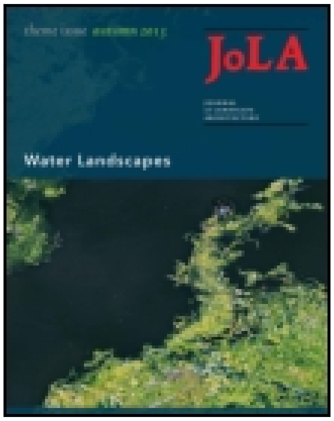

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Green infrastructure: planning a national green network for Australia

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Green infrastructure: planning a national green network for Australia

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Abstract

This paper outlines research regarding the planning and design of a bold new continental-scale Green Infrastructure (GI) for Australia, the 'National Green Network' (NGN). The NGN is a design project that aims to augment Australia's current limited protected area network and meet international and national policy targets. Such a system would improve the long-term resilience of the Australian landscape and its biota through a proposed trans-continental network of vegetated corridors spanning the Australian continent. This would provide mobility for species within a framework of additional habitat and the ability to counteract ecological fragmentation and climate change. To create the NGN, an iterative design-based methodology was employed over three scales that document the shift from conceptual to specific, from policy to practice. At the local scale, detailed design resolution in conjunction with stakeholders through a charrette fine-tuned and adjusted the NGN, reinterpreting its potential to enable multi-functional outcomes. While conceived primarily for protection of biodiversity, a GI approach enabled consideration of both potential ecological and cultural benefits of such a scheme through holistic landscape planning. This leveraged the original ecological aims and augmented the NGN's feasibility.

green infrastructure / landscape architecture / landscape ecology / National Green Network / synergistic

Background

In an age of climate change, population growth and biodiversity depletion, this research project is predicated on the creation of large-scale habitat networks that are, as Richard Forman (*2008: 344*) suggests, 'a high priority'. The establishment of a National Green Network (NGN) in Australia (and by inference elsewhere) is regarded as a reasonable and essential economic, political and environmental proposition. Such an infrastructure would provide greater resilience for human and ecological systems and help sustain the Australian continent, its landscapes, biota and population against present and future environmental challenges. An overview of protected area policy and ecological theory in Australia and its spatial implications is discussed in the introduction. The design-based methodology and the results at three scales of operation are then outlined. The article concludes with a detailed discussion of the final phase, the design charrette and its outcomes.

Protected areas in Australia

Australia's protected areas (see Fig. 1) are unevenly distributed across the continent. This mosaic of lands is inefficient in providing representative protection for the entirety of the nation's biodiversity. Such lands include national and state parks, private and public conservation reserves, numerous de facto areas, such as Indigenous Protected Areas, [1] and even some defence lands. These meet the reasonably flexible standard defined by the International Union for Conservation of Nature (*IUCN 1994*) as 'an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means'. In 1992 the International Convention on Biological Diversity (CBD) mandated a number of global actions for the preservation of biodiversity by signatory nations. This included Target 1.1, a commitment to achieving 'At least ten percent of each of the world's ecological regions effectively conserved' (*United Nations 1992*). As a signatory nation, this target underpinned the establishment of Australia's National Reserve System or NRS (*Commonwealth of Australia & National Reserve System Task Group 2009*). [2] The continually evolving NRS responds to the uneven sampling of Australia's biodiversity, informed by a scientific framework (*Commonwealth of Australia 1999*) and the delineation of Australia's eco-regions (*Thackway & Cresswell 1995*), to create a comprehensive, representative network (*Margules & Pressey 2000*). A recent overview of Australian land use data reveals that in 2012, while 12.81 percent of the nation was classified as protected area (*Department of Sustainability et al. 2012*), only 46 of the 85 eco-regions contain the mandated 10 percent protection (Fig. 2). This means that from a conservation planning point of view the minimum targets to sustain biota are not being upheld. This research seeks to address the critical missing (minimum) percentage that policy recommends.

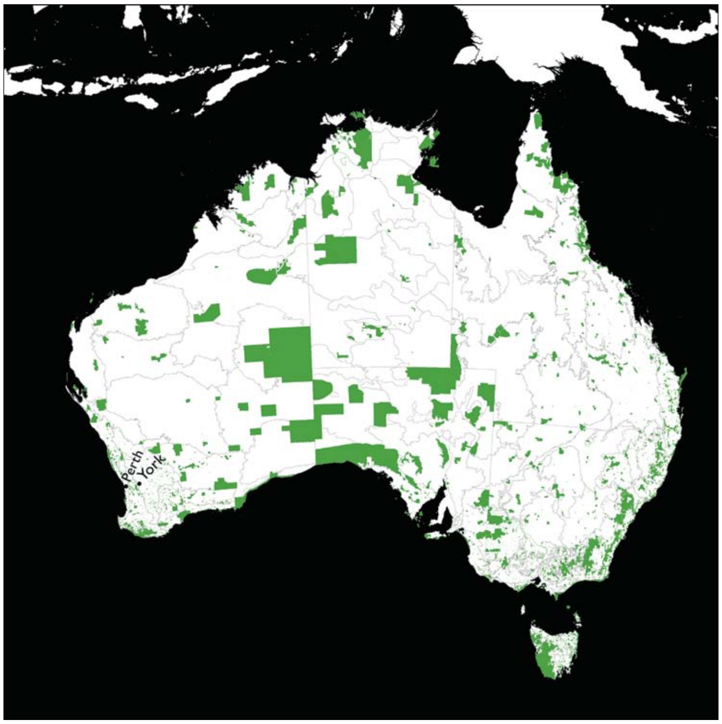


Figure 1 Existing protected areas in Australia
(*Department of Sustainability et al. 2012*)

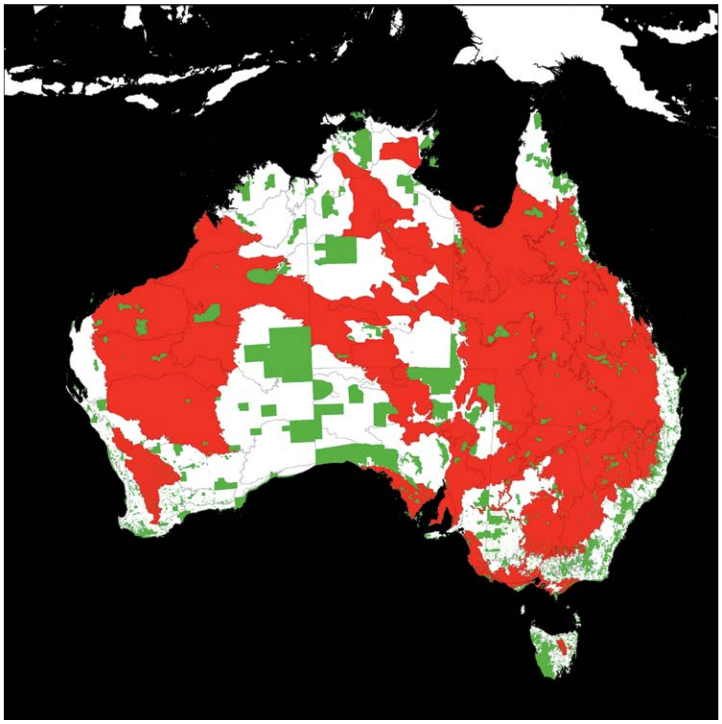


Figure 2 Forty-six of Australia's 85 bioregions are under-represented, those with less than 10% protected area shown in red.
(*Department of Sustainability et al. 2012; Thackway & Cresswell 1995*)

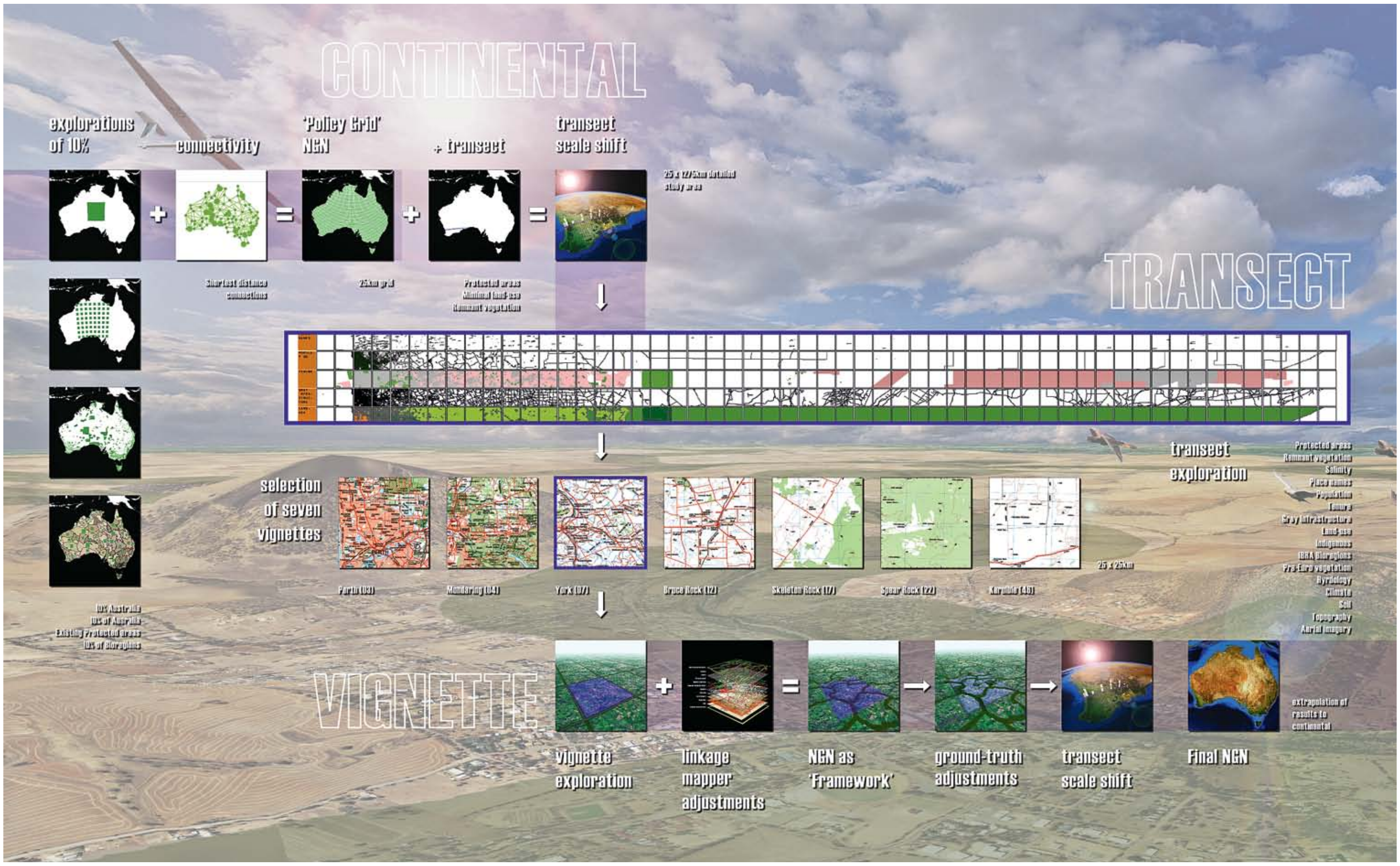


Figure 3 A research-by-design methodology evaluated the proposed NGN over three scales: continental, transect and vignette. Iterative redesign moves the NGN from abstract to real with each scale shift.

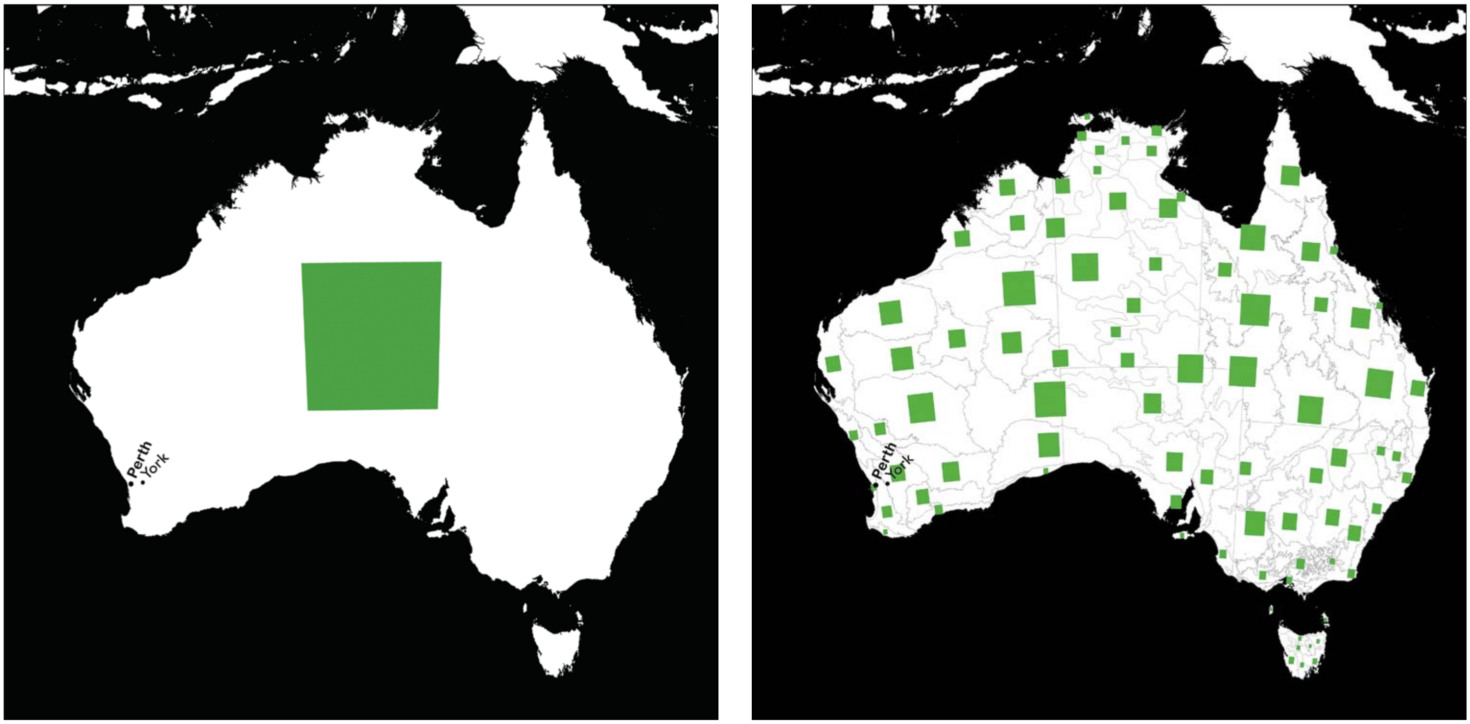


Figure 4a, b Initial options explored for the NGN that represent 10% of the continent as a single area as well as representation across eco-regions

Connectivity conservation

The Equilibrium Theory of Island Biogeography (*MacArthur & Wilson 1967*) and Metapopulation Theory (*Hanski & Gilpin 1991*) highlight the need for the consideration of ecological connectivity when undertaking ecological planning. As species persistence is dependent upon the continuation of genetic exchange via dispersal, structural connectivity should ideally be maintained to enable species mobility. Linear 'wildlife' or 'ecological corridors' are frequently employed to achieve this aim, collectively forming larger networks. The merits of connectivity planning are the source of much scholarship and conjecture (*Beier & Noss 1998; Bennett 2003: 62; Hobbs 1992; Hopper 2009; Margules & Pressey 2000; Pungetti & Jongman 2004; Simberloff et al. 1992; Soulé, Terborgh & Wildlands Project 1999; Worboys, Francis & Lockwood 2010*). This research accepts the perspective that it would be 'hard to imagine any realistic alternative that would be conducive to species persistence' (*Hilty, Lidicker & Merenlender 2006: 112*) . Specific policies at Australian state, national and international levels also share this view and explicitly embrace ecological connectivity as policy. These include Australia's Biodiversity Conservation Strategy 2010–2020 (*Natural Resource Management Ministerial Council 2010*), the National Wildlife Corridors Plan (*Commonwealth of Australia 2012*) and special confirmation at the CBD Tenth Meeting of the Conference of the Parties (*United Nations 2010: 246*). Species inhabit discrete spatial distributions or 'home ranges' based upon variables such as habitat, food availability and, importantly, climate. With a changing climate, species home ranges must adjust (Secretariat of the Convention on Biological Diversity 2003; Steffen 2009); for this reason, ecological connectivity as a precautionary principle [3] to be spatially explored is adopted.

Planning a new green infrastructure for Australia: the NGN

Most forms of infrastructure are networks: power grids, roads, drainage and telecommunications. Yet the idea of large-scale interconnected habitat is not something the public may typically appreciate as 'essential infrastructure'. Green Infrastructure (GI) is a term that is increasingly utilized in design, planning and ecological disciplines. Benedict and McMahon reflect upon the fundamental aspect of such an infrastructure as 'the ecological framework for environmental, social, and economic health—in short, our natural life-support system' (*2006: 4*). The GI approach also echoes the benefits advocated by the Millennium Ecosystem Assessment (*2005*) through provision of ecosystem services.

The planning of a GI for Australia is not without precedent. 'Connectivity conservation' is frequently referred to in ecological planning and policy and is characterized by 'ecological' or 'green networks', 'green infrastructure' or various other derivatives (*Worboys, Francis & Lockwood 2010*). [4] Such schemes exist at city, regional and even continental scales (*Hilty, Lidicker & Merenlender 2006; Naumann et al. 2011; Pungetti & Jongman 2004; Soulé, Terborgh & Wildlands Project 1999; Worboys, Francis & Lockwood 2010*). Packaged with persuasive mapping and graphics—usually derived through complex ecological modelling—these schemes frequently disregard geographical distance, land use, tenure and boundaries. Their utility is in providing an over-arching broad concept and their resolution at finer scales is often dealt with in a coarse manner, suggesting further refinement is required. The Pan-European Ecological Network and, in North America, the Wildlands Network and the Yellowstone to Yukon Conservation Initiative are examples of such schemes. Similar Australian examples, such as those noted by Whitten (*2011*), are expanded upon in the Wildlife Corridors Plan (*Commonwealth of Australia 2012*) including the Gondwana Link and the Kosciuszko to Coast, Habitat 141 and Trans-Australia Eco-Links. Their aim is to (re)create ecological connectivity in otherwise degraded and fragmented landscapes (*Soulé et al. 2004*), thereby ensuring the ability of species to mitigate extinction through structural connectivity. Currently, despite the science, global practice and supporting policy, detailed and spatially accurate plans that illustrate this connectivity conservation in Australia are lacking and the translation of such policies to on-the-ground projects is uncommon.

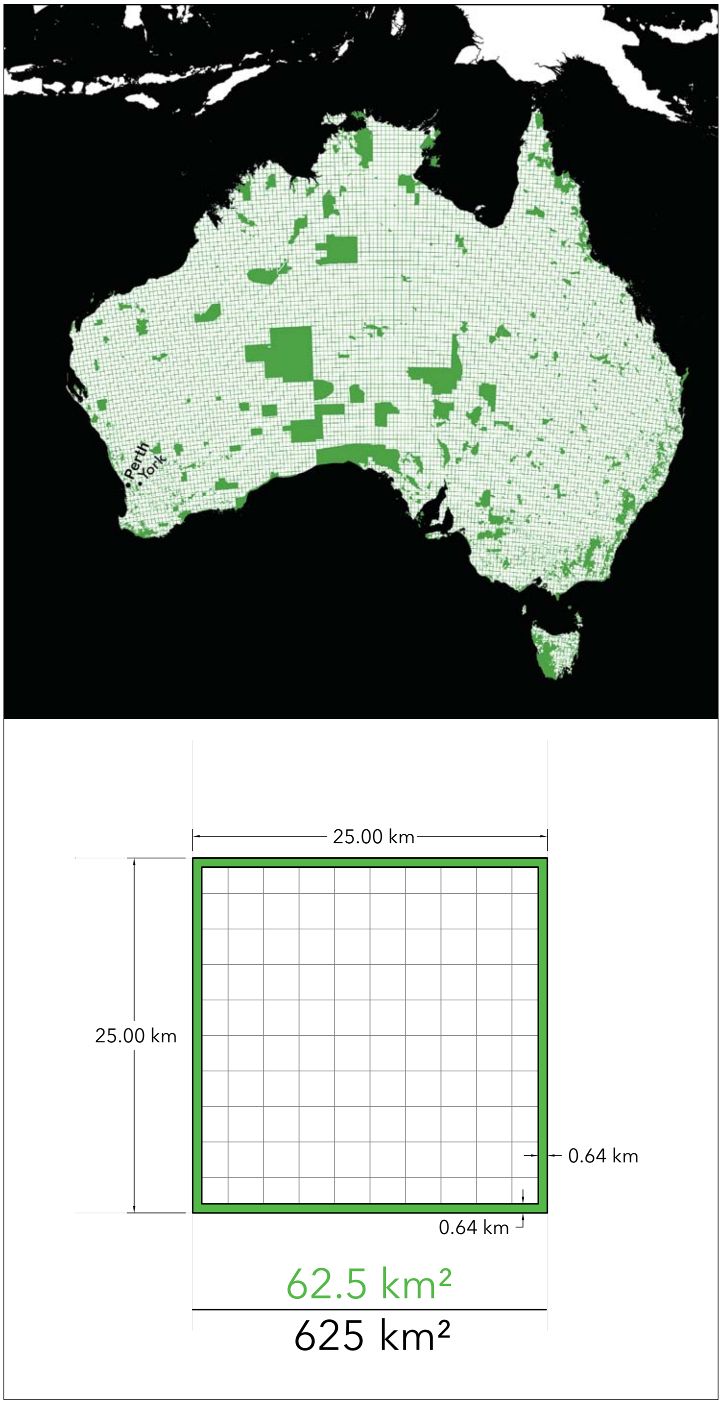


Figure 5a, b The NGN policy grid: assured representation of eco-regions and connectivity

This research project builds upon the intent of the NRS to create a design for a NGN. The ultimate aim of the new GI are designs to ensure the resilience of Australia's landscapes, biota and peoples. This trans-continental system extends the notion of 'infrastructure' from 'grey' to 'green'; from ports, roads and telecommunications to the health of our landscape systems. The NGN moniker also reflects one of Australia's newest infrastructures, the National Broadband Network (NBN), which is promoted as a reasonable and essential national proposition, despite significant expense. [5] Australia's commitment to the CBD demonstrates that the nation, at least at some levels of politics and society, is committed to ensuring the

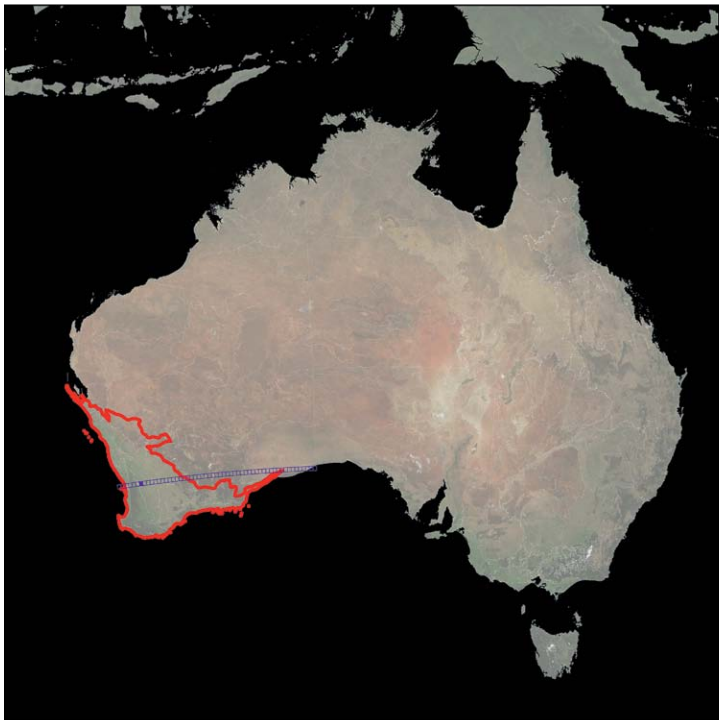


Figure 6 Transect location, biodiversity hotspot shown in red

longevity of its biodiversity. It is reasonable to expect that Australia should meet its own targets and policy; however this commitment is at risk of failure unless the spatial implications of such a plan are explored. Ideally, for Australia to meet its international obligations and policy targets it would require an ecologically robust network of protected areas distributed across the nation to provide even representation and connectivity of habitat. Without such an approach, the long-term provision of ecosystem services and the resilience of Australia's biota will be in jeopardy.

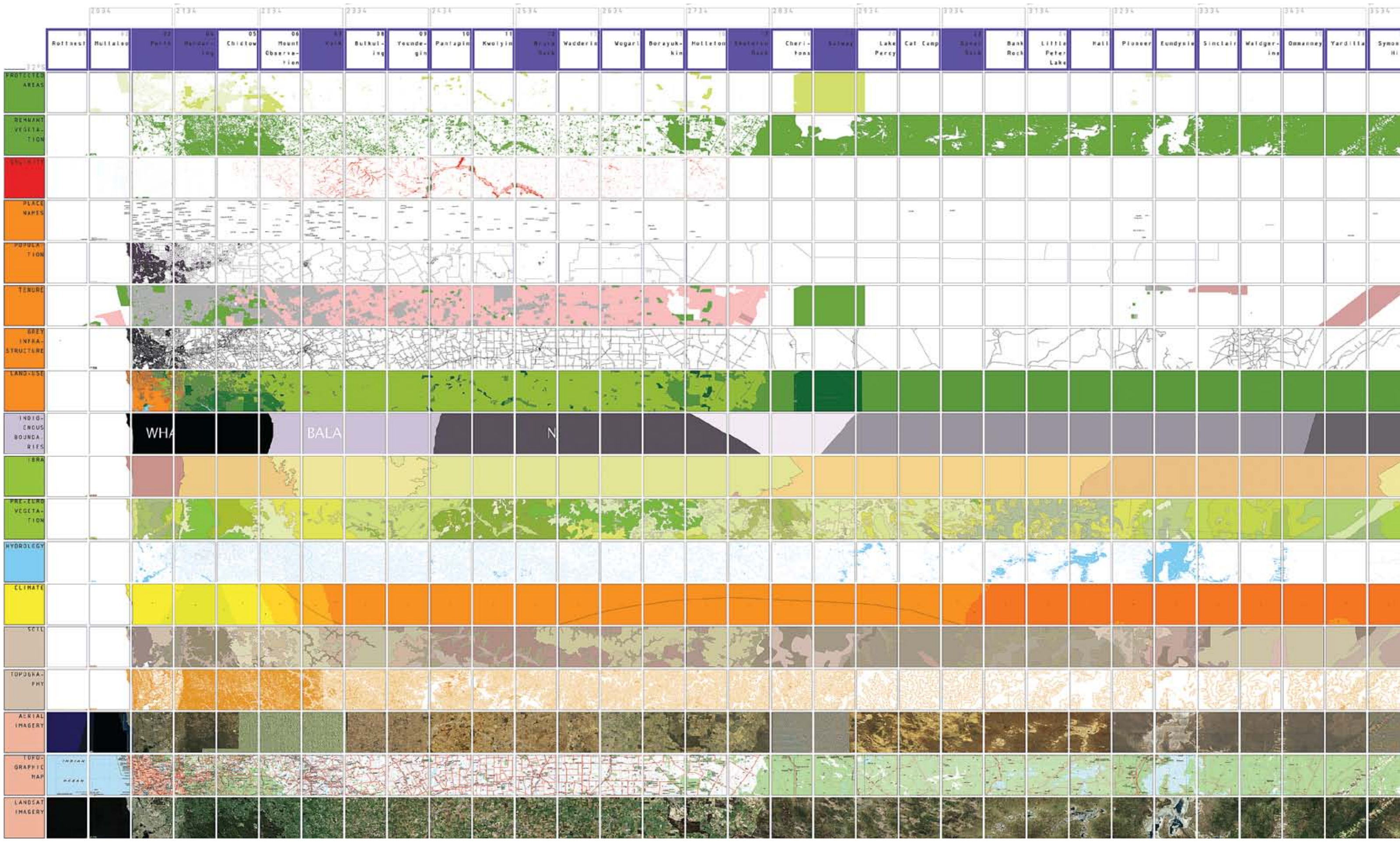
Methodology

A research by design methodology (outlined in Fig. 3) was conducted at three scales: continental, transect and vignette. The continental scale encompasses the whole of Australia; the transect scale is a 1,375 x 25 km study area and vignettes consist of 25 x 25 km sites. This projective design 'quasi-experiment' (*Deming & Swaffield 2011: 119*) approach enabled the opportunity to apply theory through a design exercise. The NGN is refined at each scale through evaluation and redesign using a variety of methodological approaches including Geographical Information Systems (GIS), ecological modelling and stakeholder design charrette.

Continental scale: the 'policy grid'

Following a review of applicable ecological theory, policy and the previously discussed precedents, two key research design principles were defined for further spatial exploration. First, in accordance with the CBD and Australia's NRS, a minimum 10 percent of each of Australia's 85 bioregions must be protected. Second, the spatial design of protected areas across the Australian landmass should maximize connectivity between otherwise isolated fragments of existing habitat.

Beginning with the continental scale, the development and visualization of abstract designs to meet these parameters were developed (Fig. 4). For instance, one enormous reserve measuring 869.66 km x 869.66 km,



could hypothetically accommodate the target 10 percent, or 756,323 km² of Australia's protected areas. Alternatively, the establishment of 10 percent territory in each of Australia's 85 bioregions would create a representative system. However, any plan must also facilitate connectivity. The use of the Map Grid of Australia, the 15 degree minute (or 25 km) graticule that covers the nation, enables the ability to create this idealized and equitably distributed matrix. An ideal NGN could therefore stretch across the continent as a 25 km x 25 km and 1.28 km-thick hypothetical policy grid of protected areas (Fig. 5) to create this ubiquitous 10 percent target. This is not a design so much as a political gesture that spatially satisfies Australia's commitments to the CBD whilst creating maximum ecological connectivity. This grid design not only evenly samples every bioregion, but all constituent landscapes and land uses that exist across the continent. This mechanistic approach, of course, ignores any appreciation of the existing landscape but it is not intended as a plan; it simply articulates policy and represents an allocation of space to biodiversity.

The NGN aims to offer a broad framework or 'big picture' approach, which according to Lucas (*1992*) is often absent in protected area planning. It is also the scale at which spatial planning for species to mitigate broad climatic changes can be accommodated. The project then becomes one of adjusting the grid across the nation to meet local specificity.

Transect scale: creation of the NGN as framework

A finer scale is required to assess the potential of the design experiment. Therefore, to test the practical complexity of the national NGN system, a 25-km-wide and 1,375-km-long transect establishes a detailed study area through the South West of Australia (Fig. 6). This region is one of the nation's only two recognized 'Biodiversity Hotspots' (*Myers et al. 2000*), identified for its high degree of biological endemism (*Hopper & Gioia 2004*) and its threatening processes, namely, land conversion and ecological fragmentation (*Hobbs 1993*). The transect bisects this region and samples a representative range of Australian land uses, from 'urban' to 'wilderness' over the breadth of its journey from the coastal metropolitan city of Perth to the sparsely inhabited Nullarbor Plain. This reflects Landscape Ecology 'transect' and 'urban to rural' gradient studies (*Forman & Godron 1986; McDonnell & Pickett 1990*). A detailed investigation of the transect's character through a site analytical process revealed the qualities of this heterogeneous landscape. Mapping the diversity of this study area was undertaken through the overlay of eight biogeographical and ten socio-cultural datasets including topography, hydrology and remnant vegetation, land use, cadastre and roads and rail (Fig. 7).

A broad initial adjustment (Fig. 8) of the policy grid using these datasets was undertaken through a combined landscape analytical and GIS ecological modelling process using the software Linkage Mapper (*McRae & Kavanagh 2011*). The objective design that was created [6] produced a better 'fit' to landscape while still achieving connectivity and protected area targets. The resultant NGN (Fig. 9) is a new framework, a matrix of protected

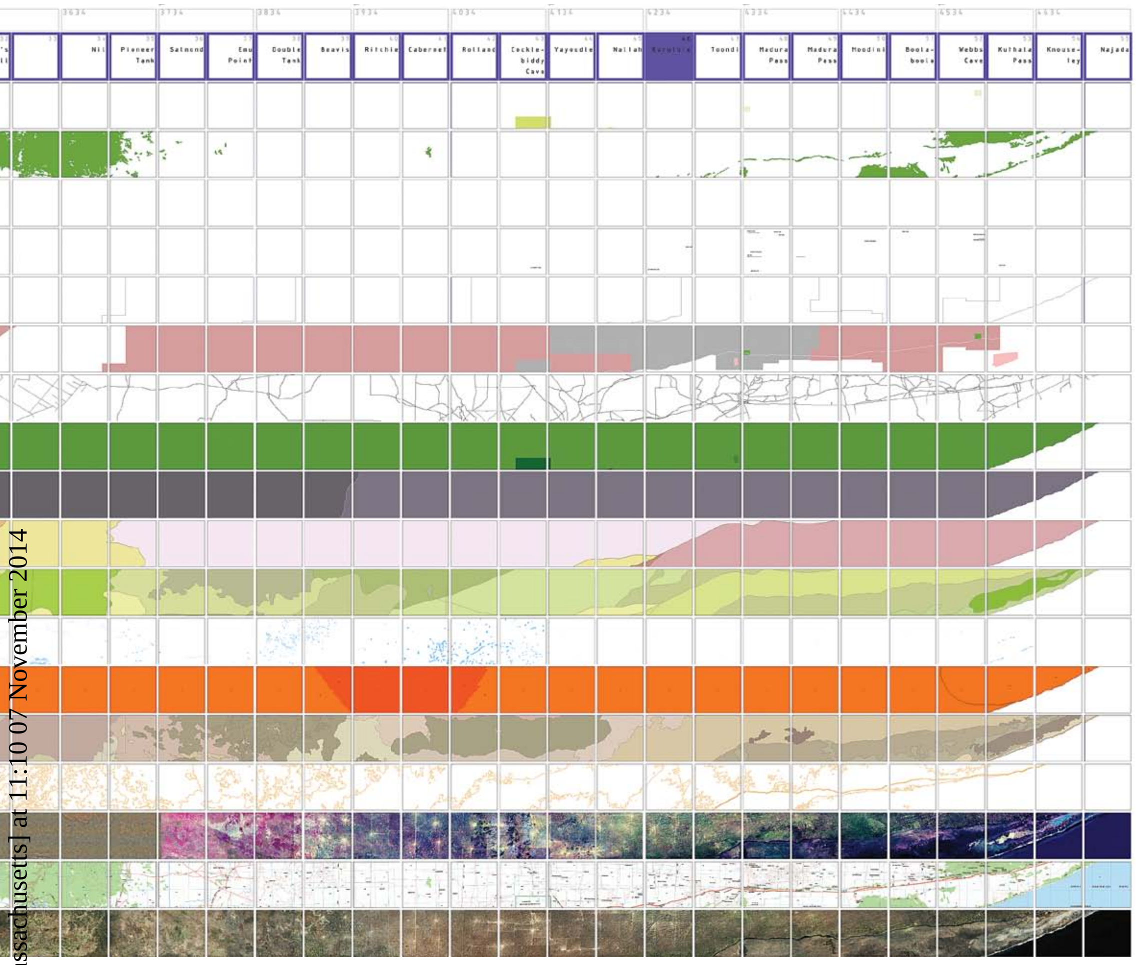


Figure 7 Overlay of 8 biogeographical and 10 socio-cultural datasets reveals the transect's diversity. (*Geoscience Australia 2007; Western Australian Land Information Authority 2012*)

lands and the first articulation of policy at continental scale. This spatially explicit, interconnected protected area network addresses and visualizes the two research principles. However despite this robust design outcome, if we are to bridge the policy–practice gap, this system's viability must be tested.

Vignette scale: ground-truthing the NGN

From the transect, seven 25 km x 25 km study vignettes were identified to test the feasibility of the system at a finer grain (see Fig. 10). The vignettes examine a broadly representative sample of typical Australian land uses. From west to east, urban, suburban, peri-urban, agricultural, range and wilderness were examined to highlight the complexity that a conceptual system such as the NGN would need to address if implemented, regardless of location in Australia.

Research next examined in detail the potential for implementation and/or conflict through superimposing such a proposal upon existing landscapes and land uses. To align to these 'real' landscapes, the research had to go beyond the NGN's ecological model and resolve potential conflict through the exploration of contingencies. The method for this reconfiguration was through the agency of a design charrette. Containing approximately 2,500 people primarily engaged in agricultural and service industries (*Australian Bureau of Statistics 2012*), York is the oldest inland European settlement in Western Australia and was considered an appropriate place to test the new NGN vision for ecological and cultural resilience. Within the ecologically fragmented landscape of the York vignette, less than 8.8 percent remnant vegetation remains in a highly fragmented state (*Western Australian Land Information Authority 2012*), while a meagre 0.11 percent is allocated as formal protected area (*Department of Sustainability et al. 2012*). Indeed, perhaps reflecting land use priorities, only one of the two IUCN-gazetted protected areas in the York study area has a formal name, Wallaby Hills Nature Reserve; the other is known as Unnamed WA40642 (*Department of Sustainability et al. 2012*).

Participation at the charrette was sought from government and community stakeholders familiar with the area. A total of fourteen participants were chosen from a range of vocations related to land and/or landscape management or intervention, including farmers, local government planners, ecological revegetation staff and natural resource managers. Participants included those explicitly engaged in the implementation and facilitation of large-scale landscape ecological restoration or revegetation projects and responsible for the distribution of federal funds for the protection of biodiversity. Meeting over one day at various locations within the study area, participants then used their local insights and expertise to critique the proposed NGN design from their own particular perspective and skill set (as ecologist, farmer, local government planner and so on). Pens in hand, they collectively redrew the NGN to consolidate these multi-faceted approaches into one ultimate design outcome. Although participants were unfamiliar with the design charrette process, an adjusted final design with a closer alignment to existing landscapes emerged: a design that demonstrated improved potential for implementation.

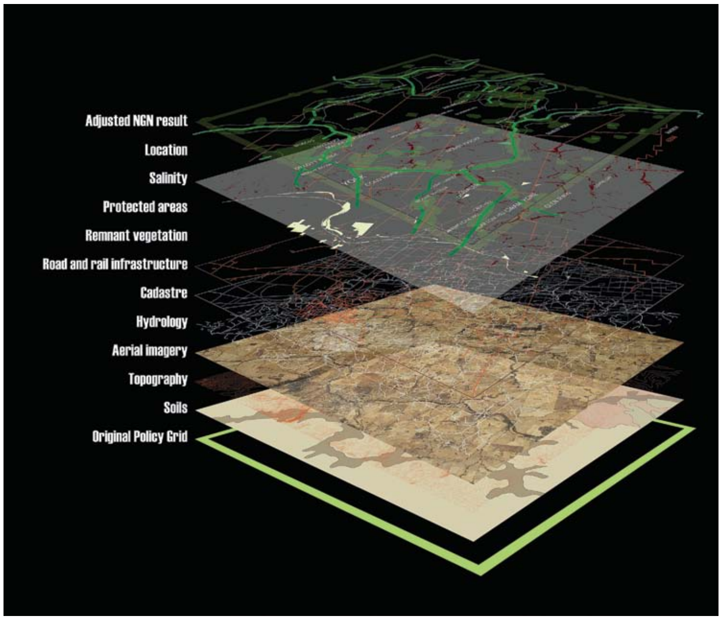
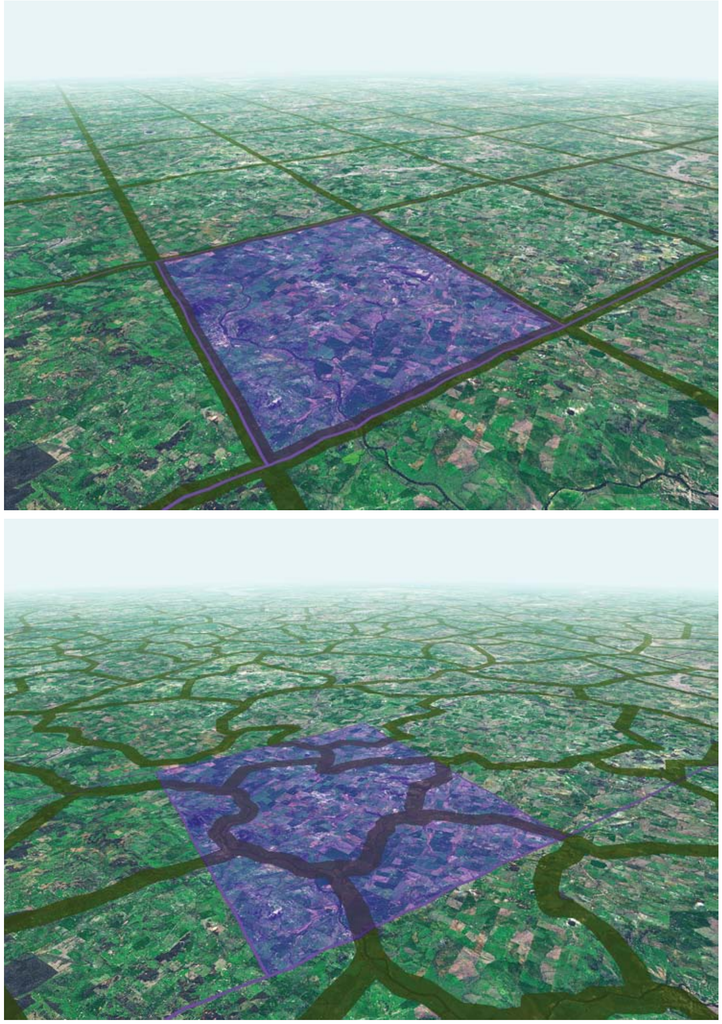


Figure 8 Diagram of the adjustment process, from initial policy grid to NGN



Figures 9a, b Examples of adjustment to create the NGN (York vignette scale)

The ground-truthed NGN design

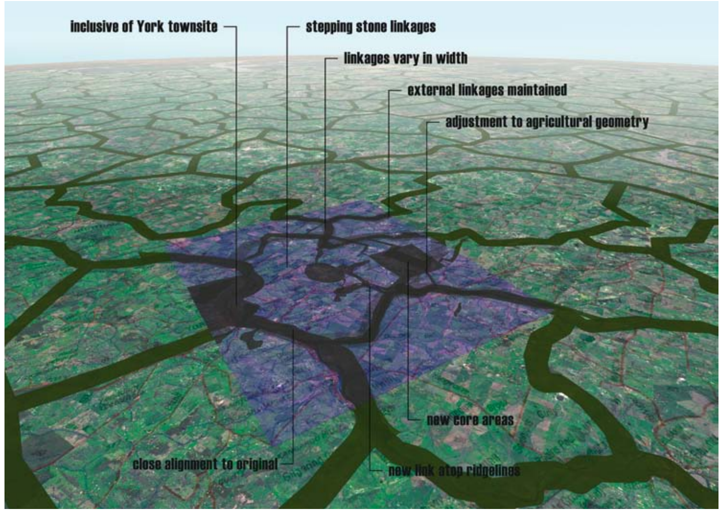
In the final design approximately 23 percent of lands were now defined as NGN, exceeding the original target of 10 percent protected areas. Although maintaining a close resemblance to the original NGN, the design charrette participants made a number of key adjustments (see Fig. 11).

First, adjustments changed the form of the NGN and a more precise design was realized. The NGN geometry was redrawn from fluid broad swathes to the specific geometry of the land cadastre, altering both alignment and width to create a network and hierarchy to follow property, fence, road and rail lines. This meant that features at a scale previously unable to be interpreted and modelled in the creation of the original NGN were now incorporated into the final design. These included topographical and hydrological features, remnant vegetation patches possessing high biodiversity value (but unprotected), lands where ownership or land use was soon to change and lands severely impacted or at risk of salinity and erosion. Notably, linkages were maintained beyond the York study area.

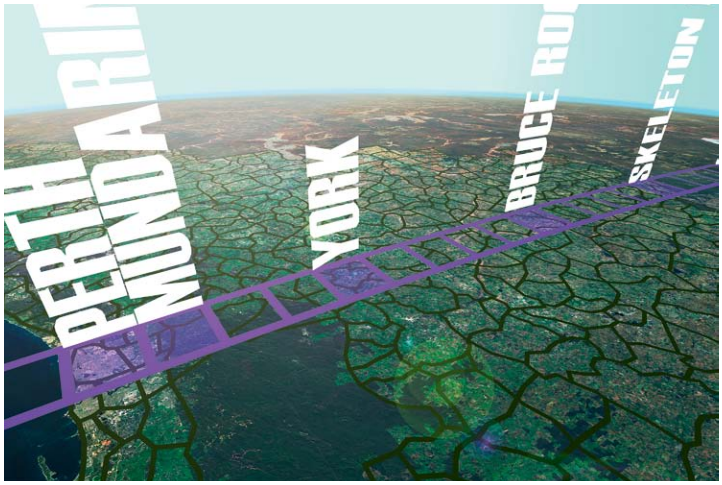
Second, the defining function of the NGN changed from one exclusively delivering a design for biodiversity to a 'multi-functional' GI. The stakeholder's freedom to manipulate the NGN geometry allowed for the potential to explore a suite of noteworthy ecosystem services while remaining within the IUCN (*1994*) protected area guidelines. This new GI could therefore enhance ecological resilience while simultaneously assisting landscapes to deal with other 'synergistic' or complementary benefits through detailed design. As a result revegetation opportunities such as agro-forestry and tree-cropping [vii] enabled the potential to concurrently mitigate salinity and increase water security, whilst qualifying for funding through government carbon sequestration policy. [8] Compatible with ecological connectivity, recreational greenways and cultural corridors that could be related to indigenous culture and to tourism were also proposed. The reinterpretation and flexibility of function takes the system from purely ecologically-focussed outcomes to create a multi-functional system with diverse ecological and cultural benefits. The reinterpretation of 'function' therefore provided leverage to achieve original ecological targets and enhance the potential for implementation.

The resultant design bears witness to the GI definition offered by Benedict & McMahon (*2006: 4*) as 'the ecological framework for environmental, social, and economic health'. The flexibility and open or 'vague' character of the proposed NGN uncovered through the charrette is, as suggested by Van der Windt & Swart, 'strong enough to bind and flexible enough to leave room for different operating forms and interpretations' (*2008: 129*). The charrette yielded timely deliverables and achieved the objective of a fine-tuned or ground-truthed interconnected protected area NGN. It revealed 'synergistic' and 'multi-functional' possibilities (*European Commission 2012: 25; Van der Windt & Swart 2008*), also referred to as the 'spatial stacking' of functions (*Ahern 2012: 6*). This means that benefits of the proposed system extend beyond protection of the nation's biodiversity to also consider the Australian landscape and its peoples.

Figure 10 The 7 vignettes sample different land uses and highlight the potential of the NGN.



Figures 11 Vignette-scale adjustments from the design charrette



Figures 12 Extrapolation to transect and continental scale

The potential of a continental plan

Confirmation of methodology

Some twenty years ago, Hobbs (*1993: 199*) spoke about landscapes typified by the York study area, suggesting that 'conservation management cannot be carried out in isolation, but must be incorporated into the overall management of the surrounding landscape'. He made further comment that a 'holistic approach may be difficult to achieve because of the many land-owners and management bodies involved' across Australian landscapes such as these. Through its methodology, this research project has achieved its original objectives and also addresses this comment.

The NGN design is posited as a continental-scale conceptual framework. Derived from robust ecological modelling, the NGN articulates policy and ecological theory. This creates a conceptual ideal, a matrix of interconnected and protected lands to meet representative protection and connectivity targets. The NGN accurately illustrates the spatial intent lacking in government policy documents and reveals the potential for conflict in achieving implementation on existing landscapes.

The charrette process is considered an essential part of the research methodology, helping to ground-truth and fine-tune this continental-scale NGN. Local stakeholders considered the NGN as a point of departure and adjusted its form and function to account for landscape specificity, which enhanced both ecological and cultural functions and arguably increased its potential for implementation. Through the charrette, designs addressed the York study area as well as linkages beyond, bridging between local actions to regional and even continental scale (Fig. 12).

Holistic landscape planning

Landscape as a whole needs to be considered in ecological planning. This was confirmed by the charrette, which allowed for propositions to be explored over the entire study area, elucidating in real spatial terms the ecological and cultural benefits of differing design configurations. The shift in focus, from an NGN providing purely ecological functions to a more flexible interpretation inclusive of the cultural, mimics current conservation planning practice and governance. Heretofore such practice has been pre-occupied with a binary view of nature/culture and protected/unprotected lands and the associated belief that the longevity of biota is maintained through such delineation. The inadequacies of this binary view have been subject to increasing criticism, and the failing of systems such as Australia's NRS to adequately protect Australian biota has been noted (*Flannery 2012*). Conservation planning now increasingly takes a holistic, 'multi-functional' or 'integrated' planning approach (*Bennett 2003: 163; European Commission 2012: 25; Van der Windt & Swart 2008*) and reflects the 'ecosystem approach' (*Smith & Maltby 2003; United Nations 2010*) across both protected and unprotected lands.

The flexible approach to NGN 'function' by the charrette process responds to the challenge of faithfully restoring the notoriously 'difficult' landscapes that characterize the study area. The York study area, composed of 'old, climatically buffered infertile lands' (*Hopper 2009: 49*), suggests the merits of new approaches in lieu of the traditional pursuit of ecological restoration towards a pre-European ecological state as benchmark. Instead, the charrette proposes the inevitability of future states akin to 'novel ecosystems' (*Hobbs, Higgs & Harris 2009: 603*) and offers a new way to envisage such future landscape trajectories through a novel landscape typology of multifunctionality. Could we one day see a future Western Australian agrarian landscape as Marris (*2011: 130*) describes: 'take salty former eucalyptus woodland and design a prairie that would feed native birds and also be ideal for biofuel'? Through understanding the importance of all lands, both protected and 'matrix' (*Ricketts 2001*), it has been established that holistic planning is desirable, notwithstanding that these lands continue to meet IUCN classification. This research posits that it is only through holistic planning that 'win-win' solutions that enhance both ecological and cultural resilience and outcomes can be explored.

Instrumentality of landscape architecture

Australia is at a crossroads. For over 200 years Australians have exploited their landscape: now it is time to care for it. Climate change and a growing population combined with fragile landscapes are impacting the nation's biodiversity. Australia's protected area network, despite best efforts, has provided only 46 of the continent's 85 eco-regions with the minimum CBD protected areas target. However protected areas with static boundaries not only fail to sample Australia's biological diversity, but as fixed spatial entities are unable to adapt to climate change, denying species the capacity to alter their distribution in the face of extinction. A designed solution explored by this research therefore aims to provide a representative protected area network that is also interconnected.

The potential of an NGN for Australia was outlined here. The translation of ecological theory and policy into practice designs has been suggested to provide for the resilience of Australia's landscapes, biota and (ultimately) peoples. A landscape architectural design-based methodology created accurate continental plans to articulate ecological connectivity and a percentage of the protected area targets of the CBD and NRS. However, while this is in itself a robust plan, the viability of realistic designs that could be implemented was only possible through the design charrette process. Central to this research methodology, the charrette proved the potential of the NGN. The final design closely replicated its original modelled form, which was further enhanced through fine-tuned improvements. While Hopper and Gioia (*2004: 641*) suggest a word of caution when applying broad-scale conservation approaches, this methodology provides both broad (NGN) and specific (charrette) processes that articulate a successful new methodology. This enables maintenance of ecological connectivity and representation at the large, transect and continental scales, yet as a framework adjusted by the design charrette creates an intimate response to existing land uses, biodiversity, cultural demands and other local-scale landscape specifics.

This demonstrates a potential shift in Australian practice, whereby leverage for ecological outcomes is dependent upon a holistic consideration of the cultural demands of landscape. The creation of a multi-functional GI becomes the framework upon which to scaffold local actions that also connect to a larger continental approach providing ecological and cultural resilience.

Although it is noted that only one vignette-scale study was detailed by the research, results were encouraging. The final design articulates the original objectives and confirms the potential of the continental-scale NGN when coupled with the charrette process. If Australia is to make the critical move from theoretical policy and planning to practical implementation, then it must embrace a method that is informed by the best science in conjunction with local knowledge. This research allowed for such a move and successfully demonstrates the shift from theory to practice to create a model of national reconstruction for the long-term ecological and cultural resilience of Australia. It is here in the space between ideas and reality that landscape architecture can be instrumental.

Acknowledgements

This research is a component of the author's PhD in landscape architecture at the University of Western Australia. I wish to thank Professors Richard Weller (Landscape Architecture) and Richard Hobbs (Landscape Ecology) as supervisors of the research, Josephine Neldner for her assistance in drafting an earlier copy of this manuscript and finally the design charrette participants for their time and efforts.

Notes

1 For instance the Ngaanyatjarra Lands Indigenous Protected Area in central Australia is the nation's largest at 9,812,900 ha (or 0.13% of the continent).

2 In 2010 at COP 10 the 'Aichi Biodiversity Targets' raised the terrestrial protected area target from 10% to 17% globally (United Nations 2012: 119). The research has retained the 10% target as member nations decide on implementation, currently and Australia's NRS is unchanged in its aspirations.

3 While the research acknowledges the conjecture surrounding ecological connectivity, as it has been widely embraced in both policy and practice and is considered by this research as the 'precautionary principle' as defined by United Nations, United Nations Conference on Environment and Development Rio de Janeiro, United Nations, Brazil, 3–14 June 1992.

4 Despite the diverse nomenclature, these schemes fit within a broad GI definition and are therefore considered as such by this research.

5 The Australian government department, Infrastructure Australia is constructing the NBN nationally at a cost of $43 billion: NBN Co, National Broadband Network [website] www.nbnco.com.au, accessed 1 January 2012

6 Adjustment to corridor width was made in order to establish a ubiquitous 10% coverage.

7 Tree-cropping and agro-forestry opportunities in the region include cropping oil mallee (*Eucalyptus* spp.) and sandalwood (*Santalum* spp.).

8 For carbon farming information see: Australian Government, 'About the Carbon Farming Initiative', Department of Climate Change and Energy Efficiency [website] www.climatechange.gov.au/government/initiatives/carbon-farming-initiative/about.aspx, accessed 1 November 2012

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