Reintroduction (2011) 1: 5–14

INVITED ARTICLE

Habitat restoration and management in avian reintroductions

* **Philip J. Seddon**[1]

Abstract Habitat loss to agriculture, and habitat change due to alien invasive species are now the principal threats facing birds globally. One successful conservation intervention involves population restoration through reintroduction. Evaluation of reintroduction outcomes has highlighted the importance of releases into appropriate habitat, and traditionally reintroductions have had a focus on relatively intact habitat. I explore habitat management at reintroduction areas, in order to highlight examples of viable reintroductions taking place within highly modified habitats. I evaluated reintroduction projects for 28 bird species to categorise the degree of habitat modification at release sites, and the intensity of ongoing habitat management necessary to support the new population. Twenty-one of the 28 species have been released into habitat that is relatively unmodified. For 15 of these 21 species, there has been pre-release restoration of habitat to approximate near pristine conditions, and for seven species intensive post-release habitat management remains essential. Only seven of the 28 species have been released into relatively modified habitat, and three species in highly modified habitats requiring intensive ongoing habitat management: the black stilt, Oriental white stork, and Japanese crested ibis. Habitat modification by agricultural and urban expansion will become an increasingly important threat to birds globally. This means that that the area of natural, relatively intact habitat available in which to undertake reintroductions is shrinking. It is worth considering restoration of viable wild populations within habitats that have been substantially altered. The challenge will be to manage the factors that limit the establishment, growth and persistence of a reintroduced population. Some native species will be more adaptable than we assume, and for some the cause of original declines may be addressed without restoring habitat to near pristine conditions. For many avian reintroduction programmes, management of the birds and their habitat must be sustained long after the successful establishment of a new population. Reintroduction practitioners cannot rely on being able to release birds into pristine patches of habitat, but rather must embrace the notion of a "*natural diversity enriched by human intervention*" (Takeuchi 2003).

Key words Population restoration, Translocation, Reintroduction, Bird conservation

Introduction

We are widely considered to be living in what has been termed the Anthropocene (Crutzen 2002), an era in which humans have become a global geophysical force (Steffen et al. 2007) effecting modification of natural habitats worldwide. Over the last ~50 years humans have altered the world's ecosystems to a greater extent and at a greater rate than at any other time in our history (Millennium Ecosystem Assessment 2005) and as a consequence the Earth has entered its sixth great extinction event (Ceballos 2010). One-fifth of species are currently classified as Threatened, and on average 52 species of mammals, birds and amphibians move closer to extinction each year, with in excess of 220 bird species declining by at least one threat category between 1988 and 2008 (Hoffman et al. 2010). Birds are highly visible but also highly vulnerable indicators of habitat change. The 2009 Red List assessment found that 1,227 species of birds are classified as globally threatened with extinction (www.iucn.org), with habitat loss to agriculture and habitat change due to alien invasive species being the principal threats to birds (Birdlife International 2008).

One intensive, and increasingly successful conservation intervention involves population restoration through conservation translocation (Seddon et al. 2007; Seddon 2010) to reenforce or reintroduce wild populations. Reenforcement involves the movement of individuals to build up an existing population, while reintroduction is the intentional

[1] Department of Zoology, University of Otago, Dunedin, New Zealand/Bird Section Chair, IUCN/SSC Re-introduction Specialist Group

* E-mail: philip.seddon@otago.ac.nz

movement of an organism into part of its native range from which it has disappeared (IUCN 1998; Seddon 2010). The number of reintroduction projects is increasing. The World Conservation Union's (IUCN) Reintroduction Specialist Group had records for current reintroduction projects for 138 bird species by 2003 (Seddon et al. 2005), up from only 69 species in 1998 (Stanley Price and Soorae 2003), and likely to exceed 200 species by 2012.

Evaluation of reintroduction outcomes across a large number of projects has highlighted the importance of releases into appropriate habitat (Wolf et al. 1998). The IUCN's *Guidelines for Re-introductions* (IUCN 1998) have been the most widely applied international framework for reintroduction planning and implementation and make five main points concerning release site selection and management: the site should be within the historic range of the species; reintroduction should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained; the area should have sufficient carrying capacity to sustain growth of the reintroduced population; there needs to be identification and elimination of previous causes of decline; and where the release site has undergone substantial degradation, a habitat restoration programme should be initiated (IUCN 1998). Thus the IUCN guidelines do not stipulate that release sites must consist of relatively intact habitat, but this is likely to be the default target since it is reasonable to assume that the less the habitat has changed since a given species was last present, the more likely it is to be able to sustain a restored population of that species.

Reintroductions have therefore had a focus on translocations into relatively intact habitat, and this has been a point of difference between the disciplines of reintroduction biology and of restoration ecology, the latter being most concerned with the restoration of degraded habitats (Seddon et al. 2007). In this paper I explore some general patterns relating to the habitat in a reintroduction area, specifically the degree of pre-release habitat modification and the intensity of post-release habitat management. In doing this I aimed to highlight some examples of viable reintroductions taking place within highly modified habitats and consider whether such examples offer a glimpse of the future where reintroduction practitioners explore increased opportunities to reintroduce bird species into modified habitats rather than assuming an overriding need for near-pristine habitat conditions.

Methods

A qualitative survey of bird species reintroduction accounts was compiled for a sample of species, derived from summaries published by the IUCN RSG (2008, 2010) and augmented from the available literature. Projects were summarised according to six factors: cause of decline, status of the original habitat, release site preparation, degree of modification of the habitat at the release site, and level of habitat management required in order to sustain the reintroduced population. I considered "habitat" to include all aspects of the environment, including vegetative features, food and predators. *Reintroduction target area* (Mihoub et al. 2009) is defined as the general region surrounding a *release site* into which the released birds are expected to disperse and settle, with the *release site* defined as the specific locale at which a release takes place. Reintroduction target area status was categorised along an approximate 5-point scale from 1 = pristine to 5 = extremely modified (Table 1). The level or intensity of ongoing habitat management required to support the

Table 1. Sliding 5-point scale of the degree of habitat modification at a release site, and the intensity of post-release monitoring necessary at a reintroduction site in order to enable persistence of the restored wildlife population.

Category	Degree of habitat modification of the reintroduction target area	Intensity of post-release habitat management at the reintroduction target area
1	● Pristine, e.g. unmodified primordial rainforest	● No ongoing habitat management post-release
2	● Relatively intact, e.g. regenerated/restored woodland	● Low intensity, intermittent management, e.g. limiting disturbance due to agricultural activity
3	● Relatively modified, e.g. mixed natural and agricultural landscapes	● Moderate intensity ongoing management, e.g. anti-poaching patrols; anti-predator vigilance
4	● Highly modified, e.g. intensive agriculture, or restored vegetation but presence of exotic predators	● High intensity ongoing management, e.g. modification of agricultural practices; predator trapping; livestock fencing
5	● Extremely modified, e.g. high density inner city urban development	● Very high intensity management, e.g. maintenance of predator-proof fencing with continuous trapping

Table 2. Summary of release-site habitat status and management in the reintroduction of 28 bird species illustrating a range of degrees of habitat modification and management intensity, from near pristine conditions and minimal ongoing management, through to highly modified habitat and intensive ongoing management.

Name	Species	Country	Original cause of decline	Current status of original habitat	Release site preparation	Degree of habitat modification at the release site	Intensity of habitat management	Reference
Ostrich	*Struthio camelus*	Saudi Arabia	Hunting	Degraded by livestock	Fencing and livestock exclusion	Restored grassland	Livestock fencing	Zafur ul-Islam et al. (2008)
Nene goose	*Branta sandvicensis*	USA	Hunting, habitat loss, introduced predators	Modified by agriculture	Predator control	Mixed natural and planted grasslands	Predator control	Marshall et al. (2008)
Great Spotted Kiwi	*Apteryx haastii*	NZ	Introduced predators	Invaded by exotic predators	Predator exclusion fencing & trapping	Beech forest & alpine	Predator exclusion	Gasson (2008)
Southern Ground Hornbill	*Bucorvus leadbeateri*	South Africa	Habitat loss due to human population growth & cattle	Degraded and fragmented by farming	Cessation of cattle ranching due to changing environment	Restored grassland, woodland and savannah	Cattle exclusion and provision of nest cavities	Theron and Turner (2008)
Red-billed Curassow	*Crax blumenbachii*	Brazil	Hunting and loss of Atlantic forest habitat	Lost to forest clearing	Restricted access and anti-poaching patrols	Remnant forest	Poaching patrols	Steiner Sao Bernardo et al. (2008)
Hawaiian Creeper	*Oreomystis mana*	USA	Habitat degradation; introduced ungulates	Degraded and lost by logging and exotic ungulates	Fencing to exclude feral ungulates; natural regeneration	Restored high altitude forest	Fencing to exclude feral ungulates	Kohley and Lockyer (2008)
NZ North Island robin	*Petroica longipes*	NZ	Exotic predators and habitat fragmentation	Fragmented by livestock farming, with rats	None	Restored forest fragment with predators	None	Morgan et al. (2008)
Seychelles White-eye	*Zosterops modestus*	Seychelles	Nest predation by exotic predators	Invaded by exotic predators	Eradication of rats and cats	Predator free islands but modified by orchards and gardens	Prevention of invasion by predators	Rocamora and Henriette-Payet (2008)
Houbara Bustard	*Chlamydotis macqueenii*	UAE	Hunting	Minor degradation by grazing	Regulation of access and hunting, some control of natural predators	Natural dune land	Hunting prevention	Lawrence et al. (2008)
White-headed Duck	*Oxiura leucocephala*	Hungary	Habitat loss, hunting and egg collecting	Drained wetlands and modified lakes	None	Modified/ restored lake with human disturbance	None	Bijomi (2008)
Cheer Pheasant	*Catreus wallichi*	Pakistan	Hunting	Low altitude hills modified by grazing and grass cutting	National Park protection, reduction of agriculture	Recovering low-mid altitude grasslands turning to unsuitable scrubland	Restriction of agricultural activity	Garson (2008)
Bearded Vulture	*Gypaetus barbatus*	Austria	Persecution	Alpine slopes with low intensity domestic ungulates	None	Relatively intact alpine slopes	None	Zink and Frey (2008)
Aplomado Falcon	*Falco femoralis septentrionalis*	USA	Unknown	Xeric grassland with low intensity cattle grazing	National Wildlife Refuge	Relatively intact xeric grasslands	Provision of some artificial nest structures	Heinrich (2008)

Table 2. Continue.

Name	Species	Country	Original cause of decline	Current status of original habitat	Release site preparation	Degree of habitat modification at the release site	Intensity of habitat management	Reference
Golden Eagle	*Aquila chrysaetos*	Ireland	Persecution	Low intensity livestock grazing	National Park	Relatively intact Irish mountains	Restriction of farming	O'Toole (2008)
Red Kite	*Milvus milvus*	England	Persecution	Woodlands and open habitats modified and fragmented by arable/grass fields	None apart from raising awareness of local farmers	Woodlands and open habitats surrounded by fields	None	Murn et al. (2008)
Corn Crake	*Crex crex*	UK	Mechanization of agriculture	Arable grasslands	Agreements with land managers for late cutting	Managed arable grasslands	Change grassing cutting regimes	Newbery (2010)
Grey Partridge	*Perdix perdix*	UK	Habitat loss to agriculture intensification	Arable farmland a fragmented schrub/woodland	None	Managed arable grasslands	Maintenance of hedges; reduce farming disturbance	Rantanen et al. (2010)
Houbara Bustard	*Chlamydotis macqueenii*	Saudi Arabia	Hunting	Severe degradation by grazing	Fencing and livestock exclusion	Restored savannah	Fencing to prevent hunting and livestock grazing	Zafur ul-Islam et al. (2010)
Malherbe's parakeet	*Cyanoramphus malherbi*	NZ	Exotic predators and habitat fragmentation	Invaded by exotic predators	Predator eradication	Predator free offshore island	Prevention of invasion by predators	Ortiz-Catedral et al. (2010b)
Red-fronted Parakeet	*Cyanoramphus novaezelandiae*	NZ	Exotic predators and habitat fragmentation	Invaded by exotic predators	Predator eradication	Predator free offshore island	Prevention of invasion by predators	Ortiz-Catedral et al. (2010a)
Yellow-crowned Parakeet	*Cyanoramphus auriceps*	NZ	Exotic predators and habitat fragmentation	Invaded by exotic predators	Predator eradication	Predator free offshore island	Prevention of invasion by predators	Adams and Cash (2010)
Helmeted honeyeater	*Lichenostomus melanops cassidix*	Australia	Habitat loss to agriculture intensification	Fragmented by agriculture	State Park	Restored riperian vegetation	Restriction of farming	Menkhorst et al. (2010)
Western Bristlebird	*Dasyornis longirostris*	Australia	Wildlfires	Fragmented by agriculture	National Park	Mixed age scrubland	Controlled fire management	Burbridge et al. (2008)
Oriental White Stork	*Ciconia boyciana*	Japan	Intensification/mechanization of paddy field agriculture	Original marshland lost to fragmented paddy fields and woodland fringe	Fish ladders, and reduction pesticides, change water flow regimes	Functional paddy fields	Restoration of traditional agricultural practises	Naito and Ikeda (2007)
Japanese Crested Ibis	*Nipponia nippon*	Japan	Intensification/mechanization of paddy field agriculture	Original marshland lost to fragmented paddy fields and woodland fringe	Fish ladders, and reduction pesticides, change water flow regimes	Functional paddy fields	Restoration of traditional agricultural practises	Sado City Government (2010)
Black Stilt/Kaki	*Himantopus novaezelandiae*	NZ	Habitat loss to farming/water abstraction; introduced predators	River deltas and farmland, with low intensity agriculture and exotic predators	Intensive predator control	Natural river deltas and farmland wetlands with exotic predators, human disturbance	Intensive predator control	Van Heezik et al. (2009)

Table 2. Continue.

Name	Species	Country	Original cause of decline	Current status of original habitat	Release site preparation	Degree of habitat modification at the release site	Intensity of habitat management	Reference
Kakapo	*Strigops habroptilus*	NZ	Exotic predators and habitat fragmentation	Invaded by exotic predators	Predator eradication	Predator free offshore island with intact forest	Predator exclusion	Lloyd and Powlesland (1994)
Southern Emu-wren	*Stipiturus malachurus*	Australia	Habitat loss and degradation due to agriculture expansion	Fragmented by agriculture	Conservation Park	Restored xeric scrubland	Restriction of agricultural activity	Pickett (2010)
Peregrine Falcon	*Falco peregrinus*	USA	Habitat loss and pesticides	Fragmented by agriculture and urbanisation	None	Urban and peri-urban areas, building mimic natural cliff side habitats	Provision of some artificial nest structures	USFWS (2011)

reintroduced population was categorised on a similar sliding 5-point scale from 1 = no management, to 5 highest intensity management (Table 1).

Results

I evaluated a total of 28 bird species (Table 2) for which sufficiently detailed information was available on current reintroduction attempts to categorise the degree of habitat modification at release sites, and the intensity of ongoing habitat management considered necessary to support the establishment, growth and persistence of the new population (*sensu* Armstrong and Seddon 2008). Twenty one of the 28 species have been released into habitat that is relatively unmodified compared to the original habitat of the species, either due to an absence of degradation or change (rarely) or due to restoration and regeneration of vegetative elements and removal or mitigation of the impacts of invasive species (Fig. 1). For 15 of these 21 species, considerable effort has gone into the pre-release restoration of habitat to approximate near pristine conditions, and for seven species intensive post-release habitat management remains essential.

Only seven of the 28 species have been released into relatively modified habitat: for the two New Zealand species, the North Island robin and the black stilt (see Table 2 for the scientific names of species mentioned in the text), the release site habitat remains modified by the presence of exotic predators; the peregrine falcon is unique in being released into an urban environment, and the remaining five species have been released into landscapes transformed by agriculture. Three species in highly modified habitats require intensive ongoing habitat management: the black stilt, Oriental white stork, and Japanese crested ibis.

Discussion

Although a majority of the limited sample of projects surveyed here describe avian reintroduction attempts taking place within relatively intact habitats that closely approximate the original pristine conditions in key respects, there are a number of examples of viable reintroduction attempts taking place in highly modified habitats. To illustrate some specific features across the spectrum of different types of habitat modification and management associated with avian reintroduction projects, I outline five case studies below (see underlined common names in Fig. 1).

1. Case studies

1-1) Relatively unmodified with high intensity habitat management: Kakapo

The kakapo is perhaps the quintessential New Zealand endemic bird: it is critically endangered and has a suite of unusual features that are both a legacy of the long isolation of the New Zealand landmass, and which make it particularly vulnerable to introduced predators. Kakapo

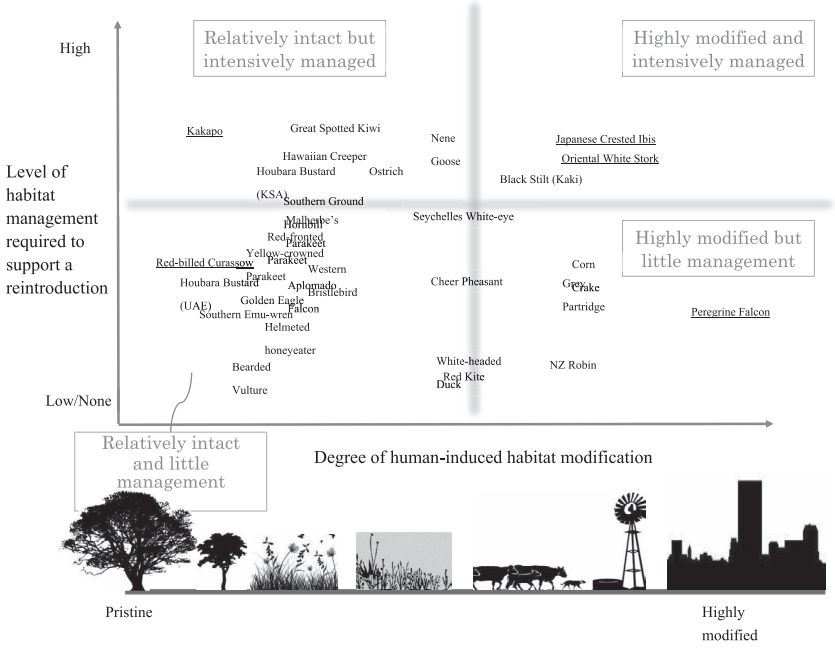

Fig. 1. Reintroduction projects for 28 bird species, plotted on two axes: x-axis is degree of habitat modification in the reintroduction area, from pristine or largely intact natural ecosystems at the left through to increasing modification by agriculture and urbanization, on the right; y-axis is the level or intensity of post-release habitat management required to sustain the reintroduced population.

are large, nocturnal, flightless, lek-breeding parrots, that were once widespread throughout New Zealand but which were reduced to a single remote location in Fiordland by the 1950s (Elliot et al. 2001). During the 1980s and 1990s all surviving kakapo were translocated to predator-free islands (Lloyd and Powlesland 1994). Currently, kakapo are on only two southern islands, Codfish/Whenua Hou, the only site with a successfully breeding population, and Anchor Island following a translocation in 2005 (www.kakaporecovery.org.nz/, accessed 22 June 2011). Both islands have dense native forest cover and highly restricted public access. These two populations are sustained through an intensive management programme that includes stringent measures to prevent reinvasion of islands by predators.

1-2) Relatively unmodified with low intensity habitat management: Red-billed Curassow

The red-billed curassow is endemic to the Brazilian Atlantic rainforest, but was driven to extinction in parts of its range by the early 20th century due to hunting pressure and the loss of habitat (Steiner Sao Bernardo et al. 2008). There have been successful reintroductions since 1991, the most recent programme returning the birds to relatively intact Atlantic forest in Reserva Ecólogica de Guapiaçu (REGUA), Rio de Janeiro State, from 2006. REGUA comprises >5,000 ha of forest within the larger Três Picos State Park, where the only post-release habitat-related management involves anti-poaching patrols by eight park rangers (Steiner Sao Bernardo et al. 2008).

1-3) Highly modified with low intensity habitat management: Peregrine Falcon

Following a rapid decline in population throughout the continental United States, in 1969 the Peregrine Falcon was placed on the U.S. Endangered Species list. The primary cause of the population crash was widespread use of the pesticide DDT, and following the ban on DDT use in 1970, projects were started to reintroduce Peregrines. Between 1974 and 1999 over 5,000 Peregrines were released, with some of the most successful releases taking place in cities (Heinrich 2009), where tall buildings effectively mimicked the bird's cliff nesting habitat. Peregrine Falcons have been reintroduced successfully to a number of range states and in a variety of environments, I have chosen to highlight their successful restoration in highly modified urban environments requiring no specific post-release habitat management. New York city now has one of the highest concentrations of peregrine falcons in the world (Luniak 2004).

1–4) Highly modified with high intensity habitat management: Oriental White Stork (OWS) and Japanese Crested Ibis (Toki)

Both the OWS and Toki were extinct in the wild in Japan by 1971 and 1981, respectively, the decline of both species being due to the combined effects of increased use of agricultural pesticides and changes in the management of the rice paddy field systems in which the species used to forage for fish, frogs, and a wide variety of invertebrates (Naito and Ikeda 2007; Sado City Government 2010). Reintroduction projects for OWS and Toki started with pilot releases in 2005 in the Toyooka Basin of Hyogo Prefecture, and in 2008 on Sado Island in the Niigata Prefecture, respectively (Naito and Ikeda 2007; Sado City Government 2010). For both species the key to future success lies in the restoration of traditional paddy field agriculture, entailing the forging of strong links with the farming community in order to reduce the use of pesticides, to restore the wet winter condition of paddy fields, to maintain peripheral water channels to support diverse invertebrate communities, and to install fish ladders to facilitate natural fish dispersal and migration pathways. The most fascinating aspect of these reintroduction projects is the almost total reliance of the birds on a highly modified agricultural landscape. The first paddy fields in Japan date to the Yayoi period, 1500–2000 years ago (Akazawa 1981), and before that time it can be assumed that OWS and Toki foraged in much less modified wetland sites. Under traditional rice paddy management systems, with no artificial sprays and with winter flooding, the birds presumably regarded paddy fields as just another wetland, albeit with more human disturbance. It is perhaps unique to have to go back more than 2000 years to locate the original habitat type of a species, but clearly the long intervening history of use of paddy fields by both species indicates that up until recently, self-sustaining populations could be sustained in this highly modified environment. However, populations of neither OWS nor Toki can persist in the face of increased mechanization necessitating changes in water flow regimes, or with the increased use of pesticide sprays. The restoration of OWS and Toki on mainland Japan will depend on strong support for the project from farmers and local communities and a willingness to restore traditional paddy field management systems in the face of economic incentives to modernise.

2. Future need for ongoing management to sustain species

By 2004 loss and degradation of habitat to agricultural expansion was the most significant threat affecting birds listed as Near Threatened in the IUCN Red List (Birdlife International 2008). Habitat modification by agricultural and urban expansion is set to become an increasingly important threat to birds globally in the very near future. This means that not only will greater numbers of bird species require conservation interventions, but that the area of natural, relatively intact habitat available in which to undertake such interventions is shrinking. It is possible, however, for at least some threatened species, to consider restoration of viable wild populations within habitats that have been substantially altered by agriculture or urbanisation. The challenge will be to determine the factors that may limit the establishment, growth and persistence of a reintroduced population and to address these specifically. The physical appearance of habitat within a reintroduction target area may be a poor guide to habitat suitability, particularly if we consider habitat to encompass more than just landscape and vegetative elements. For example, the presence of exotic predators in areas of native forest in New Zealand may not be overtly evident, and may not alter the appearance of the forest, but would significantly reduce the suitability of the site as a potential reintroduction area. This is not to say that we give up on the protection and restoration of functional natural ecosystems; relatively intact habitats will always be needed to sustain sensitive species, such as habitat specialists. However, it seems likely that some native species will be more adaptable than we may assume, and that for many species the cause of any original decline may be addressed without having to restore habitat to near pristine conditions.

The other realisation is that for many, perhaps most, avian reintroduction programmes, management of the birds and their habitat must be sustained long after the successful establishment of a new population. This idea of ongoing management is perhaps epitomised by the restoration of Oriental White Stork and Japanese Crested Ibis in the *satoyama* landscapes of rural Japan, landscapes that are characterised by the management of the natural environment, described also as "*natural diversity enriched by*

human intervention" (Takeuchi 2003). This is also an excellent description of the future of many species restorations, where success depends on long-term, perhaps even perpetual, management. The work does not stop when the released birds fly free, nor when the first wild hatchlings fledge, and not even when a robust wild population has been established. If we want to have wild populations of storks, or ibis, or kakapo, then we cannot rely on having some last pristine patches of habitat. Although the reintroduction ideal may be "*persistence without intervention*" (Seddon 1999); the reality seems likely to require a long-term commitment to the stewardship of restored wildlife populations and their habitats.

Acknowledgements

My sincere thanks to Satoshi Yamagishi, Yasuo Ezaki, Hishashi Nagata, Yoshito Ohsako, Hiromune Mitsuhashi for making it possible for me to learn more about the wonderful efforts being made in Japan for the reintroduction of Oriental White Stork and Japanese Crested Ibis. I am also grateful to Junko Sagara for her expert translation during formal discussions.

References

Adams L, Cash B (2010) Re-introduction of yellow-crowned kakariki to Long Island (Malborough), Mana Island (Wellington) and Motuara Island (Malborough), New Zealand. In Soorae PS (ed) Global Re-introduction Perspectives: Additional Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 160–164.

Akazawa T (1981) Maritime adaptation of prehistoric hunter-gathers and their transition to agriculture in Japan. Senri Ethnological Studies, 9: 213–258.

Armstrong DP, Seddon PJ (2008) Directions in reintroduction biology. Trends in Ecology and Evolution, 23: 20–25.

Bajomi B (2008) Re-introduction of the white-headed duck to Kiskunsag, Hungary. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 135–137.

Birdlife International (2008) Agricultural expansion is a major threat to birds, and it appears to be increasing in importance. Presented as part of the Birdlife State of the world's birds website. Available from: www.birdlife.org/datazone/sowb/casestudy/130. Accessed 20 June 2011.

Burbridge AH, Comer S, Danks A, Berryman A, Hamilton N (2010) Attempted re-introduction of the western bristlebird in south-western Australia. In Soorae PS (ed) Global Re-introduction Perspectives: Additional Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 171–175.

Ceballos G, Garcia A, Ehrlich PR (2010) The sixth extinction crisis: Loss of animal populations and species. Journal of Cosmology, 8: 1821–1831.

Crutzen PJ (2002) Geology of Mankind. Nature, 415: 23.

Garson P (2008) Attempted re-introduction of cheer pheasant to the Margalla Hills National Park, Pakistan. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 138–140.

Gasson P (2008) Wild-to-wild transfer of great spotted kiwi to the Rotoiti Natuirte Recovery Project, Nelson Lakes National Park, New Zealand. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 100–103.

Heinrich WR (2008) Re-introduction of the Aplomado falcon into Texas and New Mexico, USA. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 145–148.

Heinrich W (2009) Peregrine Falcon recovery in the continental United States, 1974–1999, with notes on related programs of the Peregrine Fund. In Sielicki J, Mizera T (eds) Peregrine Falcon Populations – Status and Perspectives in the 21st Century. Turul/Poznan Unmiversity of Life Sciences Press, Warsaw, pp. 429–442.

Hoffman M et al. (2010) The impact of conservation on the status of the World's vertebrates. Science, 330: 1503–1509.

IUCN (World Conservation Union) (1998) IUCN Guidelines for Re-introductions. IUCN/SSC Re-introduction Specialist Group, IUCN, Gland, Switzerland and Cambridge United Kingdom.

Kohley R, Lockyer A (2008) Release of captive-reared Hawaii creeper and Hawai'i Akepa into Kipuka 21 on the Big Island of Hawai'I, USA. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 112–115.

Lawrence M, Judas J, Combreau O (2008) Re-introduction and population re-enforcement of Asian houbara bustard in Asia. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 130–134.

Lloyd BD, Powlesland RG (1994) The decline of the kakapo *Strigops habroptilus* and attempts at conservation by translocation. Biological Conservation, 69: 75–85.

Luniak M (2004) Synurbization – adaptation of animal wildlife to urban development. In Shaw WW, Harris LK, Vandruff L (eds) Proceedings of the 4th International Urban Wildlife Symposium, Tucson, AZ, pp. 50–55.

Marshall AP, Bank PC, Misajon, K, Hu D (2008) Re-introduction of the nene, a remote island goose, Hawai'I, USA. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 96–99.

Menkhorst P, Quin B, Cartwright K, Smales I (2010) Using captive-bred helmeted honeyeaters to establish a new popula-

tion and supplement an existing population, Victoria, Australia. In Soorae PS (ed) Global Re-introduction Perspectives: Additional Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 165–170.

Mihoub J-B, Le Gouar P, Sarrazin F (2009) Breeding habitat selection behaviors in heterogeneous environments: implications for modelling reintroduction. Oikos, 118: 663–674.

Millennium Ecosystem Assessment (2005) Ecosystems and Human Well-being: Synthesis. Island Press, Washington, D.C., 137 p.

Morgan K, McArthur N, Johnston R, Richard Y, Armstrong DP (2008) Using translocation of North Island robins to counter effects of forest fragmentation in the central North Island of New Zealand. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 116–120.

Murn C, King A, Hunt S, Smith A (2008) Captive breeding and re-introduction of red kites to Hampshire, England. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 159–162.

Naito K, Ikeda H (2007) Habitat restoration for the reintroduction of Oriental White Storks. Global Environmental Research, 11: 217–221

Newbery P (2010) Re-introduction of corncrakes in the UK. In Soorae PS (ed) Global Re-introduction Perspectives: Additional Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 124–127.

O'Toole L (2008) The re-introduction of the golden eagle to Glenveagh National Park, County Donegal, Republic of Ireland. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 149–152.

Ortiz-Catedral L, Adams L, Hauber ME, Brunton DH (2010a) Conservation translocations of red-fronted parakeet on Matiu/Somes Island and Motuihe Island, New Zealand. In Soorae PS (ed) Global Re-introduction Perspectives: Additional Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 155–159.

Ortiz-Catedral L, Kearvell J, Brunton DH (2010b) Re-introduction of captive-bred Malherbe's parakeet to Maud Island, Malborough Sounds, New Zealand. In Soorae PS (ed) Global Re-introduction Perspectives: Additional Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 151–154.

Pickett M (2010) Re-introduction of the Mount Lofty Ranges southern emu-wren to Cox Scrub Conservation Park, South Australia. In Soorae PS (ed) Global Re-introduction Perspectives: Additional Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 176–181.

Rantanen EM, Buner F, Riordan P, Sotherton NW, Macdonald DW (2010) Grey partridge supplementations in Oxfordshire and east Gloucestershire, UK. In Soorae PS (ed) Global Re-introduction Perspectives: Additional Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 128–131.

Rocamora G, Henriette-Payet E (2008) Conservation introduction of the Seychelles white eye on predator-free rehabilitated islands of the Seychelles archipelago, Indian Ocean. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 121–129.

Sado City Government (2010) Sado Island Guiding Principles for harmonious coexistence with biological diversity: Aiming towards a biodiverse community nurturing Japan's Crested Ibis. Biodiversity Strategy Office, Agriculture, Forestry and Fisheries Department, Sado City, Niigata Prefecture, Japan, 25 p.

Seddon PJ (1999) Persistence without intervention: assessing success in wildlife reintroduction. Trends in Ecology and Evolution, 14: 503.

Seddon PJ (2010) From reintroduction to assisted colonization: moving along the conservation translocation spectrum. Restoration Ecology, 18: 796–802.

Seddon PJ, Armstrong DP, Maloney RF (2007) Combining the fields of reintroduction biology and restoration ecology. Conservation Biology, 21: 1388–1390.

Stanley Price MR, Soorae PS (2003) Reintroductions: whence and whither? International Zoo Yearbook, 38: 61–75.

Steffen W, Crutzen PJ, McNeill JR (2007) The Anthropocene: Are humans now over whelming the great forces of nature? Ambio, 36: 614–621.

Steiner Sao Bernardo C, Azeredo R, Simpson J, Valgas Paiva E (2008) The re-introduction of the red-billed curassow at Reserva Ecologica de Guapiacu, Rio de Janeiro state, Brazil. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 108–111.

Takeuchi K (2003) The nature of satoyama landscapes: Satoyama landscapes as managed nature. In Takeuchi K, Brown RD, Washitani I, Tsunekawa A, Yokohara M (eds) Satoyama: The Traditional Rural Landscape of Japan. Springer-Verlag, Tokyo, pp. 9–16.

Theron N, Turner A (2008) Ten tears on: a re-introduction of southern ground hornbill on Mabula Private Game Reserve ion the Limpopo Province of South Africa. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 104–107.

USFWS (2011) Peregrine Falcon Reintroduction overview. [accessed 17 June 2011, *http://www.in.gov/dnr/fishwild/3315.htm*]

van Heezik Y, Maloney RF, Seddon PJ (2009) Movements of translocated captive-bred and released Critically Endangered kaki (Black Stilt) *Himantopus novaezelandiae* and the value of long-term post-release monitoring. Oryx, 43: 639–647.

Wolf CM, Garland T, Griffith B (1998) Predictors of avian and mammalian translocation success: reanalysis with phylogenetically independent contrasts. Biological Conservation, 86: 243–255.

Zafur-ul Islam M, Boug A, Shobrak M (2008) Conservation status of re-introduced red-necked ostrich in Mahazat as-Sayd, Saudi Arabia. In Soorae PS (ed) Global Re-introduction Per-

spectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 91–95.

Zafur-ul Islam M, Bolug A, Basheer, MP, Sher Shah M, al Subai H (2010) Re-introduction successes of Asian houbara bustard in the Kingdom of Saudi Arabia. In Soorae PS (ed) Global Re-introduction Perspectives: Additional Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 132–138.

Zink R, Frey H (2008) Re-introduction of the bearded vulture to the European Alps. In Soorae PS (ed) Global Re-introduction Perspectives: Re-introduction Case Studies from Around the Globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, pp. 141–144.

(Accepted: 14 September 2011)