

POLICY PERSPECTIVE

A Wilderness Approach under the World Heritage ConventionCyril F. Kormos^{1,2}, Bastian Bertzky^{3,4}, Tilman Jaeger⁵, Yichuan Shi^{4,6}, Tim Badman⁴, Jodi A. Hilty⁷, Brendan G. Mackey⁸, Russell A. Mittermeier⁹, Harvey Locke¹⁰, Elena Osipova⁴, & James E.M. Watson^{11,12}¹ The WILD Foundation, P.O. Box 9451, Berkeley, CA 94709, USA² International Union for Conservation of Nature, World Commission on Protected Areas³ European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES), Via Enrico Fermi 2749, 21027, Ispra VA, Italy⁴ International Union for Conservation of Nature, Rue Mauverney 28, 1196, Gland, Switzerland⁵ Independent Consultant and Adviser to the IUCN World Heritage Programme, Rio de Janeiro, Brazil⁶ United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), 219 Huntingdon Road, Cambridge CB3 0DL, UK⁷ Independent Ecologist, 1447 Ash Dr., Bozeman, MT 59715, USA⁸ Griffith Climate Change Response Program, Griffith University, Parklands Drive, Southport, QLD 4215, Australia⁹ Conservation International, 2011 Crystal Drive, Suite 500 Arlington, VA 22202, USA¹⁰ Yellowstone to Yukon Conservation Initiative, Box 4887 Banff, T1L 1G1, Alberta, Canada¹¹ Wildlife Conservation Society, Global Conservation Program, Bronx, NY 10460, USA¹² School of Geography, Planning and Environmental Management, University of Queensland, St. Lucia, QLD 4222, Australia**Keywords**

Climate change; conservation; World Heritage; wilderness.

Correspondence

Cyril F. Kormos, The WILD Foundation, P.O. Box 9451 Berkeley, CA 94709 USA.

Tel/Fax: +1 510 883 1424.

E-mail: cyril@wild.org

Received

19 January 2015

Accepted

31 July 2015

doi: 10.1111/conl.12205

Abstract

The World Heritage Convention could make a bigger and more systematic contribution to global wilderness conservation by: (1) ensuring the World Heritage List includes full coverage of Earth's wilderness areas with outstanding universal value and (2) more effectively protecting the ecological integrity of existing World Heritage sites. Here, we assess current coverage of global-scale wilderness areas within natural World Heritage sites and identify broad gaps where new wilderness sites should be identified for inclusion in the World Heritage List. We also consider how existing mechanisms under the Convention can improve the ecological integrity of existing sites by expanding or buffering them, and by promoting connectivity between World Heritage sites, between World Heritage sites and other protected areas, or both. We suggest that the Convention should consider a new mechanism called a "World Heritage Wilderness Complex" to facilitate a wilderness approach. Finally, we map three landscapes and one seascape to illustrate how World Heritage Wilderness Complexes might be implemented.

Introduction

Despite a burgeoning global human population, human influence varies around the world and there are many places where natural ecological and evolutionary processes operate with minimal human disturbance (Mittermeier *et al.* 2003). These wilderness areas provide vital ecosystem services including climate stabilization, water regulation, food security, and biodiversity protection (Mittermeier *et al.* 2003; MEA 2005). They are also home to thousands of indigenous cultures living at low densities and provide livelihoods to local communities around the world (Sobrevilla 2008). However, wilderness areas are under severe threat globally, particularly

from industrial activities and accelerating climate change (MEA 2005; Laurance *et al.* 2014; Mackey *et al.* 2014).

Wilderness quality can be defined in terms of remoteness from urban settlements and modern infrastructure and the degree of ecological impacts from industrial activity (Leslie *et al.* 1988). To identify wilderness areas of global significance, Mittermeier *et al.* (2003) specified three wilderness quality criteria and thresholds: (1) minimum size of 10,000 km², (2) sparsely populated with ≤5 people per km², and (3) relatively intact with ≥70% of primary habitat remaining on an ecoregion basis. While much has changed since Mittermeier *et al.* (2003) published their global map, with improved data resulting in the identification of new wilderness (e.g.,

Great Western Woodlands; Watson *et al.* 2008) and some wilderness areas being eroded (Laurance *et al.* 2012, 2014; Mackey *et al.* 2014), there is convergence that wilderness areas are biologically and ecologically largely intact landscapes that are mostly free of industrial infrastructure (Kormos 2008; Watson *et al.* 2009). The term “wilderness area” is therefore not exclusive of people, but rather of human uses resulting in significant biophysical disturbance. Here, we explore how one of the most powerful international conservation instruments could bolster wilderness conservation.

The Convention Concerning the Protection of the World Cultural and Natural Heritage, commonly known as the World Heritage Convention (“the Convention”), has helped protect many wilderness sites. Sixty-three (28%) of the 228 natural World Heritage sites (figures at June 1, 2015) overlap with one or more of the 24 global-scale wilderness areas identified by Mittermeier *et al.* (2003), including the 2 million hectare Okavango Delta and the 5.3 million hectare Amazon Conservation Complex World Heritage sites. These 63 sites have a mean area of over 1.3 million hectares and a median area of over 580,000 hectares per site and together cover over 85 million hectares, or 63% of the land area in natural World Heritage sites. Large World Heritage sites with strong wilderness values have also been inscribed outside the Mittermeier *et al.* (2003) wilderness areas, such as the Talamanca Range-La Amistad Reserves/La Amistad National Park spanning over 570,000 hectares in Costa Rica and Panama and marine areas such as Papahānaumokuākea at over 36 million hectares in the United States. Many sites, for example, in North America (Canadian Rocky Mountain Parks) and in Africa (Selous Game Reserve), have areas within them that are legally designated as wilderness (Kormos 2008). However, the Convention provides no or little protection to many globally important wilderness areas (Figure 1).

Here, we argue that there are significant benefits to a systematic approach to identifying and protecting wilderness areas under the Convention. We first summarize the key aspects of the Convention and then outline why the Convention should adopt a new approach to wilderness and what this approach would entail. We review existing tools under the Convention that enable a wilderness approach, and identify technical guidance and policy innovation necessary for implementing such an approach. Finally, we map three landscapes and one seascape to illustrate how a wilderness approach might be implemented.

The World Heritage Convention

The Convention was born out of concern that some of Earth’s most extraordinary natural and cultural sites were

being lost. The Convention seeks to protect cultural and natural heritage of “outstanding universal value,” i.e., sites around the world whose significance is “so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity” (UNESCO 2013). Sites with outstanding universal value are inscribed on the World Heritage List (“the List”).

The Convention’s Operational Guidelines (UNESCO 2013) list 10 criteria for determining outstanding universal value, four of which focus on natural areas. The natural criteria include esthetic value (vii), geological value (viii), ecological and biological processes (ix), and biodiversity (x), all of which have been used to inscribe sites with high wilderness quality. The guidelines include two further requirements for inscription: (1) a site must demonstrate “integrity”, meaning it must be in good condition and must contain all the elements needed to represent its outstanding universal value and (2) a site must demonstrate good protection and management, meaning the nominating States Parties must demonstrate their willingness and ability to maintain outstanding universal value in perpetuity. The guidelines also call on States Parties to generate a “balanced, representative and credible” List of the world’s cultural and natural heritage (UNESCO 2013). As a finite number of sites will meet the outstanding universal value requirement, the challenge is to identify the most appropriate sites for completing the List.

Why a wilderness approach is needed under the Convention and what it entails

A new approach is needed to ensure that the World Heritage List includes Earth’s most exceptional wilderness areas to improve its balance, representativeness and credibility, and to protect and manage the integrity of existing sites more effectively. We argue that a wilderness approach under the Convention would involve expanding the List by adding new sites to better represent wilderness areas with outstanding universal value, improving the integrity of existing sites by expanding or buffering them, and promoting connectivity between World Heritage sites, between World Heritage sites and other protected areas, or both.

Ensuring better wilderness coverage on the List

IUCN’s recent World Heritage studies on terrestrial biodiversity (Bertzky *et al.* 2013) and marine conservation (Abdulla *et al.* 2013) include analysis on wilderness protection. IUCN’s analysis shows that the List contains many large natural World Heritage sites that protect wilderness values, 63 of which overlap with one of 24 global-scale wilderness areas (Figure 1; Mittermeier

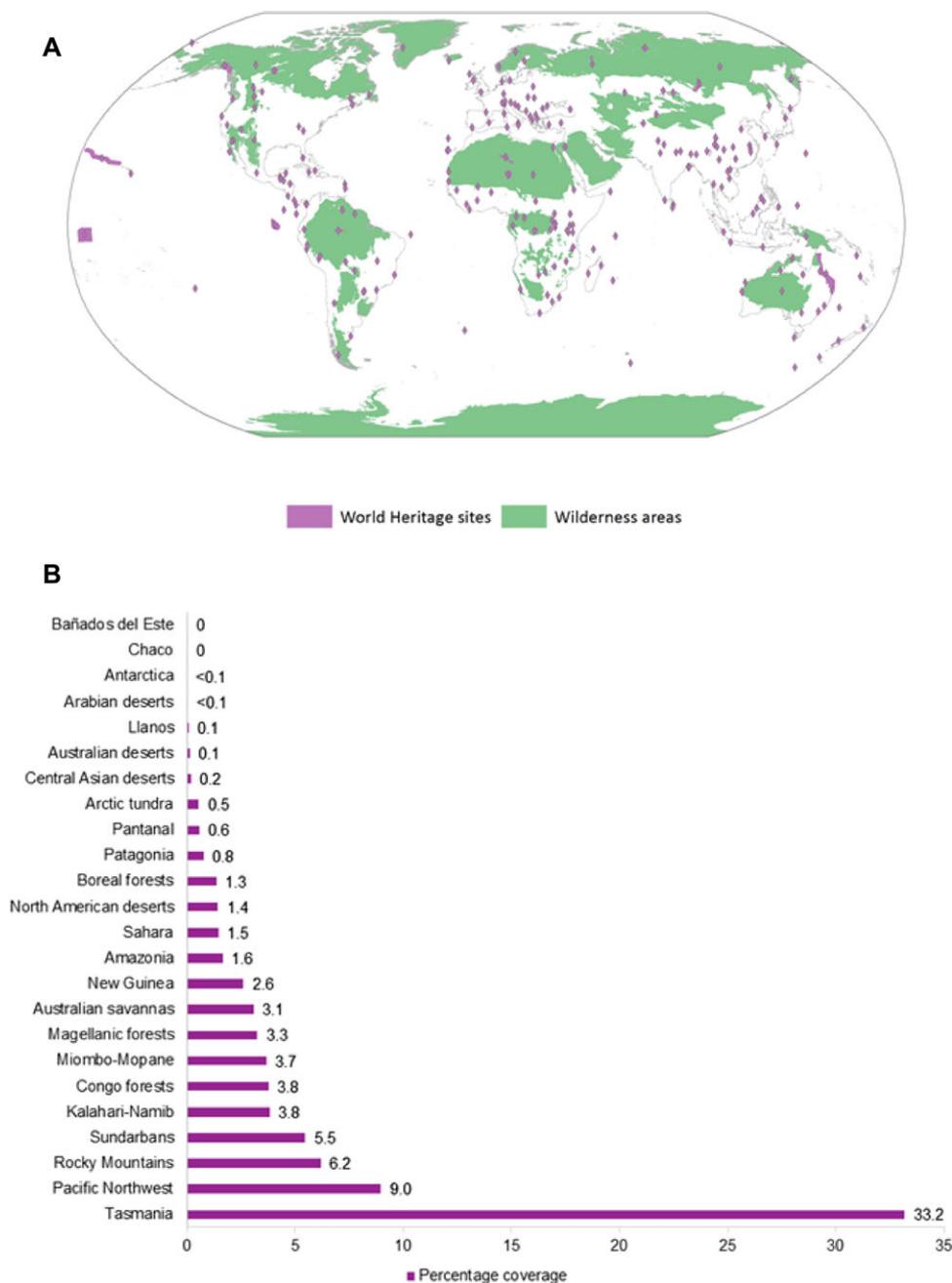


Figure 1 The locations of the 228 natural World Heritage sites against the 24 global-scale wilderness areas identified by Mittermeier *et al.* (2003) (A) and the current coverage (percentage of total area) of these wilderness areas in natural World Heritage sites (B). Names for the wilderness areas are the same as provided by Mittermeier *et al.* (2003).

et al. 2003). However, gaps are evident: two of the 24 global-scale wilderness areas are absent from the List, the Baños del Este wetlands in Uruguay and the Chaco dry forests in South America, and eight wilderness areas have <1% of their total area within natural World Heritage sites. These broad gaps highlight that additional

opportunities for wilderness conservation exist, though we recognize that the only broad-scale map of wilderness (Mittermeier *et al.* 2003) is out of date. Rapid habitat loss and accelerating climate change crises make it critical to develop an updated wilderness map to enable a formal gap analysis and secure World Heritage status for Earth’s

remaining terrestrial and marine wilderness areas with outstanding universal value.

The gap analysis should identify and prioritize for World Heritage nomination the most important wilderness sites within the broad gaps and beyond. The analysis should consider the potential of sites to meet one or more of the natural World Heritage criteria as well as the integrity, protection, and management requirements. Criteria would include the size, intactness, uniqueness, and representativeness (e.g., with regard to the major wilderness area or values concerned) of each site. Existing protected areas or indigenous and community conserved areas provide a good starting point for such an analysis because they usually already meet some of the Convention's protection and management requirements. The gap analysis should not be limited to the 24 major wilderness areas (Mittermeier *et al.* 2003; Figure 1) but should assess the best available data on remaining wilderness areas worldwide. The analysis should also identify potential for expanding existing World Heritage sites to better represent wilderness values and improve connectivity.

Ensuring the integrity of existing World Heritage sites

Ecological integrity

The integrity of many World Heritage sites depends on biodiversity that requires large, interconnected areas for its conservation. For example, wide-ranging mammals such as *Ursus arctos horribilis* (grizzly bear) in North American World Heritage sites require connectivity between protected areas to sustain viable populations (Chester *et al.* 2012). The absence of large predators very often changes community composition, dynamics, and vegetation structure (Ripple *et al.* 2014), eroding the site's outstanding universal value. Wilderness areas help maintain ecologically effective populations of keystone and other highly interactive species at regional scales (Soulé *et al.* 2004). Similarly, marine conservation areas may be compromised unless integrated with terrestrial conservation areas or other marine areas. For example, the Eastern Pacific Tropical Marine Corridor links several coastal and marine World Heritage sites to protect species as well as processes such as larvae dispersal, and to address common land-based threats to the marine environment (Ervin *et al.* 2010).

Great migrations and aggregations are spectacular natural processes and make major contributions to resource fluxes, transport, predator-prey interactions and food-web structure within and among ecosystems (Bauer & Hoye 2014), but are in very serious decline globally (Wilcove 2008). They are part of the basis for outstanding

universal value for a number of World Heritage sites, but are often poorly or only partially protected by World Heritage and other conservation areas (Berger 2004). For example, in the Greater Yellowstone Ecosystem, which includes Yellowstone National Park World Heritage site, 75% of *Antilocapra americana* (pronghorn antelope) migrations have been lost. Conservation of migrations requires new approaches such as that of the "Path of the Pronghorn," the United States' first federally designated migration corridor (Berger 2014).

The integrity of some World Heritage sites is also linked to areas to which they are not connected. Degradation of these areas could lead to species loss and compromised ecological processes in World Heritage sites. For example, Lake Natron in Tanzania is the breeding and nesting site of the *Phoeniconaias minor* (lesser flamingo), which is critical for the integrity of the Kenya Lake System in the Great Rift Valley World Heritage site (UNESCO 2011). However, the World Heritage Committee noted (Decision 38 COM 7B.91) in 2014 that Lake Natron is threatened by soda ash mining.

Responding to climate change

Adapting to rapid climate change is a growing challenge for most World Heritage sites (Osipova *et al.* 2014; UNESCO 2014). Four adaptation strategies have allowed species to survive previous climate change events: dispersal; phenotypic plasticity; microevolution; and retreat to refugia (Mackey *et al.* 2008). When these strategies are considered in planning, it becomes apparent that protecting large intact landscapes is the highest priority, no-regret response to climate change (Hilty *et al.* 2012; Watson *et al.* 2013) because these areas will protect multiple source populations across the environmental gradients occupied by the species, and maximize intraspecies genetic diversity and thus options for local adaptation and phenotypic plasticity (Mackey *et al.* 2008). It will also ensure that enduring features, such as topography or underlying geology, are protected, which may enable dispersal or retreat to refugia (Watson *et al.* 2009; Shoo *et al.* 2011). Protecting large intact areas will also sustain large-scale ecological processes, such as disturbance regimes, that sustain habitat resources, constitute selective forces to which species are adapted, or otherwise influence community composition (Soulé *et al.* 2004).

Some World Heritage sites are incorporating climate change adaptation into site design. For example, Mount Kenya National Park/Natural Forest in Kenya was expanded to include the Lewa Wildlife Conservancy and Ngare Ndare Forest, including a corridor to provide a crucial linkage to these new areas allowing *Loxodonta africana* (African elephant) and other species to disperse

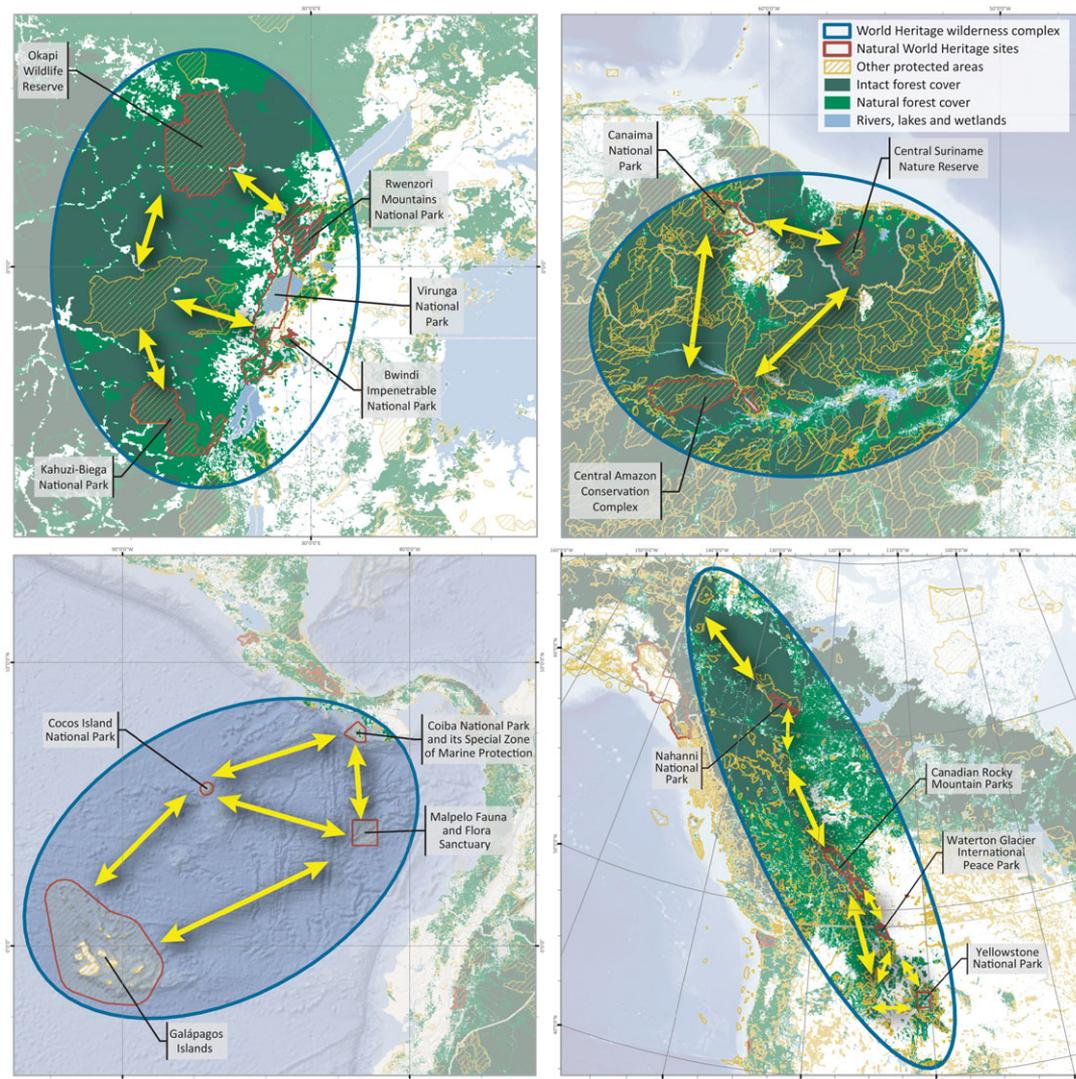


Figure 2 Four examples of how different World Heritage Wilderness Complexes could look like. The Albertine Rift World Heritage Wilderness Complex in Africa (A), the Guiana Shield World Heritage Wilderness Complex in South America (B), the Lower Yellowstone to Yukon (Y2Y) World Heritage Wilderness Complex in North America (C), and the Marine World Heritage Wilderness Complex in the Eastern Tropical Pacific Corridor (D).

(UNESCO 2014). Similarly, the Guanacaste Conservation Area in Costa Rica was expanded to link coastal areas to mountain ranges (UNESCO 2014). However, most sites have yet to take similar measures (UNESCO 2014).

Existing tools under the Convention to promote a wilderness approach

Several mechanisms under the Convention can help implement a wilderness approach. The first is the continued designation of large World Heritage sites, and contiguous extension of existing sites to embrace wilderness values. Serial World Heritage sites, defined as those

sites consisting of two or more separate components, each of which is necessary to fully represent a particular natural or cultural phenomenon, are also useful in promoting ecological integrity and connectivity (Engels *et al.* 2009). For example, the Rainforests of the Atsinanana in Madagascar, totaling six protected areas covering almost 500,000 hectares, illustrate the potential for serial sites to help protect large landscapes. Buffer zones, which are not technically part of a World Heritage sites but which the Operational Guidelines state should be included (UNESCO 2013), can also help implement a wilderness approach. Expanding buffer zones or adding them where they have not been included can improve connectivity

or the resilience of World Heritage sites (UNESCO 2009). Some World Heritage sites have extensive buffer zones. For example, the Okavango Delta's 2.3 million hectare buffer zone is larger than the site itself. Twinning agreements have also been used between countries to integrate management of World Heritage sites that have biological linkages, even if they are not part of the same ecosystem or even the same biome. For example, a twinning agreement was signed in 2014 between the Banc d'Arguin in Mauritania and the Wadden Sea, a serial site shared by Germany, Denmark, and the Netherlands, to improve protection of migratory birds along the East Atlantic Flyway that congregate in both sites. Recognition of contiguous sites in different countries as single transboundary World Heritage sites is another significant opportunity to support transnational wilderness conservation efforts.

Finally, the development of national Tentative Lists, a series of sites with potential outstanding universal value that a country, or a group of countries, intends to nominate for inscription, also presents opportunities. "Upstream processes," i.e., consultations between governments, technical experts, and civil society to evaluate sites with potential outstanding universal value, should include analysis of individual, serial, and transboundary sites with the most globally significant wilderness values.

Technical guidance to help implement a wilderness approach

Identifying wilderness gaps on the List requires definition of what qualifies as a wilderness area with outstanding universal value under each of the four natural criteria. Technical guidance exists that can inform this process. However, additional guidance on criterion (ix) to further clarify what is meant by "outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals" is likely necessary. Defining outstanding universal value with respect to wilderness sites and a review of existing World Heritage sites that qualify as wilderness sites, would help identify wilderness gaps, both within and outside of Mittermeier *et al.* (2003) wilderness areas, and candidate sites for filling those gaps. This approach could also identify potential for expanding existing World Heritage sites to protect wilderness values. IUCN is currently undertaking a study to identify wilderness gaps and candidate sites.

Given the essential role of local and indigenous communities in the conservation of wilderness areas, consistent consideration and additional analysis of the interplay between indigenous cultures and the maintenance of large landscapes with outstanding universal

value, as well as greater involvement in nomination processes, is essential to support nominations of sites with wilderness values by indigenous communities. In many cases, wilderness landscapes remain intact because they have been under indigenous stewardship for centuries or millennia. The need for further guidance on this critical nature – culture interplay was noted by the World Heritage Committee (Decision 37 COM 8B.19) in 2013.

The need for policy innovation: World Heritage wilderness complexes

Increased use of the Convention's existing tools may not fully enable a wilderness approach as they are not explicitly wilderness-focused. A new mechanism under the Convention – for example, a "World Heritage Wilderness Complex" – could help the Convention achieve its wilderness conservation potential. The key characteristics of a World Heritage Wilderness Complex ("Complex") would be that: (1) the Complex includes two or more existing World Heritage sites or a serial site and (2) 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. However, areas outside World Heritage sites that are included to provide connectivity would not be considered part of the World Heritage site, but would have specific protection policies to assure connectivity is maintained.

A World Heritage Wilderness Complex approach could be modular, beginning with two World Heritage sites or a serial site, but ultimately encompassing a larger landscape with additional World Heritage sites and connectivity conservation areas. This approach would be well-suited in many parts of the world, including where efforts are already underway to create or maintain connectivity.

We have mapped three landscapes and one seascape with potential to be recognized as World Heritage Wilderness Complexes to illustrate this approach: the Albertine Rift region; the Guiana Shield region; the Lower Yellowstone to Yukon region; and the Eastern Tropical Pacific Corridor (Figure 2). The maps show natural World Heritage sites and other protected areas from IUCN and UNEP-WCMC (2014), intact forest cover from Potapov *et al.* (2008), natural forest cover from Schmitt *et al.* (2009), and rivers, lakes, and wetlands from Lehner and Döll (2004). Arrows illustrate general connectivity corridors. They are indicative only and not meant to show exact pathways but highlight what a World Heritage Wilderness Complex could look like in practice.

Conclusion

A new wilderness approach under the Convention could identify opportunities for inscribing new wilderness sites to fill gaps on the List, improve the integrity of existing sites, and help engage indigenous peoples in the Convention's work. A new World Heritage Wilderness Complex mechanism would constitute a logical extension of existing wilderness conservation efforts under the Convention, and enable the Convention to show leadership in connectivity conservation practice. The designation of very large serial sites indicates willingness by States Parties to assess outstanding universal value at large landscape scales across multiple sites and de facto World Heritage Wilderness Complexes seem to be emerging in numerous regions. Enabling a World Heritage Wilderness Complex mechanism within the Convention would strengthen emerging practice while providing incentives for its more strategic application.

Acknowledgment

We thank Dr. William Laurance and two anonymous reviewers for their useful feedback on an earlier version of this manuscript. The opinions expressed in this article do not necessarily reflect the views or policies of IUCN or contributory organizations.

References

- Abdulla, A., Obura, D., Bertzky, B. & Shi, Y. (2013). *Marine natural heritage and the World Heritage List: interpretation of World Heritage criteria in marine systems, analysis of biogeographic representation of sites, and a roadmap for addressing gaps*. IUCN, Gland, Switzerland.
- Bauer, S. & H. B.J. (2014). Migratory animals couple biodiversity and ecosystem functioning worldwide. *Science*, **344**. doi:10.1126/science.1242552.
- Berger, J. (2004). The longest mile: how to sustain long distance migration in mammals. *Conserv. Biol.*, **18**, 320-332.
- Berger, J., Cain, S.L., Cheng, E., et al. (2014). Optimism and challenge for science-based conservation of migratory species in and out of U.S. National Parks. *Conserv. Biol.*, **28**, 4-12, doi: 10.1111/cobi.12235.
- Bertzky, B., Shi, Y., Hughes, A., Engels, B., Ali, M.K. & Badman, T. (2013). *Terrestrial biodiversity and the World Heritage List: identifying broad gaps and potential candidate sites for inclusion in the natural World Heritage network*. IUCN, Gland, Switzerland and UNEP-WCMC, Cambridge, UK.
- Chester, C.C., Francis, W.L. & Hilty, J.A. (2012). Yellowstone to Yukon, North America. In J.A. Hilty, C.C. Chester, M.S. Cross, editors. *Climate and conservation: landscape and seascape science, planning and action*. Island Press, Washington, DC.
- Engels, B., Ohnesorge, B. & Burmester, A., editors. (2009). *Nominations and management of serial natural World Heritage properties: present situation, challenges and opportunities*. Bundesamt für Naturschutz (BfN) Skripten - 248. Bonn.
- Ervin, J., Mulongoy, K.J., Lawrence, K., et al. (2010). *Making protected areas relevant: a guide to integrating protected areas into wider landscapes, seascapes and sectoral plans and strategies*. CBD Technical Series No. 44. Montreal, Canada: Convention on Biological Diversity.
- Hilty, J.A., Chester, C.C. & Cross, M.S. editors. (2012). *Climate and conservation: landscape and seascape science, planning, and action*. Island Press, Washington, DC.
- International Union for Conservation of Nature (IUCN) and United Nations Environment Programme World Conservation and Monitoring Centre (UNEP-WCMC) (2014). *The world database on protected areas (WDPA)* August 2014. UNEP-WCMC, Cambridge, UK.
- Kormos, C., editor. (2008). *A handbook on international wilderness law and policy*. Fulcrum Publishing, Golden, CO.
- Laurance, W.F., Useche, D.C. & Rendeiro, J. (2012). Averting biodiversity collapse in tropical forest protected areas. *Nature*, **489**, 290-294, doi:10.1038/nature11318.
- Laurance, W.F., Clements, G.R., Sloan, S., et al. (2014). A global strategy for road building. *Nature*, **513**, 229-232, doi:10.1038/nature13717.
- Lehner, B. & Döll, P. (2004). Development and validation of a global database of lakes, reservoirs and wetlands. *J. Hydrol.*, **296**, 1-22.
- Leslie, R.G., Mackey, B.G. & Preece, K.M. (1988). A computer-based methodology for the survey of wilderness in Australia. *Environ. Conserv.*, **15**, 225-232.
- Mackey, B.G., Watson, J.E.M. & Hope, G. (2008). Climate change, biodiversity conservation, and the role of protected areas: an Australian perspective. *Roy. Soc. Ch.*, **9**, 11-18.
- Mackey, B.G., DellaSala, D.A., Kormos, C., et al. (2014). Policy options for the world's primary forests in multilateral environmental agreements. *Conserv. Lett.*, doi:10.1111/conl.12120.
- Millennium Ecosystem Assessment (MEA) (2005). *Ecosystems and human well-being: current state and trends. Findings of the conditions and trends working group. Millennium Ecosystem Assessment Series*, Vol. 1. Island Press, London.
- Mittermeier, R.A., Mittermeier, C.G., Brooks, T.M., Pilgrim, J.D., da Fonseca, G.A.B. & Kormos, C. (2003). Wilderness and biodiversity conservation. *PNAS*, **100**, 10309-10313.
- Osipova, E., Shi, Y., Kormos, C., Shadie, P., Zwahlen, C. & Badman, T. (2014). *IUCN World Heritage outlook 2014: A conservation assessment of all natural World Heritage sites*. IUCN, Gland, Switzerland.
- Potapov, P., Yaroshenko A., Turubanova, S., et al. (2008). Mapping the world's intact forest landscapes by remote sensing. *Ecol. Soc.*, **13**(2): 51. <http://www.ecologyand-society.org/vol13/iss2/art51/>
- Ripple, W.J., Estes, J.A., Beschta, R.L., et al. (2014). Status and ecological effects of the world's largest carnivores. *Science*, **343**. doi: 10.1126/science.1241484.

- Schmitt, C.B., Burgess, N.D., Coad, L., *et al.* (2009). Global analysis of the protection status of the world's forests. *Biol. Conserv.*, **142**, 2122-2130.
- Shoo, L.P., Storlie, C., Vanderwal, J., Little, J. & Williams, S.E. (2011). Targeted protection and restoration to conserve tropical biodiversity in a warming world. *Glob. Change Biol.*, **17**:186-193.
- Sobrevilla, C. (2008). *The role of indigenous peoples in biodiversity conservation: the natural but often forgotten partners*. The World Bank, Washington, DC.
- Soulé, M., Mackey, B., Recher, H., *et al.* (2004). The role of connectivity in Australian conservation. *Pac. Conserv. Biol.*, **10**, 266-279.
- United Nations Educational, Scientific and Cultural Organization (UNESCO) (2009). *World Heritage papers No. 25: World Heritage and buffer zones*. O. Martin & G. Piatti, editors. UNESCO World Heritage Centre, Paris.
- United Nations Educational, Scientific and Cultural Organization (UNESCO) (2011). Decisions adopted at the 35th session of the World Heritage Committee (Paris, 2011), WHC-11/35.COM/20 (Kenya Lake System in the Great Rift Valley, Decision 8.B6).
- United Nations Educational, Scientific and Cultural Organization (UNESCO) (2013). Operational guidelines for the implementation of the World Heritage Convention. UNESCO, Intergovernmental Committee for the Protection of the World Cultural and Natural Heritage and World Heritage Center, WHC-13/37.COM/01, July 2013.
- United Nations Educational, Scientific and Cultural Organization (UNESCO) (2014). *World Heritage papers No. 37: climate change adaptation for natural World Heritage sites: a practical guide*. J. Perry and C. Falzon, editors. UNESCO World Heritage Centre, Paris.
- Watson, A.W.T., Judd, S., Watson, J.E.M., Lam, A. & Mackenzie, D. (2008). *The extraordinary nature of the Great Western Woodlands*. The Wilderness Society, Australia.
- Watson, J.E.M., Fuller, R.A., Watson, A.W.T., *et al.* (2009). Wilderness and future conservation priorities in Australia. *Divers. Distrib.*, **15**, 1028-1036.
- Watson, J.E.M., Iwamura, T. & Butt, N. (2013). Mapping vulnerability and conservation adaptation strategies in a time of climate change. *Nat. Clim. Change*, **3**, 989-994, doi: 10.1038/nclimate2007.
- Wilcove, D.S. (2008). *No way home: the decline of the world's great animal migrations*. Island Press, Washington, DC.