

# Comparative analysis methodology for World Heritage nominations under biodiversity criteria

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**A contribution to the IUCN evaluation of  
natural World Heritage nominations**

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**Final Version**



The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organisation. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.



*Comparative Analysis Methodology for World Heritage nominations under biodiversity criteria: A contribution to the IUCN evaluation of natural World Heritage nominations*, prepared by Elise Belle, Yichuan Shi and Bastian Bertzky.

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# Table of Contents

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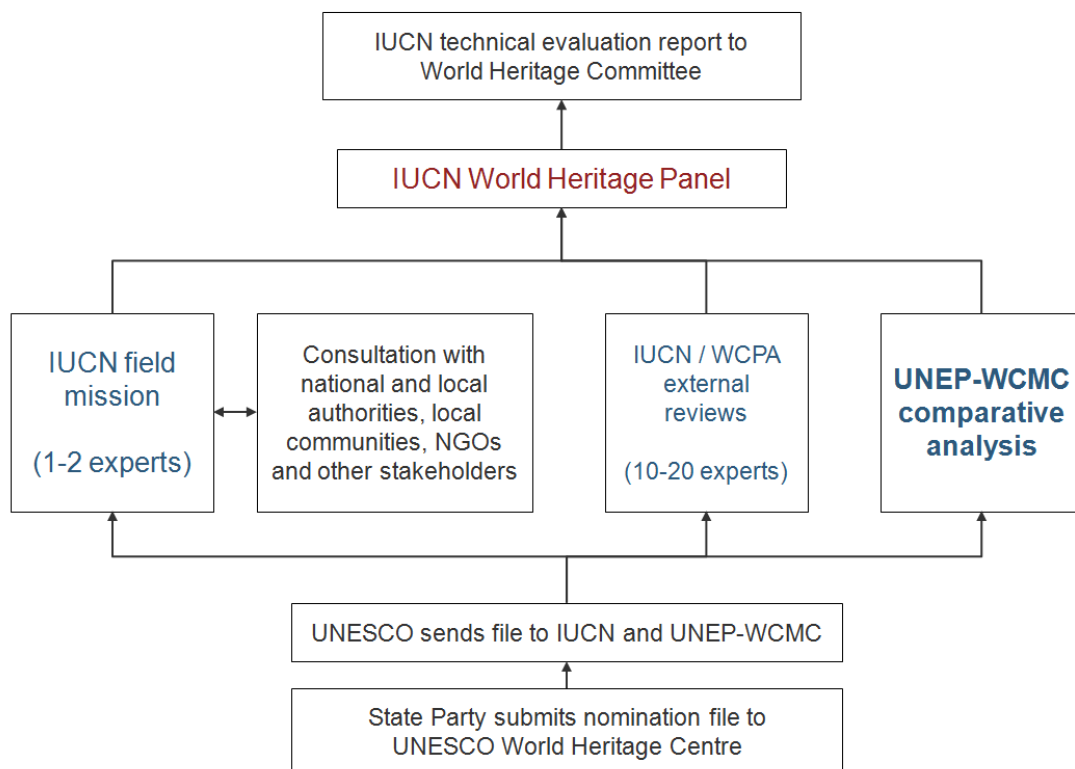
	Page Number
Introduction	4
Spatial analyses and interpretation	7
Literature review	13
Standard references used in comparative analyses	15

# Introduction

One of IUCN's roles under the World Heritage Convention is to provide technical advice on natural heritage to the World Heritage Committee in relation to the evaluation of new nominations to the World Heritage List.

The IUCN World Heritage (WH) Panel, made of conservation experts, meets at least once a year to conduct an evaluation of all nominations of natural and mixed properties to the WH List, leading to a panel recommendation on the IUCN position in relation to each new nomination. The Panel also provides comments to the International Council on Monuments and Sites (ICOMOS) in relation to nominations of cultural landscapes to the WH List, provides advice in support of IUCN's contribution to the annual cycle of State of Conservation Reports on inscribed WH sites, and input to the development of IUCN's work on WH.

Only sites nominated under the natural criteria (vii) to (x) are evaluated by IUCN for inscription on the WH List. For sites nominated under biodiversity criteria, criteria (ix) and (x), UNEP-WCMC provides comparative analyses to help inform IUCN's recommendations (Figure 1 and Box 1) based on the agreed methodology developed jointly by IUCN and UNEP-WCMC and outlined in this report.



**Figure 1.** Flow chart illustrating the IUCN evaluation process.

**Box 1.** World Heritage selection criteria, with natural criteria in italics, including biodiversity criteria in bold characters.

- (i) to represent a masterpiece of human creative genius;
- (ii) to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;
- (iii) to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;
- (iv) to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;
- (v) to be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change;
- (vi) to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria);
- (vii) to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;
- (viii) to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;*
- (ix) to be 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;***
- (x) to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.***

This document presents the methodology used to carry out the comparative analyses of the nominated sites under biodiversity criteria. Overall these comparative analyses seek to support the IUCN WH Panel in the assessment of the following general questions regarding each nomination:

- 1) What are the key arguments, or biodiversity values, for Outstanding Universal Value (OUV) proposed in the nomination file (e.g. particular species,

ecosystem values, biological/ecological patterns or processes, richness or rarity)?

- 2) Which existing WH sites, Tentative List sites and other protected area are included in the comparative analysis because they support similar values and/or share a comparable biogeographic context (e.g. same ecoregion or same biome and realm combination)?
- 3) How does the nominated site compare to these existing sites in relation to its biodiversity values (e.g. in terms of irreplaceability, vulnerability, representativeness and integrity)?

In relation to each of the biodiversity criteria, these considerations are operationalized in more specific questions as described below, based on the actual wording of the criteria and the corresponding conditions of integrity in the Operational Guidelines of the World Heritage Convention.

# Spatial analyses and interpretation

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## Evaluation under criterion (ix)

*“Be 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”*

Question 1: Does the nominated property represent ecosystems/communities that are currently underrepresented or not represented on the World Heritage List?

GIS analyses are carried out to determine the number of existing WH sites and Tentative List sites found in the same biogeographical unit as the nominated property (Table 1), namely the same:

- Udvardy biogeographical province;
- Terrestrial realm/biome/ecoregion; and
- Marine province/ecoregion (for marine sites).

The GIS boundary of the nominated property is overlaid on top of the above layers to determine its presence within these units. Having identified where the nominated property is located, a reverse step is employed to look at existing natural WH sites that may or may not be present in the same biogeographical units.

The same process is then repeated using Tentative List sites<sup>1</sup>.

A map is also included, showing the nominated property, existing biodiversity WH sites and other existing natural WH sites in the context of Udvardy's biogeographical provinces (Udvardy 1975). Similar maps could also be included in relation to other classifications, such as terrestrial ecoregions or marine provinces if required.

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<sup>1</sup> Note that due to poor Tentative List data, results identified through this process are manually checked using best available references to ensure findings are reliable.

**Table 1.** Biogeographic context of the nominated property.

	<b>Nominated property</b>	<b>World Heritage sites in same biogeographic unit (biodiversity sites in bold)</b>	<b>Tentative List sites potentially in same biogeographic unit (biodiversity sites in bold)</b>
<b>Biogeographical province</b> (Udvardy 1975)			
<b>Terrestrial realm - biome combination</b> (Olson et al. 2001)			
<b>Terrestrial ecoregion</b> (Olson et al. 2001)			
<b>Marine province</b> (Spalding et al. 2007)			
<b>Marine ecoregion</b> (Spalding et al. 2007)			

Table 1 is discussed in the main text in order to assess the level of representativity of existing WH sites and Tentative List sites found in the same biogeographical units as the nominated property.

If the ecosystems in which the nominated property is found have been highlighted in one of IUCN/UNEP-WCMC thematic studies, it is also highlighted in this section, along with additional relevant references found in the literature.

Question 2: Are these ecosystems/communities globally significant, and is the nominated property the best example, or one of the best examples, of these ecosystems/communities?

GIS analyses are carried out to determine whether the nominated site belongs to one of the following broad-scale conservation priorities (Table 2):

- Terrestrial biodiversity hotspot
- High biodiversity wilderness area
- Terrestrial/freshwater/marine global 200 priority ecoregion
- Endemic Bird Area
- Centre of Plant Diversity

In addition, marine priority areas will now also be considered based on the recent study of Selig et al. (2014).

These analyses are similar to the ones carried out in Question 1. They provide useful information on whether the conservation priority areas where the nominated site is found are already represented by existing WH sites or Tentative List sites (with possibly superior features).



**Table 2.** The nominated property in the context of broad-scale global conservation priorities.

	<b>Nominated property</b>	<b>World Heritage sites in same priority region (biodiversity sites in bold)</b>	<b>Tentative List sites potentially in same priority region (biodiversity sites in bold)</b>
<b>Terrestrial biodiversity hotspot</b> (Mittermeier et al. 2004, Williams et al. 2011)			
<b>High biodiversity wilderness area</b> (Mittermeier et al. 2002)			
<b>Terrestrial Global 200 priority ecoregion</b> (Olson & Dinerstein 2002)			
<b>Freshwater Global 200 priority ecoregion</b> (Olson & Dinerstein 2002)			
<b>Marine Global 200 priority ecoregion</b> (Olson & Dinerstein 2002)			
<b>Endemic Bird Area</b> (Stattersfield et al. 1998)			
<b>Centre of Plant Diversity</b> (Davis et al. 1994, 1995 and 1997)			

Table 2 is discussed in the main text. This analysis helps determine whether the nominated property is found within broad scale global conservation priorities, and assess the current level of representativity of existing WH sites and Tentative List sites found in the same broad scale global conservation priorities as the nominated property. More information is also provided on these priority areas and the relative significance of the nominated property within them, along with additional references found in the literature if relevant.

## Evaluation under criterion (x)

*“Contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation”*

Question 1: Is the nominated property the most diverse and/or representative, or one of the most diverse and/or representative, of its kind?

If the nominated property is part of a terrestrial biodiversity hotspot, the percentage of hotspot species in the nominated property (based on the data found in the nomination file) is compiled (Table 3), and described in the main text.

**Table 3.** Species richness and endemism in the biodiversity hotspot where the nominated property is found and in the nominated property (Conservation International 2013 and nomination files)

Taxonomic Group	Species in hotspot	Endemic species in hotspot	Percent endemism in hotspot	Species in nominated property	Percentage of hotspot species in nominated property
Plants					
Mammals					
Birds					
Reptiles					
Amphibians					
Freshwater Fishes					

In this section, we also compare the species diversity (fauna and flora) found at the nominated site with other WH sites in two different ways:

1. Number of species found according to nomination file and WH datasheets maintained by UNEP-WCMC and IUCN; and
2. Indicative number of species that may be found based on their geographic range (globally-assessed species on the IUCN Red List of Threatened Species).

We first compare the number of species found according to the nomination file to the number of species in other relevant existing WH sites (and Tentative List sites if the information is available) as indicated by the nomination file and WH datasheets (Table 4). Where necessary, this is supplemented with information from previous IUCN evaluation reports, UNESCO's Tentative List database, and other relevant sources (e.g. scientific literature, see section below).

In this section, we also summarise the biodiversity present at the property, including both the flora and fauna, as described in the nomination file.

**Table 4.** Comparison of the nominated property with relevant existing WH sites for which species numbers were available.

Property, State Party	Total area (ha)	Natural WH criteria	Mammal species	Bird species	Fish species	Plant Species	Other relevant taxa	References/Notes
Nominated property								Nomination
Other WH Sites or Tentative List Sites								Data Sheet

However, sometimes the number of species reported does not reflect the reality on the ground; the number of species can for instance be inflated (i.e. by including

subspecies) by States Parties in order to give more weight to the nomination, or on the contrary, it can be unrealistically low due to a lack of comprehensive biodiversity surveys having been carried out at the property.

In order to gain more insights into the possible number of species which could be present within the property, we perform another complementary analysis: we look at the indicative number of species that may be found based on their geographic range using globally-assessed species on the Red List of Threatened Species (Table 5).

A GIS overlap analysis is carried out between every such species and the nominated property. The result is then aggregated into different taxonomic groups as well as threatened/non-threatened categories. This process is repeated for all existing WH sites with similar geographic settings or within the same conservation priorities. Having them listed in the same table (Table 5), it becomes easy to compare overall species richness and threatened species richness between sites.

**Table 5.** Indicative number of species and threatened (TH) species with a distribution range that overlaps with the nominated property and other relevant natural WH sites.

Site name	All taxa considered	All TH taxa considered	Amphibians	TH Amphibians	Mammals	TH Mammals	Birds	TH Birds	Reptiles	TH Reptiles
Nominated property										
Other WH Sites										

However, it is very important to note that these species numbers are generated by overlaying the WH boundaries in the WDPA with the recorded species ranges in the IUCN Red List of Threatened Species. These species numbers are only indicative due to data limitations, and should not be confused with confirmed species numbers for these sites.

Question 2: Has the nominated property been identified as a global conservation priority, for example for globally threatened or restricted-range species?

This section mostly focuses on the number of endemic and threatened species found in the nominated property compared to other relevant WH sites and Tentative List sites.

This information is first extracted from the nomination file and, if possible, checked against other external references. For instance, when possible, additional references, including distribution ranges are researched for all endemic species mentioned.

Regarding the number of threatened species, if the nomination file provides a list of globally threatened species, this list is checked against current data on the IUCN Red List website. However, the nomination file often lists only species that are nationally threatened; in this case, these species are again checked against the IUCN Red List data to determine whether or not they are also globally threatened.

In addition, like for the total number of species, we also look at the indicative number of threatened species that may be found in the property based on their geographic ranges (globally assessed species on the IUCN Red List of Threatened Species) (Table 5).

Again, it is important to note that the numbers of threatened species are generated by overlaying the GIS boundaries with the recorded species ranges in the IUCN Red List of Threatened Species as being Critically Endangered (CR), Endangered (EN) or Vulnerable (VU). The numbers are only indicative due to data limitations and should not be confused with confirmed threatened species numbers for these sites.

Finally, GIS analyses are carried out to determine whether the nominated site belongs to one of the following site-scale global conservation priorities:

- Alliance for Zero Extinction sites (AZEs); and
- Key Biodiversity Areas (KBAs) other than AZEs (e.g. Important Bird Areas / IBAs)

This analysis follows the same steps used in determining biogeographical representations (see Table 1) and identifying gaps for broad-level conservation priorities (see Table 2). Both current natural WH sites and Tentative List sites are cross examined against the nominated property (Table 6).

**Table 6.** The nominated property in the context of site-scale global conservation priorities.

	Nominated property
<b>Alliance for Zero Extinction sites (AZEs)</b> (Alliance for Zero Extinction 2010)	
<b>Key Biodiversity Areas (KBAs) other than AZEs: e.g. Important Bird Areas (IBAs)</b> (BirdLife International, Conservation International, and partners 2011)	

Table 6 is described in the main text, with additional details on the AZEs and/or KBAs, and additional information on species or populations of particular interest (as mentioned in the nomination file) are also given.

# Literature review

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Three types of documents are used to complement the spatial analyses:

- Nomination file
- External references
- IUCN/UNEP-WCMC thematic studies

## Nomination file

The data provided in the nomination file are used throughout the comparative analysis document, both under criteria (ix) and (x), but caution is used when interpreting these data. When possible, the data provided are also checked against other relevant publications.

## External references

An independent search for relevant external references is carried out (both of peer reviewed journal articles and the grey literature) to complement the comparative analyses.

## IUCN/UNEP-WCMC thematic studies

Over the past 30 years, IUCN and IUCN/UNEP-WCMC have produced a series of global thematic studies on natural WH. In some cases, these provide additional information that is relevant for the evaluation of existing and candidate biodiversity sites.

Table 7 summarizes relevant clues from these studies in relation to the nominated property. IUCN recently published a series of global gap analyses, two of the most recent being on Terrestrial Biodiversity and the WH List (Bertzky et al. 2013) and Marine Natural Heritage and the WH List (Abdulla et al. 2013).

In addition, the results of the irreplaceability analyses (Le Saout et al. 2013) are also considered in this section. Here we assess whether the nominated site overlaps with a PA with a high irreplaceability score, that is to say amongst the 100, 500 or 1,000 most important PAs overall according to the study.

**Table 7.** Overview of clues from global thematic studies.

<b>Global thematic studies</b>	<b>References to the nominated property</b>
World's Greatest Natural Areas (IUCN CNPPA 1982)	
Forests (Thorsell and Sigaty 1997)	
Wetlands & Marine (Thorsell et al. 1997)	
Biodiversity (Smith and Jakubowska 2000)	
Mountains (Thorsell and Hamilton 2002)	
Biogeography, Habitats and Biodiversity (Magin and Chape 2004)	
Central Asia (Magin 2005)	
Caves and Karst (Williams 2008)	
Volcanoes (Wood 2009)	
Deserts (Goudie and Seely 2011)	
African Natural Heritage (Bertzky and Kenney 2011)	
Terrestrial Biodiversity and the WH List (Bertzky et al. 2013); PAs and effective biodiversity conservation (Le Saout et al. 2013)	
Marine Natural Heritage and the WH List (Abdulla et al. 2013)	

## Standard references used in comparative analysis

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The latest references included in the comparative analysis (published in 2013 or 2014) are listed with an asterisk; this excludes websites which are regularly updated.

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Abell, R., M.L. Thieme, C. Revenga, et al. (2008) Freshwater ecoregions of the world: A new map of biogeographic units for freshwater biodiversity conservation. *BioScience* 58 (5): 403-414.

Allen, G.R. (2007) Conservation hotspots of biodiversity and endemism for Indo-Pacific coral reef fishes. *Aquatic Conservation: Marine and Freshwater Ecosystems* 18: 541-556.

Alliance for Zero Extinction (2010) 2010 AZE Update. Online: [www.zeroextinction.org](http://www.zeroextinction.org)

Bertzky, B. and S. Kenney (2011) African Natural Heritage: Possible Priorities for the World Heritage List. UNEP-WCMC, Cambridge, UK and IUCN, Gland, Switzerland.

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# Annex. Details of GIS Analyses

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## **Software:**

ArcGIS 10.x, PostGIS 1.5/PostgreSQL 8.4

## **Data preparation:**

1. Boundaries of the nominated properties are first digitised in ArcMap using the best available information, which is usually a high resolution base map included in the nomination file.
2. The WDPA schema is used as a template to complete the attribute data for the newly created GIS boundaries, i.e. temporary WDPA IDs, criteria, country codes etc.
3. All biogeographical classifications, conservation priorities and Red List species range datasets are updated using latest releases. Consistency checks are carried out to ensure data integrity, for attributes and geometries.

## **Procedures of analysis:**

### Biogeography and conservation priorities

1. All relevant data, including natural WH boundaries, boundaries of the nominated sites, biogeographical classifications and conservation priorities, hereafter referred to as 'base layers', are imported in the PostGIS/PostgreSQL environment.
2. A spatial overlap between the nominated property and a base layer is calculated. The aim is to find regions at different scales, hereafter referred to as 'base units', (for example, in the Udvardy biogeographical classifications, it would be provinces and realms) where the nominated site intersects.
3. Once base units are identified, they are used to intersect with the natural WH boundary to determine whether they have been represented by existing sites already. Similarly, point localities of Tentative List sites are also overlaid with these units to examine their representation. Lastly, for better comparisons, complete attributes are appended to the intersection result.
4. Step 2 and 3 are then repeated between each nominated property and all biogeographical classifications (e.g. Terrestrial Ecoregions of the World, Udvardy, Marine Ecoregions of the World) and conservation priorities (e.g. Global 200 priority ecoregions, biodiversity hotspots, high biodiversity wilderness areas, AZEs, other KBAs such as IBAs).
5. An automatic process is employed using Python to retrieve results and organise the content in an Excel spreadsheet for each nominated site.

Note: Due to limited computing capacities, the current process does not work out true intersections (i.e. the geometry of the actual overlap) and the result may

therefore contain false intersections due to inconsistent boundaries between different datasets. This is largely mitigated by manually checking the resulting table. It is envisaged in the future to include an automatic fact checking process to resolve this issue, for example by examining the percentage overlap with regard to the size of the nominated property.

### Species richness

A script based on the 'Select By Location' function in ArcMap is used to intersect each nominated property with all species that have been assessed globally for the IUCN Red List (RL) of Threatened Species. Higher taxonomy and RL category information are appended to the attribute in the spatial data. Number of species, number of threatened species and these stats by each taxon are worked out by grouping and subdividing the result.

To enable comparisons with existing natural WH sites located in similar biogeographical settings or conservation priorities, the above approach is repeated using all current sites. Finally an aggregated table with results from both the nominated sites and existing WH sites is created to facilitate the comparison.

Note: For reasons explained in the main text, the findings from this analysis aim to complement information on the species numbers included in the nomination files. The comparison using species richness from this approach is indicative at best due to data limitations and should not be seen as the comparison of actual species richness.

### Species irreplaceability

The methodology follows the same procedure as documented in Le Saout et al. (2013) and Bertzky et al. (2013). It is also briefly documented at the following address: <http://irreplaceability.cefe.cnrs.fr/about>.