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The Role and Importance of Coordinated Land Information to Support Landscape Connectivity Initiatives

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Key Points

- ‘Connectivity conservation’ engages participants from a range of sectors of society and encourages the collaboration and alignment of efforts to conserve and connect habitats across whole landscapes.
- The Great Eastern Ranges Initiative (GER) was established as a connectivity conservation program to facilitate collaborative, cross-tenure conservation management along the 3,600 kilometres of mostly interconnected natural lands that extend along the Great Dividing Range and Great Escarpment of eastern Australia.
- The scale of the GER vision and the need to achieve a range of ecological, social and institutional outcomes across such a large area created new challenges for managers seeking to understand and plan for large-scale processes.
- At the continental scale, GER managers needed to understand the landscape context before being able to make clear decisions about where, how and when to act. This required the collation and analysis of information on factors such as the distribution, connectedness and

adequacy of existing protected areas, their role in providing seasonal drought and long-term climate refuge, their use by migratory species and predicted changes in habitat condition into the future.

- Combining these analyses allowed the GER to develop a strategic overview of how each region within the broader landscape contributes to the status of the whole.

Introduction to ‘Connectivity Conservation’

The accelerating loss of biodiversity from a range of threats, including climate change and land clearing, has stimulated a social and political shift in the management of global biodiversity (Worboys & Pulsford, 2011). Experience in various countries has shown that conservation managers need to move beyond the traditional approach of conserving isolated pockets of habitat to ensure the long-term survival of species and ecosystems (see Chester, 2006; McKinney, Scarlett & Kemmis, 2010; Soulé & Terborgh, 1999). Australia has a long history of investing in public and private efforts to manage natural areas that help to maintain natural and cultural heritage in the face of growing pressures. This has been the case in the highly managed landscapes of the eastern states (including Tasmania) and south-west Western Australia. Attempts to expand, link and buffer a network of protected habitats in these regions have been increasingly targeted and coordinated through enterprises variously referred to as ‘wildlife corridors’, ‘biolinks’ or ‘integrated catchment management areas’ (Department of Environment and Climate Change [DECC], 2008; Department of Sustainability, Environment, Water, Populations and Communities, 2012; Mackey, Ferrier & Possingham, 2013).

Connectivity conservation is a recent response to the need for a more expansive whole-of-landscape effort. It involves the active conservation management of natural and semi-natural areas across a range of land tenures and uses (Worboys, 2010). The purpose of connectivity conservation is to:

- conserve natural vegetation and habitats
- interconnect protected areas and other natural lands and permit the movement of animals and plants between them
- conserve animal species and healthy ecosystem processes

- respond to climate change by providing opportunities for species to move to locations with suitable climate envelopes (including altitudinally) as local environmental conditions change (International Union for the Conservation of Nature [IUCN] – World Commission on Protected Areas, 2006).

Unlike traditional single-landscape or multi-partner projects, connectivity conservation is undertaken by individuals, communities, private organisations and governments working together as a cohesive enterprise, seeking to achieve goals and objectives agreed to voluntarily by participants. The work is typically undertaken on a voluntary basis and is guided by a clear overall vision for a large-scale corridor (Worboys et al., 2016). By necessity, it involves making provision for natural processes at all spatial scales to accommodate the needs of local species, facilitate migration, maintain healthy ecosystem processes and increase the resilience of habitats. Connectivity conservation involves:

1. conservation management on lands around formal protected areas to buffer them from threatening processes originating off-reserve
2. large-scale ecological restoration and rehabilitation on heavily cleared lands to reconnect otherwise isolated protected areas
3. management and suppression of processes that would otherwise degrade the values of largely intact, high-conservation value habitat and wilderness
4. systematic conservation planning to factor in the management needs of large-scale, spatially dependent ecological processes essential for the long-term persistence of biodiversity (Mackey, Watson & Worboys, 2010).

The remainder of this paper examines the last of these considerations and focuses on how the analysis of large-scale ecological processes were considered in strategic decisions made as part of the Great Eastern Ranges Initiative (GER).

The Great Eastern Ranges

Australia's iconic Great Eastern Ranges span 3,600 kilometres (2,237 miles) from the Grampian Ranges in western Victoria, along the Great Dividing Range, through Queensland's World Heritage wet tropics to the remote peninsula of Cape York. In total, the landscape occupies

some 33 million hectares (GER, 2015). From undulating heath-covered slopes to the towering slopes of Mount Kosciuszko, the Great Eastern Ranges are a biodiversity hotspot, rich in natural resources and cultural associations that are highly valued by Aboriginal and non-Aboriginal Australians. The cultural, biodiversity and ecosystem service values of the Great Eastern Ranges have been well documented. They include:

- the longest range of mountainous and upland landscapes on the continent, spanning 21 degrees of latitude and including our greatest altitudinal gradient
- the most reliable source of water, providing fresh water for at least 11 million people across eastern Australia, both on the coast and across the inland catchments
- the greatest variety of habitats and species, including globally significant hotspots for species diversity and endemism, and habitat for 60 per cent of Australia's threatened animals and 70 per cent of its plants
- ancient species like the Wollemi Pine and ancient flowering rainforest plants, which provide living connections to our deep geological history
- migration pathways supporting the annual seasonal dispersal and long-distance movement of up to 60 per cent of Australia's forest- and woodland-dependent birds, such as the rainbow bee-eater (*Merops ornatus*) and regent honeyeater (*Xanthomyza phrygia*), as well as iconic Australian species such as the grey-headed flying fox (*Pteropus poliocephalus*), bogong moth (*Agrotis infusa*) and Richmond birdwing butterfly (*Ornithoptera richmondia*)
- an extensive network of more than 2,000 existing protected areas on public and private lands, which provides the basis for seeking to achieve the GER vision (Australian Conservation Foundation [ACF], 2015; Dean-Jones, 2009; Hyder Consulting, 2008; Williams et al., 2011).

A complex mix of ongoing pressures similarly affects the Great Eastern Ranges, exacerbating the effects of past and new disturbances that cause habitat loss. These have been documented extensively (see Great Eastern Ranges, n.d.) and include widespread agricultural use on the more fertile soils, logging, grazing, mining, urban development, competition from introduced species and changed disturbance regimes (e.g. fire and hydrology). Across extensive parts of the Great Eastern Ranges, various pressures have combined to exacerbate the loss or fragmentation of habitat for an alarming proportion of plant and animal species that were formerly

more widespread (ACF, 2015; Mackey et al., 2010). Despite this, the Great Eastern Ranges provide Australia's best opportunity to resist both the combined pressures of a growing human population encroaching from the east (DECC, 2007, 2008; Mackey et al., 2010) and the effects of climate change, which are forcing environmental envelopes to the south-east in geography and upwards in elevation (Doerr et al., 2013).

The Great Eastern Ranges Initiative

The New South Wales (NSW) Government established the GER in 2007 as a long-term strategy to enhance the health and connectivity of a network of natural ecosystems across eastern Australia, and mitigate increasing threats to the values they contain. Specifically, the GER was established to implement connectivity conservation across multiple state and territory jurisdictions as part of a vision to 'bring people and organisations together to protect, link and restore healthy habitats over 3,600 kilometres from western Victoria through NSW and the ACT to far North Queensland' (GER, 2012) (see Figure 12.1).

Connectivity conservation planning and on-ground conservation activities are structured to achieve four goals (see Table 12.1). The first relates to the 'on-ground' outcome that will be achieved in relation to connecting landscapes and ecosystems. Complementary goals direct delivery through a partnership approach, communicating with the wider community to increase awareness and support active participation and the application of knowledge. Delivery is achieved by building on a foundation of collaborative public-private partnerships established since 2007. Ten regional partnerships provide a focus for local action, bringing together landholders, agencies, non-government organisations, community and Indigenous groups, researchers, councils and industry to collectively plan and carry out projects. In addition, a number of well-recognised regional, state and national organisations have chosen to align their own activities with the vision of the GER. By leveraging the combined power and knowledge of partner organisations and regional partnerships, the GER has expanded its presence to create corridors of effort encompassing the full extent of the Ranges.

Figure 12.1: Map of Australia's Great Eastern Ranges.

Source: Pulsford, Worboys & Howling (2010).

Table 12.1 Goals of the Great Eastern Ranges Initiative

Theme	Goal
Connectivity conservation	Spanning from Cape York in Queensland to Walhalla and the Grampians in Victoria, the Great Eastern Ranges corridor is maintained as a biodiverse, functionally interconnected connectivity conservation area that positively contributes to biodiversity conservation and the delivery of ecosystem services.
Leadership and governance	Leadership and governance stewardship by the GER Board deliver effective and financially sustainable continental-scale connectivity conservation actions for the GER corridor.
Management	The GER corridor is actively and effectively managed: threats are responded to and restoration contributes to connectivity conservation, healthy ecosystems, biodiversity conservation and landscape amenity. The GER corridor provides direct service to the Australian community as a whole-of-continent natural response to climate change with active management facilitating adaptation and mitigation benefits.
Community awareness, involvement and partnerships	The GER corridor is a highly regarded household name throughout the connectivity conservation area, and the corridor is positively supported by communities. The GER corridor vision is actively managed by multiple positive, sustained and cooperative contributions from individuals, communities, private organisations, government organisations and other stakeholders.
Information	GER managers and the GER community are consistently informed by the very latest monitoring, research and modelling information that provides conditions and trends in condition analysis, adaptation research results, forecasting information, evaluation of performance results and other critical GER corridor management information.

Source: GER (2016).

The Role of Regional Partnerships

From the earliest days of the GER, it was understood that a whole-of-landscape approach to conservation would be essential to conserve the landscape's unique species, facilitate their migration, maintain ecosystem processes and increase the resilience of habitats (DECC, 2007, 2008). The GER's scope and vision inspired many organisations, landowners and managers to contribute to planning and implementing on-ground conservation actions. This was done in a coordinated and targeted way that has helped to increase public support for biodiversity conservation activities.

A collaborative approach was used to establish ‘regional partnerships’ that brought together landholders, public land managers, non-government conservation organisations, councils and other stakeholders to coordinate their efforts towards commonly agreed goals and targets (GER, 2012). The GER regional partnership delivery model has encouraged participating organisations in each priority region to agree on common values and objectives as the basis for collaborative local action, and to develop plans to prioritise actions in locations that contribute most strongly to connectivity at local and regional scales. Regional partnerships were also vital in providing a framework to develop locally appropriate governance structures and frameworks to enable the involvement of a diverse range of contributors and supporters from all sectors.

On a practical level, the partnership model enabled the GER to mobilise a broader cross-section of public and private land management approaches across all tenures (GER, 2012), including:

- protection of habitat on private land through a spectrum of conservation options ranging from entry-level instruments to in-perpetuity conservation covenants
- collaborative management of invasive weeds and feral animal populations
- habitat restoration, with emphasis on mobilising a range of techniques to enhance the condition of remnant areas and the functional connectivity value of intervening areas
- community engagement, landholder capacity building and promotion of ways to get involved
- provision of access to a wide range of information and reports—for example, through the Great Eastern Ranges website.

Prioritising Investment and Action

Considerable time, effort and investment are required to unite a group of partners, agree on common priorities and plan a program of works. Around 80 per cent of the GER corridor is comprised of lands other than protected areas (Hyder Consulting, 2008), indicating a range of opportunities in which efforts could be targeted. A clear rationale for identifying areas requiring connectivity investment was essential for

confirming the scope and direction for activities to partners in priority regions, and demonstrating transparency in program-level investment decisions to people in other regions (GER, 2012).

In mid-2009, the first GER Science and Information Delivery Plan 2010–2015 was developed by an independent panel. The plan highlighted the vital need for science-based information to depict landscape condition and guide planning at a whole-of-corridor scale. Many spatial analyses were completed including:

- a map of the distribution of existing public protected areas and private land conservation instruments
- an analysis of landscape-scale connectivity of habitats of eastern Australia (Drielsma, Barrett, Mannion & Love, 2010)
- an assessment of the distribution and significance of potential drought and climate refuge areas (Mackey & Hugh, 2010)
- an assessment of seasonal bird migration and dispersal routes (Smith, 2010)
- an assessment of the current condition of remnant vegetation and potential for future loss of condition at the landscape scale throughout the GER corridor (Drielsma, Howling & Love, 2010).

Several of these spatial layers were used to describe ecological processes and patterns operating at large regional scales, and to identify areas for targeting on-ground conservation investment and management on a local scale. A high-level overview of how these informed understandings of the status and priorities for investment at the GER scale is provided below.

The management and analysis of large-scale processes proved challenging for the GER from the outset, as it required new ways of thinking and approaches to understanding and planning for processes and activities operating across extensive areas. The next section outlines how the various analyses were used individually and collectively to inform the selection of priority landscapes to be targeted for the formation of new regional partnerships. The processes used in the analyses are not described; these are well documented in the relevant report findings and in Howling (2013).

The Distribution of Existing Public Protected Areas and Private Land Conservation Instruments

Protected areas on public and private land form both the foundation and core for any connectivity conservation initiative (Soulé & Terborgh, 1999; Worboys et al., 2016). Previous assessments of conservation values in protected area networks by state conservation agencies in Queensland, NSW, Victoria and the Australian Capital Territory (ACT) highlighted limitations in the existing reserve system (e.g. Government of Australia, 2007; National Parks and Wildlife Service, 2003; Sattler & Williams, 1999). However, the GER needed a more complete understanding. In 2010, it commissioned a spatial analysis of all public land tenures (arranged as IUCN protected area management categories) and private land conservation instruments (conservation covenants and private reserves) that form the core connectivity conservation network of the GER corridor.

Initially, the map and associated database were intended to provide a baseline against which it might be possible to track changes in patterns of reserve establishment and uptake in private land conservation instruments. However, it also proved important in providing a snapshot of the status of connectivity conservation at that time. Several patterns emerged that highlighted the general extent and connectivity of the protected area network. This was used to identify gaps in connectivity at regional, state and continental scales in different parts of the GER corridor. The analysis revealed some very substantial core sections of contiguous protected areas, including ‘large intact landscapes’ protected in contiguous national parks and other reserves, such as those extending from around the Australian Alps and Greater Blue Mountains to the Border Ranges. These act as core areas at the heart of the GER corridor in Victoria, ACT and NSW, but not in Queensland, which has a network of substantially fewer and less-extensive interconnected protected areas. Outside these core areas are ‘tenure mosaic landscapes’, which comprise a mix of public protected areas and other public lands, interspersed with private lands. Native habitats in these landscapes generally remain fairly intact, such as those across extensive areas of northern Queensland and northern NSW. However, the security and long-term viability of connections within these areas are not assured and they may be liable to degrade in future. Areas identified as ‘conservation gaps’, which comprise either very narrow connections

or gaps in the connectedness of conservation instruments, are generally adjacent to landscapes that have been extensively cleared and developed in the past. Many of these are subject to a wide range of threats.

Implementing a strategic integrated approach to conservation management in each of these connectivity management contexts was recognised as important. This can be achieved by collaborative cross-tenure management of invasive species along the margins of protected areas and targeted delivery of long-term and in-perpetuity conservation agreements to link public protected areas (Howling, 2012).

Landscape-Scale Connectivity of Habitats

Analysis of the pattern of conservation instruments was complemented by analysis of the connectivity of forest and woodland habitats through and between extant woody vegetation. The modelling (Drielsma, Howling & Love, 2010) was undertaken at a range of scales from continental to priority area (e.g. Upper Hunter Valley and slopes to summit).

In addition to assisting planning decisions, the production of maps depicting connectivity of habitats proved to be a valuable tool: first in communicating the status of existing linkages, then in demonstrating the significance of the local landscape relative to the wider GER corridor. This motivated landholders, community groups, Landcare and others to feel part of 'the bigger picture', which, in turn, led to higher rates of involvement by landholders in private land conservation agreements and habitat restoration, as well as greater alignment of delivery organisations' priorities and targeting of resources (Dunn & Howling, 2015).

Drielsma, Barrett et al. (2010) highlighted numerous significant patterns that needed to be considered by the GER in planning the placement of future regional partnerships, including:

- the role of large intact reserved landscapes in contributing to connectivity of the GER corridor on a continental scale
- landscape-scale connections between the GER corridor and adjacent landscapes, including the 'western woodlands way' network of dry forests and woodlands on the inland slopes and plains, and lowland habitats along the NSW coast; these linkages range from local-scale connections within and along the fringe of the GER corridor, to major connecting landscapes

- Hanging Rock to Watsons Creek and NSW North West Slopes
- Coffs Coast to Dorrigo and Barrington–Comboyne to Queens Lake (north and central coasts)
- Liverpool Range, Winburndale, Kanangra Boyd–Wyangala (NSW Central Tablelands) and NSW South West Slopes
- ‘bottlenecks’ whereby connectivity is narrowed because of a natural constriction of the ranges, often exacerbated by surrounding land use; these landscapes (such as Malanganee to Richmond Ranges, Illawarra Escarpment and upper Bega Valley) represent a significant potential risk for lost connectivity on a continental scale, and in some cases (e.g. Upper Hunter Valley and NSW Southern Highlands) have provided a focus for effort in the GER
- connectivity gaps, where land use development physically bisects the latitudinal or altitudinal connectivity of the GER corridor; these include settlement and infrastructure corridors associated with major crossings, such as the Bruxner, Golden, Great Western and Hume highways, and developed areas, such as the Malanganee Gap, Blue Mountains, NSW Southern Tablelands and ACT landscapes.

In summary, the analysis of connectivity of the GER habitats was, in itself, highly informative in pointing to significant existing or potential weaknesses in connectivity of the GER corridor as a whole, particularly where these occurred in landscapes with few public or private protected areas.

Seasonal Bird Migration and Dispersal Routes

Maintenance of local- and landscape-scale connections will be essential to ensure their continued contribution to seasonal migrations, and species dispersal and adaptation following major climatic changes or landscape disturbance events (e.g. fires, droughts and floods). One of the GER’s earliest commissioned science projects involved exploring the migration pathways used by birds. Birds are just one group of species that use the GER corridor; they are not necessarily fully representative of all types of movement seen in the corridor. However, they are an extremely useful focus for understanding habitat use and connectivity because:

- they are mobile
- they already provide the focus for extensive community action

- the Birdlife Australia ‘Birddata Atlas’ and network of community observers provide an extensive dataset to draw from
- in Birdlife Australia, the GER already had a partner organisation with the knowledge and ability to interpret what the analyses were observing.

In approaching the dataset, the GER specifically wanted to know:

- Where do they occur throughout the course of the year?
- How do they use the GER corridor relative to surrounding landscapes?
- Are there particular pathways that are more important for movement?
- Are there any noticeable barriers to movement at this large scale?

The existence of functional links between habitats are of particular importance for the movement of migratory birds, the dispersal of fledgling birds and birds responding to changes in their environment, such as climate change or fires. Analysing observational records in the Birddata Atlas for 18 species with recognisably seasonal migration patterns, or long-distance dispersal, enabled the movement of birds to be tracked along clearly defined pathways—referred to as the ‘flyways’ of eastern Australia (Smith, 2010).

Five general patterns of movements were revealed within the GER corridor, reflecting variation in how different species use the landscape as a result of their habitat preferences and gap-crossing ability:

1. BROADSCALE LATITUDINAL MIGRANTS (e.g. dollarbird [*Eurystomus orientalis*] and rainbow bee-eater [*Merops ornatus*]): these species are considered to have more general habitat requirements, allowing them to migrate across a broad sweep of the GER corridor using both forested and cleared areas, and a variety of forest and woodland types.
2. RESTRICTED-SCALE LATITUDINAL MIGRANTS (e.g. rufous fantail [*Rhipidura rufifrons*] and satin flycatcher [*Myiagra cyanoleuca*]): these species are restricted to vegetated areas along the GER corridor and coastal regions. They appear to be the most sensitive to the effects of fragmentation and other forms of habitat degradation and show where bottlenecks and habitat gaps exist within the GER corridor.

3. Partial migrants (e.g. grey fantail [*Rhipidura albiscapa*] and dusky woodswallow [*Artamus cyanopterus*]): these are the species for which short-distance migrations are most commonly noted; however, for the time-series analysis, they were not useful in showing such effects.
4. Altitudinal migrants (e.g. flame robin [*Petroica phoenicea*] and gang-gang cockatoo [*Callocephalon fimbriatum*]): these species undertake short migrations characterised by a shift between higher elevations within the GER corridor and lower elevations of the adjoining coastal lowlands or inland slopes.
5. 'Rich-patch' migrants (e.g. swift parrot [*Lathamus discolor*] and regent honeyeater [*Anthochaera Phrygia*]): these species display some regularity in their movement in time-series data; however, their routes were less evident than those of other species, as they are particularly rare and many of their movements depend on the distribution of flowering trees.

The most notable bird movements were the range contractions into Queensland and between the high country and inland coastal plains for overwintering. These patterns of movement highlight areas of high and low connectivity within the GER corridor at local and continental scales. For example, migration routes used by rufous fantail appeared to be bottlenecked in the regions east of the Hunter Valley and NSW Southern Highlands. The protection and restoration of habitat corridors that provide functional connectivity across the landscape of the GER corridor are essential for the long-term viability of many species.

Several landscapes were highlighted as potentially forming bottlenecks in seasonal bird migration—specifically the:

- western arc of the Border Ranges and the coastal lowlands flyway through the Gold Coast hinterland leading north into Queensland
- Murrumbidgee and Richmond Ranges and Big Scrub linkages leading south from the NSW–Queensland border
- Upper Hunter Valley (centred on four riparian corridors across the Merriwa Plateau and Manobalai Range) and Lower Hunter coastal corridor
- NSW Southern Highlands and Illawarra Escarpment
- northern ACT–NSW Southern Tablelands, linking Alpine reserves with the Murrumbidgee Range and NSW Southern Tablelands flyway (in turn, part of a western flyway into northern Victoria)

- upper Bega Valley (comprising part of the coastal flyway linking with northern Victoria).

As with the depiction of habitat connectivity, demonstrating the visual correlation between where linkages exist in the landscape and where birds are moving on a seasonal basis was highly useful in planning future priorities and engaging communities and delivery partners in understanding the relative importance of each part of the GER corridor for bird migration.

Current and Potential Future Vegetation Condition

Vegetation condition is often used as a surrogate for the proportion of biodiversity that a site can potentially support. It provides an indication of ‘effective habitat area’—that is, the area that can support targeted species of the maximum set of biota normally associated with an ecosystem (Drielsma, Barrett et al., 2010). It is also an important factor influencing functional connectivity values—that is, supporting effective species movement and ecological interactions and some ecosystems (e.g. carbon capture, water quality and catchment yield).

Across the GER corridor and adjacent landscapes, a baseline measure of vegetation condition was defined at ‘supra-regional’ scale, based on the interaction of land tenure (influences, management and security), land cover (contrasting cleared areas with extant native vegetation), land use (accommodating differences in the type and intensity of pressures expected from different uses) and changes in vegetation structure (based on changes in canopy density relative to ‘benchmarks’ for each woody vegetation type).

Across the GER corridor, the modelling highlighted at least 10 significant gaps in functional connectivity at the whole-of-GER scale resulting from clearing and other factors. In addition, it was noted that gaps formed barriers to movement between the GER corridor and natural ecosystems in adjacent landscapes, such as the NSW Southern Tablelands and peri-urban landscapes adjoining major cities. This affected the potential for movement into and out of the GER corridor for species other than habitat generalists.

Scenarios for future condition were modelled to accommodate the likely effects of key threats associated with increased land use pressure (affecting permeability of the landscape matrix), increased human population

density (implying increased habitat fragmentation and likelihood of disturbance) and proximity to infrastructure (as a surrogate for past disturbance, and likelihood of invasion by exotic plants, feral fauna and ignition of wildfires).

Combining Results to Inform Connectivity Conservation Priorities

Each of the analyses described above proved informative by themselves. However, their value for demonstrating the potential for landscape patterns, ecological processes and human pressures became more apparent when viewed together (Dunn & Howling, 2015). The GER trialled an approach to prioritising each section of the GER corridor in NSW to guide decisions regarding future efforts (Howling, 2012). The spatial products discussed above were applied to derive an understanding of each landscape within the GER corridor. Subsequent analysis identified a series of focus landscapes based on four criteria:

1. biological values—considering the contribution made at regional and continental scales to the ‘fabric’ of the GER corridor and the ecological processes it supports, including regional distinctiveness and species diversity, in situ resilience of ecosystems and native species, ecosystem processes and climate adaptation potential
2. connectivity need—considering the apparent discontinuity in connectedness of habitat and protected areas, potential for current functional connectivity to be diminished or lost, or potential for current gaps in functional connectivity to be made worse or less retrievable
3. social and institutional capacity—considering opportunities presented to implement a connectivity conservation initiative, based on there being active organisations present in the landscape with the capacity and interest in contributing to delivery of collaborative projects
4. program contribution—exploring opportunities presented to develop and test approaches that contribute to implementing an effective GER, and delivering outcomes in relation to planned geographic expansion within the GER corridor.

The analysis highlighted the extent to which each section of the GER corridor contributes to the corridor as a whole and relative to each other. In doing so, it highlighted the existence of a number of gaps or weaknesses in connectivity of the GER corridor. These included core habitat areas under sustained pressure from edge effect, habitat areas that form natural and fragmentation-derived bottlenecks, species dispersal or migration, and landscapes with potential for continued loss associated with the erosion of functional connectivity.

Based on the results of this process, the 2011–15 period saw the formation of five new partnerships in the GER corridor, including three in NSW and one each in Queensland and Victoria:

- Sunshine Coast Hinterland Bushlinks (established January 2012): this partnership area is located within a recognised biodiversity hotspot centred on the Glasshouse Mountains; it supports an important linkage between the Blackall and Conondale Ranges where weed management has been the focus of the group's activities.
- Jaliigirr Biodiversity Alliance (established May 2012): formed as an incorporated entity, this partnership area covers 337,000 hectares from Coffs Coast to the Dorrigo Plateau and is located in a tropical, subtropical and temperate convergence. The region is an area of significant ecological diversity and includes the World Heritage Gondwana Rainforests of Australia.
- Kanangra Boyd to Wyangala Link (established August 2012): this partnership was formed to implement a major \$2.7 million landscape connectivity project on NSW's Central Tablelands; it was funded by the Australian Government's Clean Energy Futures Biodiversity Fund until June 2017.
- Illawarra to Shoalhaven (established October 2012): this partnership is located where the Illawarra and Cambewarra Escarpments combine to form a narrow north–south aligned rainforest corridor linking the major sandstone reserves of the southern Sydney Basin with the wet sclerophyll forests of the NSW south coast.
- Central Victorian BioLinks (established 2013): this partnership is located between the Grampians and West Gippsland in central Victoria; it spans an ecological gradient from drier northern plains, across the woodlands and forests of the divide, to cooler and more southerly hills, gorges and grasslands.

The analyses carried out in 2010, combined with lessons learned in relation to social considerations in partnership formation (stemming from five original regional GER partnerships), proved essential in assisting the successful establishment of each of these new partnerships. The existing partner organisations and the five new regional partnerships are committed to acting cooperatively in each of these landscapes. Together, they seek:

- increased knowledge and understanding of the biological attributes of the Great Eastern Ranges, and their significance in the context of broader continental ecosystems
- greater awareness and understanding of biological, human and existence values of the GER corridor, threats to these values and opportunities and priorities for action to address these
- increased recognition of the scientific credibility and validity of connectivity conservation in the Eastern Ranges, and the importance of continued investment to understand and address conservation priorities
- increased adoption of advice from scientists and research by public and private land managers, and the mainstreaming of GER-focused conservation priorities in partners' strategic planning and program implementation.

The Role of Coordinated Land Information into the Future

In 2015, a new science and information plan (GER, 2015) was prepared to facilitate the acquisition and use of appropriate data, information and knowledge by the GER partners. This information can be used to mainstream GER-focused conservation priorities in strategic planning and investment. To better understand management needs and priorities, the plan identified five questions for consideration:

1. How is connectivity conservation important for biodiversity conservation and supporting ecosystem services in the GER corridor?
2. What are the priority regions in the GER corridor where we should focus connectivity conservation management?
3. Within priority regions, what conservation outcomes should we seek to achieve, where should we act and how should we act to be most effective?

4. How should we bring people and institutions together to deliver ethical and effective GER governance, planning and management?
5. Are we being effective in achieving desired outcomes across all relevant spatial scales?

The conservation challenges and information requirements to achieve the GER's ambitious vision are complex and manifold. Data and information at the scale of the GER corridor will be increasingly vital to addressing these questions and ensuring the successful delivery of collaborative efforts. Access to sound information on the management needs of native species and ecosystems, and the processes and pressures acting upon them, will remain essential in supporting prioritisation monitoring and evaluation of threats, investment in conservation actions and delivery outcomes (Mackey et al., 2010; Office of Environment and Heritage, 2011).

Since 2007, the GER has evolved and grown to become one of the largest connectivity conservation initiatives of its kind in the world, with a diverse cross-section of participants operating across extensive areas of the corridor. This success has depended substantially on the quality of scientific information that has been used to stimulate and inform planning, set priorities and build community engagement and support. The experience of the GER demonstrates that having access to (and a strategy to use) well-coordinated information at a range of scales is essential if connectivity conservation initiatives are to realise a landscape vision for large-scale connectivity.

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This text is taken from *Land Use in Australia: Past, Present and Future*,
edited by Richard Thackway, published 2018 by ANU eView,
The Australian National University, Canberra, Australia.

doi.org/10.22459/LUA.02.2018.12