Perspectives in Ecology and Conservation xxx (2017) xxx–xxx

ABECO ASSOCIAÇÃO BRASILEIRA DE CIÊNCIA ECOLÓGICA E CONSERVAÇÃO

Perspectives in ecology and conservation

Supported by Boticário Group Foundation for Nature Protection

www.perspectecolconserv.com

Essays and Perspectives

Threats for bird population restoration: A systematic review

Guilherme Fernando Gomes Destro[a,b,*], Paulo De Marco[c], Levi Carina Terribile[d]

[a] Programa de Pós-Graduação em Ecologia e Evolução, Universidade Federal de Goiás, Campus Samambaia, CP 131, 74001-970 Goiânia, GO, Brazil
[b] Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, Superintendência no Estado de Goiás, Rua 229, n° 95 – Setor Universitário, 74605-090 Goiânia, GO, Brazil
[c] Departamento de Ecologia, Instituto de Ciências Biológicas, Universidade Federal de Goiás, Campus Samambaia, CP 131, 74001-970 Goiânia, GO, Brazil
[d] Instituto de Ciências Biológicas, Universidade Federal de Goiás, Regional Jataí, 75801-615 Jataí, GO, Brazil

ARTICLE INFO

Article history:
Received 11 December 2017
Accepted 22 March 2018
Available online xxx

Keywords:
Avian
Predation
Reinforcement
Reintroduction
Systematic review
Threatened species

ABSTRACT

Although widespread, actions aiming at the restoration of native species populations within their indigenous range still lack a clear definition of success, given the high degree of variability in species needs. In this sense, to understand and manage the mechanisms that lead to reintroduction or reinforcement failures may be a more feasible alternative to ensure conservation objectives. In this study, we aimed to systematize the main drivers that can negatively impact bird population restoration according to researchers and practitioners. Thus, a systematic review was performed in peer-reviewed journals, identifying 75 attempts, conducted from 1990 to 2016, in 30 countries involving 64 bird species and subspecies. Thirteen drivers that negatively impact reintroduction or reinforcement attempts were identified, where predation, unexpected dispersal movement and diseases were the main factors. We believe that if these drivers were prioritized during pre-release planning and post-release monitoring, restoration population programs would be more successful.

Introduction

The IUCN Red List process has been globally applied to reveal the threat degree of species and ecosystems (Mace et al., 2008; IUCN, 2015; Rodríguez et al., 2015). To reverse or even mitigate the threat degree, different conservation strategies have been executed (Tulloch et al., 2015), and population restoration stands out as one of the most widespread (Soorae, 2013). According to the IUCN (2013), population restoration is any intentional movement (translocation) and release of a living organism to within its indigenous range. It comprises two activities: reinforcement and reintroduction, that differ in the presence or absence of conspecific populations before release, and not specifically in management techniques (IUCN, 2013; Seddon et al., 2014). Reinforcement, also known as augmentation, supplementation, re-stocking, or enhancement (plants only), is the release of an organism into an existing population of conspecifics (IUCN, 2013; Hardouin et al., 2014), aiming to enhance population viability by increasing population size, genetic diversity, or representation of specific demographic groups or stages (Bretagnolle and Inchausti, 2005; Champagnon et al., 2012; IUCN, 2013). Reintroduction, on the other hand, is the release of an organism inside the indigenous range from which it has disappeared (Armstrong and Seddon, 2007; IUCN, 2013). Its main objective is to re-establish a viable population of the focal species within its indigenous range, fulfilling a role as a keystone component of an ecosystem, and/or create the public and political support necessary to undertake habitat restoration or to put species protection measures in place (Seddon, 1999; Lipsey and Child, 2007). However, while conceptually well established, there is no consensus on how to measure the success of reintroduction or reinforcement efforts (Seddon, 1999; Haskins, 2015; Robert et al., 2015).

Several methodological proposals to evaluate population restoration are available worldwide (Soorae, 2013). As a basic metric of success, some authors consider first-year survival rates within the normal range reported for avian fledglings to be indicative of a successful release (White et al., 2005). In other studies, researchers regard survival and reproduction as the two most fundamental parameters in terms of population establishment and persistence, defining 'success' as those translocations in which first-year survival was >0.50 (i.e. survival > mortality) and in which

* Corresponding author at: Programa de Pós-Graduação em Ecologia e Evolução, Universidade Federal de Goiás, Campus Samambaia, CP 131, 74001-970 Goiânia, GO, Brazil.
E-mail addresses: gfgdesto@gmail.com (G.F. Destro), pdemarcojr@gmail.com (P. De Marco), levicarina@gmail.com (L.C. Terribile).

https://doi.org/10.1016/j.pecon.2018.03.003

released birds later bred with conspecifics, either captive-reared or wild (White et al., 2012). Moreover, other authors also believe that three objectives should be achieved in an effort to restore a population: (i) establishment: the survival of the release generation; (ii) growth: breeding by the release generation and their offspring; and, (iii) regulation: persistence of the re-established population (Seddon, 1999; Sarrazin, 2007; Miller et al., 2014). For these authors, although the establishment and growth phases are necessary for success, they do not provide accurate estimates of the long-term viability of a reintroduced population. Thus, the ultimate success criteria should focus on the regulation phase, during which population dynamics critically depend on the interactions among species and habitat characteristics, in order to draw reliable conclusions about long-term population dynamics (Armstrong and Reynolds, 2012).

To contribute to the development of the science of reintroduction biology, Robert et al. (2015) proposed a method that assesses if the viability of reintroduced populations could be evaluated using the same criteria as for remnant populations, such as the International Union for Conservation of Nature (IUCN) Red List criteria. For this, two postulates were proposed: (i) that successful reintroduction programs should produce viable populations and (ii) that reliable assessments of ultimate success require that populations reach their regulation phase (Robert et al., 2015). However, Haskins (2015) point out fragilities in this methodology, since the time and resources required cannot keep pace with the ever-growing demand for conservation action, particularly under a rapidly changing climate, and the standardized definition of reintroduction success is nearly impossible to obtain, due to the high degree of variability in species needs when it comes to reintroduction success criteria.

Despite recent efforts to develop the science of reintroduction biology, many issues are still the subject of inconclusive debate (White et al., 2012; Robert et al., 2015), and thus, pointing out reintroduction failures seems to be an easier and more viable alternative to evaluate reintroduction success (Robert et al., 2015). The environmental drivers that can negatively impact population restoration programs are listed through a conceptual model presented herein (see Supplementary Material – S.1). Intrinsic factors evidence interactions among reintroduced and resident populations, and extrinsic factors are related to other species or environment. Either isolated or taken together, these drivers may harm a reintroduced population by hampering its establishment, growth or regulation, or destabilize resident populations and ecological processes. Thus, in order to better understand these failure dynamics and be able to better plan prevention and control actions, we aimed herein to systematize the main drivers that can negatively impact the bird population restoration programs according to researchers and practitioners. In addition, the conservation status of the bird species and countries with the most attempts in population restoration were listed and evaluated.

Methods

Our search was performed on the online database ISI Web of Knowledge (www.isiknowledge.com) to identify papers published from 1990 to 2016 that report bird reintroduction or reinforcement attempts. Birds were chosen because, alongside mammals, this group presents the most available data (Champagnon et al., 2012; Seddon et al., 2014), probably due to their social image (Bajomi et al., 2010) or because they are relatively easily studied and rapid results can be obtained (Armstrong and Seddon, 2011). For the literature search, the terms “reintroduction” OR “reinforcement” AND “bird” OR “avian” were used. However, to fulfill the purposes of the study and better detail the presentation of the methods, experimental design and results, paper selection was restricted. Thus, the analysis conducted herein did not consider: (i) accidental translocations or other conservation translocation initiatives, such as Conservation Introduction (Assisted Colonisation or Ecological Replacement) (see IUCN, 2013); (ii) newsletter articles, published abstracts, books, book chapters, technical reports or other gray literature; (iii) strictly theoretical studies, such as population modeling; and, (iv) studies without direct results on reintroduction/reinforcement attempts or related to other fields of science in which these terms have another meaning (e.g. molecular biology).

In the final database, population restoration attempts were individualized according to species, country and year of release. Each species was featured according to its taxonomic family and conservation status (IUCN, 2017). Studies involving more than one species in a single article were individualized and considered as a unique restoration attempt (e.g. Miskelly et al., 2009), and identical restoration efforts presented in more than one article were grouped (e.g. Bernardo et al., 2011a,b). Altogether, 75 restoration efforts were identified which, although not resulting in an exhaustive bibliographical review, since researchers are more likely to report a “success” (Fischer and Lindenmayer, 2000), represent a reliable synthesis of peer-reviewed literature, less prone to bias and with quality assured information (Bajomi et al., 2010).

Each study was also categorized according to drivers that can negatively impact population restoration. These drivers were extracted from issues that researchers addressed in their research, reflecting their theoretical perspectives and problems they thought were relevant to the study. In sum, we identified: (i) environmental causes; (ii) anthropogenic causes; and (iii) unknown causes. Anthropogenic causes are those specifically related to failures during the pre and post-release management. Environmental causes are those who suffer the action of biotic components (e.g. predation, intra or interspecific competition or diseases), abiotic components (e.g. low environmental quality and extreme weather), or are the result of individual responses to release events or applied management (e.g. non-establishment of an animal in the release site, low population size, genetic vulnerability, reproductive limitation, nest abandonment or infanticide-chick cannibalism) (see Supplementary Material – S.1). The results were presented using tables and histograms that illustrate some of the most broad prevalent trends apparent in the data (Fischer and Lindenmayer, 2000). Thus, the most common species in this regard and their threat degree, the countries with the most restoration attempts and the main failures drivers were identified.

Results

According to the review conducted herein, from 1990 to 2016, 64 bird species and subspecies across 33 different families were used in reintroduction/reinforcement attempts in 30 countries (see Supplementary Material – S.2). The most common species were *Grus americana* (5 instances) and *Notiomystis cincta* (3), and the most frequent families were Procellariidae (8) and Gruidae (5). Regarding conservation status, 45% of the species were classified as being of Least Concern, 16% as Vulnerable, 14% as Critically Endangered and 13% as Endangered (Fig. 1). The highest number of studies was carried out in New Zealand (22 instances), USA (16), Spain (4) and Japan (4) (Fig. 2).

Thirteen drivers that may negatively impact reintroduction or reinforcement attempts were pointed out by researchers and practitioners in their studies (Table 1). Most studies presented two or more negative drivers, although some reports did not point out any obstacle. Considering only environmental causes, predation was the greatest impact (27 instances), followed by