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DATA ARTICLE

Conservation translocations from the 'Global Reintroduction Perspectives' series: Disease and other biological problems

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Abstract

1. Conservation translocations, defined as population reinforcement, reintroduction, assisted colonization or ecological replacement, have become a popular tool in efforts to restore wildlife populations and their wider ecosystems. Given that conservation translocations remain challenging to undertake, and positive outcomes are not guaranteed, we should maximize opportunities to learn from the outcomes of previous projects.
2. Case studies of animal and plant conservation translocation published in the first six volumes (2008–2018) of the IUCN/SSC's 'Global Reintroduction Perspectives' series were reviewed. Alongside project metadata, the following self-reported information was extracted from the case studies: select project strategies and methods; information relating to any mortality, ill-health or poor fecundity; and health management practices.
3. Two hundred and ninety-five of the 351 case studies clearly described a discrete conservation translocation initiative for which releases were underway or complete at their time of publication. Sixty per cent of these 295 case studies were reintroductions. Mammals were the most commonly translocated taxon (29% of case studies), and projects were most often conducted in Oceania, Western Europe or North America or the Caribbean.
4. The data set presents information on disease and other biological problems self-reported in these conservation translocation case studies. It can inform health and wider management planning for future conservation translocation projects.

KEYWORDS
conservation translocation case studies, ecosystem restoration, Global Reintroduction Perspectives, plant reintroduction, wildlife disease risk analysis, wildlife disease risk assessment, wildlife health, wildlife reintroduction

1 | INTRODUCTION

Conservation translocation is defined as 'the deliberate movement of organisms from one site for release in another… [specifically] intended to yield a measurable conservation benefit at the levels of a population, species or ecosystem' (IUCN/SSC, 2013). The term encompasses population restoration, through population reinforcement or reintroduction, and conservation introduction, which is the 'intentional movement and release of an organism outside its indigenous range' for the purpose of ecological replacement or assisted colonization (IUCN/SSC, 2013).

Conservation translocations have been instrumental in the recovery of multiple endangered animal and plant populations (Armstrong et al., 2019). Their use has increased in recent decades and this trend is likely to continue, not least through attempts to mitigate biodiversity declines associated with climate change (Swan et al., 2018). However, conservation translocations remain complex, and frequently long-term and expensive, projects to undertake (IUCN/SSC, 2013). Given our limited conservation resources, there is value in publishing the methods and outcomes from previous projects to maximize the evidence base available to plan new initiatives (e.g. Parker et al., 2012).

First published in 2008, the 'Global Reintroduction Perspectives' series (Soorae, 2008, 2010, 2011, 2013, 2016, 2018, 2021) contains a wealth of conservation translocation case studies spanning animals and plants from a diverse range of habitats around the world. The case studies have the following standardized subheadings: 'Introduction', 'Goals', 'Success indicators', 'Project summary' ('Feasibility stage', 'Implementation stage', and 'Post-release monitoring'), 'Major difficulties faced', 'Major lessons learned' and 'Success of project' including 'Reason(s) for success/failure'. Authors self-report information about their project under these subheadings and are required to qualitatively rate its success as 'Highly successful', 'Successful', 'Partially successful' or 'Failure'. This data set summarizes metadata from the case studies and information presented concerning project methods, any mortality, ill-health or poor fecundity encountered, and health management. It is a resource for health and wider management planning for future conservation translocations.

2 | MATERIALS AND METHODS

The data set (spreadsheet) was created by extracting information presented in case studies in the first six volumes of 'Global Reintroduction Perspectives' (Soorae, 2008, 2010, 2011, 2013, 2016, 2018). This included the following metadata and project methods: year of publication, case study authorship, taxonomic details, country, project timeframe, type of conservation translocation project (as per above and IUCN/SSC, 2013), source and number of released individuals and author-ascribed project success rating.

Self-reported information was abstracted concerning any problem that could be considered a form of mortality, ill-health or poor fecun-

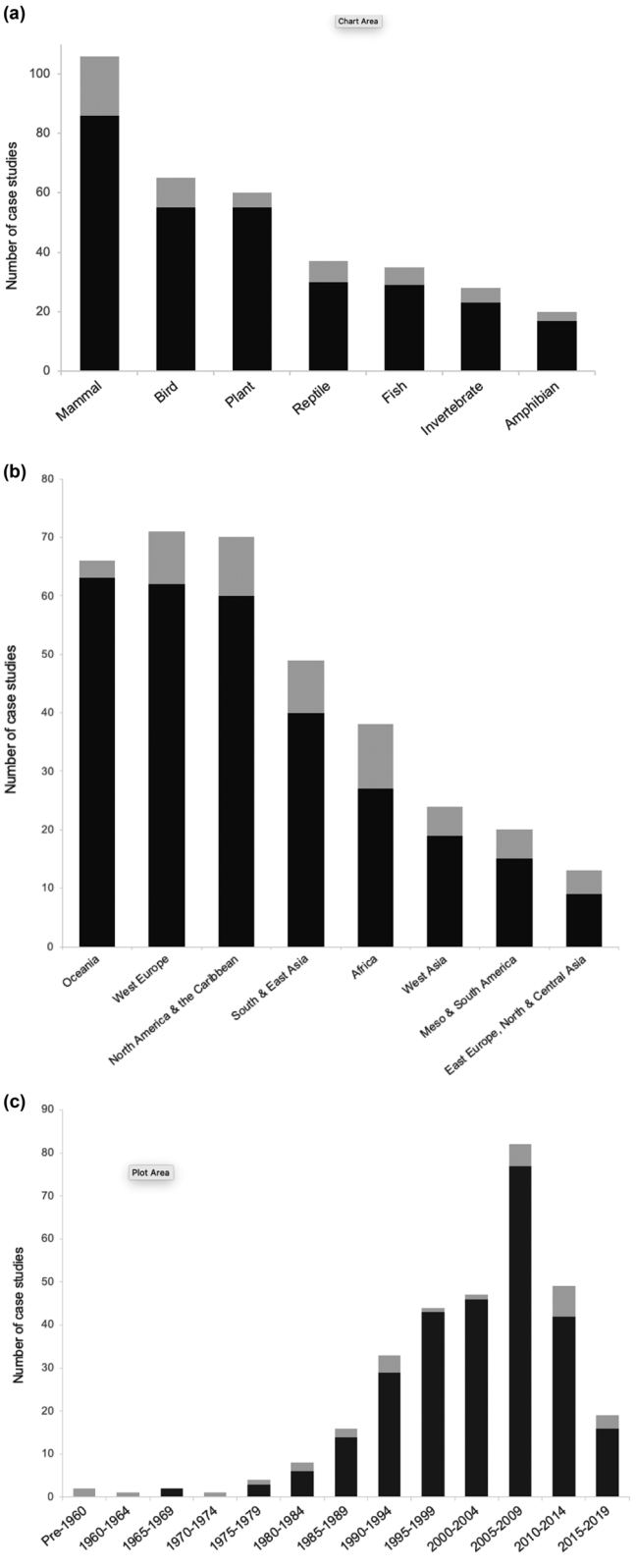

FIGURE 1 Summary details of reviewed case studies ($n = 295$), by (a) major taxonomic group, (b) IUCN statutory region and (c) year releases commenced. Pale grey bars represent case studies excluded from the review ($n = 56$).

TABLE 1 Timing of publication of case studies relative to the translocation projects they described

Time from final release to case study publication (years)	Case studies	
	Number	Percentage of total
Releases ongoing	95	32
0–5	108	37
6–10	30	10
11–15	21	7
16–20	10	3
21–25	4	1
36–40	1	0
Not specified/unknown	26	9
295	295	

dity, in translocated individuals or in animals, plants or humans linked to translocation. We included implied problems, for example, where a relevant management measure was mentioned. We included problems mentioned under any subheading while also noting if they were specifically mentioned under 'Major difficulties faced', 'Major lessons learned' and/or 'Success of project: Reason(s) for success/failure'. We recorded the attributed causes of problems and refined these causal categories during data collation. The term 'infectious agent' was used to denote parasites (infectious organisms) and other transmissible agents recognized to cause disease, or considered by case study authors to have this potential (Tompkins et al., 2015; Wobeser, 2006). An infectious agent was considered a problem if the authors expressed concern about it: we recorded if there was mention of associated disease, and, where it could be deduced, the infectious hazard pathway (Table S1).

The project stage during which mortality, ill-health or poor fecundity had occurred was noted and categorized as follows:

- In the source population;
- During capture/collection, transit or handling;
- In the captive environment, that is temporary holding or the ex situ environment, for captive rearing, captive breeding, rescue or rehabilitation; or
- Post-release (post-planting/sewing).

We recorded if authors explicitly linked the problem to failure or postponement of ≥1 release season or at ≥1 release site—which we termed 'partial' project failure—or to outright project failure.

We noted if there was mention of the IUCN's (IUCN, 1998; IUCN/SSC, 2013), or other, conservation translocation guidelines being followed, and of a disease risk analysis or 'risk assessment' for disease threat being undertaken. We also noted if authors mentioned pre-emptive health management measures being undertaken prior to releases, namely:

- Quarantine or isolation of translocated individuals;
- Infectious agent surveillance or screening;
- Health monitoring, including physical health checks;
- Vaccination;
- Prophylactic treatment; or
- Other health management measures, such as other biosecurity measures, or chemical tranquilization during transport explicitly to minimize stress.

Any mention of post-release health surveillance being undertaken, including health checks, infectious agent surveillance or post-mortem examinations, was also noted.

We recorded if, under the subheadings 'Major difficulties faced', 'Major lessons learned', or 'Reason(s) for success/failure', the benefits of health management or health expertise, or associated negative experiences, were mentioned. Similarly, we noted if, under the same subheadings, authors highlighted the importance or benefit to their

TABLE 2 Types of conservation translocation project (IUCN/SSC, 2013) described in reviewed case studies

Type of conservation translocation	Case studies	
	Number	Percentage of total
Population restoration		
Reintroduction	177	60
Population reinforcement	54	18
Reintroduction and population reinforcement	18	6
Type of population restoration programme unclear	7	2
Subtotal	*256*	86
Conservation introduction		
Assisted colonization	15	5
Ecological replacement (substitution)	2	1
Subtotal	*17*	6
Population restoration and conservation introduction	5	2
Not specified/unknown	17	6
Total	*295*	

TABLE 3 Orders of animals (e.g. Frost, 2020; HBW & Birdlife International, 2019; WoRMS Editorial Board, 2020) and families of plants (The Plant List, 2013) represented in reviewed case studies

Taxonomic group	Number of case studies
Mammals	
Artiodactyla	29
Carnivora	17
Primates	10
Perissodactyla	5
Rodentia	5
Diprotodontia	4
Lagomorpha	3
Proboscidea	3
Dasyuromorphia	2
Peramelemorphia	2
Sirenia	2
Chiroptera	1
Hyracoidea	1
Pholidota	1
Pilosa	1
Subtotal	*86*
Birds	
Passeriformes	19
Psittaciformes	8
Accipitriformes	6
Gruiformes	5
Galliformes	4
Cathartiformes	2
Falconiformes	2
Struthioniformes	2
Anseriformes	1
Charadriiformes	1
Ciconiiformes	1
Pelecaniformes	1
Piciformes	1
Procellariiformes	1
Strigiformes	1
Subtotal	*55*
Plants	
Orchidaceae	7
Compositae	5
Leguminosae	3
Amaryllidaceae	2
Caryophyllaceae	2
Cupressaceae	2
Lamiaceae	2
Proteaceae	2
Rhamnaceae	2
Rutaceae	2
Acanthaceae	1
Aspleniaceae	1
Balanophoraceae	1
Cactaceae	1
Campanulaceae	1
Cistaceae	1
Gentianaceae	1
Gesneriaceae	1
Haloragaceae	1
Isoëtaceae	1
Liliaceae	1
Magnoliaceae	1
Malvaceae	1
Marsileaceae	1
Orobanchaceae	1
Plumbaginaceae	1
Ranunculaceae	1
Rhizophoraceae	1
Sapindaceae	1
Scrophulariaceae	1
Solanaceae	1
Verbenaceae	1
Woodsiaceae	1
Zosteraceae	1
Two families translocated: Proteaceae and Myrtaceae	1
Three families translocated: Acanthaceae, Rhizophoraceae and Primulaceae	1
Subtotal	*55*
Reptiles	
Squamata	14
Testudines	9
Crocodylia	4
Rhynchocephalia	3
Subtotal	*30*
Fish	
Cypriniformes	9
Salmoniformes	4
Perciformes	3
Cyprinodontiformes	2

(Continues)

TABLE 3 (Continued)

Taxonomic group	Number of case studies
Acipenseriformes	2
Scorpaeniformes	2
Siluriformes	2
Atheriniformes	1
Esociformes	1
Gadiformes	1
Gasterosteiformes	1
Osmeriformes	1
Subtotal	*29*
Invertebrates	
Lepidoptera	5
Orthoptera	4
Gastropoda	3
Hymenoptera	2
Odonata	2
Scleractinia	2
Annelida	1
Araneae	1
Coleoptera	1
Diptera	1
Cardiida	1
Subtotal	*23*
Amphibians	
Anura	15
Caudata	2
Subtotal	*17*
Total	*295*

project of husbandry measures/skills, a multi-disciplinary approach or funding or other resourcing.

To inform the selection of case studies for critical review, we recorded whether:

- Case study projects clearly fitted the definition of a 'conservation translocation' (IUCN/SSC, 2013): namely whether conservation was an explicit, primary aim of the project, and if >5 individuals had been released (projects releasing fewer individuals were considered too small in scale);
- The case study described a discrete conservation translocation initiative. For example, summaries of translocation projects for a particular species over a prolonged timeframe, or research studies performed in parallel to a translocation for which success criteria were unrelated to translocation outcomes, were not considered to fit this criterion;
- The project was underway or complete at the time the case study had been written; and
- The case study was considered to be sufficiently detailed and clearly written for the specific purpose of our review.

To enable proxy assessment of case study 'quality', we also noted the length of the case study (number of pages), and the clarity with which it provided information about the type of conservation translocation project, year of first release(s) and number of released individuals.

3 | USAGE NOTES

While the 'Global Reintroduction Perspectives' case studies have a standardized structure, authors are under no obligation to mention specific methods, types of problem faced or management actions, although the subheadings 'Major difficulties faced', 'Major lessons learned' and 'Reason(s) for success/failure' invite them to mention any noteworthy challenges experienced. Therefore, the data reflect authors' individual perspectives and cannot be used to infer the prevalence of problems or management actions. The data are likely to underrepresent the number of disease and other biological problems encountered, because, for example, post-release monitoring was frequently suboptimal (Berger-Tal et al., 2020) and many case studies concerned projects that were at a relatively early stage in their progress (see below and Table 1).

The data were primarily collated by one author (KB) and reflect their personal interpretation of information presented in the case studies. Each problem was entered in a new row in the spreadsheet, so many case studies are represented by multiple lines: the respective row numbers are listed under 'case study line number'.

The data set is a resource for conservation practitioners and scientists planning future conservation translocations, and for further review studies.

4 | GENERAL PATTERNS

Data were extracted from all 351 case studies in the series. Eighty-four per cent ($n = 295$) of these case studies were considered to describe, with sufficient detail and clarity, a discrete conservation translocation initiative (as per the above definition) that was at least underway at the time the case study was written: the patterns we presented concern these 295 case studies.

The majority of case studies described a reintroduction project (66% of case studies, including 6% where reintroduction and population reinforcement were performed concurrently) (Table 2). Mammals were the most commonly represented taxon (29%, $n = 86$), consistent with the wider literature (e.g. Bajomi et al., 2010), followed by birds and plants (19%, $n = 55$, for each), reptiles (10%, $n = 30$), fish (10%, $n = 29$), invertebrates (8%, $n = 23$) and amphibians (6%, $n = 17$) (Figure 1a). Within each major taxon, some lower taxonomic groups

TABLE 4 Number of individuals reported to have been released (planted) in reviewed case studies, according to major taxon (listed in order of increasing number)

	Number of individuals released (where stated)		
Major taxon	Minimum	Maximum	Number of case studies
Bird	6	1393	55
Mammal	7	3500	86
Reptile	6	8450	30
Invertebrate	18	>100,000	23
Amphibian	31	140,253	17
Plant	60	>1,388,451	55
Fish	30	2,405,000	29

were particularly strongly represented (Table 3); in 5% of case studies ($n = 15$), multiple subspecies or species of the same major taxon had been translocated. The projects had been performed on all inhabited continents, most often in Oceania, Western Europe or North America or the Caribbean (Figure 1b). In a review of the broader conservation translocation literature, Fischer and Lindenmayer (2000) found that North America and Oceania were similarly strongly represented.

Bearing in mind the first volume of case studies was published in 2008, most releases had commenced in the 1990s or later (Figure 1c). At least 32% of case studies were published while releases were still ongoing, and at least another 37% within 5 years of the final release(s) (Table 1). There was wide variation in the number of years releases spanned: from 1 year (≥19% of studies) to ≥30 years (≥2% of studies). Also, the number of released individuals varied markedly, both within and between the major taxonomic groups (Table 4).

The case series reported a notably high rate of 'success': 97% ($n = 281$) of 289 case studies giving a success rating were considered either 'Partially successful', 'Successful' or 'Highly successful'. This contrasts with previous publications illustrating poorer 'success' rates across a broad range of taxa (e.g. Fischer & Lindenmayer, 2000; Silcock et al., 2019). 'Failed' projects are likely to have been underreported in this case series (Godefroid et al., 2011; Miller et al., 2014).

The frequency with which problems relating to mortality, ill-health or poor fecundity were self-reported, the attributed causes of these problems, and information presented on health management, are summarised in Beckmann et al. (2022). Briefly, 'disease' and other biological problems were described as a 'Major difficulty', 'Major lesson learned' or 'Reason for… failure' in 30% and 66% of 295 reviewed case studies, respectively. 'Disease' problems were significantly more likely to be mentioned in projects with poorer success ratings ($P < 0.05$ on a χ^2 test). Other biological problems were mentioned commonly, even in 'Highly successful' case studies: particularly post-release predation, adverse climate/weather, anthropogenic trauma and other ecological/environmental problems. Overall, disease and other biological problems appeared to be context and taxon specific, and the case studies demonstrated that a wide variety of problems could potentially impede or disrupt project progress.

5 | RELATED WORKS

The data set is explored further in an accompanying review article (Beckmann et al., 2022). The data were extracted from the 'Global Reintroduction Perspectives' case series (Soorae, 2008, 2010, 2011, 2013, 2016, 2018).

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AUTHOR CONTRIBUTIONS

Katie Beckmann extracted and analysed the data, and led preparation of the manuscript, tables and figures. Pritpal Soorae edited the Global Reintroduction Perspectives series, contributed critically to the draft and gave final approval for publication.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data set is available through the University of Edinburgh's DataShare platform (Beckmann & Soorae, 2021; https://doi.org/10.7488/ds/3135). The 'Global Reintroduction Perspectives' publications from which the data were extracted have been published online (Soorae, 2008, 2010, 2011, 2013, 2016, 2018; https://doi.org/10.2305/IUCN.CH.2018.08.en).

PEER REVIEW

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Table S1. Infectious hazard pathways.

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