CONNECTIVITY CONSERVATION AREA GUIDELINES

[DEFINITION, TYPES, SELECTION CRITERIA AND GOVERNANCE]

ADVANCED DRAFT, MAY 2016

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ADVANCED DRAFT STATUS: These Guidelines are recognised as an Advanced Draft of a Connectivity Conservation Area Guideline. Previously, these Guidelines were generated as two parts (Part One and Part Two) as a "Preliminary Draft" (pre December 2015) and as a "Consultation Draft" (January to March 2016) and consultation and feedback on the drafts on both occasions has improved the content. This Advanced Draft will be subject to an additional public consultation process prior to it being released as a Final Guideline.

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CONNECTIVITY CONSERVATION AREA GUIDELINES

FOREWORD

Connectivity conservation, the subject of this Guideline, is a key response to the destruction and fragmentation of natural habitats by humans in terrestrial, freshwater and marine environments. It is also a critical response to climate change caused threats. This response benefits native species, the conservation of biodiversity, ecosystems and ecological and evolutionary processes and importantly it benefits human well-being. Areas managed for connectivity conservation have been recognised over many years and by many names including ecolinks, biolinks, wildlife corridors, ecological networks, connectivity corridors and other titles. More recently, such areas have also been described by researchers and practitioners as Connectivity Conservation Areas (CCAs) (or areas where connectivity conservation is practised) and IUCN has adopted this more inclusive term[*1]. CCAs contribute importantly to the conservation of biodiversity of Earth and they are an essential conservation accessory to protected areas. CCAs interconnect protected areas and connect them to the wider semi-natural and natural landscapes, freshwaterscapes and seascapes. This Guideline defines and describes CCAs. It is based on connectivity conservation research and practice pioneered by IUCN WCPA researchers, practitioners and many experts from other organisations prior to and following the 2003 IUCN Durban World Parks Congress.

PURPOSE OF THESE GUIDELINES

Connectivity conservation is a relatively new field of conservation practice.
The purpose of these IUCN Guidelines is to establish a clear definition for CCAs; to define the different Types of CCAs and to define criteria for their official international recognition as a basis for consistent international data collection and analysis.
These Guidelines:

1. Describe underpinning connectivity conservation science;
2. Define Connectivity Conservation Area;
3. Describe the strategic context of CCAs;
4. Categorise CCA Types;
5. Present CCA identification criteria; and
6. Describe governance for CCAs.

The Guidelines provide a basis for the consistent and orderly identification and spatial delineation of the different types of CCAs on Earth. They (consequently) provide a basis for estimating the connectivity conservation implementation progress for Target 11 of the Convention on Biological Diversity's 2011-2020 strategic plan.

[*1. Though the acronym CCA (Connectivity Conservation Area) is similar to the acronym ICCA (Indigenous Peoples and Community Conserved Territories and Areas) it has been used by IUCN given the importance of retaining the words "Connectivity Conservation Area". An initial survey of respondents identified a preference to retain the capitalised three letter acronym. To avoid any confusion with future text where ICCA and CCA acronyms are used together, the full CCA text should be used.]

CONNECTIVITY CONSERVATION AREA GUIDELINES

CONTENTS

BOXES

FIGURE

TABLE

1. INTRODUCTION

"Habitat fragments lose species after they are isolated because these islands are no longer part of a larger natural system. (…) What we learned was that conservation depends not only on protection but also on connection". (Lovejoy and Wilson 2015)

Connectivity Conservation Areas (CCAs) contribute importantly to the conservation of biodiversity on Earth. They are an essential conservation accessory to protected areas and a critical response to climate change caused environmental health and biodiversity conservation threats. CCAs interconnect protected areas and connect them to the wider semi-natural and natural landscapes, freshwaterscapes and seascapes. They provide a fundamental contribution to maintaining the ecological integrity of protected areas (and other effective area based conservation areas - hereafter simply described as protected areas) and the habitats and species they conserve. They exist across terrestrial areas; include bird and non-bird flight migratory routes; they are found along and within fresh-water rivers; across lakes and estuaries and in estuarine and marine environments. CCAs are not however, a substitute "use" category (on land, freshwater or the sea) for areas that should otherwise be permanently protected for their important natural and cultural values. CCAs are indeed, complementary to protected areas.

The following IUCN Connectivity Conservation Area Guidelines provide the IUCN definition for a CCA. They provide brief background information including the environmental, social and policy context for CCAs and guidance provided by the Convention on Biological Diversity's (CBD) 2011-2020 Plan). The Guidelines provide a brief historical insight to IUCN's involvement with connectivity conservation action and a snapshot of the science underpinning connectivity conservation. Similar to IUCN's definition of protected areas, the CCA definition is provided for all environment types of Earth. The Guidelines identify different "Types" of CCAs; they identify criteria for their selection and they describe the different governance types for these areas.

The Guidelines also provide a glossary of terms that may be used to describe CCAs (Attachment One) and IUCN World Conservation Congress Resolutions that guided and mandated IUCN action for connectivity conservation (Attachment Two).

2. BACKGROUND

2.1 Context

In April 2016, there were 7.42 billion people on Earth and population projections conservatively estimate 9.6 billion people for 2050. Habitat destruction, fragmentation and impacts to natural Earth have accompanied this growth in population numbers and it is placing enormous pressure on ecosystems essential for life and their associated plant and animal species (MEAB 2005). Human caused climate change effects world-wide were "off the chart" in February 2016, with average temperatures being a record 1.21 degrees Celsius over the long-term average, with associated consequences that have included the mass bleaching of 1000 kilometres of the Great Barrier Reef (Climate Council 2016). For animal and plant species, scientists advise that we are experiencing the sixth great extinction event in the evolutionary history of Earth (Wilson 2002; Pulsford et al, 2015). The year 2050 is just 34 years away and further change to natural environments may be anticipated.

There have been important conservation responses to these changes in the 20th and 21st Centuries including the establishment of 209,000 protected areas by 2014 and the emergence of many large terrestrial connectivity conservation areas (Worboys 2015b) and many conservation initiatives that have focused on the conservation and restoration of river corridors (Pittock et al. 2008). Actions are still emerging, reflecting that there is a grass roots commitment by many people, private organisations and some governments to retain remnant natural habitats; to restoring disturbed lands and seas adjacent to and interconnecting protected areas. Such actions have recognised that with many, many individual and the collaborative actions, it is possible to conserve large, functioning ecological landscapes and seascapes. It is areas such as these that we potentially can recognise as CCAs and there are many benefits from these conservation actions.

Terrestrial areas

For terrestrial areas, people appreciate that CCAs help keep their national native animals extant; protect catchments and water supplies and help retain cleaner, healthier, safer, diverse and more interesting landscape environments to live in. CCAs are typically an important response to climate change and they empower people to contribute to improved futures through direct participation in their management. For many people it helps to maintain connections to country that is held sacred or important for cultural reasons. Based on multiple individual efforts across large landscapes, connectivity conservation has worked.

Freshwater areas

Connectivity conservation along freshwater systems recognises the interconnectedness of riverine and lacustrine systems along their length, at depth, and laterally across the water body. Riparian vegetation typically provides a range of species with habitat, shelter and opportunities for movement. Freshwater lakes provide many species with food and a safe environment and may provide a stepping stone role for migratory species and for species such as adfluvial fish. The individual efforts of many individuals and collaboration along waterways help achieve connectivity conservation.

Marine areas

Many private and government organisations, many local communities and many individuals may contribute to the establishment and successful management of Marine CCAs. These areas may be required for a variety of reasons and at a variety of scales:

- Some species may require a different habitat (marine or terrestrial) at different stages of their life cycle or because they reproduce in a specific place outside of a Marine

Protected Area (MPA). A marine turtle for example will nest on a terrestrial protected area beach, then utilise an MPA in coastal or offshore waters before moving out into the oceanic waters of the high seas;

- From within an MPA to habitats outside the MPA, when the MPA acts as a source population, providing gametes, larvae, juveniles or adults to maintain those external populations;
- Across the freshwater-marine realms for species with diadromous or anadromous life cycles such as for many of the salmonids; and
- Across the terrestrial-marine interface such as for the coconut crab *(Birgus latro)* in parts of the Indian and Pacific Oceans which is almost entirely a terrestrial species except for a 3-4 week marine pelagic larval stage.

Marine CCAs are often a critical investment in retaining marine biodiversity and functioning ecological processes and consequently, sustainable fisheries. Recognition of the high levels of connectivity in the marine and coastal environment, including the complexities of larval transport or species migration are fundamental for the management of coastal and marine resources.

Given these high levels of interconnectedness, a CCA or a MPA can only be as 'healthy' as its surrounding waters. Having a well-managed MPA or an extremely well connected CCA can be too little or no avail if the surrounding or adjacent waters are over-utilised, polluted or are themselves inadequately managed. Virtually all MPAs are downstream of terrestrial areas, so what happens on the land and in the rivers can have major implications for MPAs, including via groundwater. Careful consideration of all aspects of marine connectivity can be an investment in improved well-being for people dependent on the sea's amenity and natural resources.

Flight migration

Migratory birds regularly use flyways that extend thousands of Kilometres, while non-birds such as bats, gliders and insects often migrate using regular flight routes. CCAs may be very applicable to assist with their conservation and management. Many individuals, NGOs governments and conservation groups are involved with establish of flight migration CCAs, including formalised International Flyways for some species of migratory birds.

2.2 Connectivity

Connectivity science

Connectivity in the context of the terrestrial environment is a geographically framed concept concerned with the spatial dimension, including the relationships between scale, pattern and process and the biodiversity values of the broader landscape mix of natural, semi-natural and altered landscapes (the matrix) that have always informed conservation biology (Mackey et al, 2010). It is based on conservation biology theory (Box One) and an emerging, revised consensus, that the retention and protection of unfragmented, large natural landscapes is an important objective for biodiversity conservation.

BOX ONE: CONNECTIVITY CONSERVATION SCIENCE

*Connectivity Science: Terrestrial (*Ament, R., Mackey, B., McClure, M. and Tabor, G.)

Connectivity conservation corridors (areas) have become a cornerstone of conservation biology and practice. Since the introduction of wildlife corridors as a game management strategy in the 1940's (reviewed by Harris and Scheck 1991), followed by the recognition of connectivity as a fundamental element of landscape structure in the 1990's (Taylor et al. 1993), well over 1,000 scientific papers on corridors and connectivity have been published in the fields of biodiversity conservation and ecology.

During this time, habitat loss and fragmentation have widely been agreed to constitute the single greatest threat to biodiversity worldwide (Hilton-Taylor 2000; Sala et al. 2000; Dirzo and Raven 2003), and climate change is expected to exacerbate these effects as species' ranges must shift across fragmented landscapes or along river corridors to track suitable conditions (Sala et al. 2000; Travis 2003; Opdam and Wascher 2004; Abell et al, 2007; Pittock et al. 2008). Although protected areas such as national parks have long been the primary focus of conservation, it is now widely understood that isolated reserves will not be sufficient to sustain some species and communities in the face of these combined threats (Hansen and DeFries 2007b; Novacek and Cleland 2001). Land use intensification and fragmentation of dams and rivers with levees around protected areas (Hansen et al. 2004; Pittock et al. 2015) has reduced their ecological function via a range of mechanisms linking them to the degraded ecosystems that surround them (Hansen and DeFries 2007a), and climate envelopes for many species currently supported by reserves are expected to shift beyond reserve boundaries (Opdam and Wascher 2004; Phillips et al. 2008).

Corridors are expected to mitigate the effects of land use and climate change by facilitating movement of individuals among patchy resources and among populations (e.g., Dingle 1996; Gilbert et al. 1998; Gonzalez et al. 1998); providing rescue effects following stochastic local extinction (e.g., Brown and Kodric-Brown 1977; Harrison 1994; Reed 2004); supporting gene flow and thus genetic diversity (e.g., Hale et al. 2001; Mech and Hallett 2001); maintaining ecological processes (e.g., Bennett 1999; Haddad and Tewksbury 2006; Levey et al. 2005) and enabling adaptation in response to climate change (e.g., Channell and Lomolino 2000; Nunez et al. 2013; Robillard et al. 2015).

Although corridors have limitations as a conservation strategy (reviewed by Hilty et al. 2006) and connectivity will not be beneficial in all circumstances (e.g., Boswell et al. 1998; Collinge et al. 2000; Hannon and Schmiegelow 2002), conservation strategies that maintain biodiversity in human-modified landscapes beyond protected area borders, particularly those aiming to maintain or restore connectivity between remaining habitat patches, are now considered critical in the face of future landscape change (Daily et al. 2003; Hilty et al. 2006; Miller and Hobbs 2002; Rosenzweig 2003; Taylor et al. 2006).

The conceptual underpinnings of corridors and connectivity have progressed tremendously over the past decades. In 1991, corridors were defined simply as linear landscape elements facilitating movement among habitat patches (Soule and Gilpin 1991). Early corridor studies focused on monitoring wildlife use of *de facto* corridors such as fencerows, roadside vegetation, and linear remnants of logged forests (e.g., Bennett et al. 1994; Haas 1995; Lindenmayer et al. 1993; Wegner and Merriam 1990). Theoretical work focused on the impact of binary landscape pattern (i.e., habitat and non-habitat) on connectivity in artificial landscapes (e.g., Henein et al. 1998; Turner et al. 1993; With 1997; With and King 1999). These early studies conceptualized corridors as discrete elements of the landscape connecting discrete patches of habitat embedded in a

uniformly hostile 'matrix', an approach that stemmed from their roots in island biogeography (MacArthur and Wilson 1967) and in metapopulation theory (Hanski and Gilpin 1991).
The emerging field of landscape ecology (Turner 2005) reinforced this patch-corridor-matrix paradigm with a focus on quantifying habitat configuration and composition patterns primarily in terms of binary habitat, non-habitat definitions (e.g., McGarigal et al. 2002, Turner and Gardner 1991). Although these theoretical roots vastly advanced understanding of the relationships between habitat patterns and population processes, their simplistic representation of complex landscapes was also limiting.

In 1996, Gustafson and Gardner demonstrated the importance of heterogeneity in the matrix and species-specific responses to the landscape for moving beyond concepts of connectivity based solely on landscape structure. They simulated the movement of a model species with complex habitat preferences through a complex, non-binary landscape and revealed that "corridors are often diffuse and difficult to identify from structural features of the landscape". This study was the first of many to illustrate the aptness and utility of Taylor's (1993) now widely accepted definition of connectivity as "the degree to which the landscape facilitates or impedes movement", which, importantly, imposes no restrictions on the structural configuration of landscape elements that may contribute to the movement of propagules, individuals, or processes. In the freshwater realm, the survival of much aquatic biodiversity requires hydrological connectivity (Hermoso et al. 2012).

Functional connectivity has since been distinguished from structural connectivity and is understood to be species or process-specific. Structurally connected habitat patches may not be functionally connected (e.g., if the distance between them exceeds an organism's dispersal distance) and even non-contiguous habitat patches may be functionally connected (e.g., for an organism that is tolerant of a variety of habitat types) (Tischendorf and Fahrig 2000).

We have come a long way in developing the conceptual and scientific underpinnings of corridors and connectivity. Early debates over the efficacy of wildlife corridors (the "corridor controversy" reviewed in Anderson and Jenkins 2006) has waned, and the importance of landscape connectivity is now widely accepted (Hilty et al. 2006, Crooks and Sanjayan 2006). The early simplistic patch-corridor-matrix paradigm has been replaced by a more nuanced understanding of landscapes as differentially permeable to a variety of species and processes (Brodie et al. 2015; Krosby et al. 2015).

The scales at which connectivity can be studied have expanded spatially and temporally, from local, daily foraging movements of individuals through well-defined structural elements of the landscape (Bennett et al. 1994; Lindenmayer et al. 1993; Wegner and Merriam 1990); to long-distance movements of populations or communities over time in response to a changing climate (Phillips et al. 2008; Nunez et al. 2013; Robillard et al. 2015).

These scales of species movement for air, sea, freshwater and land include (for example) birds migrating over thousands of kilometres between southern and northern hemispheres; marine mammals that migrate at an entire ocean scale; fish that migrate to the sea and back again; insects that migrate for a large part of a continent; mammals whose home range is at a landscape scale and local migrations such as seasonal (summer-winter) movements up-and down mountains.

The science of connectivity is still evolving. There remains a lack of consensus about how landscape connectivity should be modelled and quantified (Beier et al. 2008; Sawyer et al. 2011; Zeller et al. 2012); whether current landscape linkage designs are driven by sufficient ecological knowledge of movement processes (Bélisle 2005; Chetkiewicz et al. 2006; Lowe and Allendorf 2010; Parks et al. 2012) and whether corridors can be effectively designed based on coarse-filter and/or multispecies approaches (Brodie et al. 2006; Brost and Beier 2012; Theobald et al. 2012; Krosby et al. 2015). These questions are not likely to be quickly or easily resolved. Perhaps the greatest remaining challenge is to address them in ways that advance the application of connectivity science to connectivity conservation on the ground. While progress is being made in this arena (e.g., Anderson et al. 2011; Aune et al. 2011; SCW 2008; NYSDEC 2010; WHCWG 2010), there are still considerable gaps between our knowledge of connectivity science and our ability to put it to use conserving connected landscapes. This goal must be kept in mind as we continue to advance the field of connectivity.

Building on the above conservation biology theory, a revised conservation science consensus is beginning to emerge in response to the limitations of conservation efforts to date, and the enormity of the challenge, given the scale of the current biodiversity extinction crisis and the potential synergistic impacts of climate change (eg Welch 2005).

The retention and protection of unfragmented, large natural landscapes is an important objective of biodiversity conservation: this includes additional protected areas that are interconnected (not islands) with corridors and active management of corridors and protected areas to deal with threats. The term “connectivity conservation” has been widely used to describe this emerging scientific consensus amoung conservation researchers and practitioners (Crooks and Sanjayan 2006).

Connectivity science: Landscape connectivity and other connectivity concepts
(Extract of David Lindenmayer text in Pulsford et al. 2015, p854)
“To best clarify various themes associated with connectivity, it is useful to make an explicit distinction between four types of [terrestrial] connectivity (Lindenmayer and Fisher 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 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 Fisher 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 process 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 necessarily 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 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”.

In river systems, connectivity is defined in terms of longitudinal (e.g. along rivers), latitudinal connectivity (e.g. access to floodplains) and vertical connectivity (e.g. fluctuating water levels or access to groundwater) and thus is dependent on hydrological management (Hermoso et al. 2012).

Recommended Reading
For further detailed information about connectivity conservation, a number of key texts are recommended and these are listed after the references.

Terrestrial areas

For terrestrial areas, "*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 interlinkages of key processes within and between ecosystems*" (Pulsford et al, 2015, p853).

The terms *'structural connectivity'* and *'functional connectivity'* are often used, with *'structural connectivity'* measuring the spatial arrangement of different types of habitat or ecological systems in a landscape without reference to the likelihood of movement of particular organisms through the landscape (Theobald et al, 2011, p2446). '*Functional connectivity'* incorporates some behavioural responses of individuals, species, or ecological processes to the physical structure of the landscape (Theobald et al, 2011, p2446).

The descriptions of structure and function recognise four types of connectivity in the terrestrial landscape and these have been described (see Box Two) (Lindenmayer and Fisher, 2006; Soulé et al, 2006; Mackey et al, 2013; Worboys and Mackey, 2013; Pulsford et al, 2015, p854):

The large migrations of mammals (such as the caribou (*Rangifera tarandus*) of Alaska and Finland; the wildebeest (*Connochaetes taurinus*) of Africa; and of insects such as the monarch butterfly (*Danaus plexipplus*) (USA and Mexico) and the bogong moth of Australia (*Agrotis infusa*) have potential to be considered as CCAs.

Freshwater areas

Freshwater ecosystems also have their own, separate connectivity requirements for ecological health. Connectivity conservation within rivers helps facilitate fish migration (such as salmon spawning) while riparian vegetation helps facilitate avian (and other species) connectivity. Connectivity across great freshwater lakes and wetlands assists the movement of many species and especially waterfowl.

Marine areas

Marine fish and invertebrates are especially relevant to connectivity conservation due to their production of microscopic larvae that disperse with ocean currents for days to months before settling onto reefs or other habitat and before growing into adults. Gillanders et al (2003) provides information that assists management and conservation efforts by focusing on those marine habitats that make the greatest contribution to adult populations. Cowen et al (2002) explains that an "understanding … (of) dispersal is an essential component of population connectivity because it addresses how biological and hydrodynamic processes interact on different spatial and temporal scales to disperse the larvae of marine organisms". Further descriptions for marine connectivity are provided (Box Two).

BOX TWO: MARINE CONNECTIVITY

A fundamental aspect of connectivity in marine and coastal environments is the three-dimensional aspect of the ocean with two very distinct parts; the pelagic realm (the water column from the surface to the seabed) and the benthic realm (the actual seabed and the layer of water above it that is influenced by the seabed). Even within the pelagic realm, conditions vary dramatically with depth, with changes due to pressure, available light and nutrients. Consequently the species inhabiting the top 20 metres of the ocean are very different to those living 1000-10,000 metres below the surface.

The benthic realm can be compared to terrestrial ecosystems, where species either live on or in the seabed, or are dependent upon it for habitat and resources. However, unlike most terrestrial ecosystems, most benthic communities do not have primary producers, and rely on resources that settle from the upper pelagic zone (Day et al, 2000). This is only one of many fundamental component of connectivity in marine environments.

Other keys aspects of marine connectivity in 3-dimensional space occur within the water column; between the water surface (and/or the airspace above) and the waters below; and between the land and the sea, including runoff and groundwater. Further aspects of ecological connectivity in the marine environment relate to the movement of species, organic matter and sediment, and include such processes as nutrient flows, species migrations, larval dispersal and gene flows. How species and materials move in the marine environment may be influenced by currents, tides and wind, and are often described in such ways as cross-shelf connectivity (inshore to offshore), long-shore connectivity (along the shore), or from 'source' reefs to 'sink' reefs.

Many marine organisms, including benthic species, demersal species (living in close association with the seafloor), and pelagic species, have complex life cycles characterized by planktonic stages of development (e.g., larvae, spores). In the case of marine invertebrates and fishes, propagules exhibit a diversity of modes, development sites, planktonic durations, and morphological development patterns that can affect patterns of connectivity (Dibacco et al. 2010). The scale of movement from juvenile to adult habitats can range from metres to thousands of kilometres, although the majority of organisms move distances of kilometres to hundreds of kilometres (Gillanders et al, 2003).

The importance of marine connectivity may be illustrated by a fish, the Red Emperor (*Lutjanus sebae*) (Figure One) which utilises a wide range of interconnected habitats during various life cycle stages, ranging from inshore estuaries, to coral isolates and deep-water seagrass communities and then mid-shelf and outer reefs.

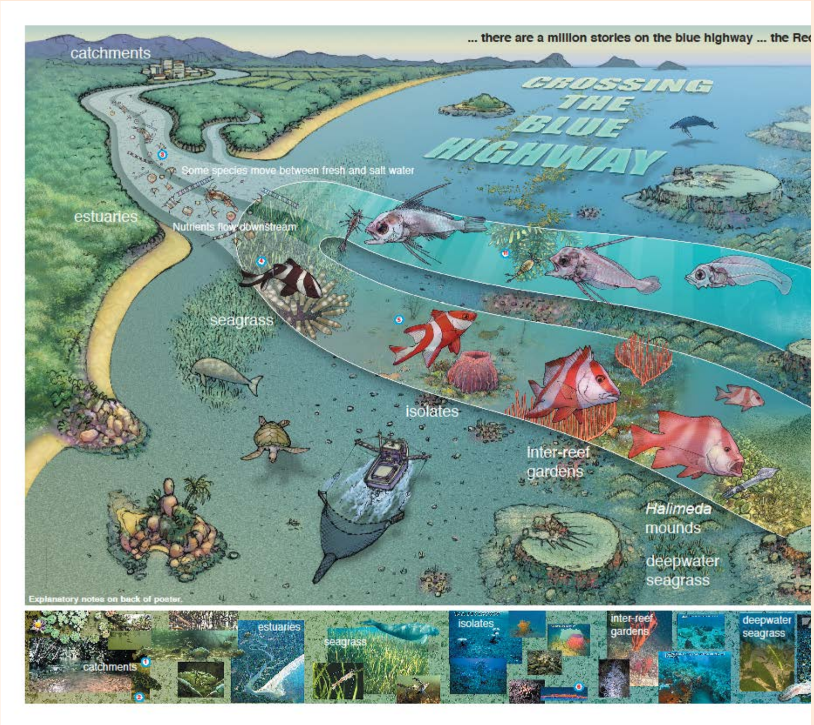

Figure One. Ecosystem connectivity - Habitats utilised during the lifecycle of the Red Emperor (*Lutjanus sebae*). Cross-shelf connectivity on a reef system is critical to maintaining habitats for recreationally and commercially important reef fish such as the Red Emperor – this example on the Great Barrier Reef, is based work by Russell Kelley and illustrated by Gavin Ryan © (Cappo and Kelley, 2001) (Reproduced with permission).

Other key aspects of marine connectivity include annual migrations or species that spend different parts of the life cycles in different areas. The green turtle (*Chelonia mydas*) (for example) lays its eggs in sand on the mainland or on islands; the young emerge from the nests, move into the nearshore marine areas before then migrating thousands of kilometres in the open sea to the waters of other countries. Surviving females return every two to eight years to nest on the same beach where they were born – but even one of the world's largest MPA's, the Great Barrier Reef is not big enough to fully encompass the full life cycle of the green turtle.

Connectivity in marine (and other) environments is not always beneficial; marine connectivity can also aid in the spread of macroalgae, disease, pollution and invasive species, all of which have the potential to impact ecosystem health. Similarly, changes to hydrological flows or the construction of artificial barriers to natural water flows, can be negative aspects of ecological connectivity; for the marine environment these negative aspects may include adjoining tidal, estuarine and riparian habitats.

Preliminary work on identifying global priorities for marine biodiversity conservation has been undertaken (Selig et al, 2014) and together with the recognition of how marine species exist as part of larger, connected and interdependent networks of ecosystems (such as coral reefs, coastal mangrove habitats, or deep sea hydrothermal vents (Day et al, 2015), the concept of CCAs in marine environments is recognised as being critical for biodiversity conservation.

Maintenance of connectivity is not only important for the maintenance of biodiversity and ecological integrity, but also for fisheries and other goods and services provided by marine ecosystems. CCAs are also an important conservation opportunity to recognise and actively protect known migration routes for marine invertebrate species (such as cuttlefish); fish (such as tuna and sharks); reptiles (such as sea turtles); marine mammals (such as migratory whales) and seabirds (such albatrosses and shearwaters), with seabird migratory routes sometimes being recognised as flyways.

The interconnectedness of marine with freshwater and terrestrial realms

The expertise of most scientists, managers and policy makers is usually specific to an individual realm and either as terrestrial, freshwater or marine. However the ecological and functional reality is that these realms are inter-connected and many species move between realms.

Birds – Flight Migration

Many bird Flyways around the world have been recognised formally and there are more than 30 different international, flyway-based governance instruments for the conservation of migratory birds (UNEP CMS 2014). Flyways for some birds involve relatively narrow, well defined routes (such as coastal routes); some require inland routes to take advantage of updraughts, while others migrate on a broad front. Many flyways are orientated latitudinally while others are more complex and can include circuitous, longitudinal and altitudinal migrations. CCAs could be considered where there was a need for active governance and management to protect bird species and their migration routes.

Non-Birds Flight migration

Some bat species move between their roosting habitat and food source and also migrate and they may need the support of formal CCA recognition to provide governance and management support for their conservation. In addition, many insects such as the monarch butterfly (*Danaus plexipplus)* of the USA and Mexico and the bogong moth (*Agrotis infusa)* of the Australian continent migrate and their routes could be recognised as a CCA if active governance and management was needed to assist with the conservation of these species.

2.3 Connectivity conservation

Connectivity conservation (the conservation of connectivity) is a direct response to the destruction and fragmentation of vegetation, habitats and loss of Earth's species. It actively retains and restores natural connectivity in landscapes, freshwaterscapes and seascapes, it interconnects protected areas and it is a basis for species survival, movement, and evolutionary development. Connectivity conservation is a key tool in the conservation and management of habitats, ecosystem processes and biodiversity, and it is an important response to climate change.

Terrestrial connectivity conservation

Connectivity conservation for terrestrial areas describes those actions taken to conserve landscape connectivity, habitat connectivity, ecological process connectivity and evolutionary process connectivity for natural and semi-natural lands that interconnect and in some instances, completely embed established protected areas within their area (Worboys et al, 2010, pxxxi)".

Freshwater connectivity conservation

Freshwater connectivity conservation measures may include habitat protection along rivers and stream banks, non-natural erosion prevention, fish ladders or other specialised structures, pollution control and responses to developments. The management of connectivity for river systems and freshwater lakes can be challenging given the competing interests of humans.

Marine connectivity conservation

The interconnectivity of marine systems requires management that is broad and ecosystem based. MPAs interconnected by CCAs provide a key tool for protecting marine biodiversity on a broader, integrated and interconnected scale where the maintenance of holistic ecosystems results in greater overall ecological, economic and social benefits. For marine environments, connectivity conservation action may include the protection (and restoration) of estuarine and marine habitats and responses to invasive threats (such as the crown of thorns starfish (*Acanthasta planci*) on the Great Barrier Reef and the comprehensive management of fishery pressures.

Flyways and flight-based species migration connectivity conservation

Connectivity conservation actions for migratory species that fly may include the protection and conservation management of habitats and supporting ecosystem processes for breeding, roosting, staging and feeding areas. The flyway-wide governance system often involves multiple countries and sites.

2.4 Connectivity conservation terms

The landscape, seascape, freshwater or air space in which connectivity conservation is being undertaken has been described as a "connectivity conservation area" (CCA) (Worboys et al, 2010). These areas may include features that contribute to connectivity such as small wildlife corridors, "stepping stones" or other features. This generic term has been chosen given that a single definition for all of the environment areas subject to connectivity conservation governance and management action is needed. Some of the terms that have been used to describe areas subject to connectivity conservation have been presented in a glossary (Attachment One).

2.5 The 2006 Papallacta Declaration

In a response to resolutions for IUCN to undertake further action to expedite effective connectivity conservation (Attachment Two), the IUCN World Commission on Protected Areas (WCPA) established a Vice Chair role in 2004 to facilitate such work. In 2006, the Vice Chair convened a workshop of international connectivity managers and experts to prepare guidance material for practitioners. This workshop contributed to the development of IUCN's future book titled *Connectivity Conservation Management: A Global Guide* (Worboys et al, 2010).

As part of the 2006 workshop, expert attendees systematically developed and adopted a critical "declaration" that has provided fundamental guidance for the concept of connectivity conservation and its management. The declaration has been described as the "*Papallacta Declaration*". It reinforced the importance of strategically conserving and managing large natural and semi-natural areas that interconnect protected areas. An extract of the consensus declaration is provided here and provides essential guidance for developing the IUCN definition of a Connectivity Conservation Area.

2006 Papallacta Declaration extract:

"*The maintenance and restoration of ecosystem integrity requires landscape-scale conservation. This can be achieved through systems of core protected areas that are functionally linked and buffered in ways that maintain ecosystem processes and allow species to survive and move, thus ensuring that populations are viable and that ecosystems and people are able to adapt to land transformation and climate change. We call this proactive, holistic and long-term approach connectivity conservation*"
(For the entire *Papallacta Declaration*, see Worboys et al, 2010 p19)

3. DEFINITION: CONNECTIVITY CONSERVATION AREA

IUCN's definition of Connectivity Conservation Area (Box Three) is guided by the *Papallacta Declaration;* the Convention on Biological Diversity 2011-2020 Strategic Plan, Target 11; and it is further refined to include migratory and other species movements for flight, on land and in association with fresh and salt water environments. A detailed explanation of the words used in the definition has been provided (Table One).

BOX THREE: DEFINITION, CONNECTIVITY CONSERVATION AREA

A Connectivity Conservation Area is *"A recognised, large and/or significant spatially defined geographical space of one or more tenures that is actively, effectively and equitably governed and managed to ensure that viable populations of species are able to survive, evolve, move and interconnect within and between systems of protected areas and other effective area based conservation areas. The purpose of a Connectivity Conservation Area is to connect protected areas and other effective area based conservation areas and to maintain or restore ecosystem function and ecological and evolutionary processes of species and ecosystems across (and between) landscapes, freshwaterscapes or seascapes for biodiversity conservation in areas that may also be used and occupied for a variety of human purposes, so that people and other species are able survive and to adapt to environmental change, especially climate change".*

Table One: Explanation of the Connectivity Conservation Area definition

Phrase	Explanation
Spatially defined large geographical space	This description applies to the land surface and below ground; the water column and bed of fresh water (rivers and lakes), brackish (estuaries) and salt water areas; and, air space. "Spatially defined" may include explicit boundary definitions, but it also includes the concept of "fuzzy or indicative boundaries" where approximate boundaries may be used deliberately in preference to specific survey or cadastral information. "Spatially defined" boundaries may (with agreement) be required to be adjusted over time as species connectivity requirements change (such as in response to climate change influences). "Large geographical space" or "Large-Scale": Terrestrial CCAs are *typically* large and may be tens of kilometres wide and hundreds to thousands of kilometres long. There may be some circumstances where connectivity conservation is needed for smaller, but quite significant conservation areas, and these areas may also be recognised as CCAs. Freshwater (river based) CCAs may be hundreds of kilometres long, but quite narrow (tens or hundreds of metres wide). Flight migration CCAs may be thousands of Kilometres long and very wide. A "Flyway" CCA" refers to the critical network of terrestrial areas along the flyway that may be used for feeding, resting, shelter or breeding. Similarly marine CCA's may be thousands of kilometres long. The scale of CCAs needs to recognise, as appropriate: • Global scale: Such as trans-hemisphere bird migrations; • Ocean scale: Such as whale migrations from polar areas to equatorial areas; • Continental scale: Such as continental scale insect migrations; • Landscape scale: For significant connectivity such as the home range of terrestrial predators • Local scale: For significant connectivity such as the movement of bats between roosting sites and food sources CCAs facilitate opportunities for the movement of species potentially over many degrees of latitude or longitude (or both). A large-scale CCA recognised by a single name may include many, many smaller wildlife connectivity areas that integrate to form the larger CCA. This may include connectivity measures taken at choke points (very narrow or constricted part of a CCA) or "impermeable locations" like a highway where a wildlife overpass or underpass is constructed. For Flyways, critical staging points are also potential choke points, and if lost could result in the loss of the migratory species. Connectivity conservation over large-scale geographic areas is important for protected areas and especially World Heritage properties and "*The integrity of many World Heritage sites depends on biodiversity that requires large, interconnected areas for its conservation*" (Kormos et al, 2015). It is also critical for maintaining the integrity of Ramsar wetlands and the health of the migratory species that use them.

Phrase	Explanation
Not large, but critically significant CCA areas	There will be many small corridors (multiple metres wide and perhaps hundreds of metres long) that are spatially defined as an IUCN CCA in their own right given their exceptional significance for species movements; their critical ecological process function and/or biodiversity conservation significance. These areas have the same status as large-scale CCAs given their very special contribution to connectivity conservation.
Of one or more tenures	A terrestrial CCA commonly encompasses a wide range of different tenures such as community-owned land, indigenous lands, private property and government owned lands. A freshwater CCA may encompass different tenures such as community-owned waters, indigenous waters, private property and government owned waters. Marine CCAs may include indigenous territories and government managed waters. Beyond territorial waters, the tenure status of a CCA would be recognised as “the commons”.
Recognised	CCAs may be recognised formally by private individuals, communities, indigenous peoples, NGOs, private companies or local, state or federal governments or collaboratively by a number of organisations. Guidance criteria for the recognition of CCAs have been developed, including core criteria. Recognition and spatial delineation of CCAs that meet IUCN criteria by WCMC provides a potential future opportunity for these areas to be recognised as a new United Nations (UN) List; a parallel to the UN List of Protected Areas. Further guidance is provided by IUCN’s “The Legal Aspects of Connectivity Conservation” (Lausche et al. 2013).
Actively governed and managed	*Actively governed* CCAs typically include many individuals, community groups, private organisations and governments and each govern and manage in their own right. For large-scale CCAs, where such individuals support the CCA vision, it is sensible for a facilitating and co-ordinating organisation to be established to facilitate the vision. Such an organisation is typically small and has a basis for governing (such as legislation that supports the establishment of a Board or equivalent); rules for governance (such as a constitution); a governance body (such as the Board); and, guidance for “quality of governance” (such as legitimacy and voice, accountability and fairness and rights considerations) and that is undertaking its responsibilities including facilitating active connectivity conservation management (Feyerabend and Hill, 2015). A CCA organisation may develop a whole-of-CCA strategic plan that guides and prioritises the resourcing of management actions and forms the basis for performance evaluation. *Actively managed* Active management of CCAs typically will include the involvement of many individuals, each contributing in their own way to the CCA vision; the involvement of community groups and NGO’s; the involvement of the private sector; the involvement of governments and potentially active partnerships between all of these groups. Active management may include responding to threats to connectivity, restoration work, research that informs prioritisation of connectivity conservation management actions and species conservation work. Active management, based on research guidance and planning, may also be a more passive watching brief with deliberate non-intervention. Active management will include the potential for tracking species populations, including

Phrase	Explanation
	the possibility of introductions of genetic variants or novel species.
Effectively governed and managed	Management effectiveness evaluation is ideally undertaken. The natural condition and the trend in natural condition of a CCA (from a known baseline) would be evaluated at a whole-of-corridor scale and (as appropriate) at more detailed scales; and CCA governance and management outcomes are assessed against the planned objectives. Formal governance recognition is assisted by supportive legal tools and preferably public law explicitly recognising connectivity. Further guidance is provided by IUCN's "The Legal Aspects of Connectivity Conservation" (Lausche et al. 2013).
Equitably governed and managed	Any benefits (Borrini-Feyerabend and Hill, 2015) arising from achieving CCA management objectives are realised by multiple stakeholders. Equitable management considerations include the sharing of responsibilities and for decision making with the CCA.
Governed	Being effectively and equitably governed requires governments in their governing role to lead with supportive laws, rules and powers and in addition, an overall structure that recognises key governance roles of other core arms of society. (Further reading, Feyerabend and Hill, 2015)
Governance	Identifies there may be one of four recognised governance types for an organisation responsible for facilitating and co-ordinating a CCA. These include "governance by government"; "shared governance"; "private governance" and "governance by Indigenous peoples and local communities" (Dudley 2008). Within a CCA, typically there would be very many different governance types linked to the wide range of tenures that are likely to be present.
Ensures species populations are viable	Population viability is a determination of the probability that a population will go extinct within a given number of years. Viability of populations is facilitated by monitoring and acting on any responses to any threats that may impact the species.
Allows species to survive and move	CCAs are managed to ensure that the amount and quality of natural habitat for the many species present is sufficient to facilitate their survival and movement.
Systems of protected areas	A CCA complements protected areas and increases the probability that objectives of protected areas will be met. A CCA is not a substitute for the establishment of a protected area and if an area does merit such status, then all efforts should be made to secure permanent protection. Large-scale CCAs connect two and or more protected areas and may completely embed some protected areas. Major mountain ranges may include multiple protected areas along their length. One CCA may interconnect these protected areas to provide connectivity conservation spanning many degrees of latitude or longitude. Riparian CCAs may connect multiple protected areas along a river or stream and protect

Phrase	Explanation
	natural vegetation that connects habitats of many species. A river may be recognised as a CCA in its own right. A migratory bird flyway route may utilise a number of geographically separated terrestrial protected areas. A CCA may facilitate co-operative management of these "stepping stone" locations CCAs may provide connectivity between marine protected areas or a mix of terrestrial (eg a sand cay where birds breed) and marine protected areas.
Other effective area based conservation measures	These are not protected areas, but are areas "where de facto conservation of nature and associated ecosystem services and cultural values is achieved and expected to be maintained in the long term regardless of specific recognition and dedication" (Borrini-Feyerabend and Hill, 2015). These areas may include many Indigenous Peoples and Community Conserved Territories and Areas (ICCA's) that are not otherwise recognised as protected areas (Kothari et al, 2012).
Connect	CCAs connect two or more protected areas or other effective area based conservation areas. Connectivity is recognised by the permeability of CCAs to species that are moving, with connection including "stepping stone" sites of flyways; contiguous habitat suitable for predator species with large home ranges and rivers that act as migratory corridors for fish. Maintaining ecological and evolutionary processes is another important aspect of connecting.
To maintain	"To maintain" also identifies that there may be a dynamic in the optimum area described as a CCA at any point in time as climate change effects or evolutionary changes dictate the need to change. This expression recognises the dynamic of nature that may include changes to wind patterns, sea currents and range zone variation for animal migrations. It may also reflect that a CCA is linked to certain environmental conditions, such as some inland flowing rivers of Australia which may only flow once every 12+ years.
Restore nature	A CCA may require restoration to assist connectivity and the movement of species. Restoration is guided by scientific inputs that help prioritise actions. IUCN has generated specific guidance on restoration.
Species ecological processes, (especially movement)	This recognises the ecology of animal movements that a CCA conserves and includes daily travel, dispersal, incidental movement, migration and the nature of movements that may be forecast for a climate change influenced future (Ament et al, 2014). It also recognises ecosystem processes and Terrestrial ecosystem processes include hydro-ecological processes; trophic relations; functional interactions; dispersal; and meta-population dynamics (Mackey et al, 2013). Marine ecosystem processes may include managing for larval dispersal, gene flows, spawning areas, nursery sites, key 'source' reefs and adult species populations. Maintaining functioning connections between key adjoining land areas (eg. wetlands) and downstream MPAs is also important.

Phrase	Explanation
Maintain evolutionary processes	With species moving and interacting, CCAs help facilitate the exchange of genes and maintenance of effective population sizes, plasticity and adaptive capacity.
Landscape	This includes all the visible features of a terrestrial area including the natural geology and morphology; the vegetation cover and patterns and the influence of humans; as evidenced at a local to regional scale.
Freshwaterscape	This may include freshwater rivers, lakes and wetlands.
Seascape	This may include estuarine areas, marine areas that are located in territorial waters and marine waters that are outside of territorial limits.
Used and occupied for a variety of human purposes	This describes CCAs where people may live or work and undertake activities such as agriculture, aquaculture, and resource harvesting, but where the landscapes are still permeable for wildlife movements.
People	People are an integral part of CCAs and may be connected to landscapes and seascapes in many different ways including through their livelihood and through spiritual, cultural and historical connections. CCAs include working landscapes, freshwaterscapes and seascapes and retention of connectivity for many species may depend on the voluntary initiatives of many individuals.
People can adapt to change	Active management of CCAs is intended to retain healthy ecological and evolutionary processes and species as the environment changes. Achieving this objective will benefit people who live and work in CCAs.
Species can adapt to change	Changes in climate and landuse will affect species and ecological and evolutionary processes within CCAs. CCAs may provide opportunities for species to evolve and to adapt to climate change. Maintaining healthy environments can help with adaptation to change.
Especially climate change	CCAs are a natural solution/response to climate change and their active management can contribute to minimising the forecast negative effects of climate change.

4. LEGAL AND POLICY FACILITATION OF CONNECTIVITY CONSERVATION AREAS

4.1 Legal and policy tools

From a legal and policy perspective, CCAs may be recognised and facilitated through a number of legal tools and policy instruments. For terrestrial areas especially, most national legal systems contain a variety of tools aimed at directly implementing conservation and sustainable use policies, from direct regulation (at one end of a spectrum) to entirely voluntary conservation agreements (at the other end) (Box Four). The mechanisms may include incentives for taking such actions. Other instruments may relate to education and training, and the promotion of non-material values such as heritage, tradition, and environmental ethics. The IUCN publication "The Legal Aspects of Connectivity Conservation" (Lausche et al. 2013) provides (essential) further reading on this topic.

BOX FOUR: LAW AND POLICY THAT FACILITATES CONNECTIVITY CONSERVATION [ESPECIALLY FOR TERRESTRIAL CCAs]

(Lausche et al. 2013)

There are a variety of applications of regulations, incentives and other supporting law, policy, and programming tools available (alone or in combination), for requiring or promoting connectivity conservation planning and actions by government agencies, landholders, land and marine managers, and the public. These tools include:

Policy statements

Official government policy statements or reports guiding development of rules, programmes, and supporting processes for specific outcomes. These may be overarching policies across all sectors (for example, national integrated development strategies, sustainable development policies) as well as policies in specific areas (for example a biodiversity strategy, a land use policy, or an environmental protection policy).

Planning

Planning is an essential initial step for assessing needs and making decisions about the appropriate legal tools to use for connectivity conservation. Planning aims to achieve certain public policy goals, such as conservation goals. Specific plans could span political levels (national, subnational, local); be integrated across sectors (for example, national integrated development plans); focus on different spatial scales (national, regional, site-specific); address specific issues across sectors or be developed in specific sectors or scales (for example, environmental and biodiversity action plans, climate change adaptation plans, land use plans, marine spatial plans and conservation plans.). Depending on the subject and purpose, plans may be advisory providing guidance, or prescriptive requiring compliance. Strategic Environmental Assessments (SEA) also may be an important tool to inform decision-making. Where feasible, planning that integrates connectivity should be a legal requirement.

Regulatory instruments

Regulatory instruments require that certain actions be undertaken.

They may be directed:

- Primarily to conservation;
- Specifically at sustainable resource use;
- Principally to land use planning and development control (for example, zoning or Environmental Impact Assessments);
- To expropriation or purchase of specific sites by government;
- Principally to transportation, infrastructure, mining, and energy developments;
- To specific tools to control individual actions including permits and licenses, conditions and obligations and planning;
- To permissions including environmental requirements and notifications to permit or prohibit activities;
- To environmental standards and quality objectives;
- To legal easements (giving the easement holder the right to do something and requiring that the landholder do something); and
- To Environmental Impact Assessments and strategic environmental assessments.

Economic instruments

These instruments may include:

- Positive incentives (technical assistance, subsidies, tax credits, reduced tax liability);
- Negative incentives (higher taxes, holding back technical assistance);
- Compensation (for example, for conservation practices that result in loss of economic productivity);
- Payments for environmental services for example, maintaining healthy forest cover for watershed services such as water supply, carbon storage, biodiversity conservation);
- Stewardship payments (for applying stewardship principles to land and resources to help maintain and restore natural systems and ecological processes using an ecosystem management approach; and
- Market-driven tools including emissions trading regimes; habitat banking and conservation banking.

Land tenure instruments

These instruments may include pre-emptive rights, purchase rights, and land exchange.

Public participation tools

These mechanisms provide for public participation in programmes and deliberations of government authorities, self-initiated public input and monitoring and participation provisions in Environmental Impact Assessments and Strategic Environmental Appraisals.

Tools for data collection, monitoring and evaluation

These tools to assist CCAs may include inventories of information; use of environmental indicators; use of performance measures and monitoring for specific indicators.

Tools to promote voluntary conservation

These tools include public education and training initiatives; the legal recognition of voluntary agreements and land trusts; covenants running with the land and conservation easements grounded in the law. They may include incentives for private conservation and community awards or publicity for special conservation achievements, stewardship and capacity building.

Highly recommended reading:

Lausche and Burhenne (2011) IUCN Guidelines for Protected Areas Legislation

Lausche et al. (2013) IUCN The Legal Aspects of Connectivity Conservation: A Concept Paper

5. STRATEGIC BIODIVERSITY CONSERVATION AND CCAS

Biodiversity conservation needs for a rapidly changing Earth will dictate priorities for the establishment of CCAs. Some priority areas for CCAs are described further here, with Convention on Biological Diversity providing important guidance.

5.1 The Convention on Biological Diversity

The objectives (Article One) of the Convention on Biological Diversity (CBD) to be pursued in accordance with its relevant provisions, "*are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights* *over those resources and to technologies, and by appropriate funding*". The Convention was signed by 150 Government Leaders at the 1992 Rio Earth Summit.

Lausche et al. (2013 pp 58-60) describe how connectivity conservation is an important part of the implementation of the Convention, and refer specifically to decisions of the Conference of Parties to the Convention and the CBDs 2011-2020 Strategic Plan Target 11. The Target requires that systems of protected areas and other effective, area based conservation measures are "well connected" and "integrated" into wider landscapes and seascapes.

Target 11 states:

> *"By 2020 at least 17 per cent of terrestrial and inland water and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and **well-connected** systems of protected areas and other effective-area based conservation measures, and **integrated** into the wider landscapes and seascapes" (CBD 2011).*

5.2 Interconnecting protected areas

CCAs interconnect protected areas and in doing so, they help integrate these areas into wider seascapes, freshwaterscapes and landscapes. This interconnection helps reduce the threat of protected areas being isolated in these areas along with the consequent diminishment of species populations. For large CCAs extending many degrees of latitude (such as along a mountain chain), they may be particularly valuable for their role in interconnecting and embedding many, many protected areas, thus substantially contributing to the conservation and movement of species polewards and up-mountain in response to climate change pressures.

5.3 A response to climate change

Large CCAs are a big response to the big issue of climate change. In addition to providing opportunities for species to move up-mountain, polewards or to refugia, healthy semi-natural and natural terrestrial CCAs help retain a natural resilience to climate change pressures in the landscape; they retain carbon stocks in vegetation communities and organic soil and peat areas and they help sequester carbon. Connectivity provided by CCAs also provide opportunities for evolutionary adaptation through species movement, interaction and adaptation responses to climate changes. Some CCAs will be established for the critical response they can make to climate change pressures. River corridors provide the most consistent elevation and mesic gradients in the wider landscape. North-south oriented river CCAs are key places (for example) to connect protected areas and facilitate movement of biota under a changing climate (Pittock et al. 2015).

5.4 Protecting Key Biodiversity Areas

Large CCAs may be established just to interconnect Key Biodiversity Areas (KBAs), the most important of the world's biodiversity areas (Woodley et al, 2015) as a basis for their enhanced conservation. The presence of many KBA's along a geographic feature (such as a mountain chain or river system) may influence the establishment and management of a CCA.

5.5 Protecting World Heritage properties

Many World Heritage properties and their Outstanding Universal Value (OUV) will be particularly susceptible to the effects of climate change. By interconnecting these properties with other protected areas and the larger landscape, CCAs can play a strategic role in helping to protect OUV. This connectivity role has been recognised (for example) by Cyril Kormos and his colleagues who have introduced the need for an important new concept called "World Heritage Wilderness Complexes" where the complex includes two or more World Heritage sites (or a serial site) (Kormos et al. 2015). This is where *"the sites are large enough and have sufficient buffer zones to maintain ecological integrity and have the functional connectivity between them needed to protect and maintain outstanding universal value. Demonstrating connectivity would be necessary to secure recognition as a World Heritage Wilderness Complex"* (Kormos et al. 2015).

5.6 Integrating with UNESCO Man and the Biosphere Reserves

The UNESCO Biosphere Reserve Programme was launched in 1971, and it combines natural and social sciences, economics and education to improve human livelihoods and safeguard natural ecosystems. It aims to promote innovative approaches to economic development that are socially and culturally appropriate and environmentally sustainable (Worboys et al. 2015 p23). In 2013, there were 621 Biosphere Reserves established in 117 countries (UNESCO 2015). Ideally, a biosphere reserve contains one or more legally protected areas, a buffer zone in which activities compatible with conservation objectives may occur and an outer transition area devoted to the promotion and practice of sustainable development (Lockwood et al. 2006 p93). Many biosphere reserves would form an integral part of a CCA.

5.7 Integrating with Ramsar Wetlands

Wetlands of importance may be officially recognised under the provisions of the Ramsar Convention, a Treaty adopted by many nations in the city of Ramsar in Iran. In 2015, there were 169 contracting parties worldwide, and 2,218 Ramsar wetlands identified (Ramsar 2015). Ramsar areas may include lakes, rivers, swamps and marshes, wet grasslands and peatlands and near shore marine areas including mangroves and coral reefs (Worboys et al. 2015, p23). Under the Convention, the Ramsar Site is elevated to a site of "international importance" and Contracting Parties have an obligation to formulate and implement national landuse planning to promote conservation of the site (Lausche and Burhenne 2011). Many Ramsar wetlands could form an integral part of CCAs and permit the movement of species between river systems, lakes and other wetland areas. Ramsar wetlands are commonly designated of a range of land tenures. Many multi-national networks of Ramsar sites have been specifically designated along flyways and through regional initiatives, and thus have the potential to be recognised as a CCA.

5.8 Integrating with Ecological Networks

Ecological networks are systems of nature reserves and their interconnections that make a fragmented natural system coherent, so as to support more biological diversity than in its non-connected form. It consists of core areas (usually protected by) buffer zones and connected through ecological corridors (Jongman and Pungetti 2004 p24). Experiences in the establishment and management of Ecological Networks, corridors and buffer zones over 40 years have been reviewed globally by Graham Bennett and Kalemani Jo Mulongoy in their important CBD Technical Series Publication No 23 (2006). This review and other work (Bennett, A. 2003; Bennett, G. 2004a, 2004b) consolidated the concept of connectivity conservation as a mainstream conservation initiative and provided impetus for its further recognition and development internationally. It is anticipated that most recognised Ecological Networks would also be recognised as a CCA or could form part of a CCA.

5.9 Integrating with Transboundary Conservation Areas (TBCAs)

Many CCAs will interact with international borders. IUCN WCPA has provided active guidance and management for these transboundary areas including the establishment of Transboundary Conservation Areas. These Transboundary Conservation Areas recognise three types of areas. These are (Vasilijevic et al. 2015):

Type 1: Transboundary Protected Areas (TBPA)

A Transboundary Protected Area has been defined “as a clearly defined geographical space that includes protected areas that are ecologically connected across one or more international boundaries and involves some form of co-operation” (Vasilijevic et al. 2015 p8).

Type 2: Transboundary Conservation Landscape and/or Seascape (TBCL/S)

The Transboundary Conservation Landscape and/or Seascape is “an ecologically connected area that includes both protected areas and multiple resource use areas across one or more international boundaries and involves some form of co-operation” (Vasilijevic et al. 2015 p10).

Type 3: Transboundary Migration Conservation Area (TBMCA)

The Transboundary Migratory Conservation Areas “are wildlife habitats in two or more countries that are necessary to sustain populations of migratory species and involve some form of co-operation (Vasilijevic et al. 2015 p12).

As defined, two of the three Transboundary Conservation Areas could form part of, or an entire Connectivity Conservation Area, though CCAs, as defined, interconnect and embed, but specifically exclude protected areas. CCAs are complementary to protected areas and would be delineated as such. CCAs are large-scale concepts and could include more than an international border. Some of these border areas may include Transboundary Conservation Areas (TBCAs) or may need TBCAs given the potential complexity of management of these areas. This may lead to some confusion over how these landscapes (being managed for conservation) are classified.

The following WCPA guidance is provided to ensure clarity for transboundary areas:
(i) For border areas and recognised or proposed Transboundary Protected Areas, CCAs would connect to these protected areas;

(ii) For border areas and recognised "Transboundary Conservation Landscapes and Seascapes", CCAs would connect to these areas;

(iii) For Transboundary Migration Conservation Areas, CCAs would connect to these areas for border areas, or, the entire migration area could be recognised (and named) as both a TBMCA and a CCA. For spatial (statistical) recording purposes, the spatial area would be recorded only once and as determined by local management.

5.10 Maintaining intactness in the large natural areas on Earth

Large remaining natural areas of Earth (such as the boreal forests of Canada, the rainforests of the Amazon Basin and the savannah lands of northern Australia) are critical because they are the least fragmented areas of Earth, and should be recognised as such and managed to retain these values. CCAs may play a role in these areas, but the goal should be to maintain their largely intact state which should be done primarily through the establishment of large protected areas and other effective area based conservation measures. CCAs in this context, may be specifically established to provide a co-ordinating governance function across sub-national, national or indigenous boundaries for the entire large natural area.

5.11 Terrestrial migration routes

The grand wildebeest migration of Africa, the caribou migrations of Alaska and Finland and other large scale migrations of mammal species on Earth are examples of great migrations that may benefit from the establishment and effective management of CCAs.

5.12 Marine connectivity conservation

The value of considering ecological connections when protecting marine environments has long been recognised in scientific recommendations (e.g. James et al, 1990: Gillanders 2003) and in management objectives (eg. GBRMPA, 2001; Fernandes et al, 2007). McCook et al (2008) point out the capacity of reefs to recover after disturbances or reorganise in the face of new stresses depends critically on the supply of larvae or propagules available to reseed populations of key organisms, such as fish and corals. Even if a particular reef is well protected and soundly managed, alterations in the surrounding marine environment may erode resilience if the supply of recruits for ecologically important organisms, such as reef-building corals, is reduced (McClanahan et al. 2002).

McCook et al. (2008) outline some 'connectivity principles' for coral reef MPAs; these principles, many of which are useful for more than just connectivity, include the following points:

- allow margins of error in extent and nature of protection, as an insurance against unforeseen or incompletely understood threats or critical processes;
- spread risks among areas;
- aim for networks of marine (and other) protected areas which are comprehensive, adequate, representative and replicated;
- protect entire biological units where possible (e.g. whole reefs), including buffers around core areas. Otherwise, choose bigger rather than smaller areas;
- provide for connectivity at a wide range of dispersal distances (within and between reef patches), emphasising distances 20–30 km.

Even very large MPAs are not likely to encompass the full life cycle of some species like humpback whales (*Megaptera novaeangliae*), marlin or marine turtles. Connectivity conservation that interconnects interdependent networks of ecosystems, migration routes for whales, sharks and turtles and other species provide a basis for recognition and management of marine CCAs (Day et al. 2015).

5.13 Flyways and stepping stone habitat protection

There are many bird flyways already established and governed under the provisions of the Migratory Species Convention that could be recognised as CCAs. These include nine major flyways for migratory waterbirds. An advantage CCAs could provide is a link between protected area management for bird resting, feeding and breeding locations and the management of the birds flyway route.

5.14 Flight migration routes

The terrestrial flight migration routes of bats and insects could be formally recognised and managed as CCAs.

6. TYPES OF CONNECTIVITY CONSERVATION AREAS

The different types of connectivity conservation in different environments may be organised into a number of distinct "types". There is a logical differentiation for CCAs based on three Biome types and a functional type (flight migration) with four major types being recognised overall (Table Two). The Types therefore recognise CCAs for land, freshwater, marine (including estuarine areas) and areas used for flight migration with a total of eight types of CCAs being recognised. Each of these types has been described further.

Table Two: Types of Connectivity Conservation Areas (CCAs)

TYPE 1: TERRESTRIAL BIOME CCAs
TYPE 1a: Terrestrial species movement CCA
TYPE 1b: Terrestrial large-scale migration CCA
TYPE 2: FRESHWATER BIOME CCAs
TYPE 2a: Freshwater species movement CCA
TYPE 2b: Freshwater large-scale migration CCA
TYPE 3: MARINE BIOME- ESTUARINE CCAs
TYPE 3a: Marine - Estuarine species movement CCA
TYPE 3b: Marine - Estuarine large-scale migration CCA
TYPE 4: FLIGHT CCAs
TYPE 4a: Bird Flyway large-scale CCA
TYPE 4b: Non-Bird flight migration large-scale CCA

6.1 TYPE I: Terrestrial Biome CCAs

TYPE 1a: Terrestrial Species Movement CCA

A "Terrestrial Species Movement CCA" interconnects protected areas and they are large natural, semi-natural and human modified landscapes that people commonly occupy and utilise for their livelihood. The CCA facilitates the conservation of natural ecosystems, ecological processes and evolutionary processes in conserving connectivity. In some circumstances, CCAs are smaller but highly significant areas for connectivity conservation.

These CCAs may interconnect coastal lowlands and highlands; low rainfall areas with high rainfall areas or different habitat types such as rainforests and high alpine areas. They may extend along mountain chains altitudinally from lowlands to mountain tops; latitudinally from areas of warmer climate to cooler areas (poleward); and include substantive parts of the Earth's large, remaining areas of undisturbed habitat. They include important ecosystems, and they facilitate the conservation of key species.

Primary objective

To actively conserve natural biodiversity and its underlying supporting ecosystems and ecological processes through the retention and restoration of large natural and semi-natural landscapes where landscape, habitat, ecological process and evolutionary process connectivity conservation management is practised; protected areas are interconnected; and, the landscape is permeable for species movement.

Other important objectives

- To maintain different wildlife movements facilitated by Terrestrial CCAs including (after Ament et al. 2014):

  - Daily travel (the continuous movement of individuals amoung primary habitat patches within home ranges);
  - Dispersal (the movement of individuals that maintain genetic and demographic connectivity amoung populations);
  - Incidental movement (the fortuitous movement of species in areas primarily designed or managed to provide amenities to people);
  - Boom and bust movement (the movement of species triggered by natural environmental phenomena that triggers extremes of food availability or shortages);
  - Multi-generation movement, where the CCA habitat is important; and
  - Future movement (the movement of individuals to and through areas expected to provide connectivity under future conditions such as climate change effects or following severe natural phenomena).
- To provide opportunities for people living and working in the CCA landscape to live harmoniously (sustainably) with nature and connectivity conservation;
- To maintain ecological services such as clean water and air and wild pollinator populations;
- To provide a response to climate change by securing carbon in-situ and by sequestering carbon;
- To help maintain source population areas of species as well as ecological refugia for species;
- To help maintain healthy landscapes for people and wildlife; and
- To keep some “wild” areas on the planet as part of the human experience and drama.

Strategic biodiversity conservation

In response to climate change influences and the threat of further habitat destruction, fragmentation and the isolation of protected areas, Terrestrial CCAs can contribute to the connection of:

- Many individual, isolated protected areas along prominent geographic features such as north-south trending mountain chains to form substantial latitudinal expanses of permeable landscapes for species. This will assist both altitudinal (up-mountain) and poleward movement of species as climate change influenced temperatures increase (also east-west mountain ranges accommodate connectivity for changes in moisture as climate changes);
- World Heritage properties with other protected areas in the landscape. This will be especially important for species dependent on certain habitat types in World Heritage areas as habitat change is influenced by climate change; and
- Key Biodiversity Areas where the individual sites of the World’s most important biodiversity areas may be vulnerable to change, and the interconnection of these sites offers greater opportunities for conservation.

TYPE 1b: Terrestrial: Large-Scale Migration

A "Terrestrial Large-Scale Migration" CCA recognises terrestrial animal migration routes of Earth and their interconnection with protected areas. These CCAs help conserve natural ecosystems, ecological processes, and evolutionary processes that support these outstanding natural phenomena (Box Five). CCAs can help conserve the migration routes used by certain animal species.

BOX FIVE: MIGRATORY SPECIES

Species that migrate are defined by the Migratory Species Convention as "*The entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdiction boundaries"* (UNEP-CMS 2014).

Lindenmayer and Burgman (2005) define migration more broadly as "*the regular annual movement of the animals between different habitats, each of which is occupied for specific parts of the year; movement of individuals or whole populations from one region to another"*. It is this latter definition that has been used by this IUCN Guideline. Many migratory species are the subject of co-operative conservation instruments facilitated by Migratory Species Convention based initiatives. Any recognition of CCAs for migratory species that are the subject of migratory species agreements would be developed collaboratively.

The routes of grand mammal migrations typically include protected areas for parts of the route and could be recognised as CCAs that link these protected areas. In the heart of Africa for example, one large migration includes over one million white-bearded wilderbeest (*Connochaetes taurinus*) and associated Thompson's gazelles *(Eudorcas thomsonii),* zebras (*Equus sp*) and elands *(Taurotragus oryx)* migrating in a large, transboundary "circular" pattern from the plains and savannah of the Ngorongoro Conservation Area in Tanzania to Kenya's Masai Mara Reserve and return (Uhlenbroek 2008). Another example is found in the high arctic lands where the great caribou (*Rangifer tarandus*) herds of thousands of animals migrate up to 5,000 kilometres (Uhlenbroek 2008).

Primary objective

To conserve and actively manage migratory route connectivity and the underpinning natural habitats and ecosystem processes that facilitate entire migratory movements of terrestrial migratory species (including mammals, amphibians, reptiles and invertebrates) and to connect protected areas found along migratory routes.

Another important objective

- To recognise current and future spatial areas that may be needed to support migrations; especially in a dynamic climate change environment

Strategic biodiversity conservation

Terrestrial species migrations where CCAs could be recognised include:

- Annual mammal migrations such as the movement of the argali sheep (*Ovis ammon*) and the snow leopard (*Uncia uncia*) in the high mountain areas of Altai-Sayan Ecoregion of

Central Asia and the seasonal movement of the caribou (*Rangifer tarandus*) in Alaska, USA;

- Annual reptile migrations (over many kilometres) such as the giant tortoise (*Chelonoidis nigra*) migrations of Santa Cruz Island in the Galapagos, Ecuador;
- Annual amphibian migrations (frogs and salamanders) that may involve a route of a number of kilometres such as the European common toad (*Bufo bufo*); and
- Annual migration of invertebrates such as the red crab (*Gecarcoidea natalis*) of Christmas Island, Australia that migrates 2+ kilometres.

6.2 TYPE 2: Freshwater Biome CCAs

TYPE 2a: Freshwater Species Movement CCA

A "Freshwater-Species Movement CCA" recognises freshwater connectivity for rivers and freshwater lakes and considers longitudinal, lateral and surface/groundwater connections (Hermoso et al. 2012). The CCA recognises the importance of freshwater ecosystems, ecological processes and evolutionary processes. An aspect of hydrologic connectivity, includes the water-mediated transfer of matter, energy and/or organisms within or between elements of the hydrologic cycle (Pringle 2006). Rivers are nature's natural corridors that transport organisms and allow for species migration and dispersal (Pittock et al. 2015). For river and floodplain systems, connectivity is essential in maintaining some key ecological processes in including (Hermoso et al. 2012).

- Longitudinal connectivity which allows long and short distance migrations of biota through river networks and is important for dispersal, reproduction and long –term population dynamics of species (such as for fish);
- Latitudinal connectivity (during inundation) between the river channel and aquatic habitats on the adjacent floodplain is important to maintain the exchange of matter and energy and maintain viable populations of many water-dependent species that develop most of the life-cycle in the floodplain and use the river channel as a dry-season refuge; and
- Vertical connectivity is important given the dependence of some surface ecosystems on groundwater or the exchange of biota.

For lakes and wetlands, they play an important connectivity role as part of a broader functional network of freshwater ecosystems and the maintenance of freshwater biodiversity. This is especially important for species such as fish, waterbirds, some reptiles and some insects (Hermoso et al. 2012). This connectivity could include a network of aquatic habitats for resting or feeding which could serve as stepping stones that facilitate movement amoung sources of permanent water (Hermoso et al. 2012).

Vegetated riparian zones associated with rivers form natural linear habitats through landscapes and are an important consideration for a Freshwater CCA. They interconnect protected areas such as Ramsar wetlands and provide a range of ecological functions including the provision of habitat for both aquatic and terrestrial species. A Freshwater CCA may be established for river beds of rivers that naturally flow intermittently, such as the "boom years" of Australia's inland rivers that only flow following rare flooding rains and that ultimately fill (otherwise) inland salt lakes such as Lake Eyre and spark a boom of aquatic and terrestrial life. For freshwater lakes, a CCA may include the lake's water column and surface waters, the lake bed and the vegetated lake shores. Groundwater dependent ecosystems require conservation of aquifer systems over large areas to conserve ecosystems such as springs, karst wetlands and some floodplain forests (Tomlinson and Boulton, 2010)

Primary objective

To conserve and actively manage for freshwater longitudinal, latitudinal and vertical connectivity for rivers, lakes and their associated natural aquatic and riparian ecosystems, habitats and ecosystem processes in order to facilitate ecosystem conservation, species movements and to connect protected areas such as Ramsar wetlands.

Another important objective

- To interconnect with marine and estuarine areas to facilitate connectivity for anadromous species (eg salmon) and catadromous species (eg eels)

Strategic biodiversity conservation

Longitudinal connectivity in riverine systems needs to allocate priority areas for conservation while minimising the propagation of threats along the river network to maintain key ecological processes such as migration pathways for biota (Hermoso et al. 2012). Lateral connectivity may be dealt with by planning at the sub-catchment scale and incorporating measures of condition or threats (Hermoso et al. 2012). Riparian areas also filter surface flows of runoff containing sediment or agricultural pollution. There are tools for selecting priority sub-catchments, focal areas for freshwater biodiversity conservation and corridors to link them through river basins (Abell et al. 2007). There are also frameworks for identifying key aspects of freshwater systems whose conservation will aid climate change adaptation (Lukasiewicz et al. 2013)

TYPE 2b: Freshwater Large-Scale Species Migration CCA

A "Freshwater Large-Scale Species Migration CCA" provides opportunities for the movement of species within rivers and lakes and other freshwater bodies as well facilitating the conservation of the associated ecosystems, ecological processes and evolutionary processes that help support these movements. Many freshwater fish migrate and sometimes for thousands of kilometres for some diadromous species. The migrations of pacific salmon such as the chinook salmon (*Oncorhynchus tshawytscha)* from marine environments to northern hemisphere river systems and their migration upstream is one example.

Primary objective

To conserve freshwater species migrations of Earth through the conservation of connectivity and the protection of natural ecosystem processes and habitats

Another important objective

- To spatially delineate and actively conserve the important freshwater fish migration routes of Earth

Strategic biodiversity conservation

The spatial delineation of Freshwater Migration CCAs will potentially permit the assessment of the conservation status of these types of CCAs for Earth and this could inform nations of conservation priorities. An example with respect to migratory waterbirds is the wetlands designated and managed as part of the East Asian – Australasian Flyway Partnership.

6.3 TYPE 3 Marine Biome CCAs (Including Estuarine Areas)

TYPE 3a: Marine Species Movement CCAs

A “Marine Species Movement CCA” recognises and conserves marine areas that interconnect MPAs and that facilitate the movement of species (at all stages of their development); that help conserve natural marine ecosystem and evolutionary processes and conserve marine habitats of benefit to species. This Type includes all marine types needed for nature and species connectivity conservation including estuarine ecosystems and is inclusive of ecosystem dynamics. Marine CCAs may extend from high water mark environments to deep water oceanic environments; they may occur in 3 dimensions (vertically and horizontally) and may include the sea floor. They may connect marine protected areas (Day et al, 2012) and potentially, terrestrial protected areas such as sand cay islands. Marine CCAs may be required for a variety of reasons or at a variety of scales:

- Some species may require a different habitat (marine or terrestrial) at different stages of their life cycle or because they reproduce in a specific place outside a Marine Protected Area (MPA) (eg. a marine turtle will nest up on a beach, then utilise a MPA in coastal or offshore waters before moving out into the oceanic waters of the high seas);
- From within an MPA to habitats outside the MPA, when the MPA acts as a source population, providing gametes, larvae, juveniles or adults to maintain those external populations;
- Across the freshwater-marine realms for species with diadromous or anadromous life cycles (such as many of the salmonids);
- Across the terrestrial-marine interface (eg the coconut crab which is almost entirely a terrestrial species except for a 3-4 week marine pelagic larval stage).

Marine CCAs may be very large in recognition of oceanic currents, tides and the dynamic nature of marine environments (while recognising that an important component may also be localized self-recruitment). The location of Marine CCAs may be influenced by sub-surface topography including sea-mounts or reefs; sub-surface geological phenomena such as deep-sea vents and they may be associated with parts of the water column, specific habitats or seasonal wind flows. Water movements such as currents, eddies and tides may provide a critical link for the life cycle processes and health of marine ecosystems and species.

Primary objective

To actively conserve natural marine biodiversity, ecosystems and underlying supporting ecological processes through the retention and management of large natural and semi-natural seascapes where connectivity conservation management is practised; marine protected areas are connected; and where key ecosystem processes, habitats and environments that support species life-history stages are conserved.

Other important objectives

- To help support the natural movement of marine species;
- To help support opportunities for evolutionary processes for marine species;
- To better understand source-sink relationships, critical pathways and life cycle traits of marine species in order to design more effective MPA networks;
- To proactively prepare for the potential spread of invasive species;
- To help conserve marine ecological refugia and habitat polewards in the context of a climate change world;
- To protect and sustain, where practicable, wind-driven ‘loop’ currents and internal waves that transport larvae from coastal spawning areas to develop in the sea, then return later in development back to the coasts and estuaries to complete the life cycle; and,
- To contribute as a natural solution response to climate change.

Strategic biodiversity conservation

Marine systems require connectivity conservation management that is broad and ecosystem based (Day et al. 2015). Understanding the spatial and temporal dynamics of marine populations, along with the biophysical processes that contribute to connectivity is complex, but has important applications for management and conservation. These processes will vary from site to site, depending on a wide range of factors such as coastal geomorphology, proximity to estuaries, water–column stratification, and seasonal wind forcing (Cowan et al. 2007).

For many marine populations, the larval dispersal component of connectivity remains uncertain, so a better understanding of a wide range of factors influencing larval production, dispersal and survival is important (eg. the duration of the pelagic larval stage in different species). Similarly an improved understanding of the dispersal distances of juvenile and adults’ (including the potential for ‘spill-over’ from MPAs) is important. In complementing

MPAs, Marine CCAs, can provide an additional opportunity to formally recognise, conserve and manage for large scale and interconnected ecosystem processes. Determining (for example) where and when economically and ecologically important fishes spawn remains an important research objective so those locations can be protected and interconnected. Also important is an awareness and consideration of the critical role of ecological processes and the linkages between coastal and marine ecosystems (land-sea connectivity) and where these linkages may have aspects that transgress jurisdictional, institutional and policy demarcations. Effective marine conservation requires a number of elements; incorporating connectivity is an important component but will not be sufficient by itself unless well integrated with a range of other management measures that may need to be supported by and adapted to special legal, policy, governance and institutional elements.

TYPE 3b: Marine Large-Scale Migration CCA (Including for Estuarine Areas)

A "Marine Large-Scale Migration CCA" recognises those marine environments that are used regularly as migration routes for marine species and they interconnect with MPAs and even terrestrial protected areas (such as turtle nesting islands on the Great Barrier Reef). These marine animal migrations include some of the most outstanding natural phenomena for our planet. Trans-hemisphere whale migrations; turtle migrations; shark and other fish species migrations and invertebrate migrations and their associated routes may warrant recognition as CCAs to help facilitate their active conservation management. These CCAs also recognise ecosystem dynamics associated with these migration areas.

Primary objective

To actively conserve and manage seascape connectivity and underpinning natural habitats and ecosystem processes that facilitate migratory movements of marine species including mammals, reptiles, fish and invertebrates.

Other important objectives

- To recognise and conserve marine spatial areas needed to facilitate marine species migrations;
- To help conserve links between adult marine species population areas, their foraging areas, spawning sites and their nursery areas; and
- To undertake connectivity conservation management that assists the conservation of marine species in an environment of climate change.

Strategic biodiversity conservation

The challenges for biodiversity conservation are great with shipping lanes, sonar and noise pollution and other human influences on migration. Intense tagging efforts are now being conducted on migratory marine mammals, sharks, and seabirds to document where and when widely migrating organisms can be found so as to match that information with knowledge of the spatio-temporal distribution of known or suspected risks. It means that

CCAs might be established and be effective along the routes – realizing the likely impracticality of requesting entire routes as MPAs.
Formal recognition of CCAs for marine species such as (for example) the migratory routes of the humpback whale (*Megaptera novaeangliae*) could extend the recognition of conservation areas from waters under national jurisdiction to the high seas. The extension of international marine agreements to recognise CCAs in the high seas could, as a future initiative, provide additional conservation protection to species such as whales. The provisions of the CBD COP decision of 2008 concerning the application of conservation tools beyond and within national jurisdiction for MPAs and connectivity would apply here.

6.4 TYPE 4: Flight CCAs

TYPE 4a: Bird Flight Migration CCA

A "Bird Flight Migration CCA" includes both officially recognised bird "Flyways" and other bird migration routes commonly used by bird species. The CCAs would interconnect protected areas along the migration route. For many, many locations on Earth, the passing of the seasons are marked by the departure or arrival of migratory birds. It can be quite a spectacle as multiple birds congregate in readiness for their departure, or equally, the distinct raucous sounds of massed bird arrivals announce the changing of the seasons. Birds may be moving seasonally to breeding or feeding areas and many of these routes are officially recognised as distinct "Flyways" and are the subject of official agreements. Other bird flight migrations may be local (such as altitudinal flight migration); regional (such as north-south continental scale migrations) and trans-hemisphere and may be reliant on a series of terrestrial ("stepping stone") habitats used for feeding and resting on route. The latter type are often the subject of Flyway agreements. Airspace for some flight migration routes may be important for protection such as ensuring that some air space zones are safe from shooters.

Primary objective

To facilitate the conservation of "stepping stone" and destination protected areas and associated habitats, ecosystems and ecosystem processes used by birds along migratory flyways; and, as necessary, to help conserve air space used by migratory birds from threats.

Other important objectives

- To connect and integrate the conservation management of protected areas that are part of bird flyways from national to trans-hemisphere scales;
- To connect and integrate important terrestrial bird areas found along CCA flyways such as between breeding grounds and wintering grounds; and
- To identify frequently used CCA flyways that may require active conservation management.

Strategic biodiversity conservation

Many bird species flyways and their terrestrial stop-over areas are formally recognised by international treaties. These flyways could be recognised as CCAs. Other bird migration routes could also be considered for CCA status. Some such migrations include:

- The trans-hemisphere ocean based migrations of the short-tailed shearwater *(Puffinus tenuirostris);*
- The continental migration of Swainson's hawk (*Buteo swainsonii*) from the prairies of the USA and the Pampas of Argentina and return; and
- The route of the wandering albatross (*Diomedea exulans*) which circumnavigates Antarctica

TYPE 4b: Non-Bird Flight Migration CCA

A "Non-Bird Flight Migration CCA" recognises that many species other than birds fly and also migrate including bats migrating between roosting sites and feeding areas. Some insects such as dragonflies migrate at a continental scale and other insects such as butterflies migrate, though the beginning to end point of a migration may involve many generations. These CCAs may interconnect protected areas (such as bat roosting sites in caves) with their feeding areas.

Primary objective

To facilitate the conservation of habitats (and their associated ecosystem processes) used by species undertaking flight migration to destination protected areas and other lands; and, as necessary, to help conserve air space used by migratory species from threats.

Other important objectives

- To connect protected areas as part of mammal and insect flight migratory routes that may be from local to international scale; and
- To conserve links between important protected species roosting or resting locations and food sources.

Strategic biodiversity conservation

Greater protection of migratory bats and migratory insects may be achieved through the recognition of CCAs. An indicative example of a "flight" migration species (non-bird) that may be considered for a CCA is the Australian grey headed flying fox (*Pteropus poliocephalus*), migratory routes between roosting sites and food sources.

7. CRITERIA FOR ESTABLISHMENT

7.1 Recognising and establishing CCAs

CCAs and other smaller connectivity conservation initiatives are playing an increasingly important role in biodiversity conservation and in helping to achieve Target 11 of the CBD Strategy 2011-2020. In 2015, the UNEP World Conservation Monitoring Centre commenced development of a consolidated international data base of CCAs, but like protected areas, in order to achieve a standardised international data base, there needed to have an agreed definition for CCAs and common underpinning (or foundation) concepts for their recognition and establishment. To be formally recognised as an International CCA, connectivity conservation initiatives would need to meet these standards. CCAs, with their minimum standards could then become a measure of progress of effective connectivity conservation and a measure of progress against CBD Target 11.

Four foundation concepts have been recognised for CCAs. They help determine whether a spatial area such as a flight migratory route, a marine species migration route or a mountain range terrestrial wildlife corridor (for example) would be recognised and established as an IUCN endorsed International CCA. Existing large-scale connectivity conservation initiatives are assumed to already include these Foundation Concepts as part of their management.

The four "Foundation Concepts"

The four Foundation Concepts include (Figure Two):

(i) Strategic biodiversity conservation

A CCA contributes strategically to biodiversity conservation including interconnecting protected areas, facilitating species movements (including in response to climate change) and providing spatial and functional interconnections with marine protected areas.

(ii) Connectivity integrity

The natural condition of a CCA is sufficiently intact to be permeable for species movements and that it facilitates connectivity;

(iii) Active and effective governance and management

There is effective and active governance and management that manages and improves connectivity conservation.

(iv) Community involvement and benefits for people

There is support from the local and wider community that helps to facilitate the conservation of the connectivity area.

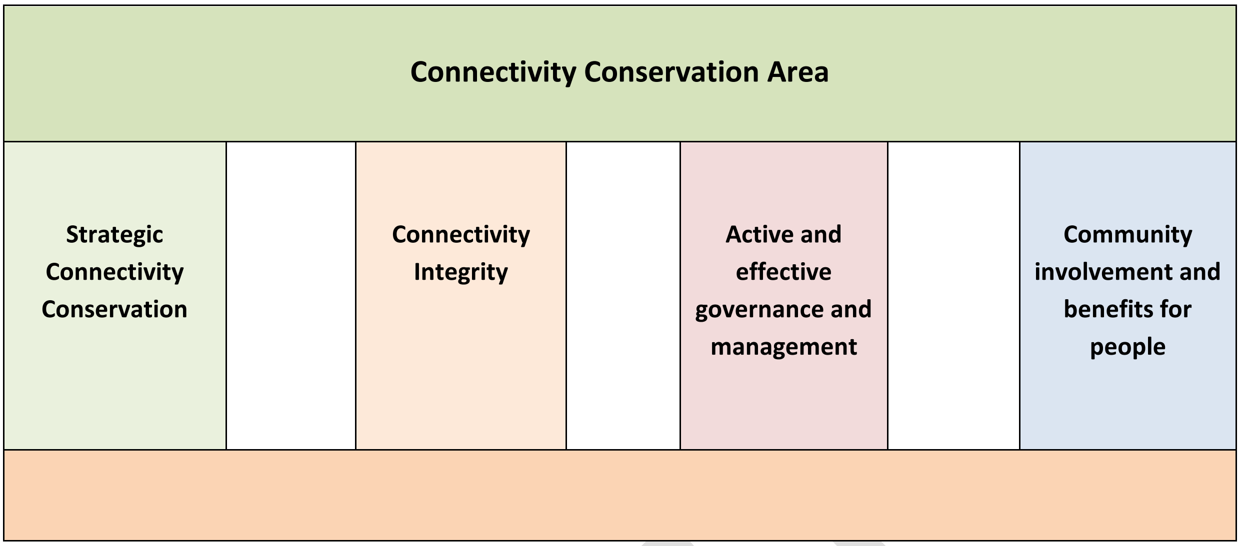

Figure Two: Foundation concepts for establishing a CCA

Recognising CCAs

Using the four Foundation Concepts, more detailed criteria have been identified to guide the recognition of a CCA. Based on the CCA definition, research and the practical experience of many connectivity conservation managers, 19 criteria have been identified that provide guidance for what constitutes a CCA (Table Three).

Establishing International CCAs: Core Criteria

Some criteria in some "Foundation Concept" areas have been identified as being very important for every CCA. It is these "core criteria" that provide best practice governance and management performance guidance themes for emerging CCAs. In formally recognising International CCAs, IUCN WCPA has used some (but not all) of these core criteria for its mandatory, minimum selection criteria for a CCA. The International CCA selection criteria is based on the following:

International CCA Selection Criteria

Recognition of an International CCA requires at least 6 Core CCA criteria including all three core criteria from Foundation Concept "Strategic Connectivity Conservation" and at least one core criterion from each of the remaining "Foundation Concepts".

Table Three: Four Foundation concepts, Core Criteria for establishing CCAs and 19 criteria that underpin CCAs (Core Criteria are shown in larger font)

Strategic connectivity conservation						Connectivity integrity			Active and effective governance and management						Community involvement and benefits to people				
Strategic biodiversity conservation	**Interconnected protected areas**	**Large-scale or significant area**	Climate change response	Species conservation	Strategic restoration	Mostly undisturbed	**Restoration of connectivity**	Working landscape or seascape	**Active management**	**Governance - Co-ordination Group**	**Planned approach**	Research	Instruments	Effectiveness evaluation	**Community involvement**	Healthy communities	Benefits for agriculture or fishery	**Equity and benefits to people**	Cultural connections

Using the IUCN selection criteria, CCAs can be formally recognised, spatially delineated and the data collected may be used for research. Using the mandatory CCA selection information collected for 6 the "core criteria", the spatial contribution of CCAs to global biodiversity conservation against CBD targets could be assessable. Data potentially collected for other criteria or all 19 criteria, would provide important insights to CCAs globally.

Given the importance of this information for the selection of CCAs and for their long term governance and management, further details are provided for each of the 19 CCA criteria. The four Foundation Concepts have been used to structure the presentation of the 19 criteria.

7.2 Foundation Concept: Strategic Connectivity Conservation

CCAs are large areas or very significant (smaller) connectivity areas that are strategically selected for their important contribution to species conservation, ecological processes and biodiversity conservation outcomes. The following six criteria (Table Four) provide guidance details for determining if a CCA has "strategic values" of "significance" for connectivity conservation. Guidance details, where appropriate, have been provided for terrestrial, freshwater and marine biomes.

Table Four: Foundation "Strategic Connectivity Conservation": Six Criteria

FOUNDATION CONCEPT **STRATEGIC CONNECTIVITY CONSERVATION**	**Scientific principles of connectivity conservation and guidance notes that support the selection criteria**
CRITERION 1: **"STRATEGIC BIODIVERSITY CONSERVATION"** A CCA contributes strategically to the long-term conservation of on-going ecological and biological processes which assist the evolution and development of one or more of a nation's terrestrial, fresh water, estuarine, coastal and marine ecosystems and communities of plants and animals. This may be at a whole-of-CCA scale and/or at more local scales.	**For Terrestrial Areas** **(after Mackey et al, 2013 pp233-243)** **(Principle 7)** CCA planning needs to consider multiple ecological processes operating at multiple spatial and temporal scales. These include: a) Hydro-ecological processes b) Trophic relations and functional interactions (especially for highly interactive species critical to top-down predator control of populations, seed dispersal and pollination) c) Dispersive species especially migratory, nomadic and eruptive specie d) Metapopulation dynamics (especially for animal species with large home ranges) e) Responses to climate change by species that involve large scale movement f) Ecological refuges; g) Fire. **(Principle 10)** CCA planning needs to consider evolutionary processes, both past and present and ongoing. This includes the need to prioritise evolutionary refugia, areas that are believed to be future sites of speciation, and also genetic diversity that may be important for adaptive responses including local adaptations. **(Principle 11)** The (…) system of (…) CCAs should include (i.e. "represent") as many biodiversity elements as possible. Spreading CCAs geographically and environmentally at multiple scales is a key strategy for achieving representation of biodiversity elements at all levels of organisation (genes, species, communities, ecosystems, biomes)
CRITERION 1: **"STRATEGIC BIODIVERSITY CONSERVATION"** (Continued)	**For Freshwater Areas (Hermoso et al. 2012)** Priority freshwater connectivity needs should be recognised using a combination of longitudinal and latitudinal connectivity assessments within hydrological catchments

FOUNDATION CONCEPT STRATEGIC CONNECTIVITY CONSERVATION	Scientific principles of connectivity conservation and guidance notes that support the selection criteria
	For Marine Areas (after Sale et al, 2010) There is a need to consider different aspects of connectivity for marine management , including: **(Principle 1) Larval dispersal** • Where practical, place MPAs within 10-30km of each other to capture effective connectivity for most reef species; **(Principle 2) Movement in later life** • Consider the range of juvenile and adult movement patterns • Protect spawning areas and habitats required at different life stages, and daily and seasonal pathways **(Principle 3) Habitat requirements** • Protect critical habitats such as important foraging areas, nursery grounds, nesting and spawning sites • Protect refugia which may serve as a source of propagules to recolonize adjacent sites if damaged • Recognise isolated sites, which may have low genetic diversity or low connectivity (such as remote oceanic reefs) and may be less resilient to disturbance • Recognise the needs for larger and higher-trophic level marine predators to be able to move among MPAs and to take advantage of their high intrinsic mobility to maximize feeding success, to reach spawning or mating areas, and to join in with migrating con-specifics. **(Principle 4) Water movement:** eg: • Ensure an even spread of MPAs where currents are complex (such as eddies or reverse tidal flows) • Consider consistent source and sink areas, (such as where currents are strongly directional) • Manage for retaining the physical currents necessary for connectivity (and therefore transport of early life stages and through their role in bio-physical coupling to drive high productivity.)

<table>
<tr><th>FOUNDATION CONCEPT
STRATEGIC CONNECTIVITY CONSERVATION</th><th>Scientific principles of connectivity conservation and guidance notes that support the selection criteria</th></tr>
<tr><td rowspan="3">CRITERION 2
“INTERCONNECTED PROTECTED AREAS”
A CCA interconnects protected areas. They may interconnect World Heritage properties, Biosphere Reserves and protected areas including those established over Ramsar Sites; Key Biodiversity Areas; and refugia sites. CCAs include naturally vegetated lands, freshwater and seas, and areas that are occupied and utilised sustainably by people and that are permeable for species movement.</td><td>For Terrestrial Areas
(after Mackey et al, 2013 pp233-243)
(Principle 1) Connectivity conservation recognizes the importance of the landscape matrix between areas of intact native vegetation, including protected areas.
• The matrix next to intact native vegetation needs to be managed to enhance and/or buffer the biodiversity values of that vegetation
• The matrix needs to be managed to facilitate natural levels of connectivity between more intact vegetation
• The matrix can have biodiversity values that are absent from more formally protected areas and those values should be identified and preserved
• Matrix management will be essential for many large-scale evolutionary and ecological processes, like fire and introduced species</td></tr>
<tr><td>For Freshwater Areas
• Interconnecting headwater catchment protected areas with downstream river based protected areas (longitudinal); floodplain protected areas and lakes and Ramsar Wetlands (latitudinal) while conserving riparian areas.</td></tr>
<tr><td>For Marine Areas (McCook et al. 2008)
• Networks of marine protected areas should aim to be comprehensive, and protect all biotypes, habitats and ecological processes and to capture as many connections as possible
• Protecting the species and habitats within an MPA is not sufficient by itself – an MPA can only be as healthy as the surrounding waters, so sustainable fishing practices and ensuring good water quality outside an MPA (such as a CCA) are also essential.</td></tr>
<tr><td>CRITERION 3
“LARGE-SCALE AREA” or “SMALLER SIGNIFICANT AREAS”
A CCA is ideally large in scale and it may include many smaller wildlife corridors integrated to form the larger interconnected whole. It is resilient and robust because of redundancy. Smaller areas that are especially significant for connectivity conservation</td><td>For Terrestrial Areas
(after Mackey et al, 2013 pp233-243)
(Principle 2) Connectivity conservation deals with biodiversity conservation at multiple spatial scales. That said, it places a particular emphasis on the medium to large scale, including connectivity across entire continents. Planning needs to be mindful of the spatial scale of relevant ecological and evolutionary processes, as well as the spatial scale of</td></tr>
</table>

FOUNDATION CONCEPT STRATEGIC CONNECTIVITY CONSERVATION	Scientific principles of connectivity conservation and guidance notes that support the selection criteria
may also be recognised as a CCA.	socio-economic systems. There are multiple types of connectivity that exist at different scales and perform different functions. **(Principle 11)** A resilient corridor will include redundancy in all its various forms. A plan that is robust to existing catastrophes, plus catastrophic processes altered by climate change, will have redundancy both in terms of the places where each species and habitat exists, plus functional redundancy between species. Ecologically, redundancy contributes to ecosystem resilience.
	For Freshwater Areas • Riparian CCAs, their headwater catchments and floodplains may be very long and punctuated by embedded protected areas that include wetland areas, lakes and deltas. • Freshwater CCAs may include very long dry river beds that are important for connectivity and migration corridors for species during a cyclical weather of extreme rain and flooding.
	For Marine Areas (McCook et al, 2008; Sale et al, 2010) • Networks of marine protected areas should aim to be *comprehensive*, and protect all biotypes, habitats and ecological processes and to capture as many connections as possible; • 'Think big' and aim to manage broad regions rather than just isolated protected areas. • Encompass entire biological units and include a 'buffer zone' (potentially a CCA) around any core areas of interest. • Any CCA designed to protect and conserve cross-ocean basin migratory routes for marine mammals, sharks, or sea birds would be large. In addition, a CCA recognizing needs for protecting circum-basin currents would also be large, but in this case the CCA would probably address access inhibitions that could prevent organisms from benefits of the physical flows.
CRITERION 4:	**For Terrestrial Areas** **(after Mackey et al, 2013 pp233-243)**

FOUNDATION CONCEPT STRATEGIC CONNECTIVITY CONSERVATION	Scientific principles of connectivity conservation and guidance notes that support the selection criteria
"CLIMATE CHANGE RESPONSE" A Terrestrial CCA provides opportunities during a time of climate change for the movement of species: i) Poleward for multiple degrees of latitude; ii) East-west for many degrees of longitude; iii) To higher altitudes and/or more complex terrain with steep environmental gradients; or, iv) A combination of the above. CCAs retain important areas of Green Carbon.	**(Principle 9) Accommodating anticipated impacts of climate change within CCAs will require multiple forms of connectivity implemented at multiple scales.** This planning needs to consider major differences in dispersal ability and adaptation responses (e.g., migration versus in situ local adaptation) between different species and functional groups, and geographic variation across the continent in the steepness of climatic gradients to which species will have to respond. • Changes in CCA spatial needs may be need managed for
	For Freshwater Areas (Pittock et al. 2015) • Conservation of riparian areas of Freshwater CCAs will assist with streambank protection during extreme rainfall and flooding events and will provide shade, shelter and habitat for species that are moving polewards or up-mountain in response to hotter conditions.
	For Marine Areas (after Sale et al. 2010) • Large CCAs in marine environments will assist with responses to climate change. • Anticipate that climate change may lead to changes in current regimes and species movements (such as buoyancy driven flows), with CCA's assisting to manage for this. • Ensure that the legal instruments governing MPAs are able to adapt for changes in the spatial needs of management, and potentially, the formal recognition of CCAs.
CRITERION 5: **"SPECIES CONSERVATION"** A CCA contains important natural habitats for the in-situ conservation of biodiversity including endangered species	**For Terrestrial Areas** **(after Mackey et al. 2013 pp233-243)** **(Principle 10) A continental system of CCAs should include (i.e. "represent") as many biodiversity elements as possible**. Spreading corridors geographically and environmentally at multiple scales is a key strategy for achieving representation of biodiversity elements at all levels of organisation (genes, species, communities, ecosystems, biomes).
	For Freshwater Areas (Pittock et al. 2015) • Riparian CCAs and their associated river side

FOUNDATION CONCEPT **STRATEGIC CONNECTIVITY CONSERVATION**	**Scientific principles of connectivity conservation and guidance notes that support the selection criteria**
	vegetation communities provide important aquatic habitats, river bank habitats and flood-plain habitats for aquatic and terrestrial species.
	For Marine Areas (McCook et al. 2008) CCAs play a key role in managing systems of MPAs in marine environments that include the following considerations. • Networks of marine protected areas should aim to be *comprehensive*, and protect all biotypes, habitats and ecological processes and to capture as many CCA connections as possible • Aim for a network (including CCAs) that provides for a wide range of dispersal distances between MPAs, recognising the extent of local retention (self-recruitment) is prevalent. • Where possible, MPAs should be placed within 10-30 km of each other to effectively capture connectivity for most target reef species. CCAs will also help to conserve these MPA systems. (Example) For a temperate rocky reef habitat occupied by valued fish (e.g., snapper/grouper in North Carolina-Florida along the Atlantic coast), there exists hard pavement bottoms that are seasonally covered by sediment transport but when uncovered are colonized by benthic epifauna characteristic of reefs and promoting reef species production. These areas serve as habitat promoting movement of reef fishes and their protection. The special scale can range from about 1 km to 20 km for a CCA.
CRITERION 6: **"STRATEGIC RESTORATION"** A CCA provides strategic opportunities for the restoration of natural habitats for functional and structural connectivity, for healthier ecosystems and as nationally significant contributions to the sequestration of carbon. This is at a whole of corridor scale, and where many restoration projects may be undertaken at the same time to improve the general ecological health, sustainability and effectiveness for biodiversity conservation of a CCA. For marine environments, restoration may be focused on maintaining ecological processes linked to key	**For Terrestrial Areas** **(after Mackey et al, 2013 pp233-243)** **(Principle 7) Ecological restoration and rehabilitation may, however, be required to restore connectivity within CCAs in more fragmented landscapes.** In this situation priority should be given to restoration that delivers both biodiversity conservation and carbon benefits. **For Freshwater Areas (Pittock 2015)** • Strategic connectivity restoration for Freshwater CCAs may be linked to the restoration of river system ecosystems at key locations and for habitat and species conservation at sites that are

FOUNDATION CONCEPT **STRATEGIC CONNECTIVITY CONSERVATION**	**Scientific principles of connectivity conservation and guidance notes that support the selection criteria**
habitats.	threatened.
	For Marine Areas • Restoration in CCAs may be required to help maintain key ecological processes supporting species and stages in species life cycles in the marine environment • CCAs protected from disturbance may provide propagules for the recolonization of damaged sites For example: Large areas of coral reefs and temperate rocky reefs have been degraded by sedimentation caused by dredging for shipping corridors, or beach nourishment. These associated sedimentation processes result in dramatic reduction of benthos and fish biodiversity and abundance. These form important targets for restoration and unaffected areas where risk is high should be protected by CCAs.

7.3 Foundation Concept: Connectivity Integrity

Integrity assesses the extent to which a CCA retains landscape, habitat, ecological process and evolutionary process connectivity in natural and working landscapes and seascapes and the extent of any existing and forecast adverse effects such as development impacts on these values. A CCA preferentially includes landscapes and seascapes which are still undisturbed but may also include degraded and disturbed environments which still contribute to functional connectivity and areas which may be subject to restoration. Many large mammals (for example) will move through landscapes that are still essentially natural. The following criteria (Table Five) provides guidance for determining if a CCA has significant “integrity values”.

Table Five: Foundation Concept: “Connectivity Integrity”: Three Criteria

<table>
<tr><th>FOUNDATION CONCEPT
CONNECTIVITY INTEGRITY</th><th>Scientific principles of connectivity conservation and guidance notes that supports the selection criteria</th></tr>
<tr><td rowspan="3">CRITERION 7
“MOSTLY UNDISTURBED”
A CCA preferentially conserves interconnected large-scale areas (or smaller, but significant connectivity conservation areas) of intact or largely undisturbed native vegetation or undisturbed freshwater or marine environments that facilitate connectivity conservation. They may also include degraded and disturbed lands or waters which still contribute to functional connectivity and areas which may be subject to restoration</td><td>For Terrestrial Areas
(after Mackey et al, 2013 pp233-243)
(Principle 5) Prevention is usually better than cure when managing vegetation within CCAs. Priority should generally be given to protecting and improving the quality of existing native vegetation over revegetation.</td></tr>
<tr><td>For Freshwater Areas (Pittock 2015)
• The natural habitats of many rivers and lakes have already been altered, so it is important to retain what natural connectivity remains along rivers and their associated floodplains.</td></tr>
<tr><td>For Marine Areas
• In establishing CCAs, preference is given to mostly undisturbed waters.
• Marine CCAs need to ensure normal ecological functioning is not disrupted by artificial barriers or activities that disrupt the ecological processes.
• There is a need to consider the resilience of the ecosystem (that is, its ability to absorb or recover from impacts). A less resilient ecosystem may fail to recover and may remain in an altered state permanently.
• Good connectivity between populations may improve their resilience to threats, through both the ability to recolonise and though genetic diversity.</td></tr>
<tr><td rowspan="2">CRITERION 8
“SITE RESTORATION OF CONNECTIVITY”
Specific areas of a CCA may require restoration of connectivity for species such as at identified “choke points” or other disturbed areas that otherwise limit the integrity or effectiveness of a CCA for the movement of one or more species. This is local, specific, targeted restoration.</td><td>For Terrestrial Areas
(after Mackey et al, 2013 pp233-243)
(Principle 7) Ecological restoration and rehabilitation may, however, be required to restore connectivity within CCAs in more fragmented landscapes. In this situation priority should be given to restoration that delivers both biodiversity conservation and carbon benefits. Increasing genetic diversity and/or species diversity could be an outcome.</td></tr>
<tr><td>For Freshwater Areas (Pittock 2015)
• Restoration of freshwater connectivity for</td></tr>
</table>

<table>
<tr><th>FOUNDATION CONCEPT
CONNECTIVITY INTEGRITY</th><th>Scientific principles of connectivity conservation and guidance notes that supports the selection criteria</th></tr>
<tr><td></td><td>species may require substantial restoration work for rivers and flood plains including changes to dams and other infrastructure.</td></tr>
<tr><td></td><td>For Marine Areas
Restoration of connectivity for marine and estuarine areas may require restoration of habitat (such as mangroves); the treatment of pollution from nearby terrestrial catchments; the removal of barriers to natural flows, or the protection of some species.
(Note) There is a need to consider the resilience of the ecosystem given a less resilient ecosystem may fail to recover and may remain in an altered state permanently.</td></tr>
<tr><td>CRITERION 9
“SUSTAINABLE USE AND OCCUPATION BY PEOPLE OF LANDSCAPES, FRESHWATERSCAPES AND SEASCAPES”
CCAs include people who are occupying landscapes, freshwaterscapes and seascapes as well as the presence of natural lands, natural freshwater areas and marine environments. Overall, human use and developments within these do not diminish the integrity of the natural values nor the associated connectivity values. Sustainable use would be an objective for people.</td><td>For Terrestrial, Freshwater and Marine Areas (after Mackey et al, 2013 pp233-243)
Connectivity conservation encompasses all landscapes and tenures, and including riparian communities, wetlands, estuaries and near coastal areas.
(Principle 13) Different conservation instruments will need to be applied to managing the landscape and seascape depending on the scale of the CCA and local social and economic circumstances. Such instruments may range from voluntary conservation actions by private landowners and stewardship payments, tax-concessions or incentives that facilitate whole of landscape or seascape conservation outcomes.</td></tr>
<tr><td></td><td>For Freshwater Areas
Freshwater rivers and lakes are heavily utilised by people are part of their livelihood and well-being. Support arrangements may be developed that link the conservation of connectivity with every day activities associated with a CCA.</td></tr>
<tr><td></td><td>For Marine Areas
Sustainable and environmentally sustainable</td></tr>
</table>

FOUNDATION CONCEPT CONNECTIVITY INTEGRITY	Scientific principles of connectivity conservation and guidance notes that supports the selection criteria
	fishing practices contribute to working seascapes and help facilitate connectivity conservation (for example, research in the Great Barrier Reef Marine Park has demonstrated the benefits of actively closing some areas to fishing enabling spill over of adult fish and the dispersal of larvae into adjacent fished areas).

7.4 Foundation Concept: Active and Effective Governance and Management

CCAs involve the active participation of individuals, local communities and many sectors of society including private organisations and governments. For many CCAs, this is a bottom-up process of governance, with or without governments participating. It is where (for example) multiple individual grass-roots contributions contribute (based on personal initiatives) to the success of connectivity conservation. Such individuals are typically inspired and guided by a clear vision for the CCA when contributing their individual initiatives.

Governance for CCAs however does vary. Sometimes governments or NGOs or private Boards may simply assist these individual efforts, both directly and indirectly. At other times, the connectivity conservation may be completely government or NGO or Board lead (see Section 8, CCA governance types). What is consistent and what international experience has shown however is that CCAs operate best when they have a whole-of-CCA co-ordinating and facilitating group. Such a group would typically be small, it would be respectful of the multiple individuals, organisations, businesses and communities present in the CCA, and it would help to facilitate multiple activities taking place in the CCA.

A strategic whole-of corridor plan (that is an overview, guiding plan) may also be prepared by the people of the CCA, or the co-ordinating group on their behalf. It would have a clear vision and management objectives and priorities established to deal with threats to biodiversity and connectivity conservation. Such an overview plan would provide a context and strategic guidance assistance for individual CCA contributions. Generic management principles practised for protected area management such as the precautionary approach would be relevant for such a document (see Worboys et al. 2015).

The following criteria provide guidance for determining if a CCA is “being actively and effectively governed managed” (Table Six).

Table Six: Foundation Concept: Active and Effective Governance and Management: Six Criteria

<table>
<tr><th>FOUNDATION CONCEPT
ACTIVE AND EFFECTIVE GOVERNANCE AND MANAGEMENT</th><th>Scientific principles of connectivity conservation and guidance notes that supports the selection criteria</th></tr>
<tr><td rowspan="3">CRITERION 9
“ACTIVE MANAGEMENT”
A CCA is actively managed for connectivity conservation outcomes as inspired by a vision (and guided by a strategic whole-of-CCA plan) through individual actions; voluntary actions by organisations and partnerships of individuals and organisations and actions facilitated by a CCA Co-ordinating Group. A description of potential governance types for the “Co-ordination Group” has been described by Borrini-Feyerabend and Hill (2015) [See Section 8].</td><td>For Terrestrial Areas
(after Mackey et al, 2013 pp233-243)
(Principle 4) Achieving conservation outcomes in CCAs will require active management targeting key threats including habitat destruction, introduced species, altered fire regimes for terrestrial areas and climate change.</td></tr>
<tr><td>For Freshwater Areas
• Active management of a Freshwater CCA would target key threats, including a capacity to respond to pollution events and to restore habitat.</td></tr>
<tr><td>For Marine Areas
• Active and adaptive management is vital for marine areas, including responses to connectivity conservation threats. This usually relies heavily on increased public awareness coupled with effective compliance, but the benefits (such as long term sustainable fishing combined with increased ecosystem health and increased resilience) justify the costs.</td></tr>
<tr><td>CRITERION 10
“CO-ORDINATION CONSIDERATIONS”
A CCA commonly includes a formally established (variously named) and small Co-ordinating Group and supporting Secretariat which are responsible for facilitating the vision of a CCA and for achieving active management including through multiple partnerships. Co-ordination also has the potential to be undertaken by a sole-entity operation.</td><td>For Terrestrial, Freshwater and Marine Areas
(after Mackey et al, 2013 pp233-243)
(Principle 14) Connectivity conservation demands partnerships with all stakeholders and action across all tenures. Such cooperation is assisted by:
• a shared vision
• strategic long-term planning
• innovative partnerships
• a system for monitoring, evaluation and reporting progress.
A Co-ordination Group or a Co-ordination sole-entity helps to achieve this management</td></tr>
</table>

FOUNDATION CONCEPT ACTIVE AND EFFECTIVE GOVERNANCE AND MANAGEMENT	Scientific principles of connectivity conservation and guidance notes that supports the selection criteria
	For Freshwater Areas • A Co-ordination Group or a Co-ordination sole-entity is essential for the effective management of a Freshwater CCA.
	For Marine Areas • Active management (which may just include monitoring and a watching brief) of a marine CCA requires a Co-ordination Group or a co-ordination sole entity– This may include a group specifically established for such coordination and may require a legislative instrument (such as a national or state/provincial law), a binding agreement or a non-binding agreement.
CRITERION 11 **“PLANNED APPROACH”** A CCA includes a vision statement and a whole-of-corridor strategic plan with clear objectives, a focus on long-term connectivity conservation and biodiversity conservation outcomes; an identification of priority threats; implementation actions and an approach to performance management evaluation that includes whole-of-CCA assessment as well as local and site based assessments. (A Strategic Plan would rely on detailed, local, site based plans for the implementation of individual projects).	**For Terrestrial, Freshwater and Marine Areas** **(after Mackey et al, 2013 pp233-243)** **(Principle 3) Prioritization and implementation of actions within CCAs should be underpinned by explicit conservation objectives,** defining precisely the intended outcome(s) of any given corridor initiative, for example: “securing populations of threatened species x, y, z”, “restoring keystone species to functional densities”, “retaining overall diversity across all levels of biological organisation”, “restoring natural hydro-ecological flows and fire regimes” **(Principle 7) Planning of CCAs needs to consider multiple ecological processes, operating at multiple spatial and temporal scales.** These processes for terrestrial areas include: • Hydro-ecological processes • Trophic relations and functional interactions (especially for highly interactive species critical to top-down predator control of populations, seed dispersal and pollination). • Dispersive species especially migratory, nomadic and eruptive species • Metapopulation dynamics (especially for animal species with large home ranges) • Responses to climate change by species that involve large scale movement • Ecological refuges • Fire (in terrestrial and freshwater environments).

FOUNDATION CONCEPT **ACTIVE AND EFFECTIVE GOVERNANCE AND MANAGEMENT**	**Scientific principles of connectivity conservation and guidance notes that supports the selection criteria**
	(Principle 8) Planning of CCAs needs to consider evolutionary processes, both past and ongoing. This includes the need to prioritise evolutionary refugia, areas that are believed to be future sites of speciation, and also places that contain genetic diversity that may be important for adaptive responses including local adaptations Additional generic considerations: • Allow for uncertainty, by precautionary approaches such as risk spreading and inclusions of margins of error (McCook et al, 2009) • Allow for review and flexible adaptive management, as now information and understanding of connectivity emerges
	For Freshwater Areas • Planning for connectivity conservation management of a Freshwater CCA is essential.
	For Marine Areas • Planning for the management of marine CCAs is essential to achieve the connectivity conservation • Prioritization and implementation of actions within marine CCAs should be underpinned by explicit conservation objectives
CRITERION 12 **"RESEARCH"** The management of CCAs actively facilitates research that contributes to threat assessment, climate change forecasts, and prioritisation of management actions, performance evaluation and management effectiveness.	**For Terrestrial Areas** **(after Mackey et al, 2013 pp233-243)** **(Principle 12) CCAs should be managed adaptively.** As new knowledge comes to hand we need to have the flexibility to alter actions to accommodate that new information. Furthermore, some actions will have the dual role of delivering outcomes and information that can be used for adaptation.
	For Freshwater Areas • Research, closely integrated with management is essential for Freshwater CCAs.
	For Marine Areas • Investments in research for marine CCAs that contribute to their improved conservation management are fundamental.

FOUNDATION CONCEPT ACTIVE AND EFFECTIVE GOVERNANCE AND MANAGEMENT	Scientific principles of connectivity conservation and guidance notes that supports the selection criteria
	• Using the best available science is important; there may be risks in applying incomplete knowledge about connectivity, but these risks are minor compared to waiting until 'complete' knowledge is known (hence, why adaptive management is important) (McCook et al. 2008)
CRITERION 13 **"INSTRUMENTS"** A CCA helps facilitate a range of incentives and instruments that assist and benefit land, water or sea owners, traditional owners and other individuals and organisations actively contributing to connectivity conservation	**For Terrestrial, Freshwater and Marine Areas** **(after Mackey et al, 2013 pp233-243)** **(Principle 13)** Different instruments will need to be applied to managing the landscape depending on the scale of the corridor and local social and economic circumstances. Such instruments will range from voluntary conservation actions by private landowners and stewardship payments, tax-concessions or incentives that facilitate whole landscape or seascape conservation outcomes. **Note** Many such instruments are described in the Connectivity Conservation chapter of IUCNs 2015 Protected Area Governance and management Book (Pulsford et al. 2015)
CRITERION 14 **"EFFECTIVENESS EVALUATION"** A CCA is evaluated for biodiversity conservation outcomes at a whole-of-CCA scale in addition to project based and site based evaluation intra-CCA	**For Terrestrial Areas** **(after Mackey et al, 2013 pp233-243)** **(Principle 12)** CCAs should be managed adaptively. As new knowledge comes to hand we need to have the flexibility to alter actions to accommodate that new information. Furthermore, some actions will have the dual role of delivering outcomes and information that can be used for adaptation.
	For Freshwater Areas • The evaluation of management effectiveness for Freshwater CCAs is an integral part of CCA management.
	For Marine Areas • The effectiveness of management assessed relative to the planning objectives of marine CCAs is an essential contribution to CCA management.

7.5 Foundation Concept: Community Involvement and Benefits for People

A CCA provides an outstanding opportunity for individuals, communities, businesses, and different types of governments to work together to assist biodiversity conservation across land and/or freshwater and/or seascapes. Governments may facilitate CCAs, but they are not critical for this to happen (though usually it is an advantage if they are involved). CCAs empower people to contribute to biodiversity conservation at a large-scale and also to provide a response to climate change threats. CCAs provide many benefits for people and local communities. Conservation investments retain the naturalness, scenic integrity and the ecological integrity of a CCA. They help provide benefits of clean air, clean water, healthy environments, conservation, and working landscapes, freshwaterscapes and seascapes focused livelihoods. They include opportunities for cultural connections of people and communities to "country". Active management of a CCA would include equity considerations and benefits to all people. The following criteria (Table Seven) provide guidance for determining CCA "community involvement and benefits to people" attributes.

Table Seven: Foundation Concept: "Community Involvement and Benefits to People": Five Criteria

FOUNDATION CONCEPT COMMUNITY INVOLVEMENT AND BENEFITS TO PEOPLE	Guidance notes that support the selection criteria
CRITERION 15 **"COMMUNITY INVOLVEMENT"** A CCA is often a voluntary community initiative guided by a shared vision. It potentially receives facilitation and active on-ground, freshwater and on-sea connectivity conservation management and assistance from individuals, communities, Non-Government Organisations, private organisations, and governments. There is an investment in the sharing of knowledge, including local knowledge, indigenous understanding, and learning from science and research. The nature of community involvement has been described by Borrini-Feyerabend and Hill (2015).	**For Terrestrial Areas** • CCAs may encompass all types of landscapes and tenures and may include people in all of these settings. These people and others may actively participate in the conservation of connectivity. **For Freshwater Areas** • Local communities are typically directly involved with Freshwater CCAs **For Marine Areas** • Many local communities are directly involved in the management of marine CCAs, and elsewhere, many other communities contribute to such management • Educational information may be provided to coastal communities, management agencies and governments on the concepts and importance of maintaining connectivity in coastal and marine ecosystems • Local communities may establish partnerships to

FOUNDATION CONCEPT **COMMUNITY INVOLVEMENT AND BENEFITS TO PEOPLE**	**Guidance notes that support the selection criteria**
	facilitate the management of their marine CCAs.
CRITERION 16 **"HEALTHY COMMUNITIES"** A CCA contributes to enhanced community well-being through the retention and restoration of natural landscapes, freshwaterscapes and seascapes and the protection of ecological processes. Direct benefits for terrestrial areas include the minimisation of dust and pollutants; the generation of clean air; the provision of clean water from undisturbed catchments; soil erosion minimised through the natural vegetation cover protection and the buffering of severe storms and flooding through the retention of catchment vegetation cover. For marine environments, natural seascapes help maintain a sustainable fishery and healthy community.	**For Terrestrial, Freshwater and Marine Areas** Conserving natural environments, biodiversity, ecosystems and ecosystem processes is an essential part of safeguarding the biological life support systems of Earth. Humans are a direct beneficiary of the retention of these healthy environments
CRITERION 17 **"BENEFITS FOR AGRICULTURE"** An actively managed terrestrial CCA contributes services to agriculture including water from natural catchments; honey production(native flowering), insect pest reduction (native bird predation); trees for stock shade, weather protection; protection from rising salt; reduced weed impacts; reduced pest animal impacts and fire prevention and wildfire fuel reduction work. CCAs also provide benefits for sustainable use of freshwater and marine areas.	**For Terrestrial Areas** • CCAs are actively managed to a pre-determined minimum standard of biodiversity conservation performance or better, threats are reduced, and threats to agriculture are reduced **For Freshwater Areas** • CCAs bring benefits to agriculture through cleaner water and healthy riparian and lake habitats that benefit sustainable fishing **For Marine Areas** • Marine CCAs are actively managed to reduce threats to biodiversity with associated benefits to a managed and sustainable fishery
CRITERION 18 **"EQUITY AND BENEFITS TO PEOPLE"** Investments in CCAs provide opportunities for investments in people including matters of legitimacy and voice, fairness and rights, and dealing with issues such as setting directions, achieving performance and establishing accountability. Gender equity issues would be considered as part of these benefits (Borrini-Feyerabend and Hill, 2015 p190). Other benefits include regional based employment through	**For Terrestrial, Freshwater and Marine Areas** CCA strategic plans are guided by working with people and the needs of people. Detailed research also helps to identify key threats and priority connectivity conservation management response areas. These on-ground or on-water work investments provide opportunities for local employment

FOUNDATION CONCEPT **COMMUNITY INVOLVEMENT AND BENEFITS TO PEOPLE**	**Guidance notes that support the selection criteria**
active connectivity conservation management; on-site restoration and tourism management. For terrestrial areas this work could include carbon management; water catchment management; soil erosion prevention; restoration; and other work. Benefits of connectivity conservation have also been documented by Barbara Lausche (2013 pp29-39) and include climate change adaptation, climate change mitigation and biodiversity conservation.	
CRITERION 19 **"CULTURAL CONNECTIONS"** A CCA provides opportunities for connecting people to country and to sites of cultural significance.	**For Terrestrial Areas** • Many CCAs have cultural and/or spiritual significance to people and this special relationship may be recognised and managed for as part of the ongoing management of the CCA. In addition, working partnerships and positive cultural connections of individuals, community groups, NGO's and public and private sector partners are critical for CCA success.
	For Freshwater and Marine areas • Many Freshwater and Marine CCAs are of special cultural and/or spiritual significance and management of the CCA would recognise these special values

7.6 Different Types of CCA: Establishment Criteria

Four foundational concepts underpin eight different types of CCAs, however, not all of the 19 CCA criteria apply to all CCA types. This reflects a wide variation in CCA environments and a remarkable variation in migratory species types. A number of "core" criteria are common to all CCA types (Table Eight) and "International CCA" establishment recognition requires three core criteria for Foundation Concept "*Strategic Biodiversity Conservation*" and at least one core criterion from each of the remaining Foundation Concepts.

Table Eight: Four foundation concepts, 19 criteria and their application to CCA Types
(Including "core" or compulsory criteria for CCA establishment – **shown in bold**)

	Strategic connectivity conservation						Connectivity integrity			Active and effective governance and management						Community involvement and benefits to people				
CCA TYPE	**Strategic biodiversity conservation**	**Interconnected protected areas**	**Large-scale or significant area**	Climate change response	Species conservation	Strategic restoration (Whole-of-CCA)	Mostly undisturbed	**Restoration of connectivity (Site)**	Sustainable use and occupation by people	**Active management**	**Governance: - Co-ordination Group**	**Planned approach**	Research	Instruments	Effectiveness evaluation	**Community involvement**	Healthy communities	Benefits for agriculture or fishery	**Equity and benefits to people**	Cultural connections
1a	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
1b	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑		☑	☑
2a	☑	☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
2b	☑	☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
3a	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
3b	☑	☑	☑	☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	☑	☑		☑	☑	☑
4a	☑	☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	☑	☑	☑	☑				☑
4b	☑	☑	☑	☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	☑	☑				☑

KEY

TYPE 1	**TERRESTRIAL BIOME CCAs**
TYPE 1a	**Terrestrial species movement CCA**
Type 1b	**Terrestrial large-scale migration CCA**
TYPE 2	**FRESHWATER BIOME CCAs**
TYPE 2a	**Freshwater species movement CCA**
TYPE 2b	**Freshwater large-scale migration CCA**
TYPE 3	**MARINE BIOME CCAs (Including Estuarine)**
TYPE 3a	**Marine species movement CCA**
TYPE 3b	**Marine large-scale migration CCA**
TYPE 4	**FLIGHT CCAs**
TYPE 4a	**Bird flight migration large-scale CCA**
TYPE 4b	**Non-Bird flight migration large-scale**
☑	**Criteria applicable to the CCA Type**

8. CCA GOVERNANCE TYPES

CCA governance typically recognises the individual rights of people, communities, private companies and government organisations within the CCA and as well, for efficiency and co-ordination and facilitation reasons, it also recognises the benefits of a small co-ordination group to help facilitate connectivity conservation work. This CCA governance is about a small entity that holds the responsibility, authority and power to co-ordinate and facilitate an effective CCA. It may be an organisation, a community, a collaborative group or some individuals who provide the overall guidance and stewardship of a CCA. Technically, governance simply identifies who sets the objectives of management; who identifies how to pursue them and who decides how decisions are made (after Borrini-Feyerabend and Hill, 2015). A small governance "Co-ordination Group" would be responsible (for example) for establishing a management vision; for developing a Strategic Plan and for facilitating priority management actions for a CCA.

The governance of CCAs may include government, but it may also be quite different to the governance of single government departments or private organisations with their more formal reporting lines and procedures. CCAs may be informal with collaboration and partnerships between individuals and organisations a dominant approach. A spectrum of collaboration may be recognised, and has been described (Borrini-Feyerabend in Lausche et al. 2013 p45). CCA governance includes developing processes that build trust; work towards shared values and goals; and develop collaboration across the dispersed network of a CCA (Pulsford et al, 2015). Leadership and effective communication at multiple scales are also vitally important to the success of a CCA.

Implementation of CCAs around the world has confirmed (Worboys et al, 2010; Pulsford et al, 2015) the same four broad types of governance identified for protected areas and that have been described in greater detail by Nigel Dudley's 2008 "*Guidelines for Applying Protected Area Management Categories*" (Dudley 2008). They have also been recognised for conservation areas by Grazia Borrini-Feyerabend and Rosemary Hill's 2015, "*Governance of the Conservation of Nature"* (Borrini-Feyerabend and Hill, 2015). These broad types and their more specific sub-categories for CCAs are presented in Table Nine.

"*Governance by government*" identifies that national, sub-national or local governments (or a partnership of governments) may take a leadership role in establishing and managing a CCA. This would include the facilitation of CCA objectives with multiple stakeholders. "*Shared governance*" recognises that CCAs may be a multi-national initiative such as the trans-hemisphere "Bird Flyways" (CCA TYPE 4a) facilitated with multiple nations under instruments guided by the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals (UNEP-CMS 2014). Shared governance also identifies the need for specific transboundary governance at national levels. Collaborative partnerships are also recognised, as are joint management arrangements. There may also be shared governance arrangements at sub-national levels.

Table Nine. CCA TYPE versus Governance Type (Adapted for CCAs from Dudley 2008 and Borrini-Feyerabend et al. 2013))

	Governance by government			Shared governance				Private governance			Governance by indigenous peoples and local communities		
CCA TYPE	Leadership by federal or national ministry/agency in charge	Leadership by sub-national ministry or agency in charge	Leadership by Government delegated management (eg to a NGO)	Multi-nation governance leadership group	Transboundary governance leadership group	Collaborative leadership (various forms of pluralistic influence	Joint management (pluralist management board)	Leadership by individual private landowner(s)	Leadership by non-profit organisations such as NGOs	Leadership by for-profit organisations such as corporate owners, co-operatives	Leadership by local communities	Leadership by indigenous peoples	Leadership by ICCA's that are declared and run by local communities
1a						☑							
1b					☑	☑							
2a						☑							
2b						☑							
3a						☑							
3b				☑									
4a				☑									
4b				☑									

KEY

TYPE 1	**TERRESTRIAL BIOME CCAs**
TYPE 1a	**Terrestrial species movement CCA**
TYPE 1b	**Terrestrial large-scale migration CCA**
TYPE 2	**FRESHWATER BIOME CCAs**
TYPE 2a	**Freshwater species movement CCA**
TYPE 2b	**Freshwater large-scale migration CCA**
TYPE 3	**MARINE BIOME CCAs (Including Estuarine)**
TYPE 3a	**Marine species movement CCA**
TYPE 3b	**Marine large-scale migration CCA**
TYPE 4	**FLIGHT CCAs**
TYPE 4a	**Bird Flyway large-scale CCA**
TYPE 4b	**Non-Bird Flight Migration large-scale**
☑	**Commonly used governance type**

"*Private governance*" reflects an absence of government organisations in the CCA leadership role and includes CCAs facilitated by large NGO's. The WWF leadership for the Terai Arc CCA in Nepal is an example of this type of governance. Governance by "*Indigenous peoples and*

local communities" recognises that many CCAs are facilitated by local communities, including by indigenous peoples and by communities that manage for ICCA's.
Some types of CCAs, by their very nature, include a dominant governance type, such as the leadership by many nations that help secure protection for flyways (CCA TYPE 4a) through instruments such as multi-government treaties; memoranda of understanding; intergovernmental treaties and bilateral intergovernmental treaties UNEP-CMS 2014) (Table Nine). Many terrestrial CCAs (TYPE 1) are governed through collaborative leadership and many large mammal migratory routes (CCA TYPE 1b) involve transboundary governance arrangements given the movement of migratory animals across national borders (Table Nine).

International flyways provide a special governance setting. The dominant governance type, such as the leadership by many nations to protect flyways, may provide a governance framework, however many different kinds of governance types apply to the individual sites in the Flyway. It is the interaction between international, national and local, and the variety of governance types that make the connectivity aspect of flyways vital. For example: attempts to protect threatened shorebird populations in the Yellow Sea of China/Korea area bottleneck need to be achieved as this area threatens the survival of migratory birds.

9. CONCLUSION

A new dimension of biodiversity conservation in addition to and complementing protected areas has been recognised and established. The concept of CCAs has been grounded in theoretical science and defined inclusively to recognise: terrestrial; fresh water; estuarine and marine areas and for flight migration routes. CCAs provide a strategic opportunity to conserve biodiversity through connectivity conservation management and particularly over large-scale areas. They can assist in managing for climate change and provide enhanced conservation for protected areas, World Heritage properties, Ramsar wetlands and Key Biodiversity Areas. Their management typically includes the active participation, support and involvement of people who live, work and are associated with a CCA.

Eight "Types" of CCA have been identified by IUCN for Earth's terrestrial, freshwater, marine biomes and for flight routes. International CCAs are formally recognised based on four Foundational Concepts, 19 supporting criteria and nine "core" criteria. Formal recognition of an International CCA requires all three core criteria from the "Strategic Connectivity Conservation Foundation Concept" and at least one "core criteria" from each of the other "Foundation Concepts". This minimum standard ensures that the future WCMC CCA data base has integrity and consistency and that the future quantification of the contribution of CCAs to biodiversity conservation as part of the CBD Strategy Target 11 is possible and meaningful. The governance of CCAs recognises parallels of governance types identified for protected areas, though there are differences, with collaborative partnerships and co-operation being important along with the involvement of many governments in some CCA agreements, especially the trans-hemisphere migratory species agreements.

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RECOMMENDED READING

There are a number of connectivity conservation references that are recommended reading for anyone interested in connectivity conservation. They have been presented here in chronological order of their publication and the source references have been provided (above).

1999

Michael Soulé and John Terborgh (1999) produced an early (classic) edited volume on connectivity conservation with their text *Continental Conservation: Scientific Foundations for Regional Reserve Networks.* The book provides (from 30 experts) scientific principles for protecting living nature at spatial scales that extend across entire regions and continents.

2002

Connectivity has long been recognised as a critical component of the marine environment and Cowen *et al* 2002 and Gillanders et al 2003 describe a range of tools available to address the challenges of determining ecological connectivity.

2003

Andrew Bennett's IUCN book *Linkages in the Landscape* (2003) focused on the value of connectivity rather than the merits of corridors *per se*. It addresses the broader theme of landscape connectivity, its role in nature conservation and theoretical concepts that underpin this.

2004

Editors Rob Jongman and Gloria Pungetti's book *Ecological Networks and Greenways: Concept, Design, Implementation* (2004) combines theoretical concepts of landscape ecology with the actual practice of landscape planning and management.

2006

Jodi Hilty and her colleagues with their text *Corridor Ecology*, described the science and practice of linking landscapes for biodiversity conservation. They also described connectivity conservation benefits and some pitfalls and provided a conclusion that reinforced the critical importance of large corridors and ecological networks (Hilty et al, 2006).

2006

Kevin Crooks and M. Sanjayan (2006) in their edited compendium text *Connectivity Conservation* dealt with connectivity research, assessment, and implementation including past controversies about corridors. They concluded connectivity conservation was an essential tool for biodiversity conservation now and for the future.

2006

Anthony Anderson and Clinton Jenkins (2006) prepared the text *Applying Nature's Design: Corridors as a Strategy for Biodiversity Conservation*, which described the conceptual foundation for corridors, and discussed corridor design and implementation. The text assessed historical controversies about corridors and concluded that corridors were critically important for biodiversity conservation, especially in a climate change world.

2010

Graeme Worboys, Wendy Francis and Mike Lockwood's IUCN (2010) book, *Connectivity Conservation Management: A Global Guide* focused on management of large connectivity conservation areas, and provided a connectivity science chapter prepared by Jodi Hilty and Charles Chester.

2010

Peter Sale and numerous colleagues in a Connectivity Working Group co-authored *Preserving Reef Connectivity: A Handbook for Marine Protected Area Managers* (published by the Coral Reef Targeted Research and Capacity Building for Management Program, UNU-INWEH).

2013

In 2013, James Fitzsimons, Ian Pulsford and Geoff Wescott prepared their book titled, *Linking Australia's Landscapes: Lessons and Opportunities from Large-scale Conservation Networks*, with a brief insight to the science of connectivity prepared by Brendan Mackey and assisted by Graeme Worboys.

2014

The Great Barrier Reef has long been regarded as one of the best managed Marine Park Areas on the planet and the *Great Barrier Reef 2014 Outlook Report* (GBRMPA, 2014) refers to the importance of ecological connectivity and McCook *et al,* 2008 provided guidelines for incorporating connectivity into the protection of coral reefs.

2014

115 marine planning studies that addressed connectivity were identified by Magris et al, (2014) and they proposed a framework for incorporating connectivity into marine conservation planning.

2015

Ian Pulsford, David Lindenmayer, Carina Wyborn, Barbara Lausche, Maja Vasilijević and Graeme Worboys prepared Chapter 27, 'Connectivity Conservation Management in IUCN's 2015 *Protected Area Governance and Management* Book (Editors Worboys, G.L., Lockwood, M., Kothari, A., Feary, S. and Pulsford, I.)

ATTACHMENT ONE:
GLOSSARY OF SOME CONNECTIVITY CONSERVATION RELATED TERMS

(After Worboys et al, 2010 ppxxxi-xxxiv)

Biolink

A biolink is a defined geographic area in the state of Victoria, Australia that is the subject of a connectivity conservation vision and active conservation management

Core area

Core areas are natural areas possessing a high level of ecosystem integrity: in most countries they are designated as protected areas and often managed in accordance with the IUCN definition and guidelines (Dudley 2008).

Corridor (for wildlife)

This is a linear strip of habitat of varying lengths or widths that facilitates fauna movement between otherwise isolated patches of habitat (Lindenmayer and Burgman, 2005)

Ecological Corridor

Ecological corridors are defined functionally to indicate connectivity and as physical structures to indicate connectedness. They are functional connections enabling dispersal and migration of species that could be subject to local extinction and they are landscape structures (other than core areas) varying in size and shape from wide to narrow and from meandering to straight, which represent links that permeate the landscape and maintain natural connectivity (Jongman et al, 2004 p29).

Ecological Network

Ecological networks are systems of nature reserves and their interconnections that make a fragmented natural system coherent so as to support more biodiversity than in its non-connected form. An ecological network is composed of core areas (usually protected areas), buffer zones and ecological corridors (Jongman et al, 2004 p24)

Flyway

The entire range of a migratory bird species (or groups of related species or distinct populations of a single species) through which it moves on an annual basis from the breeding grounds to non-breeding areas, including intermediate resting and feeding places as well as the area within which the birds migrate (Boere and Stroud 2006)

Greenway

These are networks of land planned, designed and managed for various purposes but are compatible with sustainable landuse (Jongman et al, 2004 p34)

Habitat Corridor
A habitat corridor is a linear strip of vegetation that provides a continuous (or near continuous) pathway between two habitats. The term has no implication about its relative use by animals (Bennett, 2003)

Landscape Linkage
This is a general term for a linkage that increases connectivity at a landscape or regional scale (over distances of kilometres or tens of kilometres). Typically such linkages comprise broad tracts of natural vegetation (Bennett, 2003)

Linkage
An arrangement of habitat (not necessarily linear or continuous) that enhances the movement of animals or the continuity of ecological processes through the landscape (Bennett, 2003)

Migration
The regular annual movement of animals between different habitats, each of which is occupied for specific parts of the year; movement of individuals or whole populations from one region to another (Lindenmayer and Burgman, 2005)

Migratory species
The entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdiction boundaries (UNEP CMS 2014)

Stepping Stones
These are one or more separate patches of habitat in the intervening space between ecological isolates, providing resources and refuge that assist animals to move through the landscape (Bennett 2003).

ATTACHMENT TWO
RESOLUTIONS: IUCN CONNECTIVITY CONSERVATION ACTION

IUCN Recommendation, Resolution or Guidance	Subject	Guidance for action
Recommendation 1.38: **First WCC, Montreal, 1996**	Ecological Networks and Corridors of Natural and Semi-Natural Areas	Call to action (Key words): IUCN Members to further the development of ecological networks, national, regional, intercontinental level; review experience; promote co-operation across national frontiers
Programme of Work on Protected Areas Goal 1.2: **Kuala Lumpur 2004**	Connectivity	Goal (full text): "By 2015, all protected areas and protected area systems are integrated into the wider land- and seascape, and relevant sectors, by applying the ecosystem approach and taking into account ecological connectivity/and the concept, where appropriate, of ecological networks"
Resolution 3.057: **WCC Bangkok 2004**	Climate Change	(Adopted strategy) Biodiversity conservation and climate change mitigation and adaptation in national policies and strategies.
Resolution 4.035: **WCC Barcelona 2008**	Strengthening IUCN's work on protected areas	REQUESTED the IUCN Director General to support the development of national strategies that address the impacts of climate change on biodiversity through adequate integrated landscape and seascape management and effective protected area systems by, *inter alia*, developing guidelines and case studies of best practice in consultation with Commissions.
Recommendation 149 **WCC Jeju 2012**	Iberian Peninsula Ecological Corridors	Call to action (key words): Define boundaries; single natural environment; guarantee ecological connectivity; maintenance of biological diversity and ecological processes
Recommendation 152 **WCC Jeju 2012**	Ecological Corridor, NE Asia	Call to action (key words): Recognise the NE Asia Corridor; promote the NE Asia ecological corridor; expand and link protected areas; build long-term link-up methodologies
Recommendation 164 **WCC Jeju 2012**	Altitudinal Corridor, Andes	Call to action (key words): Recognize local strategies to connect, at a landscape level, the protected areas in the Andean region in terms of altitude, and to promote working programmes on this subject; give priority to landscape connectivity along altitudinal gradients, as a strategy to support the migration of species in the face of the effects of climate change
IUCN Recommendation, Resolution or Guidance	**Subject**	**Guidance for action**

Recommendation 180 **WCC Jeju 2012**	IUCN Engagement, CBD Plan	Call to Action (key words): IUCN maintains a strong focus on the delivery of the *Strategic Plan for Biodiversity 2011–2020* including Target 11. Target 11: " By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and **well connected systems of protected areas** and other effective area-based conservation measures, **and integrated into the wider landscapes and seascapes**"
Resolution 056 **WCC Jeju 2012**	Enhancing connectivity conservation through international networking of best practice management	NOTING connectivity conservation and ecological networks are a strategic part of landscape and seascape integration of protected areas. RECOGNIZING the critical importance of people in connectivity conservation areas, their values, rights, needs and aspirations, and the need for them to be part of an integrated approach to connectivity conservation areas as part of ecological networks and to enable them to share in the benefits of protecting connectivity REQUESTS States to consolidate and continue to establish national ecological networks and connectivity conservation areas to strengthen the protection of biodiversity, including, as appropriate, biological corridors and buffer zones around protected areas; CALLS ON States to continue to strengthen the integration of biodiversity and ecological connectivity in terrestrial and marine planning, including conservation planning and especially actions on climate change mitigation and adaptation; and ENSURES that IUCN plays an active role in facilitating the effective management of ecological networks and connectivity conservation areas including by supporting an ICCN; facilitating best practice information; providing guidance on legal aspects
Resolution 086 **WCC Jeju 2012**	Integrating protected areas into climate change adaptation and mitigation strategies	WELCOMES the work of the WCPA and its partners in improving understanding of the contribution of effectively managed, ecologically representative and well-connected systems of protected areas to ecosystem-based climate change adaptation and mitigation