



Importance of including cultural practices in ecological restoration

Priscilla M. Wehi ^{1,2*} and Janice M. Lord³

¹Centre for Sustainability (CSAFE), University of Otago, P.O. Box 56, Dunedin 9054, New Zealand

²Landcare Research Manaaki Whenua, Private Bag 1930, Dunedin 9054, New Zealand

³Botany Department, University of Otago, P.O. Box 56, Dunedin 9054, New Zealand

Abstract: *Ecosystems worldwide have a long history of use and management by indigenous cultures. However, environmental degradation can reduce the availability of culturally important resources. Ecological restoration aims to repair damage to ecosystems caused by human activity, but it is unclear how often restoration projects incorporate the return of harvesting or traditional life patterns for indigenous communities. We examined the incorporation of cultural use of natural resources into ecological restoration in the context of a culturally important but protected New Zealand bird; among award-winning restoration projects in Australasia and worldwide; and in the peer-reviewed restoration ecology literature. Among New Zealand's culturally important bird species, differences in threat status and availability for hunting were large. These differences indicate the values of a colonizing culture can inhibit harvesting by indigenous people. In Australasia among award-winning ecological restoration projects, <17% involved human use of restored areas beyond aesthetic or recreational use, despite many projects encouraging community participation. Globally, restoration goals differed among regions. For example, in North America, projects were primarily conservation oriented, whereas in Asia and Africa projects frequently focused on restoring cultural harvesting. From 1995 to 2014, the restoration ecology literature contained few references to cultural values or use. We argue that restoration practitioners are missing a vital component for reassembling functional ecosystems. Inclusion of sustainably harvestable areas within restored landscapes may allow for the continuation of traditional practices that shaped ecosystems for millennia, and also aid project success by ensuring community support.*

Keywords: biocultural restoration, politics and policy, threatened species, traditional ecological knowledge, urban ecology

La Importancia de Incluir las Prácticas Culturales en la Restauración Ecológica

Resumen: *Los ecosistemas en todo el mundo tienen una larga historia de uso y manejo por parte de las culturas indígenas. Sin embargo, la degradación ambiental puede reducir la disponibilidad de los recursos con importancia cultural. La restauración ecológica busca reparar el daño a los ecosistemas causado por la actividad humana, pero no está claro cuán seguido los proyectos de restauración incorporan el regreso de los patrones de cultivo o de vida tradicional de las comunidades indígenas. Examinamos la incorporación del uso cultural de los recursos naturales dentro de la restauración ecológica en el contexto de un ave importante culturalmente, pero protegida en Nueva Zelanda; entre proyectos de restauración ecológica premiados en Australasia y a nivel mundial; y en la literatura de restauración revisada por colegas. Entre las especies de aves con importancia cultural en Nueva Zelanda, las diferencias entre el estado de amenaza y la disponibilidad para la caza fueron grandes. Estas diferencias sugieren que los valores de una cultura que coloniza pueden inhibir la cosecha por parte de los habitantes indígenas. Entre los proyectos de restauración ecológica premiados en Australasia, <17 % involucró el uso humano de las áreas restauradas más allá del uso recreativo o estético, a pesar de que muchos proyectos alentaban la participación comunitaria. A nivel mundial, los objetivos de restauración difirieron entre las regiones. Por ejemplo, la mayoría de los proyectos en América del Norte estaban orientados hacia la conservación, mientras que en Asia y en África los proyectos comúnmente se enfocaban en la restauración de la cosecha cultural. De 1995 y hasta 2014 la literatura de*

*email webip@landcareresearch.co.nz

Paper submitted March 3, 2016; revised manuscript accepted February 10, 2017.

la ecología de la restauración contenía pocas referencias a los valores o al uso cultural. Argumentamos que a los restauradores les falta un componente vital para el reensamblaje de los ecosistemas funcionales. La inclusión de las áreas sustentablemente cosechables dentro de los paisajes restaurados puede no sólo permitir la continuación de las prácticas tradicionales que dieron forma a los ecosistemas durante milenios, sino también apoyar en el éxito de los proyectos al asegurar el apoyo de la comunidad.

Palabras Clave: conocimiento ecológico tradicional, ecología urbana, especies amenazadas, política y póliza, restauración biocultural

Introduction

When if ever, can people exercise their cultural rights to harvest, and where can they do so? These questions lay at the heart of a media storm in New Zealand that stemmed from news of an illegal harvest of a protected species. In June 2015, a prominent tribal leader was arrested for possession of 5 plucked Kereru (*Hemiphaga novaeseelandiae*). The Kereru, New Zealand's largest extant forest bird (653 g), is a traditional delicacy for the indigenous Maori people, particularly for chiefs, pregnant women, or those near death. They are thus highly valued, but have also, together with other native nongame birds, been protected from harvesting since 1911 (Feldman 2001). The illegal harvest of these Kereru was widely, but not universally, condemned. For example, another prominent tribal leader declared the harvest culturally acceptable because "article two of the Treaty of Waitangi [the founding document of modern New Zealand] guarantees Maori the full, exclusive and undisturbed possession of our flora and fauna" (Newshub 2015). Nonetheless, in New Zealand, it is illegal to hunt or kill Kereru, possess eggs, or disturb a nest. Penalties include substantial fines and imprisonment (Project Kereru 2014).

The broader debate surrounding this case of illegal Kereru harvesting focuses on cultural values and harvesting by indigenous people and the place of harvesting in ecological restoration. Despite this, few researchers have quantified restrictions on indigenous management practices or their effects in ecological restoration projects (Liu et al. 2007). *Ecological restoration* is defined as assisting in the recovery of ecosystems that have been degraded, damaged, or destroyed (SERI 2004) and in particular repairing damage to ecosystem diversity and functioning caused by human activities. In some models, the associations between indigenous people and their land are considered "natural" (Jackson et al. 1995). The length of these associations (up to 40,000 years or more on continents such as Australia) means that in most parts of the world, indigenous communities have been actively involved in sustainable plant production systems (e.g., Turner 2014), and in many ecosystems human activity is integral to the maintenance of biodiversity and ecosystem functioning (Yibarbuk et al. 2001; Zu Ermgassen et al. 2012). The importance of reciprocity between people and their environment in traditional management prac-

tices, and in indigenous worldviews, is evident in these connections (e.g., Roberts et al. 1995; Kimmerer 2013), but their contributions to ecosystem functioning are frequently overlooked and poorly understood (Keenleyside et al. 2012).

Natural resources are the foundation of cultural systems and intrinsic to culture in the symbolic realms of art, music, and ritual (Fischer-Kowalski & Weisz 1999; Haberl et al. 2006). More fundamentally, human self-identity and group identity are intimately connected to the environment, as is health and well-being (Stephenson 2008; Kimmerer 2013; Clark et al. 2014). Researchers increasingly realize the implications of connections across cultural, linguistic, and biological diversities for both nature and culture (Maffi 2005). In many cases, ecological and social systems are tightly interdependent; major change in either system has repercussions in the other (Liu et al. 2007). The Convention on Biodiversity (CBD) (Intergovernmental Negotiating Committee 1992) connects biodiversity conservation to human well-being. In 2004, parties to the CBD established a framework to measure progress toward significantly reducing biodiversity loss (United Nations Environment Programme 2004). The updated 2010 framework explicitly identifies 2 of 7 focal areas in the Biodiversity Indicators Partnership (2010) as the traditional knowledge, innovation, and practices of indigenous and local communities and sustainable use. This holistic socioecological approach is evident in the restoration ecology literature, where Higgs (1997), for example, argues that healthy relationships between people and the land must take into account the full range of political, historical, and cultural contexts.

Over the last 20 years, there has been an explosion of community-managed restoration projects aiming to initiate or accelerate ecosystem recovery and reverse environmental degradation caused by human activities (Clewell et al. 2005). However, constraints on human-nature interactions (e.g., Wehi & Wehi 2010; Nuno et al. 2013; Lyver et al. 2015) are sometimes established to ensure species and ecosystem protection, despite negative consequences for the traditional relationships of local people with the land. The International Union for Conservation of Nature explicitly recognizes associated cultural values and traditional natural resource management systems in ecological restoration and the need to encourage and reestablish traditional cultural values and practices and

to contribute to sustainable livelihoods for indigenous people in protected areas (Keenleyside et al. 2012).

We sought to determine the extent to which resource use by local or traditional communities is integrated into the planning and implementation of restoration projects. We focused on restoration practice in Australasia, where strong conservation ethics and well-defined conservation practices combine with a recent history of European colonization. We first used Kereru as a case study to examine inconsistencies in the protected status of New Zealand native bird species and highlight issues at the intersection of legal and cultural frameworks that reflect fundamental differences in values among communities. Second, we analyzed data from award-winning restoration projects in Australasia and other regions listed on the Global Restoration Network (GRN) (LeFevour et al. 2007) to compare the extent to which cultural values are integrated into restoration goals and to determine whether cultural use is considered a legitimate goal of restoration. Finally, we reviewed the literature to evaluate the extent to which cultural use is discussed in restoration ecology research.

Methods

Protected Status of Tribally Valued Bird Species

We sourced threat status data for all native New Zealand bird species from Robertson et al. (2013) and compared their data with the list of species defined as game birds in the Wildlife Act 1953 (<http://www.teara.govt.nz/en/game-birds>). To identify which birds are *taonga* (i.e., highly valued) species for Maori, we focused on the Ngai Tahu Claims Settlement Act (1998), which lists bird species considered *taonga* by the Ngai Tahu people, who are traditional owners for much of the South Island of New Zealand. We consulted McCallum (2008) to further identify species particularly important as resources for southern Maori. Other tribes may have different priorities; however, we believe these sources provide a reasonable snapshot of cultural use and are thus useful for highlighting legal and cultural frameworks.

Restoration Goals in Australasia and Globally

We analyzed the goals of award-winning restoration projects from Australasia as identified by the GRN in 2009 based on criteria from the SER Primer (SERI 2004) and listed at <http://www.globalrestorationnetwork.org/countries/australianew-zealand/> (accessed May 2014). We examined online material describing these projects and sought Supplementary Data from project managers. Information to score projects was obtained for 21 of 34 projects in Australia and 9 of 9 projects in New Zealand. We scored each project (1 or 0) according to 4 categories of community involvement: planning; implementation;

aesthetic, recreational, or educational use; and economic or utilitarian use. Utilitarian activities included firewood gathering, hunting and gathering, and harvesting of plant fibers or other material for cultural purposes. In some cases, adequate information was unavailable for all categories; thus, there is some variation in sample sizes among categories. A few projects (e.g., those on military land and in scientific reserves) were excluded from the utilitarian category because legal frameworks prevent these types of activities.

To compare Australasian priorities with global restoration priorities, we examined the frequency with which resource use was a goal in 204 restoration projects catalogued by the GRN (SERI 2004). Hallett et al. (2013) investigated 203 of these projects and found that close to 60% included at least some community, cultural, economic, education, or governance goals, but they did not explore the frequency of economic use of resources as a restoration goal. The same 4 categories of community involvement used to analyze Australasian projects were applied to these 204 projects.

Cultural Values in the Literature

We searched the ISI Web of Science for journal articles published from 1995 through 2014 to evaluate the extent to which restoration ecology research included indigenous or historic cultural values, aspirations, and use of natural resources. We excluded medically, architecturally, mechanically, and technologically focused papers. We searched for articles that incorporated any of the following phrases: *biodiversity restoration*, *biological restoration*, *habitat restoration*, *nature restoration*, *restoration biology*, *restoration ecology*, and *ecological restoration*. We used these terms because, like Hobbs and Norton (1996), we were less concerned with debate over definitions and more concerned with capturing a meaningful picture of restoration theory and practice. We refined the search to identify journal articles that used at least one keyword from each of the following 2 sets: *cultur**, *history**, *tribal*, *tribe*, *tradition**, *indigenous* and *use**, *utili**, *harvest**, *gather**, *collect**, *bunt* food**, *material**, where an asterisk denotes a wildcard to ensure that all potential articles relevant to cultural values would be included. All search terms are listed in Supporting Information. We used the text-analysis application TagCrowd (Steinbeck 2006) to extract the most frequently occurring subject-matter relevant words in the abstracts of these articles, excluding the first set of search keywords used in ISI Web of Science search and scientific-method words (e.g., *control*). All excluded words are listed in Supporting Information.

Table 1. New Zealand bird species listed as *taonga* (treasures) in the Ngai Tahu Claims Settlement Act. ^b

<i>Threat category^a</i>	<i>Taonga bird species</i>	<i>Availability for customary harvesting</i>
Nationally critical	Kakapo ^b , Kaki (Black Stilt), Kotuku ^b (White Heron), Parera ^c (Grey Duck), Rowi ^b (Okarito Brown Kiwi), Takahe, Tarapunga (Black-billed Gull), Toroa ^b (Antipodean Albatross).	Dead animals may be available for cultural use (e.g., feathers for cloaks). Harvesting illegal for all species with the exception of Stewart Island Weka, which is available for harvest under Department of Conservation permit on some offshore islands (Department of Conservation 2006)
Nationally endangered	Kea, Matuku (Bittern), Matuku moana (Reef Heron), Piwauwau (Rock Wren), Tarapirohe (Black-fronted Tern), Tawaki (Fiordland Crested Penguin), Weka ^b (Stewart Island).	
Nationally vulnerable	Hoiho (Yellow-eyed Penguin), Kaka ^b , Kamana (Crested Grebe), Karearea ^b (NZ Falcon), Kowhiowhio ^d (Blue Duck), Mata (Fernbird), Mohua (Yellowhead), Ngutu pare (Wrybill), Roroa ^b (Great Spotted Kiwi), Tokoeka ^b (South Island Brown Kiwi), Turiwhatu (Banded Dotterel).	
At risk (declining, recovering, or naturally uncommon)	Kakariki (Parakeet), Koekoea (Long-tailed Cuckoo), koau (Black and Pied Shag), Korora (Blue Penguin), Kuaka (Godwit), Pateke ^d (Brown Teal), Pihoihoi (Pipit), Poaka (Pied Stilt), Pokotiwha (Snares Crested Penguin), Tieke (Saddleback), Titi ^b (Sooty Shearwater & various petrels), Torea (Pied Oystercatcher), Toutouwai (Stewart Island Robin), Toroa ^b (albatrosses and mollymawks), Tutukiwi (Snares Island Snipe), Weka ^b (Buff).	harvesting illegal for all species with the exception of Titi, which is harvested by family groups who have sole access to certain islands (Moller et al. 2009)
Not threatened	Kahu (Harrier Hawk), kakaruai (South Island Robin), Karoro ^b (Black-backed Gull), Kereru ^b (Wood Pigeon), Koau (Little Shag), Korimako (Bellbird), Kotare (Kingfisher), Kuruwhengi ^c (Shoveler), Miromiro (South Island Tomtit), Pukeko ^c , Pipipi (Brown Creeper), Pipiwharauoa (Shining Cuckoo), Piwakawaka (Fantail), Putakitaki ^c (Paradise Shelduck), Riroriro (Grey Warbler), Ruru ^b (Morepork), Tete ^d (Grey Teal), Tititi-pounamu (South Island Rifleman), Tui, Weka ^b (Western).	harvesting illegal for all species unless otherwise indicated, with the exception of Karoro which is not protected under the Wildlife Act and Kahu which has only partial protection (Department of Conservation 2006)

^aThreat classification of species following Robertson et al. (2013).

^bListed in McCallum (2008) as important sources of food or feathers for Southern Maori.

^cWaterfowl on the New Zealand Game Birds register; thus, they can be hunted in season with a license.

^dWaterfowl explicitly excluded from the Game Birds Register.

Results

Protected Status of Tribally Valued Bird Species

Threat status, game status, and importance for cultural harvesting differed among *taonga* bird species (Table 1). For example, inconsistencies existed between threat status and availability for use of Karoro (*Larus dominicanus*) and Kereru. Both species are listed as *taonga* for a number of indigenous tribes and listed as not threatened in the New Zealand Threatened Species Classification system. However, Karoro are not protected and can be legitimately hunted or culled by farmers concerned about stock attacks, whereas Kereru are fully protected

and cannot be legally harvested. Similarly, Parera (*Anas superciliosa*) are listed as nationally critical, but are legal game birds. In contrast, many mollymawks and albatrosses are protected and cannot be harvested legally despite a history of cultural harvest by Maori communities (Table 1).

Restoration Goals in Australasia and Globally

Almost all the award-winning projects in Australia and New Zealand had high levels of community representation at the planning stage. Moreover, community volunteers provided a significant amount of labor (Fig. 1).

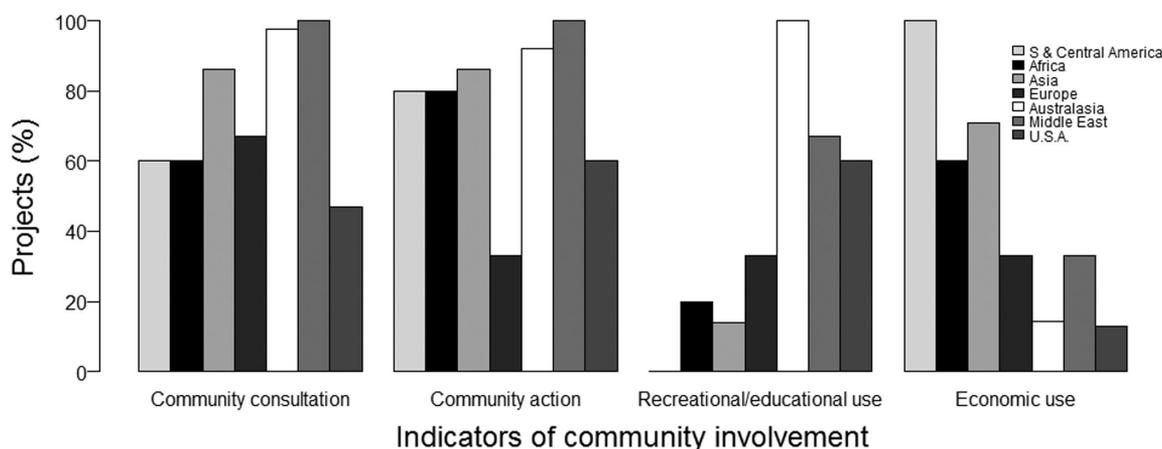


Figure 1. Inclusion of recreational, educational, and economic use of natural resources and of community involvement in award-winning Australasian restoration projects and global projects listed in the Global Restoration Network.

All projects reported aesthetic and recreational use of the restored sites by the community. However, less than half of projects in Australia and none in New Zealand reported natural resource use for medicine, food, weaving, or firewood, for example (Fig. 1). That is, utilitarian activities and cultural harvesting appeared rarely incorporated in these projects. This may, in part, be related to governance. Five of the 9 award-winning projects in New Zealand were administered by the Department of Conservation, and in all 9 projects indigenous representation (e.g., as a proportion of Trustees) at the governance level was relatively low. Notable exceptions include the Australian Bounceback project. Pastoral lease holders participating in this project are proud that 20 years of pest management have enabled yellow-footed rock wallaby (*Petrogale xanthopus*) recovery such that traditional cultural hunting of the animal may again be possible (L. Gavin, personal communication). However, even restoration projects that recognize the strong association of indigenous people with the land can have difficulty incorporating cultural use into aims and management. In a restoration project at Maungatautari, New Zealand, local Maori provide guidance on the reintroduction of wildlife to the 3400-ha predator-free sanctuary. However, the 5 key criteria that guide decision making on reintroduction potential in Maungatautari do not include cultural value to, or potential use by, the indigenous community (Smuts-Kennedy & Parker 2013).

Of the 204 projects listed by the GRN, only 40 (same subset examined by Hallett et al. [2013]) identified social goals for restoration, and the majority of these included community consultation and active involvement. The GRN database consists of unverified projects self-reported by restoration ecologists, so it does not necessarily represent an unbiased sample of projects worldwide. However, it provided project details often missing in other published sources and thus yielded useful in-

formation on patterns and approaches. Among the 40 projects we examined, the degree to which economic or utilitarian use was reported as a goal of restoration projects differed among regions (Fig. 1). Projects from North America, like the Australasian projects, seldom mentioned goals associated with economic or utilitarian use. In contrast, GRN projects from Central and South America, Asia, and Africa included these types of goals more often than not, suggesting stronger links between environmental objectives and patterns of traditional resource use in these locations (Fig. 1).

Cultural Values in the Restoration Ecology Literature

Of 3907 journal articles that met our initial search criteria, 891 referenced cultural values or tribal or indigenous people (Fig. 2), an average of 22.2% (SD 3.9, range 11.5% [1997] to 31.2% [2003]) of the restoration ecology articles published each year. Of those 891 articles, 565 (13.5%) explicitly mentioned values linked to indigenous harvesting practices or use in the context of restoration. Terms related to cultural values and harvesting did not appear often in the abstracts of these 565 papers (Fig. 3). For example, *historical* occurred more frequently than *community* or *cultural*, and *indigenous*, *traditional*, and *harvesting* were not among the 60 most frequently occurring words. The number of articles that referred to cultural values or use did not increase proportionally over time (Pearson's correlation coefficient $r = 0.3057$, $p > 0.05$), despite a concomitant increase in the overall number of restoration ecology articles (Fig. 2).

Discussion

The cultural values that underpin resource use by indigenous people are underrecognized in the literature,

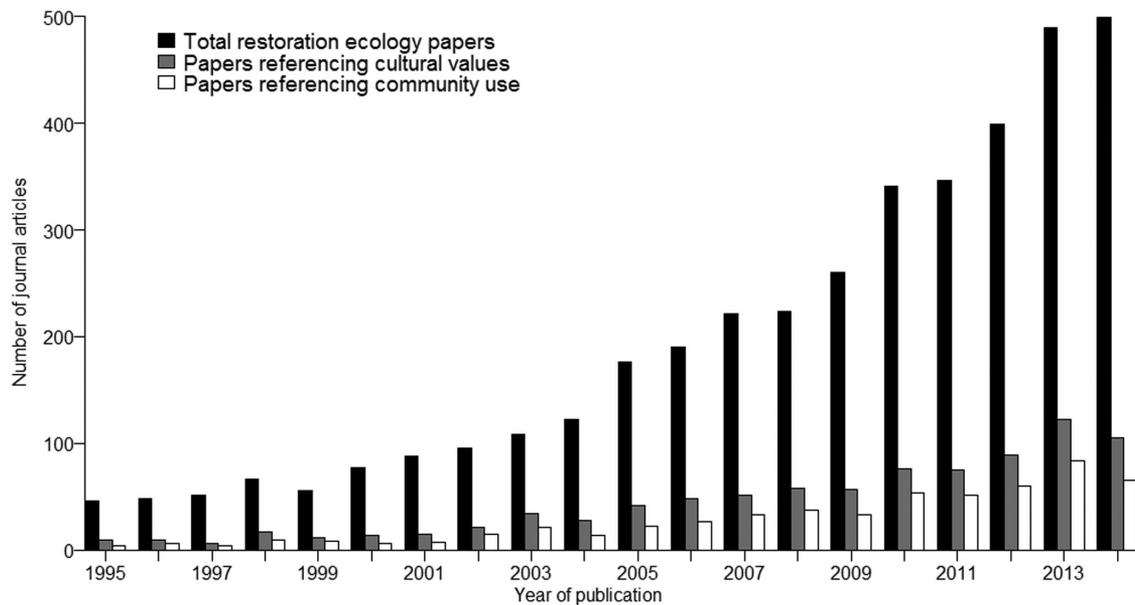


Figure 2. The number of journal articles over time abstracted on ISI Web of Science that mention restoration ecology or ecological restoration (total papers) and those that reference cultural, traditional, or tribal values and harvesting or use of natural resources. Details of the search terms are given in Supporting Information.

despite past and continuing research identifying the importance of socioecological linkages in successful biodiversity restoration (e.g., Keenleyside et al. 2012). Cultural values are also infrequently included in the goals and priorities of restoration projects self-reported by the GRN. Although this database may not be representative, our findings indicate that indigenous values and use are seldom included in ecological restoration projects in parts of the world where modern societal values and governance are strongly influenced by a colonizing culture, thus providing very limited encouragement for language and culture retention of local indigenous people, both of which are strongly linked to biodiversity use (Maffi 2005). Furthermore, neither ceremonial and medicinal harvesting of plants nor basic food requirements were prominently referenced in the literature we examined; rather, references to culture were generally historical. The failure of most restoration projects to incorporate utilitarian values that fulfill the reciprocity philosophy of indigenous worldviews contrasts with research findings that active community participation and use of resources increase the long-term success of restoration projects. For example, Tibetan villagers who retain high levels of traditional practice have more positive attitudes toward conservation and participate more actively in restoration projects (Shen et al. 2012).

The 30 award-winning Australasian restoration projects we examined represent a small sample size, but because they conformed to best practice guidelines published by the Society for Ecological Restoration, they are a useful index of dominant thought in the field. Few of

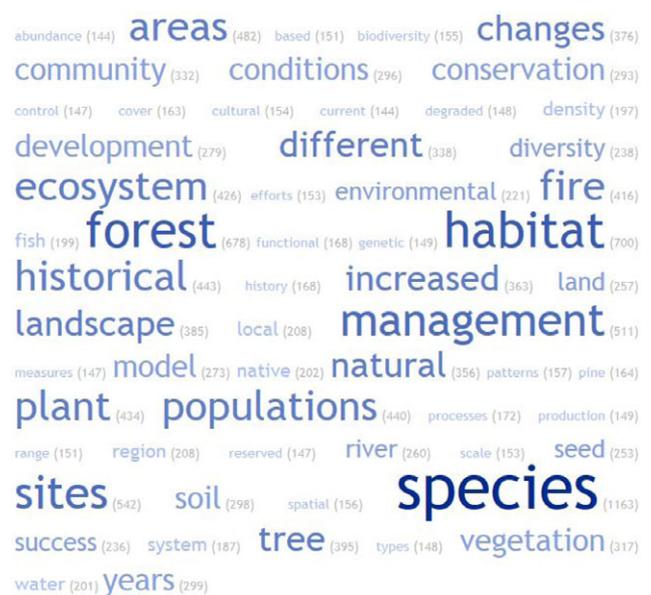


Figure 3. The 60 most frequently occurring subject-relevant words related to restoration ecology in the abstracts of 565 peer-reviewed articles published from 1995 through 2014 in the restoration ecology literature that explicitly mention cultural use of natural resources. Word size is proportional to relative frequency of occurrence.

the projects had strong cultural components, and there was a dearth of information about restoration projects led by indigenous groups in Australasia. Many projects had strong linkages between central or local government

and the community; therefore, these projects may be more influenced by government policy than independent or culturally driven projects. Establishment era may also influence the vision of restoration projects. For example, many of the award-winning Australasian projects began in the 1980s and 1990s. Since then, one of the largest national parks in New Zealand has attained personhood status, as a response to the worldviews of the local indigenous people, Tūhoe (Ruru 2014). Other projects governed by indigenous people are not included in the GRN database (e.g., the Ko Te Pukaki restoration project for which customary use is a central goal [Auckland City Council 2014]).

Despite these encouraging exceptions, the overall mismatch between cultural aspirations and restoration goals appears a fundamental feature of community engagement with restoration projects, at least in Australasia. In a survey of >600 community groups involved in New Zealand restoration projects, Peters et al. (2015) found that >95% of groups reported environmental objectives such as preserving and protecting, but even among groups that reported social and cultural objectives (e.g., “the retention of traditional practices”), activities were environmentally focused with no explicit harvesting or general-use activities or objectives listed (Peters et al. 2015). These findings align with attitudes noted in the international literature, where the separation of people from important ecological spaces often remains a priority (Reyes 2011). As such, ecological restoration runs the risk of being another form of colonial hegemony, where the needs and aspirations of indigenous people are overwhelmed by a dominant conservation ethic that places humans outside of nature.

The difficulties associated with incorporating use of native species in restoration management are magnified in legal frameworks that afford species different levels of protection. Plant harvesting and use may be easier for restoration groups to accommodate than harvesting of birds or other vertebrates. In New Zealand, both the legislative framework and strong public interest in birds are barriers to the reinstatement of traditional bird harvests (Feldman 2001). The influence of European traditions is also evident in the list of New Zealand native game birds, which includes the nationally critical Parera. In contrast, mollymawks and albatrosses, venerated by European sailors, cannot be harvested legally despite their history of indigenous use.

The case of illegal Kereru harvesting in New Zealand embodies a legacy of conflict in attitudes toward wildlife. Sport hunting was important in the establishment of colonial New Zealand society but at odds with the Maori focus on birds as a food source (Feldman 2001). Government officials used the game-management framework established in the 19th century to erode Maori rights of access to Kereru, beginning with the Wild Birds Protection Act in 1869 and leading to the absolute protection of Kereru

in 1922 (Feldman 2001). Although Kereru numbers have been considerably reduced (Lyver et al. 2008), they are still thought to have a large, stable population nationally (Robertson et al. 2013).

Population viability modeling does not unambiguously support a return to Kereru harvesting because a number of population parameters remain poorly defined and understood (Lyver et al. 2008), but there is an opportunity, in this case, to link ecological restoration with cultural use. Tribal groups are keenly aware that their role as *kaitiaki* (caretakers) has been sidelined by the full legislative protection of Kereru (Feldman 2001; Lyver et al. 2008). In the meantime, human activity that has been an integral component of indigenous culture for hundreds of years is excluded as a component of ecosystem functioning. A re-vesting of authority with tribal groups for the sustainable use of culturally important species is a long-overdue step that ought to be taken.

Without the ability to use resources in traditional ways, the principle of reciprocity that is central to both ecosystem health and stewardship in indigenous worldviews will wither (Kimmerer 2013). In turn, indigenous cultures and languages will be lost because of the powerful linkages between culture, language, and biodiversity (Maffi 2005). Long-term effects on human well-being and the desire to support biodiversity restoration and conservation could be diminished if human activity is restricted and utilitarian values ignored (Stephenson 2008; Clark et al. 2014). Preventing traditional practices in restored ecosystems may assist biodiversity conservation in the short term, but severing the link between communities and their culturally significant species and landscapes will have long-term effects.

Building Cultural Values into Restoration

Restoration ecology sits at the junction of science and society and thus is uniquely affected by the different cultures of, and conflicts among, scientists, restoration practitioners, and stakeholders (e.g., Gobster 2001; Higgs 2005; Naveh 2005). Spatially explicit local knowledge is crucial for ecosystem management and monitoring in a range of cultures (Herrick et al. 2010). Likewise, local knowledge, including indigenous knowledge, may provide more comprehensive answers to restoration and management questions and result in improved community engagement in restoration projects. The incorporation of pragmatic values provides for meaningful community involvement and a greater chance of long-term success (Saslis-Lagoudakis & Clarke 2013). Ensuring communities accrue tangible benefits can cement a long-term relationship between people and place and allow management practices to evolve (Turner 2014). However, one of the challenges of restoration projects is to convey the benefits of restoration to the focal community, be

they economic returns (Wunder 2007; Huang et al. 2012) or reinforcement of cultural values.

The costs of biodiversity monitoring can be high in poor countries (e.g., Danielsen et al. 2003), but even wealthy countries are not exempt from the financial stress of action to restore biodiversity. In 2012, the Department of Conservation in New Zealand devolved considerable responsibility for monitoring and eradication of invasive species to communities. Such a policy change increases the vulnerability of restoration efforts if community support decreases, because restored ecosystems can quickly revert to highly degraded states (Norton 2009). We suggest that the use of natural resources will not only enhance long-term commitment to restoration projects, but also support the reciprocal relationship between humans and the environment and help reestablish indigenous practices that have frequently shaped and managed environments successfully for long periods. We strongly recommend the inclusion of traditional ecological knowledge and social engagement in future restoration frameworks. Professional bodies such as the Society for Ethnobiology and the Society of Ecological Restoration also have a part to play, by including a strong commitment to local knowledge and practices in their standards documents, and reinvigorating and supporting networks such as the Indigenous People Restoration Network.

We are not advocating a return to biodiversity exploitation; some species or ecosystems may never be restored to a point where plants and animals can be used sustainably. For cultural harvesting to succeed within restoration projects, populations must be managed sustainably based on well-informed demographic models, and new legislation protecting species within prescribed population limits may be required to ensure sustainable use. Model simulations can inform sustainable-harvest goals, although insufficient data on population abundance and life history lead to uncertainty around outcomes (Lyver et al. 2008, 2009). Where key species viability parameters are unknown, other strategies could be tested. Using cultural indices to assess ecosystem function supports sustainable practice and is likely to reduce overharvesting (e.g., Tipa & Teirney 2003; Turner 2014). Using the community's most powerful resource—its people—to monitor restoration and harvesting initiatives is likely to lead to better outcomes. To ensure the maintenance of source populations, we advocate establishment of reserve patches among human-use patches. This approach has been an effective strategy in marine conservation. Such arrays are reminiscent of indigenous people's conservation methods, such as *rābui* (the setting aside of a locality to restrict harvesting in Maori culture). Returning decision making to relevant communities may avoid overharvest of a resource if communities have appropriate tools and funding to actively monitor populations and control harvest intensity. We suggest that by restoring the relationship between people and the

land and encouraging sustainable use of natural areas, whether firewood or fungi collecting, uptake and success of restoration projects is likely to increase. This will require full collaboration with local communities, beyond initial consultation, to identify their needs and priorities and answer their important questions, such as when can we harvest and where? Doing so will provide both impetus to action and hope in indigenous communities that wish to retain both cultural and biological diversity.

Acknowledgments

Ngā Pae o Te Maramatanga contract 11RFO2-BHUOT and Rutherford Discovery Fellowship funding 14-LCR-001 supported P.M.W. Many thanks to W. Lee for insightful comments on not one but 2 earlier drafts of the manuscript and to 3 anonymous referees whose thoughtful comments improved the manuscript.

Supporting Information

Search terms (Appendix S1) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

Literature Cited

- Auckland City Council. 2014. Ko te Pūkākī twelve year review. Auckland City Council, Auckland. Available from <http://www.aucklandcouncil.govt.nz/SiteCollectionDocuments/aboutcouncil/committees/ngatiwhatauaorakeireservesboard/meetings/ngatiwhatauaorakeireservesbrd12yrreview.pdf> (accessed October 2016).
- Biodiversity Indicators Partnership (BIP). 2010. BIP. Cambridge, United Kingdom. Available from <https://www.bipindicators.net/> (accessed March 2016).
- Clark N, Lovell R, Wheeler B, Higgins S, Depledge M, Norris K. 2014. Biodiversity, cultural pathways, and human health: a framework. *Trends in Ecology & Evolution* 29:198–204.
- Clewell A, Reiger J, Munro J. 2005. Guidelines for developing and managing ecological restoration projects. Society for Ecological Restoration International, Washington, D.C. Available from <https://www.ser.org/resources/resources-detail-view/ser-guidelines-for-ecological-restoration> (accessed October 2013).
- Danielsen F, Mendoza M, Alviola P, Balete DS, Enghoff M, Poulsen MK, Jensen AE. 2003. Biodiversity monitoring in developing countries: What are we trying to achieve? *Oryx* 37:1–3.
- Department of Conservation. 2006. Review of level of protection for some New Zealand wildlife. Public Discussion Document, Strategy and Policy Planning Group, Department of Conservation, Wellington.
- Feldman JW. 2001. Treaty rights and pigeon poaching. Alienation of Maori access to kereru, 1864–1960. Waitangi Tribunal Publication, Wellington.

- Fischer-Kowalski M, Weisz H. 1999. Society as hybrid between material and symbolic realms: toward a theoretical framework of society-nature interaction. *Advances in Human Ecology* **8**:215–252.
- Gobster PH. 2001. Visions of nature: conflict and compatibility. *Landscape and Urban Planning* **56**:35–51.
- Haberl H, et al. 2006. From LTER to LTSER: conceptualizing the socioeconomic dimension of long-term socioecological research. *Ecology and Society* **11**:13. Available from <http://www.ecologyandsociety.org/vol11/iss2/art13/>.
- Hallett LM, Diver S, Eitzel MV, Olson JJ, Ramage BS, Sardinas H, Statman-Weil Z, Suding KN. 2013. Do we practice what we preach? Goal setting for ecological restoration. *Restoration Ecology* **21**:312–319.
- Herrick JE, Lessard VC, Spaeth KE, Shaver PL, Dayton RS, Pyke DA, Jolley L, Goebel JJ. 2010. National ecosystem assessments supported by scientific and local knowledge. *Frontiers in Ecology and Environment* **8**:403–408.
- Higgs E. 1997. What is good ecological restoration? *Conservation Biology* **11**:338–348.
- Higgs E. 2005. The two-culture problem: ecological restoration and the integration of knowledge. *Restoration Ecology* **13**:159–164.
- Hobbs RJ, Norton DA. 1996. Towards a conceptual framework for restoration ecology. *Restoration Ecology* **4**:93–110.
- Huang L, Shao Q, Liu J. 2012. Forest restoration to achieve both ecological and economic progress, Poyang Lake basin, China. *Ecological Engineering* **44**:53–60.
- Intergovernmental Negotiating Committee. 1992. Convention on biological diversity. Convention on Biological Diversity Secretariat, Montreal. Available from <http://www.cbd.int/doc/legal/cbd-en.pdf> (accessed October 2013).
- Jackson LL, Lopolukhine N, Hillyard D. 1995. Ecological restoration: a definition and comments. *Restoration Ecology* **3**:71–75.
- Keenleyside KA, Dudley N, Cairns S, Hall CM, Stolton S. 2012. Ecological restoration for protected areas: principles, guidelines and best practices. International Union for Conservation of Nature, Gland, Switzerland.
- Kimmerer RW. 2013. Braiding sweetgrass. Indigenous wisdom, scientific knowledge, and the teachings of plants. Milkweed Editions, Minneapolis, Minnesota.
- LeFevour MK, Jackson L, Alexander S, Gann GD, Murcia C, Lamb D, Falk DA. 2007. Global restoration network (www.GlobalRestorationNetwork.org). Society for Ecological Restoration International, Tucson, Arizona.
- Liu J, et al. 2007. Complexity of coupled human and natural systems. *Science* **317**:1513–1516.
- Lyster POB, Jones C, Doherty J. 2009. Flavor or forethought: Tuhoe traditional management strategies for the conservation of kereru (*Hemiphaga novaeseelandiae novaeseelandiae*) in New Zealand. *Ecology and Society*. **14**:40. Available from <http://www.ecologyandsociety.org/vol14/iss1/art40/>.
- Lyster POB, Jones CJ, Belshaw N, Anderson A, Thompson R, Davis J. 2015. Insights to the functional relationships of Maori harvest practices: customary use of a burrowing seabird. *Journal of Wildlife Management* **79**:969–977.
- Lyster POB, Taputu T, Kutia S, Tahī B. 2008. Tūhoe Tuawhenua mātauranga of kererū (*Hemiphaga novaeseelandiae novaeseelandiae*). *New Zealand Journal of Ecology* **32**:7–17.
- Maffi L. 2005. Linguistic, cultural and biological diversity. *Annual Review of Anthropology* **29**:599–617.
- McCallum R. 2008. He kete taoka. Southern cultural materials resource kit. Komiti Taoka Tuku Iho, Dunedin, New Zealand.
- Moller H, Kitson JC, Downs TM. 2009. Knowing by doing: learning for sustainable muttonbird harvesting. *New Zealand Journal of Zoology* **36**:243–258.
- Naveh Z. 2005. Epilogue: towards a transdisciplinary science of ecological and cultural landscape restoration. *Restoration Ecology* **13**:228–234.
- Newshub. 2015. Sonny Tau kereru crime ‘culturally acceptable’—Ngapuhi leader. Newshub, 25 June. Available from <http://www.newshub.co.nz/nznews/sonny-tau-kereru-crime-culturally-acceptable—ngapuhi-leader-2015062513> (accessed March 2016).
- Ngāi Tahu Claims Settlement Act. 1998. Available from www.legislation.govt.nz/act/public/1998/0097/latest/DLM429090.html (accessed February 2014).
- Norton D. 2009. Species invasions and the limits to restoration: learning from the New Zealand experience. *Science* **325**:569–571.
- Nuno A, Bunnefeld N, Naiman L, Milner-Gulland E. 2013. A novel approach to assessing the prevalence and drivers of illegal bushmeat hunting in the Serengeti. *Conservation Biology* **27**:1355–1365.
- Peters MA, Hamilton D, Eames C. 2015. Action on the ground: a review of community environmental groups’ restoration objectives, activities and partnerships in New Zealand. *New Zealand Journal of Ecology* **39**:179–189.
- Project Kereru. 2014. New Zealand. About us. Available from <http://projectkereru.org.nz/about-us> (accessed March 2016).
- Reyes JE. 2011. Public participation and socioecological resilience. Pages 79–92 in Egan D, Hjerpe EE, Adams J, editors. *Human dimensions of ecological restoration*. Island Press, Washington, D.C.
- Roberts M, Norman W, Minhinnick N, Wihongi D, Kirkwood C. 1995. Kaitiakitanga. Maori perspectives on conservation. *Pacific Conservation Biology* **2**:7–20.
- Robertson H, et al. 2013. Conservation status of New Zealand birds, 2012. *New Zealand threat classification series 4*. Department of Conservation, Wellington.
- Ruru J. 2014. Te Urewera Act 2014. Maori Law Review. Available from <http://maorilawreview.co.nz/2014/10/tuhoe-crown-settlement-te-urewera-act-2014/> (accessed October 2016).
- Saslis-Lagoudakis C, Clarke A. 2013. Ethnobiology: the missing link in ecology and evolution. *Trends in Ecology & Evolution* **28**:67–68.
- SERI (Society for Ecological Restoration International). 2004. The SERI international primer on ecological restoration. SERI, Science & Policy Working Group, Tucson, Arizona.
- Shen X, Li S, Chen N, Li S, McShea W, Lu Z. 2012. Does science replace traditions? Correlates between traditional Tibetan culture and local bird diversity in Southwest China. *Biological Conservation* **145**:160–170.
- Smuts-Kennedy C, Parker KA. 2013. Reconstructing avian biodiversity on Maungatautari. *Notornis* **60**:93–106.
- Steinbeck D. 2006. TagCrowd web application. Available from <http://tagcrowd.com> (accessed February 2016).
- Stephenson J. 2008. The cultural values model: an integrated approach to values in landscapes. *Landscape and Urban Planning* **84**:127–139.
- Tipa G, Teirney L. 2003. A cultural health index for streams and waterways: indicators for recognizing and expressing Maori values. Technical paper 75, Ministry for the Environment, Wellington.
- Turner NJ. 2014. Ancient pathways, ancestral knowledge: ethnobotany and ecological wisdom of indigenous people of Northwestern North America, Volume 1 and 2. McGill–Queen’s University Press, Montreal.
- United Nations Environment Programme. 2004. Decisions adopted by the Conference of the Parties to the Convention on Biological Diversity at its seventh meeting (UNEP/CBD/COP/7/21/Part 2). Decision VII/30. UN Environment Programme, Rome. Available from <https://www.cbd.int/decision/cop/default.shtml?id=7767> (accessed February 2016).
- Wehi PM, Wehi WL. 2010. Traditional plant harvesting in contemporary fragmented and urban landscapes. *Conservation Biology* **24**:594–604.

- Wunder S. 2007. The efficiency of payments for environmental services in tropical conservation. *Conservation Biology* **21**:48–58.
- Yibarbuk D, Whitehead PJ, Russell-Smith J, Jackson D, Godjuwa C, Fisher A, Cooke P, Choquenot D, Bowman DMJS. 2001. Fire ecology and Aboriginal land management in central Arnhem Land, northern Australia: a tradition of ecosystem management. *Journal of Biogeography* **28**:325–343.
- Zu Ermgassen PSE, et al. 2012. Historical ecology with real numbers: past and present extent and biomass of an imperilled estuarine habitat. *Proceedings of the Royal Society B* **279**:3393–3400.