhaps one season. Treatment would, therefore, be needed every year. Expert opinion suggests that this technology will not be available for many years. Any product would have to be tested to ensure that it posed no risks to other wildlife, livestock, pets or people. Sterilisation methods may also not have any clear advantage over humane lethal control in terms of animal welfare.

Attention is now focused on management methods that would involve the direct removal of hedgehogs living wild in the Uists. Three methods have been proposed:

[1] Note:
The data presented above for both Table 1a and Table 1b represent only the areas surveyed in the 1980s and again in 2000. These areas are smaller than the total nesting areas available throughout the Uists.

1. Translocation to mainland Britain;
2. Retaining live-trapped hedgehogs indefinitely in captivity;
3. Humane, lethal control.

This paper considers the animal welfare implications of these three options.

As part of an evaluation of the translocation option, a desk-based feasibility study has already been conducted (Reeve & Bristow 2001). This study considered in detail how a small-scale translocation trial might be organised. It included detailed protocols for health checks, identified potential release sites and suggested criteria that could be used to judge the success of a pilot translocation programme. However, it was beyond the scope of the study to review welfare issues in detail, or to consider whether translocation might aid or hinder the conservation of indigenous hedgehog populations in mainland Britain. Here, we attempt to address these issues as well as considering the merits of long-term captivity of hedgehogs. Ethical debate as to whether it is morally justifiable to manipulate Uist hedgehog populations in order to conserve the islands' breeding waders is beyond the scope of this paper.

2. DISTINGUISHING CONSERVATION, MORTALITY AND WELFARE ISSUES

In summarising issues relating to animal welfare, conservation and translocation, Kirkwood (2000) concluded: "It is important not only to consider possible impacts at the population conservation level, but also the possible impacts on the quality of lives - the welfare of individual animals". Here, we make the standard assumption that 'animal welfare' refers to an individual's status along a continuum of suffering caused by, for example, illness, starvation, injury, poor body condition or stress. Suffering may be caused during life and/or as an immediate cause of death.

In relation to the three hedgehog population control methods currently proposed, this consideration raises three questions: what are the welfare risks to hedgehogs of any human interference; what are the potential effects on mainland hedgehog populations; and, what are the conservation benefits for Uist waders? In comparing the three techniques in advance of any action being undertaken at a realistic scale, there is an inevitable reliance on studies done elsewhere, extrapolation from existing data and prediction based on the best available knowledge. However, it is useful at the outset to delineate the issues under consideration.

2.1. Conservation

Conservation relates to the viability of populations in the wild. As each of the three removal methods under consideration relies, initially, on the same process of live trapping, any choice of one method over another is irrelevant to the efficacy of reducing wader egg losses on the Uists, so long as the timing and intensity of catching efforts are equal. However, translocated hedgehogs could have an impact at the population level on the conservation of mainland hedgehogs or other species. Humane lethal control and holding hedgehogs in captivity would have no impact on the conservation of hedgehogs in their native range on the UK mainland.

2.2. Mortality and Suffering

Hedgehog mortality may be induced as a deliberate (i.e. humane lethal control) or inadvertent (i.e. unintentional killing caused by capture, holding or translocation) result of the proposed control techniques. There is potential for animal suffering to be induced through capture, holding, and transport and during periods after release on the mainland. Lethal control may also impose a degree of suffering (any pain relating to method used).

Both animal welfare and conservation organisations subscribe to the conviction that, under the control of people, animals should be treated well in terms of minimising physical and psychological trauma, and any necessary killing should be humane, quick and painless. Lethal control of hedgehogs would not induce suffering beyond the stress of live capture (this would be equal for all three proposed control techniques) and any suffering caused between the time at which a lethal treatment is administered and time of death.

Any inadvertent adult mortality resulting from translocation or retention in captivity would be likely to involve a slower death than humane lethal control and overall suffering could, therefore, be greater. For all three proposed control techniques, the trapping of females whilst they have dependent young would, similarly, be likely to induce considerable suffering because the offspring would be impossible to find and would therefore die relatively slowly.

Confining evaluations to mortality alone - although sometimes easier to quantify - does not address the issue of suffering whilst living and/or preceding death. Care therefore needs to be exercised to distinguish between these factors, if discussions are not to become muddled.

3. OPERATIONAL FACTORS

If Uist waders are to be effectively conserved, some human manipulation of hedgehogs is unavoidable. Understanding relevant aspects of the ecology of both hedgehogs and waders is crucial to effectively and humanely implementing any control programme. The nature of suffering and/or death imposed will depend on the exact timing and type of interference undertaken: for example, the life-cycle stage at which interference of hedgehogs is undertaken will have implications for adults and their young (born and unborn). There are four key aspects to consider: 1. catching and holding hedgehogs; 2. wader biology and conservation; 3. hedgehog biology; 4. conditions at mainland release sites.

3.1. Catching & holding hedgehogs

Hedgehog husbandry methods are well developed and some captive animals can survive for long periods if diet and accommodation are suitable. The longer an animal is kept in captivity, however, the more critical the quality of captive conditions becomes (Reeve & Bristow 2001).

Live-detection and capture of Uist hedgehogs is most effective during the spring, when vegetation is short. The protocol for translocation suggested by Reeve & Bristow (2001) requires animals to be caught during this period, immediately post-hibernation. In this study, the total time between capture and release for animals during translocation is estimated to be between three and five days. Slow rates of capture, screening for

pathogens or receiving animals in poor body condition could also increase the holding period.

3.2. Wader biology and wader conservation

From a wader conservation viewpoint, it is most effective to catch hedgehogs in spring when removal will have the greatest effect on reducing subsequent hedgehog population size and minimising predation on wader eggs. Most wader species on Uist have commenced nesting by mid-April (Jackson & Green 2000).

3.3. Biology of Uist hedgehogs

Some hedgehogs start to emerge from hibernation by mid April, but most emerge during late April (Fig 1). Data collected on the Uists show that 96% of all adult females (i.e. those born two or more years previously) become pregnant within a few days of emergence (RSPB Unpublished data). Female Uist hedgehogs give birth to first-litters between 29th May and 27th June (Fig 2). Given that the gestation period is 30-35 days, the dates of mating can be extrapolated, indicating that females become pregnant from about 25th April onwards.

There is no known method of reliably detecting pregnancy or lactation in female hedgehogs in the field. Young are dependent on their mothers for a period of about six weeks and the average litter size on South Uist (at emergence from the nest) is about three. Adult mortality on South Uist over the six-month period from emergence to hibernation has been estimated at 18% (based on radio-tagging), with no differences between males and females (RSPB Unpublished data).

3.4. Mainland release sites

Reeve & Bristow (2001) canvassed opinion as where Uist hedgehogs should be released and concluded that that only good quality habitats, free from unnatural threats and already holding indigenous hedgehogs, should be considered as potential release sites for translocated Uist animals. An absence or a low density of hedgehogs in an area is likely to be a consequence of either natural conditions (e.g. sub-optimal habitat or high density of badgers), or of human activities (e.g. road traffic or pesticides, Doncaster 1994). It should also be noted that introducing animals to areas where they are not indigenous is against IUCN guidelines.

Fig 1: Cumulative frequency of the earliest date that individual marked Uist hedgehogs were seen following emergence from hibernation. Data from South Uist study areas, for years 1998, 1999 and 2000 were combined. Many of the individuals that first emerged before 20 April were only intermittantly active before late April.

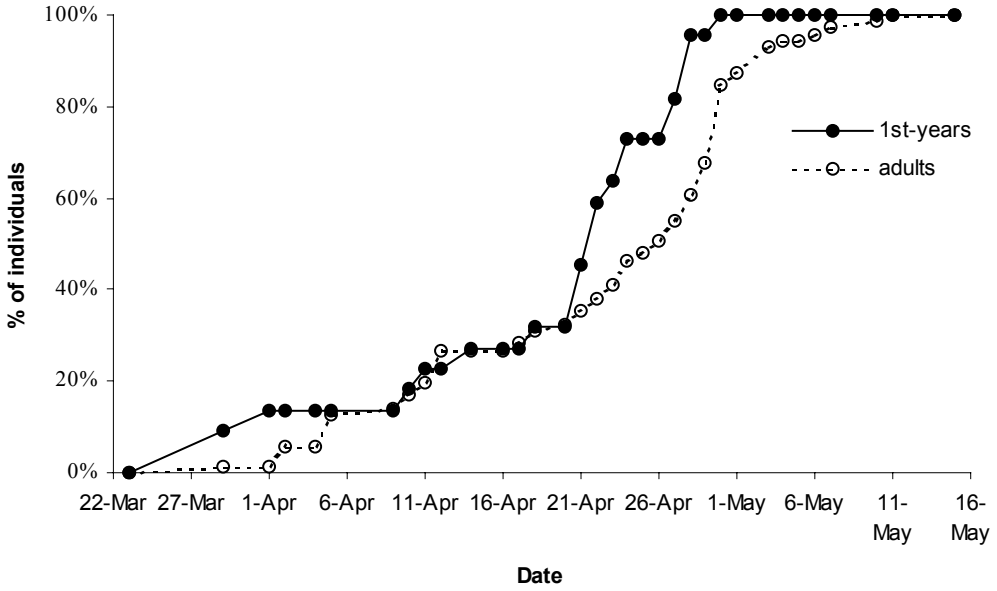
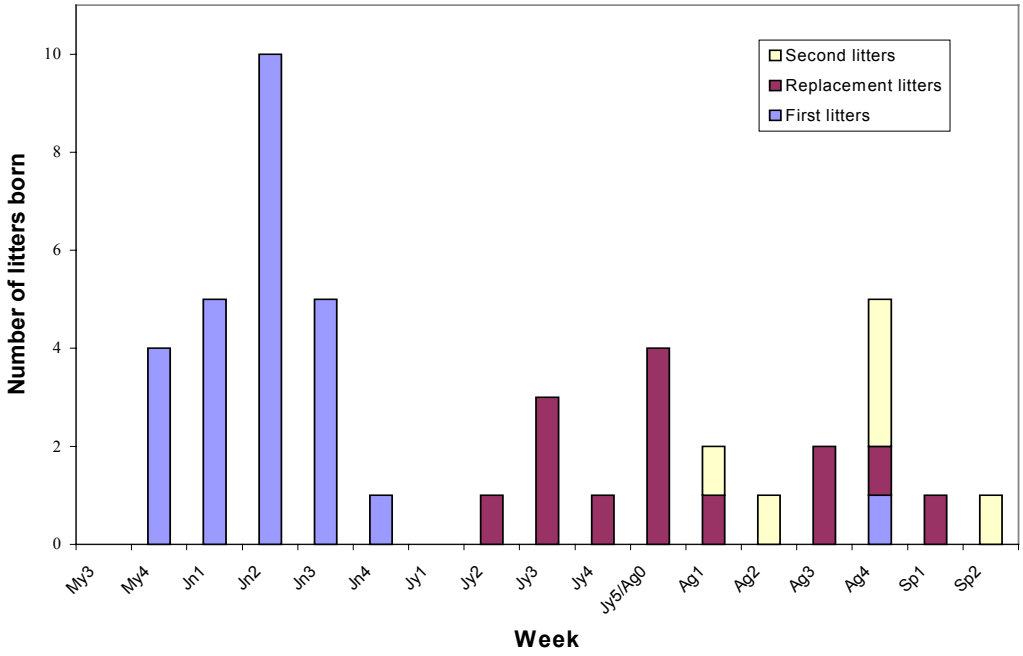


Figure 2. Frequency distribution of hedgehog litter birth dates at Uist study sites.



4. EVALUATING THE EFFECTS OF CONTROL METHODS ON HEDGEHOGS

The potential mortality and suffering of Uist and mainland hedgehogs during humane lethal control, translocation and long-term captivity are considered below.

4.1. The fate of translocated hedgehogs and host populations

Studies of UK mainland hedgehogs have investigated the fate of animals released following a period in captivity (Morris *et al.*, 1992 & 1993; Morris & Warwick, 1994; Morris, 1997; Morris, 1998; Reeve, 1998). Morris (1998) summarised the available information and showed that, after six weeks, 21% of released hedgehogs were dead, 51% were known to be alive and the fate of the remaining 27% was unknown. The mortality after six weeks of released hedgehogs monitored in these studies was, therefore, in the range 21% to 48%, depending on how the fate of 'unknown' animals is interpreted. These mortality figures contrast markedly with those of un-manipulated hedgehogs on the Uists, where mortality was estimated to be on average 4% over a similar six-week summer period (RSPB Unpublished data).

One study (Reeve 1998) followed released hedgehogs for a period of 15 weeks and found further levels of mortality. Reeve & Bristow (2001), therefore, recommended that introduced hedgehogs should be monitored for a period of 18 weeks following release. There are no published data for manipulated hedgehog populations over this time period. It is therefore not known how much higher mortality rates amongst introduced hedgehogs would be beyond six weeks. On the Uists, overall only about 18% die in the six-month active period between emergence and the start of hibernation (RSPB Unpublished data).

Research on mainland hedgehogs has also investigated the effects of manipulating the density of indigenous populations. These studies show that when the density of a hedgehog population was artificially increased, by introducing animals from elsewhere, predation, mortality and emigration rates were significantly greater than at a control site. Mortality was relatively high amongst indigenous animals in the receiving population following the introductions (20% in one month), and was very high amongst the introduced animals (42% in one month). The habitat at the donor site and the receiving site were similar, and these two sites were geographically close to each other, both being in Oxfordshire. These increased mortality and emigration rates were responsible for reducing the population density at the experimental site close to its original level within a short period. The control site was an area that also received transplanted hedgehogs, but initial population density was maintained at a constant level through capture and removal of indigenous animals. Notably, mortality was also high at the control site (Doncaster 1994).

By virtue of site-selection criteria (Reeve & Bristow 2001), translocated Uist hedgehogs would be released into good quality habitats. Populations at these sites will be unlikely to accommodate additional individuals without some form of population density regulation taking place (Doncaster 1992). The precise implications of this, in terms of mortality and suffering, are unclear, but they are potentially very significant. Indigenous or translocated animals are likely to be compelled to move (which itself may carry inherent risks) to new areas, probably with lower quality habitat or with their own indigenous hedgehog populations. Releasing hedgehogs into poorer quality habitats would not resolve this issue.

Hedgehogs lose 25-40% of their body weight over winter (Reeve 1994). This may have welfare implications for catching, holding and releasing animals during the period immediately following emergence, which has been identified as the only practical time to undertake trapping. Releasing translocated animals in poor body condition may induce suffering through starvation, injury or disease. Therefore, on welfare grounds hedgehogs should be held in captivity until they are in good body condition, particularly as a number of studies have demonstrated a tendency for hedgehogs to undergo a period of weight loss after release into the wild (e.g. Morris et al. 1992; Reeve 1997; Morris 1998). The recommended 3-5 day holding period identified in the translocation feasibility study may not be sufficient to ensure this.

4.2. The fate of pregnant females & dependent young

In terms of suffering, the humane lethal control of a pregnant female is no different to the humane lethal control of a non-pregnant individual, provided the method used ensures that the unborn young are also humanely controlled. However, translocating pregnant females or moving them to long-term holding facilities carries a significant risk to both the life and welfare of mothers and their young (unborn and born). Females caught during the early stages of pregnancy, particularly if captivity reduces body condition, are likely to abort or re-absorb embryos. The Home Office Code of Practice for the Housing and Care of Animals Used in Scientific Procedures states that small mammals should not be transported in the last fifth of pregnancy. Scottish SPCA guidelines state that animals should not be transported in the last third of pregnancy.

Those caught during a late stage[2] of pregnancy may give birth in captivity. In this situation, mothers often eat newborn offspring if they are disturbed (Reeve 1994). Since there is no reliable method of detecting the presence of young beyond looking into (and therefore disturbing) the nest, and the process of transporting animals unavoidably involves a degree of disturbance, any young born in captivity would be at risk. Young hedgehogs are difficult to rear artificially in captivity unless they are already weaned (Morris 1992).

Some translocated pregnant females may give birth at the release site. This has never been studied, but as mortality rates amongst adults released from captivity are high, there would be an elevated potential for orphaning (and therefore death) of dependent young at release sites.

Since lactating females cannot be readily distinguished from most of those without young, catching Uist females after 29th May would unavoidably result in the removal of some mothers with dependent young left in dens on the Uists. These young would inevitably die because there is no practical way to locate them in their natal den in the field. This applies equally to all three proposed control techniques.

In the light of the mainland studies outlined above, the legality of translocating hedgehogs, is questionable. Under the Abandonment of Animals Act 1960 it is an offence to release any animal that one has care of into the wild, in circumstances likely to cause the animal unnecessary suffering.

[2] Transporting females in an advanced state of pregnancy is contrary to Home Office guidance (Home Office 1999). This states that small mammals should not be transported in the last fifth of pregnancy. For hedgehogs, this would be approximately after day 25. Pregnancy stage is impossible to determine in the field.

4.3. Impacts on hedgehogs held in captivity

Capturing and holding hedgehogs, either for translocation or for long-term captivity, will result in them being handled, transported and placed in an artificial environment (physical surrounds, light, smell, sounds, temperature, restricted space) for a number of days. The aim of any housing protocols should be to ensure that no injuries occur and that the individuals experience minimum stress while they are housed (Reeve & Bristow 2001).

Wild hedgehogs held captive for short periods often undergo a period of starvation resulting in significant weight loss. Fifteen of sixteen Uist hedgehogs held in captivity overnight (c. 12 hours) refused food and lost body weight; effects of longer periods in captivity were not investigated (RSPB Unpublished data). However, as most animals resume feeding within a day or so, holding animals for a period of three to five days should not pose any difficulties (Reeve *pers comm*.). Data presented by Morris (1998) show that in the long-term hedgehogs can put on weight while held in captivity; however, it is unclear what overall body weight changes would result from the 3-5 day captivity period recommended for the translocation of Uist animals. Furthermore the large numbers likely to be involved (1000's), and the moderate life expectancy of hedgehogs (up to 5 years), would present significant challenges to providing high welfare conditions especially given the fact that individuals should be housed separately (Reeve & Bristow 2001). There are also likely to be long-term health problems associated with artificial diets (Reeve 1994). However, with appropriate expertise and experience these potential problems ought to be surmountable.

5. DISCUSSION

Mortality of Uist hedgehogs would, by definition, result from a programme of humane lethal control. However, evidence strongly suggests that significant mortality would also be a result of any translocation programme. There are considerable uncertainties about the levels of mortality that would be induced but, considering the lives of adults alone, it would almost certainly involve at least ¼ to ½ of all translocated animals dying within a few weeks of release (the range of mortality observed in mainland animals in the first 6 weeks following release from captivity). Beyond this, several factors could further affect mortality rates amongst adults, including: effects of large differences between Uist and release site habitats; effects of low pathogen resistance; mortality through population density regulation in host populations; mortality through the release of pregnant females, mortality through exposure to novel predation pressure (there are no predators of hedgehogs on the Uists). Without very detailed research we cannot quantify with any certainty what effect these factors would have. It is important to note, however, that any effects would serve to increase, rather than decrease, adult mortality rates and suffering. Furthermore, it is clear that both born and unborn offspring of females translocated whilst pregnant, or caught whilst having dependent young, are put at very high risk of mortality. Reducing the number of animals released at any one site would be likely to reduce any impacts. However, the recommended release protocol of six individuals per 100 ha would make it logistically difficult to find enough suitable sites.

Any incidental mortality of hedgehogs (adults or young) caused by the process of translocation would involve deaths that are much slower that those induced by humane lethal control. The lives of these individuals preceding death would, unarguably, be of 'low quality', and suffering is likely to be considerable where starvation, injury or illness are involved. The lives of pregnant females and their offspring are likely to be similarly compromised through the process of long-term holding in captivity. For translocated

animals and those from host mainland populations, much of this suffering would be undetectable, and therefore any suffering undergone would be 'out of sight'.

Unless the timing of capture of Uist hedgehogs is restricted to a very short period, there is a risk that a very high proportion of females caught would be pregnant: translocating or holding pregnant females imposes a significant risk of suffering (and mortality) on the mother and her offspring (born and unborn). This elevated risk of suffering would not, however, be induced if pregnant females were subject to a programme of humane lethal control. As there is no foolproof method of identifying pregnant females, the only way to minimise these welfare concerns would be to restrict catching for translocation or long-term captivity to a relatively safe 'window' between mid-April and the 25th of April. This is the period immediately following the first emergences from hibernation but during which a high proportion of females remain unmated. During this period, the time available for catching would be very limited and a proportion of individuals would still be hibernating and would therefore be impossible to catch. This ten-day window would almost certainly be insufficient to catch enough female hedgehogs to effectively reduce the Uist population, and is likely to be insufficient even to underpin a small-scale trial.

If this period were extended the number of pregnant animals caught would be increased, as would the likelihood of capturing animals in the second half of gestation, when welfare risks are highest. Extrapolating from data on the timing of Uist hedgehog births, catching animals only before 25th April would mean that, of those females destined to give birth (were no manipulation undertaken), approximately 5% would be caught whilst pregnant, all in the first half of gestation. Extending catching to mid-May would mean that approximately 75% of these females would be caught whilst pregnant and, of these, approximately 20% would already be in the second half of gestation.

Because, in terms of suffering, humane lethal control of a pregnant female is similar to doing so to a non-pregnant individual, the safe time-window available for an effective programme of humane lethal control is longer than that for translocation or long-term captivity. It is restricted to the period following the first emergences (mid-April) but preceding the first births (late May). In this way, the lethal control of mothers with dependent young would be avoided. This 6-week period would be sufficient to catch significant numbers of hedgehogs each year, and would include the period during which all adults have emerged from hibernation and are therefore susceptible to capture.

Reeve & Bristow (2001) suggest that Uist hedgehogs may harbour significantly fewer pathogens than mainland hedgehogs because they do not host hedgehog fleas, which are known to be disease vectors. If this is the case it is likely that, following translocation, individuals will be more susceptible to infections than indigenous animals because, for Uist animals, indigenous pathogens will have elevated virulence. This could potentially exacerbate low survival rates and suffering in translocated animals. Moreover, they may also have initially limited the range of parasites present in the founder population.

6. CONCLUSION

The timing considerations for catching Uist hedgehogs throw into question the practical potential for effective, legal and humane programmes of Uist hedgehog translocation or holding in long-term captivity. If these methods are to be achieved without inducing significant suffering and death they would have to be attempted very early on in the season. At such a time the life-cycle stage of hedgehogs is sub-optimal for capture resulting in an impractically short time-window of ten days for capture.

There is no obvious way of reconciling this difficulty. However, leaving it to one side, we can use the above considerations to assess the likely the impacts of the three proposed hedgehog population control techniques in terms of animal mortality and suffering.

Humane Lethal Control: This would lead to the death of all captured hedgehogs but levels of suffering per death would be lower than indirect mortality caused by translocation or indefinite captivity.

Translocation: This would almost certainly lead to at least ¼ of captured animals dying prematurely. There is also potential for high mortality of the offspring of translocated pregnant animals and for mortality of indigenous mainland hedgehogs. Therefore, the potential number of hedgehogs dying because of translocation could be similar or perhaps even higher than those dying through humane lethal control. A significant proportion of this mortality may be impossible to detect, even during a well monitored small-scale trial. The levels of suffering imposed per death would be higher than those for humane lethal control, and there is potential for suffering to be induced in animals that do not die because of manipulation. Similarly, a significant proportion of suffering caused would be impossible to detect.

Long-term Captivity: Capture and indefinite holding in captivity may lead to lower mortality rates of captured Uist hedgehogs than the previous two techniques. However, there is potential for relatively large numbers of young hedgehogs to die. Adults are likely to be exposed to relatively high stress levels, with associated suffering, and the deaths of young hedgehogs would induce more suffering per death than humane lethal control.

To achieve immediate and effective population reduction of Uist hedgehogs, as a means to achieving wader conservation the Uists, a choice has to be made between killing hedgehogs whilst minimising suffering, and allowing some survival of Uist hedgehogs but considerable concomitant suffering of both individuals that die and those that survive.

Even if serious practical considerations are overlooked, this review suggest that there is little justification in terms of animal welfare (as assessed by both mortality and suffering) for proceeding with programmes of translocation or long-term captive holding of Uist hedgehogs. The only clear advantage that these techniques appear to have over humane lethal control is that they may at first sight appear to be more palatable. Judged from the perspective of animal welfare, however, trialing translocation would be misguided.

7. REFERENCES

Department for Environment, Food and Rural Affairs (DEFRA) (1998). A guide to wildlife law enforcement in the United Kingdom. 10.1 Abandonment of Animals Act 1960. http://www.defra.gov.uk/wildlife-countryside/wildcrime/crime/law/10_1.htm

Doncaster, C.P. (1994). Factors regulating local variations in abundance: field tests on hedgehogs *Erinaceus europaeus*. *Oikos* **69**: 182-192.

Doncaster, C.P. (1992). Testing the role of intraguild predation in regulating hedgehog populations. *Procedures of the Royal Society of London B* **249**: 113-117.

HMSO (1989). A Code of Practice for the Housing and Care of Animals used in scientific procedures. http://www.homeoffice.gov.uk/animact/hcasp.htm

Jackson, D. B. (2001). Experimental removal of introduced hedgehogs improves wader nest success in the Western Isles, Scotland. *Journal of Applied Ecology* **38**: 802-812.

Jackson, D.B. (1994). Breeding dispersal and site-fidelity in three monogamous wader species in the Western Isles, UK. *Ibis* **136**:463-473.

Jackson, D. B., Fuller, R.J. & Campbell, S.T. Long-term population changes among breeding shorebirds in the Outer Hebrides, Scotland, in relation to an introduced mammalian predator. *In prep*

Jackson, D. B. & Green, R.E. (2000). The importance of the introduced hedgehogs (*Erinaceus europaeus*) as a predator of the eggs of waders (Charadrii) on machair in South Uist, Scotland. *Biological Conservation* **93**: 333-348.

Kirkwood, J. K. (2000). Interventions for the conservation or welfare of wild animals. In: *Vetinary ethics: An introduction*. (G Leggod Ed). pp 121-138. Continium Press. London/ New York.

Morris, P. A. (1998). Hedgehog rehabilitation in perspective. *Veterinary Record*, **143**: 633-636

Morris, P. A. (1997). Released, rehabilitated hedgehogs; a follow-up study in Jersey. *Animal Welfare* **6**(4): 317-327.

Morris, P. A., Munn, S. & Craig-Wood, S. (1992). The effects of releasing captive hedgehogs (*Erinaceus europaeus*) into the wild. *Field Studies* **8**: 89-99.

Morris, P. A., Meakin, K. & Sharafi, S. (1993). The behaviour and survival of rehabilitated hedgehogs (Erinaceus europaeus). *Animal Welfare* **2**: 53-66.

Morris, P. A. & Warwick, H. (1994). A study of rehabilitated hedgehogs after release into the wild. *Animal Welfare* **3**: 163-177.

Reeve, N.J. (1998). Survival & welfare of hedgehogs (*Erinaceus europaeus*) after release back into the wild. *Animal Welfare* **7**: 189-202.

Reeve, N.J. (1994). *Hedgehogs*, T & A D Poyser, London.

Reeve, N.J & Bristow, S. (2001). Feasibility study on a small-scale translocation of hedgehogs from the Uist to mainland Scotland: A non-lethal alternative to humane lethal control in order to achieve population reduction. *Unpublished Report, Uist Wader Project*.