Review

Conservation introduction: a potential tool for galliform conservation management?

MYLES M. LAMONT
Hancock Wildlife Research Center, 19313 Zero Ave, Surrey, BC, V2Z 3A5, Canada. myles@hancockwildlife.org

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Abstract Habitat loss and degradation continue to be the leading cause in species extinctions and expatriations. With the global human population increasing at exponential rates, the environmental pressures currently facing Galliformes will continue to intensify. Reintroductions and translocations are two methods that have been used to offset some of these environmental pressures in the past, however in the event that no suitable habitat exists, other options, such as conservation introductions, should be considered. Conservation introductions have recently played a crucial role in conservation initiatives for several species around the globe, but have gone relatively unnoticed by galliform conservationists. This paper reviews the use of conservation introductions as a tool for galliform conservation by looking at the use, feasibility, implications and ethics of introducing Galliformes into non-native areas.

Keywords Biodiversity protection, conservation introduction, endangered species, population restoration.

Introduction

It is generally accepted that habitat fragmentation and degradation along with human persecution are the main factors leading to the loss of avian biodiversity today (Brooks et al*.,* 1997; Owens & Bennett, 2000; Birdlife International, 2004a; Ewers & Didham, 2006). Despite efforts at the local and international scale to address the increasing number of threatened avian species, this figure has continued to rise (Birdlife International, 2000; Birdlife International, 2004a). The Galliformes encompass some of the most threatened bird species, particularly the Phasianidae with some 21 of 50 species considered to be threatened with extinction (Garson, 2005). With such a high number of threatened species, new conservation strategies need to be considered and perhaps used in conjunction with existing activities.

Reintroductions and translocations are two means of species conservation that have been used extensively in the past (Griffith et al*.,* 1989). From 1998-2005, a 50% increase in avian reintroductions (stemming from captive-born individuals) occurred, perhaps due to the recognition of the potential reintroduction programmes have in species recovery and the growing science surrounding reintroduction biology (Seddon et al*.,* 2007). Translocations of wild-source birds seems to be the preferred method for most reintroduction programmes, due to the lack of potential behavioural and disease vector issues that may be associated with captive-born individuals. The terminology of reintroductions and translocations is given in TABLE 1.

Only one conservation introduction within the entire Order Galliformes has occurred in recent history. The Polynesian megapode *Megapodius pritchardii* was considered Critically Endangered on its native Tonga before being introduced to the island of Fonualei in 1993. Surveys undertaken ten years after introduction showed that the number of individuals in the entire population had doubled, due to the project and the species has since been downgraded to Endangered (Birdlife International, 2007a). With the success seen with the Polynesian megapode, it is somewhat curious that no other conservation introductions have occurred with so many Galliformes facing similar pressures.

TABLE 1. Reintroduction guideline definitions (IUCN 1998).

Term	Definition
Reintroduction	An attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct.
Translocation	Deliberate and mediated movement of wild individuals or populations from one part of their range to another.
Reinforcement/Supplementation	Addition of individuals to an existing population of conspecifics.
Conservation/Benign Introductions	An attempt to establish a species for the purpose of conservation outside its historic distribution but within an appropriate habitat and ecogeographical area. This is a feasible conservation tool only when there is no remaining habitat left within a species historic range.

One of the obligations of the 150 signatory countries, which participated in the International Convention on Biological Diversity (UNEP, 1992), is to develop *ex situ* measures of protection for their threatened species. The establishment of sub-populations is one such option which the signatory countries can use to fulfil their commitment to the Article. The use of conservation introductions into insular landscapes may be an option for some of these countries rather than investing in large scale breeding facilities, which are often very costly and potentially unreliable in developing nations.

A policy of both the *IUCN Guidelines for Reintroductions* (IUCN, 1998) as well as the *Guidelines for the re-introduction of Galliformes for conservation purposes* (World Pheasant Association, 2009) is to assess the socio-economic impact that a reintroduction, translocation or introduction program may have on local communities. Assessing the legal, political and cultural impacts a potential introduction may have, need to be considered. As outlined in the Translocation of Living Organisms by the International Union for the Conservation of Nature (1987), it is recommended that controlled or experimental trials of conservation introductions are initiated prior to full-scale releases. Galliformes, in a sense, provide the ideal candidates for conservation introductions for a variety of reasons; perhaps most importantly, due to their mainly sedentary lifestyles, there is little risk of migration or dispersal movements outside of trial and release areas as compared to other species of bird. Secondly, in general, they carry fewer highly pathogenic diseases when compared to other species of bird such as the Psittaciformes which can pass on devastating disease to their wild counterparts if strict quarantine and health screening regiments are not carried out (Derrickson & Snyder, 1992). Further, the apparent ability for some of these health afflictions to be passed on vertically presents a much greater challenge when compared to the relative ease of disease screening in gamebirds (Brightsmith et al., 2004). Thirdly, due to a variety of factors, particularly the amount of study that has been carried out on the Order, the Galliformes represent an ideal group of birds in which to study in experimental situations. In addition to these points, the highly successful introduction of various species of Galliformes around the world for hunting purposes demonstrates their ability to adapt to new environments and provides support for the likelihood of successful conservation introductions in the future. Moreover, the number of threatened and endangered Phasianidae currently held in captivity allows for experimental trial without the need to use wild source birds.

I believe, the ideal location for a conservation introduction, particularly as an experimental trial, is on an insular ecosystem.

This opinion is based on a number of factors:

- Insular geography greatly restricts the likelihood of any introduced animals from moving outside of the trial area. It also allows for a much greater ease of monitoring

and tracking the introduced population as it increases in abundance and adapts to its new environment.
- Although island ecosystems often harbour endemic species and represent unique and fragile ecosystems, those found within the northern hemisphere, particularly smaller islands close to the mainland, often have no endemics and mirror the ecosystems found on their adjacent land masses.
- Island ecosystems often have 'empty' niches, particularly for ground dwelling birds such as the Galliformes, due to their inability to move large distances offshore.
- Island habitats usually have fewer predators, particularly mammalian, allowing for a greater likelihood of success during a conservation introduction.
- The control and monitoring of population genetics on insular systems is more easily facilitated due to restricted gene flow. The introduction of new bloodlines could be monitored through genetic screening, pair recommendations and the use of studbooks all of which are currently in place for several species.
- The genotypic behaviour of island populations could provide insight into how mainland populations react to habitat fragmentation, an early process in species extinction.
- There is no risk of introducing foreign disease into the species *in situ* population and if disease outbreak does occur, islands act as geographical quarantines simply through isolation.

Review

Historical introductions

Past introductions of Galliformes are numerous and mostly occurred during the mid 1900s, particularly in North America where Dr. Gardiner Bump carried out extensive research into the introduction potential of Asian pheasants and partridge as game quarry for the Federal Foreign Game Bird Program (Bump & Bohl, 1964).

Some of these subsequent introductions have lead to fairly large and sustainable populations of alien gamebirds in North America. Beyond the well known introductions of the ring-necked pheasant *Phasianus colchicus* and grey partridge *Perdix perdix*, there is an extensive population of Kalij pheasant *Lophura leucomelana* in Hawaii. Unfortunately it is composed of two subspecies, both the white-crested kalij *L. l. hamiltoni* and the Nepal kalij *L.l. leucomelana* where intergrades between these two subspecies have been documented (Lewin & Lewin, 1984) and hence have little to no conservation significance for the species as a whole. In addition to the kalij, the Indian peafowl *Pavo cristatus*, Erckel's francolin *Francolinus erckelii*, grey francolin *F. pondicerianus*, black francolin *F. francolinus* , California quail *Callipepla californica*, Gambel's quail *C. gambelli* and Japanese quail *Coturnix coturnix* can be found on the Hawaiian Archipelago. Within the Ruby Mountains of Nevada, USA, an estimated population of approximately 1000 Himalayan snowcock *Tetraogallus himalayensis* exist, and have maintained a relatively stable population since their introduction into the state in the 1960s. In addition, the source population appears to have all been allocated from northern Pakistan (Christensen, 1998) hence are likely of the same ecotype and of more conservation significance than if the opposite was true. A feral population of silver pheasants *Lophura nycthemera* exists on Eastern Vancouver Island, British Columbia, which originated from the closure of a small zoo in the late 1970s. No additional birds have been released since the demise of the zoo, however the population seems to be expanding fairly rapidly and observations are made of this species annually during Christmas birding counts (*per. comm.* G. Monty, 2005). In addition to the silver pheasant, a substantial population of California quail exists on Vancouver Island along with a small population of introduced mountain quail *Oreortyx pictus* (Guiguet, 1961).

The Reeves' pheasant *Syrmaticus reevesii* was introduced into both the Czech Republic and France and although there is little recently published literature on the status of these populations, it can be assumed that they are still being supplemented with captive raised birds for sport hunting (Pokorny & Pikula, 1987; Yeatman-Bertelot, 1991). Kren (2000) estimates the population in the Czech Republic to be between 200 and 400 individuals depending on the number of birds shot and released annually. Due to continued habitat fragmentation and a steady decline in overall numbers in its native China (Birdlife, 2001; Madge & McGowan, 2002), these introduced populations may prove to be of some consequence if the *in situ* population continues to decline.

Of some conservation significance are the well-established populations of black and grey francolin on the island of Guam (Kamal, 1999).

Although considered to be of Least Concern by the IUCN (Birdlife International, 2004b), both species of francolin are undergoing population decline due to habitat degradation and other human induced pressures (Madge & McGowan, 2002) and with the advent of climate change, may be facing threatened status in the near future, hence these introduced populations have the potential to act as safeguards for these two species.

Biological preservation

Beyond actual species conservation, the preservation of unique taxa or subpopulations is also possible through conservation introductions. The debate of evolutionary significant units continues to wage and there is potential for conservation introductions to play a part in the protection of this biological diversity. Various subspecies within the Phasianidae exist (Delacour, 1951; Johnsgard, 1999; Madge & McGowan, 2002), of these, it is highly probable that future genomic research will determine some should be upgraded to be given full species status, hence having a major effect on their conservation priority. Recognizing this early, may help conserve avian biodiversity that may otherwise be lost in the future. Species such as the Palawan peacock-pheasant *Polyplectron emphanum*, which have two distinct phenotypes and are separated by a natural geographic barrier, may qualify for such initiatives (*per. comm.* N. Mallari, 2007). Subspecies such as the Lewis silver pheasant *Lophura nycthemera lewisi*, Taiwan bamboo partridge *Bambusicola thoracicus sonorivox* or Taiwan ring-necked pheasant *Phasianus colchicus formosus* may eventually be upgraded to full species as recently seen with the Hainan peacock-pheasant *Polyplectron katsumatae,* Harman's eared-pheasant *Crossoptilon harmani* and Gunnison's sage-grouse *Centrocercus minimus* (Madge & McGowan, 2002). Evolutionary significant taxa, populations or unique ecotypes should also be considered for conservation introductions, particularly if their conservation status is in question, as a means of securing this biological diversity.

Other potential reasons for conservation introductions are the use of ecological replacements or substitutions. The Arabian ostrich *Struthio camelus syriacus* was a unique subspecies of ostrich only found in the Arabian Peninsula; it eventually went extinct in 1939 (Jennings, 1986). Since no captive specimens existed, this particular subspecies could not be reintroduced as outlined by the IUCN Reintroduction Guidelines (1998), hence selection criteria for this conservation introduction was based on similarities in phenotype, ecological compatibility and conservation value. Based on these criteria, the North African subspecies of *S. c. camelus* was selected as the most appropriate replacement form (Seddon & Soorae, 1999). This decision was later confirmed through the use of mitochondrial DNA and showed that *S. c. camelus* was indeed the closest living relative of the now extinct Arabian race (Robinson & Mathee, 1999). Arguably of more importance was that this introduction would benefit the long-term survival of this nominate subspecies, as the population in the Western Sahara is nearly extinct (Cramp & Simmons, 1997).

A similar case exists in Guam where the Micronesian megapode *Megapodius l. laperouse* once existed, but has since been extirpated. The introduction of the brown tree snake *Boiga irregularis* was a major contributor to the extinction of numerous Guam endemics. Although the decline of the megapode began before the arrival of the brown tree snake, it would likely have had some effect on the survival of young chicks and hamper population growth. With this being said, the impact of the snakes seems to mostly affect those birds within the range of 4 – 125 g (Fritts & Rodda, 1998). With adult birds weighing well above this, and having much different reproductive strategies than other ground dwelling birds on the island, it is perhaps worth looking into a conservation introduction even before the snakes are eradicated. The race *Megapodius laperouse* still occurs on the islands of Palau and the Northern Mariana Islands and, although having a population estimate of between 2000 and 2500 individuals, it is listed as Endangered by IUCN (Birdlife International, 2007b); one of the reasons for this being its very small distribution. Having a subsequent population on the island of Guam would provide an additional population and help protect this particular race from future stochastic events.

A comparable situation exists in the case of the greater sage-grouse *Centrocercus urophasianus*, which had historical distribution into central British Columbia, Canada but has since been extirpated. Translocation efforts in 1958 were considered unsuccessful at re-establishing this population, as after ten years, no more records of this species were made (Campbell et al*.,* 1990). However, only this single reintroduction attempt occurred which perhaps was too small to create a sustainable population. With this species being on a

continual decline due to habitat loss and overgrazing and being considered Near-threatened by IUCN (Birdlife International, 2004b) it would be of benefit to the species to attempt to establish a population in British Columbia once again, particularly since this region faces much less human pressure than in other parts of North America. Indeed, it has been recommended that translocations of this species may be necessary to expand its distribution and increase its population, particularly where no dispersal corridors exist (Schroeder et al., 1999).

Benefits of island populations

If a sustainable *ex situ* population of a threatened species is developed and a reintroduction programme for that species is eventually deemed necessary, these introduced populations represent an ideal source in which to procure individuals for reintroduction or reinforcement. Once the population is established, all birds will eventually be parent reared and will have likely developed much better anti-predatory behaviour when compared to captive-reared birds. In addition, the introduced population of birds will have grown accustomed to locating natural sources of food and will not be dependant upon pelleted food items provided only in a captive environment. These two factors alone will undoubtedly increase the chances of a successful reintroduction program, as poor anti-predatory behaviour and adapting to natural food sources are usually the two leading causes of death for reintroduced individuals (Ellis et al., 1978; Hill & Robertson, 1988; Griffith et al., 1989; Garson et al., 1992; Maxwell & Jamieson, 1997; Brightsmith et al., 2004; Robbins & Corder, 2005).

Factors affecting introduction success

Numerous factors exist in determining the success of introduced species into previously uninhabited locations and these have been looked at by other researchers and will not be looked at here in detail (Green, 1997; Blackburn and Duncan, 2001). Blackburn determined that introduction success was significantly higher when the difference between the species latitude of origin and latitude of introduction were small. In addition, Blackburn stated that when species are found in similar abiotic environments, it increases the likelihood of an introduction success. This bodes well for most species in the Phasianidae, which are often found at similar latitudes to potential introduction sites in North America. Further, much of North America shares many similar ecological aspects to eastern Asia which has been outlined by various researchers (Guo, 1999; Wen, 2001; Qian, 2002). Predators and natural competitors need to be considered before any introduction should take place and predator management may be a necessary step before an introduction occurs.

It is unfortunate that despite the incredible amount of literature that exists on introduced gamebirds, particularly the grey partridge and ring-necked pheasant, very little published literature exists on the effects they have had on their introduced environments based on searching through numerous literature archives. This could, in part, be due to the fact that the majority of their areas of introduction occurred in already human degraded habitats where their effect on the native ecosystem would go mainly unnoticed. Although there are undoubtedly some effects on local ecosystems in terms of seed dispersion, disease or pest transmission and competition with local fauna utilizing the same niche type, the ultimate effect on these human modified landscapes appears to be relatively small, at least when compared to the effects of other introduced species. Interestingly, there is a large amount of evidence that suggests there maybe some direct benefit to these local landscapes and the native species that inhabit them, in that many conservation and hunting groups actively promote the protection and management of these habitats for the benefit of these introduced gamebirds, indirectly protecting valuable habitat for both native and non-native species (Joselyn et al., 1972; Kruse et al., 1984; Henry, 1986; Knight et al., 1988).

Discussion

Although a highly controversial topic, conservation introductions continue to be used in various conservation programmes, particularly in Australasia where they have proven to play an integral part in numerous species restoration programmes (Hayson, 1994; Colbourne & Robertson, 1997; Gailbraith and McHalick, 1998; Colbourne, 2005). In addition, this method of conservation is seemingly growing within the conservation community itself as seen with the emergent idea of "Re-wilding" of North America concept brought forth by Donlan et al. (2005; 2006). It should be pointed out that even the managers of high profile and charismatic species programmes such as the California condor *Gymnogyps californianus*, which are subject to much public and private scrutiny, are very

willing to look at conservation introductions as a feasible tool in their conservation programmes in the future (*per. comm.* M. Wallace, 2007).

Conservation introductions should not be limited to having to wait until no remaining habitat is left in a species historic range; indeed there are numerous reasons why conservationists should not wait until such a critical scenario occurs before implementing this conservation tool. Unforeseen stochastic events, the creation of subpopulations as genetic banks, political instability, climate change and species substitutions are just a few potential reasons for attempting a conservation introduction.

It is my belief that the main reason behind the lack of attempted conservation introductions with Galliformes in recent history is due to the stigma that is associated with species introductions without conservation intent. It is a well known fact that historical introductions have resulted in, not only extinctions of entire populations and species, but have changed entire ecosystems, hence it is not surprising that such a stigma exists. It can be argued, however, that since Galliformes have been subjected to perhaps more introductions around the world than any other order of bird, there is no known published literature holding them alone accountable for any extinctions or dramatic alterations in ecosystems. Perhaps the worst they can be accountable for, is competing with other native Galliformes and acting as potential vectors in disease transmission (Kenaga et al., 1955; Lewin & Lewin, 1984). These of course are factors that must be taken into account before any species introduction but unfortunately were all too often overlooked in the past.

There is no denying that the introduction of a species into a foreign environment will have consequences in regards to its long term evolution and development as a species. Moreover, the impact the introduced population will have on the local ecosystem and the organisms within, also needs to be considered (Phillips et al., 2004). Despite the fact that a very strong argument can be made against introductions simply based on the long term effect that introductions can have on a species evolution, as conservationists, we must also consider the effect of relying solely on traditional conservation methods which often require changing political policies, educating local communities and creating natural reserves. These processes for the most part require relatively long periods of time, particularly when attempting to change the mindset of future generations. We are currently facing the most rapid loss of diversity mankind has ever witnessed (SCBD, 2006). Conservation initiatives that may otherwise not be attempted, should therefore be, at the very least considered and discussed. Conservation introductions, when successful, offer an accelerated method of securing a species' survival, beyond captive breeding. Very few other conservation methods can offer this same promise.

In closure, I would like to make a plea to galliform conservationists on an international scale, to consider the viability and potential that conservation introductions can have when implemented properly and to not abandon the idea based on history, where the purpose of an introduction was not for the preservation of a species, but for its benefit to man; instead, opinions should be based upon the use of current conservation introductions and how they are managed for both the benefit of a species and biodiversity as a whole.

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Biographical sketches

MYLES LAMONT is an active zoologist with a strong interest in avian conservation breeding and management programmes and is particularly interested in the behavioral and evolutionary science and ethics of reintroduction biology.