1 · *Moving Species: Reintroductions and Other Conservation Translocations*

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1.1 Background

The increasing threats to our wildlife species have been reported for decades. However, the last few years have seen a dramatic increase in public awareness and concern, with a call for political representatives and decision makers to make 'transformative' changes to improve the prospects for nature. How we respond over the next decade will prove crucial if we wish to maintain and restore our biological diversity and ecosystem services.

In May 2019 the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) published its landmark report. It made a sobering read: around one million species are threatened with extinction, the abundance of native species in most land-based habitats has fallen by 20 per cent, mostly since 1900, and at least 680 vertebrate species have become extinct since the sixteenth century (IPBES, 2019). The five main, modern drivers of these impacts were listed as changes in land and sea use, the direct exploitation of organisms, climate change, pollution, and invasive non-native species – all of which carry the fingerprints of human activity. It is not surprising that many scientists now recognise a new geological time interval, the 'Anthropocene', defined by the conditions and processes on Earth profoundly altered by human impact (Crutzen & Stoermer, 2000) and characterised by the developing sixth mass extinction. Furthermore, a headline message of the 'Dasgupta Review' of the economics of biodiversity is that 'our economies, livelihoods and well-being all depend on our most precious asset: Nature' (Dasgupta, 2021). We ignore this at our peril.

We have been increasingly adept at recognising and measuring changes in nature. But the more difficult work involves identifying solutions and applying them. In fact, good tools already exist, and the IPBES report not only describes the scale of the challenge but also proposes ways forward. It lists methods that have '…been successful in preventing the extinction of some species', including the practice of 'translocation'. The report concludes that 'transformative change' is required to ensure a more sustainable future, and that the biodiversity challenge can be addressed effectively if that change starts now.

The specific tool of 'conservation translocation' has become increasingly used in the battle to save species and restore ecosystems. There are multiple formal definitions, but in short they describe people deliberately moving and releasing organisms where the primary goal is a conservation benefit. 'Reintroductions' are the best known type, and specifically refer to the translocations of organisms to places where they have become extinct, or where they could have been reasonably expected to occur, in order to try to re-establish viable populations. The science and practice surrounding conservation translocation have grown massively in recent decades, the result being that there are now many types and sub-types, with an increasingly confusing array of different terms. The International Union for Conservation of Nature (IUCN) (2013) has therefore come up with helpful, standard definitions (see Figure 1.1 and Box 1.1) that are widely accepted and employed, and indeed are used throughout this book.

Even so, conservation translocation is a tool that needs careful consideration before being used. Such projects are often complex, expensive, and time consuming, with a strong element of risk (not only in biological but also socio-economic terms) and some past failures (e.g. Griffith et al., 1989).

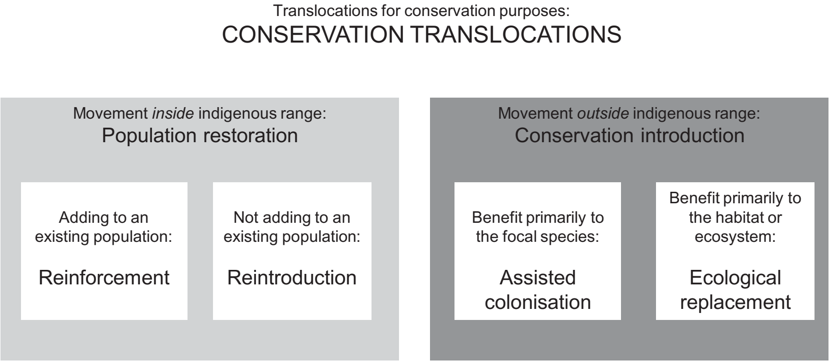

Figure 1.1 Overview of the types of conservation translocations (based on IUCN, 2013, and also applied in National Species Reintroduction Forum, 2014).

Box 1.1 *Definition of terms*

These definitions are based on the 2013 IUCN Guidelines, and are also widely applied in country-based approaches around the world. Also see Figure 1.1.

Conservation translocation – the intentional movement and release of a living organism where the primary objective is a conservation benefit. This usually involves improving the conservation status of the focal species and/or restoring natural habitat or ecosystem functions or processes.

Conservation translocations can entail releases either within or outside the species' indigenous range (the known or inferred distribution generated from historical records or physical evidence of the species' occurrence), and can be subdivided into the following categories:

1. **Population restoration** – a conservation translocation within the indigenous range, including:
   (a) **Reinforcement** – translocation of an organism into an existing population of the same species.

   Reinforcement aims to enhance population viability, for instance by increasing population size, by increasing genetic diversity, or by increasing the representation of specific demographic groups or stages. [Also known as: Augmentation; Supplementation; Re-stocking; Enhancement.]

   (b) **Reintroduction** – translocation of an organism inside its indigenous range from where it has disappeared, to re-establish a viable population of the focal species.
2. **Conservation introduction** – a conservation translocation outside the indigenous range, including:
   (a) **Assisted colonisation** – translocation of an organism outside its indigenous range where the primary purpose is to benefit the focal species.

   This is typically aimed at establishing populations in locations where the current or future conditions are likely to be more suitable than those within the indigenous range. The scale of assisted colonisation can range from local movement to wide-scale international range shifts. [Also known as: Benign introduction; Assisted migration; Managed relocation.]

   (b) **Ecological replacement** – translocation of an organism outside its indigenous range where the primary purpose is to perform a specific ecological function that has been lost through extirpation or extinction.

Ecological replacement usually involves replacing the extinct taxon with a related subspecies or species that will perform the same or similar ecological function. [Also known as: Taxon substitution; Ecological substitutes/proxies/surrogates; Subspecific substitution, analogue species.]

In all cases, conservation translocations have the primary goal of achieving a conservation benefit, which is defined as an improvement in the status of the focal species, habitat, or ecosystem.

Some of the more controversial and sometimes poorly executed examples, especially where local people were not involved in the decision-making, have resulted in conflict (Glikman et al., this volume), the result being that some people regard all 'reintroductions' as something that should be resisted, which makes organising new projects more difficult. The effect of translocation on the welfare of the individual animals involved has also been questioned (Harrington et al., this volume). And there are alternatives that should always be considered first (IUCN, 2013): area-based solutions such as wider habitat management; species-based solutions such as targeted control of invasive non-native animals and plants; social/indirect solutions such as setting up protected areas or changing legislation; or no action. Therefore, translocation has sometimes been described as a tool of last resort. But it is also an approach that works and has saved species and populations, and restored ecosystems (Novak et al., 2021). The release and return of a long-lost animal or plant can also be an exciting, inspiring, and engaging event for people, and demonstrates that there are still things we can do that make a positive difference. It is no longer just a tool of last resort – the urgency of the biodiversity crisis is such that we need to look at how we can be more creative and proactive with conservation translocation, for example through using certain influential species or combinations of species to help restore and upgrade ecosystem processes, whilst at the same time applying best practice.

Much of this edited volume was written during the 'anthropause' resulting from the COVID-19 pandemic (Rutz et al., 2020), during which people's minds turned even more to the crises in nature we are all grappling with, and the solutions we urgently need. The book brings together authors from across the world who use the IUCN (2013) guidelines as a way of making sure best practice is used in conservation translocations, thereby increasing the chances of success and decreasing the chances of failure. It looks at the key challenges that face practitioners, decision-makers, and other stakeholders who deal with conservation translocation, and provides the latest science-based theory and practice. Specific, fast-developing, and more radical topics are also covered, and attempts are made to look into the crystal ball and predict what will become most important, especially as we try to learn how to deal with a rapidly changing environment. Finally, a series of case studies is presented in the book that provide a taste of the range of species, ecosystems, places, and issues in which conservation translocation is used. This first chapter attempts to summarise some of this and provide a foundation for the details that follow.

1.2 A Very Short History of Translocations

Conservation is not the only reason people have translocated, or moved, species over the centuries. Seddon et al. (2012) recognised at least seven other motivations:

- Non-lethal management of problem animals.
- Commercial and recreational.
- Biological control.
- Aesthetic.
- Religious.
- Animal rights activism and animal liberation.
- ⋆Wildlife rehabilitation.

⋆(Although increasingly such 'welfare translocations' may sometimes be viewed as also having a conservation motivation where there have been short-term, enforced absences of animals from the wild (e.g. for gorillas and orang-utan). See the discussion of temporarily displaced species in Moehrenschlager et al. (this volume).)

Conservation translocation is also not new, although its early practitioners would not have described their actions using this terminology. For example, in Scotland the capercaillie *Tetrao urogallus* became extinct in the eighteenth century and was reintroduced in the 1830s (Stevenson, 2007), and the red squirrel *Sciurus vulgaris* became extinct in parts of the country around the same time, with animals from England and Scandinavia used to reintroduce or reinforce the Scottish population (Tonkin et al., 2016). Kakapo *Strigops habroptilus* in New Zealand and snowy egrets *Egretta thula* in the USA were both subjects of pioneering conservation translocations in the 1890s (Armstrong et al., 2018). The Eurasian beaver *Castor fiber* population was restricted to around 1200 animals scattered across a few isolated populations in Europe and Asia by 1900, but translocation began in 1922 using Norwegian animals to Sweden (Halley & Rosell, 2002), followed by dozens more initiatives across many European countries over the following decades. The motivations for some of the earlier translocations are sometimes unclear, and may not have been purely 'conservation' – for example the capercaillie is a game bird and the beaver has been an important resource for the fur trade.

Reintroduction as a modern conservation tool became progressively more used during the second half of the twentieth century, with high-profile examples including the Arabian oryx *Oryx leucoryx* to Oman (Stanley-Price, 1989) (Figure 1.2) and California condor *Gymnogyps californianus* to the western USA and Mexico (Walters et al., 2010). However, the inherent riskiness of reintroduction meant that, up to thirty years ago, failure rates were relatively high (Griffith et al., 1989). This overall growth in the use of the tool led to the establishment of a dedicated 'Reintroduction Specialist Group' (RSG) by the IUCN

Figure 1.2 Rangers in the Sultanate of Oman protect and monitor the first herd of Arabian oryx released in 1982 (photo: Mark Stanley-Price). (A black and white version of this figure will appear in some formats. For the colour version, please refer to the plate section.)

Species Survival Commission in 1988 to help the development of best practice. Ten years later the RSG published its first 'Guidelines for Reintroductions' (IUCN, 1998), a simple, pragmatic approach that thousands of practitioners around the world have subsequently used to support their decision-making.

1.3 From Reintroductions to All Conservation Translocations: Species Conservation, Ecological Restoration, and Rewilding

The RSG later produced a revised version of their key publication, with the new title 'Guidelines for Reintroductions and Other Conservation Translocations' (IUCN, 2013). In late 2018 the RSG then announced a change in its name to the 'Conservation Translocation Specialist Group' (CTSG). So why has there been this subtle change in scope from just species reintroductions to all forms of conservation translocation? In part it reflects the increasingly complex range of conservation challenges and issues that are being identified, and the fast developing science and practice. Therefore reinforcement, assisted colonisation, and ecological replacement, as well as reintroduction, provide a broad suite of actions that can help address the significant and increasing threats of climate change, disease transmission, habitat loss, and others. At the same time the guidelines continue to provide a simple framework to advise how such work should be done.

The numbers of such projects have also increased dramatically over the last three decades. Seddon et al. (2007) looked at the numbers of papers referring to reintroduction and found very small totals before the early 1990s (no single year reached double figures) but then a rapid increase, with a total of 454 papers for the 15 years up to 2005. The IUCN RSG/CTSG have been publishing case studies in their 'Global Conservation Translocation Perspectives' series since 2008, and by the time of their 2021 volume they had amassed details of 418 projects (Soorae, 2021). This trend is continuing, and it seems likely there have been thousands of projects taking place in recent decades, based on what continues to be published in journals and the grey literature, and the significant proportion that are not formally reported.

In addition, the types of projects are changing and diversifying. The primary goal of any translocation of this type must be a conservation benefit. This has often involved improving the conservation status of a focal species, for example reintroducing a threatened species to part of its indigenous range to help restore the population. There are plenty of examples of this approach, and often habitat restoration (and/or other actions, such as managing invasive non-native species) is required at prospective destination sites to treat the cause of a species' decline before the translocation can take place.

However, there is increasing use of conservation translocation to contribute directly to the restoration of the natural habitat or ecosystem functions and processes, rather than just focussing on the conservation benefits to the translocated focal species. There are a number of imaginative and ambitious examples involving 'keystone species' (those which have a disproportionately large effect on their environment relative to their abundance (Paine, 1995)), including 'ecosystem engineers' (organisms that directly or indirectly control the availability of resources to other organisms by causing physical state changes in biotic or abiotic materials (Jones et al., 1997)). These terms sometimes generate controversy in the scientific community, but they are useful to communicate and highlight the important ecosystem-level role certain individual species can play. Examples include the reintroduction of predators such as wolves *Canis lupus* to Yellowstone National Park in the USA, burrowing and digging species such as black-tailed prairie dog *Cynomys ludovicianus* to North American prairies and eastern bettong *Bettongia gaimardi* to south eastern Australia (Munro et al., 2019), reef-forming species such as corals (Swan et al., 2015), and the wetland-creating Eurasian beaver across many European countries (Figure 1.3).

'Ecological restoration' is a topic that has received considerable and increasing attention in recent years (the science behind it is called 'restoration ecology'). It is defined as '. . .the process of assisting the recovery of an ecosystem that has been degraded or destroyed' (Society for Ecological Restoration, 2004). However, advocates increasingly recognise that restoration has to be integral to land management in the modern world, and that goals for the future ecosystem should be achievable, rather than based on some arbitrarily selected point in the past (Hobbs & Harris, 2001). The term 'restoration' can therefore be problematic: it can be perceived as too backward looking if the focus is too much on composition, but less so if the focus is the return of ecological processes. The science and practice surrounding species reintroductions have also been developing over the last few decades, and the opportunities for synergy and collaboration between these two fields have started to be more fully recognised and realised. The translocations of key species to degraded systems are now regularly promoted as elements of

Figure 1.3 Beavers are ecosystem engineers and have been used in conservation translocation projects as a means of restoring ecological processes. At this Scottish site a metre-wide stream was dammed by beavers, resulting in an extensive beaver pond and associated wetland habitat (photo: Martin Gaywood). (A black and white version of this figure will appear in some formats. For the colour version, please refer to the plate section.)

wider ecological restoration. For example there are now numerous studies that have shown the importance of apex consumers and their role in 'trophic cascading', and the trophic 'downgrading' that can result when such species are removed by humans (Estes et al., 2011). The process of returning such species, and restoring and upgrading our ecosystems, is conservation translocation.

More recently still the term 'rewilding' has gained prominence and caught the public imagination to such an extent that it is now used to describe all manner of projects at all types of scales. Rewilding projects can also generate controversy and division, as some view them as an attempt to return to previous, natural ecosystems where people's livelihoods are given lower priority. This is a particularly sensitive issue in rural communities with long and complex socio-political histories of land use and ownership. In part, this reflects the range of definitions that different advocates use, although many recognise the complexities of the human dimension and the need to work and engage with those who are best placed to 'steward' the land concerned, including Indigenous Peoples (Moehrenschlager et al., this volume). Some definitions of rewilding include a particular focus on species reintroduction, such as that of Naundrup and Svenning (2015): 'Reintroduction of extirpated species or functional types of high ecological importance to restore self-managing functional, biodiverse systems'. Others have a wider scope, such as that of Carver et al. (2021), who attempted to identify guiding principles for rewilding, noting that '. . .rewilding sits upon a continuum of scale, connectivity, and level of human influence, and aims to restore ecosystem structure and functions to achieve a self-sustaining autonomous nature'. Both of these descriptions of rewilding focus more on restoring or reorganising ecological functions and processes than on trying to return and recreate places to the wild state of some particular historical moment of time.

Clearly there is overlap between the concepts of rewilding and ecological restoration, although the targets of the latter are generally more pre-defined than those of the former. Either way, these are concepts where the restoration process might involve not only 'passive' colonisation and recolonisation of sites by species but active intervention through conservation translocation. Seddon (this volume) provides a comprehensive assessment of how ecological restoration, rewilding, and conservation translocation compare and contrast, and where the commonalities lie.

Such approaches have to recognise that the starting points for such conservation activities are ecosystems that have been transformed by human activity. Indeed the term 'novel ecosystems' has been used to describe this phenomenon, although the term has courted controversy as some suggest it may predispose people to abandon attempts at restoration since it could be perceived as too difficult and costly (Aronson et al., 2014; Hobbs et al., 2014). However, the fact remains that many ecosystems have been or are being modified substantially; a full return to a system as it appeared before human impact will often not be possible, especially in light of continuing climatic change, but restoration can still achieve significant improvements to biodiversity and wider ecosystem functions. A challenge lies in where and how such restoration efforts should be prioritised, noting that the IPBES report concluded that participatory spatial planning on a landscape approach is vital where multiple land uses coexist, to enable the allocation and management of land to achieve social, economic, and environmental objectives in landscape mosaics (IPBES, 2019).

1.4 Drivers of Conservation Translocation

The IPBES recognises five main, modern drivers that have resulted in the current biodiversity crisis. In order of significance these are: changes in land and sea use, direct exploitation of organisms, climate change, pollution, and invasive non-native species. There are examples of conservation translocations that have tried to respond to all these drivers in different ways. In the following sections we also consider the inter-related issue of pathogens and disease transmission.

1.4.1 Changes in Land and Sea Use

Probably the majority of conservation translocations are done in response to the loss and decrease in quality of land and marine habitats, the challenge often being to find destination sites where the habitat is still suitable or can be adequately restored. Examples include the reintroduction or reinforcement of plant species such as woolly willow *Salix lapponum* (Figure 1.4) and alpine blue sow-thistle *Cicerbita alpina*

Figure 1.4 Woolly willow is a montane species that is vulnerable to grazing pressures. In Scotland it is now restricted and at risk, but an ongoing reinforcement programme has taken place over several years to try to restore this and other subarctic willow scrub species (photo: Lorne Gill/NatureScot). (A black and white version of this figure will appear in some formats. For the colour version, please refer to the plate section.)

(Marriott et al., 2015; Royal Botanic Garden Edinburgh, 2021) to specific sites in the Cairngorms, Scotland, where grazing pressure is less intense.

1.4.2 Direct Exploitation

Species that have been over-exploited include the freshwater pearl mussel *Margaritifera margaritifera* (Figure 1.5), and Scotland remains a country where illegal pearl fishing is still a threat. Freshwater pearl mussels have therefore been reintroduced to secret locations in the Scottish Highlands, and varying levels of success have been recorded through monitoring (Watt et al., 2018).

1.4.3 Climate Change

Climate change will continue to be a cause of species loss, but also a driver of more novel and creative approaches to how conservation translocation might be used to mitigate at least some of the impacts (Hopkins et al., 2007;

Figure 1.5 The freshwater pearl mussel has been subject to a range of pressures including pollution, river engineering, and pearl fishing, to the extent that it is now critically endangered. A range of conservation interventions is being applied and tested in Scotland, including the use of conservation translocations (photo: Sue Scott/NatureScot). (A black and white version of this figure will appear in some formats. For the colour version, please refer to the plate section.)

Scottish Natural Heritage, 2019).There is now increasing interest and debate in this field. Some species are particularly vulnerable where climate change reduces suitable habitat in their current locations, but their ability to respond is hampered by poor dispersal abilities. Climate change also does not act in isolation; it interacts with other potentially problematic factors such as habitat fragmentation and loss, and the presence of any natural or human-made barriers in the landscape. Brooker et al. (2011) highlighted the complexity in identifying the potential vulnerability of individual species to such impacts, especially those whose autecology was less understood, such as many cryptogams, other plants, and invertebrates. Even so, efforts have been made to identify species in Britain that may be particularly vulnerable (Brooker et al., 2011; Pearce-Higgins et al., 2015), the latter study identifying 640 of 3048 plant and animal species as at high risk from climate change under a 2°C warming scenario, and 188 at medium risk. Such measures of risk are helpful in informing decisions on where action may be prioritised, although there will be a level of uncertainty over the adaptability of such species to changing conditions.

In light of the increasing urgency of threats from climate change, how can we better use the potential of conservation translocation? The use of reintroduction and reinforcement will continue to have a role in some situations, focussing on the restoration of populations within the indigenous range of the species concerned. But if climate change, and other interacting factors, make potential destination sites in the indigenous range unsuitable in the short to medium term, the alternative option is to translocate a species outside its indigenous range, in other words to do an 'assisted colonisation', a type of 'conservation introduction'. However, the accidental or reckless introduction of non-native species has been the cause of substantial biological and socio-economic problems around the world, to the extent that the IPBES highlights this as a main cause of biodiversity loss as referred to in Section 1.4. Therefore the use of introduction for conservation purposes is an extreme measure that comes with added risk, although the climate emergency is now such that we need to increasingly consider such approaches, informed by guidelines that help us assess such risks (IUCN, 2013, 2017; Moehrenschlager, this volume). This is explored further in Section 1.5.1.

1.4.4 Pollution

The story of the peregrine falcon *Falco peregrinus* is a well-known example of where the impact of pollution prompted conservation translocation.

Approximately 1173 peregrines were released in the Midwestern USA and adjacent regions of Ontario and Manitoba (Tordoff & Redig, 2002) in a successful attempt to replace the population that had been extirpated by chlorinated hydrocarbon poisoning resulting from pesticide use in the 1950s.

1.4.5 Invasive Non-native Species

The threat posed by invasive non-native species (invasives) has probably been best documented in Australia and New Zealand. Many species recovery projects there have the difficult challenge of tackling the presence of invasives first, often followed by conservation translocation. One approach has been the use of offshore islands as destination sites where invasives are not present or can be more easily managed, or the use of large, fenced exclosures to form 'mainland islands' from which invasives are removed. Although this latter approach has received criticism because of the costs involved and the questions over long-term viability (Scofield et al., 2011), mainland islands have been increasing in numbers and scale. Examples include the Maungatautari Restoration Project, a 3,363 ha forested ecological island in the North Island of New Zealand, enclosed by a 47 km fence and from which most introduced animals, such as feral domestic cats *Felis catus*, brush-tailed possums *Trichosurus vulpecula*, and black rats *Rattus rattus* have been removed. Since it was established in 2001 at least seven indigenous bird species, such as North Island brown kiwi *Apteryx mantelli* and takahe *Porphyrio hochstetteri*, have been reintroduced to the enclosed area (Smuts-Kennedy & Parker, 2013). Australia also has a number of such exclosures that apply the same principles, including the Newhaven wildlife sanctuary that covers 262,000 ha in central Australia and involves a major programme of removing species such as feral domestic cat, fox *Vulpes vulpes*, and dromedary camel *Camelus dromedarius*, that will ultimately be followed by planned reintroductions of mala *Lagorchestes hirsutus*, central rock rat *Zyzomys pedunculatus*, and golden bandicoot *Isoodon auratus* (Australian Wildlife Conservancy, 2022).

1.4.6 Pathogens

The IPBES has also highlighted the heightened risks to people from zoonoses (infectious diseases that can be transmitted from non-human animals to humans) as human activities intensify and increased contact with wildlife results. This is not something that conservation translocations can address directly. However, at the basic level care should always be taken to ensure that any public health risks, and risks to domesticated animal health, are properly assessed and mitigated when conservation translocations are carried out. Furthermore, the risk of disease transmission between wild animal species, and between wild plant species, should always be considered.

The challenges associated with disease transmission in wild species have become more significant, partly as a result of the increased presence of invasives that can act as hosts (e.g. crayfish plague carried by North American signal crayfish *Pacifastacus leniusculus* which has devastated native crayfish *Astacus* spp. populations in Europe) and partly through the complicating effects of climate change. In some cases the impact of disease on native species populations has been so dramatic that conservation translocation has been used to move animals to isolated destination sites that can act as refuges. This has sometimes involved assisted colonisation, one of the best known examples being the 2012 translocation of Tasmanian devils *Sarcophilus harrisii* to Maria Island, which is not within the indigenous range of the species. By mid-2014 over 100 individuals were present, and the population is now used as a source of trial releases back to mainland Tasmania, and to genetically augment the wild diseased populations (Hogg & Wise, this volume). The decision to translocate had to take into account the risks of devil predation to the resident bird colonies on the island, some of which have subsequently been impacted.

The act of conservation translocation of an organism also involves moving a 'biological package' of organisms hosted by the focal species. Consequently the practitioner also needs to be very aware of the disease transmission risks associated with a translocation and how they can be mitigated. Sainsbury and Carraro (this volume) cover this in detail for animal diseases, and Mitchell et al. (this volume) for plant diseases.

1.5 More Radical Approaches to Conservation Translocations

1.5.1 Assisted Colonisation

Assisted colonisation is an emerging tool (Hällfors & Dalrymple, this volume). The risks and uncertainties involved in using it, and the necessary mitigation required, will vary depending on factors such as the biology of the species concerned, the 'reversibility' of any release, and the species' potential impact in biological and socio-economic terms.

Figure 1.6 Assisted colonisation of the fruticose terricolous arctic-alpine lichen *Flavocetraria nivalis* has been tested and monitored within the Cairngorm Mountains, Scotland. Each individual transplant was tagged as shown, to assist future identification (photo: Lorne Gill/NatureScot). (A black and white version of this figure will appear in some formats. For the colour version, please refer to the plate section.)

At one extreme the relatively localised, assisted colonisation of the arctic-alpine crinkled snow lichen *Flavocetraria nivalis* has been tested between mountains in the Cairngorms, Scotland (Brooker et al., 2018) (Figure 1.6). This demonstrated the difficulty in building predictive models of habitat suitability for immobile species that respond strongly to very local conditions, and the need to also involve expert judgement and the use of many individual transplants to increase the likelihood of success. Perhaps unsurprisingly, this project generated little controversy and was generally regarded as an acceptable experimental trial to test whether arctic-alpine crypytogams potentially vulnerable to climate change would benefit from this type of intervention.

However, the acceptability of using assisted colonisation for some other species, especially vertebrates, and over far greater translocation distances, will no doubt prove to be a more contentious topic. Some have highlighted concerns that we have not yet developed sufficient understanding of the impacts of introduced species to be able to make informed decisions about translocating them (Ricciardi & Simberloff, 2009). However, Thomas (2011) argued that consideration could be given to translocating species at risk from climate change from further afield, such as the Provence chalkhill blue butterfly *Polyommatus hispanus* and the de Prunner's ringlet butterfly *Erebia triaria* from southern Europe to southern England. More bold, and inevitably more controversial, suggestions made in the same paper include vertebrates such as the Pyrenean desman *Galemys pyrenaicus*, Spanish imperial eagle *Aquila heliacea adalberti*, and Iberian lynx *Lynx pardinus*, with the argument that Britain could be an ideal assisted regional colonisation area (ARC) and contribute to the conservation of globally threatened species. It will be interesting to see how the acceptability or unacceptability of such dramatic, proposed interventions develops over the years to come. Such proposals will need to assess the importance of different 'values', and apply appropriate structured decision-making tools (Ewen et al., this volume).

1.5.2 Ecological Replacements

Assisted colonisation is a form of conservation translocation where the benefit is primarily to the focal species concerned. However, in another form of conservation introduction called 'ecological replacement', again the translocation involves moving a species outside its historic, indigenous range but the primary purpose is to perform a specific ecological function that has been lost through extinction. The benefit is therefore primarily for the relevant, wider habitat or ecosystem. Again, this is a relatively novel approach with different levels of risks to address, and it has only been used or proposed a few times (see Hällfors & Dalrymple, this volume).

Probably the best known examples have been with giant tortoises. The Giant Tortoise Restoration Initiative led by the Galápagos Conservancy and Galápagos National Park Directorate uses a range of conservation actions, including ecological replacement. Giant tortoises specific to Santa Fe Island and Pinta Island are now extinct ('Lonesome George', the famous Pinta Island tortoise *Chelonoidis abingdonii*, died in 2012), and the tortoises of Floreana went extinct in 1835 although hybrids exist on another island (Galápagos Conservancy, 2022). The giant tortoises of these islands provided important ecosystem roles such as trampling vegetation, opening areas, and dispersing seeds, thereby providing habitat conditions that support other island species. Work is now underway to identify which alternative, extant giant tortoise species could be introduced to these islands to continue these ecosystem roles. On Pinta the decision on the species to be used in the long term is still awaited, but in the meantime sterilised giant tortoises have been introduced to allow their impacts to be monitored. Initial results have demonstrated increased local vegetation patchiness and shown that even moderate density tortoise populations can reverse woody plant encroachment (Hunter & Gibbs, 2013). Meanwhile, on Santa Fe Island, fertile Española giant tortoises *Chelonoidis hoodensis*, endemic to Española Island, were first introduced in 2015, again followed by post-release monitoring.

Similar ecological replacements of giant tortoise species have also been used in the Mascarene Islands, where five native species became extinct by the mid-1800s. On Ile aux Aigrettes, Mauritius, the non-native Aldabra giant tortoise *Aldabrachelys gigantea* was therefore introduced as an ecological replacement, first into enclosures and then into the wild. Its role in creating and maintaining 'tortoise lawns' in open areas, thereby contributing to a more heterogeneous habitat mosaic beneficial to biodiversity, improving seed germination of an endemic ebony species after ingestion, and other factors, is described by Jones et al. (this volume). Animals have now been translocated to Round Island as well, and there are plans for other destination island sites.

The predicted effects of climate change and disease on woodland communities in Britain are also creating debate over how interventionist we should be, including whether we should be starting to replace some dominant tree species that are likely to decline increasingly over time (e.g. ash *Fraxinus excelsior* as a result of ash dieback fungal disease *Hymenoscyphus fraxineus*, Mitchell et al., 2014). One form of what one might arguably class as ecological replacement has been used for some time in Britain and elsewhere in Europe. The aurochs *Bos primigenius* became extinct in the seventeenth century, although much of its gene pool lives on in the domesticated cattle breeds we have today. These large herbivores would have played influential roles in maintaining structural diversity, and consequently biological diversity and wider ecosystem functioning (van Wieren, 1995), although we cannot be certain of their precise ecological effects. More 'traditional' breeds of modern cattle and ponies are likely to perform some of these roles, and they are often used in modern nature conservation management. Perhaps these are not examples of planned, deliberate ecological replacement in the strict sense but, in the absence of aurochs, such traditional breeds may have an increasingly important role in large scale ecological restoration and rewilding projects, and maintaining special grassland and open woodland habitats (Hodder et al., 2005). This might seem to go against the general push to reduce the numbers of cattle because of their contributions to creating carbon emissions, but traditional breeds of cattle used in low intensity situations are small in number compared to conventional farming in industrialised countries, and can have benefits in climate change mitigation (Pyke & Marty, 2005). Recently a small number of European bison *Bison bonasus* have been released within an enclosed reserve in Kent, UK. Some would describe this as an ecological replacement of species such as the steppe bison *Bison priscus* that became extinct in the late Pleistocene.

1.5.3 Multi-species Conservation Translocations

Conservation translocations usually focus on single focal species, but increasingly some projects are attempting to translocate groups of species in order to restore communities and thereby wider ecosystems. For example Foundation Rewilding Argentina's work in the Iberá wetlands resulted in the first jaguars being reintroduced in 2021, with associated ongoing conservation translocations of prey species such as Pampas deer *Ozotoceros bezoarticus*, giant anteaters *Myrmecophaga tridactyla*, and collared peccaries *Pecari tajacu* (Donadio et al., this volume). On Wedge Island, Australia, the release of an ecosystem engineer, the southern hairy-nosed wombat *Lasiorhinus latifrons*, was accompanied by translocations of black-footed wallaby *Petrogale lateralis pearsonii* and brush-tailed bettong *Bettongia penicillata*. The wombat burrows increased habitat complexity and were subsequently used by the wallabies and bettongs as well (Ostendorf et al., 2016), and all three species have increased in numbers. Arguably, even the sowing of diverse, native species seed mixtures on ex-arable soils to produce species-rich swards could be described as a type of multi-species conservation translocation with the aim of restoring grassland communities, although the reinstatement of the associated microbial and faunal communities is more of a challenge (Walker et al., 2004), and requires time to allow natural processes to take effect.

Such multi-species translocations involve an additional level of complexity because of the potential interactions between the species involved. Plein et al. (2016) developed models that highlighted the need to consider the types of interspecific interactions (e.g. consumer-resource, mutualism, and competition), the sequencing of releases, and founder sizes on the type of translocation strategies that should be used. Another modelling exercise looked at options for restoring disturbed plant-pollinator communities and concluded that reintroducing multiple, highly interacting generalist species worked best for restoring the species richness of lightly disturbed communities, whereas the introduction (rather than reintroduction) of generalist species was more effective for more significantly disturbed communities (LaBar et al., 2014).

1.5.4 De-extinction and Genetic Interventions

The IUCN (2016) has produced 'Guiding Principles' on de-extinction, defined as 'the process of creating an organism that resembles an extinct species'. To date most de-extinction proposals have involved mammal and bird species. The methods used have ranged from back breeding (e.g. of domesticated cattle to produce Heck cattle that resemble the extinct aurochs), to CRISPR gene-editing technology. An example of the latter is the work underway to produce birds with the traits of the extinct passenger pigeon *Ectopistes migratorius*, a species once so numerous that it has been considered an ecosystem engineer of North American forests (Revive & Restore, 2021). Seddon (this volume) explores this topic in more detail.

De-extinction therefore raises the future prospect of conservation translocations involving extinct species, or at least functional proxies of such species. Genetic technology is also being developed for interventions on extant species (Neaves et al., this volume). For example, permission is currently being sought to allow the planting in the wild of genetically engineered American chestnut *Castanea dentata*, an ecologically important species of eastern North America devastated by an introduced fungal blight (Newhouse & Powell, 2020). The genetically engineered trees are blight resistant. Meanwhile, in late 2020, a Przewalski's horse *Equus ferus przewalskii* named Kurt was born, and made global news by becoming the first animal cloned for conservation purposes. We can expect the development and use of such technologies to accelerate, presenting powerful new tools for conservation translocations and other conservation interventions, but also complex biological, social, and ethical challenges.

1.5.5 Mitigation Translocations

These involve the '. . .removal of organisms from habitat due to be lost through anthropogenic land use change and release at an alternative site' (IUCN, 2013). Examples include developments where legal permissions to proceed may be conditional to mitigating specific environmental impacts, including on particular species that may be present. Such reactive, economically motivated uses of translocation contrast with the more proactive, purely conservation motivated translocations described elsewhere in this chapter. Mitigation translocations can clearly serve a conservation purpose where the alternative is leaving the organisms at the development site and risking their destruction, but their use can be controversial. The concern is that translocation is too often put forward as a publicly acceptable 'solution' by developers when protected species, or habitats, are present at a site. Alternative, and potentially less risky solutions, may be more appropriate, including the least risky option from a conservation perspective of not permitting the development at all where the conservation value of a site is high.

Even so, mitigation translocations have become increasingly used. Despite the fact that such translocations can often be well resourced, their long-term effectiveness for the species concerned remains uncertain. Indeed the general pattern has often been that the resourcing goes primarily into the planning and execution of the translocation itself, but far less into the post-release monitoring and reporting that is so essential to allow assessments of effectiveness. Germano et al. (2015) noted that many mitigation translocations fail; there was a failure to document outcomes, and a need for the billion dollar environmental consulting industry to address such shortcomings. There are some species of conservation value that have become regular candidates of mitigation translocations. Britain is the European stronghold for the great crested newt *Triturus cristatus*, a highly protected but fairly widespread species. A review of 460 licensed projects involving the species found that only 22 provided post-development monitoring data, of which 16 reported that at least one small population was sustained (Lewis, 2012). The Conservation Evidence (2021) web site scores the 'effectiveness' of this type of action for great crested newt at 50 per cent.

Guidelines have been published that emphasise the value of properly considering options when assessing development proposals, and ensuring that approved mitigation translocations are properly designed and monitored (IUCN, 2013; Randall et al., 2018). The mitigation translocation of Mojave desert tortoises *Gopherus agassizii* from areas scheduled for solar energy developments was judged to have been well designed and monitored, and to have demonstrated the wider conservation value of reporting the details of properly considered pre- and post-release work (e.g. Dickson et al., 2019).

1.6 The Biological Considerations behind Conservation Translocations: Using Science and Guidance to Make Better Decisions

The challenges of any conservation translocation are often complex and involve a range of risks and uncertainty. The applied science of reintroduction biology has therefore developed since the 1990s, in part prompted by observations that many earlier reintroduction projects had failed. Efforts have been made to encourage more strategic approaches, to address specific issues *a priori* (i.e. beforehand, based on reasoning and experience), and to apply appropriate research such as predictive modelling techniques and experimental studies to improve the outcomes of released captive-bred animals (Seddon et al., 2007). The aim has been to help decision-making become more evidence-based, thereby improving the likelihood of project success.

Taylor et al. (2017) carried out an analysis of how recent advances in reintroduction biology are actually being applied in reintroduction practice. They looked at four broad areas where the science has been developing: population establishment, population persistence, meta-populations, and ecosystems. A total of 361 reintroduction-related papers were examined, and they found that 61% of papers addressed questions at the population establishment level, 32% at the population persistence level, 4% at the meta-population level, and just 3% at the ecosystem level. They also found that 49% of all the papers clearly stated *a priori* questions, although this increased over time to 64% by 2016, which might suggest an improvement in best practice. The authors of this and other studies noted the need for decision-making to be better incorporated into reintroduction biology, to target management uncertainties and to apply adaptive management approaches rather than trial and error (Canessa et al., 2016; Albrecht, this volume; Ewen et al., this volume).

Such rigorous application of scientific approaches should improve the likelihood of success for conservation translocations, and therefore provide benefits beyond improving the conservation status of the species or ecosystem concerned. Such benefits include: ensuring limited financial resources are most efficiently and effectively directed; improving the likelihood of relevant stakeholders remaining enthused and engaged during the work; and ensuring that potentially limited stocks of the relevant donor plants and animal populations (which are often threatened species) are utilised in the best way possible. However, the meta-analyses of such projects reported in the scientific literature, such as those referred to in the paragraph above, will inevitably be skewed by focussing on those written up by practitioners with access to scientific expertise and able to publish in peer-reviewed journals. The details of many (probably most) projects do not get published in these fora, and some do not apply more robust scientific approaches for a variety of reasons. In many cases the project personnel may feel overwhelmed by some of the apparent complexity of the methods advocated by reintroduction biologists. Others are simply not convinced of their value; they may feel that 'perfection can be the enemy of good', and assume such approaches will result in delay.

The aim, therefore, is to find ways by which beneficial projects can be supported with simple, pragmatic guidance leading to action. The developing scientific literature is a vital source of information, but it is not always accessible to some of the key audiences (in a physical or readable sense) who may be involved in conservation translocation practice. Therefore other ways of sharing knowledge and experience are also needed. Increasingly, more 'straightforward' decision support tools are being developed and made available to help practitioners prioritise their efforts and deal with the inevitable uncertainties they can come up against (e.g. Ewen et al., this volume; IUCN, 2017). Further guidance on the types of biological and socio-economic issues to consider is included in the IUCN Guidelines (IUCN 2013), related documents such as the Scottish Code for Conservation Translocations (National Species Reintroduction Forum (NSRF), 2014), and this book (e.g. Dalrymple & Bellis, this volume; Ewen et al., this volume; Maschinski & Albrecht, this volume). The Scottish Code includes a list of the potential biological and socio-economic risks associated with any translocation that should be considered during an initial appraisal (Box 1.2). Similarly, assessments can be made of the potential benefits of the translocation (Box 1.3) and legal requirements. If the initial appraisal process suggests clear benefits, and the legal requirements and risks seem surmountable through a realistic level of mitigation, the next step is to formalise the planning process and address any key issues (especially the higher risk issues) in more detail.

Future options to improve capacity should include the development of more 'plain language' guidance – for example handbooks and simple web-based material that summarise the latest applied research, and the provision of simple online, decision-making tools that can be accessed anywhere in the world. The IUCN CTSG has already organised workshops and training in different countries to help with capacity building, Box 1.2 *Examples of biological and socio-economic risks associated with conservation translocations (National Species Reintroduction Forum, 2014)*

Biological:

- Distance of the translocation.
- Threat to the source population.
- Establishment following the translocation may cause loss/reduction of important habitat.
- Establishment may cause loss/reduction of important species.
- Translocation may spread pests and diseases.
- Hybridisation threat (intra-specific or inter-specific).
- Species is likely to spread beyond the confines of the destination site (this can be a measure of success, but risks need to be considered).
- Potential for animal welfare concerns to released animals or those they interact with.

Socio-economic:

- The likelihood of strong social resistance by some to translocation.
- Harm to human health and well-being.
- Harm to human livelihoods.
- Insufficient resources may prevent successful implementation of the translocation plan.
- Major financial cost once the translocation has been completed (e.g. control measures if the population has greater impacts than envisaged).

Box 1.3 *Examples of benefits associated with conservation translocations (National Species Reintroduction Forum, 2014)*

Focal species – reducing extinction risk and/or improving the conservation status of a species:

- Increasing the number of individuals, improving population structure, and/or increasing the number of locations at which species occur.
- Improving the genetic health and resilience of a population by directly introducing genetic diversity.
- Establishing ‘bridging populations’ to facilitate migration and/or gene flow.

- Establishing populations in areas where the species will experience reduced levels of threat (e.g. by moving organisms into more suitable 'climate space', disease-free areas, or localities with suitable management).

Habitats/ecosystems – improving the conservation status of an ecosystem, habitat, and/or other species:

- Increasing the overall species richness of a habitat to enhance its biodiversity value.
- Increasing habitat quality (e.g. translocating species to change grazing regimes).
- Improving ecosystem services and functions (e.g. translocating species to provide pollinator services).

People – socio-economic benefits that may arise as a result of a conservation translocation:

- Enriched human experiences and environmental awareness due to increased contact with biodiversity.
- Increased benefits to humans from ecosystem services (e.g. pollination).
- Increased income (e.g. revenue from ecotourism where the translocated species leads to increased visits or spend).

and produced some initial, web-based training videos (IUCN, 2021). It will take time to further develop and promote these tools but, for the mean time, all practitioners should be encouraged to monitor their projects after release (a failing of many projects as reported in Sutherland et al., 2010) and report the results even, and indeed especially, if they fail. This does not necessarily have to be in scientific journals that require intensive peer-review; it could be as submissions to repositories such as the IUCN CTSG's 'Global Conservation Translocation Perspectives' series of case studies published every few years (most recently Soorae, 2021).

1.7 The People Considerations behind Conservation Translocations

Historically many conservation projects, including translocations, have tended to focus predominantly on biological considerations. This has been in part due to the fact that such projects often involve specialists and practitioners with more biological backgrounds and training, and much of the relevant scientific literature and international guidance still has that strong focus. Biological expertise is a vital element of these types of projects where the primary aim is to improve the conservation status of focal species and wider habitats and ecosystems.

However, as time has moved on there has been increasing recognition that the socio-economic, 'people' side of this work (including cultural and spiritual considerations) needs to improve to ensure more effective, fair, and democratic approaches are used. Furthermore, better engagement with key stakeholders helps to increase the likelihood of project success and therefore biodiversity benefits. The human population and its use of the land and sea continues to increase, and therefore the likelihood of conservation translocations overlapping with people's interests, and sometimes creating conflict or opportunities, will also rise.

1.7.1 Addressing the Risks and Opportunities for People

The revised IUCN Guidelines (2013) therefore included an expanded section on 'social feasibility' compared to the original 1998 version. In Scotland, the socio-economic aspects of such projects have been given a particular focus, starting with the formation of the 'National Species Reintroduction Forum' (NSRF), which includes members of not only the usual conservation and environmental non-governmental organisations (NGOs) and government bodies but also organisations representing land and water management and interests. Its origin was partly grounded on the experiences of two high-profile projects – the reintroductions of the white-tailed eagle *Haliaeetus albicilla* (Figure 1.7) and the Eurasian beaver to Scotland – both of which resulted in intense and passionate debates within the public, political, and media arenas. The formal, licensed reintroduction of Eurasian beaver was complicated by unofficial escapes or illegal releases, with consequent impacts on trust between the conservation and land management communities, and ultimately on the prospects of other, future mammal reintroduction proposals (Campbell-Palmer et al., this volume). The white-tailed eagle release resulted in complaints by farmers and crofters over the lack of consultation before the original releases, and debate over how they should be compensated for the loss of lambs they reported.

There are now fora in Scotland that were specifically set up to enable the management and conservation issues surrounding these species to be

Figure 1.7 Following its extirpation in the early twentieth century, the reintroduction of the white-tailed eagle to the west coast of Scotland began in the 1970s, with a second phase in the 1990s. This was followed by the 'East of Scotland Sea Eagle Project' that ran from 2007 to 2012. There are now estimated to be about 150 breeding birds in the country (photo: Lorne Gill). (A black and white version of this figure will appear in some formats. For the colour version, please refer to the plate section.)

discussed. Disagreements and concerns remain but both species are becoming increasingly established, and some socio-economic benefits have started to be realised (Morling, 2022). The NSRF therefore used these and other experiences to inform the design of its Scottish Code for Conservation Translocations, based around the IUCN Guidelines framework but with a strong Scottish focus and consideration of people issues, as well as the usual biological aspects (Box 1.2). The Code was therefore not just the product of biological specialists but also representatives of land and water managers and users, conservationists, government agency specialists, and others.

Conservation translocation projects therefore should always consider the human dimension to their projects (Dalrymple & Bellis, this volume; Glikman et al., this volume; Moehrenschlager et al., this volume). This will vary tremendously depending on the species concerned. The translocation of a lichen species from one hill top to another may be biologically complex, but the socio-economic implications are likely to be limited to engagement with the relevant land managers, interest groups, and statutory authorities. However, the translocation of a predator (which in some ways might arguably be less biologically complex, or at least better researched, than a lichen translocation) will often be a contentious proposition and involve a far wider range of stakeholders.

Therefore the planning and implementation of conservation translocations, especially those with complex people considerations, need good governance and stakeholder involvement (Martin et al., 2012). Ultimately the communities living in areas where organisms are released or planted will not only be most affected by such projects but also in a key position to facilitate the long-term viability of any restored population. Complex projects will benefit from the use of specific planning tools (e.g. Ewen et al., this volume) and the involvement of neutral facilitators (IUCN, 2017). Key stakeholder individuals and organisations need to be identified and engaged as early on in the process as possible. Such engagement should be a genuine, two-way listening process with the proposers providing information and other stakeholders invited to set out their own values, experiences, and any concerns they have or benefits they wish to access. Trust can be built by providing clarity over who is responsible for making decisions, and transparency over how decisions are made. Engagement with indigenous communities is fundamental (e.g. McMurdo Hamilton et al., 2021; Moehrenschlager et al., this volume).

Conservation translocations tend to be driven by biological specialists, but where there are complex socio-economic aspects to a project then it is necessary to draw on the professional input of experts in public engagement, social aspects, and wildlife conflict. It would be unthinkable not to use experts on the animal or plant concerned during a conservation translocation, so on that basis it seems common sense to involve experts in the social sciences and humanities for projects with significant human dimensions.

The potential real or perceived negative impacts of a translocation on people have to be considered early in project development, but there may be a range of direct and indirect socio-economic benefits too (Box 1.3). The IPBES report, in addition to identifying the five main drivers of biodiversity loss, also identified two other significant, indirect drivers: the lack of connection people have with nature, and the lack of value and importance placed on nature (IPBES 2019). Conservation translocation has a role to play here too, by helping to engage people in positive solutions to challenges that can sometimes feel overwhelming in their scale. It is, by its very nature, a very visible, immediate, and concrete activity that the public can easily relate to, thereby providing a way of promoting wider biodiversity issues. The media, public, and political interest generated when an animal is released or a rare plant put back in the wild can be substantial, and provides opportunities for practitioners to explain the underlying problems that caused the decline of the species in the first place and why such desperate measures are needed to try to restore them.

Such projects can also help to promote the wider ecosystem value that translocations can have as part of ecosystem restoration, creation, or resilience initiatives, whether tagged as ‘rewilding’ or not (e.g. through reintroducing ‘ecosystem engineer’ or other ‘keystone’ species). Beavers, for example, provide a range of ecosystem services (Gaywood, 2015). These include ‘provisioning ecosystem services’ such as increased ground water storage, ‘regulation and maintenance ecosystem services’ such as flow stabilisation and flood prevention, and ‘cultural ecosystem services’ that relate to people’s recreational, educational, and spiritual interactions with the environment. All of these contribute to human well-being and have socio-economic impacts.

The South of Scotland Golden Eagle Project has given particular attention to cultural ecosystem services, involving local communities and those further afield, with dedicated project officers covering stakeholder engagement and public outreach (Barlow, this volume). This has included supporting local ‘Eagle Schools’ that learn about and champion the project and link with schools from areas where the donor animals came from. In New Zealand there has been a large increase in the number of community-led projects that can result in wider engagement and interest in environmental issues (Department of Conservation, 2012). The reintroduction of bison *Bison bison* to North America’s Great Plains was found to have immediate positive benefits on visitors and in connecting people to conservation (Wilkins et al., 2019). There can be direct economic benefits too; for example £4.9 to £8 million of annual tourist spend on the Isle of Mull in Scotland results from people wishing to see the white-tailed eagles that resulted from reintroduction (Morling, 2022).

1.7.2 Working with Other Environmental Stakeholders

The IUCN guidelines for conservation translocations (IUCN, 2013) are used by many sectors involved in wildlife conservation. Since they were first developed over three decades ago, subsequent scientific developments and practical experiences have informed their further refinement. They have also provided a framework on which to build guidelines and codes of best practice that are more relevant at domestic levels (e.g. DEFRA, 2021; National Species Reintroduction Forum, 2014) and legal recommendations at regional scales (The Standing Committee of the Convention on the Conservation of European Wildlife and Natural Habitats, 2012). However, the promotion and application of such best practice frameworks designed for conservation translocations tend to be more prevalent within certain sectors of biodiversity conservation, reflecting the unintentional silo approaches that often develop in many aspects of environmental work. Are there opportunities to widen the application of such frameworks, and to learn from the approaches developed by other sectors?

Examples of translocations that have wider environmental and other motivations, and have not always been classed as conservation translocations by practitioners, include:

- Forestry. The translocation of tree species is a widespread forestry practice that historically tended to result from more socio-cultural and commercially driven motivations. However, tree planting is increasingly viewed by governments as a 'low tech' means of capturing carbon and helping to meet international climate change targets. There will be increasing opportunities to build in biodiversity benefits to reforestation and ecosystem restoration and creation (including 'rewilding'), using tree species and genetic strains resilient to future environmental change.
- Freshwater and marine fisheries. Fishery management has traditionally had commercial interests and sustainable harvesting as key motivations behind the translocation of fish species, crustaceans, and molluscs, etc. However, the conservation of specific fish species, and other evolutionary significant units, is recognised to be of increasing importance. Native oyster translocation is being used to develop sustainable fisheries and at the same time restore oyster species and oyster reef habitats (e.g. Bromley & Donnan, this volume).
- Habitat management and restoration. Examples include work involving sea grass beds, species-rich grasslands, native woodlands, and standing freshwaters. These can involve the translocation of a range of plant species, from seed to mature plant life stages, for environmental

benefits. There is increasing use of coral translocations to restore reef habitats (Swan et al., 2015).

These types of translocations have many of the associated risks that also apply to more species-focussed conservation translocations, such as the transmission of pathogens, the potential invasive effects of non-native species, and socio-economic impacts. Even so, such projects are often led by bodies with primarily non-conservation roles who may not necessarily be aware of conservation translocation best practice frameworks. Equally, they will have developed their own protocols and approaches to address their particular challenges, from which conservation translocation practitioners could learn and benefit. The motivations of such projects increasingly overlap, especially as governments require biodiversity, climate change, and other environmental considerations to be addressed holistically as part of wider initiatives associated with food production, timber supply, and other land and water uses. This therefore seems a good time to develop new and wider multidisciplinary links between the conservation and key land and water management sectors to increase opportunities for synergy and coordination, exchange knowledge and identify nature based solutions, and promote conservation translocation best practice more widely, thereby reducing risks and increasing benefits. The same argument applies within the conservation sectors, with species conservation translocation practitioners needing to collaborate more closely with those who focus on wider habitat and ecosystem restoration, to ensure that the big landscape-scale projects we need can better meet their biodiversity potential.

1.7.3 Don't Forget the Law

There will often be associated international and domestic legal considerations for conservation translocations. These may work in a supportive way, or a restrictive way. They may relate to the protective status of the species concerned and their movement between countries. The site of the donor population, or the proposed destination sites, may be designated for nature conservation or other purposes and therefore covered by relevant legislation. Other legislation may apply in terms of non-native species, animal welfare, biosecurity, land access and permissions, and where dangerous species are involved. These types of issues are covered in detail by Trouwborst et al. (this volume).

1.8 Conservation Translocations into the Twenty-First Century

Although conservation translocation has a longer history, the last three decades in particular have seen major advances in the ways many projects are designed, planned, and operated. This chapter has attempted to introduce and summarise these concepts, and they are described in more detail elsewhere in this book.

The urgent call for more transformative approaches to address the biodiversity crisis will result in conservation translocations being used more often and more widely. The good news is that there is now a wealth of knowledge and information to draw on, the result of not only numerous academic studies but also practical experience from *ex situ* and *in situ* work. There will always be levels of risk and uncertainty when planning conservation translocation projects, and sometimes these might be considered high – for example with assisted colonisations that attempt to 'rescue' species and move them to places they have never inhabited before. Therefore the tools of modelling, and the use of field-based trials where time allows, will become more frequently used to inform the project design of more complex conservation translocations. It will continue to be important for practitioners to be open and transparent and to share experiences, including the failures, in a way that is accessible to as wide an audience as possible.

So where will we be in 2030? At the time of writing we are all still dealing with the COVID-19 pandemic, but the lockdowns seem to have heightened people's thoughts about nature and the ways in which we can try to repair the damage we have done. Even before COVID-19, calls were increasing to bring about transformational change and urgent action to address the unfolding and, to a large extent, preventable biodiversity and climate crises. Conservation and other forms of environmental management have to be bolder, more ambitious, and radical. There may be associated biological and socio-economic risks, but these can often be managed through the use of tried and tested best practice, professionalism, and sensitivity. Increasingly these assessments of risks, and benefits, have to take account of the alternative risks of inaction or insufficient action.

Until now, conservation translocation has tended to be used in more extreme situations when the alternatives are limited. However, we are now moving to a point where it will need to become more commonly used as we struggle to respond to increasing threats. It will remain a method that can benefit many individual threatened species, but increasingly we need to find opportunities to move species that have key ecosystem roles and thereby restore and create habitats and ecosystems and make them more resilient. We are now in the UN Decade on Ecosystem Restoration, signifying an expectation that governments and people will act quickly and effectively. Conservation translocation practitioners need to be ready to respond.

1.9 Key Messages

- The May 2019 IPBES report emphasised the scale of the current biodiversity crisis and the need for transformative change, but highlighted that the tools exist to enable this change.
- Conservation translocation is an increasingly used tool that involves people deliberately moving and releasing organisms where the primary goal is conservation; it includes species reintroductions, reinforcements, assisted colonisations, and ecological replacements.
- It can be complex, expensive, time consuming, and sometimes controversial, but when best practice guidelines are followed it can be a very effective conservation method and a way of exciting and engaging people in environmental issues.
- Conservation translocations have an important role to play not only in improving the conservation status of individual species but also in ecological restoration and rewilding by moving keystone and other influential species.
- As the climate continues to change, species with poor dispersal abilities or opportunities will be at particular risk. Assisted colonisation, which involves moving species outside their indigenous range, is likely to become an increasingly used method. It is also a tool that may become increasingly used to avoid threats from the transmission of pathogens.
- Other more radical forms of conservation translocation, such as ecological replacements, multi-species conservation translocations, and the use of de-extinction and genetic interventions, are also likely to be given stronger consideration within the wider framework of ecological restoration.
- There have been significant advances in the science of reintroduction biology over the last three decades. However, new ways of transferring and sharing such information are needed to enable a wider spectrum of practitioners to have easier access to knowledge and guidance.

- In the past the biological considerations of conservation translocations have often heavily outweighed the people considerations. However, it is increasingly important that socio-economic factors are also built into projects and that relevant experts are involved in order to reduce conflict and improve the chances of success.
- Some level of biological and socio-economic risk will be present for most conservation translocations, but risk can often be managed through the use of sensitivity, professionalism, and the application of tried and tested best practice.
- Species reintroduction and other forms of conservation translocations will be an increasingly important tool if we are to restore, and make more resilient, our damaged ecosystems.

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