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Four Islands EcoHealth Network: An Australasian initiative building synergies between the restoration of ecosystems and human health

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Abstract

Reversing the spiralling trajectory of ecological degradation requires a profound paradigm shift that more explicitly links human and ecosystem health. Human health, as used here, includes wellbeing and livelihoods, which are largely determined by socio-cultural, economic and environmental drivers. Ecological restoration and related restorative activities can contribute substantially to human health. However, restoration projects differ widely and health impacts can be difficult to quantify. Interdisciplinary restoration networks are important for investigating the complex socio-cultural, economic and environmental dynamics that characterize restoration practice and related health outcomes. We present the Four Islands EcoHealth Network (FIEN) as an exemplar for establishing interdisciplinary project connectivity to clarify intersections between ecosystem restoration and human health. FIEN is a cooperative regional restoration network within Australia and Aotearoa New Zealand which aims to research and devise strategies for restoration to simultaneously improve human health and repair native ecosystems. FIEN will operate collaboratively at local and regional scales to expand interdisciplinary research and outreach by linking research with experience-based and Traditional Ecological Knowledge-based restoration activities. The group's primary focus is value-adding to the efforts of its constituent organizations by sharing expertise and methodologies to enable large-scale analysis and comparison across adjacent regions, ultimately disseminating collective results through impactful science communication. We consider explicitly linking human and ecosystem health the best way forward to reverse the current downward trajectory of ecological degradation and declining human health, and propose FIEN as an approach which other restoration-minded groups and coalitions might follow.

Key words: ecological restoration, human health, public health, planetary health, environmental health, traditional ecological knowledge, biodiversity loss, restorative activities.

Implications for Practice

- To halt and reverse ecological degradation and deteriorating public health we must increase understanding of the direct and indirect effects of ecosystem restoration on human health.
- We must learn to better repair and manage ecosystems while being mindful of ecological, socio-cultural, and Traditional Ecological Knowledge contexts and interactions.
- Independent restorative initiatives across a range of sites and ecosystem types can be strengthened and enhanced by participating in regional networks aspiring to achieve global ecohealth outcomes.
- Ecohealth networks are intended to promote a restorative culture while addressing social, cultural and environmental injustice, including through decolonization of biodiversity conservation and ecological restoration.

Introduction

Globally, ecosystems and societies within them are on a downward spiral of ecological degradation. The destruction of natural areas reduces biodiversity and ecosystem services while increasing human health risks (e.g., Speldewinde et al. 2009; Siebielec et al. 2016). Although research identifying the exact mechanisms connecting ecological and human health is still in its infancy (Orlando and Aronson, unpubl.; Breed et al. 2020), degraded ecosystems have been shown to contribute to communicable (Gibb et al. 2020) and non-communicable diseases such as poor mental health (Romanelli et al. 2015). Therefore, if ecological degradation represents an “illness” affecting human wellbeing (especially when livelihoods are rightly considered part of wellbeing), then its deleterious effects might be alleviated by ecological restoration (Breed et al. 2020; Cross et al. 2019; Nabhan et al. 2020).

This “ecosystems approach to health”, or ecohealth for short (Rapport 2007; Aronson et al. 2020), reflects the intersection between ecological restoration and human health, recognizing that when the functioning and biodiversity of restored ecosystems improves, so too does human health. There is demonstrable evidence of the positive effect of nature on human health (Twohig-Bennet and Jones 2018); many pathways have been proposed for this beneficial association including increased physical activity, social contacts, better air quality and reduced stress (Hartig et al. 2014). There is also emerging evidence that exposure to biodiverse microbial communities benefits health (von Hertzen et al. 2015; Liddicoat et al. 2020), leading to calls to use, design and restore or establish biodiverse urban green spaces that provide a safe and adequate level of exposure to health-promoting environmental microbiomes (Flies et al. 2017, 2018; Mills et al. 2020). By taking an interventionist and rigorous experimental approach, restoration ecology can clarify mechanisms and provide strong evidence for the large-scale and long-term health impacts of restorative interventions (Breed et al. 2020).

We argue that these restorative interventions must be associated with a transition to a restorative culture (Cross et al. 2019). Humanity needs a profound paradigm shift driven by the explicit linking of human and ecological health to achieve changes in human behaviour and government policy (Breed et al. 2020). This draws from - and helps return us to - the ancestral paradigms of many Indigenous Peoples where “*the old ways are becoming the new ways*” (pers. comm. Eugene Eades 2019, a Noongar statesman from south-western Australia).

Moreover, undertaking restoration at scale is challenging, as it requires aggregation of local actions into a broader context, with consideration of unpredictable socio-cultural and ecological factors and the (often competing) interests of multiple and diverse stakeholders (Menz et al. 2013). Successful scaling up of ecological restoration requires increased capacity, which can be addressed through the operation of restoration networks that aggregate and disseminate knowledge gained at the science-practice interface while also recognizing the economic and social values of restored ecosystems (Menz et al. 2013). We present a newly-formed collaborative restoration network in Australasia as one potential vehicle to deliver beneficial restoration outcomes as an approach for other restoration-minded groups and coalitions to consider.

The Four Islands EcoHealth Network

The Four Islands EcoHealth Network (FIEN) is a cooperative regional network recently developed following the establishment of the related, international EcoHealth Network (EHN; <http://www.ecohealthglobal.org/>). The EcoHealth Network exists to develop capacity and strengthen research between ecological restoration and public health, and hosted its first international workshop in St. Louis, Missouri, in May 2019. A subsequent workshop in Hobart,

Tasmania, in February 2020 established the cooperative regional network, FIEN, linking together pre-existing restoration initiatives in mainland Australia, Tasmania, and the north and south islands of Aotearoa New Zealand. FIEN is a coordinated alliance of affiliated organizations (member organisations of the EHN) who have formally agreed to coordinate activities toward a shared vision for ecological restoration (Table 1). It aims to investigate the links between ecosystem health and human health in the context of restoration activities (Figure 1; Appendix 1).

[Insert Figure 1 near here]

FIEN harnesses the unique geographical, cultural, and historic coherence of Australia and Aotearoa New Zealand, and aims to collaboratively explore restoration across the bioclimatic, biophysical, political and socio-cultural contexts offered by these two countries. Additional coherence comes from the interwoven strands of support and interdependence within and among FIEN organisations, as well as from the supportive relationships with the larger EHN. This structure supports the multiple interacting programs with shared techniques, experiences, cultural perspectives and data. Crucially, there is a strong involvement by Indigenous Peoples and communities across FIEN programs, providing a unique opportunity to incorporate and apply the importance of Traditional Ecological Knowledge and the holistic approaches of Indigenous Peoples' philosophies and cultures (Aronson et al. 2020). For example, projects in Aotearoa New Zealand (Reconnecting Northland and People, Cities & Nature) incorporate Māori restoration values and priorities (Hall et al. 2021), while ecological restoration and land management in Australia are increasingly driven and undertaken by First Nations people including the *Ngadju* peoples of south-western Western Australia (Gondwana Link), the *Miriuwung* and *Gija* peoples of the eastern Kimberley (Gelganyem Limited), and the *Kaurna* peoples of the Adelaide Plains.

Strategies and objectives

There are numerous ways through which cooperation can facilitate disparate programs achieving their goals. FIEN is working to achieve this by:

1. Establishing holistic research frameworks that incorporate robust monitoring of cultural, social, and public health benefits from ecological restoration programs.
2. Documenting the beneficial effects of ecological restoration on human health and wellbeing both in terms of environmental outcomes and participation in the restoration process itself.
3. Communicating results in a purposefully distributed, effective and impactful manner.

Priorities to achieve these objectives include a) enabling collaborative linkages between existing ecological restoration and human health research projects and securing the funds to assist this process; b) standardizing data collection and management protocols to enable cross-validation of site-specific results and the testing of cause-and-effect relationships with greater statistical power; c) expanding partner involvement to strengthen and enable inter-disciplinary, inter-professional, and transcultural projects; d) building institutional and community relationships to ensure project longevity; e) establishing a range of effective science communication strategies achieving impact across multiple target audiences; and f) providing greater opportunities for on-site training, peer-to-peer learning, and capacity-building.

It is our view that:

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1. Effective demonstration, documentation, and communication through various outlets will lead to improved understanding of the importance of ecological restoration at local and political levels and consequently improved policy support and increased budgets.
 2. Working relationships developed between ecological restoration researchers, public health researchers, and practitioners in both of those fields, will lead to integration of resources and increased operation at more effective scales, with wider application achieved through effective public science communication (e.g., Strategy #3 in Aronson et al. 2020). Positive feedback loops will be initiated to promote greater nature connectedness and societal appreciation for biodiversity, ecological functioning, and ecosystem integrity (Figure 1), as there is increasing recognition that the practice of ecological restoration can itself be a “public health intervention” (Breed et al. 2020), and a “reciprocal healing process” (Nabhan et al. 2020) for people involved in restorative activities.
 3. Restoration projects can be modified to increase public health impacts, with increased involvement of local communities improving their understanding of the multiple benefits of restoration, and greater appreciation of restoration’s positive impact on their lives.

The organisations establishing FIEN operate at scales ranging from local to regional. Examples of local scales include the facilitation and support for Indigenous Peoples involvement in a post-mining restoration project in the East Kimberley by Gelganyem Limited, and the restoration of native forest on sites formerly managed for pine forestry across northeast Tasmania by the North East Bioregional Network. Regional scale examples include the broader restoration programs of Gondwana Link and Great Eastern Ranges, which build on many interactive local projects in a given region to improve ecosystem connectivity along corridors spanning hundreds of kilometers (see *Founding Organisations* below). Across this range of scales, and in each of its member sites and hubs, FIEN aims to integrate public health practice and research into restoration projects, and support affiliated organisations as they develop, share, and discuss restoration- and health-related data and experiences. At most sites, cohesive arrangements already operate that support the sharing and discussion of key data, and this can be built upon further by including data related to public health benefits, and sharing across a broader biogeographic and cultural spectrum. Multilateral sharing of knowledge, data and experiences among people from different backgrounds and disciplines will strengthen working relationships among researchers, restoration ecologists, healthcare professionals, Indigenous leaders and local communities that may be many thousands of kilometres apart. Such collaboration is essential in developing an evidence base for linkages between ecological restoration and improvements in human health.

We recognize the difficulties in demonstrating the causal relationships between ecosystem and human health, which stem from complex social, cultural, economic and ecological interactions. However, the array of sites within FIEN provides ecological and socio-cultural diversity, which support the identification of patterns in common results from different regions. Additionally, there is already some existing capacity to monitor public health responses to ecological restoration, such as in the effect of biodiverse urban greenspaces on social connectivity and mental wellbeing by the Healthy Landscapes group, and the health effects of exposure to environmental microbiomes by the Healthy Urban Microbiome Initiative; see *Founding Organisations* below). FIEN also provides a framework for establishment of research, job, and livelihood training programs for students, young professionals, and others seeking to participate and gain experience in ecological restoration.

Founding organisations

Eight affiliated organisations have so far joined FIEN (Table 1; Fig. 2), providing a broad geographic and demographic spread. In addition to restoration ecology researchers and veteran restoration practitioners, within our ranks are several public health experts, as well as regional and municipal public health practitioners. All founding organisations have close and well-established links to other movements and organisations that may not necessarily be directly engaged with ecological restoration. As a collection of networks with shared values, we strive toward similar goals for human and ecological health under the principle that “cooperation on seemingly unrelated goals can lead to synergistic or multiplier benefits” (see Strategy #3, Aronson et al. 2020).

[Insert Table 1 near here]
[Insert Figure 2 near here]

Gondwana Link (GLink)

GLink (<http://www.gondwanalink.org/>) was established in 2002, and is the recognized ‘keeper of the vision’ for a 1,000 km-long restoration effort operating across 23,000 km² of south-western Australia (Bradby 2013). The project is a loose coalition of community-led land management organisations collaborating with larger NGOs, businesses, individuals and research institutions (Bradby et al 2016), and aims to restore ecological connectivity and other critical ecological functions. Most on-ground work is undertaken by groups affiliated to GLink, inspired by and working broadly consistent with the vision of the overall program. Significant collective achievements include the establishment of the multi-tenure transformational vision for restoring ecological health and resilience across south-western Australia (Bradby et al. 2016), the purchase and protection of ca. 16,000 ha of strategically-placed land, ongoing restoration of ca. 14,500 ha, and the implementation of targeted conservation programs in seven key areas. One key mechanism involves re-establishing self-replicating biologically-diverse ecosystems consistent with the region’s heterogeneous mosaic of native vegetation associations (Jonson 2010). Another has been achieving recognition of the 16-million-ha Great Western Woodlands as the largest remaining temperate woodland on earth. Particularly noteworthy is increased significant management by First Nations people, who are regaining a leadership role. In the words of Les Schultz, convenor of Ngadju Conservation Aboriginal Corporation: “*Ngadju is playing catch up, with our people being trained in all aspects of natural resource management and becoming the scientists. This will be a major step towards a holistic recovery – spiritually, physically, economically, geographically, ecologically. Ngadju want our land manager jobs back from when the first whitefulla visited our shores*” (Les Schultz, in Bradby 2016).

Great Eastern Ranges (GER)

GER (<https://ger.org.au/>), established in 2007, is a network of more than 250 local, regional and national organisations involved in projects that stem the loss of native species, provide natural solutions to a changing climate, protect precious resources and ensure a healthy, resilient landscape for wildlife and people (Howling and Spencer-Smith, 2019). It encompasses a 3,600-kilometre mountainous spine, harbouring ecosystems from undulating heath-covered slopes to the towering cliffs of Mount Kosciuszko (Great Eastern Ranges Initiative, 2015). It includes a biodiversity hotspot and locations of rich cultural significance and connection for Indigenous Peoples, and supports 60% of Australia’s threatened animals and 70% of its threatened plants (Mackey et al.,

2010). Ecological restoration across this landscape is achieved through a series of related and complementary projects undertaken by partner organisations working in local nodes of collaboration ('regional alliances'). Priority projects target ecosystem linkages contributing to enhancing or maintaining functional connectivity of habitat at local, regional and continental scales.

North East Bioregional Network (NEBN)

NEBN is a community-based not-for-profit nature conservation organisation established in 2003. The group aspires to cultivate and embed a culture of conservation and restoration in local communities, while creating jobs in nature conservation and ecological restoration. NEBN aims to protect, maintain and restore ecological resilience and integrity on the East Coast of Tasmania, and undertakes a wide range of environmental activities, in partnership with government, landowners and community groups, on public and private land at varying scales. NEBN has accessed and delivered over \$AUD 5 million worth of conservation and restoration programs in the last 15 years, and is a vocal advocate for protecting forests of high conservation value on public land to enhance landscape connectivity. Its Linking Landscapes campaign has so far seen over 100,000 ha of forestry land transferred to Tasmania Parks and Wildlife Service management. NEBN has also produced a long-term vision to connect, sustain and restore ecosystems in northeast Tasmania.

People, Cities & Nature (PCaN)

PCaN is a socio-ecological program leading urban restoration research in Aotearoa New Zealand. It comprises six interrelated, targeted projects, with findings shared through publications, workshops, on-site visits, and a website (www.peoplecitiesnature.co.nz).

The Restoration Plantings project discovers efficient pathways to restore urban forests (e.g., Fig. 3). This helps support native biodiversity and ecosystem service provision (Wallace & Clarkson 2019). The Urban Lizards project surveys native lizards in cities and assesses habitat-enhancement techniques to determine how their populations should be managed. The Mammalian Predators project quantifies the activity of introduced invasive urban mammals that predate native species, and determines the benefits of different control regimes in order to develop effective multi-species management programmes. The Māori Values project investigates characteristics of Māori-based restoration within cities, including how Māori restoration values and priorities are applied (Walker et al. 2019). The Green Space Benefits project focuses on increasing engagement of urban-dwellers in biodiversity management to provide support for biodiversity, while simultaneously delivering human health benefits. The Cross-Sector Alliances project investigates cross-sector relationships relating to environmental improvements, aiming to develop case studies evaluating the feasibility of collaboration for effective urban ecological restoration.

Reconnecting Northland (RN)

RN is a community-led program established to connect human communities as a way of reducing ecological fragmentation and achieving widespread conservation and restoration of native biodiversity (www.reconnectingnorthland.org.nz/). The program operates across Te Taitokerau (Northland), the land north of Aotearoa New Zealand's largest city of Auckland, and is designed so that its short-term outcomes create foundational infrastructure for all program partners to mobilise collectively and deliver the greatest positive impacts for native biodiversity. The two

fundamental principles crucial to achieving the short-term outcomes and the later collective impact are co-design and community-leadership.

RN supports community-led research projects in such a way that the communities are encouraged to generate their own questions. One example is: *Te Kawa Waiora*, an *iwi/hapū* (tribal community/ies) led research project that investigates ways *mātauranga* Māori (indigenous knowledge) can be used as a *iwi/hapū* contribution to improving the health, wellbeing, and mauri (life force/vital essence) of the Wairoa River catchment (www.reconnectingnorthland.org.nz/takiwa-initiatives/waima-waitai-waiora).

Gelganyem Limited (GLT)

GLT (<https://gelganyem.com.au/>) is a charitable organisation that manages funds and assets on behalf of the Traditional Owners in a mining lease area in the East Kimberley region of Western Australia. Diamond mining has been taking place on the Traditional Lands of the *Miriuwung* and *Gija* peoples since the late 1970s, and the areas disturbed by mining are required to be rehabilitated and restored such that the ecological values of the post-mining landscape respect the expectations and cultural traditions of the Traditional Owners. A shared desire to build a better future for indigenous communities in the East Kimberley has seen the mining company meaningfully engage Traditional Owners in many aspects of the restoration process. Gelganyem manages Traditional Owner-led projects in large-scale native seed collection and the propagation of local-provenance native plants to supply restoration activities at the mine site, and aspires for this engagement to result in enduring cultural and business outcomes for Traditional Owners to the long-term benefit of both the environment and local communities.

Healthy Landscapes Group (HeaLa)

HeaLa, based at the University of Tasmania, is establishing local initiatives that use the extraordinary natural heritage of Tasmania to improve the health of Tasmanians and the global evidence-base for nature-health connections (<https://www.utas.edu.au/rural-health/projects-and-activities/external-projects/the-healthy-landscapes-research-group>). HeaLa projects are highly interdisciplinary, often participatory, and examine a range of human and environmental health outcomes. Project outcomes are communicated through scientific, public, policy, and artistic (e.g., art, film, media) venues.

Cities disconnect humans from natural environments in ways that can contribute to urban-associated diseases (Flies et al. 2019). While biodiverse urban green spaces can go a long way to restoring health (Lai et al. 2019), little is known about urban nature benefits in small and regional cities (Kendal et al. 2020), and how they are shaped by the surrounding socio-ecological context (Marsh et al. 2020). HeaLa is working to bridge these knowledge gaps through co-designed research and outreach to better understand and strengthen the connections between environmental and human health, especially in the context of small and mid-sized cities.

Healthy Urban Microbiome Initiative (HUMI)

HUMI (www.humicity.org) was established in 2016, and is a UN-backed initiative that seeks to restore the immune-restorative power of biodiverse green spaces in cities to maximize human health gains. The research led by HUMI is dedicated to understanding the effects of ecological restoration on the environmental microbiome (Liddicoat et al. 2019), human exposure to environmental microbiomes (Robinson et al. 2020; Selway et al. 2020), and the health effects from exposure to environmental microbiomes (Liddicoat et al. 2020). It has two active projects in

Australian urban centres, including the City of Adelaide (Baruch et al. 2020a,b) and the City of Playford (Mills et al. 2020) in South Australia.

[Insert Figure 3 near here]

Conclusions

The collective experience and insight of the FIEN founders suggests that the restoration activities underway through our affiliated organisations (Fig. 3) are having tangible benefits for human health. Our current and newly-initiated research focuses on elucidating this and communicating results to influence wider practice. Broad communications and on-site, or inter-site, capacity-building programs will contribute to achieving positive and profound societal change in tandem with ongoing improvement and refinement of ecological restoration practice.

Our collective enthusiasm is driving accelerated action to deliver the much-needed health benefits that ecosystem restoration provides. Launching FIEN now enables us to build on the momentum of our current initiatives at a moment of global ‘soul-searching’ resulting from a series of environmentally-related disasters with clear anthropogenic drivers alongside socio-cultural injustices. Evidence is already available suggesting increased policy support of restoration research is crucial to further understand the synergistic interactions between ecological restoration and human health. However, much more empirical and creative work, plus networking, is required to demonstrate the benefits of expanded, holistic restorative activities at landscape, catchment, and regional scales. As a pilot regional network of the global EcoHealth Network, the Four Islands EcoHealth Network aims to provide this additional evidence within its geographical context. In this way, we hope to advance the implementation of the strategy of the UN Decade (see <https://www.decadeonrestoration.org/strategy>) through all three implementation pathways: by building the technical capacity for ecohealth research and promoting action to create an evidence base that helps generate political support to empower a global movement of ecohealth, we will celebrate a culture of restoration and help build the UN Decade’s desired #GenerationRestoration in Australasia.

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Tables

Table 1. Founding affiliated organisations of the Four Islands EcoHealth Network (which are also member organisations of the larger EcoHealth Network). They represent collaborating socio-ecological restoration research groups and practitioners linked to a set of associated sites (spatially defined areas that contain one or more ecosystems benefitting from ecological restoration and/or rehabilitation) and projects (activities such as research focused on restorative processes but which may not be operating within a site). Asterisks indicate EHN Hubs (umbrella organizations that leverage their associations with other organizations and individuals to coordinate sites and a shared vision for ecological restoration).

Member Organisations	FIEN Site/Project Locations	Number of FIEN Sites/ Projects	Site/Project types (as defined by the EHN)
Gondwana Link*	South-western mainland Australia	4	Farms & Ranches, Complex sites, Indigenous-led
Great Eastern Ranges Initiative*	Eastern mainland Australia	4	Forest, Farms & Ranches, Complex sites
North East Bioregional Network*	North-eastern Tasmania, Australia	2	Forest
People, Cities & Nature*	North Island, Aotearoa New Zealand	3	Urban
Reconnecting Northland*	North Island, Aotearoa New Zealand	TBC	Complex sites, Indigenous-led
Gelganyem Limited	East Kimberley, mainland Australia	1	Post-mining; Indigenous-led
Healthy Landscapes Group	Hobart, Tasmania	1	Urban
Healthy Urban Microbiome Initiative	South Australia	2	Urban

Figures

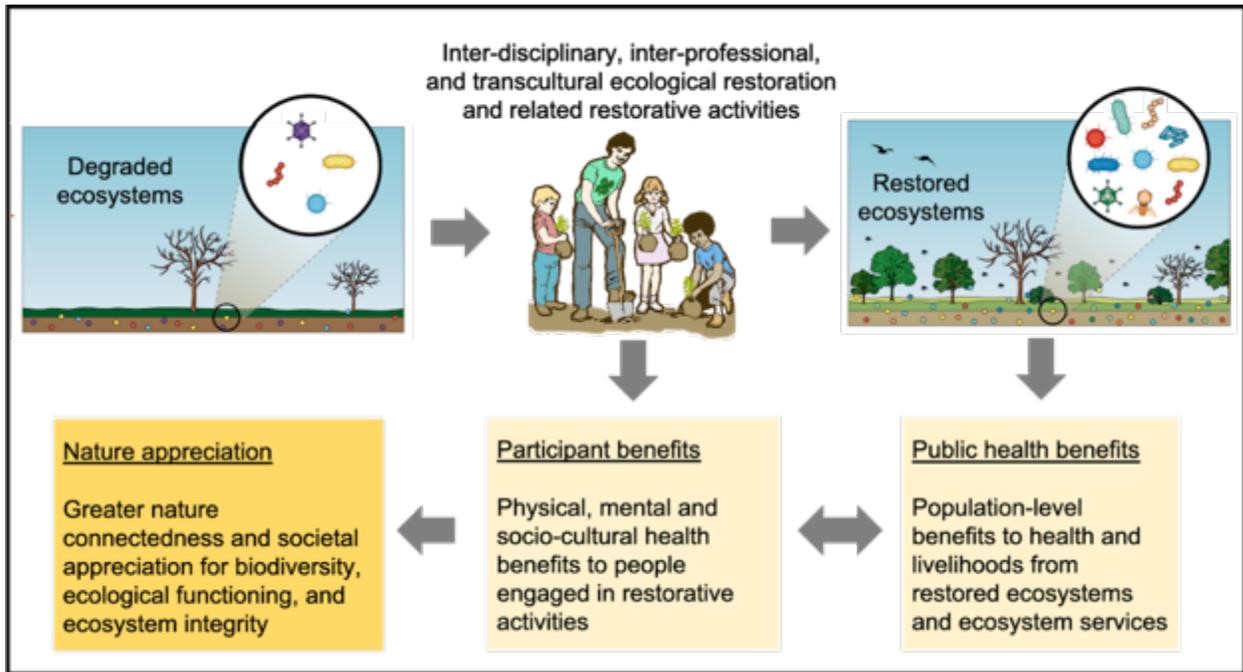


Figure 1. A conceptual diagram of how ecological restoration activities have interacting flow-on effects that benefit individual and public health and enhance societal appreciation of and connection with the natural world, adapted from Breed et al. (2019).

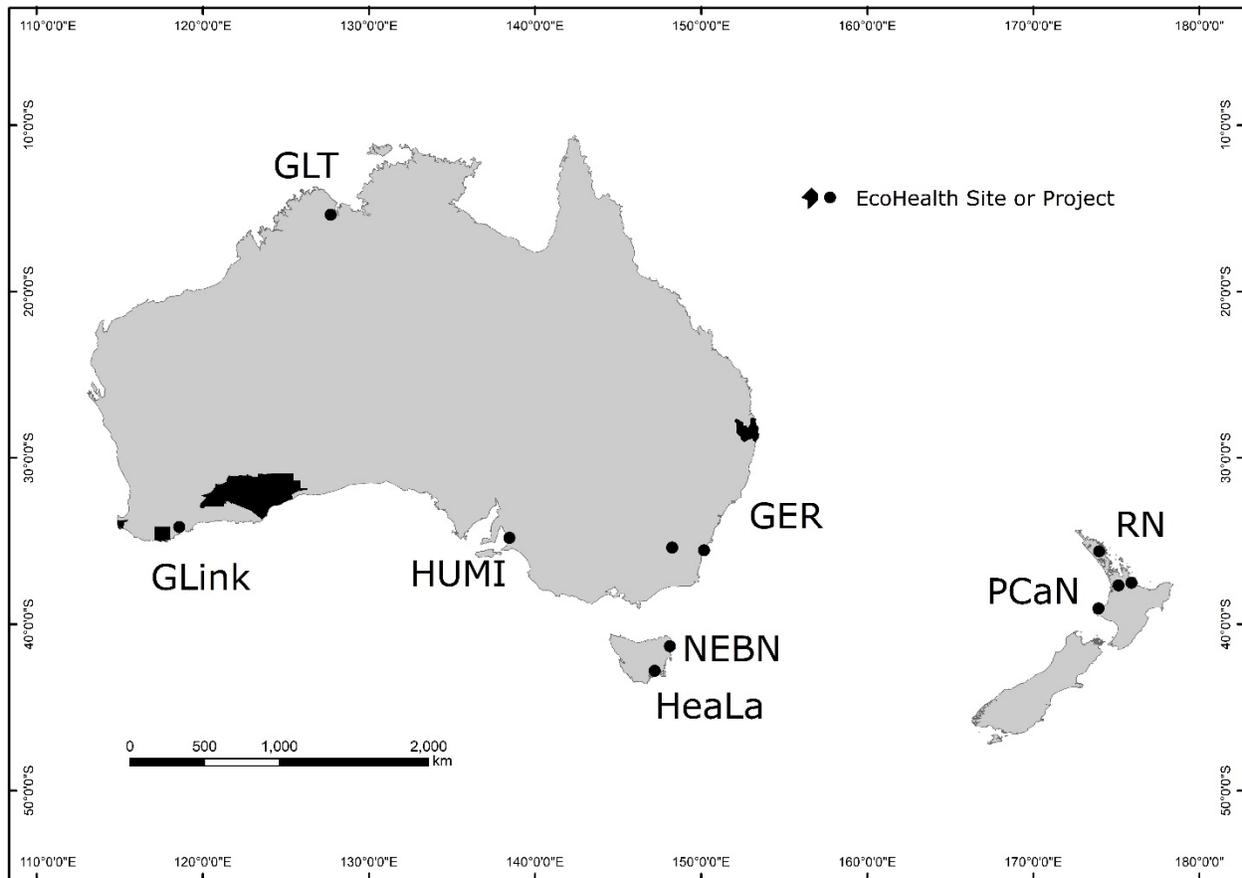


Figure 2. Map illustrating the spatial distribution of Sites (spatially defined areas that contain one or more ecosystems benefitting from ecological restoration and/or rehabilitation) and Projects (activities such as research focused on restorative processes but which may not be operating within a site) of founding Four Islands EcoHealth Network organizations. New Sites, Projects and Affiliated Organisations will likely join FIEN over time, and therefore a dynamic list is available at the EcoHealth Network website: <https://ecohealthglobal.org/network-sites/>.

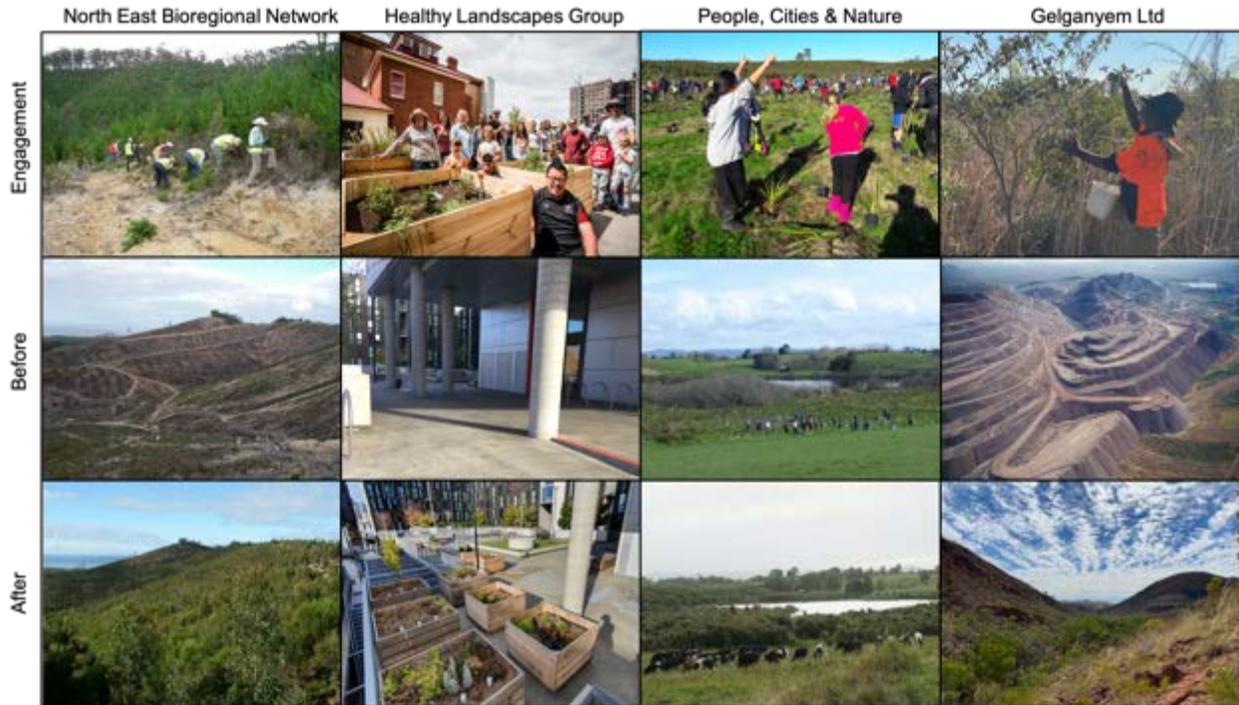


Figure 3. Examples of engagement and participation in restorative activities, as well as before and after images of restoration sites, for several of the Affiliated Organisations in the Four Islands EcoHealth Network. **North East Bioregional Network** - The Skyline Tier is the largest ecological restoration project in Tasmania, aiming to restore 2,000 ha of Radiata Pine plantation back to native forest. (Photos: Todd Dudley). **Healthy Landscapes Group** - This recently-created University Student Accommodation site was a sterile cement slab. The Healthy Landscape Group is helping to create an on-site community garden and tracking the impact on local perceptions, community and wellbeing (Photos: Bodhi Diaz-Icasuriaga, Pauline Marsh, Emily Flies). **People, Cities & Nature** - Waiwhakareke Natural Heritage Park is a 65-ha urban forest restoration project in Kirikiriroa Hamilton, Aotearoa New Zealand. Engagement occurs year-round with the general public including school groups, retirees, Indigenous Peoples (Māori), city council employees, religious groups, nature clubs, and many more. Their noteworthy collective efforts since 2004 have resulted in remarkable forest re-construction from former pasture (Photos: Catherine Kirby & Gerard Kelly). **Gelganyem Ltd** – Indigenous Peoples in the East Kimberley region of Western Australia are engaged in a range of restorative activities to focus restoration and rehabilitation of country degraded by mining activities for which they remain the Traditional Owners of the land. These activities include native seed collection and the propagation of restoration-ready native plants. Their aspirations are that the site is restored such that its ecological and cultural values support traditional and customary practices (Photos: Adam Guest, Adam Cross; ‘after’ image indicating the pre-disturbance landscape). For current and specific detail on the restoration projects and initiatives being undertaken across Australia and Aotearoa New Zealand by FIEN, we encourage the reader to visit the websites for each group provided in Table 1: *Founding Organisations*.

Supplement S1. The Hobart Declaration on EcoHealth: Ecological restoration that supports human health.

The world is witnessing global environmental degradation, displacement and undermining of Indigenous communities, accelerating climate change, and rising public health costs. Environmental degradation and public health are intrinsically linked, and need to be tackled together. Mistreatment of our environment is closely bound with a drastic rise in the allergies, immune dysfunction, infectious disease, and mental health disorders so pervasive in modern society, causing a loss of livelihood and human wellbeing across the globe and straining public health systems.

The EcoHealth Network (EHN) is a global action initiative working at the interface of ecological restoration and human health (www.ecohealthglobal.org). The Four Islands EcoHealth program has been established to work across the North and South Islands of Aotearoa/New Zealand, Tasmania, and the Australian mainland. While there are of course many other, smaller islands in Australian and Aotearoa/New Zealand territories, the Four Islands represent those where EHN projects and partners currently operate.

We note that:

- The science and practice of restoration has improved the ecological quality of thousands of square kilometres of degraded land in our Four Islands region.
- Restoration occurs at different scales from local backyards to cities to large-scale ecosystems, reconnecting and reinvigorating fragmented landscapes.
- The communities involved in ecological restoration benefit from improved social cohesion, physical and mental health, and ecosystem services.
- The involvement of Indigenous people in restoration contributes significantly to cultural healing and social support, as well as ecological repair.
- The evidence base for health and wellbeing benefits from restoration is rapidly growing.

Our core message is that ecological restoration activities are good for both ecosystems and people. Restored riparian areas deliver clean water. Participation in restoration programs can have mental health benefits, particularly for disadvantaged and disconnected people. The soil microbiomes in natural and restored areas have the potential to significantly improve the health of human gut microbiomes, as do healthy agricultural soils. Newly-planted native forests contribute to long-term carbon storage, provide enhanced habitat at landscape scales, and reduce air and water pollution. While our knowledge of all the precise mechanisms involved in providing public health benefits from restoration work is developing, there is clear evidence to support action which combines ecological restoration and public health programs.

Our interdisciplinary working group has agreed to address the key issues that we consider most important:

- 1) Establishing holistic research frameworks which include the robust monitoring of cultural, social and public health benefits of ecological restoration programs.
- 2) Documenting the beneficial effects that occur when restoration processes are integrated, with attention to human health and wellbeing.
- 3) Communicating the results of our findings in an impactful way.

We have much in common across the Four Islands, enabling us to compare results and easily exchange information on approaches and outcomes. Our collaborative strategy addresses the underlying causes of ecosystem and health dysfunctions, rather than just treating the symptoms of each.

By the end of 2020 we expect to have established a number of human health studies that are embedded within both established and new ecological restoration programs in our region in order to elucidate and evaluate the benefits of linked conservation, restoration and human health approaches.

For further information please contact fourfriendlyislands@gmail.com or info@ehnglobal.org.

The workshop was held in Hobart from 18-19 February, 2020. This document is dated 11 March, 2020

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Rod Barnett – 13

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1- EcoHealth Network (www.ecohealthglobal.org)

2- Gondwana Link (WA) (www.gondwanalink.org)

3- Great Eastern Ranges Initiative (QLD, NSW, Vic) (www.ger.org.au)

4- North East Bioregional Network (Tas) (www.nebn.org.au)

5- Healthy Landscapes Group, School of Natural Sciences, (www.utas.edu.au/natural-sciences), and School of Technology, Environments and Design (www.utas.edu.au/technology-environments-design) University of Tasmania (Tas)

6- Reconnecting Northland (NZ) (www.reconnectingnorthland.org.nz)

7- School of Public Health, University of Adelaide (SA) (health.adelaide.edu.au/public-health/)

8- College of Science and Engineering, Flinders University (SA) (<https://www.flinders.edu.au/college-science-engineering>)

9- Healthy Urban Microbiome Initiative (HUMI, www.humicity.org)

10- Public Health Dorset, UK. (<https://www.publichealthdorset.org.uk/public-health-dorset.aspx>)

11- School of Molecular and Life Sciences, Curtin University (WA) (<https://scieng.curtin.edu.au/schools/school-of-molecular-and-life-sciences/>)

12- People, Cities and Nature Research Programme, University of Waikato (NZ)
(www.peoplecitiesnature.co.nz)

13- Sam Fox School of Design and Visual Arts, Washington University, St Louis (USA)
(<https://samfoxschool.wustl.edu/>)

14- Nita Education (Tas) (www.nita.education)

Note that:

NSW – New South Wales, QLD – Queensland, SA - South Australia, Tas – Tasmania, UK – United Kingdom, Vic – Victoria, WA – Western Australia, etc.; NZ – Aotearoa/New Zealand.