Chapter 2
The Wilderness Continuum Concept and Its Application in Australia: Lessons for Modern Conservation

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Abstract Wilderness is relative; it occupies parts of a spectrum of environmental modification ranging from synthetic high-input urban and agricultural systems through to environments with minimal human interference (Lesslie RG, Taylor BG, Biol Conserv 32:309–333, 1985). This chapter considers the wilderness continuum concept which accounts for the degree to which a place is remote from and undisturbed by the influences of modern technological society, accepting that there are no absolutely inaccessible and undisturbed areas remaining on earth. The focus of the wilderness continuum concept on degrees of remoteness and naturalness in the landscape contributes to our understanding of how modern conservation landscapes can be created, including the role of larger and more intact natural areas. Discussion points to the need for comprehensive disturbance mapping and monitoring focused on patterns of land use, settlement and access across the landscape – as these represent key drivers of terrestrial environmental change. A review and discussion of Australian National Wilderness Inventory (ANWI), a wild land evaluation program conducted in Australia during the 1980s and 1990s (Lesslie RG, Maslen M, National wilderness inventory: handbook of procedures, content and usage, 2nd edn. Australian Government Publishing Service, Canberra, 1995), is provided. More recent environmental assessments that draw on the work of the ANWI are introduced. An updated global assessment of wilderness quality based on ANWI methods is presented.

Keywords Wilderness continuum • Remoteness • Naturalness • Mapping • Monitoring change • Disturbance • Modification • Fragmentation • Unmodified reference

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2.1 Introduction

It seems simple. The idea that wilderness epitomizes 'the big outside' – places beyond the touch of civilization where natural processes prevail (Forman and Wolke 1992). However, modern earth and conservation sciences, in highlighting the state of earth systems today, challenge that idea. Human-induced global climate change and other large-scale human interferences (including introduced species and pathogens, chemical and nutrient pollution and fire) have left no place on the surface of the earth untouched by humans. This recent change is additionally set against the recognition of widespread environmental modifications brought about by indigenous people over millennia, often through deliberate manipulation. Modern earth and conservation sciences are increasingly focused on coupled human-environment systems and the sustaining of ecosystem services. Concepts such as the 'anthropocene' are also in the ascendancy (Ellis 2011). Does wilderness have any place in twenty-first century conservation? Is the concept of wilderness simply an outmoded ideal from a bygone era?

To answer these questions we need a clear definition of wilderness – including clarity as to the attributes that define wilderness environments. To appreciate the wilderness continuum concept we also need to understand the idea that wilderness quality is a relative condition – occupying parts of a spectrum of modified environmental conditions. This spectrum ranges from synthetic high-input urban and agricultural systems at one extreme through to environments without direct human interference at the other.

This chapter argues that the rationale for the wilderness continuum concept is relevant and essential to the systematic survey and assessment of large intact natural areas, the framing of legislative and administrative approaches for their protection, and the design and implementation of modern landscape-wide nature conservation measures. The Australian National Wilderness Inventory (ANWI) (Lesslie and Maslen 1995), a wilderness mapping program completed in the late 1990s (also known as the Australian Land Disturbance Database), was based on the continuum concept. The ANWI was a fundamental exercise in natural resources inventory and assessment that continues to inform environment policy and programs in Australia and other countries.

2.2 Wilderness – Alternative Viewpoints

The notion of wilderness and its place in social-ecological discourse has evolved over the last century. This has seen concern for protecting wilderness areas extend from spiritual, aesthetic and cultural concerns in the early 1900s, to providing special recreation opportunities and habitat for iconic species to, most recently, an anchoring role in sustaining natural systems and processes. Post-war conflicts over the use of undeveloped land led to the passage of the US Wilderness Act in 1964 and the establishment of the National Wilderness Preservation System (NWPS)

with mechanisms for the review and designation of wilderness on federal land. One feature of that evaluation process was the 'purism' debate, the issue being how 'wild' an area needs to be for inclusion within the NWPS.

A similar pathway was followed in Australia with measures for the protection of wilderness introduced in a number of states and nationally. By the 1990s wilderness protection had become established as a conservation objective. Wilderness, along with biodiversity and old growth forest values were, for example, explicitly identified as criteria for sustainable forest management under Australia's National Forest Policy Statement (Commonwealth of Australia 1992).

The relevance of wilderness to modern nature conservation debate is now commonly questioned (Mackey et al. 1998). It is argued, for example, that wilderness areas are unrepresentative of biodiversity and that wilderness protection often comes at the expense of the protection of more threatened or rarer habitat. A focus on wilderness is also cited as counter to the trend to landscape-wide conservation, including the promotion of off-reserve conservation management, ecological connectivity and conservation in production landscapes. More fundamentally, the concept has been criticised on the grounds that it is not measurable in any objective scientific manner – as evidenced in 'purism' debates and historically changing criteria for wilderness identification and assessment. Moreover, its cultural origin in western frontier societies is seen as difficult for societies that do not share this tradition. This particularly applies to indigenous societies where the line of separation between natural and managed landscapes is subtle or non-existent, notwithstanding the often widespread employment of powerful management tools such as fire (e.g. Gammage 2011).

The validity of these criticisms hinges very much on matters of definition and perspective. The wilderness continuum concept provides insights in this regard.

2.3 The Wilderness Continuum Concept

Differences in the definition, identification and mapping of wilderness areas prompted the suggestion by Nash (1973) and others that wilderness be considered a range of conditions at the wild end of a spectrum of remoteness and primitiveness extending from highly inaccessible and virtually undisturbed land at one end to settled land at the other. This way of viewing wilderness put a premium on variations of intensity rather than absolutes so that finding the watershed where wild becomes non-wild is made less critical.

Lesslie and Taylor (1985) took this approach a step further in introducing the wilderness continuum concept, maintaining that the attributes that characterise wilderness are remoteness and naturalness and defining wilderness quality as the extent to which a location is remote from and undisturbed by the influences of modern technological society. They argued that remoteness and naturalness are entirely relative – there being no absolutely inaccessible and undisturbed areas on Earth. It is thus possible to regard wilderness quality as existing to various degrees along the length of the continuum of remoteness and naturalness formed by the world's

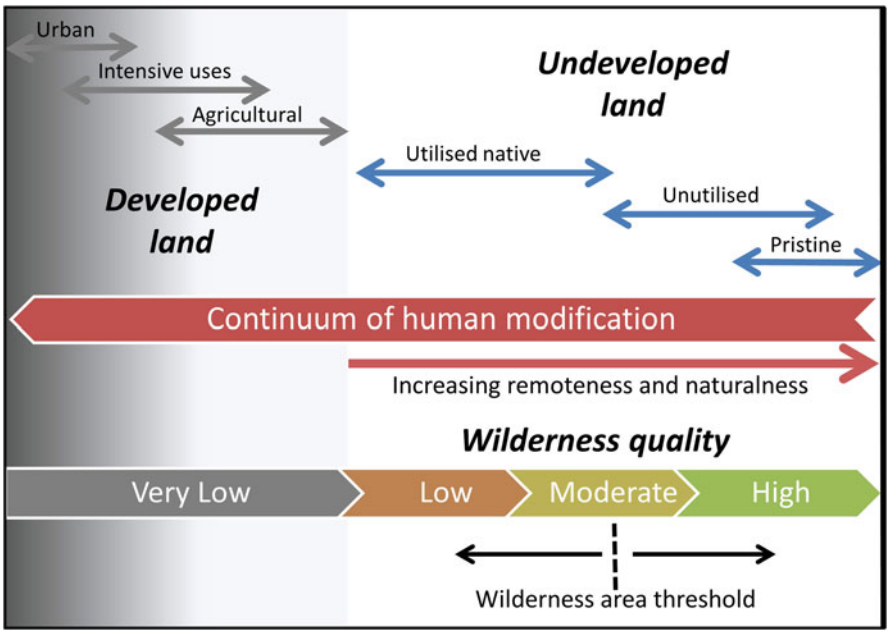

Fig. 2.1 The wilderness continuum concept (Adapted from Lesslie and Taylor 1985)

remaining areas of undeveloped land. Undeveloped land at the less remote and natural end of the continuum, such as small disturbed natural areas, can be viewed as having relatively low wilderness quality. Large intact natural areas can be viewed as having relatively higher wilderness quality. The value placed on these areas depends on context. The wilderness continuum concept is illustrated in Fig. 2.1.

The wilderness continuum concept recognises wilderness quality as a relative condition, there being no absolutely remote and undisturbed areas on Earth. The threshold or level at which remote and natural values are considered worth recognising and protecting, for example as 'wilderness areas', changes according to environmental context and over time as the demand for and supply of remote and intact land changes.

Viewing wilderness quality as a continuum of remote and natural conditions provides a solid conceptual foundation for approaching the problem of identifying wilderness resources; it also provides a coherent basis for discussion and debate regarding wilderness more broadly – from concerns about its cultural context through to measures for wilderness protection and management. A key reason for this is its focus on variability in the factors that characterise the spatial extent and impact of modern technological society in landscapes: land use and management, settlement and access.

These issues are considered further below in relation to the survey and assessment needs, the cultural context for wilderness, the protection and management of wilderness, and finally, broader lessons for conservation.

2.3.1 Survey and Assessment

A distinction needs to be made between (a) wilderness quality and (b) wilderness areas. Wilderness quality is the extent to which any specified unit area is remote from and undisturbed by the impacts and influence of modern technological society. Wilderness areas are relatively large intact natural areas – places where wilderness quality is defined using agreed thresholds recognized by society.

Selection criteria for wilderness areas, including thresholds of remoteness and naturalness, may be applied flexibly to single out areas having sufficient value as remote and natural places to warrant recognition. This approach accommodates the often confusing historical shifts in wilderness area identification criteria that have occurred as the supply of remote and natural land has changed and the value ascribed to these lands has evolved. Selection criteria may include factors such as size, or take into account environmental or ecological context, including the broader landscape setting. Different wilderness area selection criteria may be applied, for example, to arid or tundra environments (which are generally less developed) in contrast to temperate woodland or grassland environments (which are typically more highly affected by development and are fragmented). The application of the wilderness continuum concept to wilderness inventory and appraisal in Australia is discussed in more detail later in this chapter.

2.3.2 Cultural Context

By defining wilderness quality as the extent to which a location is remote from and undisturbed by the influences of modern technological society, rather than human activity *per se,* the wilderness continuum concept explicitly excludes the environmental impacts of indigenous societies. This is a critical point, noting for example in the Australian context the evidence provided by Gammage (2011) and others that that the ecology of landscapes across the continent, including forests, deserts and grasslands, have been deliberately managed and profoundly impacted by the indigenous Aboriginal population. A similar argument can perhaps be mounted for most continents with indigenous populations. Against this broader background the concept of wilderness has limited meaning. Limiting the definition to terms that describe the imprint of modern technological society distinguishes the modern definition of wilderness from earlier frontier-oriented understandings of the concept.

2.3.3 Wilderness Protection

The wilderness continuum concept offers insights into appropriate mechanisms for wilderness protection. Potentially, the wilderness quality of any area may warrant protection if, in a given context, its remoteness and naturalness is sufficiently valuable. The largest intact natural areas will generally be valued regardless of context. However, lesser degrees of remoteness and naturalness may also be recognised as important in areas that represent critical environment types (that is, the 'best of what's left'), or in other ways make significant contributions to ecological processes.

Legislation for the identification, protection and management of wilderness in the state of South Australia is based on this principle. The South Australian *Wilderness Protection Act, 1992* does not prescribe a rigid formula for the identification of wilderness areas. Wilderness criteria require that (a) the land and its ecosystems must not have been affected, or must have been affected to only a minor extent, by modern technology; and (b) the land and its ecosystems must not have been seriously affected by exotic plants or animals or other exotic organisms. Notably the wilderness quality of land may receive protection if it meets the wilderness criteria to a sufficient extent to justify its protection as wilderness or to enable it to be restored to a condition that justifies its protection as wilderness. An expert committee makes recommendations as to the potential suitability of areas for inclusion in the State's wilderness protection system. The assessment process takes account of wilderness quality measurements as well as factors such as environmental context and potential for rehabilitation.

Protected wilderness in South Australia includes relatively small intact natural areas that are now uncommon in temperate coastal regions subject to widespread development. It also includes extensive areas in the arid north of the State, including some of the best high wilderness quality locations in the world. The common feature that these protected areas share is that they represent the 'best of what's left' – the most intact examples of particular environmental settings – and for that reason alone being something worth protecting.

2.3.4 Management Principles

Application of the continuum concept to wilderness management places focus on maintaining and enhancing remoteness and naturalness. This includes protecting native species and ecological processes and controlling non-indigenous plants and animals. Regardless of the existing level of wilderness quality, management objectives remain consistent – the protection of remoteness and naturalness; ensuring areas retain or improve their remoteness and intactness. Active management may be required to ameliorate the impacts of threatening processes. Wilderness management may also provide for other uses that are compatible with the maintenance and

enhancement of wilderness quality such as traditional indigenous uses, self-reliant recreation and scientific research.

2.3.5 Lessons for Conservation

The challenges for nature conservation in the twenty-first century include maintaining biodiversity and ecological function against a background of continuing habitat loss and fragmentation, climate change and other threatening processes including pest plants and animals and inappropriate fire regimes. Modern approaches to nature conservation aim to protect the functional integrity and resilience of natural systems in addition to more conventional approaches to protecting areas with biodiversity values. There is also an increasing emphasis on 'whole of landscape' conservation strategies and promoting connectivity.

What role can wilderness play in modern conservation? Larger, more intact natural areas have high inherent connectivity, they provide environmental benchmarks against which change can be assessed, they provide the best opportunities for effective long-term retention of species and communities and ecological processes at minimal cost (including buffering against large-scale threatening processes such as climate change and fire). In addition, these areas may be landscapes of importance to indigenous communities providing opportunities for cross-cultural and self-reliant recreation.

How large and how intact? That depends on context, such as the importance of the environmental setting to conservation (e.g. its rarity, biodiversity, endemicity, functional importance) and its level of threat. In fragmented landscapes relatively smaller-scale intact natural areas will provide corresponding conservation benefits, although to a lesser extent. Thus, both larger- and smaller-scale intact natural areas form core areas around which whole-of-landscape conservation and restoration activities can be developed, for example Australia's National Wildlife Corridors Plan (Australian Government Department of Sustainability, Environment, Water, Population and Communities 2012).

2.4 The Australian National Wilderness Inventory

The Australian National Wilderness Inventory (ANWI), an Australia-wide survey and assessment of remote and natural lands completed by the Australian Government in the late 1990s, is a prime example of the application of the wilderness continuum concept in land resources assessment (Lesslie and Maslen 1995). The ANWI developed a spatial database and analytical techniques to identify and evaluate remote and natural lands across Australia. It assisted decision-makers in delineating wilderness areas, monitoring wilderness loss, defining management options, and predicting the effect of impacts on wilderness.

The conceptual basis for the ANWI is the wilderness continuum concept. The inventory process did not take any particular biocentric or anthropocentric view of wilderness. Emphasis was placed on identifying and assessing degrees of remoteness and naturalness across the landscape using patterns of access, settlement and land use.

Four spatially-explicit wilderness quality indicators representing the two essential attributes of wilderness – remoteness and naturalness underpin the ANWI (Lesslie and Maslen 1995). The indicators are:

- ***Remoteness from settlement*** – how remote a site is from places of permanent human occupation;
- ***Remoteness from access*** – how remote a site is free from established access routes;
- ***Biophysical naturalness*** – the degree to which a site is free from biophysical disturbance caused by the influence of modern technological society;
- ***Apparent naturalness*** – the degree to which a site is free from the permanent structures associated with modern technological society.

The methods used for calculating values for these indicators reflect the constraints on available data and spatial processing capability for a continental-scale survey at that time. The type of information included land cover, land use, land management, and infrastructure.

The ANWI produced indicator values for all undeveloped areas – practically defined as areas still retaining a native vegetation cover. Values for remoteness from settlement and remoteness from access were based on calculations of distance from each survey site to the nearest settlement and access feature. A weighting regime was applied to each site; the final remoteness values of a site reflecting the greater influence of, for example, a small town compared with a single farmhouse or a highway compared with a vehicle track. Values for the apparent naturalness indicator were similarly produced, using measures of weighted distance to all structures.

The measurement of Biophysical Naturalness was approached by assuming the degree of anthropogenic change sustained in an ecosystem is directly related to the intensity and duration of land management practices associated with particular land use types. The ANWI used two rating procedures, based on five levels of land use intensity for livestock grazing and timber harvesting. The first procedure was applied to regions of the continent where arid and semi-arid livestock grazing predominates and where livestock distribution is controlled by the location of watering points. The intensity of grazing was rated according to the grazing suitability of range type, the proximity of permanent water, and tenure. The second procedure was applied to regions where grazing is less restricted by the availability of water or where commercial timber harvesting takes place. Sites were rated according to the intensity and duration of logging and grazing activity.

A total wilderness quality index was produced by combining standardised indicator values. The standard ANWI process was unweighted additive although the methods provided the ability to weight the contribution of individual indicators, and to apply criteria to account for other needs such as minimum indicators thresholds.

The resulting spatial pattern of wilderness quality assessed at a resolution of 500 m across Australia is shown in Fig. 2.2.

The map in Fig. 2.2 shows the distribution of wilderness quality across Australia based on the results of the ANWI (Lesslie and Maslen 1995). (Survey incomplete in far south-western Australia as at 1995; additional survey work completed for limited areas since 1995.) The threshold at which 'wilderness' is recognised changes according to environmental context and over time. The map shows areas of potential national significance as wilderness delineated using a set of area selection criteria and additional assessments to validate and revise ANWI results (survey not completed for Western Australia) (Australian Government Department of Sustainability, Environment, Water, Population and Communities 2008).

The continental pattern of landscape modification reflects Australia's history of exploration, settlement and development since European settlement in the late 1700s. Major urban centres and more intensive agricultural development in Australia are concentrated in the temperate regions of the east and south-east. Remoteness and naturalness values are consequently generally lower in these regions. Pastoralism and other minimal uses occur over much of the remainder. The large intact natural areas evident through central and northern Australia are arid or seasonally arid – these include some of the most extensive areas of high quality wilderness of this type in the world. These differences mean that geographic stratification is important in any analysis of results. A breakdown of these patterns by biome, for example, shows the skewed distribution of very high wilderness quality (wilderness index values greater than 18) (Table 2.1).

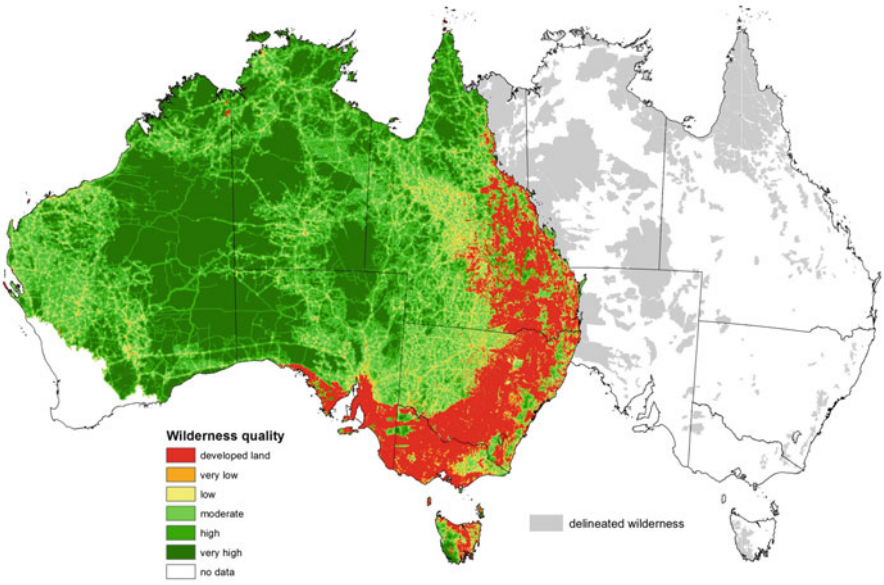

Fig. 2.2 Wilderness quality and delineated wilderness in Australia (circa 1990)

Table 2.1 Area of remaining very high wilderness quality in Australia classified using global biomes

Global biome	Very high wilderness quality	
	Area (km^2)	Proportion biome (%)
Montane Grasslands and Shrublands	0	0.0
Temperate Grasslands, Savannahs and Shrublands	2700	0.5
Temperate Broadleaf and Mixed Forests	6100	1.1
Tropical and Subtropical Moist Broadleaf Forests	400	1.3
Mediterranean Forests Woodlands and Scrubs[a]	89,100	11.1
Tropical and Subtropical Grasslands, Savannahs and Shrublands	476,200	22.3
Deserts and Xeric Shrublands	1,656,100	46.5

[a]Excludes very high wilderness quality in far south-western Australia. The area of high wilderness quality in this region is likely to be very small. Wilderness quality after ANWI; Biomes after Olsen et al. (2001). Area estimates calculated using Albers projection

More isolated locations of high wilderness quality are evident along the spine of forested ranges in eastern and south-eastern Australia. The relatively high remote and natural values in south-western Tasmania are also prominent in this context. The majority of this area is currently contained in the Tasmanian Wilderness World Heritage Area.

2.4.1 Uses of the ANWI Database

The database has been used in national processes aimed at promoting sustainable forest management in Australia, helping to identify and protect larger intact areas of native forest. Nationally agreed criteria for the establishment of a comprehensive, adequate and representative reserve system for forests in Australia include 90 % or more of high quality wilderness as measured by ANWI methods (Davey et al. 2002).

A national assessment was also completed to assist the Australian Government delineate areas of potential national significance as wilderness (Australian Government Department of Sustainability, Environment, Water, Population and Communities 2008). The delineation process involved application of a wilderness index threshold, a series of minimum size thresholds to accommodate different environmental settings and additional land assessments to validate and revise ANWI results. The result of this process, showing the extent of large relatively intact natural areas in Australia, is shown in Figure 2 (map at right). The database has been used at the national and state level to underpin wilderness assessment. The delineation process could also be used to identify core areas supporting development of landscape-scale conservation programs. One such program is the Great Eastern Ranges Initiative which aims to protect and connect intact native ecosystems along 3600 km of the Great Dividing Range and Eastern Escarpment.

2.5 Related Work

2.5.1 An International Perspective

The wilderness continuum concept and ANWI methods for survey and assessment share similarities with methods used elsewhere in the world. Surveys have been conducted in the Barents region, in parts of South America, Africa, Asia and Europe (e.g. Husby 1995). A synoptic international wilderness assessment, based on the ANWI method, has also been completed (Lesslie 1998). The assessment was based on calculations using access, settlement and infrastructure information available in the Digital Chart of the World (DCW) developed for the US Defence Mapping Agency. A more recent assessment of the distribution of global wilderness quality is shown in Figure 3; this draws on additional primary land cover and land use information in recent Globcover and global pasture datasets (Bontemps et al. 2011; Ramankutty et al. 2010). The remaining area of high wilderness quality classified by biome is shown in Table 2.2. While in the case of Australia some differences in national-level and global-level patterns are evident, spatial configurations are generally similar (comparing Figs. 2.2 and 2.3). This analysis helps place national and regional wilderness assessments in a global context. The patterns of wilderness quality in this survey also broadly reflect other remote-area global surveys produced in the last couple of decades (e.g. McCloskey and Spalding 1989; Hannah et al.1995; Bryant et al. 1997; Sanderson et al. 2002).

Figure 2.3 is a synoptic global assessment of wilderness quality completed at 10 km resolution, based on ANWI methods. The map is an update of a global wilderness analysis completed in 1998 (Lesslie 1998) incorporating more recent land use and land cover information shown using the Robinson projection.

2.5.2 Vegetation Condition Assessment in Australia

National needs for the survey, assessment and reporting of human-induced vegetation change in Australia have benefited from the work of the ANWI and its grounding in the wilderness continuum concept. The Vegetation Assets, States and Transitions (VAST) framework has been developed as a means for ordering vegetation by degree of anthropogenic modification as a series of condition states, from a base-line condition through to total removal (Thackway and Lesslie 2008). The VAST framework accounts for change and trends in the status and condition of vegetation. The framework makes clear the links between land management and vegetation condition states and provides a mechanism for describing and tracking the resulting transitions between states caused by changes in land management practices (Thackway 2013). The VAST framework distinguishes seven condition states: Naturally bare (0), Residual (I), Modified (II), Transformed (III), Replaced (adventive) (IV), Replaced (managed) (V), and Removed (VI). The VAST

Table 2.2 Area of remaining very high wilderness quality in the world classified using global biomes

Global biome	Very high wilderness quality	
	Area (km^2)	Proportion biome (%)
Temperate grasslands, savannahs and shrublands	90,000	0.9
Mediterranean forests woodlands and scrubs	50,000	1.6
Temperate broadleaf and mixed forests	300,000	2.4
Tropical and subtropical coniferous forests	20,000	2.6
Tropical and sub tropical dry broadleaf forests	90,000	3.2
Temperate conifer forests	420,000	10.5
Mangroves	30,000	11.6
Tropical and subtropical grasslands, savannahs and shrublands	2,380,000	11.8
Flooded grasslands and savannahs	140,000	12.7
Montane grasslands and shrublands	910,000	17.6
Tropical and subtropical moist broadleaf forests	5,200,000	26.6
Deserts and xeric shrublands	8,540,000	30.7

Biomes represented in Australia

Note: Estimates not included for Tundra and Boreal Forests/Taiga due to data limitations. (Wilderness estimates modified from Lesslie 1998; biomes after Olsen et al. 2001) Area estimates calculated using Mollweide projection

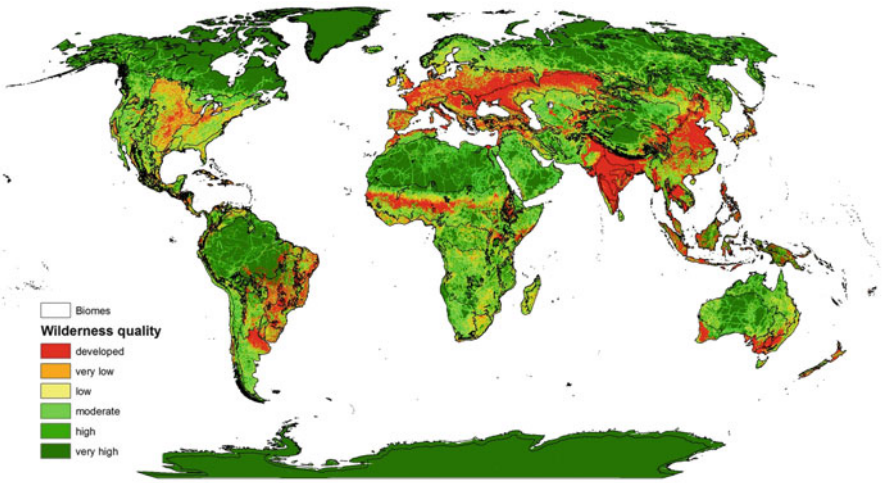

Fig. 2.3 Global wilderness assessment (Lesslie 1998)

framework prescribes a set of diagnostic criteria for each condition state including the distinction between native and non-native vegetation. The Biophysical Naturalness layer of the ANWI was a key input into an Australian VAST dataset (Lesslie et al. 2010). The VAST analysis underpins the national assessment of native vegetation condition included in the Australian report of the State of the Environment 2011 (State of the Environment 2011 Committee).

2.6 Future Directions

The perspectives and tools presented in this chapter help frame an effective approach to the survey and identification of large, relatively intact natural areas. What are current needs in advancing this capacity?

Increasing demands on land resources, including land use intensification and population growth, emphasise the need for the systematic survey and assessment of intact natural areas at local, regional and global scales. Survey information is important for these areas given the irreversible consequences of most development options. Several global surveys of human impact have been conducted, including a comprehensive global monitoring program for large intact forest landscapes (Potapov et al. 2008). However, these either target specific environments (e.g. forests) using particular size/condition thresholds (Potapov et al. 2008) or use disturbance indicators that are too generic for sufficiently precise area assessments (e.g. Sanderson et al. 2002). To provide systematic coverage at finer scales and a long-term monitoring capacity this survey work could adopt the continuum approach and be applied across all landscapes. It could also use metrics derived explicitly from settlement, infrastructure and land use features – the drivers of human-induced landscape change. Survey work of this kind has recently been completed in Europe (e.g. Fisher et al. 2010; Kuiters et al. 2013) but this requires extension elsewhere such as South America, Africa and South East Asia. Completion of further survey work, particularly in regions undergoing rapid landscape change, is a priority.

Metrics for measuring relative remoteness and intactness used for the ANWI have been improved upon in more recent European survey work (e.g. Carver et al. 2002; Fisher et al. 2010). This includes topographic and view-shed analysis for improved measurement of remoteness and apparent naturalness. There is a particular need for the development of better biophysical naturalness metrics linked to the measurement of land use and land management and broader ecological approaches to measuring the intensity and biophysical impact of human activity in landscapes (Lesslie 1997; Thackway and Lesslie 2008).

Detailed spatio-temporal data is increasingly available to support improved survey and assessment work (Stafford et al. 2012). This facilitates more accurate mapping and provides better capacity to track change. This includes tracking ‘hotspots’ of change and threats to remote natural lands arising from pressures such as land use intensification and climate change. Detailed survey work will also help establish priorities for the conservation of large intact natural areas as well as for investment

in the complementary management of the intervening matrix, including rehabilitation. Newly available data streams include remotely sensed land cover data, digital topographic and terrain mapping and land use and dynamic vegetation.

Finally, recent advances in spatial analysis, including spatial multi-criteria analysis, enable more sophisticated contextual analysis of remote and natural lands. Factors such as biodiversity, productivity, carbon, water resources and other ecosystem services are important in considering land allocation and management priorities. The innovative spatial decision-support tool MCAS-S (ABARES 2011; Lesslie 2012), for example, is used here (Figure 4) to analyse the relationship between the spatial distribution across Australia of wilderness quality as measured by the ANWI and Net Primary Productivity as measured by mean annual net primary production (t/ha/year) from MOD17A3 data 2000–2009. The results, shown on the MCAS-S interface, point to locations where there is a coincidence of relatively high wilderness quality and high primary productivity (bottom centre map). These locations are notable along the forested ranges of eastern and south-eastern Australia, in south-western Tasmania, in Cape York Peninsula and Arnhem Land in northern Australia, and in the Great Western Woodlands of south-western Australia. These locations are a prime focus of community interest and concern for wilderness, as opposed to more extensive areas of lower productivity wilderness in the arid and semi-arid inland.

The spatial coincidence of relatively high wilderness quality and net primary productivity (bottom centre Fig. 2.4) analysed using the MCAS-S spatial decision-support tool (ABARES 2011). A matrix (far left) highlights class relationships. Total wilderness quality (as measured by the ANWI) is constructed by summing four ANWI wilderness indictors (maps at left) with equal weighting. MCAS-S features live-update functionality enabling new views to be immediately constructed

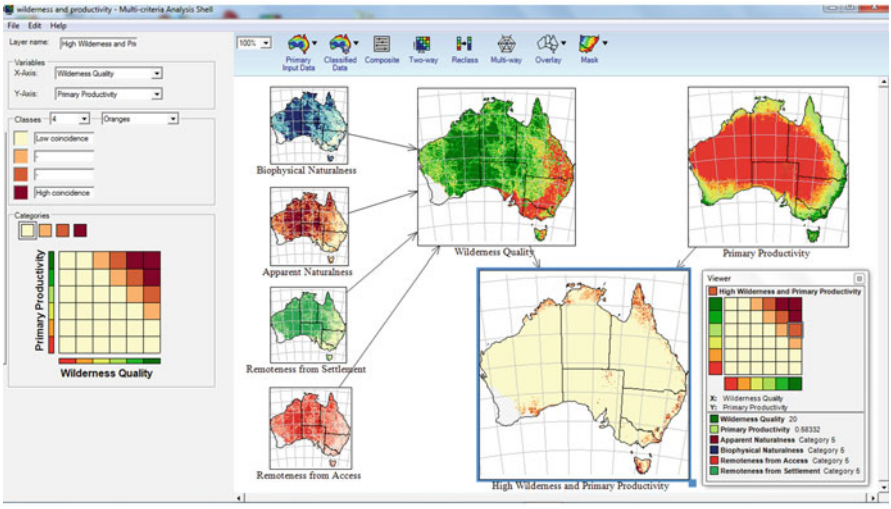

Fig. 2.4 High wilderness quality and primary productivity in Australia

and examined. The MCAS-S Viewer (bottom right) shows, at a selected point, the relationship between wilderness quality, primary productivity, and all four wilderness indicators.

Other types of spatial analyses, such as spatial connectivity analysis, also help define the role remote and natural areas can play landscape-wide conservation. Such assessments are necessary in order to place wilderness and wild-land protection in the wider framework of sustainable natural resources management and ecosystem services delivery.

2.7 Conclusion

As modern technological society extends its reach and its effects become global, those places that remain relatively remote and intact are becoming increasingly valuable. The wilderness continuum concept, in calibrating degrees of remoteness and naturalness across the landscape, contributes to our understanding of these places and options for their future management. It helps reconcile diverse interpretations of wilderness with modern views of the ecological importance of large intact natural areas, and it provides an operational basis for the identification and assessment of these resources. The ANWI is one successful example of this. Its approach has remained relevant and useful to natural resources planners and managers in Australia for over two decades, and its methods have been successfully extended internationally.

Databases like the ANWI provide the flexibility to monitor change in wilderness resources over time as land conditions change, or as previously overlooked areas become better understood and valued. These databases can also be used to examine the impact of management options or development proposals, and identify areas of potential for protection. Larger intact natural areas have in situ value as ecological reference areas supporting the continuation of evolutionary processes. They also provide the core structure for modern conservation landscapes managed for a range of ecosystem services, including biodiversity.

Spatial survey and analysis has a critical role to play in delivering on this potential. The forward agenda requires comprehensive disturbance mapping and monitoring focused on patterns of land use, settlement and access across the landscape at a range of scales from global to local. These features represent key drivers of terrestrial environmental change. New streams of satellite imagery and other spatial data describing these features mean that this basic mapping can be completed with high levels of accuracy and precision.

Once primary disturbance mapping based on land use, settlement and access is competed, next steps for spatial analysis should include:

- locating the ‘the best of what’s left’ of key ecosystems and environments;
- identifying locations critical to the delivery of primary ecosystem services (e.g. productivity, carbon, water);

- tracking hotspots of change and threatening processes

In this way, with improved survey information, and more sophisticated analysis of the environmental, cultural and spatial context, we will be better equipped to understand the role that remaining larger and more intact natural areas can play in the future management of our landscapes, society and planet.

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