

redacted

From: [redacted]
Sent: 24 November 2010 14:41
To: [redacted]
Cc: Hacking in falconry
Subject:

[redacted]

Following the planning application (which you may have seen) that related to commercial hacking of birds of prey, we have been discussing the issue of hacking in general and have concluded that we need to find out more about what it involves in practice (specifically in relation to non-native or hybrid birds). We think we need more information both to understand the potential risks and to be able to take a view on whether to issue licences, or how to take this forward under the WANE Bill – do we provide a general exemption, regulate by order or by licence?

[redacted] suggested that you might be able to assist as you are likely to know experts in the falconry field who might be able to provide us with further information.

Some of the questions it would be useful to know answers to include:

- What types of hacking are there and how do they differ?
- How old are birds that are hacked?
- How long are they hacked for (at what age are they captured back)?
- How far (on average) do they fly by the end of the hacking period?
- Do they catch their own prey during the hacking period?
- How many/ what proportion of birds "go missing"? At what stage are birds most likely to go missing (i.e. are they likely to be able to survive)?
- What is considered to be the likely fate of the missing birds?
- What is the view of experts in the use of non-natives/hybrids in hacking?
- Any view on whether there is a risk to native populations?

Is this something you would be able to take forward for us? Grateful for your thoughts on the above, and happy to discuss

Best Wishes

[redacted]

Invasive Non-Native Species Policy

Rural and Environment Directorate

Tel: [redacted]

For more information on invasive non-native species, visit: www.scotland.gov.uk/invasivespecies

Falconry related questions from the SG

Some of the questions it would be useful to know answers to include:

What types of hacking are there and how do they differ? Hacking is the practice of taking young falcons through the fledging period, getting them to fly, strengthen their wings and become ready for training. This can be done in large aviary pens 'pen hacking' or from platforms open to the environment 'wild hacking'. Hacking sites should ideally be free from disturbance and interference, but need to be accessible to the falconer. Wild hacking improves the hunting skills of falcons, and some markets for falcons prefer birds which have been wild hacked. Up to 100 falcons may be hacked at one location in summer.

- **Wild hacking involves** releasing young falcons into the wild to improve their hunting and flight skills. Just before fledging the young falcons are moved from the nest aviary into boxes on stilts, in the wild. The young falcons are allowed to fly, hunt and exercise close to the box. There are some good websites on hacking, such as:

- **Pen hacking involves** rearing falcons in a large enclosed pen, so that they are not released into the wild. Some falconers view this as an inferior way of training birds as they are not able to hunt for themselves in the wild.

- Some useful websites:

- <http://www.gyrfalcons.co.uk/?page=hacking>

[http://wildlife1.wildlifeinformation.org/s/00man/avianhusbandrytechniques/ukbhusbindtech/Cas Release Av Birds of Prey.htm](http://wildlife1.wildlifeinformation.org/s/00man/avianhusbandrytechniques/ukbhusbindtech/Cas%20Release%20Av%20Birds%20of%20Prey.htm)

http://en.wikipedia.org/wiki/Falconry_training_and_technique

<http://www.themodernapprentice.com/glossary.htm>

- **How old are birds that are hacked?** Wild hacking typically begins at around four weeks old, when most falcons in the nest would be exercising in the nest but not yet flying. At first the birds are kept in the hack box for a couple of days, then the door is opened and the birds can make short steps onto a platform, or even down onto the ground. After further days, the young falcons will flutter and fly further, attempting to take 'easy' prey, such as rabbits. The first website above provides a good description of the progression of activities.
- **How long are they hacked for (at what age are they captured back)?** Wild hacking lasts for four - five weeks, so that by the end of the period the young falcon is independent, strong and capable of hunting. There is considerable variation in

this, and during the latter period falcons may be away from the hack box for several days.

- **How far (on average) do they fly by the end of the hacking period?** There is a lot of debate about this. Initially, falcons will stay close to the shelter boxes. But, as they mature and develop they will fly much further. Some suggest birds will stay away for three days or so. We do not know the distances birds travel from hacking sites, but some may fly 20 km or more from the hacking site, and of course some birds 'escape' into the wild.
- **Do they catch their own prey during the hacking period?** They do catch their own prey, but throughout the period the falcons are fed up to twice a day; the ad lib food is the lure to catch the birds at the end of the hacking period.
- **How many/ what proportion of birds "go missing"? At what stage are birds most likely to go missing (i.e. are they likely to be able to survive)?** We don't know. Wall says he loses up to 20% of his birds currently. Sites with continuous observation of young falcons probably lose fewer birds. This varies considerably. Once birds show signs of leaving the wild hack site they are trapped, and exercised further in large netted areas; but this varies.
- **What is considered to be the likely fate of the missing birds?** Many missing birds will die, but others will travel considerable distances until they locate a ready supply of prey, and depending on competition and predation pressures, they may remain in one location or move on.
- **What is the view of experts in the use of non-natives/hybrids in hacking?** Not sure exactly what is meant by this question; the use of wild hacking for the conditioning of non-native or hybrid falcons must raise the risk of the release of a non-native species into the wild; pen hacking would be more secure and not raise legal questions about the practice. There are growing concerns about the release of hybrid falcons and the further hybridisation of some species (male hybrid gyrfalcons can breed). However, this is difficult to quantify without genetic testing.
- **Any view on whether there is a risk to native populations?** There are concerns about 'escaped' hybrids, and their impacts on native populations of peregrine in the UK. There are concerns about the impacts of hacked birds on some local game bird stocks, and potentially on some wild birds. And there are some welfare concerns regarding the potential harm caused to abandoned birds, though these can readily be managed through provision of food (so long as birds are well fed and watered at hacking sites this should not be an issue).

[redacted]

[redacted]

From: [redacted] >
Sent: 03 February 2011 12:17
To: R[redacted]
Cc: RE: WANE Bill: Falconry related questions
Subject:

[redacted]

Apologies for being so late getting back to you on this.

I would agree that from my understanding of the process wild hacking involves the 'release' of birds into the wild. Therefore if these birds are covered under Section 14 of the amended Act (although see my comments below on hybrids) then this activity would be an offence. Therefore the activity would have to be licenced to be undertaken legally. I guess that the point I'm trying to make is that as far as I see it, the legislation already says that it should be a regulated activity. It might be useful to get a legal interpretation of the legality or otherwise of this activity and, should they agree, ensure that the relevant stakeholder groups are aware of this and subsequent licensing implications.

On a related note, is there a reason why hybrids will no longer be covered by Section 14 of the Act post WANE? Although I assume that hybridisation between some falcon species will occur in the wild, I would suspect that many of the hybrids used by falconers do not have a 'natural range' - one might therefore argue that they would not be covered by the amended Act (unless an Order is made covering hybrids under s14(1)(a)(i)). If this was the case then of course the argument put forward above would not apply.

I hope this makes sense

[redacted]

Scottish Natural Heritage
Great Glen House
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Mob: [redacted]
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For licensing application forms and guidance visit: <http://www.snh.gov.uk/protecting-scotlands-nature/species-licensing/>

>>>[redacted] 1/25/2011 11:45 am >>>

[redacted]

Thanks for your response. I am copying this reply to [redacted] to see if they have views.

You ask if 'wild hacking' (effectively the release of) non-native birds should be regulated. I think that we have to consider wild hacking as involving the release of non-native as well as native falcons into the wild. Whilst many of the 'released' birds will return to their base, some will not, and there is then the ensuing risk of hybridisation or

even settlement. I have to admit I have not seen hybrid falcons in the wild, and consider the incidence of hybridisation to be low.

We do not know how many falcons are wild hacked, however, and we do not know how many birds escape into the wild. So, my preference would be for wild hacking to be undertaken under licence, so that we can have oversight of the nature and extent of the practice.

[redacted]

>>> 01/24/11 5:36 PM >>>

[redacted]

Thanks for your answers to the hacking questions I posed.

I gather from your response that by the time birds are brought in from hacking they are ?independent, strong and capable of hunting? may fly ?20 km or more? from the hacking site and if they do not return, it is ?possible that they have travelled a considerable distance until they have located a ready supply of prey?.

So my next question is whether you consider this activity should be allowed to continue without any regulation given the potential threat to native birds from hybridisation and that in many cases this seems to be a release to the wild? Should this be an activity that is carried out under licence or should a general exemption on release be provided by the code of practice on non-native species indicating that hacking does not constitute release (to my mind what you've said suggests that it can constitute release)?

Thanks

[redacted]

[redacted] redacted]

Invasive Non-Native Species Policy

Rural and Environment Directorate

Tel: [redacted]

For more information on invasive non-native species, visit: www.scotland.gov.uk/invasivespecies

From: [redacted]

Sent: 19 January 2011 13:44

To: [redacted]

Cc: [redacted]

Subject: WANE Bill: Falconry related questions

[redacted]

Would you please let [redacted] have these answers to questions she had put to me over falconry matters. Do let me know if you need mre; we can discuss tomorrow.

Cheers

[redacted]

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[redacted]

From: [redacted]
Sent: 05 February 2020 14:45
To: [redacted]
Subject: FW: Peregrine paper 2011.pdf
Attachments: Peregrine paper 2011.pdf

From: [redacted]
Sent: 18 October 2011 12:58
To: [redacted]
Subject: Fwd: Peregrine paper 2011.pdf

The full paper for you ... [redacted]

>>> [redacted] 18/10/2011 12:55 >>>
[redacted]

As requested.

[redacted]
Policy & Advice Directorate
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Great Glen House
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IV3 8NW

Telephone: 01463 725000 (switchboard)
Direct dial: [redacted]
E-mail: [redacted]

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sgr`iobhaidh.

Thoiribh an aire airson adhbharan gnothaich, 's d'ocha gun t`eid
s`uil a chumail air puist-dealain a' tighinn a-steach agus a' dol a-
mach bho SNH



Captive breeding of peregrine and other falcons in Great Britain and implications for conservation of wild populations

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ABSTRACT: Numbers of captive-bred peregrine falcons *Falco peregrinus* and other species of falcon, which are subject to compulsory registration in Britain, increased substantially over the period from 1983 to 2008, such that >7800 were registered in captivity in 2007. Much of this increase has been due to the international demand for, and consequent production of, novel hybrids for international trade. Over the same period, the wild peregrine population recovered from pesticide-induced decline and expanded its range into lowland Britain. Wild and captive peregrine 'populations' are linked through the taking into captivity of wild birds and through the escape of captive birds. Such escapes occur in numbers (>1500 over the study period from 1983 to 2007) that are potentially capable of enabling recruitment to the wild; escaped birds are predominantly hybrid and peregrine falcons, and the latter may be of mixed or uncertain provenance. Escaped peregrines are under-recorded by birdwatchers compared with non-native falcons. The benefits and risks for wild peregrine populations of the captive breeding of falcons are considered, especially with respect to any potential human-induced genetic introgression from escaped falcons.

KEY WORDS: Captive breeding · Peregrine falcon · *Falco peregrinus* · Genetic introgression · Hybrid falcons · International trade · Escapes · CITES

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INTRODUCTION

The role of captive breeding in conservation has typically been considered in the context of its contribution to the recovery of wild populations or the maintenance of *ex situ* populations (e.g. Rahbek 1993). Captive production and breeding of wildlife for primarily commercial purposes (www.cites.org/eng/res/05/05-10R15.shtml) or for personal use has rarely been subject to similar scrutiny. However, whether such captive production has an impact on wild populations of the same species is subject to a range of opposing views (see www.cites.org/eng/cop/14/doc/E14-48.pdf). On the one hand, some

claim that captive production can reduce the demand in trade for wild-taken specimens by providing an alternative, legitimate source of supply and so may undermine or displace illegal trade. In doing so, such captive production can contribute significantly to the conservation of wild populations (IUCN SSC unpubl.; see also www.cites.org/eng/cop/14/doc/E14-48.pdf). On the other hand, some claim that such captive production may have unintended negative consequences, such as potentially reducing incentives to conserve wild populations, shifting the benefits of wildlife trade from developing to developed countries, providing a cover under which to 'launder' into trade illegally taken wild specimens and, by stimu-

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lating but not meeting demand, place greater pressure on wild populations (IUCN SSC unpublished, also see www.cites.org/eng/cop/14/doc/E14-48.pdf). However, there are relatively few well-documented case studies to enable the relative merits of these arguments to be examined (IUCN SSC unpubl.). MacGregor (2006) provided an example of the implications of the captive production and breeding of crocodilians for incentives to conserve wild populations; Haitao et al. (2008) considered the potential impacts of large-scale commercial captive production of turtles in China. For crocodilians, Hutton & Webb (2003) concluded that legal trade, including that derived from captive production, could displace illegal trade.

There is a significant trade in, and demand for, birds of prey, especially falcons *Falco* spp., for the sport of falconry and for captive collections. As a result, all *Falco* spp. have been listed in Appendices I and II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since its ratification in 1975. Accordingly, international trade in these species is regulated by a series of import and export permits. In brief, species in Appendix II may be traded internationally if such trade is not detrimental to their survival in the wild. By contrast, commercial international trade is prohibited in the more threatened species listed in Appendix I unless such specimens are captive bred, in which case they are treated as if they are Appendix II specimens. Some of the species traditionally most valued in falconry, namely peregrine falcon *F. peregrinus* and gyrfalcon *F. rusticolus*, are listed in Appendix I. Techniques for captive breeding of peregrine and other falcons were originally developed in North America, and to a lesser extent in Europe, in the 1960s and 1970s and focused on the peregrine falcon, firstly because of its desirability for falconry and, secondly, to provide birds to re-populate, through re-introduction, some declining or extirpated peregrine populations (Cade & Temple 1977). As a result of CITES provisions, which provide a de facto incentive for captive breeding of Appendix I species valued in trade, and a related series of legislative measures at the national level to protect wild populations of these falcons, there has been a major shift in Europe, including Britain, away from the use of wild-taken specimens for falconry and a corresponding shift towards the increased use of captive-bred falcons (Kenward & Gage 2009, Kenward 2009).

Great Britain (GB) provides a useful case study to assess any impacts on the conservation of wild falcons of this move to captive breeding and to consider

the conditions under which trade in captive-bred specimens may be beneficial for wild populations (Sutherland et al. 2009). Britain has a long and continuing tradition of falconry (Ratcliffe 1993, Kenward 2009). It also has significant populations of wild falcons, especially of peregrine falcons, which are now in recovery following earlier pesticide-induced declines and which are subject to regular population monitoring (Ratcliffe 1993, Greenwood et al. 2003). Significantly, from 1983 to 2007, legislation in Britain required a number of bird taxa, including falcons and their hybrids, if kept in captivity to be ringed and registered with a government department as a measure to deter the illegal take of wild birds (Williams & Evans 2000); subsequently, following a review (Defra 2006), the number of species for which registration is required has been substantially reduced (e.g. www.legislation.gov.uk/uksi/2008/2356/made). There is thus a 25 yr period of documented changes in the numbers and species composition of most falcons kept in captivity which also spans a period when the licensed removal of falcons from the wild in GB ceased.

In this study we aim to: (1) describe trends in the numbers, origin and taxonomic composition of peregrine and other falcons in captivity from 1983 to 2007; (2) analyse the factors affecting such changes; and (3) assess any risks and benefits of captive breeding for wild peregrine populations. We focus particularly on the peregrine falcon because it is the only falcon breeding in the wild in Britain which is also listed in Appendix I of CITES; it is desirable in falconry; it has been the focus of considerable conservation attention; and it has special protection under British legislation (Ratcliffe 2003).

METHODS

Trends in numbers and taxonomic composition of falcons in captivity

Information on captive birds of prey held before 1983, when the requirement for registration began, is derived from Kenward (1979), who estimated the number and origin of such birds held in 1975 and 1978. Subsequently, the provisions of the 1981 Wildlife & Countryside Act (WCA) required any bird listed in its Schedule 4 to be ringed and registered if kept in captivity (Williams & Evans 2000). This legislation applies only to GB (namely England, Scotland and Wales) and not to the United Kingdom (UK) as a whole (thus the legislation does not apply to north-

Table 1. *Falco* spp. Falcon species listed in Schedule 4 of the Wildlife & Countryside Act (WCA) from 1983 to 2007

Common name	Scientific name
Barbary falcon	<i>Falco pelegrinoides</i>
Gyr Falcon ^a	<i>F. rusticolus</i>
Hobby ^a	<i>F. subbuteo</i>
Lesser kestrel	<i>F. naumanni</i>
Mauritius kestrel	<i>F. punctatus</i>
Merlin ^a	<i>F. columbarius</i>
Peregrine ^a	<i>F. peregrinus</i>

^aSpecies receiving additional protection under Schedule 1 of the WCA

ern Ireland). All such registrations are now with the Animal Health agency (formerly with predecessor bodies) which also supplies the rings or cable-ties, each uniquely numbered, to be fitted to the birds; compliance is encouraged through a series of inspections (Williams & Evans 2000). Failure to register any bird listed in Schedule 4 constitutes a criminal offence.

In 1981, the Schedule listed all birds in the family Falconidae. Subsequently, a review in 1993 removed from the Schedule all falcons apart from the 7 species listed in Table 1. Unless stated otherwise, all references to captive falcons in this paper refer to these 7 listed species and not to species formerly included in the Schedule. All hybrids of the listed species (Table 1) also had to be registered during the study period (1983 to 2007), whether they were hybrids between falcons listed in Schedule 4 or between a Schedule 4 species and a non-listed species. Data for peregrine falcons, hybrid falcons and 'other' falcons (namely all species in Table 1 other than hybrids and the peregrine falcon) are presented separately in the present study. Nomenclature follows that used in the WCA and CITES, the latter being based on Dickinson (2003).

All bird registrations are entered into an electronic database with details of the species, ring number, location where kept, keeper, date of registration (and when registration ceases), and, if known, hatch date, parental details, origin (wild, wild-disabled, captive bred, imported and unknown) and ultimate fate (dead, transferred to another keeper, exported, lost, released or unknown). Details are recorded in the database as they are provided by the keeper and are not routinely subject to any secondary checks. Electronic data entry only began on 20 March 1986; all birds registered before, and still alive on, this date will thus appear as if registered in 1986. The database is owned and managed by Animal Health and is

not publicly available. The dataset, supplied by Animal Health, on which most of the analyses in this paper are based, was downloaded on 26 February 2008. Archived data on the species removed from the Schedule in 1993 remain available.

The database does not enable certain retrospective analyses to be undertaken (e.g. to query how many specimens of a particular species were registered on a certain date in the past). However, it has been the practice by Animal Health and its predecessors (from 1989) to collate, on a specific date towards the end of each calendar year, an annual census of all birds registered. This census was taken on 15 November each year except in 1999, 2000 and 2002 (when taken on 1 January), 2001 (15 September), 2003 (15 January) and 2004 (17 January). No census data are available for 1998. Census data are presented by the calendar year in which they were taken (see Fig. 1). Records for the number of young produced each year (with the exception of 1989) were also recorded by Animal Health and its predecessor bodies: for peregrine from 1987 to 2007 and for other falcons from 1989 to 2007. Data for hybrids in such annual censuses were only distinguished from data for full species beginning in 1994.

Factors affecting trends in captive falcons

The UK has been a Party to CITES since it came into force in 1975. There are thus full data on all regulated imports and exports of *Falco* spp. into or out of the UK and, indeed, from any other country Party to CITES. These data are accessible from the United Nations Environment Programme – World Conservation Monitoring Centre (UNEP-WCMC) CITES Trade Database (www.unep-wcmc.org/citestrade/trade.cfm); UNEP-WCMC (2004) provides guidance on the interpretation of such data. It is not possible from CITES trade data to distinguish between trade in birds derived from the component parts of the UK (in particular between Britain and Northern Ireland).

Within the European Community (EC), CITES has been implemented since 1984 through regulations that apply in all member states (Morgan 2003). These regulations were amended in 1997 (EC Regulation 338/97) following, amongst other things, the abolition of internal border controls within the EC (Morgan 2003). As a result, from 1997, data are no longer available for 'imports' and 'exports' between other EC member states; moreover, the number of member states has increased over the same period. However, these later EC CITES regulations required that all

commercial use of species listed on their Annex A (including all *Falco* spp.) be regulated by the issue of certificates. As a result, there is good information from 1997 onwards on internal trade in, and other commercial use of, falcons within the UK. These data are stored on a licensing database known as Unicorn, managed by Animal Health and its predecessors (and not publicly available), to which we had access.

Estimates of the prices charged for falcons in trade in the UK were obtained by examining advertisements in the weekly national periodical 'Cage & Aviary Birds' (IPC Media, London) over the period from 1 September 2005 to 30 March 2006; care was taken to avoid repeated advertisements being counted more than once. These figures were then compared with an earlier exercise (The Royal Society for the Protection of Birds unpubl.) when advertised prices had been recorded from the same periodical over a period of 8 yr (1981 to 1987 inclusive). In order to correct figures for monetary inflation, the retail price index (www.crownsnest.co.uk/north/rpi.htm) for the median month of each study period was used to adjust the 2005/2006 figures to 1984/1985 prices.

Origin of founder stock. The use of peregrine nestlings taken from the wild for falconry or aviculture (including captive breeding) in GB was permitted under licence until 1988; thereafter, no licences for such wild use were issued (Fox & Chick 2007). Numbers of birds legally removed from the wild in this way between 1971 and 1978 were reported by Kenward (1979) and, subsequently, were derived from UK reports on derogations from the EC Birds Directive (1979/EEC/409) and correspondence, where available, taken from archived internal files, between the relevant government departments and the Nature Conservancy Council, the statutory adviser on nature conservation at the time. Imported falcons also contributed to the taxonomic composition and increase of falcons in captivity (Kenward 1979; UNEP-WCMC CITES trade database) as did some injured wild birds which may, by law, only be retained in captivity if they are so disabled as to prevent their return to the wild (referred to as 'wild-disabled'). Data for 204 wild and wild-disabled birds, all registered before 2000 but whose date of first registration had been corrupted to 1 January 2000, were excluded from some analyses. The bird registration scheme does not routinely record the nature of any disabilities affecting wild-disabled birds, but such data are available, from 1997, for applications for the commercial use of such birds.

Risks and benefits to wild populations

Size of wild populations. Breeding peregrines in both GB and the UK as a whole have been subject to full national censuses at intervals of ca.10 yr since 1971 (Ratcliffe 1972, 1985, Crick & Ratcliffe 1995, Banks et al. 2010). Between these censuses, wild populations are less intensively monitored by voluntary fieldworkers in raptor study groups (e.g. Etheridge et al. 2007).

Evidence of illegal take or trade. Peregrine and other falcon species are listed in Schedule 1 of the WCA (Table 1), which gives them special protection under law, making it an offence, amongst other things, to take, possess or to sell, offer or possess birds for the purposes of sale. Information on any illegal activity is, by its nature, difficult to obtain. However, information was taken from literature and other sources where available.

Numbers of falcons released or escaping to the wild. Numbers of captive birds lost to the wild (typically when being flown for falconry), and which had not been recovered, were recorded in the registration database. These data exclude birds which temporarily escape or are at hack in the wild for falconry purposes and which are subsequently re-captured. The deliberate release to the wild of peregrine falcons of wild or wild-disabled origin was analysed separately from that of birds of captive-bred origin.

In addition, in order to assess how many escaped falcons were observed by birdwatchers, a sample of annual county, regional or country bird reports was consulted (see Table S1 in the supplement, available online at www.int-res.com/articles/suppl/n014p243_supp.pdf). Although the number of bird reports available for each year was not constant (ranging from 8 to 15), they represent 322 'report years' from 1981 to 2006, account for a significant geographical coverage of GB and are likely to indicate the relative abundance of escaped falcons observed by birdwatchers. We did not attempt to determine whether observations represented repeat sightings of the same bird nor did we attempt to correct for 1 bird being recorded in more than 1 report unless such interpretation was suggested in the report itself. Thus, sightings are more likely to be over-estimates of birds seen than under-estimates. Evidence for birds being presumed to have escaped from captivity is typically because the birds still have falconers' jesses attached (the majority of records for peregrine falcons), because the birds appear to be hybrids, or because they are non-native species whose occurrence in a genuine wild state is deemed unlikely, or a combina-

tion of these factors. As gyrfalcons can occur in a genuine wild state in Britain, only those records which indicated a captive origin of such birds were collated.

Statistical analysis. Descriptive statistics were undertaken using Microsoft Excel. Regression analyses were undertaken using SPSS version 13 software (under licence). The dependent data in such analyses were in percentages; following tests to determine the normality of such data, these data were not transformed.

Definitions. Definitions of captive breeding vary between CITES and the WCA, being less strict in the latter. A bird recorded in the registration database as captive bred might thus conceivably be considered captive bred by the WCA but not by CITES; in practice this is likely to refer to only a small number of birds.

RESULTS

Trends in numbers, origin and taxonomic composition of falcons in captivity

Trends in the numbers of captive falcons (Table 1), derived from bird registration, in GB are illustrated in Fig. 1a. In all, since registration commenced in 1983 (to 26 February 2008), some 8051 peregrines, 4273 other falcons and 11 778 hybrid falcons have been registered as being in captivity. The overwhelming majority of these birds are recorded as being captive bred (21 902 or 91% of all falcons; 6918 or 86% of peregrines). On 15 November 2007, 7824 falcons were registered as being in captivity, comprising 2457 peregrines, 1231 other falcons and 4136 hybrids. This represents a significant increase from the 99 falcons which Kenward (1979) estimated were possessed by falconers in 1978, of which only some 3% were peregrine or Barbary falcons *Falco pelegrinoides*. Several species commonly kept by falconers, such as saker *F. cherrug* and lanner *F. biarmicus* falcons, and for which registration is not required (see Table 1), are not included in these totals.

Artificial insemination has enabled a wide range of hybrids to be produced between virtually any *Falco* species. At least 12 falcon species in a wide variety of combinations are represented in the lineage of the hybrids bred in captivity in GB. Based on birds registered in November 2007, most registered hybrids (95%, 3921 birds) were a combination of 2 species (in varying proportions), a smaller number (5%, 210 birds) had 3 species in their lineage, and a very small number (0.1%, 5 birds) had 4 species. Of hybrids reg-

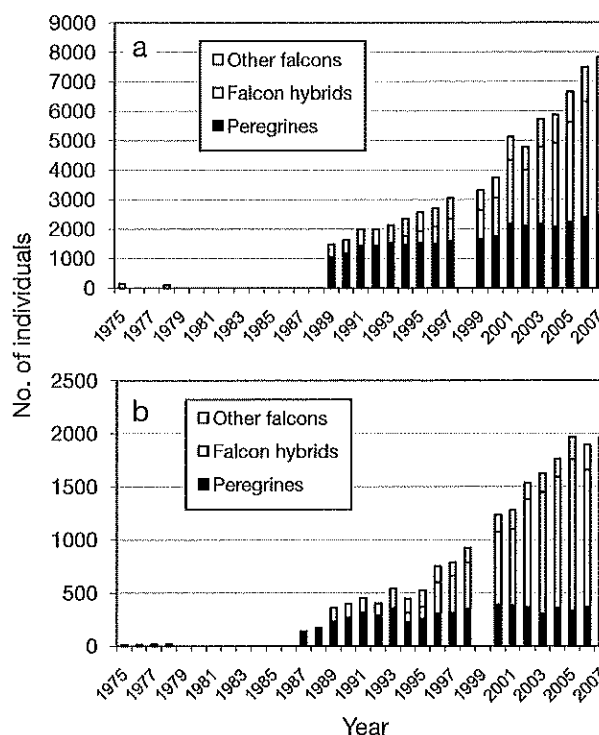


Fig. 1. *Falco* spp. Numbers of peregrine, hybrid and other falcons (a) registered as being in captivity on a sample census date in each of the years from 1989 to 2007 (no census data are available for 1998) and (b) recorded annually as being bred in captivity in each of the years from 1987 to 2007 (no data for 1999; data for peregrines available from 1987, for other falcons from 1989). Data for hybrid falcons were only distinguished from full species from 1994 onwards. Note that data for the years 1975 and 1978 are derived from Kenward (1979) and refer to all falcons except for common kestrel *F. tinnunculus*

istered in November 2007, the most abundant hybrid combination was between gyr and saker falcons (44%, 1843 birds), followed by peregrine and gyrfalcon hybrids (16%, 679 birds), peregrine and saker falcon hybrids (12%, 521 birds), and hybrids of these 3 species combined (3%, 133 birds). In all, hybrids of these 3 species, in their various combinations, accounted for 77% of all hybrids.

Although data for hybrid falcons were not distinguished from pure species until 1994, hybrid falcons have been largely responsible for the striking increase in numbers of captive falcons overall (Fig. 1a). Hybrid falcons registered on annual census dates did not outnumber peregrine falcons until 2003 (and did not outnumber peregrine and all other full falcon species combined until 2005). However, when the numbers of birds bred annually are compared (Fig. 1b), production of hybrids exceeded numbers of peregrines bred from 1997 onwards and all other

species combined by 2000. For example, in 1994, peregrines accounted for 50 % of the total number of falcons bred in captivity (226 of 447 birds) and hybrid falcons for just 20 % (89 birds). By contrast, in 2007, peregrines accounted for only 17 % of all young produced (340 of 1969 birds) and hybrids for 70 % (1371 birds); the production of peregrines appears to have reached a plateau with a mean of 341 ± 23.3 (SD) birds produced annually over the 5 most recent years indicating constant, if limited, demand.

Origin of founder stock. The founders of peregrines bred in captivity in Britain are derived from imported birds and wild-taken British birds. From 1971 to 1978, Kenward (1979) recorded 804 falcons (of all species except common kestrel *Falco tinnunculus*) as imported into the UK, a mean of 100 ± 47.1 (SD) per year. Over the same period, he estimated the recruitment of 49 native falcons (mean: 6 ± 4.1 per year) wild-taken under licence supplemented with, from 1973 onwards, 85 (mean: 10 ± 8.2 birds per year) captive-bred birds. In other words, imported birds constituted the majority (86 %) of birds estimated to have been obtained by falconers between 1971 and 1978. CITES trade data are available from 1975 onwards. Over the period 1975 to 1978 where CITES data overlap with those reported by Kenward (1979), gross imports to the UK of all falcons reported to CITES totalled 98 birds (24 ± 16.6 per annum), suggesting lower levels of imports than those estimated by Kenward (1979), viz. a mean of 64 ± 30.1 per annum over the same period. CITES gross import data themselves are likely to over-estimate actual imports (UNEP-WCMC 2004). Of the CITES-recorded imports of falcons for 1975 to 1978, only 18 were peregrine falcons, of which 13 (72 %) were of the sub-species *F. peregrinus brookei* and *F. p. calidus*, neither of which is native to the UK.

Imports of peregrines to the UK reported to CITES peaked in the early 1980s and again in the early 1990s (Fig. S1, available in the supplement at www.int-res.com/articles/suppl/n014p243_supp.pdf). Most CITES imports are not recorded to sub-species level, but of 398 peregrines imported to the UK in 1976 to 2005 inclusive, 63 (15 %) were non-native sub-species. The majority of these (51 %) were *Falco peregrinus pealei* but, in addition to the sub-species recorded above, also included *F. p. anatum* and *F. p. peregrinator*. It is likely that a greater proportion of imports than these figures suggest were of non-native sub-species; a further 88 peregrines (22 % of all imports) were imported from countries, notably the United States and Canada, where captive-bred birds were more likely to be sub-species other than

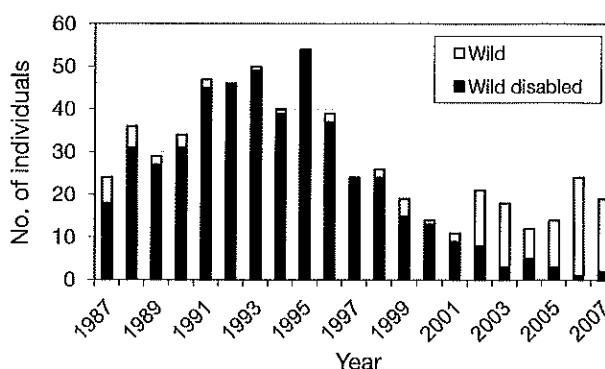


Fig. 2. *Falco peregrinus*. Numbers of peregrine falcons of 'wild' and 'wild-disabled' origin registered in captivity by the year in which they were first registered (note that these data exclude birds for which no first date of registration is recorded and birds whose registration date had been corrupted; see 'Methods' for explanation)

the nominate sub-species native to Britain. Early imports of non-native peregrines, as founder stock for captive breeding, are likely to have made a proportionately greater contribution to the genetic composition of the captive progeny than those imported later when numbers had increased. Relatively few falcon hybrids (91) have been imported.

Recruitment of wild birds to captivity. From 1985 to 2007, some 646 wild-disabled and 159 peregrines of wild origin were registered in captivity, a total of 805 birds (Fig. 2). Of these, 178 (22 %) were recorded as subsequently lost or released (Table 2). The proportion of each category lost or released to the wild is similar between wild-disabled birds (21 %) and birds of wild origin (26 %), suggesting that the distinction between these categories is not being applied consistently, that the definitions are not clear to keepers or that some birds make a greater recovery from injuries than anticipated. Nevertheless, 627 birds, comprising 117 wild and 510 of wild-disabled origin, were retained in captivity. In order to assess how many of these may have bred, we took, as a sample, all the birds of wild (36) or wild-disabled (107) origin

Table 2. *Falco peregrinus*. Total number of peregrines registered in captivity of wild origin or of wild-disabled origin and percentages (in parentheses) recorded as released to the wild or as lost/escaped birds; data from 1987 to 2007 inclusive

	Wild-disabled	Wild	Total
Lost	55 (8.5)	12 (7.5)	77 (9.5)
Released	81 (12.5)	30 (18.9)	111 (13.7)
Total lost/released	136 (21.0)	42 (26.4)	178 (22.1)
Total registered	646	159	805

registered in captivity on 15 November 2005 and then examined how many of these were subsequently recorded as parents in the database. Of this sample of wild and wild-disabled birds, 4 birds of wild origin (11%) and 25 of wild-disabled origin (23%) had bred; extrapolating these proportions to all 627 retained birds suggests that 13 birds of wild origin and 117 of wild-disabled origin could have bred in captivity, equivalent to 21% of all retained birds.

Data on licensed use from 1978 onwards are incomplete but suggest that some 32 peregrines were legally removed from the wild for the purposes of falconry and/or aviculture over the period from 1985 to 1988 inclusive. This is a rate broadly consistent with that reported by Kenward (1979) for the years 1971 to 1978. This licensed use probably accounts for the numbers of wild-origin birds first registered in the late 1980s. Even so, birds of wild-disabled origin significantly outnumber these, and the numbers of peregrines registered in this category continued to rise to a peak in the mid-1990s (Fig. 2). Thereafter, numbers of wild and wild-disabled peregrines registered in captivity declined, although in recent years, more birds have been recorded as being of wild origin than of wild-disabled origin. The reason for this trend is not clear, especially as the number of peregrines in the wild was increasing over this period (and so more disabled birds were likely). The greater availability and affordability of captive-bred birds may have reduced the incentive for keepers to retain and tend disabled birds.

In a sample of 145 applications for the commercial use of wild-origin peregrines made between 1997 and 2004 inclusive, no record of any disability is recorded for 67 birds (46%), and a further 14 (9%) were birds confiscated by law enforcement authorities. Of the remainder, 57 (39%) had physical injuries and disabilities, and 13 (9% of applications, 19% of recorded disabilities) were recorded as being mal-imprinted upon humans, thus preventing their release.

Factors affecting trends in captive falcons

Value of captive falcons. The advertised values of captive-bred falcons, when adjusted for inflation, diminished considerably from the 1980s to 2005/2006 for all species for which there are comparable data (Table 3). Whilst retail price indices are commonly

Table 3. *Falco* spp. Mean prices (in Great Britain pounds sterling, GBP) of a selection of falcons offered in advertisements in 1980 to 1987 (derived from The Royal Society for the Protection of Birds unpubl.) and over a 7 mo period in 2005/2006 (shown with \pm 95% confidence limits; $p = 0.05$) and the latter adjusted to 1984 values with the % of the 1984 price in parentheses. Dashes indicate no data (1980s) or fewer than 3 specimens offered for sale (2005/2006). £1 GBP is equivalent to \$1.59 US dollars and €1.15 euros (at 9 Sep 2011)

Species	Mean price (1980–1987)	n	Mean price (2005/2006)	n	Mean price (2005/2006) adjusted
Gyr Falcon ^a	–	–	1717 \pm 1386.3	3	–
Hybrid falcons	405	21	450 \pm 91.5	38	211 (52)
Lanner	454	216	431 \pm 58.4	8	202 (44)
Merlin ^a	427	56	–	–	–
Peregrine ^a	852	122	494 \pm 72.3	23	231 (27)
Saker	850	21	305 \pm 48.4	18	143 (17)

^aSpecies (including their hybrids) which had to be registered post-1993 under British law

used to adjust figures for inflation, their use here should be interpreted with caution. The indices are based on the prices of a range of commonly available household goods which do not include commodities such as live falcons. Nevertheless, they provide the only readily available means of comparing prices between different periods of time. For some species, too few figures were available in 1 of the 2 periods to determine a mean price; accordingly, we also included data on saker and lanner falcons (for which registration was not required after 1993) as commonly available captive-bred falcons. Gyr falcons are advertised at much higher prices than other captive falcons.

Trade in captive falcons. Falcons captive bred in the UK are in demand elsewhere in the world, and a proportion of such birds are exported annually (Fig. S2 at www.int-res.com/articles/suppl/n014p243_supp.pdf). UK trade reports do not enable exports of full species to be distinguished from hybrids and so, for analysis of UK exports of captive falcons, these data are derived from reports made solely by importing countries. Typically such reports more accurately record actual trade, but as some countries which are the recipients of exported birds may only have joined CITES in recent years, they will not have reported any imports of birds before they acceded to the Convention. Some importing countries may also have formal 'reservations' on some listings, where they opt out of applying the provisions of CITES with respect to the species concerned, and so may not fully report trade. Accordingly, these data should be treated with some caution. These data also exclude exports of

peregrine and other falcons to other member states of the EC before 1997 which, typically, were not reported by the importer.

Whilst there has been a continuing low volume of reported international trade from the UK in peregrine falcons (typically far fewer than 100 specimens yr^{-1}) suggesting a regular but limited demand, recent years have seen a substantial increase in trade in hybrid and other falcons, matching the growth of production of hybrids recorded in Fig. 1b. In all, from 1975 to 2005, 2355 hybrid falcons produced in the UK are recorded as imports by non-EU countries, with the majority recorded in trade to the United Arab Emirates (75%), Qatar (14%) and Kuwait (9%); 97% of all imports of UK-produced hybrid falcons have been reported from, and including, the year 2000 (but Qatar and Kuwait only acceded to CITES in 2001 and 2002, respectively). Trade in other falcons produced in the UK has also grown in recent years, and this trade is dominated by gyrfalcons, with 300 individual birds reported as being imported from the UK during the period 1995 to 2005 inclusive.

If CITES-reported imports by other countries of UK-bred peregrine and hybrid falcons are expressed as a percentage of the birds bred in that year (Fig. S3 at www.int-res.com/articles/supp/n014p243_supp.pdf), there is an exponential increase in the proportion of hybrid falcons being exported annually ($y = 0.1015e^{0.3469x}$; $r^2 = 0.9561$; $n = 9$, $p = 0.001$, based on analysis of untransformed data with x-axis values converted to Year 1 in 1987, Year 2 in 1988 and so on). Less than 10% of such hybrid birds were exported in 2000 compared with, in 2005, 51% (724 birds) of the 1423 birds reported as bred in captivity that year (Fig. S3). It is possible that this proportion

will not be exceeded, as the larger female birds are most in demand in the export trade, with the smaller males retained for the domestic market (International Hybrid Committee 1999). By contrast, the apparent increase in the proportion of peregrines exported is not significant ($y = 0.7544x - 0.0936$; $n = 18$, $p > 0.1$).

Risks and benefits to wild populations

Size of the wild population. The size of the UK peregrine population has been subject to a national census approximately every 10 yr since 1962 (Ratcliffe 1963, 1972, 1984, Crick & Ratcliffe 1995, Banks et al. 2010). Following the pesticide-induced nadir in the 1960s, the number of territories occupied by peregrines has recovered, such that in 2002 it stood at 1426 pairs, representing 163% of the 1930s baseline of 874 pairs (Banks et al. 2010).

Estimates of illegal nest interference and take. Information gathered during the course of the national censuses provided estimates of illegal take of eggs or nestlings and other incidents of nest interference (Table 4). As the presentation of data in the various censuses does not enable direct comparisons between the proportion of known clutches removed or destroyed (Table 4), nest interference is expressed here as a proportion of all breeding opportunities (or known pairs). The data suggest apparent low levels of known nest interference in 1961/1962 and 1971 (ca. 2% of breeding opportunities), a proportional and absolute rise in known nest interference in 1981 and 1991 (5 to 6%), with a subsequent fall in 2002 (to 1%). These data exclude cases of nest interference which were only suspected and whose inclusion

Table 4. *Falco peregrinus*. Increase in the UK wild peregrine population and estimates of nest interference involving eggs and chicks as derived from decadal censuses since 1961. Occupied territories are considered 'breeding opportunities'. Estimates of known nest interference exclude cases recorded as 'suspected' only. Known nest interference is shown as a % of breeding opportunities. GB: Great Britain

Year	Occupied territories	No. of clutches/broods	Estimate of known nest interference	Known nest interference (%)	Source
1961 & 1962	356 (GB only)		Young taken from 9 nests in each of 1961 (legally) and 1962 (illegally)	2	Ratcliffe (1963)
1971	341 (GB only)	157 broods hatched	Young taken from 6 nests	2	Ratcliffe (1972)
1981	768	531 clutches	Nests robbed of 29 clutches & 18 broods	6	Ratcliffe (1984)
1991	1283	912 clutches	Nests robbed of 45 clutches & 21 broods	5	Crick & Ratcliffe (1995)
2002	1426		13 incidents of 'persecution' of eggs or young	1	Banks et al. (2010)

would increase these percentages. Records of nest robberies and destruction provide an estimate of human interference but must be treated with caution because it is not clear if records of nest interference were analysed consistently between censuses and because it is not always possible to determine with certainty the motive behind any nest interference, the ultimate fate of any specimens illegally removed from nests or whether nest contents were simply removed or destroyed by those wishing to protect game stocks or racing pigeons. In the 1971 census, Ratcliffe (1972) considered that illegal taking of young for falconry was then the commonest cause of breeding failure once the young had hatched; he also noted that in the period of the 1981 census, eggs were also being taken to hatch and rear young in captivity (Ratcliffe 1984). Mearns & Newton (1988) reported that human robberies of eggs and young, recorded from a more intensive study of peregrines in southern Scotland from 1974 to 1982, accounted for 6% and 3% of all breeding opportunities, respectively. Locally, rates of nest interference may have been higher still, with peaks in the early 1990s (Horne & Fielding 2002).

The use of DNA profiling to determine familial relationships amongst captive raptors enables claims of captive breeding to be tested (Shorrock 1998). A sample of birds (<60 peregrines; G. Shorrock pers. comm.) tested in 1993 and 1994 in targeted investigations found that 39 peregrine falcons declared as captive bred were not related to their claimed parents, amounting to some 11% of the 360 peregrines and their hybrids registered as having been bred in captivity in 1993 (Shorrock 1998). These tests resulted in successful prosecutions and custodial sentences. Subsequently, further DNA testing during announced inspections in 1995 and 1996 of 35 peregrine falcons found no discrepancies with claimed familial relationships (Williams & Evans 2000). In 1994, between these 2 sampling periods, the number of peregrine falcons (and their hybrids) recorded as having been produced in captivity fell by more than 20% (Williams & Evans 2000; Fig. 1b).

Loss of captive birds to the wild. In total, the registration database records the loss to the wild of 1564 individual falcons during the study period. The majority of these (687 ind.; 44% of total) were peregrine falcons, followed closely by hybrid falcons (642 ind.; 41%). The remainder comprise other falcon species (235 ind.; 15%), of which merlins comprised the majority (77%) of that category (182 ind.; 12% of all escapes). These figures exclude birds of wild or wild-disabled origin.

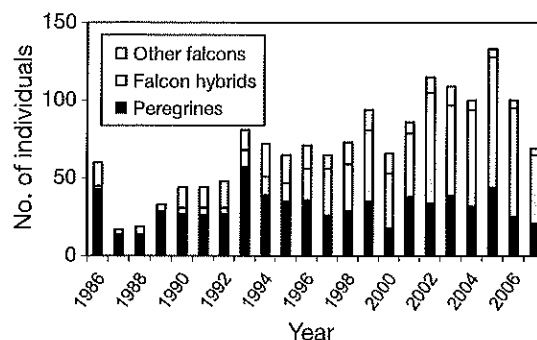


Fig. 3. *Falco* spp. Number of registered falcons recorded as having been 'lost' from captivity in Great Britain from 1983 to 2007 (note that data for 1986 include all losses from 1983 to 1986 inclusive). Data exclude wild and wild-disabled birds reported as lost or released

Peregrines accounted for the majority of all escapes, with a peak of 57 birds in 1993 (Fig. 3), until 1997 when losses of hybrid falcons first exceeded those of peregrine. Since then the proportion of hybrid falcons has steadily increased such that by 2006 they accounted for 71% of all losses to the wild.

Excluding combined data from 1983 to 1986, losses of peregrine falcons from captivity to the wild have, on average, been broadly similar over the 2 decades (1987 to 1997 and 1998 to 2007 covered by registration with means of 30 ± 7.3 and 31 ± 5.1 (95% confidence limits, $p = 0.05$) birds yr^{-1} lost to the wild in each decade, respectively. By contrast, losses of hybrid falcons have increased 6-fold between the 2 decades, from a mean of 9 ± 3.9 ind. yr^{-1} to 54 ± 13.1 ind. yr^{-1} . There is no legal obligation for keepers to report lost or escaped birds, so these figures can safely be considered as underestimates.

From 2005, there is an indication of a reduction in the number of birds, in all categories, being lost to the wild (Fig. 3). When the number of birds reported as lost in a year is expressed as a percentage of the number of birds recorded as registered on the census date in the same year (data only available from 1989 to 2007; Fig. 4), there is a clear indication of a reduction over time in the proportion of birds being lost from captivity to the wild. These results should be treated as being indicative only—birds are lost in a series of chance events throughout the year, whilst the numbers of birds registered are derived from a single but variable census date in each year. Nevertheless, this decline in the proportion of birds being lost each year is statistically significant when subject to simple regression analysis on untransformed data (with x-axis values converted to Year 1 in 1987, Year 2 in 1988 and so on) as follows: peregrine ($y = -0.078x + 2.874$; $n = 18$; $p < 0.01$), hybrid falcons

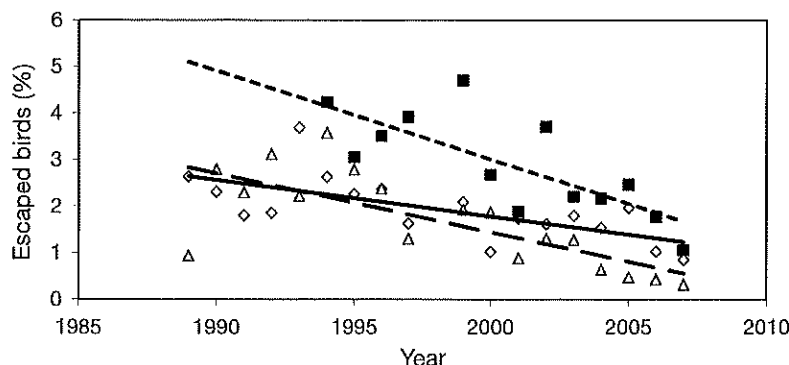


Fig. 4. *Falco* spp. Number of peregrine (◇; solid line), hybrid (■; dotted line) and other falcons (△; dashed line) reported annually as 'lost' (i.e. escaped to the wild) as a percentage of the total number registered in captivity on a census date in each year (see Fig. 1). No data available for 1998; data exclude wild and wild-disabled birds reported as lost or released

($y = -0.191x + 5.678$; $n = 13$; $p < 0.01$) and other falcons ($y = -0.126x + 3.213$; $n = 18$; $p = 0.001$). The proportion of birds escaping is now substantially lower than the proportions reported by Kenward (1974), when 60 to 73% of peregrines trained by falconers were lost.

Escaped birds observed in the wild. From 1981 to 2005, some 31 escaped peregrines and 66 hybrid or unidentified escaped falcons were reported by bird-watchers in a sample of county and regional bird reports (Fig. 5; see supplement at www.int-res.com/articles/suppl/n014p243_supp.pdf). However, by far the greatest number of escaped birds reported was in the 'other falcons' category (182 birds), of which lanner falcons (71 birds) and saker falcons (104 birds) accounted for 97% of all birds. These last 2 species were not subject to bird registration after 1993 (and thus we have no recent data on number of escapes), but we report these species here because they constitute the majority of escaped falcons reported by birdwatchers. Many unidentified escaped falcons were reported as 'saker-type' or 'lanner-type'. Indeed, whilst hybrid falcons begin to be reported from the 1990s and rise to a peak in 2004, 'other falcons' were routinely reported in greater numbers (Fig. 5). It is likely that many birds identified as lanner or saker falcons may have been hybrids (and perhaps vice versa) given the difficulties of discriminating between species and their hybrids (Eastham & Nicholls 2005) especially when observed in the wild. These results need to be treated with some caution. Some bird watchers may be

less likely to report birds thought to have escaped from captivity (Marchant 1996), and it was clear from our collation that the number of bird reports recording non-native escaped birds increased over time. Equally, peregrine sightings may have been subject to greater scrutiny in counties where they are, or were, naturally scarce.

Archived bird registration data are available for escaped saker and lanner falcons from 1986 to 1994 inclusive, which, when combined with data on escaped peregrines, enable comparison of escaped birds with those reported in the wild by birdwatchers. Over this period, 275 peregrines, 200 lanner falcons and 84 saker falcons were recorded as lost to the wild, a ratio of 3.3 peregrines and 2.3 lanners to every escaped saker. In the bird reports analysed for this period, 12 peregrines (4% of reported escaped birds) were recorded along with 21 lanner falcons (10% of escapes) and 18 saker falcons (21% of escapes), a ratio of 0.7 peregrines and 1.2 lanners to every saker with, overall, 9% of birds being seen post escape. From this sample, escaped peregrines are evidently under-recorded by birdwatchers relative to the number of escaped birds. This is not surprising when the only means most observers will have to distinguish escaped peregrines from native wild individuals is by the presence or absence of jesses, bells or other falconry furniture. By contrast, other falcons, such as sakers, will be conspicuously different from native birds and are likely to attract attention from birdwatchers.

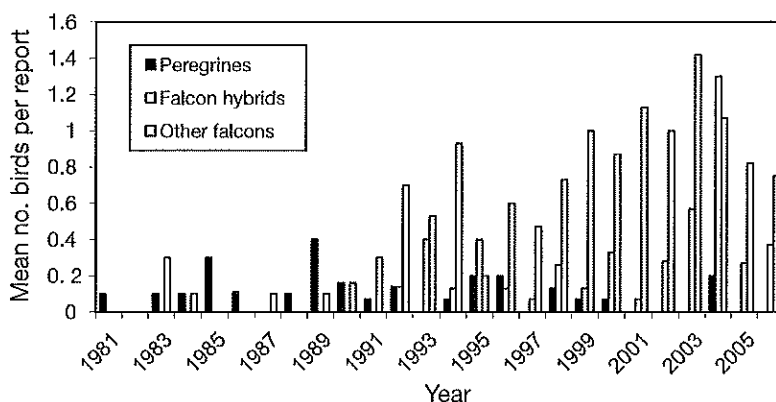


Fig. 5. *Falco* spp. Mean number of escaped peregrines, hybrid or unidentified falcons (as 'hybrids' in key), and other falcons reported annually in a sample of regional bird reports from 1981 to 2005; note that in this instance 'other falcons' includes sightings of saker and lanner falcons

It is also clear from the various bird reports that some escaped hybrid and non-native falcons are capable of surviving in the wild for extended periods, with some birds being reported persistently over 1 or more years. The Devon Bird Report records attempted breeding by a saker falcon in 1992 when, having displaced a pair of breeding peregrines, an escaped female laid a clutch of 3, presumably infertile, eggs. This bird was recorded at the site in a third year. We are also aware of other occasions where escaped falcons have interfered with breeding peregrines and where peregrines, having the appearance of non-native sub-species of peregrine falcon, have been observed breeding in the wild (N.P. Williams pers. obs.).

DISCUSSION

This paper records the significant increase in the captive breeding of peregrine and other falcons in Britain from 1983 to 2007. This increase mirrors that for other CITES-listed species which are in demand in trade. For example, 72% of all the crocodilian specimens recorded in trade in 1999 were of captive-bred origin (MacGregor 2006), and 95% or more of orchids in trade are artificially propagated (www.cites.org/eng/cop/12/prop/E12-P51.pdf).

The probable factors driving this increase in captive breeding of falcons include the ongoing market demand for falcons in Britain and overseas, the limitations on the availability of specimens from the wild and the development of improved captive breeding techniques. Moreover, for species listed in Appendix I of CITES, such as the peregrine, commercial trade is only permitted in captive-bred and not wild specimens, thus providing a significant incentive for captive breeding. Indeed, the incipient increase in captive breeding of peregrines in Britain provided the justification, under EC Directives, for regulatory authorities to suspend licensed removal from the wild of birds (because captive breeding provided a satisfactory alternative to such wild use). The increase in captive breeding supported a comparable increase in the number of falconers in Britain (Kenward 2009). A substantial shift towards the production, through artificial insemination, of novel falcon hybrids has also occurred. Such hybrids have attributes which make them more desirable to falconers than pure-bred birds – they may be larger and faster than pure-bred specimens, be less prone to disease, be more desirable aesthetically and may outperform wild-caught or pure-bred falcons (International Hybrid Committee 1999, Kenward 2009). Indeed, the

production of such hybrids now greatly exceeds that of pure-bred specimens and is strongly linked to the demand for them in international trade, especially in the Middle East where their use has been promoted as a means of reducing unsustainable use of wild-taken saker falcons (www.cites.org/eng/com/AC/20/E20-08-1.pdf). A similar pattern has emerged for orchids where the trade is also dominated by the artificial propagation of hybrids (www.cites.org/eng/cop/12/prop/E12-P51.pdf).

Over the same period in which the numbers in captivity have increased, peregrines breeding in the wild in the UK have also undergone a period of population recovery and expansion, such that they now considerably exceed the 1930s baseline (Banks et al. 2010). The increase in the wild population has been driven by controls on the use of organochlorine pesticides, increased legal protection and a reduction in deliberate illegal killing and nest interference (Ratcliffe 2003). However, within this overall population increase there have been declines in some regions (typically in north and west Britain) but also a significant range expansion into lowland Britain using man-made structures as novel breeding sites (Banks et al. 2010).

Although these 2 'populations', wild and captive, appear to have increased independently of one another, our results show that there is a continuing interchange between them. On the one hand, wild birds are routinely taken into captivity, while on the other hand, captive birds escape to the wild in significant numbers. In the continuing absence of licensed removal of peregrines from the wild for falconry or aviculture, the majority of wild birds known to be taken into captivity have been predominantly disabled birds (Fig. 2). With up to 21% of these wild-origin birds breeding in captivity, combined with previous imports of, presumably unrelated, birds from outside the UK and EC (Fig. S1), it seems that there should be little risk of inbreeding in the current captive 'population' overall.

Birds in captivity may also originate from illegal take, but the extent of this is difficult to assess. It is evident from DNA testing (Shorrock 1998, Williams & Evans 2000) and estimates of nest interference from census data that illegal taking of wild birds into captivity has occurred, perhaps especially before 1993. This risk had been effectively mitigated by a combination of regulation (compulsory bird registration), more effective enforcement techniques (targeted inspections and DNA testing) and market responses (greater availability of falcons and hybrids at lower prices), all deterring or reducing the incen-

tive for the illegal take of birds from the wild. Indeed, the production of hybrids may, initially, have been stimulated, amongst other things, by the desire of some breeders to avoid allegations of illegal take (Shorrocks 1998, Fox & Chick 2007, Kenward 2009, Kenward & Gage 2009).

However, whilst wild birds have found their way variously into captivity, an unintended consequence of the increase in numbers of captive falcons has been an associated rise in their number escaping to the wild. What is the likelihood of such escaped birds surviving, and subsequently breeding, in the wild?

Unlike planned re-introductions, the escape of captive falcons, as a series of chance events, is likely to be dispersed spatially and temporally, thus reducing the chances of birds of non-native species or provenance establishing breeding populations. Wild-reared birds are more likely to survive and recruit to wild populations than captive-bred falcons (Brown et al. 2006) especially as escape from captivity is more akin to a 'hard release' than to the 'soft release' favoured in deliberate re-introductions. Fox & Chick (2007) estimated that most escaped falconers' birds would die within days. Yet Holroyd & Banasch (1990) found that 6 to 10% of (soft) released captive-bred peregrines were re-sighted after 1 yr. Kenward et al. (1981) found that 40% of falconry-trained goshawks *Accipiter gentilis* survived after simulated loss to the wild. However, there is clearly likely to be a difference in probable survival after escape between falconry-trained birds experienced at hunting and inexperienced or untrained birds.

Nevertheless, for peregrines (687 escaped birds) and hybrid falcons (642), these escapes occur at levels which exceed or approach those known to be capable of establishing populations of peregrines in the wild through planned re-introductions (e.g. Holroyd & Banasch 1990, Tordoff & Redig 2001, Jacobsen et al. 2007). Equally, the escape or deliberate release from captivity of other raptors is implicated in the establishment in Britain of breeding populations of goshawk (Marquiss 1981, Marquiss & Newton 1982) and eagle owl *Bubo bubo* (Melling et al. 2008). Evidence from county bird reports and Everitt & Franklin (2009) also demonstrates that some escaped birds are capable of surviving in the wild for prolonged periods (in some cases years) after their escape and have attempted to breed, even if rarely.

What are the consequences to wild populations of escaped birds? On the debit side, such escaped birds may compete with wild birds for mates, food and/or nest sites. There is also a risk, first recognised in the 1970s (Beyerbach 1977) and more

recently reiterated by Birdlife International (2008), that hybrid birds may pair with wild birds and introduce alien genes into the population (Eastham & Nicholls 2005). Birdlife International (2008) called for the production of hybrid falcons to be banned in the EC to reduce the risk from such introgression to native falcon populations, especially of the globally threatened saker falcon. The risks to wild populations from human-induced introgression with non-native species (Simberloff 1996) or domestic forms of the same or closely related species are well recognised for other native species such as polecat *Mustela putorius* (Davison et al. 1999) and wildcat *Felis sylvestris* (Beaumont et al. 2001, Kitchener et al. 2005). Measures to address such risks have included a programme to eradicate ruddy duck *Oxyura jamaicensis* from the UK, to protect white-headed duck *O. leucocephala* in Spain from the threat of hybridisation (Hughes et al. 2006), and to suspend the release of captive-bred lesser white-fronted geese *Anser erythropus* in Scandinavia, due to concerns about the genetic integrity of the captive stock (Jones et al. 2008). Whilst there is 1 reported example in Britain of a hybrid falcon pairing and producing young with a wild peregrine (Everitt & Franklin 2009), others are reported from Europe and North America (Tordoff & Redig 1997, Lindberg & Nesje 2002, Birdlife International 2008, Kleinstäuber et al. 2009) and more may go undetected; falcon hybrids, especially juveniles, are not always readily distinguishable from their parent species (Eastham & Nicholls 2005, Birdlife International 2008). This risk may also apply in regions to which hybrid falcons are exported (Birdlife International 2008). Yet Kenward (2009) considered that selection pressures operate against the survival of intermediate phenotypes and that the occasional escape of hybrids would not threaten healthy falcon populations; although escapes in Britain are regular, not occasional, numbers of escaped hybrids are small relative to the size of the wild peregrine population. Any risk of hybrids breeding in the wild is likely to be diminished further by the reduced fertility of some hybrids, especially of female birds (Eastham & Nicholls 2005). Despite falconers' birds escaping to the wild for many years, no non-native falcon species has yet become established in the UK.

Anthropogenic-induced genetic introgression is not only a risk posed by hybrid birds; many of the peregrines bred in captivity may be sub-species (derived from imports) other than *Falco peregrinus peregrinus* of native provenance or they may have a

complex lineage comprising different sub-species and provenances. Escaped captive-bred peregrines breeding in the wild are even less likely to be detected than hybrids, such as escaped peregrines being significantly under-recorded by birdwatchers compared with other escaped falcons. Different sub-species and genotypes of captive-bred peregrines, released as part of recovery programmes, are known to persist in the wild in proportions which do not differ significantly from those of released birds (Tordoff & Redig 2001) and which are sufficient to alter the genetic composition of the wild population (Jacobsen et al. 2007).

On the credit side, such escapes of peregrines may arguably have contributed, albeit inadvertently, to the current recovery of peregrines in Britain and may even have provided some unintentional compensation for birds, broods and clutches lost to illegal human persecution and nest interference. Ratcliffe (2003) suggested that multiple factors may be involved in the recent range expansion of peregrines into lowland, inland Britain and their increased elasticity of choice of breeding site, especially in their use of man-made structures. Whilst this shift in range and nest site choice has coincided with an overall increase in the peregrine population (Banks et al. 2010), and so presumably increasing competition for nest sites, it has also coincided with the regular escape to the wild of captive-bred birds. We suggest a complementary hypothesis that may explain, in part, this shift to novel structures in lowland Britain, namely that recruitment of escaped captive-bred peregrines to the wild may have contributed to this plasticity of nest site choice. Whilst we have no direct evidence to support this hypothesis, such escaped birds will have been raised in artificial structures, may be habituated to people (and so be more tolerant of urban environments) and will not have any natal fidelity to the traditional range of peregrines. Whilst sporadic nesting on buildings in Britain has previously been recorded (Ratcliffe 1993), most man-made structures in lowland Britain were not used for breeding by peregrines. Any escaped captive-bred birds which survived sufficiently long in the wild may have been able to initiate breeding on such novel sites, free of competition from established wild birds. Captive-bred peregrines released in the United States most often returned to the kind of site from which they were released (Holroyd & Banasch 1990); nest site selection was strongly influenced by the type of site (cliffs versus man-made structures) from which birds fledged (Kleinstäuber et al. 2009), especially for males (Tordoff et al. 1998). Re-intro-

duced captive-bred peregrines are, in some areas, now predominantly birds of urban areas (Tordoff & Redig 2001).

The recent reduction in the proportion of captive birds escaping to the wild (Figs. 3 & 4) may be linked to the adoption by falconers of a policy statement and code of practice on flying hybrid and non-native falcons (Fox & Chick 2007), to the greater use and availability of radio telemetry equipment and to a disproportionate increase in keepers of captive falcons for breeding and display purposes rather than for practising falconry. Regardless, as the impact of escaped falcons on wild populations is not known, we strongly recommend that evidence be sought for any human-induced genetic introgression into native peregrine populations arising from escaped captive-bred falcons and that the fate, survival and recruitment to the wild of such escaped birds be studied to enable any risks, or indeed any benefits, to be evaluated and quantified.

Taking all these factors into account, is it possible to assess the risks and benefits of the growth in captive production of peregrine and other falcons? It is clear that captive breeding of falcons has been successful in its role of providing a legitimate and reliable supply of birds for falconry and as an alternative to taking birds from the wild. Demand for falcons in Europe could not now be met from sustainable wild harvests (Kenward 2009), and export of captive-bred birds, especially hybrids, to parts of the Middle East has reduced there the demand for, and unsustainable harvests of, wild-taken birds, especially saker falcons (www.cites.org/eng/com/AC/20/E20-08-1.pdf). The techniques developed for captive breeding could and have been applied to the conservation and recovery of other raptors, although it is not clear what proportion, if any, of the captive falcon gene pool in Britain has been managed to maximise any future contribution to conservation needs. Risks of illegal take have been mitigated by regulation (although now amended; www.legislation.gov.uk/ukxi/2008/2356/made), enforcement (using DNA analysis) and the greater affordability of captive-bred birds; the extent of any human-induced genetic introgression into wild populations arising from escaped captive-bred falcons remains to be evaluated.

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Editorial responsibility: Mike Bruford,
Cardiff, UK

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Proofs received from author(s): September 15, 2011

[redacted]

From: [redacted]
Sent: 17 November 2011 16:09
To: [redacted]
Cc: RE: Non native Code of Practice amended ferreting and falconry sections

Subject:

[redacted] – thank you for the reply and apologies for not getting back to you sooner.

I feel it's important for me to be clear here that the risk of hybridisation is not what the Code is addressing. It merely seeks to clarify what the legislation allows – and the Wildlife and Countryside Act 1981 as amended will now contain an offence of *releasing, allowing to escape from captivity, or otherwise causing and animal to be at place outwith its native range.*

The risks associated with licensing otherwise illegal activities is where consideration of hybridisation etc will be relevant. Falconry is by no means being singled out here – as you will be aware, there are many activities in Scotland that already require to be licensed and the non-native species part of the Act may create more.

With reference to the confusion over the term 'release' – this is the term in the legislation and the fundamental purpose of this part of the Code is to provide certain sectors, or groups of people, with more clarity regarding how this terms applies to them.

The paragraph in question therefore attempts to clarify that the activities of falconers, where there is a reasonable expectation of birds returning, are not considered to be 'release' for the purposes of the Act. I included a reference to a responsible number of birds flown together to remove further ambiguity – and therefore provide some further reassurance to falconers – but I understand that this an area where there is too much variety. I will therefore remove the reference to the number of birds. The paragraph will read:

d) The flying of non-native birds of prey in falconry and display

Where non-native birds of prey are flown responsibly, for falconry or display, the handler will be able to demonstrate that they remain under control - in that they can reasonably expect the bird to return. This would also apply to, often longer, training flights - sometimes referred to as tame hacking. The use of telemetry is advisable as that should enable the owner to demonstrate that they have exercised due diligence if the bird can not be retrieved.

The practice of releasing larger numbers of birds with the intention of gathering them after a period of days or weeks, sometimes referred to as wild hacking, will require a licence if it involves non-native birds. To obtain a licence, contact Scottish Natural Heritage.

The release of unwanted birds, with no intention of retrieval, is an unlawful release for the purposes of section 14(1) of the 1981 Act. Note that in this case, offences relating to abandonment may also be committed under the Animal Health and Welfare (Scotland) Act 2006 – see Annex A).

Queries or comments regarding the General Licences would be better sent to [redacted] in the Licensing Team of Scottish Natural Heritage [redacted] – I have already highlighted to him that you have concerns.

Please note that we are looking separately at your emails (and [Redacted]) regarding the sea eagles.

Regards

[redacted]

From: [redacted]

Sent: 09 November 2011 22:51

To: [redacted]

Subject: RE: Non-native Code of Practice - amended ferreting and falconry sections

Hi [redacted]

Thank you for your email both [redacted] and I appreciated at the meeting being informed that the intention of any legislation was not to impinge upon our use of birds of prey in Falconry. I am gladdened that you take my point about the lack of invasiveness of birds that have escaped from captivity or been lost while hawking, but it is a fact that the matter of hacking has only been raised due to erroneous reporting of a perfectly acceptable falconry use which has over the decades never caused any invasive problems with lost birds. In fact the only detrimental comment on it was by [redacted] at the meeting, where he gave a quote of a 20% expected attrition rate. Whilst I am surprised of the facts of this statement I have yet to hear from [redacted] where this statement came from and I would like confirmation of where its origin was, as I asked previously.

Our problem lies with the word 'release' I don't think we understand this as you do, falconers 'cast off' their birds or put them 'at hack' release is not a term that we as falconers usually associate with what we do with our birds. No one fly's or hacks a bird expecting it to not come back, it is intended that falconers birds are at all times under our control, unless some external factor out with our control causes a bird not to return. We then do our utmost to retrieve it.

You are asking for specifics, e.g. how many birds can be flown by a responsible falconer. Of the 3 individuals that we discussed who did hack falcons, should they have 50 falcons or 10 over the season in batches of 2-15, this would be quite responsible for them. This is due to their experience and knowledge of hacking. Just because a commercial falconer will hack larger numbers of birds as opposed to the single falconer hacking for his own use does not make one more responsible than the other.

The other point you are commenting on I think relates to my last paragraph about flying a number of birds together, as I said this would be more of a 'falconry' (flying a bird of prey) situation rather than a 'hacking' one although both are falconry (as a field sport) related. Some field meetings will allow a number of birds to hunt together if the birds are used to one another and are of a gregarious nature. Some falconry centres will take guests out hawking, each carrying a bird and they allow a number to be flown at one time. It could in theory be 10 birds on 10 guests fists being escorted by a single falconer. Or some bird of prey demonstrations can have a number of falcons flying together for the public to see. Another option is to fly a group of kites (the bird kind) together. The act of doing this is not whether the act itself is responsible or irresponsible but whether the falconer is competent to do this.

I would also like to point out that while it is clear to us that you don't wish to restrict responsible falconry methods you seem determined to issue licences for a hacking situation. It is of concern that Falconry is being singled out here, it is a clear fact that the release of the cat and homing pigeon, which are not to be licensed, have both been scientifically identified as an invasive release with the hybridisation of the

Scottish wild cat and the Rock dove. Whereas there is no scientific evidence to show the invasiveness of lost falcons.

As to the general licence issue, I am currently writing a paper for NE for their general licence review. Once I have concluded this I can forward you a copy.

If we can be of any further help, please don't hesitate to contact me.

Speak soon

[redacted]

From: [redacted]

Sent: 07 November 2011 12:17

To: [redacted]

Cc: [redacted]

Subject: RE: Non-native Code of Practice - amended ferreting and falconry sections

[redacted] – thank you for your email and also thank you to both you and [redacted] for taking the time to come in to our offices to discuss the issues that the falconry and ferreting section of the Code had brought up.

I hope that it was clear from our conversation that our intention continues to be to avoid doing anything that unduly affects falconry, while still giving useful advice regarding the release of non-natives in the Code.

While I take your point regarding the potential for 'invasiveness' of released birds of prey I feel I should point out that this is not the question being addressed by Chapter 4 – this merely seeks to clarify what does or does not constitute 'release of a non-native animal'. That being said, the responsible attitude that the falconry community have taken to trapping any escaped birds is one that fits well with the approach behind the new legislation. In addition any knowledge regarding the behaviour of birds, should they escape/be released, may be of interest if another operator proposes an operation on the scale that we were discussing in the meeting. At that point, if a licence application was to be considered by SNH, the detail in your email could be relevant.

I've taken your point regarding the title of the ferreting section and amended my draft. I do need to pin down however how many birds are flown *together* by responsible handlers. You say in your email that some falconers could fly *many more birds* than this, however in our discussions we seemed to be referring to anything between one and five. While the Code does not define what is or is not an offence I would like to give an example of what would normally be deemed responsible. Do have any further advice?

I will forward your comments to the SNH Licensing Team [redacted] and ask him to get in touch with you regarding the General Licences.

Regards

[redacted]

[redacted]

Wildlife Management Team

[redacted]

From: [redacted]

Sent: 20 October 2011 23:15

To: [redacted]

Cc: [redacted]

Subject: RE: Non-native Code of Practice - amended ferreting and falconry sections

Dear [redacted]

Thank you for the meeting, I hope you found it productive. I would like to point out that I agree that the matter of hacked falcons should be addressed, due to the planning application of [redacted], which raised the issue of non native species released at hack. However, over the hundreds of years that non native species such as saker, lanner, lugger, prairie and gyr, falcons etc. have been used in the UK for falconry there has never been any invasiveness by them. If the issue is one of the releases of hybrids, then again I would add that over the last 20 years that hybrids have been produced there has never been an issue of invasiveness. Yes, as discussed hybrids have been recorded as taking up territories and have been recorded as breeding with native species, but the falconry community is vigilant in this area and has vigorously trapped or assisted in the destruction of any individuals thus identified and so far as I am aware no invasiveness has occurred.

My opinion is that due to the acrimonious planning application a large amount of unsubstantiated exaggerated and erroneous information has been bandied about for the instigators own ends. As you agreed at the meeting up till this planning issue was raised neither you nor SNH had any idea of what hacking was and it certainly didn't raise any invasive issues. I would also be interested in seeing where the 20% expected attrition rate of hacked falcons was quoted, as I have looked on the 3 main websites of UK breeders that hack falcons and can find no mention of that. Perhaps [redacted] could send me the link to it? My main concern is for the integrity of falconry to continue in the manner it has for the past thousands of years and hacking is an important part of that. I understand that the higher number of birds hacked in a commercial operation can equate to a perceived higher number of losses, but as discussed these losses would be far more likely to be mortality issues than live losses. I include (below) a list of the usual falcons at hack which [redacted] has sent to me. As you can see the odds are stacked against any lost captive-bred birds surviving in the wild, especially as on top of that up to 50% - 75% of young naturally bred wild birds of prey are not expected to survive over their first year, so parentless hacked birds would be at even more at risk.

I have first-hand knowledge of one hack site. There is no expectation of any losses and I would estimate that at the very most there would be a 5% loss rate, probably less, of which by far the majority would be by predation. If you take those numbers lost alive, the facts of [redacted] list and natural survivability then any numbers are so minimal that invasiveness would be not an issue.

It should also be noted that any new legislation has to be competent and my concern is that there is no one who could monitor, identify or prove without doubt that any hacking was legally taking place or needed licensing under your proposed changes.

List of falcons most commonly hacked:

Gyr Falcon... Male and Female.

Peregrine Falcon... Female. (Small numbers if any)

Saker Falcon... Female. (Small numbers if any)

Gyr x Saker... Male and Female. (Mostly female)

No threat of inter breeding with UK indigenous population.

Male and Female are fertile but because of the Saker element would have limited chance of surviving UK winters.

Average body weights... Males 2lb to 2lb 10oz. Females 2lb 10oz to 3lb 14oz

Gyr x Peregrine... Male and Female. (Mostly female)

Females are infertile. Males may have some fertility. Only a small number of males would be hacked due to limited demand, most of which would be of exceptional size and or colour (white or black)

Average body weights... Male's 1lb 14oz to 2lb 6oz... Females 2lb 10oz to 3lb 10oz

On the other matter I raised with regards to the General Licence SGGL 12/2011, this is not competent, in that no breeder of Sch 4 species is able to comply with the 7 day period listed in the licence.

In answer to [redacted] email, its wording seems to be fine if you are going down the licensing route, but I should add that there are some professional falconers who while flying their birds in demonstration / educational displays will at times fly more than 3 birds at one time responsibly. Also some falconers can allow many more birds to fly free together if they are of a gregarious species, again responsibly. Although these will be flown in a falconry situation and any hacking is only done with birds that are probably under 16 weeks old.

In the item relating to ferrets, this should be headed domestic ferrets. The term polecat ferret relates to a colour (being similar to wild polecats) and not any suggestion of hybrids. Some people have tried crossing wild polecats with domestic ferrets and the offspring tend to take the temperament of the wild polecat and thus makes them totally unsuitable for their use with humans.

If we can be of any more help with this matter please contact us.

Speak soon [redacted]

From: [redacted]

Sent: 19 October 2011 16:45

To: [redacted]

Cc: [redacted]

Subject: Non-native Code of Practice - amended ferreting and falconry sections

TO: [redacted]

CC: [redacted] for info only

Dear all, many thanks for your time last week, it was certainly very useful in clarifying the situation for me.

I have amended the text of the Code as per table below. Not a great many changes but hopefully a bit clearer in describing what we believe to be responsible in both cases.

Two points –

I have limited the number of birds flown at one time, by one handler, to three. In your opinion would this be unduly restrictive? In our discussions we had considered five but it seemed from other comments that any one handler would be unlikely to be flying five birds at once.

I have retained the advice that telemetry be used to show simply that the handler exercised due diligence. This does not preclude the possibility that a handler would be able to demonstrate due diligence in another way but this will depend on each situation and therefore I felt that sticking to most generic advice was the best option in this case.

If you have any further comments then I would glad to consider them.

Many tanks again for your input

[redacted]

c) Use of ferrets and polecat ferrets in ferreting

Where ferrets are used responsibly for ferreting, the handler will be able to demonstrate that they remain under control – in that they can reasonably expect to retrieve them. It is advisable to use electronic ferret finding equipment, as that should enable the owner to demonstrate that they have exercised due diligence if the ferret can not be retrieved.

The release of unwanted ferrets, with no intention of retrieval, is an unlawful release for the purposes of section 14(1) of the 1981 Act. Note that in this case, offences relating to abandonment may also be committed under the Animal Health and Welfare (Scotland) Act 2006 – see Annex A);

d) The flying of birds of prey in falconry and display

Where birds of prey are flown responsibly, for falconry or display, the handler will be able to demonstrate that they remain under control - in that they can reasonably expect the bird to return. This would also apply to, often longer, training flights - sometimes referred to as tame hacking. The use of telemetry is advisable as that should enable the owner to demonstrate that they have exercised due diligence if the bird can not be retrieved. In these circumstances flying more than three birds would not be considered responsible.

The practice of releasing larger numbers of birds with the intention of gathering them after a period of days or weeks, sometimes referred to as wild hacking, will require a licence if it involves non-native birds. To obtain a licence, contact the SNH CONTACT DETAILS TBC

The release of unwanted birds, with no intention of retrieval, is an unlawful release for the purposes of section 14(1) of the 1981 Act. Note that in this case, offences relating to abandonment may also be committed under the Animal Health and Welfare (Scotland) Act 2006 – see Annex A).

[redacted]

Wildlife Management Team

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