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ORIGINAL RESEARCH

Factors influencing species reintroduction success

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Abstract

Conservation reintroductions are widespread in species conservation but evaluation of their success, and particularly the reporting of failures is lacking. Here we evaluate aspects of species reintroduction that influence success and how conservation practitioners measure success. We analysed trends and reasons for perceived failure and success across 341 documented reintroduction case studies from across the globe. Reintroductions in Africa had lower scores for success compared to East Europe, North & Central Asia; fish had higher scores than invertebrates; and government and non-government organisations scored projects as more successful than did zoos or aquaria. Goals and Indicators do not appear to influence the success score, although too many goals may have a negative influence on success. Qualitative analysis of the reasons for failure and success showed that activities linked to Partnerships & Support (e.g. community support, government partnerships) were the most regularly cited reason for success, and Habitat & Release site (e.g. poor habitat connectivity, lack of suitable release sites) were the most frequently cited reason linked to failure, or failed elements. Current conservation efforts continue to comprise a disproportionately high number of reintroductions for mammals and birds compared to other taxa, and the number of reintroductions in developed countries outweigh those of developing countries.

Keywords Conservation planning · Success · Action plans · Translocation · Project evaluation

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Introduction

In response to biodiversity loss, species reintroductions have continued to increase over recent decades and have now become a common tool in species conservation, often forming a key part of species action and recovery plans (Seddon et al. 2007; Bubac et al. 2019). Despite their growing application, species reintroduction remains challenging (Armstrong and Seddon 2008; Linhoff et al. 2021) and can often take many years to plan, deliver and monitor. The core principles of planning and implementing a reintroduction involve (1) *Planning* (deciding on goals, objectives, actions, a monitoring programme and an exit strategy); (2) *Feasibility* (biological, ecological and social aspects, compliance with regulations and legal requirements, availability of resources); (3) *Release strategies* (finding suitable release sites, deciding on the best release protocols and stock); and (4) *Monitoring and management* (collecting data, habitat and adaptive management, responding to unexpected outcomes) (IUCN/SSC 2013). Yet, even when all these stages and their components are met, many reintroductions fail or are unable to determine whether the intervention has been successful in enabling the sustained recovery of a population (Muths and Dreitz 2008; Sutherland et al. 2010). Reintroductions are often deemed to be successful after breeding in the wild is observed (White et al. 2012; Harding et al. 2016) or when a viable population is established (Seddon 1999; Germano and Bishop 2009; IUCN/SSC 2013), yet there are no clear or agreed definitions for success (Fischer and Lindenmayer 2000; Seddon et al. 2007; Robert et al. 2015; Brichieri-Colombi and Moehrenschlager 2016; Morris et al. 2021; Marino et al. 2024). However, current guidance relates success to long term cyclical monitoring and, if necessary, regular adjustment until the goals of the reintroduction are met (IUCN/SSC 2013; Taylor et al. 2017).

Appropriate timescales and monitoring are needed to measure success, but protocols depend on the species and project goals. For example, for bird reintroductions it is recommended that monitoring is carried out for at least 5 years, and for between 10 and 20 years for longer lived species (Sutherland et al. 2010). For amphibians it has been recommended that to determine success, a population should be monitored for at least 10–15 years (Dodd 2005). A study looking at the success of 42 amphibian reintroductions supported this suggestion by demonstrating that high levels of success were only seen in reintroduction programmes running for more than 7 years, with most successful reintroductions having been in place for 10 years or more (Harding 2014). The benefits of long-term monitoring are also reflected in bird reintroductions. The red kite (*Milvus milvus*) – a relatively long-lived species – was first reintroduced in the UK in 1989. Despite successful breeding early on at some locations, there remained problems at others (Carter and Newbery 2004) and it was not until 30 years later, after 1800 breeding pairs were established at numerous sites across the UK, that the reintroduction was cited as a success (RSPB no date; Barkham 2020; Evans 2020). Such examples highlight the importance of long-term monitoring as well as the reality that initial signs of success do not always constitute population stability due to the population dynamics and ecology of each species, as well as other related or unrelated management activities (Watts et al. 2020).

There are an increasing number of reintroduction case studies available (Griffith et al. 1989; Brichieri-Colombi and Moehrenschlager 2016; Bubac et al. 2019) and reviews of reintroduction outcomes have identified several factors relevant to success: release site, species diet, species status and numbers of individuals released (Griffith et al. 1989; Wolf et al. 1998; Fischer and Lindenmayer 2000; Bellis et al. 2019; Bubac et al. 2019; Morris et al. 2021). These have highlighted failure to address threats (Fischer and Lindenmayer 2000), initial causes of decline, (Cochran-Biederman et al. 2015; Bubac et al. 2019) and funding dynamics (Ewen et al. 2014; Berger-Tal et al. 2020) as the main causes of failure. Whilst some studies have focussed on taxon-specific factors of success (Cochran-Biederman et al. 2015; Bellis et al. 2019) and global regions (Resende et al. 2020), there remains a gap in comparing success across taxa and geographical regions. Consequently, we analysed published case studies from the IUCN Global Reintroduction Perspectives series (Soorae 2008, 2011, 2013, 2016, 2018) to compare perceived success in relation to planning, regions, taxa and organisational infrastructures. We undertook a mixed method approach to the analysis by assessing both quantitative data (common variables across the case studies) and qualitative data (practitioner comments and experiences). Specifically, we asked: (1) What factors influence reintroduction success? (2) What are the most frequently cited reasons/characteristics that relate to success and failure? (3) What are the most frequently cited reasons for assigning a particular success score?

Methods

Data collection

Data were collected from six editions of the IUCN publication Global Reintroduction Perspectives (Soorae 2008, 2011, 2013, 2016, 2018). This data source offers the most comprehensive set of reintroduction case studies currently available, covering a variety of taxa and regions, with authors assigning an overall success score for each reintroduction. The published case studies are submitted by practitioners using a standardised reporting template; however, no further standardisation is applied to the assignment of success scores, and authors were not required to justify their scoring rationale beyond the Reasons for Success/Failure section. These studies were not subjected to formal peer review beyond editorial oversight. Consequently, the dataset may reflect subjective interpretations and practitioner or organisational biases, particularly in the evaluation of project success. All projects were conducted with the aim of species recovery and included both reintroductions and population reinforcements (IUCN/SSC 2013).

The six publications comprise between 50 and 74 case studies per volume, giving an overall total of 351 published cases. The following data were extracted from each case study: species name, taxon, type of organisation(s), author affiliation, number of different organisations involved, country (filtered into IUCN region, (IUCN 2019), goals, indicators, success score, and if there was reference to a species action plan. Success scores were assigned by the authors of each study on a four-point scale: (1) Highly Successful, (2) Successful, (3) Partially Successful, and (4) Failure. The following qualitative data were extracted from each section of the case study: Project summary, Major Difficulties Faced, Major Lessons Learned, and Reasons for Success/Failure.

Profile of cases

Out of the 351 case studies, 11 were excluded from analysis due to missing or unusable success scores, species overlap, or by being in early feasibility stages. One additional project covered two species with separate scores and was counted twice, resulting in 341 case studies analysed. Taxonomic breakdown comprised: 18 amphibians, 63 birds, 34 fish, 27 invertebrates, 104 mammals, 59 plants and 36 reptiles. The studies spanned eight IUCN regions, with 38 studies from Africa; 13 from East Europe, North and Central Asia; 19 from Meso- and South America; 69 from North America and the Caribbean; 63 from Oceania; 48 from South and East Asia; 23 from West Asia; 67 from West Europe, and one which bridged more than one IUCN region. Success scores, assigned by study authors, were distributed as, 8 Failures, 131 Partially Successful, 133 Successful and 69 Highly Successful.

Data analyses

Quantitative

Exploratory tests to identify trends and relationships between the common variables and success were undertaken using Kruskal-Wallis tests in R 3.5.3 (R Core Team 2019) and post-hoc comparison using the kruscalmc command in the pgirmess package (Giraudoux 2018). To explore relationships further and to establish factors influencing success levels assigned to the reintroduction projects, we ran a multinomial logistic regression model using multinom command in the nnet package in R (Venables and Ripley 2002). A multinomial model was chosen because it accommodates nominal response variables with multiple, non-ordered categories more appropriately than binary or ordinal approaches. Success score was the dependent variable in our model, with the following variables included as potential predictors: Taxon, IUCN Region, Goals, Indicators, and Type of organisation. These were chosen as they were the most consistently reported variables for each case study. An additional variable, Number of different organisations was included in an earlier model, however the results of a VIF analysis (Zuur et al. 2010) showed the multicollinearity between the number of organisations and types of organisations was too high. As number of different organisations showed the highest VIF, this was removed and the model re-run with just types of organisations. Odds ratios from the model output were used to assess the importance of each potential predictor.

As only eight projects were classed as failures (according to the IUCN publications defined success score scale) the overall distribution of scores (and therefore cases) resulted in some poorly fitting models. Case studies scored as failures were therefore omitted from the multinomial models. As the univariate and multinomial analyses used different types of data, results from both are presented.

Qualitative

The data were imported into NVivo 12 Pro (QSR International Pty Ltd. 2018) for coding and analysis. Open ended questions relating to the reasons given for success and failure of the reintroduction project were analysed and coded into relevant recurring themes using thematic analysis. Thematic analysis is a method that identifies patterns of meaning (themes) within qualitative data, allowing analysis through the common themes (Clarke and Braun 2017). Some responses from 'Lessons learned' and 'Difficulties faced' sections were also coded where relevant additional information was provided. An initial coding framework was developed based on known and common reasons for success and failure. This was then expanded with new codes and subcodes created from emerging themes during the coding process. Themes were then refined and organised to create consistency and merge duplicates. Additional codes were created for success and failure ratings to identify the most frequent reasons given. These were taken from reasons for success/failure rather than an analysis of the objectives. The coding framework was developed and applied by the first author using a reflexive and interpretivist approach to qualitative analysis. Given the emphasis on deep, contextually grounded interpretation rather than statistical consistency, formal intercoder reliability measures—such as Kappa analysis—were not employed (Braun and Clarke 2021). To support transparency and analytical rigor, the framework was collaboratively reviewed by co-authors during the study, and a subset of case studies was assessed to foster reflexivity and critical dialogue (Yardley 2000).

Results

Success and taxa

Across 341 reintroductions, fish had the highest percentage of highly successful projects (26%, $n=9$) and birds had the highest percent of projects classed as failures (8%, $n=5$; Fig. 1). Although success levels were related to the taxon involved when failures were included ($H(6)=14.37$, $p=0.026$), post-hoc comparisons did not show any significant differences between individual taxa. When failures were excluded the relationship between success and taxon became non-significant ($H(6)=11.81$, $p=0.066$).

Success and regions

Relatively more highly successful and failed reintroductions came from East Europe, North & Central Asia (Fig. 2). However, IUCN region did not appear to affect the success level overall (including failures $H\ (7)=5.0$, $p=0.660$; excluding failures $H\ (7)=6.52$, $p=0.481$).

Type of organisation

The type(s) of organisation involved in each case study was identified indirectly using the organisations to which each author was affiliated, with the assumption being that the affiliation reflects the institutions involved in the reintroduction. Government agencies were involved in 50% of the 341 reintroduction projects studied, whilst zoos and aquaria were involved in 24% (Fig. 3). Success levels were similar across the organisational types and no trend was observed (including failures $H\ (3)=2.85$, $p=0.4151$; excluding failures $H\ (3)=1.58$, $p=0.665$). The number of organisations involved varied between 1 and 10 (with a mean of 2.15), but as there were no relationships between number of organisations and success level, and as there was multicollinearity with the type of organisation (see Methods), analyses using number of organisations were not pursued further.

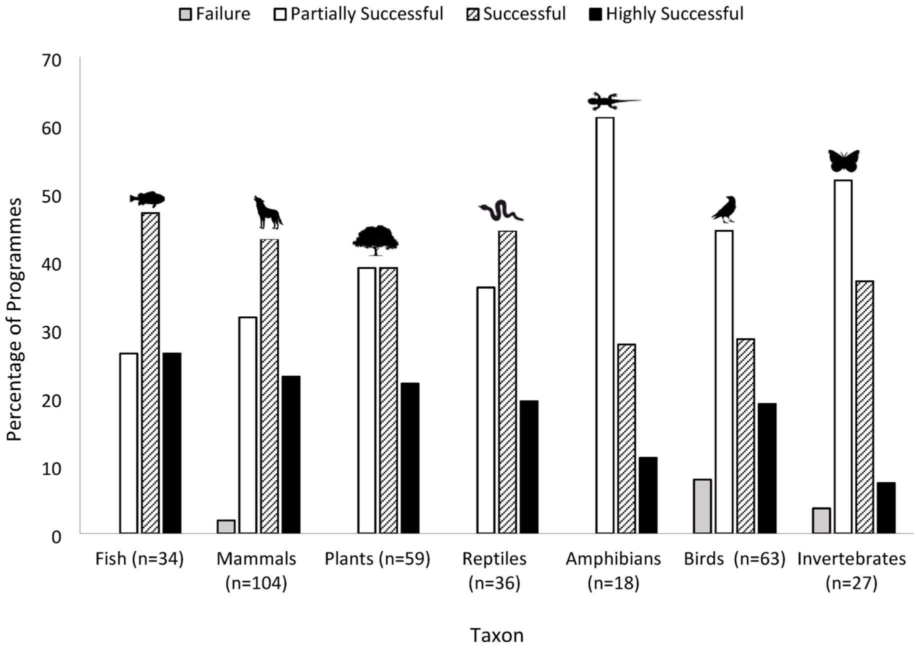

Fig. 1 Success categories according to taxa, as assigned by the authors of the case studies (n = number of case studies from the taxon)

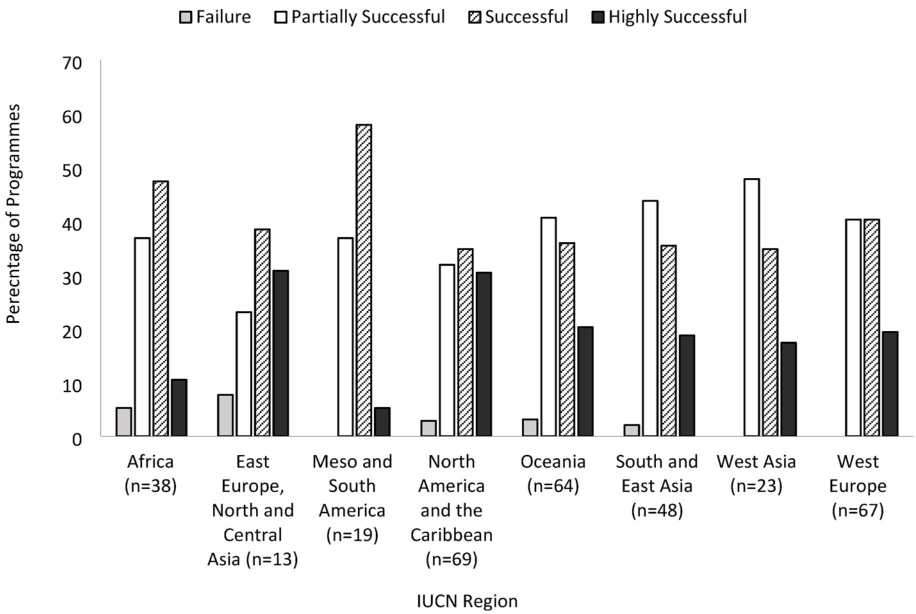

Fig. 2 Success categories by IUCN Region, as assigned by the authors of the case studies (n = number of case studies from the IUCN region)

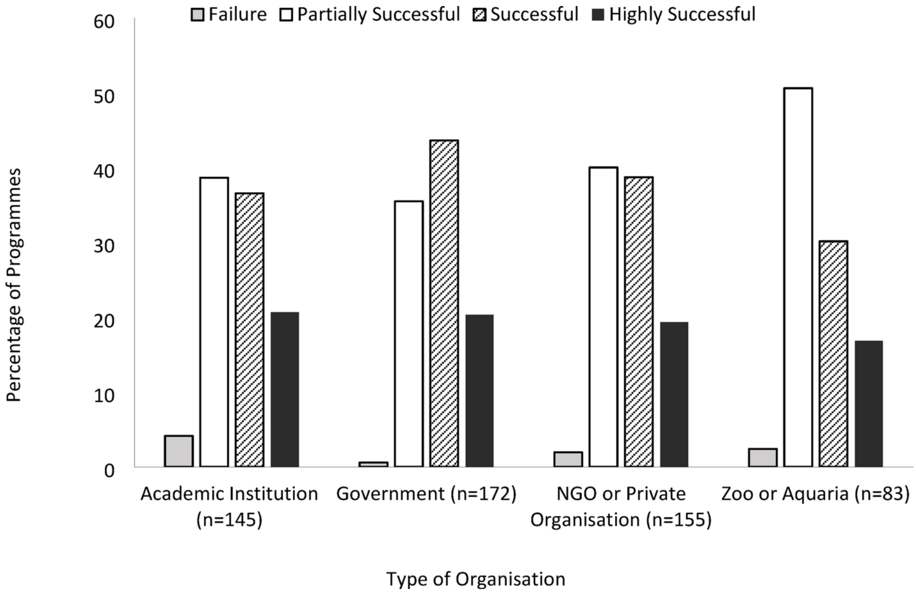

Fig. 3 Success categories in relation to type of organisations based on authors affiliations, as assigned by the authors of the case studies (n = number of case studies from the organisation)

Success and number of goals and indicators

The number of goals set within a project ranged between 1 and 8 with a mean of 3.8 goals per project (Fig. 4a). Although a trend was seen relating to increasing number of goals and initial increased success, followed by decreased success after 5 goals, this was not significant (H (4) = 1.36, p = 0.851). The number of indicators used, ranged between 0 and 10 with a mean of 3.9 indicators created (Fig. 4b) (H (4) = 2.60, p = 0.627).

Multinomial logistic regression results

Using multinomial logistic regression analysis, we examined the odds of a reintroduction being scored as successful or highly successful when compared to the base category of partially successful (Table 1). Failures were not included in this analysis as there were too few cases to fit the model.

Zoos and aquaria were more likely to score projects as partially successful than successful than academia or government and non-government organisations. However, there was no difference between institutional types in the relative number of projects scored as highly successful (Fig. 3; Table 1).

When compared to fish, reintroductions involving invertebrates were more likely to be scored as partially successful rather than highly successful. When compared to East Europe, North & Central Asia, reintroductions in Africa were more likely to be scored at a lower success level (Fig. 1; Table 1).

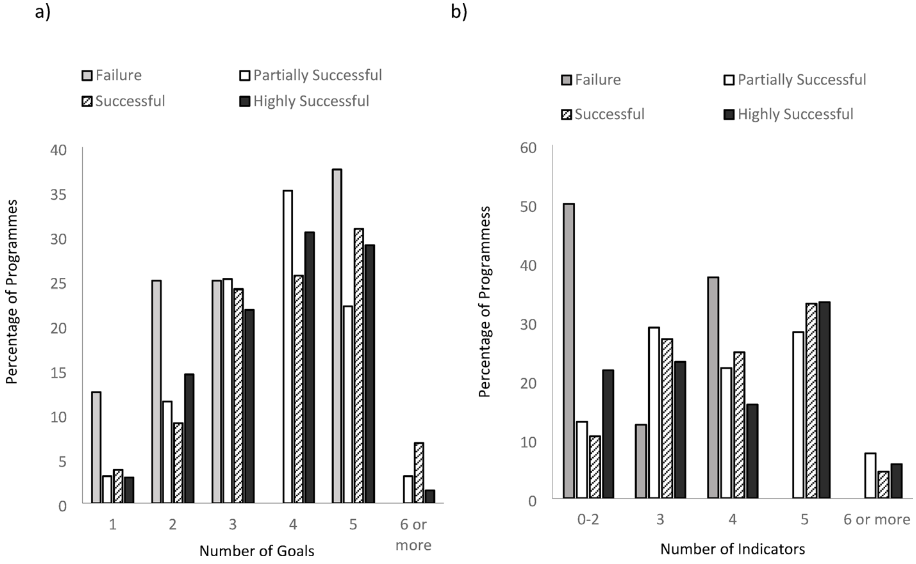

Fig. 4 **a** Success categories in relation to number of goals set, as assigned by the authors of the case studies and **b** Success categories in relation to number of indicators set, as assigned by the authors of the case studies

Qualitative analyses

The qualitative analysis showed that the same themes were related to both success and failure. A Pareto analysis (Juran 1989; Black 2024a) of success and failure shows that 80% of the reasons given for successful projects are covered by just a few of the themes, many of which cross over with reasons for failure (Table 2).

Reasons for success

The theme of Partnerships & Support, which included community, government support and partnerships, was the most frequently cited reason for a reintroduction being considered successful. Active Management (e.g., supplementary feeding, predator control and habitat enhancement) and Habitat & Release Site (e.g., site selection, quality of habitat and release site within native range) were the next most frequently cited themes, closely followed by Resource & Funding (e.g., staff, facilities, and adequate funds) and Planning & Feasibility Studies (e.g., pilot studies, protocols, and modelling).

Reasons for success in relation to taxon and IUCN region

Reasons relating to the themes Partnership & Support and Active Management were most frequently cited for mammal reintroductions and reintroductions in North America and the Caribbean. In contrast, Habitat & Release Site was most frequently cited for Mammal and Plant reintroductions and reintroductions in Oceania and West Europe. Highly Successful

Table 1 Multinomial logistic regression output table (Residual deviance: 659, AIC: 739) *<0.05

	B (SE)	95% CI for odds ratio		
		Lower	Odds Ratio	Upper
Successful against a base category of Partially Successful				
Taxa: Fish set as the reference category				
Intercept	0.86 (1.0)	0.301	2.4	18.45
Amphibians	−1.0 (0.72)	0.090	0.37	1.51
Birds	−0.94 (0.55)	0.132	0.39	1.15
Invertebrates	−0.92 (0.62)	0.119	0.40	1.33
Mammals	−0.045 (0.51)	0.351	0.96	2.60
Plants	−0.4 (0.54)	0.231	0.67	1.94
Reptiles	−0.025 (0.59)	0.304	0.97	3.12
IUCN Region: East Europe, North & Central Asia set as the reference category				
Africa	−0.74 (0.87)	0.087	0.48	2.63
Meso and South America	−0.34 (0.93)	0.114	0.710	4.43
North America and the Caribbean	−0.71 (0.84)	0.094	0.49	2.54
Oceania	−0.9 (0.84)	0.078	0.41	2.13
South and East Asia	−1.2 (0.85)	0.055	0.29	1.57
West Asia	−1.5 (0.95)	0.034	0.22	1.40
West Europe	−0.74 (0.83)	0.094	0.48	2.41
Indicators	−0.062 (0.13)	0.735	0.94	1.20
Goals	0.212 (0.12)	0.968	1.2	1.58
Zoo/Aquaria	**−0.78 (0.32)***	0.244	0.46	0.86
Academic	−0.27 (0.29)	0.428	0.76	1.354
NGO/Private	0.12 (0.29)	0.502	0.89	1.56
Government	0.39 (0.28)	0.844	1.5	2.56
Highly Successful against a base category of Partially Successful				
Taxa: Fish set as the reference category				
Intercept	1.41 (1.2)	0.412	4.1	40.76
Amphibians	−1.4 (0.94)	0.037	0.24	1.51
Birds	−0.67 (0.63)	0.149	0.51	1.75
Invertebrates	**−2.02 (0.91)***	0.022	0.13	0.79
Mammals	0.144 (0.58)	0.368	1.15	3.63
Plants	−0.5 (0.62)	0.179	0.61	2.07
Reptiles	−0.239 (0.70)	0.198	0.79	3.13
IUCN Region: East Europe, North & Central Asia set as the reference category				
Africa	**−2.03 (1.01)***	0.018	0.13	0.95
Meso and South America	−2.64 (1.36)	0.005	0.071	1.02
North America and the Caribbean	−0.48 (0.88)	0.110	0.62	3.49
Oceania	−1.1 (0.90)	0.056	0.33	1.93
South and East Asia	−1.6 (0.92)	0.034	0.21	1.26
West Asia	−2.0 (1.05)	0.018	0.14	1.10
West Europe	−1.16 (0.89)	0.055	0.31	1.79
Indicators	−0.145 (0.15)	0.639	0.86	1.17
Goals	0.079 (0.15)	0.803	1.1	1.46
Zoo/Aquaria	−0.63 (0.39)	0.245	0.53	1.15
Academic	0.12 (0.36)	0.442	0.89	1.78
NGO/Private	−0.16 (0.35)	0.427	0.85	1.69
Government	0.20 (0.34)	0.620	1.2	2.39

Table 2 Reasons given as contributing to success and/or failure in the reintroduction programmes

Theme contributing to Success or Failure	No. of programmes reporting theme as a reason for Success	No. of programmes reporting theme as a reason for Failure
Partnerships & Support	157	8
Active Management	83	17
Habitat & Release site	80	48
Resource & Funding	73	37
Planning & Feasibility Studies	70	19
Data & Knowledge	55	20
Stakeholders & Community	51	16
Release & Methods	46	5
Captive Breeding & Rehabilitation Methods	43	9
Monitoring	41	8
Species Specific Issues (behaviour)	40	15
Founders & Genetics	35	9
Adaptive Management	24	1
Staff (relations, attitude & leadership)	21	1
Long term Commitment or Long running project	20	18
Threats	8	2
Predation & Competition	5	17
Weather Events & Conditions	4	15
Legislation & Politics	2	12
Human-wildlife conflict (controversial species)	1	14
Animal Health	0	10
Mortality	0	9

reintroductions involving Fish, which had the most success overall, frequently cited Partnership & Support as a reason for success and included the following examples:

> **European mudminnow *(Umbra krameri)* reintroduction in East Europe.** "*Extensive collaboration among different NGOs (e.g. Tavirózsa and Nimfea Associations - Hungary, Umbra Association - Slovakia), Directorates of National Parks, Universities, authorities and Government Institutes, Local government of Szada village, "VITUKI" Institute (ceased operation from 2012) and media (national and local TVs, radios, gazettes etc.)*" (Bajomi et al. 2013).

> **Cutthroat Trout (*Oncorhynchus clarkia*), USA.** "*An effective collaborative partnership between private conservation organizations and public resource management agencies created a shared vision, spread financial obligations, and pooled resources*" (Kruse et al. 2013).

Reasons for failure

Habitat & Release Site were the most cited reasons for failed or partially successful reintroductions. This included reasons such as lack of roosting features for birds, poor connectivity for frogs, and lack of suitable release sites for gibbons. Resource & Funding was the next most common, and included lack of or exhaustion of funds, costs being higher than anticipated, no premises on site or additional facilities being required. The third most frequent theme cited in relation to failure, or failed elements was insufficient Data & Knowledge (e.g., lack of expertise, more research needed).

Reasons for failure in relation to taxon and IUCN region

Habitat & Release Site was most cited for bird reintroductions and reintroductions in West Europe in relation to failure. Resource & Funding was most frequently cited for plant reintroductions and reintroductions in South and East Asia. Data & Knowledge was most frequently cited for mammals and South and East Asia. Failed reintroductions for birds, which had the most failures overall, included the following statement in relation to Habitat & Release Site:

> **White-headed duck (*Oxyura leucocephala*), Hungary.** *"The release sites were not suitable. Lake Péteri was not a past breeding site for white-headed duck and, moreover, it is a fishing area with human disturbance. Lake Kondor had been largely dry for several years before the reintroduction, and there may not have been enough food for a species preferring eutrophic, productive habitats"* (Bajomi 2008).

> **Northern aplomado falcon *(Falco femoralis septentrionalis)*, USA. "***Habitat, as defined by prey populations and the abundance/distribution of predators, was of insufficient quality"* (Sweikert and Phillips 2016).

Success rating

Most programmes considered success to be achieved when natural recruitment or breeding had occurred (95 programmes), or when reintroduced species had survived in the wild (57) see Table S1 of the Supplementary Information for a full list of reasons given for considering a reintroduction a success.

Failure rating

Most programmes gave no or low survival (15) or goals not yet met (8), as the reason they did not consider a project to be highly successful (see Table S2 of the Supplementary Information for a full list of reasons given for considering a reintroduction to be of lower success). Sixty-three programmes, despite giving a score, acknowledged that it was too early to assign success or failure to a project.

Discussion

Species reintroductions can be a valuable tool for conserving and restoring populations of endangered or extinct species. While perceived success rates for species reintroductions vary, several factors such as habitat quality, partnership and support, and the availability of resources, can influence the outcome. The results also suggest the relative success of reintroductions can be influenced by taxon, geographical region, project goals, and the types of organisations involved.

Relevance of taxa

Fish were the most successful taxon overall, and birds had the highest number of failures. Success scores varied significantly between taxa, and there appear to be differences in the factors relating to the success of reintroductions for different taxa.

A previous study of 260 fish reintroductions found that the species intrinsic characteristics were not a crucial factor in their success (Cochran-Biederman et al. 2015). Similarly, in our data, reintroductions that involved fish were generally more reliant on factors that fell into the themes of Partnership & Support, Stakeholders & Community, and Active Management, and did not depend so heavily on factors relating to Habitat & Release Site or species-specific issues. Generalist species with broader niches are likely to be less complex and more responsive to general best practice recommendations (IUCN/SSC 2013). In contrast, reintroduction efforts involving taxa that tend to have complex social structures, such as mammals and birds, often need to consider additional measures, such as pre-release training, enrichment, and supplementary feeding (White et al. 2012; Reading et al. 2013; Berger-Tal et al. 2020).

Twenty-one of the case studies that involved mammals or birds stated that the resilience or adaptability of the species was a reason for success. Part of the reasoning for this may be that with endangered mammals and birds, litter and clutch sizes are generally small, and it is not feasible to release large numbers. In the absence of a high initial release population, success rates can be lower (Fischer and Lindenmayer 2000; Germano and Bishop 2009) and mortality a major issue. In the case of reintroductions, species with a high degree of resilience and adaptability are more likely to be successful in establishing a viable population in their new environment (Sarrazin and Barbault 1996; IUCN/SSC 2013), whilst other behavioural traits can put an individual at greater risk. One example involving the reintroduction of the swift fox (*Vulpes velox*) found that released individuals that showed greater boldness (lack of fear) in captivity were less likely to survive and thus less suited for release (Bremner-Harrison et al. 2004). Consideration of such traits is crucial to ensure species can overcome the challenges of their new habitat, such as finding food and mates, and avoiding predators (Kaye 2009; Houde et al. 2015).

Whilst reintroductions involving mammals and birds may appear to have more complexities relating to conditioning and social structure, there remains a positive bias towards them that has been observed within conservation reintroductions over many decades (Seddon et al. 2005; Bubac et al. 2019). 30% of the case studies we reviewed involved mammals, and 18% involved birds, whilst these percentages are not high compared to previous reviews which reported > 40% for mammals and > 30% for birds (Fischer and Lindenmayer 2000;

Seddon et al. 2005; Resende et al. 2020) the bias continues to be an issue within conservation management and prioritisation.

Relevance of IUCN region

From the case studies analysed, almost 60% came from the principally developed regions of North America and the Caribbean, West Europe, and Oceania. This is a trend that has continued for many years (Seddon et al. 2014; Bubac et al. 2019; Resende et al. 2020), with higher numbers in developed regions likely driven by stronger conservation legislation, better access to funding, and the fact that programmes from developed regions typically also include species threatened at a national, rather than global level (Seddon et al. 2005; Brichieri-Colombi and Moehrenschlager 2016; Bubac et al. 2019; Evans et al. 2022). Although developed regions had the highest numbers of reintroductions, they did not show the highest numbers of failures, in fact they had some of the lowest. For North American reintroductions this may follow a trend noted in previous studies (Fischer and Lindenmayer 2000; Brichieri-Colombi and Moehrenschlager 2016) where very few reintroductions are considered failures or are reported as such. However, for Oceania this may be a change in trend: as Fischer and Lindenmayer (2000) reported that a high number of failures were published for reintroduction projects in Oceania. Suggestions for this bias towards reintroduction success, particularly in developed regions, has been linked to the tendency of developed regions to focus on IUCN low risk species which in turn tend to have a lower rate of failure (Bubac et al. 2019), and inconsistencies relating to definitions of success (Fischer and Lindenmayer 2000; Miller et al. 2014).

The model output showed Africa to be significantly less likely to be highly successful when compared to East Europe, North & Central Asia – which had the most success overall. Qualitative analysis showed that factors relating to Resource & Funding, and Species Mortality, were the main reasons for low success in Africa, whereas higher levels of success in the region were mostly attributed to factors relating to Partnership & Support. Current and future reintroductions in Africa could therefore be supported by focussing on known success factors such as partnerships and support, and by ensuring adequate resources and funding are in place.

Goals and indicators

Conservation management theory suggests that clear short-term goals are important to success (Black et al. 2011), but where multiple goals and associated indicators occur, they can often compete, causing goal-displacement which can undermine commitment and make monitoring unfeasible (Dalton and Spiller 2012; Ewen et al. 2014; Hunter et al. 2020; Black 2024b). The data from our study suggests a discrete number of goals (from 2 to 4 per project) appear to be most useful, and less useful once they exceed five goals. Establishing which goals to prioritise can be a challenge, but other studies have shown that decision analysis techniques and tools can support this process (Ewen et al. 2014; Hunter et al. 2020), and aligning goals and indicators to non-biological components, such as funding and partnerships, can be beneficial (Ewen et al. 2014; Black 2024c).

Type of organisation involved

The involvement of zoos and aquaria was associated with partial success, and the involvement of government and non-government organisations was associated with higher success. This may have historical origins, particularly where zoo involvements were focused on ex-situ elements with perhaps less consideration of in-situ conservation (Stanley Price and Fa 2007; Gilbert et al. 2017). However, since the first World Zoo Conservation Strategy in 1993, zoos have had increasing levels of commitment and involvement in the conservation of threatened species with integration of in-situ and ex-situ approaches and more rigorous reporting of outcomes (Mace et al. 2007; Stanley Price and Fa 2007; Gilbert and Soorae 2017; Gilbert et al. 2017). The lower scoring of success by zoos may be due to their involvement in riskier projects often involving captive bred animals, that may be more threatened, less charismatic, and require longer timeframes for success to be assigned (Gilbert et al. 2017). Riskier projects may therefore carry a higher risk of lower success using the science-based scoring systems that are increasingly used by zoos. In contrast, government and some non-government organisations may be more focussed on local or regional projects with wider public support and potentially greater possibilities of success. Clearly, partnerships between organisations and stakeholders can be a key factor in reintroduction success (Kleiman et al. 1994).

Reasons attributed to success

The qualitative analysis of the case studies (Table 2) forms a narrative from a diverse range of practitioner perspectives that describe the issues that arise when reintroduction projects are reviewed post-hoc by their managing teams. The two most frequently cited reasons for success are discussed in detail below.

Reasons related to the Partnership & Support theme were most frequently attributed to success. Most of these focussed on community support, with examples such as active engagement, the forming of specialist groups, and the involvement of private landowners – all topics that are frequently discussed in reintroduction literature (Lopes-Fernandes et al. 2018; Auster et al. 2020; Hawkins et al. 2020). This theme also captured the importance of partnerships and good working relationships with the private sector, government, NGOs, volunteers, and the media, something that is discussed less frequently within reintroduction literature (Westrum and Clark 2014) but has emerged as key to this theme. The establishment of relevant and productive partnerships with a clear decision-making structure is perhaps the strongest foundation for any reintroduction initiative (Kleiman et al. 1994; Black and Groombridge 2010; Black 2024c).

The next most frequently cited reasons for success were those linked to the Active Management and Habitat & Release Site themes – which are often considered the building blocks to reintroduction success (Cheyne 2006; Vaissi et al. 2019; Berger-Tal et al. 2020). The most quoted sub-categories given in our dataset in relation to habitat were good availability and quality of habitat, and increased site protection. In relation to active management, habitat enhancement and control of predators and alien species were the sub-categories most frequently linked to success. Ensuring these habitat elements are correct at the planning and feasibility stage and allowing resource for long term management can, in many cases, improve reintroduction success (Cheyne 2006; Moorhouse et al. 2008; Ewen et al. 2012; Albrecht and Long 2019).

Reasons attributed to failure

Reasons relating to inadequacies in the habitat and release site were most frequently associated with failure. This is unsurprising given that habitat management and suitability are a frequently reported issue for lack of success in many reintroductions (Cheyne 2006; Moorhouse et al. 2008). What was perhaps surprising was the number of reintroductions within the study that released species without considering habitat quality or securing long term funding to maintain suitable habitat. Such an oversight may be due to lack of ecological knowledge or access to expertise, a theme that also featured heavily in our dataset, or it could be down to poor planning, or pressure to reintroduce species before all causes of decline are known (Bubac et al. 2019). In recent years, trial releases have been valuable in identifying novel threats and assessing the likelihood of successful population establishment (Jones and Campbell-Palmer 2014; Kemp et al. 2020; Wilson et al. 2020). The use of trial releases, along with the application of well researched guidance could be one solution to such problems (Kemp et al. 2015).

Assigning a success score

Reasons given for assigning a particular success score were extracted from the data and split into common themes. For reintroductions scored as partially successful, species presence or survival in the wild was the most frequent reason given, and for projects scored as successful and highly successful, observed breeding was the main reason for the score. These results reflect those observed in previous studies where short term/high level outcomes tend to be the most likely driver of success measurement (Ewen et al. 2014; Brichieri-Colombi and Moehrenschlager 2016). Indeed, 18% of the case studies stated in their reasons for success or failure, that despite allocating a score, it was too early to say if the reintroduction was a success. This indicates that many programme managers endeavoured to fit the reintroduction assessment into a success category that may not yet be applicable. Within the 18% that stated it was too early to say if it was a success, 6% still proceeded to score the outcome as successful ($n=19$) or highly successful ($n=2$). Of the eight failures within the data, all gave either low or no survival, unstable population, or abandonment of the programme as one of the reasons for scoring it as a failure.

Perceptions of success

The methodology used to review the reintroductions could be used as a model to review wider conservation actions. The self-selecting success score is an inherent limitation associated with the IUCN reintroduction case studies. Indeed, perceived success may depend on the scorer, with experience, professional affiliation, involvement in conservation practice and country of residence all being potentially influential (Meredith et al. 2018). One approach to mitigate this could be to develop a standardised process of assigning a score based on the percentage of objectives or indicators met.

Conclusions

The measurement of reintroduction success varies according to goals, criteria, and personal judgement (Seddon 1999; Ewen et al. 2014; Cochran-Biederman et al. 2015; Brichieri-Colombi and Moehrenschlager 2016). It is therefore important that these drivers are recognised alongside the general reluctance within the conservation community to document failures (Seddon et al. 2007; Catalano et al. 2019, 2021; Resende et al. 2020) which could be a potential explanation for the low number of failures in the studies. There is no single factor that drives reintroduction success; predictors of success are complex and difficult to assess with any certainty. However, both the quantitative and qualitative analyses in our study suggest that taxa that are more typically hard-wired, and/or have broader niches, have more success, and that active species management is highly influential. Comparisons by Griffith et al. (1989) and Wolf et al. (1996, 1998) found that some traits such as varied diet may influence success, but traits such as reproductive potential, which were initially thought to be significant, were not found to increase success (Wolf et al. 1998). These analyses support many of the conclusions made in previous studies, particularly those relating to habitat quality and management, which seem to be an undisputable factor in success (Griffith et al. 1989; Cochran-Biederman et al. 2015; Brichieri-Colombi and Moehrenschlager 2016; Bellis et al. 2019).

With the continuing need for conservation management and increasing pressure on threatened species from development, coupled with emerging rewilding agendas, species reintroductions are likely to continue to increase (Reading et al. 2013; Resende et al. 2020). It is therefore vital that reintroduction initiatives are well-planned, resourced, executed, and recorded, and sharing 'failures' becomes an acceptable part of the process.

This study showed Active Management, Habitat & Release Site, Resource & Funding, Planning & Feasibility Studies, Data & Knowledge, and Stakeholders & Community are linked to both success and failure. These actions will not guarantee success but will drive innovative opportunities that will enable conservation practitioners to proactively manage and improve the effectiveness of reintroduction initiatives. Species reintroductions are increasingly viewed as proactive conservation tools rather than measures of last resort. In the current biodiversity crisis, it is essential to balance science-led approaches with the urgency of action.

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Declarations

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