Conservation and restoration in peopled landscapes in Oceania: opportunities and challenges

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Abstract. While the role of humans in causing high rates of species extinctions worldwide is well established, philosophies and opinions as to how to mitigate the current biodiversity loss are once again hotly debated topics. At the centre of the debate are differences in opinions regarding the value and the best methods of conserving and restoring biodiversity in peopled landscapes. Here we synthesise information from different case studies from Oceania that demonstrate how biodiversity conservation in peopled landscapes will require different, and often novel, socio-ecological approaches. We draw special attention to the importance of prioritising human dimensions in the conservation of different ecosystems, ranging from highly modified urban areas to largely intact wilderness areas. Particularly, we explore the importance of understanding motivations to conserve biodiversity, implementing well designed conservation actions, both socially and ecologically, and involving different stakeholders in the design and implementation of conservation projects. On the basis of our synthesis, we suggest that conservation in peopled landscapes in Oceania offers great opportunities for community involvement, including traditional landowners, in all aspects of conservation planning and implementation. Where uncertainties regarding the suitability of established management strategies exist, novel guidelines should be based on the best available ecological and social evidence to avoid potential negative outcomes.

Additional keywords: biodiversity, human dimensions, predator control, stakeholder involvement, urban areas

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Introduction

While the role of humans in causing high rates of species extinctions worldwide is well established (Dirzo *et al.* 2014), philosophies and opinions as to how to mitigate the current loss of biodiversity are once again hotly debated topics (e.g. Kareiva and Marvier 2012; Soulé 2013). At the centre of the debate are perceived and real differences in the comparative value of natural wilderness areas versus human-modified landscapes for biodiversity conservation. What appears obvious is that an ever-increasing footprint associated with a human population approaching eight billion necessitates conservation and

restoration approaches being directed at landscapes both inhabited and used by humans (e.g. Lindenmayer and Franklin 2002; Ives *et al.* 2016). The impact of humans on biodiversity in these ‘peopled landscapes’, however, varies in type (i.e. primary causes associated with observed population declines or species extinctions), intensity, and scale, and will thus likely require local and flexible approaches to achieve positive conservation outcomes.

Oceania is a diverse geographic region consisting of both large continental landmasses and numerous and often remote islands in the Pacific Ocean. Presently, Oceania is also home to

over 40 million people (United Nations 2017). While overall population density is lower than in all other geographic regions with the exception of Antarctica, it can be very high locally. For example, levels of urbanisation in Oceania are among the highest in the world (e.g. 90% in Australia, 86% in New Zealand, 95% in Guam: The World Bank 2017). The historical impact of humans on the environment also varies dramatically across Oceania. Specifically, the region is home to the longest genetically isolated human population (i.e. indigenous Australians: Rasmussen *et al.* 2011), a continental landmass, isolated for >70 million years, and only settled by humans ~750 years ago (i.e. New Zealand: Wilmshurst *et al.* 2011), and diverse oceanic archipelagos with varying levels of human habitation and influence. Furthermore, there are substantial differences across Oceania with respect to impacts of European colonisation, including the acceptance of conservation approaches by traditional landowners, standard of living, which is considerably lower for people on Pacific Islands, type and intensity of land use (e.g. industry and agriculture) as well as regional extinction rates (e.g. Recher and Calver 2004). On the basis of this diversity, Oceania is an ideal region to explore opportunities and challenges to conserve and restore biodiversity in peopled landscapes.

Our objectives for contributions to this special issue were three-fold. First, we wanted to present case studies covering much of the Oceania geographic region (spatial representation). Second, we wanted to explore opportunities and challenges across gradients in human impact ranging from highly modified (and densely populated) urban areas to largely intact wilderness areas and National Parks. Third, recognising the current debate about the role of people in conserving biodiversity, we wanted to explore both the ecological and social challenges associated with biodiversity conservation in Oceania. This necessitates considering the needs and roles of all residents of its landscapes, including engagement of traditional landowners. Combined, the contributions highlight that the opportunities for conserving or restoring biodiversity to human-modified landscapes have not yet been taken full advantage of (Table 1). The contributions also emphasise that the challenges of biodiversity conservation in peopled landscapes require different, and often novel, approaches that integrate both social and ecological perspectives. Here we discuss special issue contributions in three separate categories: (1) conservation in urban areas, (2) control of invasive species in peopled landscapes, and (3) stakeholder involvement for conservation actions in protected areas.

Conservation in urban areas

Cities currently represent <1% of the earth's land surface (Schneider *et al.* 2010), yet more than 50% of all people worldwide already live in these landscapes (World Health Organisation 2016). The value of urban areas for biodiversity conservation, however, is often overlooked. Cities are among the most highly modified habitats, characterised by a large proportion of artificial structures (McPhearson *et al.* 2016), interspersed by small and fragmented patches of remaining vegetation (Aronson *et al.* 2014). These modifications have affected biodiversity patterns in surprisingly similar ways. Specifically, many groups of species, such as birds, have become homogenised in urban areas with generalists dominating the resulting communities

(McKinney 2006). In addition, many non-native and invasive species have become firmly established in urban areas, where they now interact with native species in both positive and negative ways. Despite the substantial habitat modifications and establishment of novel communities, cities can still host many endemic species, including those threatened with extinction (Aronson *et al.* 2014). Managing for species conservation in urban environments not only offers opportunities for conservation but also educates people about the importance and value of local biodiversity (McKinney 2006).

Urban environments in Oceania provide many opportunities that can benefit biodiversity conservation, both through community-led action and national and local government effort. There is significant opportunity to enhance effort on both fronts. For example, due to the large number of potential volunteers, environmental community groups can make invaluable contributions to conservation and restoration projects in urban environments (Peters *et al.* 2016), including help control invasive species (Gaertner *et al.* 2017), and analyse monitoring data (Anton *et al.* 2018). Furthermore, urban gardens, in particular, offer opportunities for habitat enhancement and subsequent biodiversity increases (Lin *et al.* 2015). These efforts can feed into government-led programs of work that generate landscape-level outcomes.

In this special issue of *Pacific Conservation Biology* we compiled three studies that investigate different aspects of the design and implementation of successful conservation programs in urban environments. First, Shanahan *et al.* (2018) discuss the motivations for conservation in Oceania and highlight opportunities for harnessing effort. Second, van Heezik and Seddon (2018) explore the motivation and potential for species reintroductions into urban environments as a conservation tool. Lastly, Linklater *et al.* (2018) evaluate and discuss best practice for species reintroductions in cities.

The first step in harnessing energy to protect or restore urban biodiversity is to understand motivations for conservation; this understanding is vital to ensure that actions are effective and maximise outcomes. To understand motivations for conservation, Shanahan *et al.* (2018) evaluated publicly available urban biodiversity conservation strategies from 12 cities across Australia ($n = 7$) and New Zealand ($n = 5$) ranging in population size from ~50 000 to over 5 million people. In addition, the authors surveyed five biodiversity strategies from Pacific Islands. From these documents they extracted information that allowed them to develop broader categories as to why strategies were developed in the first place: (1) protecting ecosystem services, (2) addressing declines of biodiversity, and meeting (3) ethical and (4) statutory responsibilities.

Despite some differences across regions, local biodiversity strategies highlight that ecosystem services and benefits for people remain the key motivators for implementing conservation actions (Shanahan *et al.* 2018). Given recent findings of links between experiencing nature in various ways and human well-being (e.g. Shanahan *et al.* 2015), these results give cities in Oceania a clear mandate to continue investing in conservation strategies.

Concerns for biodiversity, on the other hand, were important motivators in New Zealand (100% of strategies assessed) but much less so in the Pacific Islands (60%) and Australia (40%).

Table 1. Summary of articles in the special issue on 'Conservation and restoration in peopled landscapes in Oceania'.

Topic	Region/country	Peopled landscapes	Summary	Reference
Motivations for conservation	Oceania-wide	Urban	<ul style="list-style-type: none"> • Ecosystem services and benefits to people main drivers for conservation in urban areas; • Biodiversity concerns most often considered in New Zealand; • Opportunities using biodiversity objectives for conservation in urban areas. 	Shanahan <i>et al.</i> (2018)
Reintroductions to cities	New Zealand	Urban	<ul style="list-style-type: none"> • Reintroductions rarely attempted in urban environments; • Habitat suitability key consideration; • Opportunities for restoring biodiversity in cities (including threatened taxa). 	van Heezik and Seddon (2018)
Reintroduction of kākā, Wellington	New Zealand	Urban	<ul style="list-style-type: none"> • Case study reintroduction of kākā into urban area; • Concerns that damage from ill-advised feeding may erode public support; • Carefully consider suitability of species for reintroductions into urban areas. 	Linklater <i>et al.</i> (2018)
Management of introduced predators	New Zealand	Urban/rural	<ul style="list-style-type: none"> • Introduced mammalian predators drive faunal loss in Oceania; • More research is required in urban and rural landscapes; • Natural and social sciences contribute to effective management. 	Russell and Stanley (2018)
Control of yellow crazy ants, Atafu, Tokelau	Tokelau	Mixed: medium-density village and natural	<ul style="list-style-type: none"> • Ecological and human perspectives driving ant control in an atoll environment; • Decision to control invasive species (ants) should consider multiple perspectives 	Gruber <i>et al.</i> (2018)
Multispecies reintroductions to national parks	Australia	Natural (public)	<ul style="list-style-type: none"> • Multispecies reintroductions into predator-proof fenced areas in National Park; • Legislative, policy, and economic challenges; • Opportunities for engagement and adaptive management by Indigenous people as well as benefits of funding certainty. 	Pedler <i>et al.</i> (2018)
Reintroductions to remote Indigenous land	Australia	Natural (Indigenous)	<ul style="list-style-type: none"> • Reintroduction of black-footed rock wallaby to unfenced Indigenous lands; • Social, economic and ecological challenges including ongoing predator control; • Significant opportunities including cultural benefits. 	Ireland <i>et al.</i> (2018)

The apparent differences between New Zealand and Australia are particularly surprising given the similarities in development and standard of living in the two countries. Also, despite the known potential to conserve biodiversity – including endangered species – in urban areas (e.g. [Ives *et al.* 2016](#)) these results suggest that cities across much of Oceania are not yet contributing as much as they potentially could to biodiversity conservation.

More importantly, variation in motivation to conserve biodiversity among regions in Oceania suggests that localised approaches to education and conservation implementation are ultimately necessary. Specifically, the findings of [Shanahan *et al.* \(2018\)](#) provide city managers with opportunities to develop novel frameworks for biodiversity conservation that incorporate differences in values. For example, in New Zealand it might be sufficient to emphasise increases in urban biodiversity associated with proposed strategies (ecocentrism) while strategies on Pacific Islands and Australia might be more effective by emphasising direct and indirect benefits for humans (anthropocentrism).

On the basis of dissimilarities in development and living standards, differences between Australia and New Zealand, on the one hand, and island nations, on the other, were to be expected. What is surprising is that these results (i.e. greatest differences appeared independent of development) indicate that other issues significantly influence motivations (or the lack thereof) for conservation.

Another crucial step to protecting or restoring urban biodiversity is to identify conservation tools that are well suited to achieve the desired conservation goals. Given the high motivation and potential for biodiversity conservation in cities in New Zealand, [van Heezik and Seddon \(2018\)](#) explore whether we should use species reintroductions into urban environments as a conservation tool. While many examples exist worldwide of rare and endangered species occurring and indeed thriving in cities (see references in [van Heezik and Seddon 2018](#)), only seven of 182 reviewed animal reintroductions involved releases into urban areas.

Based on an expert survey, [van Heezik and Seddon \(2018\)](#) provide a list of species (including 15 forest birds) potentially suitable for reintroduction to urban areas in New Zealand. Reintroductions, however, should only be considered if several key factors have been addressed or met. These include (1) increasing habitat restoration in cities ([Clarkson and Kirby 2016](#)) as habitat loss is a major limiting factor for many native forest bird species in New Zealand; (2) social acceptability and willingness to implement changes needed to make cities more suitable habitats for wild species, including, for example, management of domestic pets such as cats ([Kikillus *et al.* 2017](#)); and (3) intensive and widespread control of invasive predators (i.e. the primary causes of the initial local extinction). The latter is particularly important as all suitable bird reintroduction candidates are threatened by predation from invasive mammals across their distribution in New Zealand.

A large contributor to the perceived suitability for reintroduction in urban areas is the recent and widespread commitment to controlling invasive mammals – namely rats, possums and mustelids across New Zealand (e.g. the ‘Predator Free New Zealand’ initiative). Much of the control of invasive species in

urban areas can be achieved by trapping efforts initiated and managed by local community groups. Advantages include cost effectiveness and a scale of control efforts that would be difficult to attain without volunteers and citizen scientists. Including the public in invasive species management is also important given the variability among people in acceptance of lethal and non-lethal control methods used to reduce and eradicate invasive mammals ([Dubois *et al.* 2017](#)), as well as the necessity to conduct control efforts over long periods. Effective monitoring could also be aided by citizen scientists ([Anton *et al.* 2018](#)), ultimately leading to an improved understanding of the feasibility and value of reintroducing endangered species into urban areas. Such data are not yet readily available and thus support previous calls to treat reintroductions as experiments and opportunities for gaining ecological knowledge ([Seddon *et al.* 2007](#)).

Compared with uninhabited landscapes, conservation efforts and species reintroductions to cities occur in a more complex, people-dominated social, economic and ecological system. [Linklater *et al.* \(2018\)](#) thus draw attention to the importance of prioritising the human dimensions of wildlife introductions. They illustrate the ‘pitfalls’ to be avoided and the best-practice possible using the reintroduction of kākā (*Nestor meridionalis*), a large social parrot, to Wellington City. From household surveys of Wellington City residents, the authors show that the reintroduction of kākā has initiated a human–wildlife conflict because some birds damage private and public property. Feeding of kākā by residents is shown to intensify the damage and lead to a polarisation of attitudes amongst residents. Thus, a human–wildlife conflict becomes an even more serious, human–human conflict over kākā. While quantifying the problem and illustrating how it might have been avoided, the authors provide remedies too. For example, the paper outlines the usefulness of the concept of ‘social capacity’, alongside ‘ecological capacity’ for deciding on urban reintroductions.

Control of invasive species in peopled landscapes

Some populations of introduced species can become invasive and, among other impacts, cause species extinctions (e.g. [Blackburn *et al.* 2004](#)). As invasive species are typically not perceived as a problem until their effects are strongly felt, prevention through biosecurity is often not a high priority, particularly in developing countries. Although biosecurity in developed countries such as New Zealand and Australia is significantly more advanced, these countries have well established populations of invasive species. As a consequence, the most used management tool for invasive species is lethal removal ([Doherty and Ritchie 2017](#)), often using pesticides, or trapping and shooting in the case of larger mammals.

The control of invasive species is a conservation approach that has received increasing attention in Oceania, particularly where mammals have been controlled for the protection and recovery of endemic fauna (e.g. [Russell *et al.* 2017](#)) and flora (e.g. [Wolf *et al.* 2018](#)). Much of our current understanding of the positive biodiversity effects of eradication in Oceania comes from invasive mammal eradications on offshore islands, often reserves or National Parks, resulting in positive conservation outcomes (e.g. [Jones *et al.* 2016](#); [Russell *et al.* 2017](#); [Wolf *et al.*](#)

2018). However, these areas are often uninhabited by people or inhabited at very low density.

The control of invasive mammals and other invasive species in more densely inhabited areas provide unique challenges, particularly regarding the acceptability of using pesticides, and killing for conservation in general, and the logistics of operations. One example of the unique ecological and social challenges in urban environments is to assess the impact of companion animals on biodiversity and to propose management solutions informed by science that are acceptable to the broader public.

Russell and Stanley (2018) provide a broad overview of opportunities for invasive mammal control in peopled landscapes in New Zealand. Their review summarising our current understanding of predator management in peopled landscapes of New Zealand highlights the unique opportunities for biodiversity protection in inhabited environments. For example, initiatives such as 'Predator Free New Zealand' provide additional opportunities for the general public to get directly involved in management aimed at restoring biodiversity in cities. This can be through a range of activities, including the organised local trapping of invasive species such as rats and mustelids by local community groups, controlling the movements of companion animals, and contributing to the analysis of monitoring data (Anton *et al.* 2018). Positive ecological and social outcomes of invasive species management need to be demonstrated via effective monitoring to ethically justify control efforts (Dubois *et al.* 2017).

In Oceania mammals, particularly rats, are the species most often targeted for eradication. However, another major pest group are introduced ants. Of the five ant species listed among a selection of the 'world's worst invasive species' (Lowe *et al.* 2004), Australia already has all five, while most Pacific Islands have at least three (Gruber *et al.* 2017). These ants can sometimes cause large changes in ecological communities (O'Dowd *et al.* 2003). New Zealand maintains comprehensive biosecurity protocols to minimise the threat of these ants establishing there, including a hygiene system for sea containers (the major pathway for entry: Ashcroft *et al.* 2008) and a recurrent nationwide ant survey (e.g. Peacock *et al.* 2015).

Gruber *et al.* (2018) focus on a fine-scale case study of ant control in the territory of Tokelau, and provide an example of an approach that considered both ecological and social perspectives to decide whether to control invasive yellow crazy ants (*Anoplolepis gracilipes*). During field trials, researchers first quantified the distribution and abundance of yellow crazy ants to establish baseline data needed to define the problem. Ant surveys were followed by studies aimed at understanding the potential negative effects of yellow crazy ants on invertebrate communities and local seabird populations. Results from these follow-up studies suggested that white terns (*Gygis alba*) were sensitive to negative effects even at relatively low abundances of yellow crazy ants.

Ecological impact assessments were followed by qualitative surveys (interviews). Survey respondents were particularly concerned about the possible negative impact on all aspects of their lives once yellow crazy ants became established. Concerns included perceived effects on food production and storage, harm to other species, both domestic and wild, and to the people

themselves. At the same time, residents did not voice concerns about the potential use of pesticides to control ant populations.

Based on outcomes from the ecological impact assessments and the surveys gauging people's concerns and attitudes, the decision was made to control ants using pesticides. Notably, potential funders cited the survey of people's opinions as a major component to their decision to fund control work. The study serves as an example for community engagement in the development of suitable and acceptable control efforts of invasive species in the Pacific Islands. It could serve as a model for developing invasive pest control efforts in peopled landscapes across other regions in Oceania.

Stakeholder involvement for conservation actions in protected areas

Conserving biodiversity in protected areas such as national parks is a mainstay of conservation biology worldwide (e.g. White *et al.* 2013). Protected areas essentially function by separating the impact of people on biodiversity by managing, for example, access, hunting, or (for-profit) use of environmental resources. Traditionally, protected areas were established in areas with much lower human densities and impact, including remote wilderness areas. Despite our best efforts, biodiversity within protected areas is often at risk from human actions in surrounding landscapes (Brashares *et al.* 2004). In addition, wildlife moving into landscapes used by people outside protected areas can occasionally affect their livelihoods (White *et al.* 2013). The resulting conflict has the potential to erode support from local communities for protected areas.

Protected areas, particularly large ones, can help conserve species that are otherwise difficult to maintain in peopled landscapes. This includes species with large area requirements such as carnivores. The intensive management needed to maintain biodiversity in protected areas is costly and thus necessitates the need for involvement of different stakeholders, even in landscapes with low population densities. The involvement of different stakeholders, however, can increase the complexity of the design and management of protected areas, particularly if there are unresolved issues of traditional landownership (Sterling *et al.* 2017).

Oceania has a large network of protected areas, both in marine and terrestrial environments, intended to safeguard its highly endemic faunas and floras from extinction. However, a wide range of processes (i.e. the overwhelming impact of invasive species, climate change and overexploitation) threaten the effectiveness and efficiency of the protected areas in this region (Kingsford *et al.* 2009). Furthermore, the pressure posed by humans on protected areas of Oceania is expected to increase more than in other regions of the world. For example, the spatial distance between protected areas and cities in Oceania is expected to decrease by 17 km by 2030 when compared with 1995, which is more than double the average distance worldwide (McDonald *et al.* 2008). To highlight how managers of protected areas can overcome the ecological and social challenges associated with biodiversity conservation in remote areas, Ireland *et al.* (2018) and Pedler *et al.* (2018) discuss two case studies.

Ireland *et al.* (2018) focus on the challenges and opportunities associated with reintroducing threatened species to lands

managed by Indigenous people, which occupy over 20% of the Australian landmass. They outline the planning and logistical issues as well as project costs that helped ensure support for the reintroduction of threatened black-footed rock-wallabies (waru, *Petrogale lateralis*) from traditional owners. The authors conclude that large-scale conservation efforts on land managed by Indigenous people not only provides significant opportunities for biodiversity conservation but help further cultural opportunities and improved livelihoods for often disadvantaged communities by providing opportunities for employment and training.

While Ireland *et al.* (2018) report on a case study from Australia, including Indigenous people in the conservation and management of land and resources also has relevance and tradition in New Zealand. For example, a range of reintroduction projects in New Zealand incorporate close partnership between conservation professionals and Māori groups due to the special status or *taonga* held by many endemic species (e.g. Harms 2015), and the ownership of lands by Māori. In addition, the New Zealand government is in active negotiations with many Māori groups (iwi) to settle grievances against the Treaty of Waitangi – often involving land claims. A recent example of how such settlements can increase involvement of Māori in conservation and resource management involves the former Te Urewera National Park. Specifically, as part of a settlement with the Tūhoe iwi, Te Urewera ceased to be a National Park in 2014 to allow joint management by the iwi and the government. This allows for management objectives to include future Tūhoe resource use inside the protected area while Tūhoe continue to allow and support biodiversity conservation on their lands.

Pedler *et al.* (2018) summarise results from a project aimed at reintroducing seven locally extinct marsupials into Stewart National Park, New South Wales, Australia. As a national park, the land is managed by governmental organisations. Due to the negative impact of introduced predators, the reintroduction could only go ahead once two predator exclosures had been erected. Construction and maintenance of fence infrastructure is costly and governed by increasingly complex legislation. Due to the large scale of the project, it not only required ecological impact assessments but significant stakeholder involvement including that of both traditional and non-traditional landowners. The information provided by the authors further highlights legislative and economic challenges. More importantly, the study emphasises the advantages of government-driven conservation projects in remote areas including funding certainty needed for large-scale and long-term projects. Engagement from traditional and non-traditional landowners and other stakeholders, however, will be needed for such strategies to succeed.

Conclusions

Given the overwhelming impact of humans on current high rates of species extinctions worldwide, developing novel conservation and restoration strategies that embrace opportunities in peopled landscapes are required. This is particularly topical in Oceania, an area with highly endemic faunas and floras and among the highest rates of species extinctions (e.g. Duncan *et al.* 2013). Conservation strategies will need to integrate social and

ecological perspectives to account for differences in values among peoples and to reflect variation in issues along urban, rural and wilderness gradients. Current methods, including those used to monitor and manage invasive species, need to be adapted so they can be effectively used in peopled landscapes. This provides great opportunities for community-led initiatives but also poses challenges that should not be underestimated. At the same time, however, government commitment to conservation should expand and embrace stakeholder involvement including with traditional landowners.

Opportunities exist to significantly broaden human involvement in all aspects of conservation planning and implementation. Opportunities for community involvement include problem identification as well as project design, implementation, monitoring, data analysis and dissemination of results (e.g. Peters *et al.* 2016; Anton *et al.* 2018). Increasing community involvement will require rethinking traditional conservation approaches including being proactive about resolving or preventing human–wildlife conflict that is likely to increase due to greater differences in opinions in peopled landscapes (Redpath *et al.* 2013). Finally, uncertainties exist when trying to expand conservation into peopled landscapes. This may sometimes require taking a precautionary approach that offers opportunities for learning and adapting conservation and restoration strategies as projects move along.

Conflict of interest

The authors declare no conflicts of interest

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