CHAPTER 27

CONNECTIVITY CONSERVATION MANAGEMENT

Principal authors:
Ian Pulsford, David Lindenmayer, Carina Wyborn, Barbara Lausche, Maja Vasilijević and Graeme L. Worboys

Supporting author:
Ted Lefroy

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IUCN WCPA WORLD COMMISSION ON PROTECTED AREAS Convention on Biological Diversity

PRINCIPAL AUTHORS

IAN PULSFORD is an independent consultant and is a member of the International Union for Conservation of Nature (IUCN) World Commission on Protected Areas (WCPA) Connectivity, Conservation and Mountains theme, Australia.

DAVID LINDENMAYER is a Professor of Ecology and Australian Research Council Laureate Fellow at the Fenner School of Environment and Society at The Australian National University, a member of the Australian Academy of Science and of the New York Academy of Science, Australia.

CARINA WYBORN is a social scientist at the University of Montana, USA, and a member of the IUCN WCPA Oceania section, Young Professionals Network and Mountains and Connectivity theme.

BARBARA LAUSCHE is the Director of the Marine Policy Institute, Mote Marine Laboratory, and is a member of the IUCN World Commission on Environmental Law (WCEL) and WCPA, Florida, USA.

MAJA VASILIJEVIĆ is the Director of Eco Horizon, and is Chair of the WCPA Transboundary Conservation Specialist Group, Croatia.

GRAEME L. WORBOYS is Co-Vice-Chair, Connectivity Conservation and Mountains, IUCN WCPA and an Adjunct Fellow at the Fenner School, The Australian National University.

SUPPORTING AUTHOR

TED LEFROY is Professor of Environment and Director of the Centre for Environment at the University of Tasmania, Australia.

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Holbrook Landcare: landholders (including protected area practitioners) work together to restore linkages between forests, woodlands, riparian and wetland areas on private land and Woomargama National Park in the Slopes to Summit section of the Great Eastern Ranges corridor, New South Wales, Australia
Source: Ian Pulsford

Introduction

As the global human population grows rapidly past the seven billion mark, the overexploitation of our planet goes on unabated to such an extent that there is now unequivocal evidence that Earth is experiencing the sixth major mass extinction of species in its evolutionary history (Wilson 1992, 2002), that warming of the global climate system is occurring and that this is almost certainly attributable to human activities (IPCC 2013). The global destruction and fragmentation of habitats resulting in the parcelling up of landscapes have been caused by human population growth and development activities. This has resulted in the sixth mass extinction of biodiversity in the Earth's evolutionary history and the first for 65 million years (Wilson 2002). Problems of this scale require big solutions.

In response, we are witnessing a social and political revolution in the care and management of global biodiversity (Worboys and Mackey 2013). In recent decades landholders, grassroots organisations and governments have been undertaking action to address the massive destruction of habitat. One critical response of this global movement has been the establishment of systems of protected areas on every continent to conserve the most significant remaining strongholds of biodiversity and heritage, although certainly for the past decade, more strategic concepts such as comprehensiveness, adequacy and representativeness have driven this establishment. Unfortunately, this action is widely recognised as being insufficient on its own to prevent the ongoing loss of species (CBD 2011). This is partly because the reserve system will never be big enough to retain all species and ecosystems. Protected areas often remain 'islands' in the midst of unsustainable land and water uses. Many species need to move between protected areas and the surrounding landscape either seasonally or as ecosystems change.

Connectivity conservation has emerged as a big-thinking response to a range of threats to biodiversity that include habitat degradation and destruction, fragmentation, changed fire regimes, the spread of introduced species and a changing climate. Connectivity conservation management is a strategic approach that helps to link habitats across whole landscapes, which can enable species and their ecosystems to move or adapt as conditions change. Connectivity conservation is a way of maintaining connections for nature by involving people. So, what is the scientific basis for connectivity conservation, how is this being put into practice and what are the benefits? In this chapter, we aim to address these questions by bringing together a range of experts who have worked extensively in the field of connectivity conservation science, other knowledge, governance and management. The focus of this chapter is on the management of connectivity conservation corridors or areas.

Industrial logging of mountain ash (*Eucalyptus regnans*), the world's tallest flowering plant, is a significant threat to the endangered arboreal Leadbeater's possum (*Gymnobelideus leadbeateri*) in the upper Yarra Valley, Victoria, Australia

Source: Ian Pulsford

The science of connectivity conservation management

The term 'connectivity' is widely used in the literature on landscape change and conservation practice and generally refers to the ease with which organisms move between particular landscape elements, the number of connections between patches of habitat relative to the maximum number of potential connections or the interlinkages of key processes within and between ecosystems (Lindenmayer and Fischer 2007). There are other forms of knowledge that are also important and can be included, such as the knowledge systems of indigenous peoples and other local communities, but these are not the focus of this section. The scientific concept of

connectivity incorporates relationships between key ecological processes and the spatial pattern and scale of vegetation cover, not only in natural landscapes, but also in semi-natural and even highly modified landscapes (Forman 1995). The concept of connectivity has become increasingly important in the past three decades as a result of modification of ecosystems and subsequent declines in biodiversity resulting from a range of direct and/or indirect human influences including vegetation clearing (and resulting habitat loss), altered fire regimes, invasion by exotic species and climate change (Crooks and Sanjayan 2006; Fitzsimons et al. 2013a).

Given the multiple and multifaceted meanings of connectivity, it is not surprising that while the concept is universally agreed to be important, it is often conceived very broadly, thereby rendering it difficult to use in practice and sparking much academic debate (for example, on the ecological value of wildlife corridors; see Simberloff et al. 1992; Beier and Noss 1998; Lindenmayer and Fischer 2007).

Landscape connectivity and other connectivity concepts

To best clarify various themes associated with connectivity, it is useful to make an explicit distinction between four types of connectivity (Lindenmayer and Fischer 2007). First, *habitat connectivity* can be defined as the connectedness between patches of suitable habitat for an individual species; it is the opposite of habitat isolation (in which areas of habitat suitable for a given species are subdivided and made smaller). Second, *landscape connectivity* can be defined from a human perspective of the connectedness of patterns of vegetation cover in a given landscape. This typically entails physical connection of natural vegetation between two otherwise physically isolated patches of natural vegetation. Third, *ecological process connectivity* can be defined as the connectedness of ecological processes across multiple scales including processes related to highly dispersive species, highly interactive species, disturbance regimes and hydro-ecological flows (Lindenmayer and Fischer 2006; Soulé et al. 2006; Mackey 2007; Mackey et al. 2013). Fourth, *evolutionary process connectivity* refers to spatially based natural processes that pertain to both macro-evolution (leading to speciation) and micro-evolution including coevolutionary interactions and local adaptions by a population to environmental conditions. The spatial dimension of evolutionary processes relates to the exchange of genetic material between populations, the extent to which populations are open or closed to inflows and outflows, the degree to which climate change will result in forced movements and the impacts of other threatening processes. For many large animals and dispersive species, evolutionary processes involve the movement of these species over long distances (Soulé et al. 2006; Worboys and Mackey 2013).

Although these connectivity concepts are interrelated, they are not synonymous with one another. Landscape connectivity may increase habitat connectivity for some species but not for others (Driscoll et al. 2014). Similarly, low habitat connectivity for functionally redundant species (*sensu* Walker 1992) may have relatively little impact on the overall connectedness of ecological processes. For other species that fulfil irreplaceable ecological functions, however, the loss of habitat connectivity can have major impacts on ecological connectivity. For example, some bat and bird species in Central America are instrumental in dispersing the seeds of rainforest plants across agricultural areas (Galindo-González et al. 2000), thereby contributing to the genetic viability of plant populations (Cascante et al. 2002). The loss of habitat connectivity for these vertebrate species would have severe implications for ecological connectivity because the key ecological process of seed dispersal would be lost with likely negative consequences for numerous plant species and the animals that depend on them.

The following section of this chapter focuses primarily on a human perspective of ecosystems, and therefore its primary focus is on landscape (Box 27.1). Other forms of connectivity are discussed later in the chapter. Where appropriate, links between habitat connectivity, landscape connectivity, ecological process connectivity and evolutionary process connectivity are identified.

Negative effects of reduced landscape connectivity

Landscapes that retain more connections between patches of otherwise isolated areas of vegetation and therefore have higher levels of landscape connectivity are assumed to be more likely to maintain populations of various species that inhabited the original landscape (Brown and Kodric-Brown 1977; Haddad and Baum 1999). Conversely, a lack of landscape connectivity can have a range of negative impacts on assemblages. It may result in vegetation patches remaining unoccupied for suites of species (Robinson 1999; Driscoll et al. 2014), meaning that the spatial distribution of these taxa may not directly correspond with the spatial distribution of available habitat for them (Stenseth and Lidicker 1992; Wiens et al. 1997; Driscoll et al. 2014). This is illustrated by some forest bird taxa that are unable to cross gaps and avoid open areas (Desrochers and Hannon 1997).

Similarly, sets of species in patches of remnant vegetation where the surrounding matrix is unsuitable for foraging are more likely to suffer extinction than those assemblages where the matrix provides landscape connectivity (Laurance 1991; Driscoll et al. 2013).

A particular case of reduced landscape connectivity is the dissection (*sensu* Forman 1995) of formerly continuous vegetation by roads. Roads can negatively influence a wide range of species, thus not only fundamentally altering landscape pattern, but also reducing habitat connectivity for many individual species and changing ecological processes (that is, impairing ecological connectivity). As an example, roads have major negative impacts on the migration of populations of elk (*Cervus canadensis*) as well as the movement of predators like wolves (*Canis lupus*) and grizzly bears (*Ursus arctos horribilis*) in North America (Foreman 2004; Canadian Parks and Wilderness Society 2013).

Species whose primary habitat does not correspond with human-defined patches of vegetation also can be negatively affected by reduced landscape connectivity because of altered ecological processes. For example, Gray et al. (2004) examined the effect of landscape structure on two species of frogs in wetland playas of the Southern High Plains in the central United States: the New Mexico spadefoot (*Spea multiplicata*) and the plains spadefoot (*S. bombifrons*). They found that increased agricultural development increased levels of sedimentation and decreased the length of time areas supported water. This in turn reduced landscape connectivity for both amphibian species.

Finally, reduced landscape connectivity can alter ecological connectivity, thus leading to a range of cascading effects. For example, the loss of landscape connectivity may alter the structure of food webs (Holyoak 2000; Galetti et al. 2013) and disrupt ecological processes such as the decomposition of wastes (Klein 1989), seed dispersal (Cordeiro and Howe 2003) or pollination (Paton 2000; Tscharntke et al. 2012).

Features contributing to landscape connectivity and wildlife corridors

One of the key aims of landscape management is to increase landscape connectivity. Three broad types of features can contribute to landscape connectivity: 1) wildlife corridors, 2) stepping stones, and 3) a 'soft' matrix. Different features will result in increased habitat

Box 27.1 Landscape connectivity versus habitat connectivity

Landscape connectivity reflects human perceptions of landscape connectivity of the vegetation patterns of a landscape. A given landscape pattern can correspond with low habitat connectivity for some species, but high habitat connectivity for other species, even within the same assemblage.

In the Tumut Fragmentation Experiment in south-eastern New South Wales, Australia (reviewed in Lindenmayer 2009), species such as the red wattlebird (*Anthochaera carunculata*) and golden whistler (*Pachycephala pectoralis*) were among a suite of taxa significantly less abundant in areas with low levels of landscape connectivity and many spatially disconnected patches of remnant vegetation than in areas where remaining areas of native eucalypt forest were consolidated as a small number of contiguous stands (Lindenmayer et al. 2002).

In contrast, the common ringtail possum (*Pseudocheirus peregrinus*) and the crimson rosella (*Platycercus elegans*) showed the reverse response, possibly because they are edge-attracted species (Youngentob et al. 2013) and the longer boundaries created in landscapes characterised by many spatially separated patches made these areas more suitable for them (Lindenmayer 2009). This emphasises the fact that higher levels of landscape connectivity as perceived by humans will not always directly correspond with higher levels of habitat connectivity for a given individual species, or vice versa. It also reinforces the rationale for the key distinction between habitat connectivity for individual species and landscape connectivity as the human-defined connectedness of vegetation cover within a landscape.

Remnant island of eucalypt forest retained in recently planted pine forests near Tumut, New South Wales, Australia

Source: David Lindenmayer

Box 27.2 Wildlife corridors: Landscape connectivity, habitat connectivity and ecological connectivity

Levey et al. (2005) studied seed dispersal by birds in relation to wildlife corridors in a forest ecosystem in South Carolina, USA. They set up eight experimental landscapes, each of which contained a mix of forest patches connected by wildlife corridors and unconnected patches. The study focused on the wax myrtle (*Myrica cerifera*) and one of its major seed dispersers, the eastern bluebird (*Sialia sialis*). Observations of the behaviour of the eastern bluebird suggested the species was more likely to travel along the edge of wildlife corridors than cross the non-forested matrix. This mode of corridor use inspired the 'drift-fence hypothesis', which states that vegetation corridors intercept and direct the movement of species that may otherwise move through the matrix (Levey et al. 2005). In addition, Levey et al. (2005) were interested in where in the landscape seeds of the wax myrtle were dispersed. A particular question was whether seeds were more likely to be dispersed between patches that were connected by wildlife corridors than between unconnected patches. To answer this question, Levey et al. (2005) sprayed the fruits of the wax myrtle in some patches with a dilute solution of fluorescent powder. Using this method enabled defecated seeds of the wax myrtle to be identified in forest patches elsewhere in the landscape. The results demonstrated that, on average, seeds were 37 per cent more likely to be dispersed to connected patches than to unconnected patches. This study demonstrated that wildlife corridors can sometimes provide habitat connectivity—for the eastern bluebird and the wax myrtle. Finally, by maintaining an important ecological process—that is, seed dispersal—throughout the landscape, the study also demonstrated that wildlife corridors have the potential to enhance ecological connectivity.

Remnant eucalypt forest corridor within the fragmented Tumut pine plantation landscape matrix, New South Wales, Australia

Source: David Lindenmayer

connectivity for different species, and will maintain different aspects of ecological connectivity. The focus of the remainder of this section is on wildlife corridors.

Wildlife corridors are physical linkages between patches of native vegetation (for example, Bennett 1998) including within and between core protected areas. Wildlife corridors contribute to landscape connectivity and can facilitate increased habitat connectivity for some species (for example, Bennett 1990; Beier and Noss 1998). Many studies have attempted to examine the contribution that wildlife corridors can make to landscape connectivity. A detailed set of studies by Haddad (1999a, 1999b) and colleagues (for example, Tewksbury et al. 2002; Haddad and Tewksbury 2005; Levey et al. 2005) explored the responses of a range of biota to the establishment of wildlife corridors in a plantation forest ecosystem in South Carolina, USA. Many interesting results have been generated from this pioneering work. For example, wildlife corridors directed the movement of various animal species, although some taxa also moved through the matrix (Haddad et al. 2003). Population densities of several groups of species were significantly higher in connected patches than in isolated ones (Haddad and Baum 1999). Perhaps most significantly, the work has demonstrated that the landscape connectivity provided by corridors has the potential to enhance both the habitat connectivity of some species and the ecological connectivity of some key ecosystem processes (Box 27.2).

Some species may benefit from wildlife corridors that link suitable habitat (Gilbert et al. 1998; Haddad et al. 2003), including species that do not use areas outside corridors such as open areas (Berggren et al. 2002) as well as those that disperse only through suitable habitat (for example, Nelson 1993; Driscoll et al. 2014).

Not all species use corridors (Lindenmayer et al. 1993), and their use may depend on the ecology of the species in question—for example, their scale of movement (Amarasekare 1994), patterns of behaviour (Lidicker 1999) or social structure (Horskins 2004). Similarly, attributes of corridors such as their width and length, habitat suitability for a particular species, location in the landscape, and a range of other factors can affect corridor use by wildlife.

Protected areas and connectivity

Large ecological reserves and protected area networks provide important connectivity over extensive areas and through time (Soulé et al. 2004; Worboys et al. 2010). For example, recent work in southern Africa has shown that networks of protected areas have been instrumental in assisting the distributional movements of an array

Fitzgerald River National Park is part of an internationally recognised biodiversity hotspot in Western Australia's Gondwana Link corridor
Source: Graeme L. Worboys

of bird species in response to changes in climate (Beale et al. 2013). Networks of connected areas have formed the basis for establishing very large corridors that extend across regional to even continental scales—for example, Yellowstone to Yukon, Great Eastern Ranges, Terai Arc and the Mesoamerican Biological Corridor (Bennett 1998; Foreman 2004; Fitzsimons et al. 2013a).

Maintenance of connectivity as a key principle for conserving biodiversity

In summary, the ecological importance of the four broad forms of connectivity outlined above means that the maintenance of connectivity is one of the key principles for conserving biodiversity and ecosystem function and therefore a key principle in informed landscape management (Lindenmayer et al. 2008; Worboys et al. 2010). The best way to maintain connectivity will vary according to the ecosystem in question, patterns of landscape heterogeneity, the species and processes targeted for conservation, and the processes threatening a given area. The approaches to maintain and/or enhance connectivity may vary, from setting aside large ecological reserves (Beale et al. 2013), protecting smaller (meso-scale) reserves such as riparian or streamside buffers, and planning roads and other human infrastructure to avoid subdividing areas (Foreman 2004) to 'softening' the matrix by retaining or replanting trees and other vegetation in areas outside reserves (Franklin 1993; Gustafsson et al. 2012). In many cases, a combination of these approaches at different scales will better meet the requirements of a diverse set of species and key ecosystem processes and hence deliver positive outcomes for the maintenance of habitat connectivity, landscape connectivity, ecological connectivity and evolutionary process connectivity.

The global network of connectivity corridors

Historically, wildlife corridors are a relatively recent concept, implemented initially at small scales, usually to fulfil notions of landscape amenity and for the retention and movement of wildlife and for recreation including hunting (Crooks and Sanjayan 2006). During the last phases of the 20th century, industrial-scale land clearing accelerated globally, removing or fragmenting in many places nearly all the native vegetation. This mostly occurred in the most arable and productive lowlands in many

countries, dramatically disrupting ecosystem function and diminishing the space available for wild species. As the global population increased, mass extinction of wild species accelerated rapidly (Crooks and Sanjayan 2006; Hilty et al. 2006). Until the 1990s, most conservation efforts focused on establishing networks of protected areas as a response to the onslaught of land clearing. Protected areas were established to conserve parts of natural landscapes, though many remained as 'islands' in a sea of cleared agricultural land. Corridors of native vegetation were often accidental, being made up of what was left over after the most valuable land had been cleared. Retained vegetation was often restricted to roadside strips, areas that were too steep or arid, or along the banks of creeks and rivers. Local communities and enlightened landowners often retained other forest patches for various purposes. In recent decades, programs involving farmers and other landholders in many countries have established small linear corridors as windbreaks and clumps of trees to conserve wildlife or to improve productivity and redress land degradation.

From the 1990s onwards, grassroots action informed by the emerging science of conservation biology also helped to drive the conservation agenda to conceive a new, much larger and more inclusive landscape conservation approach. A bold new approach to conservation thinking was required. This new approach went way beyond the bounds of linking the habitats or landscapes of a single bioregion or biosphere reserve. The first of the many really large continental-scale conservation corridor networks was the 'Yellowstone to Yukon' or 'Y2Y Conservation Initiative'. Y2Y was conceived in 1993 (Chester 2006). Y2Y extends along more than 5150 kilometres of the Rocky Mountains from Yellowstone National Park in the United States to the Yukon region in north-western Canada, and was eventually to encompass 1.2 million square kilometres and involved more than 300 conservation organisations (Chester 2006). Since then many large and continental-scale corridors, including transboundary corridors, have been established on every continent except Antarctica and across all the world's terrestrial biogeographic realms (Worboys et al. 2010) (Figure 27.1).

Managing connectivity conservation corridors

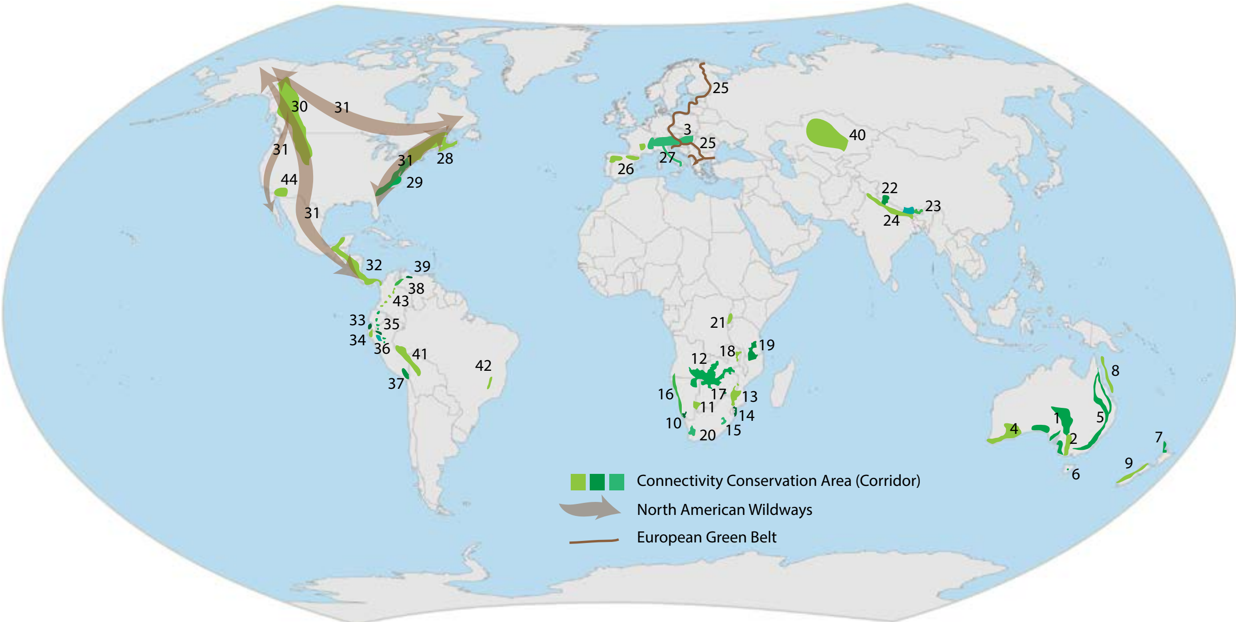
This section outlines the principles of connectivity corridor establishment and management, provides a summary of the International Union for Conservation of Nature (IUCN) connectivity conservation management framework and a framework for monitoring and evaluating effectiveness.

Yellowstone River, Yellowstone National Park, USA. The Yellowstone to Yukon corridor extends along the Rocky Mountains from Yellowstone National Park in the United States to the Yukon region in Canada

Source: Graeme L. Worboys

Establishing corridor management

Experience gained by many connectivity initiatives has shown that establishing a large conservation corridor is a major undertaking fraught with many challenges, including securing funding and other demands (Fitzsimons et al. 2013b; Pulsford et al. 2013). To be successful, a mutually agreed vision has been found to be very important. There must also be inspirational and skilled leadership; a careful assessment of biodiversity values; a clear understanding of social and political contexts; strategic whole-of-corridor planning and prioritisation of investment; and skilful implementation (see 'Governance principles and requirements' subsection below). Success requires a long-term commitment by many organisations to implement adaptive management to ensure that ecological processes and functions are



	CONNECTIVITY CONSERVATION AREA (CORRIDOR)	COUNTRY/IES
1	South Australian Nature Links	Australia
2	Habitat 141	Australia
3	ALPARC Alpine Ecological Network and Protected Areas	France, Italy, Switzerland, Germany, Austria, Slovenia, Principalities of Liechten-stein and Monaco
4	Gondwana Link	Australia
5	Great Eastern Ranges	Australia
6	Midlandscapes	Australia
7	Reconnecting Natural Northland	New Zealand
8	Great Barrier Reef Marine Park WHA	Australia
9	Te Wāhipounamu South West New Zealand World Heritage Area	New Zealand
10	Ai /Ais - Richtersveld Transfrontier Park	South Africa and Namibia
11	Kgalagadi Transfrontier Park	Botswana and South Africa
12	Kavango Zambezi (KAZA) Transfrontier Conservation Area	Angola, Botswana, Namibia, Zambia and Zimbabwe
13	Great Limpopo Transfrontier Park	Mozambique, South Africa and Zimbabwe
14	Lubombo Transfrontier Conservation and Resource Area	Mozambique, Swaziland and South Africa
15	Maloti-Drakensberg Transfrontier Conservation and Development Area	Lesotho and South Africa
16	Iona - Skeleton Coast Trans Frontier Con-servation Area	Angola and Namibia
17	Greater Mapungubwe Transfrontier Conser-vation Area	Botswana, South Africa and Zimbabwe
18	Malawi-Zambia Transfrontier Conservation Area	Malawi and Zambia
19	Selous and Niassa Wildlife Protection Corridor	Mozambique and Tanzania
20	Greater Cederberg Biodivesity Corridor	South Africa
21	Greater Virunga Biodiversity Corridor	Uganda, Rwanda
22	Kailash Sacred Landscape	China, India and Nepal

	CONNECTIVITY CONSERVATION AREA (CORRIDOR)	COUNTRY/IES
23	Bhutan Biological Conservation Complex	Bhutan
24	Terai Arc	India and Nepal
25	European Green Belt	*see list below
26	Cantabrian Mountains Pyrenees-Massif Central -Western Alps Great Mountain Corridor	Spain, France, Italy
27	Espace Mont Blanc	France, Italy, Switzerland
28	Northern Appalachian/ Acadian Region Connectivity Initiative	USA/ Canada
29	Southern Appalachian Ecoregion	USA
30	Yellowstone to Yukon Conservation Initiative	USA/Canada
31	North American Wildways Network	Mexico/ USA/ Canada
32	Mesoamerican Biological Corridor	Mexico, Guatemala, Belize, Honduras, El Salvador, Nica-ragua, Costa Rica, Panama
33	Amotape	Peru
34	Bosque seco	Peru
35	Amazonas	Peru
36	San Martin	Peru
37	Sur	Peru
38	Corredor Sierra Nevada - Sierra de La Culata - Tapo Caparo	Venezuela
39	Corredor San Esteban - Henri Pittier - Codazzi - Macarao	Venezuela
40	Altyn Dala Conservation Initiative	Kazakhstan
41	Vilicambia - Amboro Conservation Corridor	Bolivia, Peru
42	Serra do Espinhaço Biosphere Reserve	Brazil
43	Llanganates - Sangay Ecological Corridor	Ecuador
44	International Sonoran Desert Alliance	USA/Mexico

* EUROPEAN GREEN BELT COUNTRIES: Finland, Russia, Norway, Estonia, Latvia, Lithuania, Poland, Germany, Czech Republic, Austria, Slovakia, Hungary, Croatia, Slovenia, Italy, Serbia, Romania, Bulgaria, Macedonia, Kosovo *(in accordance with UNSCR 1244 and opinion of ICJ)*, Montenegro, Albania, Greece, Turkey

Figure 27.1 Indicative map of actively managed large-scale connectivity conservation areas (corridors) on Earth

Source: Ian Pulsford (2014). Compiled from data aggregated by Rod Atkins and Ian Pulsford, WCPA International Connectivity Conservation Network, Canberra, Australia.

Buddhist Mani wall near Khumjung village's view of Ama Dablam (peak) in Sagarmatha National Park; the park and its people form a core of the Sacred Himalayan Landscape corridor

Source: Ian Pulsford

maintained, threats are abated, habitats retained or restored and wild species are conserved (Worboys and Lockwood 2010; Fitzsimons et al. 2013a, 2013b; see also Chapter 21). A crucial measure of success is the engagement of people and communities who understand the benefits of connectivity. This includes access to wild places that provide essential ecosystem services such as clean water and sustainable products. The decision to undertake large-scale corridor establishment is often made after years of prior conservation achievements and land-allocation decisions. There have now been 10 to 20 years of experience in building large corridors in many countries. In order to guide current and future practitioners and policymakers who wish to undertake a corridor project, the IUCN has developed a connectivity conservation management framework (Worboys and Lockwood 2010) that is summarised below.

Management framework considerations

Connectivity corridors include many large and complex landscapes with many land tenures and activities, and they need to be actively managed at site, landscape and whole-of-corridor levels if they are to be effective. This requires a strategic approach that is based on a framework that unifies the key elements of the connectivity conservation management concept. A connectivity conservation management framework was developed by the IUCN World Commission on Protected Areas (WCPA) to provide a systematic approach for the management of connectivity areas (Worboys and Lockwood 2010; Figures 27.2 and 27.3). It accounts for corridors being very large, geographically diverse, environmentally varied as well as including many people, a variety of tenures and multiple sectors of society. The framework recognises a bold, guiding vision that provides direction and the 'glue' for the many individual initiatives that help to conserve biodiversity within the corridor. Connectivity conservation areas are always changing, which is why the framework recognises the need to closely monitor the dynamic contexts of 'nature', 'people' and 'management', with this information constantly used to assist the implementation of the four management functions (Figures 27.2 and 27.3).

Context

Understanding the context of a connectivity conservation area is a crucial first step. The corridor is set in a landscape that is undergoing constant change. Many land-use decisions have been implemented over long periods that provide the history and context of and setting for connectivity conservation strategies and action. Any corridor proposals will of necessity involve people, so understanding people's needs, aspirations and willingness to be engaged is most important. It is also necessary to take into account government policies, legislation and competing needs for financial resources and skills. These three 'contexts' are described further below.

Nature context

The nature context is the principal driver of and reason for establishing a connectivity conservation initiative. It does not operate in isolation from other factors, especially people, and interacts with them in a dynamic way that requires constant review and adaptation. The nature context consists of four interacting considerations—the need to assess: 1) landscape connectivity, 2) ecological connectivity, 3) habitat connectivity, and 4) evolutionary process connectivity, including the degree of habitat fragmentation, the presence of remnant habitat stepping stones and opportunities to rehabilitate connections in the context of climate change and other threats.

People context

People live in and utilise resources within a connectivity conservation area. The corridor is usually made up of multiple land tenures that are utilised for a variety of other activities that support livelihoods. This knowledge ensures

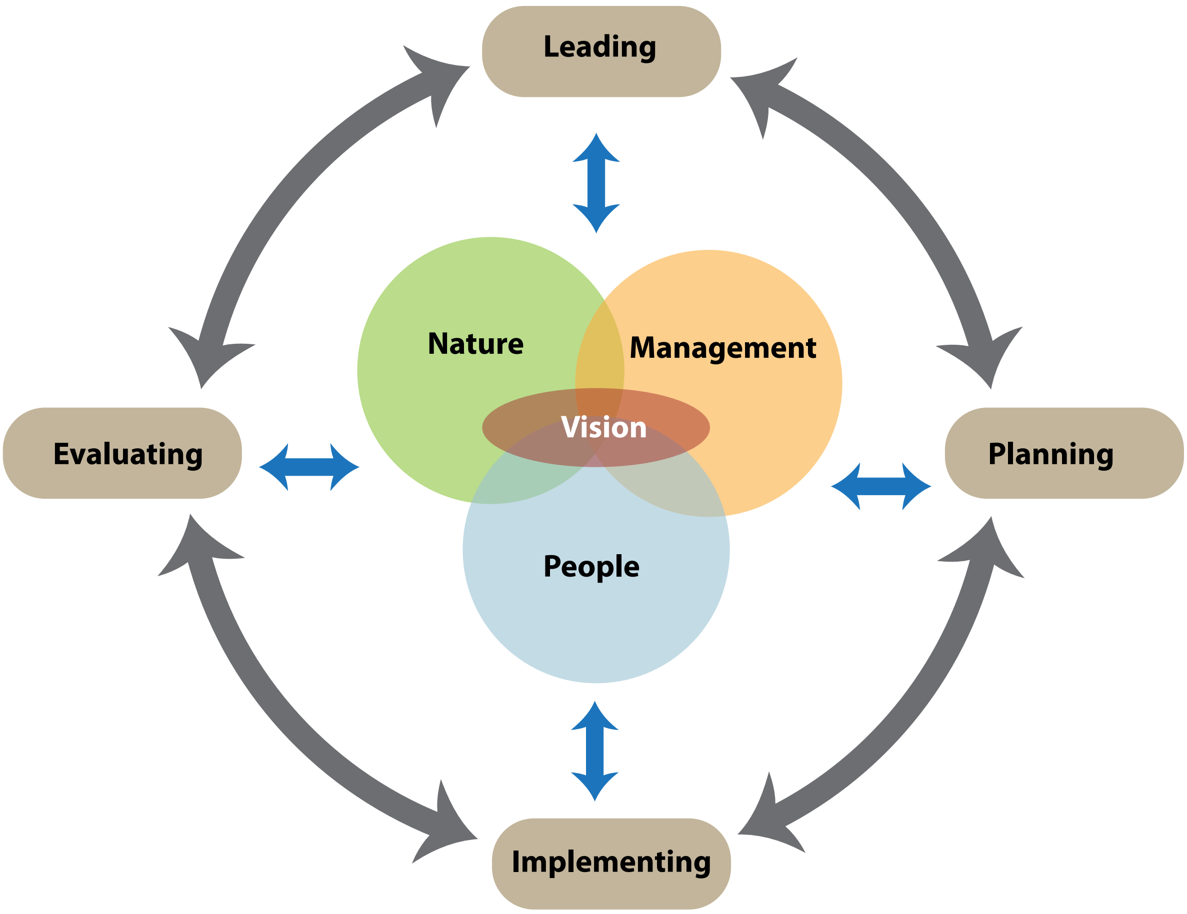


Figure 27.2 IUCN WCPA Connectivity Conservation Management Framework
Source: Worboys et al. (2010)

that people and communities are appropriately informed and engaged. Without people's engagement and support, it is unlikely that the vision and goals will be achieved.

Governance and management context

Assessing the governance and management context involves:

- identification of how land is legally and institutionally organised, planned and managed, including community requirements and laws and policies of governments, the tenure of the land and how it is managed, and the planning status of lands
- legislation or other governing instruments that may facilitate or encourage landholder involvement
- identification of programs and incentives for achieving conservation actions on the ground that need to be tailored to the individual needs of communities.

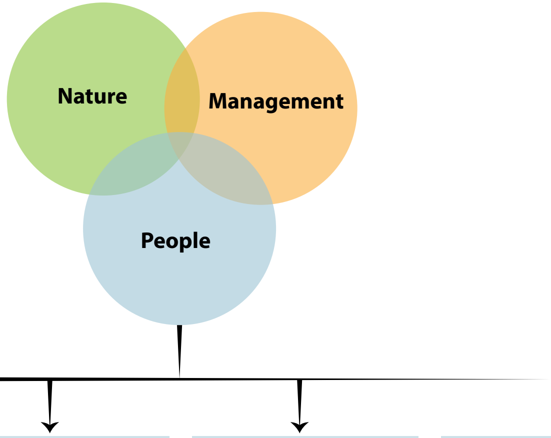
Corridor management must take into account a long history of prior government and community decisions. It is also important to understand the capacity and skills of land managers and local communities.

Management functions

Active management of a corridor area will have regard to the ever-changing context and will have prioritised management and effort based, in part, on those inputs. Implementing management within a corridor will have regard to four important management functions that may occur at three levels: whole of landscape, regional landscape, and site or project.

Leadership

Leadership of any initiative is the most crucial function of all. Charismatic and skilled leaders can inspire and motivate participation. For leadership to be successful, a truly collaborative approach will be required that inspires ownership of the initiative by many people and organisations. Leadership is best if it ensures that one individual or organisation does not dominate the organisation. In general, leaders are people who are visionary, consistent, have a deep understanding of connectivity conservation, are courageous, determined, flexible and have the ability to take action that changes the status quo (IUCN WCPA 2006).



	LEADING	PLANNING	IMPLEMENTING	EVALUATING
1. Entire connectivity conservation area scale	Establish and promote the vision Establish the political, social, and financial capacity to implement the vision Integrate the connectivity vision into the regional landscape	Develop a strategic plan for the whole of the connectivity conservation area	Achieve a capacity to operate Respond to critical connectivity conservation area threats	Establish evaluation needs and systems
2. International trans-boundary scale	Facilitate a coopera-tive international partnership for the connectivity corridor	Establish a transboundary plan and MOU	Implement cooperative tasks	Identify international evaluation information needs and evaluate
3. National or state scale	Achieve government endorsement and support	Integrate the vision into national strategies for biodiversity and sustainable development	Implement response to national issues such as climate change	Evaluate the performance of national implementation actions
4. Landscape scale	Achieve community support	Develop multiple cooperative task plans	Implement multiple cooperative tasks	Evaluate the performance of cooperative tasks
5. Individual site scale	Encourage individual 'champions' and their initiatives	Facilitate individual project plans	Provide individual projects with support and assistance	Evaluate project management against objectives

Figure 27.3 Application of the IUCN WCPA Connectivity Conservation Management Framework at various spatial scales

Source: Worboys et al. (2010)

Planning

Planning is a process to determine goals for a future course of action required to achieve a desired outcome. Land-use (corridor) planning can occur at various geographic and organisational scales. Planning can be completed for the whole corridor and there can be separate plans that detail the actions that will need to be undertaken in core conservation areas, buffer zones and connectivity gaps. Planning can identify areas where critical action should be undertaken and identify the timetable for achieving this, including how the community can be involved. Commonly, plans are undertaken at three levels of detail. The overall purpose of the corridor, organisational goals and direction, and the ways to achieve those goals are outlined in a strategic plan that passes down the hierarchy into a series of regional or tactical and operational plans. 'Bottom-up' planning is also undertaken, and influences these three types of planning.

Implementation

Implementation involves the process of putting into practice management actions, usually in accordance with a corridor plan and a project plan. A range of organisations or individuals working separately or together at many different spatial scales may implement management actions. Implementation requires strategic communication and coordination of partnership and individual activities.

Evaluation

It is critical to evaluate the progress and success of any conservation effort from time to time to determine if the desired vision and goals are being achieved. If not, a new course of action or additional actions may be required to ensure that species or ecosystems do not decline further. To do this, a separate evaluation plan is a wise investment (Magoluis and Salafsky 1998). A range of monitoring and evaluation techniques will be needed (see 'Monitoring and evaluating corridor performance' section below), including techniques for tracking the big picture (whole-of-corridor) from an established baseline as well as reporting on the progress of actions on the ground.

Implementation of the four management functions recognises the need for an ordered, but dynamic approach to management, guided by an understanding of this changing context. Leadership is given primacy in the framework and is responsible for driving the four management functions to achieve the vision. The framework also applies at three scales of connectivity conservation areas. These include the national, whole-of-continent scale, which includes international considerations; the landscape (regional) scale with its potential for trans-boundary management needs; and site scales, which may, for example, be individual properties. The framework recognises that management will be situational. Local approaches to biodiversity conservation for one area may not be appropriate for other parts of the same corridor. Local planning helps resolve this matter, but again, the vision provides the broad, overarching guidance for an entire connectivity conservation area. The framework also identifies 16 key actions that underpin the establishment, delivery and crosscutting tasks of managing connectivity conservation areas.

Management tasks

Initiating and delivering a connectivity conservation initiative typically involve 16 generic tasks, divided into 'foundational actions', 'delivery tasks' and 'crosscutting tasks'. Large-scale connectivity conservation projects are mostly implemented in semi-modified landscapes that are complex systems in which human activities and land

Participants at an IUCN international connectivity conservation planning workshop held in 2008 at Dhulikhel, Nepal

Source: Graeme L. Worboys

uses interact with both individual species and the natural habitats that remain (Lindenmayer and Fischer 2007; Lambert 2013). Management of these interactions at multiple scales is a key consideration of connectivity conservation management actions (Hilty et al. 2012; Pulsford et al. 2013). Connectivity conservation functions (leadership, planning, implementation and evaluation) and tasks must be implemented at a range of spatial scales, such as the whole corridor, for individual regions or zones within the corridor and at the site level.

Foundational actions

1. **Feasibility and scoping:** A first step could include a process to discuss and agree on the need to establish connectivity. This requires access to good information, which can be obtained by undertaking some form of scoping study. An assessment is needed to provide a sound basis for developing a corridor proposal including outer and internal boundaries. Such an assessment might involve reviewing intrinsic natural values including connectivity considerations, social, spiritual and cultural values, and the political and management contexts. Review topics that are likely to be important include the location and distribution of ecological

Monteverde Cloud Forest Reserve in Costa Rica, part of the Mesoamerican Biological Corridor, which unites conservation goals with sustainable development initiatives of local peoples throughout nine Central American countries
Source: Graeme L. Worboys

communities and species; gaps in connectivity; habitat fragmentation; the design of corridor boundaries; as well as identifying key threats and dynamic influences such as fire, floods, pest species, pollution, development and social factors. In an assessment of social values, it may be important to determine whether an initiative is desirable and viable before making a decision to proceed.

2. **Establish a shared community vision:** A bold connectivity conservation vision is a critical element that provides a direction for local individual actions.
3. **Undertake preplanning (such as targeting the strategically most important lands):** During this phase of corridor establishment and management, it is highly desirable to undertake systematic conservation planning to identify core areas and linkages and any gaps in connectivity (Margules and Pressey 2000; Bottrill and Pressey 2009; Pressey et al. 2009; Chapter 13). Systematic conservation planning can provide a scientifically defensible basis for establishing a corridor. It can also be used to identify connectivity gaps and areas that are degraded or under threat or that contain restricted or endangered species or communities that require the most attention. Conservation planning can be used to inform the development of a foundation proposal document that can be developed in partnership with interested community groups and guide early prioritisation and research work.
4. **Establish governance and administration (which may include trans-boundary governance):** Governance is the mechanism that identifies who in an organisation makes decisions and how these are made (see 'Connectivity conservation governance' section below). Many corridor initiatives extend across jurisdictional boundaries. These can be trans-border (across jurisdictions within a country) or trans-boundary (between countries; see 'Trans-boundary corridor governance' section below).
5. **Establish strategic management priorities and requirements:** Strategic management deals with management of the corridor at the big-picture level and is guided by the agreed vision and goals. This is best achieved by developing a strategic plan (which may include a business plan) for the whole corridor and a separate plan for each regional component area. Conservation plans should identify the goals, priorities, investments, resources, partners and a timetable for on-ground investment. To ensure community ownership and commitment, conservation planning must be undertaken in consultation with the initiative partners and tailored to local community needs.
6. **Monitoring and evaluation:** An essential part of the strategic management cycle of any project is the implementation of a regular review and evaluation process (see 'Monitoring and evaluating corridor performance' section below).

Delivery tasks

Seven key delivery tasks have been identified to characterise the implementation phase of a connectivity conservation initiative.

1. **Manage finances, human resources and assets:** Managing funding, people and any assets is an essential task that needs to be done competently. It is a basic requirement. There is a wide range of legal responsibilities for managing finances and staff safely and effectively that vary with each country and organisation.
2. **Deploy instruments that foster connectivity conservation (such as financial incentives for landowners) in priority areas for the conservation of biodiversity:** A key goal of connectivity conservation is to coordinate the efforts of many organisations and individuals to achieve the integrated

Private landholders on the Atherton Tableland, Queensland, Australia, work together to replant and reconnect remnant rainforest habitat of several climate-sensitive endangered arboreal marsupial possum and tree kangaroo species

Source: Campbell Clarke

delivery of conservation programs. A wide range of instruments may be used (see section on 'Legal considerations' below and Case Study 27.4). The instruments can be used most effectively if targeted at landholders whose properties are located in areas identified as connectivity conservation priority areas.

3. **Actively manage for threats (stressors) (such as responding to introduced species):** A major threat to connectivity conservation and land management is the threat to ecosystem integrity from the impacts of introduced species, changed fire regimes, pollution and other disturbance. A strategic and timely management investment by all public and private land managers in a corridor is required. Corridor strategic plans can identify areas that require priority investment to control weeds and pest animals such as in connectivity gap areas, in buffer areas around protected areas and throughout the corridor matrix including both public and private lands. If implemented effectively, a key benefit will be the likely improvement of the sustainability and productivity of farms, particularly for those landholders who rely on their land for their livelihoods.
4. **Assist with the management of incidents:** Management of incidents by key agency or land-use authorities in the corridor includes management of wildfire, storm impacts such as flooding, pollution events and other environmentally damaging or illegal activities such as poaching of wildlife or unauthorised logging. Effective management of incidents requires a significant and usually government agency-coordinated response. The corridor partner and land management organisations and community volunteers would typically contribute to the response.
5. **Strive for sustainable resource use:** An important component of corridor management is the sustainable and productive use of natural resources. Sustainable use helps to ensure that all parts of the corridor matrix help sustain wildlife and people in the long term. Sustainable resource use may include using protected areas for recreation and tourism; using government, community or private forest timber, seed supplies or grazing; and ensures that water supplies including groundwater are used in a way that maintains biodiversity, agriculture, towns and industry in the long term.
6. **Rehabilitate degraded areas (using methods such as large-scale ecological restoration):** Rehabilitation of degraded areas and gaps in connectivity corridors requires long-term and well-planned investments informed by the best available science and techniques. The field of

restoration ecology is underpinned by a large and growing body of scientific and practical knowledge such as the restoration guidelines prepared by the IUCN (Keenleyside et al. 2012). Carefully selecting priority focal areas to target restoration activities can provide the most cost-efficient and biologically beneficial outcomes.

7. **Provide and manage research opportunities:** An understanding of conservation biology provides an important contribution to connectivity conservation management principles and actions. Spatial analysis of biological values provides the ability to prioritise investment for on-ground conservation activities that need to be delivered in the right places in the most cost-effective way. Connectivity conservation research provides a basis for understanding the changes taking place in corridor landscapes, for evaluating threats and for measuring the corridor condition and the effectiveness of conservation actions, which often need to be assessed at multiple scales.

Crosscutting tasks

1. **Working with partners:** Connectivity conservation promotes innovative models of collaborative governance to connect landscape-scale science with local-scale action. It is founded on the premise that the collaborative whole will have a greater conservation impact than the sum of the parts. Establishing effective long-term relationships with a wide range of partners is a complex, crucial and challenging task. To be successful there need to be good formal and informal institutional linkages between these governance levels.

2. **Working with stakeholders, communities and rights-holders:** Connectivity conservation involves working with many hundreds if not thousands of stakeholders located in cities, towns, villages and farms throughout the corridor landscape. It is by working and communicating with, motivating and involving large numbers of stakeholders that landscape-scale conservation can be achieved. Landholders are key stakeholders who must be supportive to take action to help restore and manage landscapes. Without their support and cooperation little can be achieved. Key delivery partner organisations can offer on-ground conservation programs using a range of voluntary conservation instruments that can include incentive payments. Different partners may participate at different levels. At the whole-of-corridor scale, corridor initiatives may establish partners that could include national governmental organisations to assist with tasks such as management of large-scale wildlife migrations, trans-boundary management and environmental data management.

3. **Undertaking communications (such as constantly marketing an inspiring vision):** Connectivity conservation requires frequent effective communication and marketing of an inspiring vision as well as feedback about the programs, projects and individual contributions that have been implemented to help achieve this vision. A strategic communication plan for the whole corridor is important and in some cases a communication plan in parts of a corridor or for specific projects. Products include corridor information brochures, corridor science books, videos and a website that is actively managed and from which press releases, audio/radio technologies, progress reports, scientific and technical reports and other downloadable material can be made available to the widest possible audience (Pulsford et al. 2013). As far as possible, this should happen in locally used languages. Communication tools that use social media may be employed including technology such as smart-phone and specialist applications for citizen science data recording (such as wildlife observations) and reporting threats to and impacts on corridors (see Chapter 15).

Monitoring and evaluating corridor performance

Monitoring is the process of recording the condition of a feature to determine the extent to which it matches some predetermined standard or objective. Monitoring provides a systematic framework for answering questions such as 'connectivity for what, where, when, by whom and how'. There are three main types of monitoring that can be used to help answer these questions (Table 27.1).

1. *Compliance* monitoring involves determining if actions have been carried out in accordance with an agreed plan. While connectivity conservation is a means of achieving ecological outcomes, it is a complex activity carried out by a mixture of diverse groups and individuals over large spatial scales and long periods and so relies on a sound monitoring process.

2. *Response* monitoring involves testing hypotheses. This means testing using robust statistically valid designs to measure the extent to which management actions are achieving their intermediate outcome of

Table 27.1 Types of monitoring indicating their purpose, targets and associated risks

Monitoring type	Compliance	Response	Effectiveness
Target	*Management actions* Action 1 Action 2 Action 3, and so on	*Response to management actions* Output 1 Output 2 Output 3, and so on	*Outcomes* Viability of species, communities and ecosystem processes
Risks	*Procedural* Internal: failure to carry out agreed actions due to lack of resources, lack of commitment or lack of clarity of responsibility External: changes in tenure, zoning or planning that render actions impossible or irrelevant	*Scientific* The relationship between action and output relies on an understanding of the links between interventions and improved functional connectivity; the major risk is inadequate understanding of these links, which is very common as available data are frequently at inappropriate or insufficient temporal or spatial scales to detect change	*Deliberative* Lack of clarity of outcomes, unachievable outcomes, inadequate scale of intervention, insufficient time elapsed between interventions and the anticipated responses, new threats such as invasive species and diseases

maintaining or improving functional connectivity in a landscape, region or whole corridor, and the extent to which they are achieving their ultimate outcome of maintaining or improving the viability of populations, communities and ecosystem processes.

3. *Effectiveness* monitoring is tailored specifically to evaluate and report the high-level outcomes of management programs or interventions. While the task is more complex when monitoring the effectiveness of connectivity conservation in landscapes with mixed tenures, management effectiveness approaches used in protected area management offer useful precedents (see Chapter 28).

Monitoring requires the selection of a range of suitable indicators, metrics and spatial analysis to measure whether established clear goals are being achieved and so that timely changes in priorities for the most appropriate action can be determined. The ability to measure change in a connectivity conservation project will always be challenging as management actions usually take decades to have a measurable impact given that interventions need to occur over large areas before any change is detectable, and outcomes can be influenced by many natural and human factors other than the planned interventions.

Connectivity conservation governance

Governance refers to the structures and processes used to negotiate and reach collective goals (Lemos and Agrawal 2006). Governance applies to the internal mechanisms of a single entity, public or private, but can also relate to interactions, partnerships, collaborations or networks among actors. Governance includes both formal rules—laws, regulations, negotiation, mediation, conflict resolution, elections, public consultations and informal interactions—and norms and principles shaping decision-making. Beyond power-sharing and the equitable distribution of resources, governance should engender shared purpose, trust and mutual understanding (IUCN 2007).

Connectivity conservation includes and promotes the recognition and support of diverse governance types across a landscape (see Chapter 7). These require a governance mosaic approach that respects the mandates and legal requirements of different governance types of protected areas as 'other effective area-based conservation measures' in order to spread and strengthen connectivity conservation management across the landscape. These measures include Indigenous Peoples' and Community Conserved Territories and Areas (ICCAs), a generic term that includes specific names used in different countries, such as community conserved areas (CCAs), indigenous protected areas (IPAs), biocultural heritage sites, community reserves, locally managed marine areas, and so on. ICCAs are potentially as widespread and cover as much area as government protected areas (if not more), and have significant conservation, cultural, livelihood and other values (Couto and Gutiérrez 2012; Kothari et al. 2012; see also Case Study 27.1 and Chapter 7).

Land tenure, land use and property rights

Lands beyond protected area boundaries are managed for diverse uses: conservation, agriculture, forestry, recreation, tourism and mining. These land uses often correlate with different tenure and regulatory requirements, which challenge coordinated landscape-scale conservation (Binning and Fieldman 2000).

Land tenure embodies the legal property rights, implied or prescribed land use and rules of access, yet property rights are also cultural, reflecting deep-seated values of ownership, motivations and expectations of the rights of an individual to manage their land.

Connectivity conservation provides a framework for integrating a whole-of-landscape strategic approach to fostering conservation on lands with diverse land uses, tenure and ownership. Consequently, connectivity conservation cannot be adequately implemented without a collaborative, multi-person and multi-agency approach. Effective conservation planning requires that land managers be included in decision-making, with planning embedded within institutions responsible for program delivery (Knight et al. 2006).

Social and cultural considerations

Connectivity conservation is actively framed as a people-centred approach to biodiversity conservation. Without social and institutional connectivity, the ecological goals of connectivity conservation are unlikely to be met. Much like the need to work within the existing legal requirements of land tenure, connectivity governance requires sensitivity to the local social and cultural dynamics. Engaging in on-ground connectivity conservation partnership activities is usually voluntary, creating a need for these initiatives to inspire rather than enforce participation. The support of local communities is more likely to be established when an initiative respects the values and relationships the community has with the landscape. Where a connectivity initiative traverses large regions and crosses international or national political boundaries, it is important to recognise the diverse aspirations of communities living in a connectivity area.

Connectivity and development

Areas of lower socioeconomic development, particularly in lower Human Development Index (HDI) countries, present different conditions for connectivity governance compared with more developed nations. In these cases, the progress of conservation can create real or perceived threats to economic development (see Chapter 25). Through decentralised decision-making, connectivity governance has the potential to provide a necessary voice for local actors in conservation. Decentralisation can, however, also reinforce local power structures, undermining democratic aspirations to give voice to marginalised communities (Ribot 2008). These issues are acute in areas where local communities do not have the social, financial and human capital to effectively participate in decision-making.

Cross-scale considerations

Worboys and Lockwood (2010) identify five scales of operation relevant to connectivity conservation: individual site; landscape; entire connectivity area; nation or state; and (where relevant) international trans-boundary scale (Figure 27.3). Decisions made at one scale will influence outcomes at another, and focusing activities at one of these scales is insufficient to achieve the desired landscape-scale conservation outcomes. Effectively operating across and between multiple scales requires coherent governance where the rules operating at one scale do not undermine the capacity of participants at other scales to meet their goals. As these actors are often distributed across vast distances, however, operating in different social, ecological and institutional contexts, connectivity governance requires mechanisms to support cross-scale coordination and communication.

Governance principles and requirements

The principles of good environmental governance (see Chapter 7) readily apply to connectivity governance. In brief, this involves developing processes to build trust, integrity, inclusivity, transparency, accountability, flexibility, reciprocity and communication as foundations of good governance and collaboration (Lockwood et al. 2010). Governance should facilitate work towards shared values and goals while creating mechanisms to deal with diversity and conflict (Schliep and Stoll-Kleemann 2010). Collaboration requires strong leadership, particularly in dispersed networks challenged by spatial scales that separate actors across a landscape (Folke et al. 2005). Collaboration, however, must not rely solely on the strength of one or two key individuals. Institutionalising collaborative management will enable ongoing momentum after key individuals move on, while building individual and institutional capacity (Carr 2002). Given that many of the partners involved with connectivity conservation are likely to be distributed across large landscapes, the importance of communication mechanisms—websites, emails, print newsletters, human messengers, phones, radio, TV/cable and face-to-face meetings—cannot be overstated (see Chapter 15).

Governance across scales

Successful connectivity governance requires attention to how an initiative functions at multiple scales. Governance of larger-scale collaboration often involves nesting smaller decision-making units within a larger framework (Ostrom 2005). In Australia, many leading connectivity conservation initiatives operate on three scales: site-scale implementation, regional-scale planning and governance

across the whole connectivity area. Not all partners work across the entire region so smaller planning units operate at a scale that enables planning to be tailored to, and negotiated within, the specific context. This requires an initiative to consider which tasks are best performed at local, regional or whole-of-initiative scales (Wyborn and Bixler 2013).

Collaboration

Collaboration commonly entails: involvement of diverse stakeholders; equal opportunity to participate in decision-making; decision-making processes building towards consensus; and a sustained commitment to collective problem solving (Margerum 2008). In practice, the term is applied broadly, referring to sharing information, coordinating actions or integrated decision-making. Any of these approaches are appropriate for connectivity governance; however, partners should have shared expectations of the collaborative processes and outcomes. Collaboration with equitable distribution of power and consensus decision-making are time and resource intensive. If such collaboration is the goal, necessary resources must be found to enable it. If, however, the goal is to ensure that regional conservation actions meet a particular outcome, a more modest interpretation of collaboration, or a different approach to governance (regulatory or market-based), may be more efficient or effective (Case Study 27.1).

Public engagement

Connectivity governance includes broader community engagement. Connectivity conservation areas cover public and private land tenures; this creates an ethical and practical imperative for an initiative to consider the perspectives of local and regional communities. Effective participation can improve the quality, legitimacy and capacity of environmental decision-making while building community trust (Dietz and Stern 2008). Community input can be gained through various formal and informal mechanisms. The International Association for Public Participation lists a 'toolbox' of approaches that can provide further guidance (IAP2 2006).

Flexible and adaptive governance

Effective governance is not static; rather effective institutions evolve in response to changed circumstances. Social, political and ecological systems are constantly changing at different rates in response to internal or external stressors: actors and policies change with fluctuations in government; and knowledge of a system and its stressors changes in response to broader social, political or ecological dynamics. Governance itself is an evolving process: a workable arrangement for the start-up phase of an initiative is unlikely to remain viable as collaborations solidify and start to attract large sums of money. Connectivity initiatives are guided by long-term (50 to 100-year) visions for landscape change. Operating across these time frames requires flexible and adaptive governance and strong leadership in order to remain relevant in the face of change.

Tasks of governance

While specifics should be negotiated in context, governance tasks can be broadly grouped into four areas: 1) maintaining internal and external communication; 2) strategic planning; 3) obtaining financial resources; and 4) ensuring accountability (Mitchell and Shortell 2000). In addition to these generic tasks, connectivity governance requires coordination and supporting collaboration among diverse actors, and mechanisms of dialogue and dispute resolution. The mechanisms of connectivity governance should support internal alignment with the characteristics of the partners and external alignment with the context and needs of specific landscapes and communities.

A framework for connectivity governance

Connectivity governance can be thought of as operating at the intersection of four domains: context, knowledge, vision and collective action (Wyborn 2013). Connectivity governance will be most effective when the arrangements have been tailored to suit a particular landscape; draw on the best available local, scientific and sociological knowledge; have a clearly articulated vision; and provide a coherent framework to support actors to work towards the vision. Articulating and negotiating the elements covered by these four domains provide a framework for connectivity practitioners to tailor governance arrangements to their context.

Context

Context considers the social, ecological and institutional dimensions of an initiative. This involves identifying the key actors in the process, the landscape context (major land use, threats, conservation assets and targets), the economy of the region, major market drivers, the organisations involved or affected, and the overall institutional and regulatory context that constrains or enables collective action. A thorough understanding of contextual factors is desirable in order to most effectively tailor governance to the specifics of a particular place. Identifying financial resources is critical, as the availability of resources shapes the nature of governance and implementation.

Case Study 27.1 Western Himalaya, India: Landscape conservation using a mosaic of governance and management models

The mountain landscape stretching from the Nandadevi Range to the Askot Valley in the State of Uttarakhand in India's Western Himalaya is home to several globally important plant and animal species, unique human cultures and critical ecosystem functions that provide benefits to millions of people. Currently this landscape is governed and managed in a variety of ways, including under government-designated protected areas like Nanda Devi National Park and Askot Sanctuary, ICCAs like *van panchayats* (forests under formal management of village committees), sacred natural sites, reserves and protected forests under government management, and other governmental, community and private lands. A substantial part of the west of this region is under the Nanda Devi Biosphere Reserve—also designated as a World Heritage site. Several of these designations or land uses overlap—for instance, one-third of the Askot Sanctuary is under van panchayats or other village commons. Moreover, when seen on the same map, the various governance types together form much larger areas of contiguity and connectivity than if only the formally designated protected areas were considered (see Figure 27.4). One of India's biggest conservation landscapes, spread over more than 2500 square kilometres, can be envisaged through such an approach.

There have, however, been few attempts in the past to see this landscape in terms of connectivity. Second, lack of consultation and participation in the designation and management of the government protected areas has in the past caused hostility, alienation and loss of livelihoods among local communities. Finally, lack of interdepartmental coordination in the State Government has allowed the establishment of a number of hydro-electricity and other projects that have threatened both biodiversity and local communities.

In 2010, the Wildlife Institute of India and the NGO Kalpavriksh initiated a dialogue process among government officials, local community members, civil society organisations and wildlife researchers. The aims were to discuss and resolve the above issues of contention, and collectively envision the landscape as one in which conservation and livelihoods can be integrated through a mosaic approach. There are a number of ongoing processes that could be opportunities for such an approach: the presence of the biosphere reserve where such an integrated view is already intended (and includes some ecodevelopment inputs to villages); the Government of India's Biodiversity Conservation and Rural Livelihoods Improvement Project (funded by the World Bank, with Askot as one of the main sites); the possibility of recognising rights-based community conservation under the Forest Rights Act 2006; and mobilisation among communities for securing livelihoods including through new approaches like community-led ecotourism.

Four dialogues have been held, including two for the participation of a range of rights-holders and stakeholders in the Nanda Devi and Askot areas, and one in the State capital to bring on board senior officials of the forest bureaucracy and wildlife scientists who have been working in these areas. These were co-organised with the Uttarakhand State Forest Department, and NGOs like Alliance for Development and Himal Prakriti. These have come up with a number of recommendations on how the various governance types and management categories can be brought together, what kinds of livelihoods can be encouraged and enhanced, and how principles of good governance such as participation (see Chapter 7) can be incorporated. A discussion paper on a possible institutional arrangement for integrated governance, planning and management of the region was circulated. All these have also been sent to the State Government for consideration. The going has been slow, as the approach suggested is fairly new to India, and has to overcome institutional, informational and attitudinal challenges including the creation of trust among the various parties concerned and creating greater transparency in governmental functioning. Continued top-down planning of hydro-electricity projects is also a constraining factor. In 2014, the initiating organisations were planning the next set of consultations and actions.

— Ashish Kothari, Kalpavriksh, Pune, India

Knowledge

The knowledge required to support connectivity conservation and connectivity governance is diverse. The knowledge context of an initiative will shape how conservation, management and governance challenges are understood; how governance, planning and intervention are monitored and evaluated; how learning is shared and accumulated over time; and what counts as credible and relevant knowledge in the context of a particular problem.

Vision

An initiative's vision requires practitioners to imagine a desired future. A bold connectivity conservation vision is a critical element that provides the context for local individual actions. The vision is a key component of the management framework (Figures 27.3 and 27.4) and provides the 'glue' that provides guidance to multiple stakeholders implementing actions across the landscape at multiple scales. A vision should be compelling and motivating. Stakeholders need to believe that the vision is achievable and that their own individual actions can make a difference. Vision statements that work best utilise powerful imagery and are easily grasped and accepted (Robinns et al. 2003). An example is the vision statement of the Great Eastern Ranges Initiative:

> To conserve and manage a 3,600km 'continental lifeline' of habitats, landscapes and people, that will support the continued survival of native plants and animals along the Great Eastern Ranges from the Grampians in Victoria to far north Queensland and maintain the natural processes on which they depend. (OEH 2012:2)

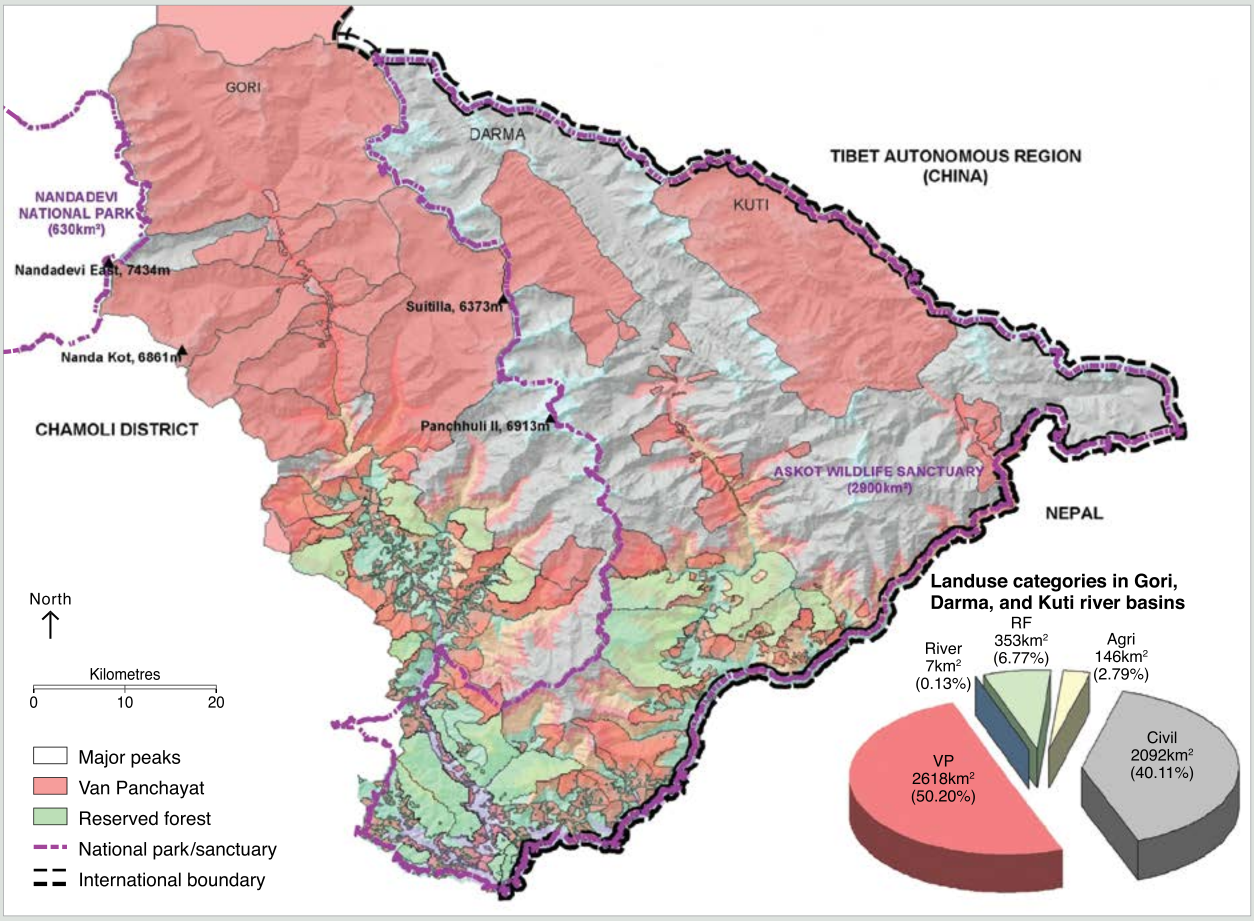


Figure 27.4 Community and State Protected Areas of the Gori, Darma and Kuti River Basins in the Western Himalaya

Source: Modified from Foundation for Ecological Security

Collective action

The collective action dimensions of connectivity governance concern the social and institutional dimensions of moving from vision to action. These dimensions of governance revolve around processes of leadership, building trust among participants, and creating an environment where the group can learn from each other and learn together (social learning) and build the necessary social capital to create viable working relationships. The culture and relationships that emerge from these interactions form the informal, often unwritten, rules and norms of governance. Beyond informal rules come more formal processes and the structural dimensions of governance. This involves having clear lines of accountability, transparent decision-making processes, clarity around the respective roles and responsibilities of actors and inclusive decision-making processes.

Corridor benefits to the community

Effective corridors and their governance provide many benefits for biodiversity, people and communities. For example, maintaining connected landscapes increases landscape amenity for recreation and enjoyment, may help to increase farm productivity and sustainability, can maintain or increase connectedness with nature and other land managers and provides for human physical, spiritual and economic wellbeing. This is because corridors extend across multiple tenures that may be used for many purposes and may include protected areas and areas used for settlements, forestry, agriculture, pastoralism, fishing and even mining.

Box 27.3 Six potential governance models for connectivity conservation

1. Single, 'top-down' organisation: Authority is vested in a single organisation with wideranging powers and/or resources with sole responsibility for an initiative. This model is likely to be adopted by a governmental agency or a large NGO with the capacity to undertake the tasks of governance and coordinate with local actors.
2. Single, 'bottom-up' organisation: Another single-organisation approach, however, a community organisation or local indigenous group assumes the primary governance role. As many local-scale initiatives have limited reach across a large landscape, this approach often revolves around connecting a number of local initiatives across the landscape.
3. Decentralised authority: Decentralisation is a process whereby a centralised authority (usually a government) devolves responsibility for decision-making to regional or local authorities. This could involve devolving certain aspects of decision-making to different organisations, or a governmental agency relegating authority to a local organisation. Problems can arise when responsibility for decision-making is devolved without the necessary power or resources to act.
4. Representative authority: Representative governance involves an electoral process whereby the governing body is legitimised through formal voting. Given the diversity of interests in a connectivity area, the question of who gets to vote can be difficult: is voting restricted to residents in the landscape, to organisations in a collaboration, to anybody who is interested in the region?
5. Representative federation: Governance through a federation emerges when a group of organisations formalises their collaboration or partnership. While the rules and structures of governance will vary depending on the context, federations tend to involve partners collectively shaping an initiative's strategic direction. In this approach, the federation is often considered a separate entity comprising more than the collective sum of the partners.
6. Loose confederation: Under a loose confederation, partners focus on a common vision; however, under this model the individual partners operate somewhat independently of each other. Each partner is free to implement activities under the vision without having to consult with other partners. The collective effort is the sum of the partners' efforts.

Source: Adapted from Worboys and Lockwood (2010)

Types of governance arrangements

Connectivity conservation strives to provide flexible governance that is responsive to the local context while maintaining coherence and alignment across vertical (jurisdictions) and horizontal (land tenure) scales. This can be achieved through a variety of different means: multi-level partnerships that link local organisations and national governments; multi-sectoral collaborations involving public, private and civil society actors; or multi-organisational partnerships with groups from the same background or sector working together (Box 27.3).

Partnerships

Regardless of the governance model developed, partnerships are central to connectivity conservation. The nature of the partnerships will depend greatly on the organisations present and the level of diversity represented in the partners. Partnership complexity increases in more heterogeneous collaborations and these partnerships may take longer to reach agreement or consensus (Huxam 2003). Partnership composition as well as the expectations of collaboration will influence the nature and formality of governance arrangements. Partnerships based on information sharing between organisations of similar size and backgrounds are unlikely to need complex governance structures. In contrast, multi-party partnerships between public, private and civil society organisations seeking to collectively raise and distribute funding are more likely to require formalised governance outlining the roles and responsibilities of the different partners.

Representatives of four non-governmental organisation (NGO) lead partners (OzGreen, National Parks Association, Greening Australia and Nature Conservation Trust) and the NSW Department of Environment, Climate Change and Water witnessing the signing of a memorandum of understanding in May 2010 to provide leadership for the Great Eastern Ranges Initiative

Source: Ian Pulsford

Case Study 27.2 European Green Belt: A continent-wide wildlife migratory corridor

Transboundary migratory corridors can range from very local to continental scales (Vasilijević and Pezold 2011). A prominent example of a continental-scale trans-boundary migratory corridor is the European Green Belt. In addition to having biodiversity conservation benefits, the European Green Belt addresses specific symbolism of reconciliation and renewed cooperation after the long period of the 'Iron Curtain'. This initiative aims to consolidate a network of protected areas located at border areas of sovereign countries spanning from a Fennoscandian part of northern Europe to the Adriatic and Black seas in the south. While this example is relevant to the issue of scale, it is also an example of the significant challenges protagonists face in the development of transboundary initiatives where there are vastly different socioeconomic and sociopolitical dynamics and circumstances.

— Maja Vasilijević, Director of Eco Horizon, Croatia

Secretariat

A number of tasks need to be considered to support a connectivity initiative extending beyond the remit of partnerships focused on implementation on the ground. These include: leadership to promote the vision; developing strategic planning for the whole initiative; supporting administrative and operational capacity to communicate and coordinate across partners; working to integrate the vision into land-use planning; establishing, supporting and collating ongoing evaluation across scales (Worboys and Lockwood 2010). In more formalised initiatives, this work often falls to a 'secretariat' that acts as the public face of an initiative and performs many of these tasks in collaboration with partners. For example, in 2014 the secretariat in the Great Eastern Ranges Initiative in Australia consisted of a director, conservation manager, communications expert and a web designer.

Top down or bottom up?

The question of whether governance is more effective when directed through a top-down hierarchy or decentralised grassroots initiatives is largely a philosophical one. For those in favour of a hierarchy, this brings clear lines of accountability and efficient decision-making as the directives flow from an executive director or a board. Top-down governance can, however, lack the local connections necessary to truly connect a connectivity initiative to a place.

In contrast, grassroots governance is seen to provide better connections to a place, local knowledge, communities and the 'boots on the ground' undertaking the conservation work. Without coordination between disparate efforts, however, the cumulative landscape-scale impact may be lost. A centralised 'face' or coordinator can collate and promote what would otherwise be disparate local efforts. Their cumulative impact can provide a greater voice for a region in policy or land-use planning debates that drive landscape change; however, passion and connection to place provide the vision and motivation for connectivity conservation.

Role of protected area managers in corridors

Protected area managers of community, private and public protected areas can provide a critical role in the leadership and governance of connectivity conservation partnerships (Worboys et al. 2010). This is because they manage permanently protected lands, and these areas are often the most intact and important core habitats remaining within a corridor. Protected areas are an essential foundation stone of connectivity conservation. In addition, protected area managers bring specialist conservation management skills that are valuable for the larger corridor area and its management. If the purposes for the establishment of the protected area are to be fulfilled, managers must manage the ecosystems within the reserve. Often, this can only be achieved if managers work beyond protected area boundaries to

Protected area managers re-signing a five-year transboundary agreement of cooperative management, Katunsky Zapovednik (Russia) and Katon-Karagay State National Nature Park (Kazakhstan), part of the proposed Altai-Sayan mega-connectivity conservation corridor
Source: Graeme L. Worboys

ensure that protected areas are interconnected into larger landscapes. They achieve this by working in partnerships with landowners and many governmental and non-governmental organisations that operate at various scales. The creation of new protected areas can play an important role in catalysing the connectivity conservation initiatives. For example, in Australia the purchase of significant private land by NGOs to establish protected areas often resulted in the formation of connectivity initiatives extending beyond their boundaries (Fitzsimons and Wescott 2005).

Transboundary corridor governance

Many biodiversity conservation corridors that form part of connectivity conservation areas span international borders. They are important for conserving habitats that enable movement and maintenance of viable species populations, while conserving ecosystem services that enhance the welfare of local communities and socioeconomic systems further afield. Trans-boundary conservation can enable the free movement of wildlife and the migration of species, especially of those animals requiring large areas (it also enables ecological connectivity—for example, the free flow of waterways). Such undisturbed migration of species leads to easier genetic exchange and less isolation, resulting in the reduction of the risk of biodiversity loss. Trans-boundary conservation enables maintenance of healthy and viable populations of species through coordinated management measures across borders. It can be an effective approach for the conservation of biodiversity in that cross-border threats can be dealt with through coordinated action; however, establishing shared governance and cooperative management—a necessity in transboundary conservation approaches—is usually a long-term dynamic and complex process (Case Study 27.2).

Assessing the need for transboundary conservation

Transboundary approaches in conservation provide new opportunities through opening new channels of cooperation and can result in multiple benefits if planned and managed well. They are probably one of the most complex 'types' of conservation due to a variety of elements that need to be negotiated between two or more countries. This is why careful assessment of needs and potential opportunities and benefits must be performed prior to engaging in a transboundary initiative. Vasilijević (2012) presents a practical diagnostic tool for trans-boundary conservation planners that enables self-assessment through a questionnaire, completion of which helps in deciding whether or not to engage in a transboundary initiative. The tool is designed in such a way as to assist protected area authorities and other governmental agencies, NGOs, local communities and all interested parties in examining their readiness to initiate a transboundary conservation process, while not neglecting the ecological or biodiversity reasons for transboundary conservation, and the accompanying opportunities and potential risks. The diagnostic tool enabling automated report generation is available from the IUCN (Vasilijević 2012).

Benefits of transboundary approaches

While biodiversity conservation is the core objective of transboundary migratory corridors, transboundary conservation may have many other potential benefits and can provide important opportunities that may not have existed prior to establishing a transboundary initiative (Case Studies 27.2 and 27.3). It enables regular interaction between protected area authorities and continuous sharing of information; it supports a learning process; it establishes connections between cultures, enabling the development of trust and friendships between local communities; it provides for economic development of the given area; and it enables the establishment or strengthening of bilateral and multilateral diplomatic relations. This list is not all inclusive and the potential benefits and positive implications of trans-boundary conservation potentially go way beyond those suggested here. What is important though is the development of trust between key stakeholders. Without mutual trust and understanding, the chances of achieving good cooperation will be limited.

Legal considerations

This section provides an overview of key international and national legal instruments supportive of corridor management and connectivity conservation, along with their governance considerations. It draws from *The Legal Aspects of Connectivity Conservation: A concept paper* (Lausche 2013) and the parent document, *Guidelines for Protected Areas Legislation* (Lausche 2011).

Case Study 27.3 Kgalagadi Transfrontier Park

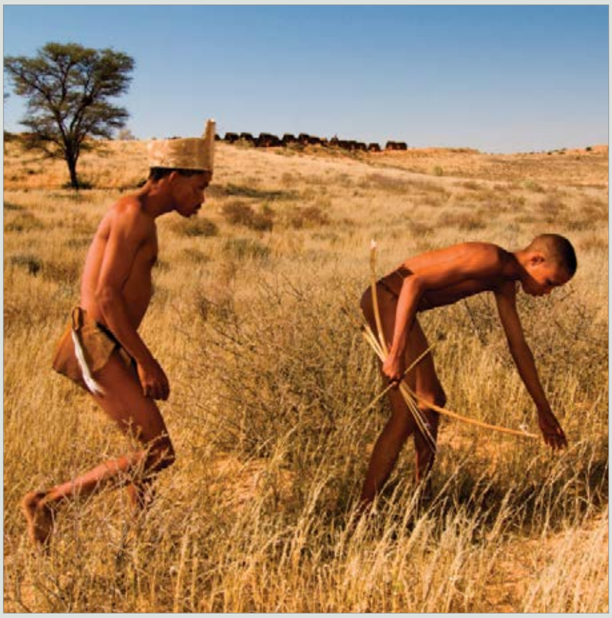
In the far north-western corner of South Africa there is a small portion of land that is squeezed in between Botswana to the east and Namibia to the west, for approximately 235 kilometres. Here, the boundary between South Africa and Botswana is the Nosob River, while that between South Africa and Namibia is a straight line running north to south. While both of these boundaries have been derived through various political processes, the former is a clear illustration of the need for trans-boundary cooperation to achieve conservation objectives. This is particularly true considering this area is in the southern Kalahari Desert, where the scarcity of water is a key driver of ecosystem functionality, and therefore where it would make sense for Botswana and South Africa to see their international boundary as one that needs to be cooperatively managed.

South Africa proclaimed the Kalahari Gemsbok National Park in 1931 and Botswana proclaimed the Gemsbok National Park in 1971. Cooperative management of these adjacent areas has, however, been in *de facto* existence since 1948 through a verbal agreement between the two countries. Since 1964, the warden of the Kalahari Gemsbok National Park and some of the rangers have been recognised as ex-officio honorary game wardens in Botswana. On 7 April 1999, the Kgalagadi Transfrontier Park was formally recognised through the signing of a bilateral agreement between Botswana's Department of Wildlife and National Parks and South African National Parks (SANParks), thus bringing into being the first formal trans-frontier park in Africa. On 12 May 2000, Botswanan President, Festus Mogae, and South African President, Thabo Mbeki, officially opened the Kgalagadi Transfrontier Park. This was preceded by the establishment of a joint management committee between the respective conservation agencies in June 1992 and the approval of the reviewed management plan in 1997.

Not only has the establishment of this 35 551 square kilometre trans-frontier park (Figure 27.5) allowed for the maintenance of ecosystem processes and the uninterrupted movement of large mammals, it also has ensured that important cultural linkages and features have been reinstated. Although Namibia does not contribute to the trans-frontier park in terms of landmass, the opening of the Mata-Mata tourist access facility on 12 October 2007 reunited local communities, as it is a historical access point between Namibia and South Africa. In addition, a successful land settlement agreement between the ‡Khomani San and Mier communities, and the South African Government and SANParks, has seen a 500 square kilometre portion of land within the Kalahari Gemsbok National Park transferred to the communities.

— Kevan Zunckel, ZUNCKEL Ecological and Environmental Services, South Africa

The information presented in this case study has largely been obtained and abridged from the Peace Parks Foundation (2014), unless otherwise indicated.



Representatives of the ‡Khomani San and Mier communities tracking within the !Ae!Hai Kalahari Heritage Park, with the !Xaus Lodge on the skyline in the background, South Africa

Source: !Xaus Lodge

Figure 27.5 The location of the Kgalagadi Transfrontier Park and its constituent national parks in Botswana and South Africa

Source: Modified from Peace Parks Foundation

International legal frameworks

Key international legal instruments with global or regional scope for their role in promoting connectivity conservation directly or indirectly include the following.

Global instruments

- **Convention on Biological Diversity (CBD).** While not addressed in so many words, several convention provisions are directly relevant, particularly Article 8 on *in situ* conservation. That article calls for establishing systems of protected areas and other areas where special measures need to be taken to conserve biodiversity—such measures necessarily including connectivity. The CBD Programme of Work on Protected Areas is clear about the need for ecological networks, ecological corridors and buffer zones as part of protected area frameworks. Several Aichi Biodiversity Targets (5, 11 and 14) also directly reinforce the need for connectivity, as do subsequent decisions of the parties. For example, Target 11 calls for 'well connected systems of protected areas and other effective area-based measures, and integrated into the wider landscape and seascapes' (CBD 2011:2). For further examples and discussion, see Lausche et al. (2013).
- **UN Framework Convention on Climate Change.** Mechanisms created to further implement this convention—in particular, Reducing Emissions from Deforestation and Forest Degradation (REDD) and REDD+—may generate 'co-benefits' for connectivity conservation by providing incentives for conservation of natural forests and their ecosystem services. This is because the movement from REDD to REDD+ in 2010 reflected a changing perspective and more conservation-oriented purpose for the mechanism itself. REDD+ does not view natural forests just as carbon stock, but far more importantly, it views natural forests also as part of natural systems that support biodiversity and provide ecosystem services that in turn help to keep landscapes and seascapes stable in retaining and enhancing their carbon storage. REDD+ provides incentives to take action, including connectivity conservation action, which aids climate change mitigation while also playing a significant role in conserving biodiversity and ecosystems.
- **Convention on the Conservation of Migratory Species of Wild Animals (CMS).** The parties to the CMS have acknowledged that the objectives of the convention cannot be achieved without ensuring adequate connectivity conservation and protecting ecological networks (see, for example, Resolution 10.3, 2011). For endangered species in Appendix 1, Article III(4) calls upon the parties to prevent, remove, compensate for or minimise adverse effects of activities or obstacles that seriously impede or prevent migration of the species, and agreements made under the convention are to conserve and where required and feasible restore habitats of importance in maintaining a favourable conservation status (Article IV[1][4]). CMS ancillary instruments (agreements and memoranda of understanding) are important for promoting connectivity conservation for specific groups of species.
- **Convention on Wetlands of International Importance especially as Waterfowl Habitat ('Ramsar Convention').** Parties to Ramsar are obliged to formulate and implement plans for conservation of listed wetlands and wise use of all wetlands as far as possible. Because wetlands, such as rivers, provide essential connectivity functions, and 'wise use' (interpreted as 'sustainable use') also should provide for sufficient degrees of connectivity, obligations under the convention contribute to connectivity conservation.
- **World Heritage Convention (WHC).** Each party to the WHC is to integrate the protection of their natural heritage into comprehensive planning programs as much as possible and to take appropriate measures (including legal measures) to protect, conserve and rehabilitate this heritage (Article 5). Operational guidelines instruct parties to provide for specific connectivity measures, such as buffer zones, to such heritage sites. In that context, WHC obligations may extend to connectivity conservation.
- **UNESCO Man and the Biosphere Programme (MAB).** Supplementing legally binding instruments such as those noted above, there are other relevant global arrangements that are not legally binding. A notable arrangement is the UN Educational, Scientific and Cultural Organisation (UNESCO) Man and the Biosphere Programme, with its biosphere reserve concept applicable to terrestrial, coastal, marine and island areas. Important connectivity functions are served by biosphere reserves beyond their core areas (normally a formal protected area) as they require extensions to buffer zones and transition zones (which may not be formal protected areas) (UNESCO 2013).

Regional and supranational instruments

- **Regional treaties.** Many regional legal instruments have relevance to connectivity conservation. Examples include: African Convention on the Conservation of Nature and Natural Resources (1968, revised in 2003, not yet in force); Convention

on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979); Convention on Nature Protection and Wild Life Preservation in the Western Hemisphere (Western Hemisphere Convention, 1940); Convention for the Conservation of the Biodiversity and the Protection of Wilderness Areas in Central America (1992); European Landscape Convention (2000); the Alpine Convention (1991) and in particular its Protocol on the Conservation of Nature and the Countryside (1994); Carpathian Convention and its Protocol on Conservation and Sustainable Use of Biological and Landscape Diversity (2003); Protocol on Environmental Protection to the Antarctic Treaty (1991); and a range of CMS ancillary instruments.

- **European Union (EU) Natura 2000.** As a supranational body, the EU legislature has enacted two principal legal instruments that support biodiversity and connectivity. These are the Birds Directive (Directive 2009/147/EC) and the Habitats Directive (Directive 92/43/EEC). Among other things, the directives call for the establishment of an ecological network ensuring the favourable conservation status of target species and natural habitats. Taken together, these directives have facilitated the creation of a coherent, continent-wide European ecological network, called Natura 2000. The legal framework for this network includes a legally binding set of rules for all 27 EU member states (Article 3, Habitats Directive).

National legal tools for connectivity conservation

Most national legal systems already contain an array of legal tools that can be used for promoting and managing corridors and other area-based connectivity conservation measures. Following a short note on governance considerations, the remainder of this section reviews key instruments in national law that can be used to support corridors and connectivity.

Legal governance approaches

Governance approaches for connectivity conservation are still in the early stages of development in most legal systems. Early lessons from case studies and research suggest that the conventional approach to protected area governance—state-owned or state-controlled areas—is not significant in the connectivity conservation context. This is because most areas outside a protected area system important for connectivity are owned or controlled by other entities—namely, private individuals, local communities or indigenous peoples, NGOs, or corporations.

Just as no single model of governance will work for protected area systems, no single approach works for connectivity conservation areas. Diverse governance approaches need to be possible—from those appropriate for small-scale connectivity sites (for example, hedgerows, patches of plants, small woods, urban parks) to those appropriate for large-scale sites (major river systems, chains of islands, coastal zones, seas and oceans). This means that responsive laws and policies need to provide authority, rules and incentives to support such diversity, and need to provide flexibility for changing partnerships, biophysical conditions (including climate change) and management needs (Worboys and Pulsford 2011).

Conservation and sustainable use laws to support corridors and connectivity

In order to achieve their goals, most conservation and sustainable use laws require or are linked to natural connectivity in some manner.

- Stand-alone connectivity legislation: While research found no enacted legislation of a generic nature, some site-specific legislation exists—for example, the *South Korea Act on the Protection of the Baekdu Daegan Mountain System (BDMS) 2003* (Act No. 7038, as amended in 2009).
- Protected area legislation: Protected area legal frameworks are a foundation tool for biodiversity conservation. As such, connectivity conservation should be a consideration throughout the legislation, from system design to selection of sites, management planning, coordination, governance and monitoring.
- Biodiversity/nature conservation laws: Some countries have enacted national biodiversity or nature conservation laws as framework laws—for example, Australia's *Environment Protection and Biodiversity Conservation Act 1999*. These require consideration of connectivity conservation to achieve their biodiversity goals.
- Wildlife conservation laws: Most countries have legislation on wildlife conservation, generally in one or more instruments, and typically covering endangered or threatened species, general wildlife conservation and hunting. These laws generally assume or require certain standards for species management and protection that make connectivity conservation an essential consideration.

- Sustainable use laws for resources or ecosystems: Laws to secure sustainable use of natural resources (forests, soils, peatlands, prairies, fisheries, agricultural lands) and specific ecosystem types (watersheds, wetlands, coastal zones, hydrologic flows) are becoming increasingly common around the world. The goal is to maintain the connectivity of biological systems that support resource production and healthy ecosystem functioning with time, including in the face of ongoing threats and global change such as climate change.

Land and development control instruments

Land-use planning law (also sometimes referred to as 'spatial planning' law) has an important role to play in setting regulatory ground rules to support connectivity conservation. The focus is on future development and the use of such regulatory tools as zoning to control, develop and protect significant conservation areas, including for connectivity, from incompatible future development. Several points are relevant here.

- Land-use planning relies on direct regulation to control proposed future development. It does not rely on the voluntary cooperation of landowners or rights-holders, although it sets the framework within which voluntary initiatives can advance specific conservation objectives in the land.
- Modern land-use plans should incorporate conservation plans and be consistent with the provisions of such plans by identifying areas that are ecologically significant, along with the specific conservation values needing protection in those areas, including connectivity conservation.
- Environmental impact assessment legislation plays a crucial role in the implementation of land-use plans and supportive development controls consistent with the conservation needs and values of a landscape or site as well as ensuring compliance with other environmental laws (for example, on pollution control).
- Regulation of development is essential not only in maintaining connectivity but also in ensuring that fragmented landscapes being restored continue to be protected from inconsistent development.
- Jurisdictions with fully developed urban and rural land-use plans have the greatest potential for delivering comprehensive controls over development and maintaining or restoring important connectivity values across a landscape. Particularly in Europe and Australia, legally binding land-use planning is a well-established tradition for both urban and rural areas.

Economic and market-based tools

In contrast with land-use planning (which focuses on regulation of future uses, not existing uses), economic instruments provide an additional tool with respect to existing uses. Economic instruments can be used to encourage and direct active management of existing uses, including to better support voluntary connectivity conservation. Economic instruments introduce the element of choice. They use negative incentives (for example, taxes and charges) and positive incentives (for example, management payments and tax credits) to influence people to change their behaviour.

In practice, economic and market-based tools are frequently used in combination. Direct regulation can be used to protect existing areas from proposed development where it is incompatible with connectivity conservation; economic incentives can be used to encourage landowners and rights-holders to voluntarily change existing practices in support of connectivity conservation (for example, to implement traditional agricultural or forestry practices and restoration projects).

The economic tool called 'payment for ecosystem services' (PES) is an example of a specific economic incentive. PES is a contractual arrangement whereby a landholder agrees to provide and sustain certain ecosystem services through land uses that are compatible with the production of those services (for example, protecting a watershed for its water resources) and in return the beneficiary (for example, a public or private utility) promises to pay an agreed amount for that service for an extended duration.

As another example, an emerging market-oriented tool being recognised in some legal systems, and now being tested mainly in Western countries, is 'conservation banking'. This is a mechanism that allows private landholders to create conservation credits through active conservation management actions on their land to enhance its biodiversity values, and sets out arrangements for guaranteeing the long-term security of those credits.

Special legal instruments for voluntary conservation

Voluntary conservation arrangements need some legal recognition to be secure for all parties over the long term. The most common tools to provide a legal basis for voluntary conservation, including for connectivity conservation, are conservation agreements, easements and covenants.

Voluntary conservation agreements

Many countries (for example, Australia, the United Kingdom, the United States and several countries in Latin America) provide for the use of conservation agreements to set forth commitments and other elements for voluntarily conserved areas. Such commitments may be for areas important for connectivity conservation that qualify to be part of the formal protected area system or they may be outside the formal system but important for supporting the connectivity needs of the system. The extension of this tool to areas important for connectivity conservation is particularly important in light of the diversity of governance situations, mainly dominated by private or community lands, likely to exist on lands or resources within or outside the formal protected area system but important for its sustainability. A conservation agreement—in some jurisdictions called a 'voluntary conservation agreement' or simply an agreement—is a legally binding contract between parties recording mutually agreed long-term conservation and other voluntary arrangements and associated conditions. Ideally these agreements should apply in perpetuity; however, even a fixed-term agreement can form a building block for gaining permanent commitment.

In formal systems, long-term voluntary conservation agreements attached to land are normally registered at the land office so that the public and future owners or rights-holders are informed that the conservation measures 'run with the land' whoever the owner is. Any incentives that may be conditional on the permanent arrangement (for example, reduced taxes, revenue benefits, security of tenure) should be clearly identified in the agreement and also should remain in place even if owners change. In order to give it full legal force and effect, the agreement normally is approved or endorsed by a high-level government body responsible for overseeing implementation.

One of the important elements to cover in a voluntary conservation agreement is the governance arrangement that will apply to the site. This includes the specific institutions taking the lead in governance and in management, whether these functions are joined, separate or combined in one institution or entity. Where it is anticipated that governance arrangements may change with time, it is advisable for the legislation to allow separating documents into a framework document and a management plan so that management changes can be made without amending the framework agreement.

Easements and covenants

Easements and covenants are used in some legal systems for conservation purposes and are sometimes called 'conservation easements'. There are important legal distinctions on how different jurisdictions may apply, use or recognise the terms 'conservation agreement' and 'conservation covenant' (or easement). This is because they have evolved with differing legal frameworks. A conservation easement is a particular form of formal legal agreement that commits the landowner or rights-holder to certain obligations with respect to the land or resource. It may limit the type or amount of development on the property (normally protecting the land from unwanted development)—legally understood as a negative easement. Or it may oblige the party to carry out specific actions on the land or to use the land in a certain way related to active management and conservation—legally understood as an affirmative easement. After the easement is signed, it is recorded with the appropriate official land registry responsible for land deeds, and all future owners are bound by the easement. As such, it works essentially as 'a covenant running with the land'.

A conservation easement or covenant running with the land may be attractive for a government (or a conservation organisation that may purchase the easement) because it secures a partial legal interest in the land for conservation without requiring that the government or conservation organisation purchase the land. It is of interest to private landowners because they retain title and ownership, allowing continued use in perpetuity as long as it is consistent with the terms of the covenant or easement, with successors being equally bound.

In the United States, the United Kingdom, Australia and some countries in Latin America, tax incentives are provided for concluding such easements as long as the easement is perpetual and meets certain conditions. To receive these tax incentives, typically in the form of tax deductions, the property must normally be determined to have significant conservation value (Case Study 27.4).

Legal tools for strategic planning

In some countries, a legal tool for broader strategic planning for connectivity conservation is the strategic environmental assessment (SEA). This tool represents a way of integrating conservation considerations into national strategic and land-use planning processes. In an SEA, the impact on the environment of a draft land use or development plan has to be assessed. Major infrastructure projects and large spatial developments, such as new residential areas, can obviously have a major impact on connectivity as they may form massive barriers for wildlife. It is important that connectivity requirements, using the best scientific information available, are well presented and assessed in SEAs, so that they are taken into account at this level. This instrument is a new and emerging tool and has had limited experience with application to date.

Case Study 27.4 Legal instruments: Great Eastern Ranges Initiative

The Great Eastern Ranges (GER) Initiative aims to establish a conservation corridor inland of the east coast of Australia, stretching 3600 kilometres from north to south. The corridor is primarily defined by the Great Dividing Range and the Great Escarpment of eastern Australia (Mackey et al. 2010).

There is no legislation in Australia that specifically recognises connectivity conservation, although biosphere reserves that inherently incorporate connectivity conservation are recognised under the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A recent Draft National Wildlife Corridors Plan (National Wildlife Corridors Advisory Group 2012) recommended a National Wildlife Corridors Act, but this would only have provided a legal process for community nomination and government declaration of national wildlife corridors, not the tools for achieving this. The proposed legislation was subsequently abandoned in favour of a non-legislative process (Government of Australia 2012).

In practice, the Australian States and Territories have traditionally undertaken responsibility for environmental management, and one of the legal challenges is that the corridor runs through four jurisdictions—the States of Victoria, New South Wales and Queensland, and the Australian Capital Territory—each with its own environmental legislation. The Federal Government may, however, make legislation relating to 'external affairs' (*Australian Constitution*, s. 51[xxix]). This allows it to implement Australia's obligations under international nature conservation conventions (*Commonwealth v Tasmania* [1983] 158 CLR 1), including the CBD. The EPBC Act identifies a number of 'matters of national environmental significance', including species and ecological communities listed as threatened at a national level. Any activity likely to have a significant impact on these matters must be assessed and approved by the Federal Government, in addition to obtaining approvals required under State law (EPBC Act, Part 3, Division 1). What this means is that the Federal Government may impose stringent conditions on development approved at the State level, and even veto it completely.

Another legal challenge is posed by the variety of land tenures. In New South Wales, while 59 per cent of the corridor is public land, including 39 per cent in protected areas, 41 per cent is privately owned. In Queensland the corridor incorporates significant areas of privately leased public land and private land (Pulsford et al. 2012). Privately controlled gaps between protected areas provide a challenge to the development of the corridor. These areas are the ones that have been the primary interest of the initiative so far.

Activity is focused on the State of New South Wales, although new GER alliances have formed recently in the other jurisdictions. The initiative in New South Wales is led by a lead partners' group (three conservation NGOs, a semi-independent statutory body and the NSW Government environmental agency). Eight GER regional partnerships have been set up, covering different sections of the corridor. These involve from 10 to 35 organisations, including NGOs, industry groups, governmental agencies, local government, Indigenous groups and academic institutions. Each regional partnership has its own approach to planning and implementation. Various strategic planning processes are being utilised even though they have not been specifically designed for connectivity conservation. For example, the priorities for on-ground conservation investment in one area are being informed by two regional multi-species/ecological community recovery plans that set out the actions necessary for maximising long-term survival in the wild. Recovery plans can be harnessed to achieve connectivity objectives because enhancing habitat connectivity is a key strategy for maintaining species' dispersal capacity and viability in the context of climate change (DECCW 2010:42). In another section of the corridor, strategic biodiversity conservation planning is coalescing around strategic assessment, under the EPBC Act, of proposed coalmines that are likely to have a significant impact on matters of national environmental significance.

When it comes to implementation of on-ground conservation actions on private land, NGOs must necessarily rely on voluntarism. Even where government plays a role, it emphasises voluntary instruments rather than regulatory ones (OEH 2013).

The voluntary instruments used include outright purchase of land by conservation NGOs and management agreements with landholders. Agreements that bind both the existing and the future owners of the land in perpetuity remain the holy grail of private land conservation. In Australia, however, unlike the United States, NGOs cannot usually enter into such arrangements. They are only available to statutory bodies, under legislation, although NGOs may enter into cooperative arrangements. These statutory bodies may also employ 'revolving funds', allowing them to purchase land and then sell it subject to the attachment of a covenant upon sale, investing the proceeds in further purchases.

Garth Dixon OAM, at his 'Warriwillah' property near Canberra, who signed in perpetuity conservation agreement with the NSW National Parks and Wildlife Service in the Kosciuszko to Coast section of the Great Eastern Ranges Initiative

Source: Ian Pulsford

Landholders who enter into perpetual covenants, or purchase land already subject to them, are usually motivated by an environmental ethic rather than specific incentives, although they are rewarded with tax benefits and, in New South Wales, relief from local government rates. At the other extreme, there are agreements and registration schemes that are primarily symbolic, lasting only as long as the landholder chooses. The aim is to secure an initial commitment in the hope of extending the length and depth of this over time.

In between these extremes, practice varies. The aim of obtaining an enforceable commitment providing long-term security must be balanced against landholder reluctance if incentives are insubstantial, even in a context where enforcement action is unlikely. One approach requires agreements for at least five years where required management interventions are modest (for example, grazing management) but a minimum of 15 years where restoration (revegetation, fencing for stock exclusion and weed management) is involved. If the only objective is feral animal control, or weed suppression by a landholder after weed removal by the other party to the agreement, there may be few formalities and no legally binding commitments.

A voluntary rather than regulatory approach is essential to securing the cooperation of private landholders in ongoing active management. A regulatory backdrop, however, controlling proposed development that threatens existing connectivity is an essential precursor. In the GER, this is provided by State controls over development and clearance of native vegetation and Commonwealth regulation of proposals that have a significant impact on matters of national environmental significance. In addition, local government planning schemes may seek to protect corridors through zoning or through environmental overlays that have to be considered in determining development applications. The existence of direct regulation fundamentally improves the bargaining position of those seeking to negotiate management agreements with landholders. These regulatory processes were established long before the emergence of connectivity conservation, with its emphasis on voluntarism. Connectivity conservation is not their objective, but they are important building blocks in achieving it.

— David Farrier, Faculty of Law, University of Wollongong, Australia

Conclusion

Connectivity conservation is a 21st-century approach to managing landscapes and ecosystems. In today's rapidly changing world and in the future, it is not possible for protected areas on their own to adequately conserve biodiversity. It is only by working to understand and effectively manage protected areas as part of the surrounding and interconnecting landscapes that we will ensure that the greatest possible number of species and ecosystems can move and adapt as climate and other conditions change. Connectivity conservation has many benefits for people and nature, and provides a natural solution for helping to mitigate the effects of climate change. Connectivity conservation is underpinned by a sound scientific basis. The concept is now sufficiently mature that a global management and governance framework has been developed by the IUCN for people to work together over large regions. These approaches are being implemented all over the world including many initiatives that reach across jurisdictional borders. This framework begins to address the need for connectivity conservation to be supported by many legal instruments and tools that already exist in most national legal systems. A two-pronged approach is needed: making better use of existing instruments and strengthening existing frameworks with new and innovative tools and processes as feasible. Readers may refer to two principal source documents (Lausche 2011, Lausche 2013) and their extensive reference lists of articles, reports and websites for more detailed analyses of these topics and additional reading on law and connectivity conservation.

Wildlife crossing, Banff National Park: the Trans-Canada Highway and other roads cut across a major north–south migratory corridor for wildlife, part of the Yellowstone to Yukon (Y2Y) corridor. In response to this situation, forty-four overpasses and underpasses have been constructed in the park and many animals including black bear (*Ursus americanus*), grizzly bear (*Ursus arctos*), gray wolves (*Canis lupus*), cougar (*Felis concolor*) and wapiti (*Cervus elaphus*) are using them. The structures help to maintain the connectivity for wildlife, they maintain the effectiveness of the Y2Y corridor and have lowered the number of vehicle–wildlife incidents on park roads.

Source: Graeme L. Worboys

The Australian snowgum (*Eucalyptus pauciflora*) at its altitudinal limit, Charlotte Pass, Kosciuszko National Park, New South Wales. The park is part of the Great Eastern Ranges Initiative, and this connectivity conservation area extends over 3000 kilometres northwards from Victoria, through Australia's alpine national parks all the way through New South Wales to the Wet Tropics of Queensland World Heritage area and beyond

Source: Graeme L. Worboys

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