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

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Acronyms and abbreviations

ABNJs	Areas Beyond National Jurisdiction
AZEs	Alliance for Zero Extinction sites
CoML	Census of Marine Life
EBAs	Endemic Bird Areas
EBSAs	Ecologically or Biologically Significant Areas
EEZs	Exclusive Economic Zones
GBIF	Global Biodiversity Information Facility
GOODS	Global Open Ocean and Deep Sea Classification
IBAs	Important Bird Areas
ICM	Integrated Coastal Management
ICCROM	International Centre for the Study of the Preservation and Restoration of Cultural Property
ICOMOS	International Council on Monuments and Sites
IUCN	International Union for Conservation of Nature
KBAs	Key Biodiversity Areas
LIPS	Large Igneous Provinces
MEOW	Marine Ecoregions of the World
MPA	Marine protected area
mWHS	Marine World Heritage sites
Mya	Million years ago
MSP	Marine Spatial Planning
OBIS	Ocean Biodiversity Information System
OUV	Outstanding Universal Value
WH	World Heritage
WHS	World Heritage site
WIO	Western Indian Ocean
WSSD	World Summit on Sustainable Development
UNCLOS	UN Convention on the Law of the Sea
UNEP-WCMC	United Nations Environment Programme World Conservation Monitoring Centre

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Foreword

The 1972 World Heritage Convention is one of the most significant international environmental agreements, recognizing the highest level of common concern for protecting sites of Outstanding Universal Value. Since its outset the Convention has been concerned with the oceans, seas and coasts of our "blue planet". Australia's spectacular Great Barrier Reef was one of the first listings, and a continuing series of iconic marine sites has been added to the list.

But a convincing and updated "road map" or "navigational chart" to ensure the application of the World Heritage Convention to marine ecosystems globally is needed to ensure that the Convention addresses the diversity of the marine realm, and can make a relevant contribution to the new and growing challenges that face our planet and its oceans in the 21st Century. As the Advisory Body to the World Heritage Convention for natural heritage, IUCN is pleased to launch the present study, in order to enhance the use of the Convention to protect oceans and seas in the territories of the signatory States Parties, including their Exclusive Economic Zones (EEZ), while finding ways to secure conservation of wildlife and habitats in the areas of ocean beyond the jurisdiction of any individual country (the High Seas).

The interest in more comprehensive marine representation on the World Heritage List can be traced to the 1994 Global Strategy of the World Heritage Committee and the 1997 paper on Wetland and Marine Protected Areas on the World Heritage List, followed by a UNESCO/IUCN/UN Foundation workshop in Hanoi, Vietnam in 2002. As follow-up to the latter, three pilot projects were developed with national and international partners to promote serial and trans-boundary approaches. In 2003 a workshop was held in conjunction with the IUCN World Parks Congress in Durban, South Africa, for site managers and experts to discuss the development of a partnership-based World Heritage Marine Programme and the World Heritage Marine Site Manager's Network. This was followed by work to prepare a provisional World Heritage Marine Strategy, and ideas were generated to convene a workshop to discuss marine World Heritage nomination opportunities. The following year a US$ 3.135 million United Nations Foundation/Global Conservation Fund supported project was initiated by UNESCO and Conservation International in the Eastern Tropical Pacific. Alongside these efforts, a marine policy workshop was held in Paris to further develop the marine approach under the Convention.

In the most recent phase of thinking, leading to this study, a marine World Heritage workshop, convened by IUCN in partnership with UNESCO and with support of the Kingdom of Bahrain, was held in 2009, leading to the Bahrain Action Plan for Marine World Heritage, published in 2010. This concluded that while regional representation is important, attention should also be given to a properly balanced approach to different types of marine ecosystems under the World Heritage Convention. This would ensure that in addition to coral reefs (that now form about 40 per cent of the inscribed World Heritage marine sites) the World Heritage List also includes the most outstanding examples of other types of marine ecosystems, such as kelp forests, seamounts, rocky reefs, polar habitats, among others. Nations need assistance to achieve this and there is a clear need for better guidance.

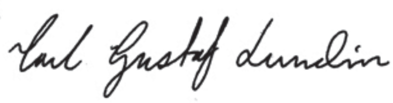
To address this concern, while also incorporating lessons from recent pilot studies coordinated by the UNESCO World Heritage Centre, IUCN has developed this thematic study, with notable technical support coordinated by our partners UNEP-WCMC, and the support of many contributors and reviewers. IUCN would like to thank in particular the exceptional work of the authors of the study, and all those who have contributed to it. We particularly thank the Arab Regional Centre for World Heritage (ARC-WH), headquartered in the Kingdom of Bahrain, for the sustained partnership supporting the study and marine World Heritage, following up on the 2009 meeting that started the process in Bahrain, and in particular their support for translation and printing of the study.

The study provides better technical assistance on understanding the Convention and the criteria and guidance to address major gaps relating to marine World Heritage. It outlines a new thematic framework for applying the natural criteria to marine World Heritage, giving attention to all four of the criteria as entry points for marine World Heritage listing. It includes new and updated analysis on the coverage of marine World Heritage, including identifying biogeographic gap provinces that provide a framework for future joint work by States Parties and their partners, and reflecting the shared responsibility we have for the High Seas, as areas that transcend national borders. The regional and cooperative follow-up approach recommended here mirrors the one suggested in the recent global gap analysis for terrestrial World Heritage. IUCN considers this approach essential to determine those individual and serial sites that will be convincing nominations, able to meet not only the relevant World Heritage criteria, but also the requirements of integrity and protection and management that are prerequisites for inclusion on the World Heritage List.

Lastly the study opens some of the challenges to be addressed and that will undoubtedly affect what we recognize as marine World Heritage. These include the relative lack of available data for the marine realm, which may lead to new ideas coming to light, as new areas are explored and discovered, and also perhaps as new threats are identified. These challenges also include a central need to look beyond natural heritage in examining marine World Heritage. This is currently a limitation of the UNESCO Marine Programme and the next decade should see a common approach to recognizing marine World Heritage as encompassing cultural heritage, and the intimate links between people and nature across vast swathes of our ocean that are recognizable as cultural seascapes, including those areas where traditional ways of life are threatened. The third and fundamental challenge is the fact that marine World Heritage exists beyond the areas where individual States have responsibility, in the High Seas, beyond national borders where responsibility for protection is only able to be taken internationally. World Heritage will need to wrestle with both the technical limitations and the legal instruments necessary to make a relevant contribution to the protection of all outstanding areas of our common oceans.

IUCN stands ready to assist States Parties and the marine community, working in partnership with the UNESCO World Heritage Centre and our partner advisory bodies ICOMOS and ICCROM, to realize the challenges and opportunities posed by this study to recognize, and to protect for future generations, the marine World Heritage of our blue planet.

Tim Badman
Director
IUCN World Heritage Programme



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Executive summary and recommendations

The *Convention concerning the Protection of the World Cultural and Natural Heritage* was adopted by the General Conference of UNESCO in 1972. The primary objective of the Convention is to identify and protect the world's natural and cultural heritage considered to be of "Outstanding Universal Value" (OUV). The marine World Heritage thematic study was written to provide guidance to States Parties and conservation practitioners on how to best apply the World Heritage Convention in the oceans and seas. The study proposes a scientific framework as the foundation for a well-balanced and representative set of features that may be of Outstanding Universal Value to inform choices when nominating or inscribing sites. It also analyses the current biogeographic coverage of marine World Heritage sites (mWHS) and identifies broad gaps in representation. Specifically, Chapter One introduces the World Heritage Convention and how it relates to marine ecosystems, while Chapter Two provides guidance on interpreting the World Heritage criteria for "Outstanding Universal Value" in relation to marine systems, and on applying these criteria to the nomination of marine sites for potential inclusion on the World Heritage List. Chapter Three examines the current distribution of mWHS and identifies areas with potential to include sites of Outstanding Universal Value but which are currently un- or underrepresented. Finally, Chapter Four provides guidance on processes for developing a more representative network of mWHS.

The World Heritage Convention provides the potential for a comprehensive legal and policy framework that allows for the identification, management, governance, and protection of the world´s most outstanding natural marine areas. There are currently 46 sites included in the World Heritage List that have been designated primarily for their marine natural features of Outstanding Universal Value. In addition to these 46 sites, 25 other natural and mixed WH sites contain marine areas or features of marine interest. For future designations, this study suggests a framework of 16 broad themes of marine and ocean features to which natural World Heritage criteria might be applied in the development of mWHS. In regard to criterion (vii), the study recommends the criterion be invoked (for the largest, fastest, highest, deepest, etc.) for a natural feature, but usually (but not exclusively) that feature will have satisfied one of the other three natural criteria in addition to criterion (vii). Extending the application of the World Heritage Convention to the marine environment requires a significant expansion of features that could be classed under criterion (viii). From a focus on geology and geomorphology, this criterion most naturally is able to encompass the physical components of oceanography. Finally, in keeping with the recent World Heritage thematic study on terrestrial biodiversity, this report recommends that ecosystems, communities and the processes that underpin them be considered under criterion (ix), while criterion (x) is used with a focus on species, in particular of threatened species with high global value, and the importance of key sites and habitats in achieving their survival.

Currently, there is a relatively small number (46 of 981 or 4.7%) of WHS that have been inscribed for their outstanding marine values, and these marine WHS represent predominantly tropical ecosystems as opposed to temperate and polar ecosystems. A large majority of the world's 62 nearshore biogeographic provinces (47 provinces or 76%) do not contain any mWHS or contain a low (<1%) coverage that is not likely to capture the full range of values and features present in these provinces. Finally, a large proportion of the world's offshore provinces, representing 40% of all global oceans, do not contain any mWHS. In order to fulfill the World Heritage Committee's Global Strategy of developing a representative, balanced and credible World Heritage List, States Parties are encouraged to increase their efforts, with the support of IUCN, the UNESCO World Heritage Centre, and regional and global marine scientists and conservationists, to identify and nominate marine sites of potential OUV, especially in biogeographic regions that are not yet represented, or underrepresented, on the WH List.

- This thematic study proposes two main linked approaches, data-driven and expert-driven, to address the gaps in biogeographic representation of mWHS. Also, it provides a foundation to identify priorities and develop nominations of appropriate sites that also meet the rigorous integrity and protection and management requirements of the Convention. Specific recommendations and next steps for States Parties include to:

- Promote the information needs of and standardize data collection for marine World Heritage in scientific and research communities to ensure that the best available data informs decision-making in nomination and designation;

- Review and re-examine existing World Heritage sites and sites on the Tentative List with a focus on the 16 marine themes proposed by this study to evaluate priority nominations and/or revisions to designated WH sites;

- Review planned and existing marine protected areas for potential to be added to national tentative lists;

- Fund and conduct national and larger scale marine biodiversity inventories with a particular focus on the gap provinces presented in this study and the 16 marine themes;

- Utilize current work on IUCN Key Biodiversity Areas and CBD Ecologically and Biologically Significant Areas and the World Heritage criteria to highlight ABNJ sites with OUV potential; and

- Develop an independent process under the World Heritage Convention to complement wider and more complex UNCLOS discussions to select, nominate, and evaluate sites of potential OUV in the high seas.

1. Introduction to marine World Heritage: the Convention, criteria, and relevance to marine ecosystems

1.1 The importance of the marine environment and its different features

Planet Earth should be more aptly named Planet Ocean as we live in a world of oceans (see Box 1.1). Over 70% of the surface of Earth and more than 95% of the volume of habitable space is ocean. In the past decade modern science has come to recognize the variety and beauty of the marine world, but also the essential role it plays in keeping the planet functioning. Oceans and seas contain the bulk of the water, process essential gasses, removing carbon dioxide and producing life-giving oxygen. They contain the least explored areas on Earth, habitats that exist nowhere else, such as the underwater sulphur volcanoes, and unique communities such as those around deep sea thermal vents that gain their energy from chemical reactions rather than the sun. Our knowledge of the marine realm is growing rapidly as new species and critical habitats are discovered every day.

1.2 The purpose of this study

The purpose of this study is to provide guidance to States Parties on how to best apply the World Heritage Convention in the oceans and seas. The study proposes a scientific framework as the foundation for a well-balanced and representative set of features that may be of Outstanding Universal Value (OUV) that will help to inform choices when nominating or inscribing sites. The study also analyses the current biogeographic coverage of marine World Heritage sites (mWHS) and identifies broad gaps in representation. Both the framework and analysis are intended to help increase the number of successful nominations and thus significantly add to the credibility of the World Heritage List in representing marine OUV. A number of documents provide useful information that is relevant and necessary for nomination of mWHS, but not all of these are easily available or accessible. This thematic study on marine World Heritage pulls together the disparate information and tools on sites of exceptional value in marine areas and guidance on how to nominate new sites.

Box 1.1 Planet Ocean

- Over 70% of the Earth's surface is covered by oceans
- Oceans are home to 80% of the world's biodiversity
- About half of the Earth's human population lives in coastal regions
- 10% of the Earth's surface is covered with marine ice
- Oceans produce over 50% of the oxygen in the atmosphere
- Only 2.9% of the world's oceans are protected
- Less than 0.2% of the high seas are protected

Thus, this study aims to:

1. Describe and clarify the nomination process of the World Heritage Convention with particular reference to marine sites;
2. Clarify and interpret criteria (vii), (viii), (ix) and (x) in the context of the natural values and features of marine systems; and
3. Identify biogeographic gaps in the distribution of mWHS.

Chapter One introduces the World Heritage Convention and how it relates to marine ecosystems, while Chapter Two provides guidance on interpreting the World Heritage criteria for "Outstanding Universal Value" in relation to marine systems, and on applying these criteria to the nomination of marine sites for potential inclusion on the World Heritage List. Chapter Three examines the current distribution of mWHS and identifies areas with potential to include sites of Outstanding Universal Value but which are currently un- or underrepresented. Finally, Chapter Four provides guidance on processes for developing a more representative network of mWHS.

1.3 The World Heritage Convention, properties, and marine ecosystems

The *Convention concerning the Protection of the World Cultural and Natural Heritage* was adopted by the General Conference of UNESCO in 1972. The primary mission of the Convention is to identify and protect the world's natural and cultural heritage considered to be of "Outstanding Universal Value" (OUV). OUV is the central concept of the Convention and the threshold that sites must meet to be inscribed on the World Heritage List, and is defined in the Operational Guidelines[1] to the World Heritage Convention as: *cultural and/or natural*

[1] UNESCO 2012, see: http://whc.unesco.org/en/guidelines/

significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity. As such, the permanent protection of this heritage is of the highest importance to the international community as a whole.

To elaborate further on the concept of OUV, IUCN has suggested the following points that should be considered:

Outstanding – The site should be *exceptional*. The World Heritage Convention sets out to define the geography of the superlative – the most outstanding natural and cultural places on Earth.

Universal – The scope of the Convention is *global* in relation to the significance of the properties to be protected as well as its importance to all people of the world. Sites cannot be considered for OUV from only a national or regional perspective.

Value – This implies clearly defining the *worth* of a property, ranking its importance based on clear and consistent standards, including the recognition and assessment of its integrity.

An essential point is that for a site to be regarded as being of OUV it must not only meet one or more of the World Heritage criteria, but also meet rigorous requirements regarding its integrity (see section 2.7), and its protection and management.

The World Heritage Convention provides a unique framework for securing the conservation of the world's most important natural and cultural places. The Convention establishes the World Heritage List, which includes natural, cultural and mixed (cultural and natural) properties. It promotes co-operation among all nations and peoples to contribute effectively to the protection of these important sites. The Convention is governed by the World Heritage Committee, and its Secretariat is the UNESCO World Heritage Centre, based at UNESCO headquarters in Paris. IUCN, with the International Council on Monuments and Sites (ICOMOS) and International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) are the independent technical Advisory Bodies to the World Heritage Committee.

As of August 2013, following the 37th Session of the World Heritage Committee, the World Heritage List contains 981 terrestrial and marine sites, including 759 cultural, 193 natural, and 29 mixed properties, all recognized for their outstanding universal cultural and/or natural values, located in 160 countries[2]. They include many of the 'household names' of conservation such as the Serengeti, Ngorongoro, Galapagos Islands, Grand Canyon and Great Barrier Reef. The total area of natural World Heritage properties is almost 2,660,000 square kilometres – over 10% of protected areas worldwide, (and including almost 19% of the area of all marine protected areas). These special places face many significant challenges, from direct degradation due to local human pressure, lack of political support, lack of sustainable financing, to global indirect stressors such as climate change impacts.

The World Heritage Convention is a high profile global conservation agreement that can both recognize the outstanding importance and quality of the most exceptional marine natural and cultural sites, and act as a global mechanism to secure their conservation. Unfortunately, the Convention has not been applied to its full potential in the marine environment, and thus one of the key challenges for the Convention is to enhance its application to oceans and seas. The context for marine conservation globally has changed significantly since the World Heritage Convention was adopted in 1972. The boundaries of coastal states in 1972 extended at most to a maximum of 12 nautical miles (nm) from coastal baselines but by 1982 new boundaries were agreed extending coastal state sovereign rights and jurisdiction out to 200 nm from shore and to the natural prolongation of the seabed out to 350 nm[3].

The oceans, covering 71% of Earth's surface, contain rich, largely unexplored, undersea worlds from the sea surface to the seabed, with an average depth of 3,790 metres, and extreme depths of over 10 km. Currently, it is estimated that only about 2.93% of Earth's coastal and marine areas have any form of protected status[4], and only 0.01% of the global area is reserved as "no-take", fully protected from extractive uses[5]. While the number and extension of marine protected areas (MPAs) is growing, progress has been slow[6], even as countries strive to meet the World Summit on Sustainable Development (WSSD) target to establish representative networks of MPAs by 2012. With the recent designation of a number of very large MPAs (such as Phoenix Islands Protected Area, Kiribati), the total area protected has accelerated although effectiveness of protection is still a question[7]. The Convention on Biological Diversity has presented a new target for 2020 by when 10 per cent of coastal and marine areas should be conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and integrated into wider landscape and seascapes[8].

2 See http://whc.unesco.org/en/list
3 Sometimes, depending on the thickness of the sediment, this is extended even further.
4 Spalding *et al.* 2013
5 Laffoley and Langley 2010
6 Wood *et al.* 2008
7 Spalding *et al.* 2013
8 Target 11 of the CBD, adopted at COP 10, Nagoyo, Japan in 2010

As noted above, natural World Heritage sites protect c.2,660,000 km^2 of the planet's land and marine waters, and this figure includes c.643,000 km^2 of inland lands (c.24%) and c.455,000 km^2 of coastal and island lands (c.17%). About 1,562,000 km^2 (c.59%) of this total area is located in offshore marine waters[9,10] due to a few very large mWHS. Marine World Heritage properties are flagship sites and contain features that are recognized by the international community for their outstanding natural beauty, extraordinary biodiversity, or unique ecological, biological and geological processes. These iconic sites demonstrate the importance, quality and variety of marine habitats, and encourage nations to do more to protect other areas in waters under their jurisdiction.

However, despite all efforts, only 46 (4.7%) of 981 existing WH sites are formally recognized for Outstanding Universal Value of their marine natural values (Figure 1.1). This is around 20% of all natural sites, and the area included in these marine sites is extremely large relative to other classes of WHS due to the very large size of some marine listings (notably Papahānaumokuākea, Phoenix Islands Protected Area, and Great Barrier Reef which are, by a considerable margin, the three largest World Heritage sites). Many marine areas and ecoregions with outstanding marine values are not yet represented on the World Heritage List. Furthermore, ocean areas beyond the governance jurisdiction of any individual country cover half the surface of the Earth, a vast area with areas of potential Outstanding Universal Value that currently goes unrecognized and unprotected. Though the Convention only establishes a mechanism for the identification and listing of heritage sites in areas under national jurisdiction, the methodology of nomination and the criteria and standards that have been recognized by the signatory parties to the Convention can potentially be used as a model to prioritize efforts both in areas under national jurisdiction and areas beyond national jurisdiction in the high seas.

For the purpose of this study, marine natural World Heritage is defined in two categories of sites:

- Forty-six natural or mixed World Heritage sites for which marine natural values have been identified as the principal reason, or one of the main reasons, for inscription on the World Heritage List (e.g. Great Barrier Reef and the Sian Ka'an Biosphere Reserve). These are the sites that are currently included in the marine programme of the UNESCO World Heritage Centre. Despite some limitations, this selection makes up the *de facto* network of mWHS at present.

In a separate category, we present 25 World Heritage sites that are:

- Natural or mixed sites with marine areas / values, but that have not been inscribed formally on the basis of these marine features (e.g. Pitons Management Area, Saint Lucia).
- Natural or mixed World Heritage sites that have coastal components with no marine areas included, but with a clear marine/coastal aspect to their values (e.g. Dorset and East Devon Coast).

It should be noted that marine features in these 25 sites may not necessarily meet standards of OUV. One implication of the present study is the need to evaluate the coverage of marine features in natural and mixed World Heritage sites, as well as for sites that are listed for cultural values such as cultural landscapes/seascapes.

Of the multiple and overlapping conventions relevant to marine conservation, the World Heritage Convention provides a specific means for safeguarding the world's most outstanding and biologically diverse marine areas within national jurisdiction. Successful application of the Convention involves legal protection, conservation action, local and national pride, and possible contributions towards sustainable development. The World Heritage Convention can operate at multiple spatial scales, from an international level down to the level of grassroots local engagement. There are, however, significant challenges to achieving effective application of the Convention to our oceans and seas. Progress in representing the full diversity of the marine environments and its features is far behind what might be expected by comparison to terrestrial World Heritage sites, despite the small number of very large marine areas inscribed. In addition, there are major challenges to effective networking across the existing properties, effective management of their OUV and ecological integrity, and issues concerning the adequacy of data on marine World Heritage properties and values.

1.4 Nominating sites by States Parties[11]

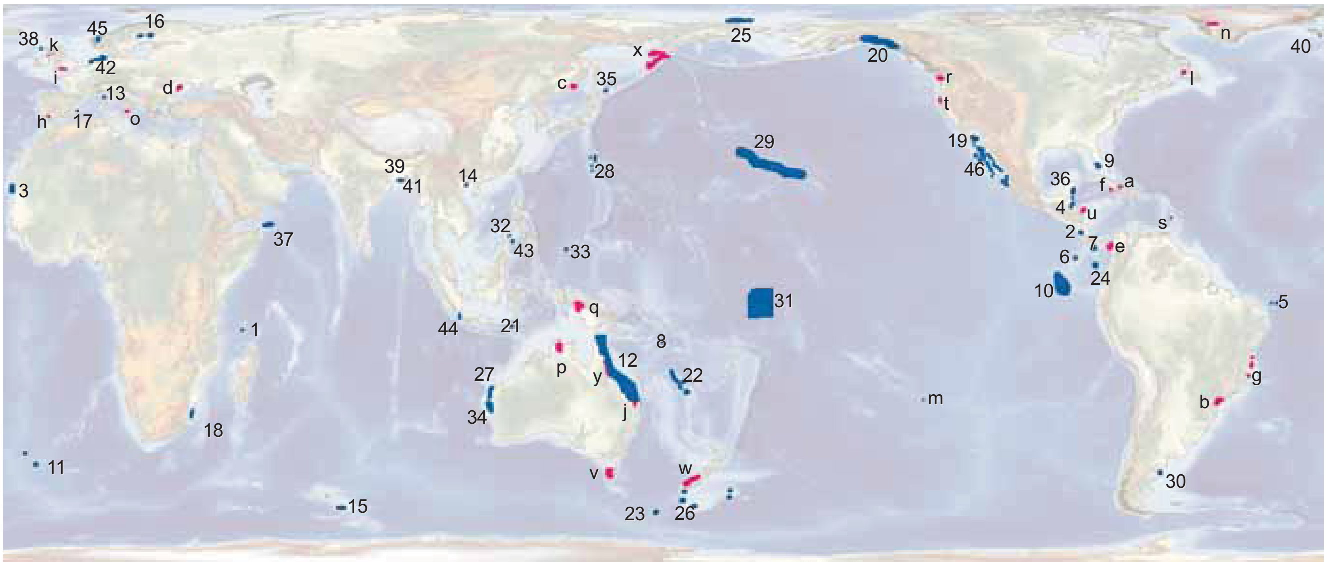
Countries that have signed the World Heritage Convention, pledging to protect their natural and cultural heritage, can submit nomination proposals for properties on their territory to be considered for inclusion in UNESCO's World Heritage List. The first step a country must take is to make an 'inventory' of

[9] With the 2010 inscription of Phoenix Islands Protected Area (Kiribati) and Papahānaumokuākea (United States), and the Ningaloo Reef (Australia) in 2011, marine areas protected under the World Heritage Convention more than doubled

[10] IUCN and UNEP-WCMC (2012)

[11] UNESCO 2011

Figure 1.1 Natural and mixed World Heritage sites with marine components.



46 natural World Heritage sites recognized for inscription in relation to marine values

25 other natural World Heritage sites that include a marine component

ID	Name	Country
1	Aldabra Atoll	Seychelles
2	Area de Conservación Guanacaste	Costa Rica
3	Banc d'Arguin National Park	Mauritania
4	Belize Barrier Reef Reserve System	Belize
5	Brazilian Atlantic Islands: Fernando de Noronha and Atol das Rocas Reserves	Brazil
6	Cocos Island National Park	Costa Rica
7	Coiba National Park and its Special Zone of Marine Protection	Panama
8	East Rennell	Solomon Islands
9	Everglades National Park	United States of America
10	Galápagos Islands	Ecuador
11	Gough and Inaccessible Islands	United Kingdom
12	Great Barrier Reef	Australia
13	Gulf of Porto: Calanche of Piana, Gulf of Girolata, Scandola Reserve	France
14	Ha Long Bay	Viet Nam
15	Heard and McDonald Islands	Australia
16	High Coast / Kvarken Archipelago	Sweden; Finland
17	Ibiza, Biodiversity and Culture	Spain
18	iSimangaliso Wetland Park	South Africa
19	Islands and Protected Areas of the Gulf of California	Mexico
20	Kluane / Wrangell-St Elias / Glacier Bay / Tatshenshini-Alsek	USA; Canada
21	Komodo National Park	Indonesia
22	Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems	France
23	Macquarie Island	Australia
24	Malpelo Fauna and Flora Sanctuary	Colombia
25	Natural System of Wrangel Island Reserve	Russian Federation
26	New Zealand Sub-Antarctic Islands	New Zealand
27	Ningaloo Coast	Australia
28	Ogasawara Islands	Japan
29	Papahānaumokuākea	United States of America
30	Península Valdés	Argentina
31	Phoenix Islands Protected Area	Kiribati
32	Puerto-Princesa Subterranean River National Park	Philippines
33	Rock Islands Southern Lagoon	Palau
34	Shark Bay, Western Australia	Australia

ID	Name	Country
35	Shiretoko	Japan
36	Sian Ka'an	Mexico
37	Socotra Archipelago	Yemen
38	St Kilda	United Kingdom
39	Sundarbans National Park	India
40	Surtsey	Iceland
41	The Sundarbans	Bangladesh
42	The Wadden Sea	Netherlands; Germany
43	Tubbataha Reefs Natural Park	Philippines
44	Ujung Kulon National Park	Indonesia
45	West Norwegian Fjords – Geirangerfjord and Nærøyfjord	Norway
46	Whale Sanctuary of El Vizcaino	Mexico
a	Alejandro de Humboldt National Park	Cuba
b	Atlantic Forest Southeast Reserves	Brazil
c	Central Sikhote-Alin	Russian Federation
d	Danube Delta	Romania
e	Darien National Park	Panama
f	Desembarco del Granma National Park	Cuba
g	Discovery Coast Atlantic Forest Reserves	Brazil
h	Doñana National Park	Spain
i	Dorset and East Devon Coast	United Kingdom
j	Fraser Island	Australia
k	Giant's Causeway and Causeway Coast	United Kingdom
l	Gros Morne National Park	Canada
m	Henderson Island	United Kingdom
n	Ilulissat Icefjord	Denmark
o	Isole Eolie (Aeolian Islands)	Italy
p	Kakadu National Park	Australia
q	Lorentz National Park	Indonesia
r	Olympic National Park	United States of America
s	Pitons Management Area	Saint Lucia
t	Redwood National and State Parks	United States of America
u	Río Plátano Biosphere Reserve	Honduras
v	Tasmanian Wilderness	Australia
w	Te Wahipounamu – South West New Zealand	New Zealand
x	Volcanoes of Kamchatka	Russian Federation
y	Wet Tropics of Queensland	Australia

its important natural and cultural heritage sites located within its boundaries. This 'inventory' provides the basis to define the Tentative List of the nominations that a State Party may decide to submit for inscription in the next five to ten years and this list may be updated at any time. It is an important step since the World Heritage Committee cannot consider a nomination for inscription on the World Heritage List unless the property has already been included on the State Party's Tentative List.

Tentative Lists provide an important planning and evaluation tool early on in the process of identification of Outstanding Universal Value[12]. Not only are States Parties encouraged to consult widely among stakeholders (site managers, local and regional governments, local communities, indigenous peoples, NGOs and other interested partners and stakeholders) within their own country but also they can be guided by the analyses of the World Heritage List, specific thematic studies such as this one and other technical reviews by the Advisory Bodies to the World Heritage Committee (ICOMOS, ICCROM and IUCN) in the development of their Tentative List. Such information is intended to assist States Parties in identifying gaps in the network and comparing themes, regions, geo-cultural groupings and biogeographic provinces for prospective World Heritage properties.

Once a property is on the Tentative List, a State Party can submit a World Heritage nomination. The nomination file is the means by which a property is proposed for World Heritage listing, and the file must be prepared to a specific format, defined by the World Heritage Committee. A critical component of a nomination is the proposed Statement of Outstanding Universal Value of the property. This Statement must make clear why the property is considered to be of OUV, based on a global comparative analysis with similar properties, whether or not they are on the World Heritage List. The comparative analysis must explain the importance of the nominated property in the international context. In addition, the nomination must make clear how the property meets the conditions of integrity, and the protection and management requirements. Both the World Heritage Centre and the Advisory Bodies can offer advice and assistance to the State Party in its work in preparing a nomination, including making sure the necessary scientific evidence and literature, documentation and maps are included. Once submitted a nomination is checked by the World Heritage Centre to confirm it is complete. There is also an option to submit a draft nomination to the World Heritage Centre for an early, informal completeness check. If a nomination file is complete, the World Heritage Centre sends it to the appropriate Advisory Bodies for evaluation. Guidance on the expectations for nominations are provided in resource manuals[13] prepared by the World Heritage Centre and Advisory Bodies, and these are a key reference for all potential nominations and should be consulted from the earliest stages.

Provisions within the Operational Guidelines for the nomination of transboundary and serial properties have increasingly been used by States Parties and may be especially important in nominating marine World Heritage properties. Such provisions also provide opportunities to enhance existing World Heritage properties through extensions, including through serial sites (as discussed below). Transboundary nominations are to be submitted jointly by States Parties[14], and the Operational Guidelines encourage States Parties to establish a joint committee or similar body to oversee the management of the entire property. A serial World Heritage property[15] comprises a series of related component parts that are geographically separated from each other. The series as a whole must be of Outstanding Universal Value, though not necessarily each individual component part. By definition, therefore, it is possible to have a serial, transboundary property. The first serial property, the Central Eastern Rainforest Reserves of Australia, was established in 1986 and later extended in 1994.

A nominated property is independently evaluated by Advisory Bodies mandated by the World Heritage Convention, which provide their evaluations to the World Heritage Committee. Nominations for cultural heritage are evaluated by ICOMOS, while nominations for natural heritage are evaluated by IUCN. A third Advisory Body, ICCROM, is an intergovernmental organization that provides the Committee with expert advice on conservation of cultural sites, as well as on training activities. Once a site has been nominated and evaluated, it is up to the intergovernmental World Heritage Committee to make the final decision on its possible inscription. Once a year, the Committee meets to decide which sites will be inscribed on the World Heritage List. It may also refer its decision and request further information on sites from the States Parties, defer the proposal, in which case the State Party needs to consider preparing a revised nomination, which would need a full new evaluation, or decide to not inscribe a nominated property.

To be included on the World Heritage List, sites must meet at least one out of ten selection criteria of OUV. These criteria are explained in the Operational Guidelines that, besides the Convention text, are the main working document of the World Heritage Convention. The criteria are regularly revised by the Committee to reflect the evolution of the World Heritage concept itself. Until the end of 2004, World Heritage sites were selected on the basis of six cultural and four natural criteria.

[12] IUCN 2006
[13] See http://whc.unesco.org/en/resourcemanuals/
[14] In accordance with Article 11.3 of the Convention
[15] The word "cluster" has also been used synonymously for "serial". In this document, only the term "serial" is used

With the adoption of the revised Operational Guidelines, in 2005 only one set of ten criteria now exists. In addition to meeting these criteria, additional requirements for integrity and protection and management also need to be met (as well as requirements of authenticity for cultural sites.) Detailed guidance on the application of the concept of Outstanding Universal Value, as envisioned in the World Heritage Convention and defined in terms of criteria in the Operational Guidelines, with respect to the nomination of natural World Heritage properties, is also available from IUCN[16].

Table 1.1 outlines the ten criteria under which OUV is assessed, six of which relate to cultural heritage [criteria (i)–(vi)] and four to natural heritage [criteria (vii)–(x)]. This report focuses on the application of natural criteria for marine World Heritage, as a full treatment of cultural criteria is the mandate of ICOMOS. Nevertheless, some aspects of cultural value and importance ascribed to natural processes are discussed, in particular with respect to a growing focus under the Convention on cultural landscapes which would here apply as cultural seascapes (see section 1.6).

1.5 Potential benefits and implications of World Heritage listing for marine sites[17]

Benefits of World Heritage status include belonging to an international community of concern for universally significant properties that are outstanding examples of cultural diversity and natural wealth. The prestige that comes from being a State Party to the Convention and having sites inscribed on the World Heritage List often serves as a catalyst to raising awareness for heritage preservation, and securing conservation action "on the ground or on the water". Sites inscribed on the World Heritage List benefit from the required development and implementation of a comprehensive management plan that sets out adequate conservation measures and monitoring mechanisms. In support of these, international experts often provide technical training to the local site management team. The inscription of a site on the World Heritage List brings an increase in public awareness of the site and its outstanding value. This allows for enhanced opportunities for improving tourism image and profile, potentially increasing tourist activities at the site, and niche branding of local products and services. When these are well planned and organized, respecting sustainable tourism principles, they can bring important funds to the site and to the local economy. One benefit of World Heritage status, particularly for developing countries, is access to financial support from the World Heritage Fund, which is available to assist States Parties in identifying, preserving and promoting World Heritage sites. Emergency assistance may also be made available for urgent action to repair damage caused by human-made or natural disasters. In the case of sites included on the List of World Heritage in Danger, the aim is that attention and the funds of both the national and the international community are focused on the conservation needs of these particularly threatened sites. Additional funding is raised by UNESCO from donors to support the needs of World Heritage sites, such as through the UNESCO World Heritage Centre's marine programme.

Today, the World Heritage concept is well understood and sites on the list attract international cooperation and may thus receive financial assistance for heritage conservation projects from a variety of sources.

Table 1.1 Cultural and Natural Criteria of the World Heritage Convention.

The World Heritage Criteria	
Cultural (6)	**Natural (4)**
(i) Represent a masterpiece of human creative genius;	(vii) Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;
(ii) 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;	(viii) Be outstanding examples representing major stages of Earth's history, including the record of life, significant ongoing geological processes in the development of landforms, or significant geomorphic or physiographic features;
(iii) Bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;	(ix) Be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;
(iv) Be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;	(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.
(v) 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) 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).	

[16] See http://www.iucn.org/about/work/programmes/wcpa_worldheritage/
[17] Kokkonen *et al.* (in progress).

In 2003, the World Heritage Centre surveyed site managers from 10 mWHS to determine if and how their sites have improved as a result of inscription[18]. Most sites reported receiving clear benefits after gaining World Heritage status. Seven reported increased national and regional attention for marine protection efforts; six also reported increased international attention. Four reported benefiting from increased preparatory and/or training assistance during the nomination process, while two experienced an increase in technical cooperation. Four sites received increased financial support due to their World Heritage status, mainly from UN funds and from international agencies dealing exclusively with World Heritage sites.

Overall, managers reported that World Heritage listing had a perceived positive effect on the conservation of marine resources, with seven of the 10 sites saying marine resources had improved since inscription. Managers cited several reasons for improvement, including increased attention from national and international stakeholders; improved coordination between site managers and other government agencies; new restrictions on fishing and decisions not to re-issue existing fishing permits for unsustainable activities; improved awareness among local people; increased funding for management and vigilance; development of specific rules for resource use; and overall strengthening of infrastructure in and around protected sites.

The nomination process itself, feedback given during IUCN's evaluation phase, and recommendations given by the World Heritage Committee help galvanize national governments to action. A study of 150 World Heritage sites nominated between 1992 and 2002 found that the World Heritage Committee's decisions to defer nominations until governments responded adequately to IUCN concerns improved the status of 35 sites[19]. In 17 of these cases, the size of the protected area was enlarged; in 12 sites, major improvements to management were made; in 11 sites, additional funding was identified; in nine sites, the legal regime was strengthened; and in five sites, major threats to integrity were avoided, such as unsustainable development projects.

1.6 Cultural aspects relevant to natural marine heritage

The scope of this study is natural heritage, however it is important to note the natural and cultural linkages when applying the WH Convention to the oceans. The application of cultural criteria is not considered in detail here, not least because expertise from cultural fields, and in particular the input of the Advisory Bodies focused on cultural heritage (ICOMOS and ICCROM), would have to be involved. However IUCN recognizes the significance of considering cultural values within any consideration of marine aspects of World Heritage. Marine or maritime features are consistently a part of historical, social, archaeological, anthropologic, mythological and cosmological values of marine sites. For greater guidance on dealing with these in World Heritage nominations, an analysis of marine cultural heritage should be undertaken in a future study. IUCN considers more reflection is required on the cultural aspects of marine conservation, and the intricate links between nature and culture relevant to many marine sites.

1.6.1 Cultural landscapes and seascapes

The Convention increasingly recognizes the value of cultural landscapes[20], which are defined as 'cultural properties that represent the "combined works of nature and of man"'. It goes further to note that they are illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal. A key component of cultural landscapes may be where the cultural component has evolved to sustain the biodiversity and ecosystem integrity on which it is dependent. To date, 86 properties with five transboundary properties on the World Heritage List have been inscribed as cultural landscapes[21].

Large marine areas with high biodiversity and tight integration of cultural values with ecologically sustainable use of the natural resources may include areas suitable for the application of the cultural landscape (seascape) concept of the World Heritage Convention. These areas may also enable the recognition of regionally important marine protected areas, where the natural values might not necessarily be sufficient to meet the relevant natural criteria, but where the combination of human use and significant marine nature and conservation values presents an alternative means to demonstrate Outstanding Universal Value. The island cultures of the Pacific are famous for the tightly interwoven cultural and natural characteristics[22], which were necessary to sustain small communities on limited land and freshwater resources of the small islands. This, and the trans-oceanic migrations and navigational prowess of these cultures make for a clear example of the potential for cultural seascapes. These values led to the justification of two cultural criteria (iii and iv) for inscription of the Papahānaumokuākea World Heritage site [the northwest Hawaiʻian islands, in 2009,

[18] Hillary and Kokkonen 2003; Sites included Komodo National Park, Indonesia; Cocos Island, Costa Rica; East Rennell, Solomon Islands; Lord Howe Island, Australia; Ujung Kulon National Park, Indonesia; Sian Ka'an Biosphere Reserve, Mexico; Desembarco de Granma, Cuba; Tubbataha Reef, Philippines; Ha Long Bay, Vietnam; and St Lucia Wetland Park, South Africa
[19] Thorsell 2003
[20] UNESCO 2002
[21] http://whc.unesco.org/
[22] Johannes 1981

in conjunction with three natural criteria (viii), (ix) and (x)], though the concept of cultural landscapes / seascapes in the Convention was not used formally in this case, as the property was listed as a "mixed" site including cultural and natural values[23]. Possible recognition of cultural landscapes/seascapes may also be an option worth exploring where existing cultural World Heritage sites are found, such as the old towns on the East African coast of Lamu, Mombasa, Zanzibar, Kilwa and Mozambique Island, which are all part of the Swahili culture that evolved in the maritime environment of the East African and Omani coasts.

1.6.2 Contemporary human culture and the oceans

The concept and terminology of 'heritage' tends to conjure up historical and traditional values, implying that cultural connections in this case to the oceans are relevant only for traditional and old societies, cultures and mores. However, modern humans and societies have intimate interactions with and dependencies on the sea, in many cases in exclusively modern ways. Coastlines and beaches are among the principal assets and values that sustain global tourism, and many modern urbanized cultures have developed (young) traditions focused on the sea and 'getting back to nature' in it. In addition, with growing technical abilities to explore the oceans, and record mesmerizing imagery to show in videos and film, the oceans have a visual and entertainment appeal that is strong in modern societies. Thus modern cultural values might also be considered in the context of World Heritage nominations.

At a more fundamental level, an increasing proportion of the world's population also depends on food generated by the sea, whether from fisheries, or increasingly mariculture. Could an area important for fisheries be considered under criterion (ix) for ecosystem services, or (x) for species or cultural seascapes if its integrity could be established? The values under criterion (ix) could be the ecosystem processes such as high productivity or resilience that sustain fisheries, or under criterion (x) could be abundance and distribution of particular species. Some parts of the world are particularly important for services to humans (e.g. fisheries, as discussed here, or tourism, in the previous paragraph) and these could provide an opportunity to link modern cultural values to natural values to allow proposing mixed sites. Fisheries and human usage are often given as reasons why marine areas are not designated as MPAs, as user lobbies do not want to see reduced access. However, perhaps non-destructive and/or artisanal/traditional methods, or high tourism value would allow a co-existence of nature and culture in support of some World Heritage listings?

1.7 Conclusion of Chapter One

The World Heritage Convention provides the potential for a comprehensive legal and policy framework that allows for the identification and best practice management, governance, and protection of the world's most outstanding natural marine areas. Potential sites within national jurisdiction must first be added to a State Party's Tentative List before nomination files can be submitted to the UNESCO World Heritage Centre for evaluation by the Advisory Bodies. Sites nominated for World Heritage must meet one of ten selection criteria of which four are natural and six are cultural, as well as rigorous requirements for integrity, protection and management, as well as authenticity for cultural sites. There are currently 46 sites included in the World Heritage List that have been designated primarily for their marine natural features of Outstanding Universal Value. In addition to these 46 sites, 25 other natural and mixed WH sites contain marine areas or features of marine interest. Benefits of inscription on the World Heritage List include access to the World Heritage Fund (for eligible States Parties) that can assist in identifying, preserving, and promoting World Heritage sites. In addition World Heritage sites also benefit from a management plan and monitoring mechanisms that help sustain and conserve the site. World Heritage sites generally attain a high level of visibility that leads to increased awareness and touristic interest. The significance of cultural values, and the interaction of culture and nature in all aspects of marine World Heritage requires much greater consideration and reflection. Chapter Two discusses in more detail the four natural criteria for Outstanding Universal Value, and identifies different types of marine themes and features that may be considered under these four criteria.

[23] http://whc.unesco.org/en/list/1326

2. Interpreting the natural criteria of the World Heritage Convention for application in marine systems

2.1 Introduction

Following earlier thematic reports on World Heritage, this chapter clarifies how the criteria and concepts of the World Heritage Convention may be applied to marine systems to support nomination of marine sites to the World Heritage List. We have followed a two-step process for each natural criterion of the Convention – first, we examine the text of the criterion, to identify how well this relates to marine features, processes, and phenomena, and second, we list broad marine themes we judge to be most relevant to the scope and intention of the Convention with respect to natural heritage. Following this, the chapter briefly considers related integrity issues as well as cultural aspects relevant to marine natural heritage.

This Chapter draws in particular on four World Heritage documents to establish a framework for considering marine or ocean features for World Heritage. These include:

1. A report on geological heritage outlining how to consider geological features in World Heritage listing under criterion (viii)[24];
2. Technical guidance on assessing natural World Heritage criteria in nominated sites[25];
3. A global analysis of the biodiversity coverage of the natural World Heritage network for terrestrial systems[26]; and
4. Case study application of a regional approach to identifying features of potential Outstanding Universal Value in the Western Indian Ocean[27].

A number of other UNESCO and IUCN reports have also been consulted, as listed in the references and cited as appropriate in the text[28].

2.1.1 Matching marine features to the natural World Heritage criteria

Matching marine features to the natural criteria of the Convention is challenging, as there is no specific language in the text or supporting documents to the Convention that deal with the particulars of the marine environment. This section presents an introduction to the findings of this chapter, as this helps to justify the organization of the sections, and how we have linked different marine features to the criteria. The subsequent inspection of the criteria shows that marine features can be treated in the same way as terrestrial ones if they relate to geological processes and formations [criterion (viii)], biological and ecological processes [criterion (ix)], species [criterion (x)], and superlative phenomena or exceptional natural beauty [criterion (vii)].

Two significant gaps in applying the Convention and its criteria to the oceans are identified in this analysis with respect to marine sites:

- The properties and dynamics of seawater and the ocean itself. Apart from ecosystem processes specific to coastal and marine systems in criterion (ix), and references to coastal and marine geological processes and themes in criterion (viii), the physical and chemical nature of seawater and ocean water bodies are not mentioned, and these are fundamental to the biological processes and species that are the subject of criteria (ix) and (x);
- The availability and global coverage of relevant data of marine features that would enable comparative analyses in support of criteria (vii), (ix) and (x).

By analogy with the current wording of the criteria, the physical nature and structure of the oceans are extensions of the physical nature of the Earth as a whole, i.e. its geology and bio-geo-chemical substrate it provides. Both the land and oceans provide the physical medium on or within which life processes occur, and given the common evolutionary origin of all life on Earth, these processes are identical in terrestrial or marine domains, though with significant differences in their outcomes due to the different physical nature of these domains.

We have identified a typology of 16 themes that seek to encompass the scope of marine features and ocean phenomena for which World Heritage natural criteria might be applied

24 Dingwall *et al.* 2005
25 IUCN 2006
26 Bertzky *et al.* 2013
27 Obura *et al.* 2012
28 Thorsell *et al.* 1997, UNESCO 2001, IUCN 2006, Laffoley 2006, Badman *et al.* 2008, Engels *et al.* 2009, Laffoley and Langley 2010

(Tables 2.1 and 2.3). These themes are described in the following sections, using selected references to the scientific literature. This explication of the marine features and their relation to the natural criteria of the Convention may appear to over-emphasize criterion (viii), often called the 'geology' criterion. This is because the major innovation required for applying the criteria to the marine environment is the inclusion of oceanographic features and processes, under this criterion (and hence this criterion should more appropriately be called the 'geology and oceanography' criterion). Biological processes and species found in the sea, though different in many ways from processes and species on land, are not fundamentally different, so criteria (ix) and (x) do not require such expansion, and hence those sections are shorter, focusing on the overarching differences of life in the oceans.

2.2 Criterion (viii) – Geology and oceanography

This section adapts an analysis of geological / geomorphological features that was mainly focussed on terrestrial systems[29], to the marine environment. However, for oceanographic features, there is no precedent in documentation of the World Heritage Convention, and here we attempt to mirror the thematic scope of marine geology with overarching themes in oceanography that may be considered under the Convention.

In general terms, many geological features are found both in the sea or on land, so the same conventions apply in using criterion (viii) for marine systems. Dingwall and colleagues (2005) identified 13 geological and geomorphological themes within which OUV can be assessed, of which we have identified nine as relevant to marine environments (Table 2.2). Four of the themes have no or very limited relevance to marine features and unlikely to be featured in site nominations for various reasons. Those themes that are relevant to marine environments are explored further here, though following a structure more relevant to marine systems than Dingwall *et al.*'s (2005) numbered list. In keeping with their approach, this thematic structuring is not intended to be fully exhaustive or detailed, but indicative. We identify four geological features that may be considered for assessing OUV (below). These aggregate the themes from Dingwall *et al.* (2005) in order to have a reasonable total number of marine features across the four criteria. We exclude features that are predominantly terrestrial and well described in thematic studies focused on terrestrial systems (e.g. karst systems[30]), though these features may also be found in shallow seabeds and the coastal zone (including submerged examples that have resulted from sea-level changes).

We additionally propose four general features within which most oceanographic phenomena with potential relevance to World Heritage may be grouped, and considered alongside marine geological phenomena in criterion (viii). Two of the features in Table 2.2 are a result of interactions between geology and seawater – the hydrogeological features of the ocean floor, and land-sea interactions in the coastal zones. As will be noted in the relevant sections, unique aspects of the interactions between these physical features result in unique and important biological processes and species assemblages, themselves with potential to demonstrate OUV.

2.2.1 Plates and associated tectonic features

Global-scale lithospheric processes – continental drift and seafloor spreading – are the engines that drive both continental and ocean basin dynamics. While the most apparent tectonic features are visible on land, such as mountain ranges produced from crustal collisions, the driving forces happen under the sea – at the mid-ocean seafloor spreading ridges where active formation of oceanic crust drives oceanic plates apart[31], to themselves drive or collide with continental crusts.

The continental shelf (to 200 m depth) and continental slope (to about 4,000 m) are the extensions of continental crusts under

Table 2.1 Geological, physical oceanographic and biological themes with potential for Outstanding Universal Value under the World Heritage Convention.

Criterion (viii)		Criterion (ix)	Criterion (x)	Criterion (vii)
Geology	**Oceanography**	**Ecological and biological processes**	**Species and biodiversity**	**Superlative phenomena and/or exceptional beauty**
1. Plates and tectonic features 2. Hotspots, seamounts 3. Sedimentary processes (slope, rise and deep seabed, submarine canyons) 4. Vents, seeps, and other hydrogeological features	5. Water masses 6. Ocean currents 7. Waves and other phenomena 8. Coastal processes and land-sea interactions 9. Ice	10. Biogeochemical cycles and productivity 11. Connectivity 12. Marine ecosystem processes and services	13. Diversity of marine life 14. Biogeography and components of diversity 15. Threatened and flagship species	16. Marine phenomena and spectacles

[29] Dingwall *et al.* 2005
[30] Williams 2008
[31] Earle and Glover 2008

Box 2.1 Criterion (viii): Be outstanding examples representing major stages of Earth's history, including the record of life, significant ongoing geological processes in the development of landforms, or significant geomorphic or physiographic features.	
Phrase	**Interpretation**
Earth's history	Focuses on physical representations of the planet's history. This is possible in rocks and rock formations, which may be on land or in the sea. These may include tectonic processes, meteorite impacts and/or glaciations from the geological past. In marine systems this would be represented by submarine canyons, underwater rift valleys, and continental shelves, but also in biogenic structures that record past climate, such as in coral skeletons and coral reefs.
Record of life	This part of the criterion applies to the fossil record, the record of life on Earth as preserved in geological features. Examples of fossil records in marine deposits include coral reefs (e.g. in New Caledonia WHS), as well as sedimentary deposits. Outstanding examples of marine paleontology representing important stages of the development of marine habitats and species can be included under this criterion (e.g. a coral reef).
Geological processes	Relates to Earth features and ongoing geological processes. Properties recognized under this element include examples of: arid and semi-arid desert processes; glaciation; volcanism; mass movement (terrestrial and submarine); fluvial (river) and deltaic processes; and coastal and marine processes. These processes may occur in oceanic as well as continental crusts and rocks, and in marine environments as much as on land. Representations of such processes could include seamounts, volcanic islands, atolls, and submarine canyons.
Significant geomorphic or physiographic features	Relates to significant landforms or rock features that are landscape products of active or past processes, which can be identified as significant physical landscape features (these may also be of significant aesthetic value). Properties recognized under this criterion may include: desert landforms; glaciers and ice caps; volcanoes and volcanic systems, including those that are extinct; mountains; fluvial landforms and river valleys. For marine systems, this would include coasts and coastal features; reefs, atolls and oceanic islands; glacial and periglacial landforms, including relict landscapes; and underwater caves and karst. These can also include less apparent ocean physiographic features such as seamounts and continental shelves (e.g. the Phoenix Islands Protected Area WHS and its seamounts).

Table 2.2 Geological themes for application of World Heritage criteria (from Dingwall *et al.* 2005).

High marine relevance	Low marine relevance
1. **Tectonic and structural features –** Elements of global-scale crustal dynamics including continental drift and seafloor spreading. Major crustal landforms and structural features at plate boundaries. Geosyncline/anticline development and erosion; rift valley systems. 2. **Volcanoes/volcanic systems –** Major areas and types of volcanic origin and evolution. These may include examples of major features such as the "Pacific Ring of Fire" as a global-scale expression of volcanic activity and associated crustal movements. 3. **Mountain systems –** Major mountain zones and chains of the world. 5. **Fossil sites –** The record of life on Earth represented within the fossil record. 6. **Fluvial, lacustrine and deltaic systems –** Land systems resulting from large-scale river erosion and drainage system development, lakes, wetlands and deltas. 7. **Caves and karst systems –** Subterranean hydrological processes and landforms, together with their surface expressions 8. **Coastal systems –** The role of water at oceanic margins on large-scale erosional and depositional coasts and banks. 9. **Reefs, atolls and oceanic islands –** Geo-biological and/or volcanic features in oceanic areas or with oceanic influences. They may also record significant features of Earth's history. 10. **Glaciers and ice caps –** The significant role of ice in landform development in alpine and polar regions, including periglacial and nivation (snow) influences.	4. **Stratigraphic sites –** Rock sequences that provide a record of key Earth history events. 11. **Ice Ages –** Global patterns of continental ice sheet expansion and recession, isostasy, sea-level changes, and associated biogeographic records. 12. **Arid and semi-arid desert systems –** Land systems and features reflecting the dominant role of wind (eolian processes) and intermittent fluvial action as agents of landform development and landscape evolution. 13. **Meteorite impact –** Physical evidence of meteorite impacts (astroblemes), and major changes that have resulted from them, such as extinctions.

Box 2.2 Plate tectonics – seafloor spreading ridges and plate margins. *Examples of features that may provide a basis for OUV at a site.*	
Primary, criterion viii • Seafloor spreading ridge – rate, height above abyssal floor, role in regional/global tectonics. • Subduction or collision zone – rate, associated volcanic activity, role in global tectonics and other processes. • Features of a continental margin. • Active/passive continental margins as records/signs of Earth's history and processes.	**Supporting** • Subduction zones as major regions of spectacular volcanism and volcanic features (criterion vii). • Plate collision zones as incubators of global biodiversity highs (Renema *et al.* 2008) (criterion x).

the sea, and give way to oceanic crust that forms the deep abyssal plains. Continental margins may be passive (no active collision with the adjoining crust) or active (resulting in subduction of oceanic crust, or the formation of fold mountains). Subduction zones are areas that create volcanic activity, where melting crust rises to the surface, producing frequent volcanic eruptions and earthquakes. The 'ring of fire' around the Pacific – the ring of active volcanoes and island arcs and archipelagos around the Pacific plates – shows the action of active plate collisions and the resulting subduction[32].

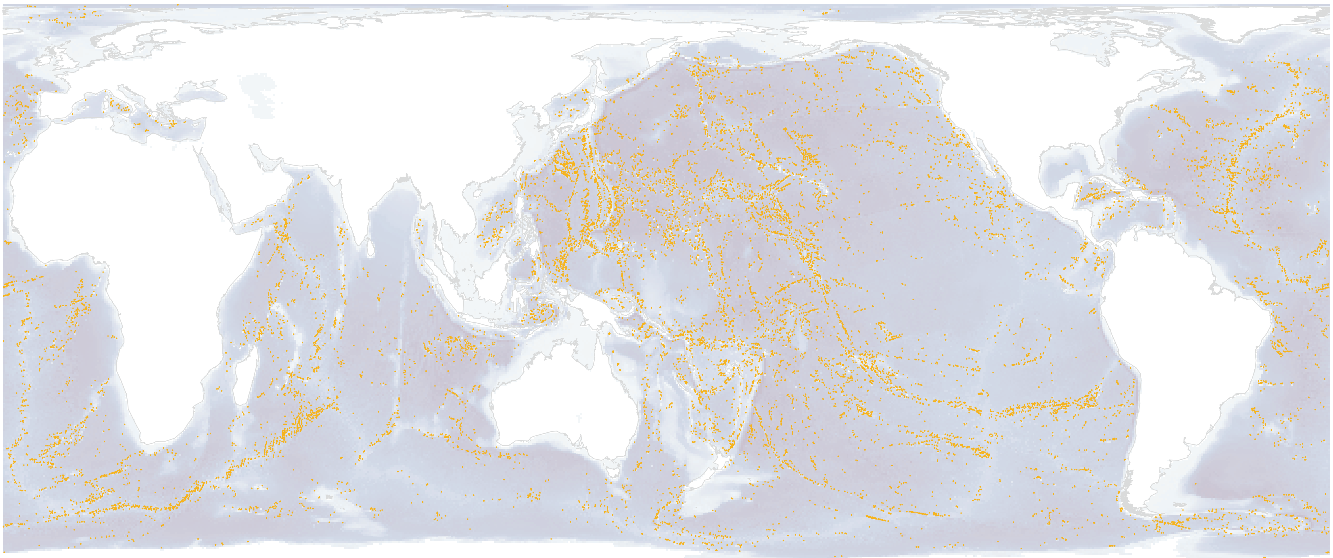
2.2.2 Hotspots, seamounts and Large Igneous Provinces

The origins of individual mountainous massifs under the ocean may be a result of point-sources where magma from the mantle breaks through the oceanic crust above (see Figure 2.1)[33]. The largest events are massive relatively short-lived (geologically in millions of years) magmatic eruptions called 'superplume' eruptions that form Large Igneous Provinces (LIPs)[34]. Less intense but longer-lived magmatic extrusions are a result of sustained convection of magma in the mantle, called hotspots[35], producing linear chains of mountains and islands as a result of motion of the Earth's crusts over the mantle. Individual short-lived magmatic eruptions may produce isolated volcanic mountains and seamounts[36].

2.2.3 Sedimentary features and submarine canyons

Most of the ocean floor shows little tectonic activity, and over 1,000s and millions of years, becomes covered by sediment sinking to the seabed through the water column. This may result from violent events such as turbidity currents – essentially underwater landslides of sediment typically down the continental slope, forming thick deposits of 'turbidites' and abyssal fans on the

Figure 2.1 Global distribution of seamounts.[37]



[32] Poreda and Craig 1989
[33] Morgan 1981
[34] Coffin and Eldholm 1994
[35] Morgan 1981
[36] Morgan 1981
[37] Source: Seamounts in the Sea Around Us Project database, http://www.seaaroundus.org/doc/saup_manual.htm#22

Box 2.3 Hotspots, seamounts and Large Igneous Provinces. *Examples of features that may provide a basis for OUV at a site.*

Primary, criterion (viii)	Supporting
• The size, rate of formation, distance of activity of a seafloor spreading ridge, hotspot or seamount chain (criterion viii). • The size, volume or rate of formation of an LIP [criteria (vii), (viii)].	• The rate of formation or movement of oceanic crusts on either side of a seafloor spreading ridge and its role in island chain/stepping stone properties [criterion (viii)]. • Isolated young volcanic island, allowing evolution of endemic species and unique habitats [criterion (x)].

continental slope, rise and abyssal plains. Alternatively, sediment layers build up from the imperceptible rain of fine sediments on the abyssal plain and deep trenches from biological and mineral material raining down through the water column.

Around the continents, a thick sediment wedge typically overlies the granitic rock of the continental shelf, the continental slope (see section above) and the continental rise (gentle slope where the continental slope meets the ocean crust and abyssal plains), formed from deposition of terrestrial sediments carried to the coasts over millions of years. Different parts of the ocean floor may have different types of sediment, originating from calcareous or siliceous-shelled plankton, as well as terrigenous and mineral origins.

When sediment builds up on the continental shelf and upper parts of the continental slope, instability (such as from earthquakes) can cause turbidity currents that cut deep submarine canyons, and produce large abyssal fans of sediment over the abyssal plain. The steep slopes and varied topography of submarine canyons result in a high diversity of habitats and species in small spatial scales.

Over time, sediment layers 1,000s of metres thick can build up, in places with fine layering providing a perfect time record of sedimentation, and sequences of microscopic life preserved in the layers. Where mudslides and turbidity plumes occur, large rocks and animal material may be rapidly buried forming coarse fossil deposits, but preserving larger life forms in the fossil record.

2.2.4 Hydrothermal vents, seeps and other hydrogeological features

Seawater permeates the rocks and sediments of the ocean floor, resulting in a variety of hydro-geological interactions that are only recently being discovered and described. Hydrothermal vents are found where deep cold ocean waters seeping into the oceanic crust come into contact with molten lava or hot rocks closer to the mantle. The resulting super-heated water dissolves minerals from the rocks it has passed through. When injected into the near-freezing water on the ocean floor, the minerals precipitate, forming rock formations and chimneys. Cold seeps, or cold vents (sometimes called mud volcanoes), occur where water only a few degrees above ambient temperatures carries hydrogen sulfide, methane and hydrocarbons from the basement rock to the sediment surface, often in a brine pool[38].

In the near-freezing temperatures and high pressures on the ocean floor, gasses may coalesce into icy chunks, often bonded with sediment and in layers over 1,000 m thick, in formations called clathrates, or gas hydrates. The most common type is methane hydrates, and when brought to the warmer and lower pressure surface, the trapped gas bubbles out and into the atmosphere[39].

Due to the unusual chemistry in these hot and cold mineral-rich waters, unique biological communities have evolved. In some cases, organisms have evolved chemosynthetic metabolic pathways through which they derive energy from

Box 2.4 Abyssal plains, sedimentary processes and submarine canyons. *Examples of features that may provide a basis for OUV at a site.*

Primary, criterion (viii)	Supporting
• Large sedimentary features or submarine canyons with unique properties globally, such as the canyons in the Bering Sea.	• Dynamic and high-complexity in topographic features of a submarine canyon that support a high diversity of habitats and species [criteria (ix) or (x)].

[38] Vanreusel *et al.* 2010
[39] Vanreusel *et al.* 2010

Box 2.5 Hydrothermal vents, seeps and other hydrogeological features. *Examples of features that may provide a basis for OUV at a site.*	
Primary – criterion (viii) • The only existing alternative energy source (other than the sun) that is capable of supporting food webs [also criterion (ix)]. • Most extensive, largest or deepest vents known of their type [also criterion (vii)].	**Supporting** • Unique habitat and biodiversity [criterion (x)]. • Unique ecological processes leading to significant evolutionary development of communities [criterion (ix)].

the water-borne chemicals, such as hydrogen sulphide, forming ecosystems fully independent of photosynthetically driven production in shallow waters (see 2.3.1)[40]. These unique communities may be treated under criteria (ix) and / or (x).

2.2.5 Water masses and stratification

Ninety-seven percent of the water on Earth is in the sea, providing the largest biome by volume (97%) and surface area (70%) on the planet[41]. The chemical composition of seawater has profound influences on its physical properties, and both of these profoundly affect biological processes, including the evolution of life on Earth and ecological processes[42].

The oceans are a three-dimensional fluid biome, unlike terrestrial systems, which are essentially two-dimensional. The oceans are contained in a 'bowl' determined by the geology of the oceanic and continental crusts. At present sea level stands, the edge of the continental shelf/edge is generally at 200 m depth, after which the bottom slopes more steeply down to the abyssal plains of the oceanic crusts. This establishes a basic dichotomy that defines some of the major biogeographical systems (see section 3.2.3):

- continental shelf/coastal/neritic waters adjacent to continental coastlines up to 200 m deep and generally narrow, but in some places may be extensive shallow platforms 100s of km across; and
- open sea/pelagic/deep waters, over the oceanic crusts, and generally > 1,000 m depth, and including abyssal plains and trenches.

The oceans are also strongly stratified vertically by depth, from the surface to the bottom. Three basic vertical zones can be identified, combining aspects of density/depth effects and of the decrease in light with depth due to its absorption by water:

- epipelagic zone – the top 200 m of the water column, where light penetrates sufficiently for sight. Active photosynthesis occurs in a narrower band near the surface, the photic zone, ranging from a few metres up to 70 m thick depending on the transparency of the water.
- mesopelagic zone – in the mesopelagic zone, from approximately 200–1,000 m depth a dim twilight may be discerned.
- bathypelagic, abyssopelagic and hadal zones – the bathypelagic zone stretches from 1,000–4,000 m deep, and below this, the abyssopelagic and hadal zones extend to the bottom of the deepest trenches, at 11,000 m deep. These zones are characterized by no light penetration from the surface.

Finally, the oceans and atmosphere are strongly coupled such that large semi-permanent climatic and atmospheric phenomena maintain a complementary semi-permanent structure of water masses and surface currents (see section 2.2.6) – and vice versa. Examples of these are the ocean basin 'dipoles' such as the El Niño Southern Oscillation in the Pacific Ocean and the Indian Ocean Dipole in the Indian Ocean, or 'Walker cell circulations' over the tropical belt across the Indo-Pacific.

2.2.6 Ocean currents

Water in the oceans is in constant motion on spatial and temporal scales from the planetary (1,000s of km and tens of thousands of years) to the minute (fractions of millimetres and seconds). At the global level, a single 'conveyor' belt drives the flow of ocean waters[43], a particle of water taking more than

Box 2.6 Water masses and stratification. Examples of features that may provide a basis for OUV at a site.	
Primary – criterion (viii) • It is unclear, a priori that water mass zonation in horizontal or vertical dimensions may constitute OUV of themselves, except in conjunction with a superlative measurement.	**Supporting** • Water mass zonation may more appropriately be used in a supporting context for ecological processes, species and habitats characteristics [criteria (ix), (x)].

[40] Tunnicliffe 1991
[41] Earle and Glover 2008
[42] Gould 1994
[43] Wyrtki 1961, Rahmsdorf 2003

Box 2.7 Ocean currents. *Examples of features that may provide a basis for OUV at a site.*

Primary, criterion (viii)	**Supporting**
• A unique western boundary current system, such as the variable eddies in the Mozambique channel. • An ocean front of very high mixing and productivity, such as the North Pacific Transition Zone Chlorophyll Front that supports the largest feeding aggregation of albatross in the northern hemisphere. • A unique eastern boundary current system, transporting cold, low salinity and high nutrient waters towards the equator.	• Gyres and recirculating currents that isolate and support unique biological assemblages [criterion (x)]. • Currents that support unique processes such as in seasonal upwelling systems, or that concentrate and create higher levels of productivity, such as the Costa Rica/Central American Dome [criterion (ix)]. • A broad high productivity coastal domain (up to 1,000 km offshore) with wind-driven coastal upwelling hotspots of primary production.

1,000 years to travel around the world in this conveyor system. At the level of ocean basins, the Coriolis force causes water to flow in massive 'gyres' that flow in opposite directions in the northern (clockwise) and southern (anticlockwise) hemispheres[44]. These gyres (e.g. North Pacific and South Pacific gyres), the equatorial zone between them where water flows principally from east to west, and the circumpolar currents to the north (Arctic) and south (Antarctic) define the major current features of each ocean basin.

At more localized levels, affected by continental shapes and bathymetry, regional features interact with these larger scale processes resulting in strong boundary currents (e.g. the Kuroshio Current), upwelling systems (e.g. the Somali Current) and complex features such as fronts, eddies and localized gyres. Currents interact with one another, resulting in complex mixing and interactions, called 'fronts', with characteristics determined by their geographic location and the dynamics of the interacting water bodies (e.g. the Antarctic Polar Front or Antarctic Convergence). Fronts appear to be particularly important as they are where exchange between physical, chemical and biological features results in major transitions in ecosystem processes and biodiversity. Eddies occur at different scales depending on the speed of the flow and in some cases, such as in the Mozambique Channel[45] define ecosystem processes of importance (see section 3.3.2). Along with the basic regional properties of water masses (e.g. temperature, nutrients), and the depth and lateral stratification of water masses, currents control the primary biogeographic patterns of the marine realm[46].

2.2.7 Waves and other fluid phenomena

In addition to currents, a broad range of other physical phenomena affect the movement and mixing of water masses[47]. Some act on a large scale, such as Kelvin and Rossby waves, which are planetary in size and travel at high speed along sharp gradients in density in seawater, with wavelengths on the order of 100s to 1,000s of km. Localized upwelling or downwelling of water may occur when their peak or trough hits a coastline, and they influence the marine and atmospheric climate of a site. Other waves forms may be uniquely powerful or regular, such as the large waves from winter storms that pound the north coast of Hawaii, or the south coast of Tahiti.

Tides result from the gravitational attraction of the moon and sun on the water masses of the oceans, and may strongly affect ecological processes at a site, such as the macro-tidal regimes of the Bay of Fundy (between the US and Canada). A broad range of other physical properties of seawater or the oceans affect the ecology and diversity of individual locations – for the purposes of World Heritage, these may be difficult to justify as primary features of OUV, but understanding their influence on the values of a site may be essential as supporting processes of other features of OUV.

Box 2.8 Waves and other phenomena. *Examples of features that may provide a basis for OUV at a site.*

Primary, criterion (viii)	**Supporting**
• Wave forms of regular and near-perfect shape may be assessed with OUV, such as regular and large waves of the north shore of Oahu, Hawai'i, or the southern point of Tahiti. • The combination of ocean basin and local bathymetry may result in super-tides, such as in areas such as the Bay of Fundy or the Chiloe Archipelago in southern Chile [criteria (vii), (viii)]. • The unique eddy dynamics of the Mozambique Channel.	• The perfect and exceptionally large waves of the north shore of Oahu, Hawai'i, or the southern point of Tahiti may be classed as superlative phenomena [criterion (vii)], or in supporting (traditional and modern) cultural forms (see section 1.6). • The tidal dynamics of sites such as the Bay of Fundy may generate other features of OUV, such as in the productivity and community assemblages of subtidal and intertidal communities [criterion (ix), (x)].

[44] Price *et al.* 1987
[45] Schouten *et al.* 2003
[46] Spalding *et al.* 2007, 2012 and Vierros *et al.* 2009
[47] Pond and Pickard 1983, Talley *et al.* 2011

2.2.8 Coastal and land-sea interactions

The coastal zone is the boundary between land and sea, a highly dynamic interface between geological and oceanographic features, and including atmospheric (weather and climate) processes and how these are affected by land and sea. The geomorphology of the coastal zone reflects this interaction over time. Thus many diverse geomorphological features are described in coastal zones, including fjords, estuaries, barrier islands, rias, canyons, caves, blue holes, mudflats, coastal lagoons and more (see Table 2.2). With the interactions between the atmosphere, land and sea at the coastline, many terrestrial features can also arguably be termed marine, such as dune systems built up by wind transport of sediments from beaches.

The coastal zone is affected by freshwater transport, and thereby by phenomena that may occur thousands of kilometres inland, away from the coastal zone itself. Sediment transport contributes to the geomorphology and ecology of the immediate coastlines and continental shelves, as well as to the formation and dynamics of submarine canyons and their habitats (see section 2.2.3). Further, due to the interaction of many different physical processes (geological, oceanographic and climatic) in small geographic areas, coastal waters and intertidal areas are among the most biologically diverse of marine features.

Finally, by virtue of the concentration of human populations in the coastal zone, as well as in drainage basins of many river systems, coastal zones are among the most threatened globally, affecting aspects of the integrity of any coastal features that may be assessed for OUV.

2.2.9 Ice

Physical and biological features related to ice age cycles and processes are identified among the 13 geological themes recognized under criterion (viii) and included in Table 2.2. However sea ice is fundamentally different, in the northern and southern polar regions being a principal feature determining the physical and biological features of the oceans. When water freezes into ice, the expansion in volume that it undergoes results in a reduction in its density, thus it floats on water. Two main forms of ice on the sea are recognized:

- Icebergs are the broken fragments of glaciers formed on land, that flow slowly to the sea. The outer edges break off forming isolated icebergs, though these may be from a few metres to 100s of km in size and up to many millions of cubic metres in volume;
- Fast ice and pack (or drift) ice are formed from freezing of the surface layers of seawater during winters. Fast ice is fastened or attached to coastlines or the shallow sea bottom while pack/drift ice floats freely. These may grow to several metres in thickness.

The biological communities and species associated with sea ice are highly specialized, and may be considered under criteria (ix) and (x) of their own right.

2.3 Criterion (ix) – Ecological and biological processes

In the past, criteria (ix) and (x) were often invoked together as the language in the original Convention text is not explicit in the context of current definitions of the terms used in the criteria. Further, guidance documents treated them together[48], acknowledging that they are frequently "considered together because they are closely linked and often used in combination with each other". Application of the natural criteria has evolved over time, reflecting advances in biodiversity theory and data availability that enable

Box 2.9 Coastal processes and land-based interactions. *Examples of features that may provide a basis for OUV at a site.*	
Primary, criterion (viii)	**Supporting**
• Many coastal features may be assessed as having OUV due to the many interacting features that result in their formation (e.g. bay or dune systems, estuaries, island groups, shallow marine ecosystems, blue holes, karst systems, etc.).	• Due to their complexity and many contributing features, coastal systems may result in unique or highly diversity communities and species assemblages, or distinct species occurrences [criteria (ix) or (x)], or superlative phenomena [criterion (vii)].

Box 2.10 Ice. *Examples of features that may provide a basis for OUV at a site.*	
Primary	**Supporting**
• Ice features in the polar regions may themselves be classified as OUV, for example the glaciers and pack ice of portions of Antarctica that form the largest icebergs on the planet [criterion (viii)].	• The seasonal changes in surface pack ice on the fringes of the Arctic and Antarctic systems drive the productivity and life cycles of many species under the surface of the ice and below in underlying waters, which may be of OUV [criteria (ix) and (x)].

48 See for example IUCN 2006

Box 2.11 Criterion (ix): Be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.	
Phrase	**Interpretation**
Ecological and biological processes	This is the primary clause of the statement, making this criterion focus on ecological and biological processes. IUCN (2006) states that "assessment of criterion (ix) depends on a scientific understanding of the world's ecosystems and their associated ecological and biological processes". Principles of ecology and biology are equivalent on land and in the sea, so this applies equally to marine systems. For example, predator-prey trophic interactions in a food web, complex mutualistic interactions in high-diversity ecosystems, and inter or intraspecific competition are equivalent biological and ecological processes, whether they occur in a coral reef or rain forest. Examples of such processes particular to the marine environment include connectivity and dispersal of juveniles and adults such as coral or fish larval dispersal in ocean currents; important migration routes, such as of whales or whale sharks; ontogonetic and physical shifts in habitat use for many tropical marine species; and breeding and aggregation grounds of emblematic or cornerstone species.
Evolution and development	This phrase relates to how processes shape and sustain ecosystems and communities, including evolutionary history, phylogenetic diversity, speciation, adaptive radiation, and others. These processes act both on land and in the sea, though differ in the detail of how they are manifested. Life in the oceans and on land belong to the same evolutionary tree, with early life forms that lived in the sea evolving characters to enable them to live on land. Thus developmental patterns are also similar in the biology of individual organisms, and in the construction of communities and ecosystems of plants and animals. Primitive examples representative of the earliest species still abound in the oceans and include cartilaginous fishes such as the sharks and rays.
Coastal and marine ecosystems and communities of plants and animals	This is the only explicit reference in the criteria to marine systems, making this criterion equally applicable to marine and terrestrial systems.

comparative analyses on global scales, which is an explicit requirement for defining OUV.

Improved guidance on when and how to use each criterion has repeatedly been called for. This study is addressing this call for marine systems, and is written in conformity with a study assessing the coverage of WH sites under these two 'biodiversity' criteria in terrestrial systems[49]. Most succinctly, **criterion (ix) relates to ecosystems, communities and the ecological and biological processes that shape and sustain them, while criterion (x) relates to species and the habitats or sites most important for their conservation**. This reflects a general convergence over time in how the criteria can be most consistently applied, thus it can be misleading to review historical applications of these criteria for guidance on how to use them now. Similar guidance has been presented on identifying Ecologically or Biologically Significant Areas (EBSAs) in the pelagic realm[50].

In relation to criterion (ix), Bertzky *et al.* (2013) focus on globally significant terrestrial ecosystems and communities, and in particular their irreplaceability. Species endemism, or other measures such as taxonomic uniqueness or rarity of major habitat types[51] are used as proxies of the ecological processes that produce them. Assessment is based on well-established broad-scale conservation prioritization schemes: Biodiversity Hotspots, high biodiversity wilderness areas, Centres of Plant Diversity, Endemic Bird Areas (EBAs) and Global 200 terrestrial ecoregions. There is now a global effort to harmonize these approaches and develop a globally agreed methodology for Key Biodiversity Areas (KBAs) (see Box 3.1). Under the World Heritage Convention, the ecologically most significant (irreplaceable, unique or rare) locations, rather than representative ones, are most likely to qualify for OUV.

The condition of integrity for criterion (ix)[52] requires properties to be of sufficient size – an important element of integrity, though not the only one. It also requires properties to contain the necessary elements and processes that are essential for the long-term conservation of the ecosystems and communities they contain. The Operational Guidelines note that a tropical rainforest property, for example, should include variation

[49] Bertzky *et al.* 2013
[50] Dunn *et al.* 2011
[51] Brooks *et al.* 2006, 2010 and Schmitt 2011
[52] Operational Guidelines #94

in elevation above sea level, changes in topography and soil types, patch systems and naturally regenerating patches. Marine properties, on the other hand, should ideally be large enough to encompass linked ecosystems that regulate nutrient and sediment inputs and include connectivity, dispersal and upwelling zones.

In practice, evaluations of WH nominations have focused predominantly on community and ecosystem types, their diversity and representation in nominated sites, their complexity and patchiness and degree of restrictedness to the nominated site, inclusion in global prioritization schemes, and degree of representation on the World Heritage List and Tentative Lists. In assessments of this criterion for terrestrial systems, data on community and ecosystem presence and state, which are available in global datasets for many systems, are used as indicators of the processes that sustain them. For marine systems, however, global data is less comprehensive, so a stronger focus on regional-scale processes and indicators may still be needed. This criterion contains the only explicit mention of marine systems (coastal and marine ecosystems), making it equally applicable to marine and terrestrial systems.

Biogeographic classification systems are an important tool to categorizing broad habitat types and ecological processes (see section 3.2.3). As in terrestrial analyses, it is necessary to classify marine habitats and environments as a first step in undertaking the comparative analyses necessary for World Heritage evaluation. A number of different bio-classification systems are available for the marine environment (see Table 3.1). This study applies the MEOW and GOODS classifications, which are now widely used by the conservation community. However, any classification has its weaknesses as well as strengths, and it is important to consider multiple classifications, or the complementary findings from different classifications in assessing OUV, rather than relying without critical thought on just one system.

2.3.1 Productivity and biogeochemical cycles

The productivity of ocean waters depends on many factors, including the intensity of sunlight and the availability of inorganic nutrients (nitrate, nitrite, and phosphorus) and some trace elements such as iron. Light intensity is strongest at the surface, and decreases rapidly due to absorption by water molecules and other dissolved or suspended substances in the water, so the 'photic zone' in which algae can effectively photosynthesize and grow can be very narrow – in some turbid coastal waters just 10–20 m deep, and in exceptionally clear ocean waters up to 100 m deep. Most open ocean waters have very low productivity, as organic matter sinks out of the photic zone to the seafloor. Near the coasts, where rivers pour nutrients into the sea and upwelling currents raise nutrients to the surface waters, massive increases in productivity occur, visible in satellite images of ocean surface productivity.

The cycling of nutrients between shallow and deeper waters is illustrative of the role of the oceans in the large-scale cycling of nutrients in biogeochemical cycles, for example of carbon and nitrogen, and water itself. Ocean water masses are in many cases the largest reservoir of elements in the biogeochemical cycles that govern life on Earth[53]. In an era of anthropogenically induced climate change, the oceans are the largest reservoir of inorganic carbon, that absorbs a large proportion of the carbon dioxide being released into the atmosphere[54]. While this is beneficial to terrestrial and airborne life and climates, it has potentially severe negative consequences on life in the ocean.

The discovery of hydrothermal vents (see section 2.2.4) revealed the first ecosystems known to be independent of sunlight and photosynthesis[55], and comprising significant gateways for biogeochemical exchange between geological, hydrodynamic and biological realms.

2.3.2 Connectivity

Connectivity is a process with both physical and biological elements. The vast majority of marine organisms spend at least a part of their life cycle in the water column and subject to transport by currents, whether passively suspended or swimming actively. For both invertebrates and fish, passive transport usually occurs in early life stages after fertilization of an egg, during larval development. This typically occurs as one-way

Box 2.12 Biogeochemical cycles and productivity. *Examples of features that may provide a basis for OUV at a site.*

Primary, criterion (ix)	Supporting
• Chemosynthesis in hydrothermal vents; • The massive productivity of upwelling regions (such as Oman, Peru, etc.) that support high biomass of fish and the largest commercial fisheries [criteria (vii), (ix)]; • Brine shrimp systems in the polar regions?	• Local-scale upwelling such of the Humboldt Current to the west of the Galapagos Islands supports the highly productive and cold water ecosystems of Isabella and Fernandina islands, one of the three main marine biodiversity regions of the Galapagos World Heritage Site that make it unique.

53 Earle and Glover 2008
54 Kleypas and Langdon 2006
55 Tunnicliffe 1991

Box 2.13 Connectivity. *Examples of features that may provide a basis for OUV at a site.*	
Primary, criterion (ix) • It is not clear if connectivity could be considered a primary feature of OUV, but certainly as supporting feature for a species, habitat or for site integrity (see right).	**Supporting** • Inclusion of the major nodes and/or pathways of connectivity in the design of a nominated site, to support ecological processes [criterion (ix)], species [criterion (x)] or a superlative phenomenon [criterion (vii)]. • Contributing to the integrity of a site and sustaining the values inscribed under criterion (ix) and/or (x).

transport in ocean currents, though in some cases, larvae and young may return to the same location carried by circular currents and gyres. Pelagic species that remain suspended in the water column may be subject to transport throughout their life cycle. Some large fish, such as tuna and sharks, and many marine mammals and turtles, actively swim vast distances in seasonal or annual migrations, usually coordinated with current systems to reduce the energetic cost of movement.

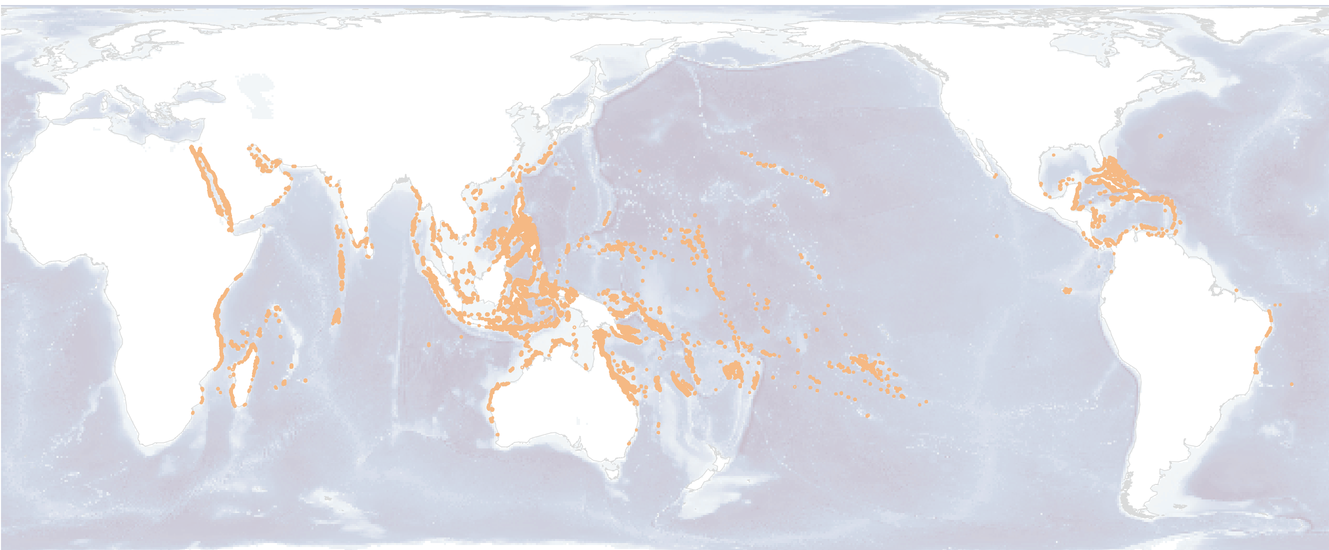
Connectivity plays an important role in ecological relationships, such as the movement of fish or invertebrates between habitats, as seen in the use of coral reefs and seagrass beds by many snapper species. This movement can be ontogenetic, as seen in snapper species, where shifts in habitat are correlated to different phases in a species' life cycle or it can be adult movement to reach feeding, copulating, or breeding areas as seen in turtles and dugong. And finally, nutrient and energy exchange between adjacent habitats may be linked not just by short-term movement of animals, but also by flux of nutrients and/or detritus carried in currents and tidal flows. Over larger spatial and temporal scales, connectivity establishes persistent ecoregions and biomes defined by shared species assemblages that can correspond to biogeographic classification schemes (see Table 3.1).

Any of these components of connectivity may be considered with respect to World Heritage criteria, though their relevance may extend from being a supporting feature to being the primary feature for justifying OUV (Box 2.13). However, at the global scale, explicit indicators or maps of functional connectivity are still lacking. Thus the use of connectivity concepts in the design of mWHS in the near future may still have to rely on proxies, rules of thumb, and comparative analyses. It is important to note that while attention may focus on the end-points of migration routes, it may also be that the migration corridor (or bottleneck) itself may be the most significant feature.

2.3.3 Marine ecosystem patterns, processes and services

The most basic dichotomy in marine ecosystems is between those that are suspended in the water with no functional contact or link with the seafloor (pelagic) and those that are essentially bottom-associated (benthic). Pelagic ecosystems are comprised of microorganisms, plants and animals that live their entire life cycles suspended in the water column. They may either float passively, being essentially neutrally buoyant

Figure 2.2 Global distribution of coral reefs.[56]



[56] UNEP-WCMC, WorldFish Centre, WRI and TNC (2010)

or slightly negatively buoyant (so sink slowly over time), or they may be actively mobile and able to move randomly or purposefully.

Benthic ecosystems are associated with the seafloor, whether in well-lit shallow waters such as coral reefs, or on the abyssal ocean floor, in permanent darkness. Benthic ecosystems may be associated with hard, or rocky substrates or with soft, or silty/sandy substrates. In the latter case many organisms live in the interstitial spaces between sand and silt grains. Examples of benthic ecosystems include coral reefs (see Figure 2.2), kelp forests and other communities on hard substrates, seagrasses (see Figure 2.3) on soft substrates, and mangroves (see Figure 2.4) and salt marshes in the intertidal zone, and the vast expanse of seafloor sediments in the abyssal plains.

Figure 2.3 Global distribution of seagrass species.[57]

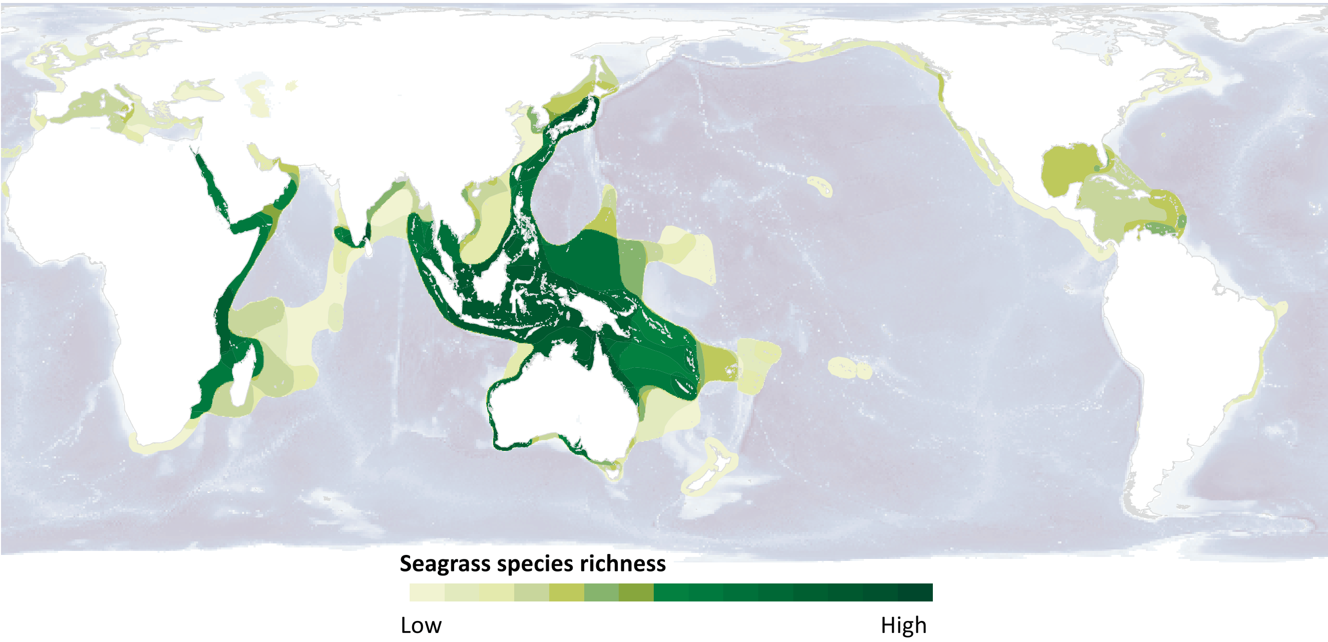
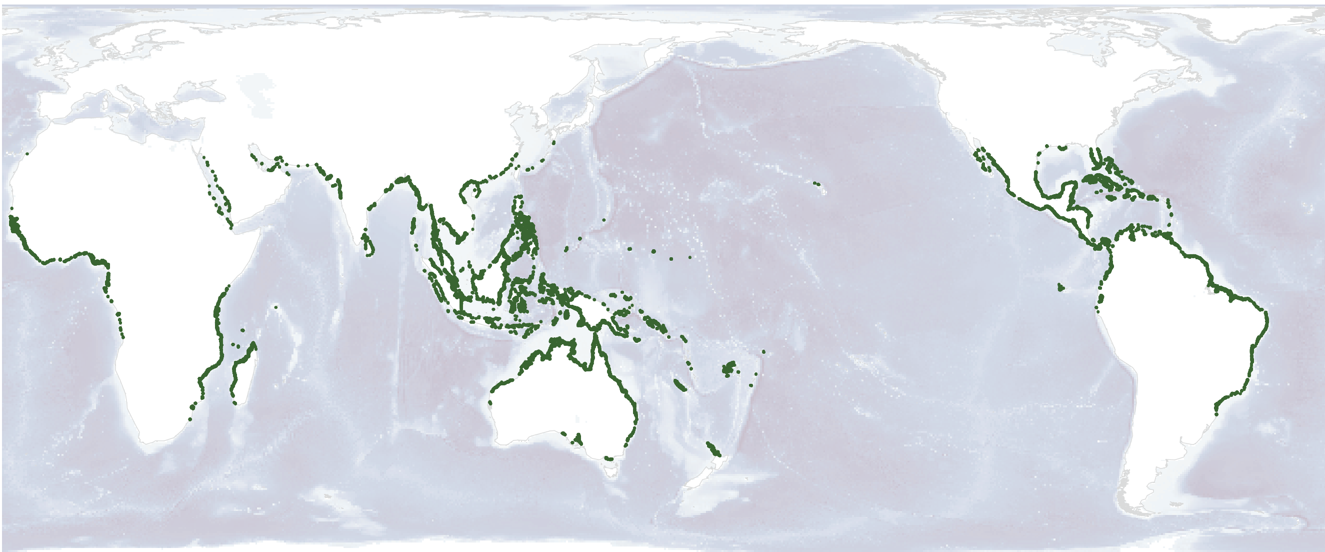


Figure 2.4 Global distribution of mangroves.[58]



[57] Global seagrass diversity (V 1.0, 2003) prepared by UNEP World Conservation Monitoring Centre (UNEP-WCMC) in collaboration with Dr Frederick T. Short

[58] Global Mangroves (USGS) 2011. Compiled from LandSat imagery covering the period 1997–2000
Status and distributions of global mangroves have been mapped using recently available Global Land Survey (GLS) data and the Landsat archive
Approximately 1,000 Landsat scenes were interpreted using hybrid supervised and unsupervised digital image classifcation techniques

Box 2.14 Marine ecosystem patterns, processes and services. *Examples of features that may provide a basis for OUV at a site.*	
Primary, criterion (ix) • The best, most intact, or most diverse example of a particular ecosystem or process on a global scale, such as of chemosynthesis in a hydrothermal vent. • An exceptional or outstanding ecosystem / community and/ or ecological / biological process.	**Supporting** • An intact example of a particular ecosystem that supports the highest number of species, or greatest number/proportion of endemic species or threatened species [criterion (x)].

A fundamental dichotomy in ecosystem classification that is relevant to deep ocean assessments is between those systems that are photosynthetic versus chemosynthetic in their primary energy supply. Physical variables also distinguish marine ecosystems and include temperature, such as between tropical, temperate and polar regions; depth, which affects light availability, pressure and other more subtle details of environmental quality; availability of inorganic nutrients such as iron, for example between continental and oceanic zones; and others. Finer differentiation of marine ecosystems is highly complex, and as a result many different biogeographic classification schemes have been developed for different purposes (see section 3.2.3 and Table 3.1).

The ecological processes that structure ecosystems are varied, but common across many are primary production, trophic interactions, competition, parasitism and disease, and, connectivity. Details of how they vary from one location to another, or are expressed to superlative levels in some locations, are important for consideration for OUV under criterion (ix). Some ecological processes, such as migration or spawning aggregations, can also be considered under criterion (vii) as spectacular phenomena (see section 2.5.5). Some marine ecosystem processes are transient and variable in nature, being associated with species and specific stages in their lifecycle. For example, aggregations or congregatory events of species to spawn or feed occur in response to environmental and temporal cues, and may be variable in location and timing. While transient, they may play a critical role in maintaining populations of a species, or broader ecosystem dynamics.

The role of ecosystem services is increasingly being recognized by countries, referring to the ecological processes and functions that provide goods and services to people. Food provisioning, climate regulation and coastal protection are examples of these services, and it may be that these could be viewed from a heritage perspective, given their value to humanity.

2.4 Criterion (x) – Species and diversity

Revisiting the introductory paragraphs to criterion (ix) in section 2.3, this study conforms with a study assessing the coverage of WH sites under these two 'biodiversity' criteria in terrestrial systems[59] to emphasize that **criterion (x) relates to species and the habitats or sites most important for their conservation, while criterion (ix) relates to ecosystems, communities and the ecological and biological processes that shape and sustain them**. This reflects a general convergence over time in how the criteria can be most consistently applied and it can be misleading to review historical applications of the criteria for guidance on how to use them now.

Criterion (x) is associated with one of the core competencies of IUCN (the conservation of nature and biological diversity)[60], and a range of tools are available to assess this criterion, which include the IUCN Red List of Threatened Species and Key Biodiversity Areas (KBAs) such as Important Birds Areas (IBAs) and Alliance for Zero Extinction sites. With respect to the marine environment, the concept of Ecologically or Biologically Significant Areas (EBSAs)[61] has been advanced in the last two years, through the Convention on Biological Diversity, along with the identification of marine IBAs and marine KBAs (see Box 3.1).

The Operational Guidelines focus on the place-based identity of the property, being the most significant globally for the conservation of certain species. Emphasis is on habitats and their sufficient diversity and integrity to maintain the species, including nodes in migratory pathways [while the pathways themselves might be considered under criterion (vii)]. While the criterion is often used in relation to globally threatened species, exceptional concentrations of endemic, restricted-range or 'congregatory' species may also provide a strong justification of OUV under criterion (x). In practice, evaluations of WH nominations have focused strongly on species diversity and globally threatened species.

This criterion is equally applicable in marine as in terrestrial systems, but as with criterion (ix), fewer and weaker datasets in marine systems hamper quantitative assessment for the criterion on a global scale (see discussion in section 2.3 and Chapter 3). Nevertheless, it is increasingly possible to use (and the sub-clauses of the criterion also offer) proxies if species data are poor, for example by considering the distribution of

[59] Bertzky *et al.* 2013
[60] IUCN 2006
[61] SBSTTA 2012a, b, c

Box 2.15 Criterion (x). *Contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of OUV from the point of view of science or conservation.*	
Phrase	**Interpretation**
Most important and significant natural habitats	This introductory clause highlights the focus of this criterion on protecting the "most important and significant natural" sites for the conservation of biological diversity. The habitat of a species refers to the physical space that its population utilizes. Protecting those places that contain the most important habitats for species is stated as the objective of this criterion. This concept applies equally in the sea and on land.
In-situ conservation of biological diversity	This is the primary clause of the statement. Significant diversity may be in relation to maximum diversity, endemism, or unique diversity or rarity such as in enclosed seas, bays, or cave systems. The in-situ conservation of biological diversity is equally applicable in the sea and on land.
Threatened species of OUV from the point of view of science or conservation	This sub-clause focuses efforts under the Convention, though not exclusively, on species most in need of protection to avoid extinction and irreplaceable loss of the OUV that they represent. This concept applies equally in the sea and on land, for example in the protection of whales, or rare and vulnerable species such as black corals. The IUCN Red List of Threatened Species provides an important data source for this, and the number of marine species assessed on the Red List is increasing every year. The second sub-clause also provides a focus for this criterion, on threatened species assessed to have OUV from the perspectives of science or conservation. For example, the best-studied population of a species may have particular importance for scientific reasons, as compared to another population that may be important for conservation reasons (e.g. if it is larger, or in a region with higher integrity).

important sites (such as KBAs, see Box 3.1) and of threatened species (as flagships for other species that may co-occur with them). The importance of "natural habitats" is a key element for in-situ conservation, and provides a focus for the Convention on sites of importance for conservation.

2.4.1 Diversity of marine life

The oceans are the cradle of life and the largest biome on Earth. Many of the early steps in the evolution of life on Earth occurred in the sea, such as the formation of the first biogenic habitat structures, stromatolites[62]. Almost all of the major divisions of life, the phyla, are found in the ocean, while about half are found on land. Some examples of animal phyla that are exclusively marine include the following, from ubiquitous and common species to rare and recently discovered ones[63]:

- ***Echinoderms*** (starfish, sea urchins, sea cucumbers and their relatives) – among the most ubiquitous of marine phyla, they are an old evolutionary lineage, found in the Burgess shale deposits of Cambrian origin (about 500 million years old[64]). They play important ecological roles as deposit feeders, suspension feeders and predators in many marine ecosystems, from tropical to polar waters, and the surface to the deep sea.
- Marine mammals, including the ***Sirenia*** (dugong and manatee), ***Cetacea*** (whales and dolphins, though some of the latter occur in freshwater) and ***Pinnipedia*** (sea lions and seals), evolved separately from three terrestrial mammalian groups starting about 60 mya, now found throughout the oceans and from tropical to polar waters.
- ***Ctenophores*** (comb jellies) – have distinctive rows of cilia (hairs), in 'combs' running along their gelatinous bodies, and are free-swimming like jellyfish in the world's oceans.
- There are a number of worm-like phyla, including the ***Echiura*** (spoon worms), containing some 150 species, globally distributed and relatively common; ***hemichordates*** (acorn worms), ***sipunculids*** (peanut worms), and others.
- The rarest phyla are the most recently discovered and shed interesting light on evolutionary lineages, include the ***Cycliophora*** (three known species, first described in 1995), the ***Xenacoelomorpha*** and others.

Estimates of the number of species in the oceans range from about 1 million[65] up to 10 million, though less than 2 million have been named in the sea and on land combined[66].

62 Gould 1994
63 WoRMS 2013
64 Gould 2000
65 Appeltans *et al.* 2012
66 Mora *et al.* 2011

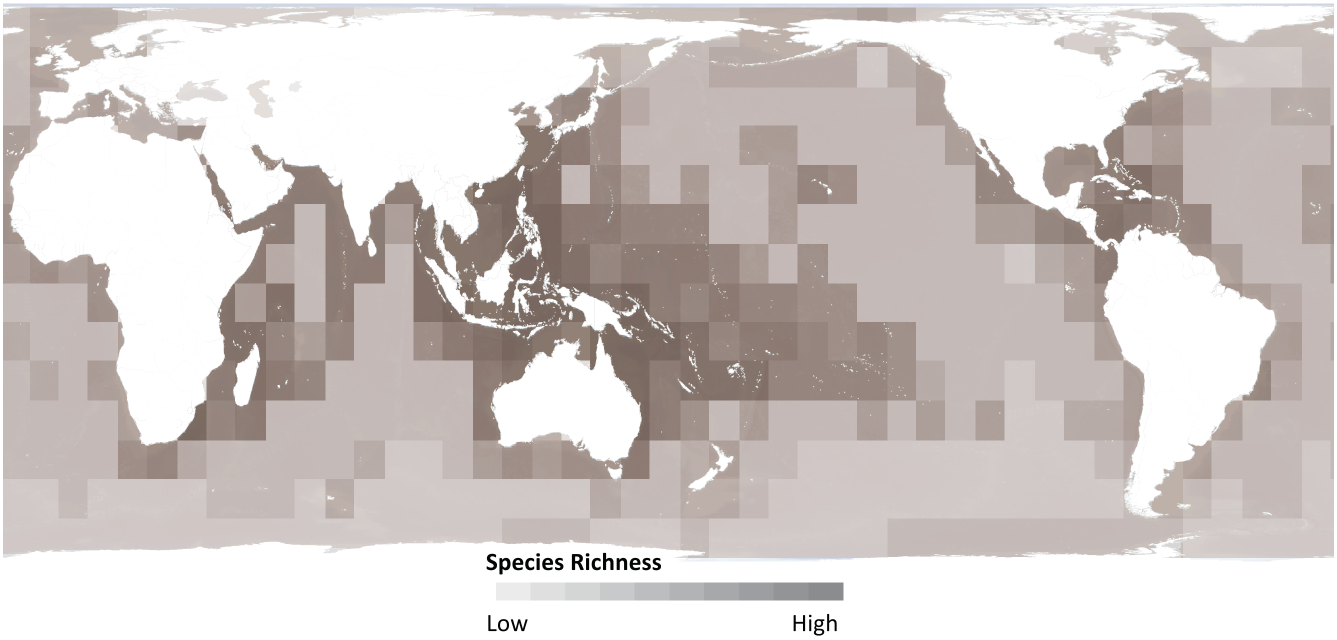
Box 2.16 Diversity of marine life. *Examples of features that may provide a basis for OUV at a site.*	
Primary, criterion (x) • A set of distinctive or unique species, whose presence at a site is of OUV because of their distinctiveness, rarity, or irreplaceability.	**Supporting** • A set of unique species at a location, indicating the importance of evolutionary and ecological processes at the site [criterion (ix)] or a unique geological and oceanographic history criterion (viii)].

2.4.2 Biogeography and components of diversity

Biogeography is the study of how species are distributed over space, and is a foundation of understanding large-scale processes and patterns, and biogeographical classifications (section 3.2.3 and Table 3.1). The diversity of species at any place (see, for example, Figure 2.5) depends on myriad characteristics of the site and region, both past and present, giving insights into the cumulative effects of all these processes[67].

Shallow tropical marine systems that include ecosystems, communities, food-webs, and habitats, etc. in bays, estuaries, archipelagos, etc. are characterized by warm temperatures, benign conditions, intermediate disturbance and benthos-water column interactions. These areas tend to have the highest diversity of all marine systems, for example in coral reefs and estuarine systems in the tropics, compared to open ocean and temperate/sub-polar systems where diversity is low, but productivity may be higher[69]. Species richness, or total diversity, is one of the key characteristics of sites with high biodiversity importance. The central region of the Indo-Pacific, in the Southeast Asian region now coined the 'Coral Triangle', hosts a far greater abundance of species per unit area within tropical marine ecosystems than any other place on Earth, reflecting the confluence of multiple speciation and diversity maintaining processes over periods of tens of millions of years and multiple geographic scales[70].

Figure 2.5 Global distribution of marine species[68].



Box 2.17 Biogeography and components of diversity. *Examples of features that may provide a basis for OUV at a site.*	
Primary, criterion (x) • Highest species diversity, e.g. the coral reefs in the core of the Coral Triangle. • Highest species endemism, e.g. the Hawaiian Islands.	**Supporting** • A unique regional fauna that contributes to exceptional ecological or ocean processes, such as krill in the Southern Ocean, supporting massive whale populations [criterion (ix)]. • Natural beauty and/or natural phenomena [criterion (vii)].

[67] Bellwood *et al.* 2005, Spalding *et al.* 2007, Reaka *et al.* 2008
[68] Tittensor *et al.* 2010
[69] Randall 1998, Spalding *et al.* 2007
[70] Roberts *et al.* 2002

Box 2.18 Threatened and flagship species. *Examples of features that may provide a basis for OUV at a site.*	
Primary, criterion (x) • Some threatened species (e.g. marine mammal or bird species) may have OUV by virtue of their profile, status, numbers and/or restricted geographic range. • Large concentrations of threatened species in a specific location are more likely to be considered of OUV than an individual threatened species. • A flagship species for a unique ecosystem or location, for example of Gray Whales for the Bering Sea might be argued as having OUV.	**Supporting** • The Bering Sea has the largest submarine canyons on the planet [criterion (viii)], and Gray Whales might be considered a flagship species supporting listing of the region.

Endemism is another key aspect of biodiversity, as sites with endemic species have global significance by virtue of their irreplaceability. This often occurs in peripheral or isolated locations – for example the Eastern Pacific has a depauperate shallow marine fauna with high endemicity. Seamounts, hydrothermal vents and isolated island groups are classic examples where isolation results in unique assemblages and endemic species. Some low-diversity sites may be of critical importance in the maintenance of species populations, such as zones of high productivity in upwellings, where the amount of energy in biomass in the food webs sustains key populations, some of which may migrate large distances to take advantage of the availability of food.

In practical terms, the application of biogeographic analysis to the oceans at a global scale has been hampered by the difficulty of obtaining spatially accurate and complete datasets. With advances in marine science and bioinformatics, global initiatives such as the Census of Marine Life (CoML), the Global Biodiversity Information Facility (GBIF), Ocean Biodiversity Information System (OBIS), and others, are both generating new research and collating existing but fragmented datasets into comprehensive databases with global coverage, that can assist in assessing the uniqueness and OUV of species at a particular site.

2.4.3 Threatened and flagship species

The extinction rate of species on a global scale is faster in recent decades than background rates of extinction over many millions of years of geological time[71]. Because of the pervasive human impacts demonstrated and hypothesized to be causing this increase in extinction rates, some authors have coined a name for this new geological epoch, the Anthropocene[72]. The IUCN Red List of Threatened Species[73] was developed to explicitly address the problem of anthropogenically-induced extinction, identifying those species most at risk. Other conservation tools, such as Alliance for Zero Extinction[74] (AZE) sites also address threatened species.

Criterion (x) of the World Heritage Convention focuses on the plight of threatened species (Box 2.15), making it a potentially powerful instrument for conserving threatened species. The IUCN Red List and related tools focused on threatened species, and are useful in identifying the data to support recognition of OUV under criterion (x). There is debate about the degree of vulnerability of marine species to extinction, as compared to terrestrial species. Because of higher levels of connectivity in marine populations, and greater challenges of people reaching and affecting all parts of the larger oceanic realm, it is generally thought that extinction risk in the sea is lower. However, many new studies show high levels of extinction risk in even wide-ranging species and ecosystems, such as in coral reef[75] and pelagic systems[76] and for taxonomic groups such as seabirds[77].

The term "flagship species" can be applied in a range of contexts, where a species may symbolize an assemblage of species, ecosystem or ecological processes, a cultural or historical entity, a geographic region or location, or others. It should be noted, however, that defining flagship species and assessing their potential OUV may be more subjective than the consideration of threatened species.

2.5 Criterion (vii) – Superlative natural phenomena or natural beauty

Criterion (vii) is discussed after the other three natural criteria, as its use is more generally considered subsequent to identification of features that satisfy OUV under one of the other criteria.

The oceans contain many features that can be described as superlative and / or exceptionally beautiful. The first part of the criterion can be assessed objectively, as it can be supported by a measurement of the superlative nature of a site (see Box 2.19). Spectacular biological phenomena that are unique or the largest of their kind may also meet this criterion, such as massive migrations or aggregations of animals (e.g. sardine or

71 Barnosky *et al.* 2011
72 Zalasiewicz *et al.* 2011
73 See www.iucnredlist.org
74 See www.zeroextinction.org
75 Munday 2004, Veron 2008, Carpenter *et al.* 2008, Huang and Roy 2013
76 Dulvy *et al.* 2003, Myers and Worm 2008
77 Stattersfield and Capper (2011), http://www.birdlife.org/action/science/sites/marine_ibas/index.html

Box 2.19 Criterion (vii). *Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.*	
Phrase	**Interpretation**
Superlative natural phenomena	Includes any exceptional natural phenomena and biological spectacles, whether terrestrial or marine. This can often be objectively measured and assessed (the highest mountain, the most extensive or largest cave system etc.). In the case of marine features, this may refer to, for example, the largest or longest seamount chain or barrier reef, the most extensive underwater cave systems, the most productive upwelling system, the largest underground source of freshwater, the most extensive and productive seagrass beds in the world, etc. This criterion is often used to encapsulate the 'wow factor' of a site.
Exceptional natural beauty (aesthetic importance)	Includes any exceptionally beautiful phenomena, though the judgment of beauty is subjective. It tends to be assessed on the basis of a wide range of expert advice, which compares the property under consideration to other comparable WH properties inscribed under this criterion. It has been suggested that this component of the criterion should only be used when the other component (superlative natural phenomena) or another criterion is also met as alone it may not be objectively justified.

anchovy shoals, aggregations of sharks, whales, rays or other species, or spawning aggregations of fish). In this case it might also be appropriate to consider application of criterion (ix) for ecological and biological processes.

Application of the second part of the criterion, on beauty, has been variable. In the past, it has required consideration of one of the other natural criteria as a primary quantifiable reference and to provide evidence of outstanding features. An example of this is the Great Barrier Reef World Heritage site which is not only the largest barrier reef system on Earth, but is also of exceptional natural beauty. The application of this criterion to marine systems is indistinguishable from its application in terrestrial ones. For example, certain waveforms or seascapes, coastlines, rifts, seamounts chains, tropical and cold water coral reefs, kelp forests, sponge reefs, hydrothermal vents and ice-scapes are of exceptional natural beauty.

2.5.1 Marine phenomena and spectacles of nature

Marine ecological processes and 'events' may also be, or create, spectacular phenomena, often because of the unfamiliarity of the ocean to people and the dramatic nature and size of some of these processes and events. For example, the sardine run in South Africa could be considered a superlative phenomenon under criterion (vii), as well as an outstanding ecological process under criterion (ix) such as a mass aggregation or migration of a species for feeding or reproduction. Outstanding aggregation sites for threatened species such as whale sharks may also be considered under criterion (x) as critical habitats for the conservation of such species. Thus, aggregation phenomena or sites, migratory routes and bottlenecks, feeding groups, and nursery grounds might be inscribed under combinations of these criteria, depending on the characteristics of the particular feature being considered. In general terms, if a spectacular phenomenon is not an irreplaceable part of a species or ecological process then it would primarily be inscribed under criterion (vii), with supporting features described under criteria (ix) and/or (x). If the phenomenon is essential to the species or ecological process globally, then it might also be inscribed under criteria (ix) and/or (x).

Box 2.20 Biological phenomena. *Examples of features that may provide a basis for OUV at a site.*	
Primary, criterion (ix)	**Supporting**
• Aggregation sites (e.g. groupers, sharks and rays), migratory routes and bottlenecks (marine mammals and turtles), feeding groups (dugong), and nursery grounds (marine mammals) that are superlative examples of these phenomena.	• These phenomena may support or be necessary for the survival of a threatened species [criterion (x)].

2.6 Some issues for consideration in relation to the application of the World Heritage criteria to marine systems

Interpretation of the Convention text, Operational Guidelines and accepted practice in applying the concept of OUV have evolved over time, requiring repeated reconsideration. Table 2.3 shows how the marine themes listed in this chapter may best be divided among the criteria (see also Table 2.1).

With respect to marine systems, some additional factors should be considered in relation to the application of the natural criteria, which include the following:

- ***Criterion (vii)*** – There has been discussion in the past about matching ocean features to criterion (vii) based on them being superlative natural phenomena, but this may

Table 2.3 Summary table of marine themes and their relevance to the natural criteria. The table indicates the primary criterion relevant to each theme, but also where secondary (sec) consideration might be possible for a theme, or its role in supporting (supp) the OUV of another feature or theme.

Marine Themes	vii- superlative phenomena & natural beauty	viii- geology & oceanography	ix- ecosystem processes	x- species & conservation
Geology				
1. Plates and tectonics	sec	**primary**		
2. Hotspots, seamounts	sec	**primary**		
3. Sediments, canyons	sec	**primary**		
4. Hydrogeological features	sec	**primary**		
Oceanography				
5. Water masses	sec	**primary**		
6. Ocean currents	sec	**primary**		
7. Waves etc.	sec	**primary**		
8. Coastal/land-sea inter.		sec/supp	**primary**	
9. Ice	sec	**primary**		
Biology				
10. Biogeochemistry, productivity	sec	sec/supp	**primary**	
11. Connectivity	sec	sec/supp	**primary**	sec
12. Marine ecosystems, processes	sec/supp	sec/supp	**primary**	
13. Diversity of marine life	sec	sec/supp		**primary**
14. Biogeography and diversity	sec	sec/supp		**primary**
15. Threatened species	sec.	sec/supp		**primary**
16. Marine phenomena/ spectacles of nature	**primary**	sec/supp	sec/supp	sec/supp

simply have reflected the lack of clear guidance on ocean as compared to geological features. In keeping with current practice with terrestrial features, the superlative clause of this criterion can be invoked (for the largest, fastest, highest, deepest, etc.) for a natural feature, but usually (although not exclusively) that feature will have satisfied one of the other three criteria. A recent thematic study by IUCN on criterion (vii) has explored some of these issues and can be consulted for further guidance, especially if criterion (vii) is being considered for application on its own[78].

- ***Criterion (viii)*** – Extending the application of the World Heritage convention to the marine environment requires a significant expansion of features that could be classed under criterion (viii). From a focus on geology (initially from an interest in the heritage value of the Earth and its history to people), this criterion most naturally includes the physical components of oceanography. Regularizing this as a process in World Heritage nominations will require a number of years of experience and lessons learned, following which the advice in this report will likely need to be updated.

This expansion in use of criterion (viii) may give a misleading impression that marine World Heritage features may be 'geology biased'. This is incorrect, as we have tried to show that the primary content of the criterion contains both oceanography and geology, and many of the biological values that might be considered in the oceans will have a strong coupling with both oceanographic and geological (physical) environmental features (see next topic).

The lack of text or reference in the primary documents of the World Heritage Convention with respect to the ocean is problematic for expanding the coverage, scope and representativity of marine sites on the World Heritage List. The ocean and marine themes summarized in this section need to be treated objectively and in a repeatable way in nominations for WH sites (see also Table 2.3). How this may be done in the texts of the World Heritage Convention requires some consultation, as a number of options may be possible, from procedural guidance documents, to amendments to the Operational Guidelines, to changes in the formal Convention and criteria texts.

[78] Mitchell *et al.* 2013

- ***Criterion (ix) versus (x)*** – as noted earlier, how these criteria have been used under the Convention has shifted over time, so historical analysis of the nomination files and justifications of OUV of existing sites can be misleading in the preparation of new nominations. In keeping with the terrestrial study[79] on these criteria, this report recommends that ecosystems, communities and the processes that underpin them be considered under criterion (ix), while criterion (x) is used with a focus on species, in particular of threatened species of OUV, and the key sites and habitats that support their survival. Therefore, to invoke criterion (ix) in a site nomination, a State Party must demonstrate that the site is an exceptional example of ecosystems or communities of OUV and their underlying processes and is large and intact enough to maintain these. In order to invoke criterion (x) a State Party has to demonstrate that the site is critical habitat for the conservation of species of OUV and / or supports exceptional levels of biodiversity in terms of species and / or habitat richness.

2.7 Specific aspects of integrity for marine sites

Integrity is a specific requirement for all natural World Heritage sites and is defined in the Operational Guidelines[80] as:

> *"a measure of the wholeness and intactness of the natural and/or cultural heritage and its attributes. Examining the conditions of integrity, therefore requires assessing the extent to which the property:*
>
> *a) includes all elements necessary to express its Outstanding Universal Value;*
> *b) is of adequate size to ensure the complete representation of the features and processes which convey the property's significance;*
> *c) suffers from adverse effects of development and/or neglect."*

Thus for instance, integrity under criterion (ix) requires sites to be of sufficient size and to contain the necessary processes that are essential for the long-term conservation of the target ecosystems and communities[81].

This thematic study does not provide detailed advice on the application of the concept of integrity within the proposed thematic framework, however we do note some specific considerations for integrity in relation to marine nominations, and other aspects are incorporated in the earlier discussion on the criteria.

2.7.1 Scale and connectivity

In terms of scale, the magnitude of migration distances, juvenile recruitment, ontogenetic shift in habitat use, and habitat size are more pronounced in marine systems due to the fluidity of the habitat (as a result of both the medium and prevailing oceanographic conditions) in addition to the high mobility of both juveniles and adults which potentially leads to larger areas that are needed to maintain marine ecological processes.

The importance of connectivity in the marine environment (section 2.5.3) adds an added level of complexity in determining the relationship between geographic scale and integrity. Non-contiguous sites connected by currents may result in a higher level of integrity if designed appropriately, but connectivity science is largely at early stages to be able to assess this with confidence. Thus integrity for marine properties will require additional care to meet this pillar of the WHC. Work on Key Biodiversity Areas (KBAs, Box 3.1) for marine species will be relevant in this regard, as identified KBAs are on a sufficient scale to ensure the conservation of biodiversity at the genetic, species and ecosystem level[82].

2.7.2 Serial sites

The larger scale of ocean basins, and of transport and connectivity in the marine environment opens up a series of challenges and opportunities for World Heritage site design. One of the main ones is that larger properties may be needed to maintain the integrity of the values for which a site is inscribed. At the same time, the importance of connectivity and the existence of migration or connectivity corridors suggest that though an entire region may be necessary to protect, for example, a migratory species, not all locations within that region may be necessary.

Thus, the concept of non-contiguous locations linked by transport corridors may be sufficient for protection of such species or features, and hence the establishment of "serial" sites. Serial sites for natural heritage are defined as properties made up of non-contiguous component locations that belong to the same geological or geomorphological formation, the same biogeographic province, or the same ecosystem type[83]. With respect to marine systems the serial site concept has

[79] Bertzky *et al.* 2013
[80] Operational Guidelines #88
[81] Operational Guidelines #94
[82] IUCN 2012
[83] Engels *et al.* 2009

been considered since 2001, being highly applicable to marine locations connected by water currents[84].

Serial sites may be the only practical way to inscribe certain types of marine features in the World Heritage list, applying a 'core, buffer and utilization' zone concept commonly applied in Integrated Coastal Management (ICM) and Marine Spatial Planning (MSP)[85], where the integrity of fully protected sites is further assured by rational and planned use to minimize impacts in adjacent or interacting zones.

2.7.3 Land-based threats and integrity of marine ecosystems

All the foregoing text has focused on characteristics of the marine environment, and with the exception of the coastal features and processes (section 2.2.8), interactions with land have been ignored. Yet with human development on land, and much of the pollution load from land being swept into the sea by freshwater flow, it is essential to also consider land-based influences and freshwater systems in assessing the OUV of marine features, and whether they retain sufficient integrity to meet the criteria of the World Heritage Convention. Most of the existing marine WH sites, and many sites inscribed for terrestrial features but with an unacknowledged marine component (e.g. in coastal waters or estuaries), have terrestrial components that may impact on the marine environment. Building consideration and management of these linkages explicitly into the design of new mWHS will be increasingly important for ensuring their integrity in the future.

2.8 Conclusion of Chapter Two

In this Chapter, we have suggested a framework of 16 broad themes of marine and ocean features to which natural World Heritage criteria might be applied in the development of mWHS. Interpretation of the Convention text, Operational Guidelines and accepted practice in applying the concept of OUV have evolved over time, requiring repeated clarification of differences or ambiguities. In regard to criterion (vii), we recommend that the criterion can be invoked (for the largest, fastest, highest, deepest, etc.) for a natural feature, but usually (but not exclusively) that feature will have satisfied one of the other three criteria in addition to criterion (vii). Extending the application of the World Heritage Convention to the marine environment requires a significant expansion of features that could be classed under criterion (viii). From a focus on geology and geomorphology (initially from an interest in the heritage value of the Earth and its history to people), this criterion most naturally is able to encompass the physical components of oceanography. Finally, in keeping with the recently completed terrestrial biodiversity thematic study[86], this report recommends that ecosystems, communities and the processes that underpin them be considered under criterion (ix), while criterion (x) is used with a focus on species, in particular of threatened species with high global value, and the importance of key sites and habitats in achieving their survival. Chapter 3 presents the current distribution of mWHS and identifies broad biogeographic gaps. It also considers how future nominations can be prioritized and developed by States Parties, taking into account the 16 broad marine themes and their relationship to the World Heritage criteria presented in this Chapter.

[84] Hillary *et al.* 2002
[85] Ehler and Douvere 2009
[86] Bertzky *et al.* 2013

3. Distribution of marine World Heritage sites, broad biogeographic gaps, and approaches to address these gaps

3.1 Introduction

Chapter One of the thematic study introduced the World Heritage Convention and how it can be related to the marine realm, while Chapter Two provided guidance on interpreting the World Heritage criteria for "Outstanding Universal Value" in relation to marine systems and features, and on applying these criteria to the possible nomination of marine sites for potential inclusion on the World Heritage List. In Chapter Three, we examine the current distribution of mWHS, identify broad biogeographic gaps, and provide guidance on potential approaches to prioritize these gaps for nomination and designation of mWHS in order to enhance marine representation on the World Heritage List.

3.2 Identifying biogeographic gaps in the current global distribution of mWHS

The World Heritage Committee developed its Global Strategy in 1994 with the central aim of developing a representative, balanced and credible World Heritage List. At the core of the Strategy's objectives is establishing a set of WH sites that reflect the wide-ranging diversity of cultural and natural areas of Outstanding Universal Value. Motivating site nominations from regions with outstanding values that are not represented or underrepresented is key to the success of this Global Strategy. It is important to note, however, that OUV remains the key requirement for inscription on the World Heritage List and not representativeness[87]. Unlike the Convention on Biological Diversity or UNESCO's Man and Biosphere Programme, the World Heritage Convention seeks to establish only a select list of the most outstanding areas around the world and not an ecologically representative network of protected areas[88]. However, gaps in the current coverage of biogeographic regions can be very useful in guiding the search for outstanding sites towards areas with distinctive biodiversity values that have not yet been included on the World Heritage List. It is important to note, while it is useful to identify a biogeographic province as a gap, this alone does not qualify a nomination from that province for World Heritage listing.

3.2.1 Defining a marine site on the World Heritage List

The UNESCO World Heritage Centre has recognized (as of January 2013) 46 natural and mixed World Heritage sites in 35 countries as the mWHS. The marine values and features of these 46 sites have been recognized as being of OUV under natural criteria (vii), (viii), (ix) and/or (x). However, as noted in earlier chapters, a further 25 natural and mixed World Heritage sites contain significant marine and/or coastal features[89]. These features were recorded and described in relevant World Heritage documents such as the State Party nominations, IUCN evaluations or UNESCO decisions on these sites. This study maps both the 46 and 25 sites for reference but includes only the 46 official sites in the analyses[90].

3.2.2 Global distribution of mWHS

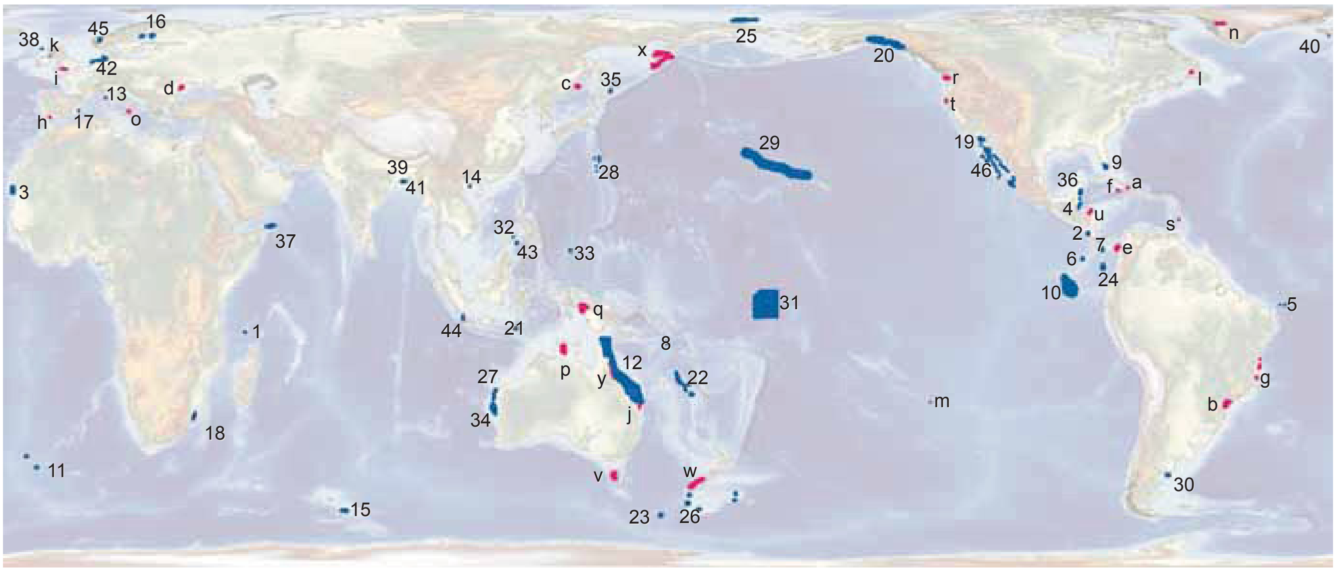
The 46 marine World Heritage site (mWHS) are distributed across 35 countries and represent all continents (see Figure 3.1). They occur from the Arctic to the Southern Ocean although a large proportion occurs in the tropics (30 sites; 65%). The largest mWHS are in the Pacific Ocean and include the Phoenix Islands Protected Area (Kiribati), Papahānaumokuākea (USA), the Great Barrier Reef (Australia), and the Galapagos Islands (Ecuador). Large mWHS elsewhere include the Wadden Sea (Netherlands and Germany) and Ningaloo Reef (Australia). The country with the highest number of mWHS is Australia (five sites) with the USA having the second highest (three sites), and UK, Indonesia, Costa Rica, and France all with two sites each (see Figure 3.1).

3.2.3 Biogeographic classifications in marine environments

Biogeographic classification systems and biodiversity schemes are used in this study to assess the coverage of the current set of mWHS and to identify gaps in global coverage. A number of different biogeographic classifications and biodiversity prioritization schemes have been used in the last 50 years

[87] Badman *et al.* 2008
[88] Magin and Chape 2004
[89] Spalding 2012
[90] As noted earlier, it may be appropriate to review the list of mWHS recognized by the World Heritage Centre's marine programme

Figure 3.1 Global distribution of the 46 natural and mixed World Heritage sites that are formally inscribed for marine values and 25 other natural and mixed World Heritage sites with significant marine values (Sources: Spalding 2012, IUCN / UNEP-WCMC 2013 and UNESCO 2013).



46 natural World Heritage sites recognized for inscription in relation to marine values

25 other natural World Heritage sites that include a marine component

ID	Name	Country
1	Aldabra Atoll	Seychelles
2	Area de Conservación Guanacaste	Costa Rica
3	Banc d'Arguin National Park	Mauritania
4	Belize Barrier Reef Reserve System	Belize
5	Brazilian Atlantic Islands: Fernando de Noronha and Atol das Rocas Reserves	Brazil
6	Cocos Island National Park	Costa Rica
7	Coiba National Park and its Special Zone of Marine Protection	Panama
8	East Rennell	Solomon Islands
9	Everglades National Park	United States of America
10	Galápagos Islands	Ecuador
11	Gough and Inaccessible Islands	United Kingdom
12	Great Barrier Reef	Australia
13	Gulf of Porto: Calanche of Piana, Gulf of Girolata, Scandola Reserve	France
14	Ha Long Bay	Viet Nam
15	Heard and McDonald Islands	Australia
16	High Coast / Kvarken Archipelago	Sweden; Finland
17	Ibiza, Biodiversity and Culture	Spain
18	iSimangaliso Wetland Park	South Africa
19	Islands and Protected Areas of the Gulf of California	Mexico
20	Kluane / Wrangell-St Elias / Glacier Bay / Tatshenshini-Alsek	United States of America; Canada
21	Komodo National Park	Indonesia
22	Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems	France
23	Macquarie Island	Australia
24	Malpelo Fauna and Flora Sanctuary	Colombia
25	Natural System of Wrangel Island Reserve	Russian Federation
26	New Zealand Sub-Antarctic Islands	New Zealand
27	Ningaloo Coast	Australia
28	Ogasawara Islands	Japan
29	Papahānaumokuākea	United States of America
30	Península Valdés	Argentina
31	Phoenix Islands Protected Area	Kiribati
32	Puerto-Princesa Subterranean River National Park	Philippines
33	Rock Islands Southern Lagoon	Palau
34	Shark Bay, Western Australia	Australia

ID	Name	Country
35	Shiretoko	Japan
36	Sian Ka'an	Mexico
37	Socotra Archipelago	Yemen
38	St Kilda	United Kingdom
39	Sundarbans National Park	India
40	Surtsey	Iceland
41	The Sundarbans	Bangladesh
42	The Wadden Sea	Netherlands; Germany
43	Tubbataha Reefs Natural Park	Philippines
44	Ujung Kulon National Park	Indonesia
45	West Norwegian Fjords – Geirangerfjord and Nærøyfjord	Norway
46	Whale Sanctuary of El Vizcaino	Mexico
a	Alejandro de Humboldt National Park	Cuba
b	Atlantic Forest Southeast Reserves	Brazil
c	Central Sikhote-Alin	Russian Federation
d	Danube Delta	Romania
e	Darien National Park	Panama
f	Desembarco del Granma National Park	Cuba
g	Discovery Coast Atlantic Forest Reserves	Brazil
h	Doñana National Park	Spain
i	Dorset and East Devon Coast	United Kingdom
j	Fraser Island	Australia
k	Giant's Causeway and Causeway Coast	United Kingdom
l	Gros Morne National Park	Canada
m	Henderson Island	United Kingdom
n	Ilulissat Icefjord	Denmark
o	Isole Eolie (Aeolian Islands)	Italy
p	Kakadu National Park	Australia
q	Lorentz National Park	Indonesia
r	Olympic National Park	United States of America
s	Pitons Management Area	Saint Lucia
t	Redwood National and State Parks	United States of America
u	Río Plátano Biosphere Reserve	Honduras
v	Tasmanian Wilderness	Australia
w	Te Wahipounamu – South West New Zealand	New Zealand
x	Volcanoes of Kamchatka	Russian Federation
y	Wet Tropics of Queensland	Australia

to assess and classify terrestrial biodiversity and identify conservation priorities[91]. Classification schemes for the marine environment have taken longer to develop as datasets are sparser, and this process has been further impeded in offshore areas where datasets are even more depauperate. Indeed a recent study estimates that approximately 91% of species in the oceans are not yet described[92]. Nevertheless, a number of classification schemes have been developed over the years that use marine oceanography and taxonomy as the main determinants of biogeography (see Table 3.1). This study uses the most recent and comprehensive of these classification schemes[93] to assess current coverage of mWHS in continental shelf, pelagic, and deep sea areas and identify large marine gaps that may harbour sites of potential OUV[94].

3.2.3.1 Nearshore and continental shelf waters

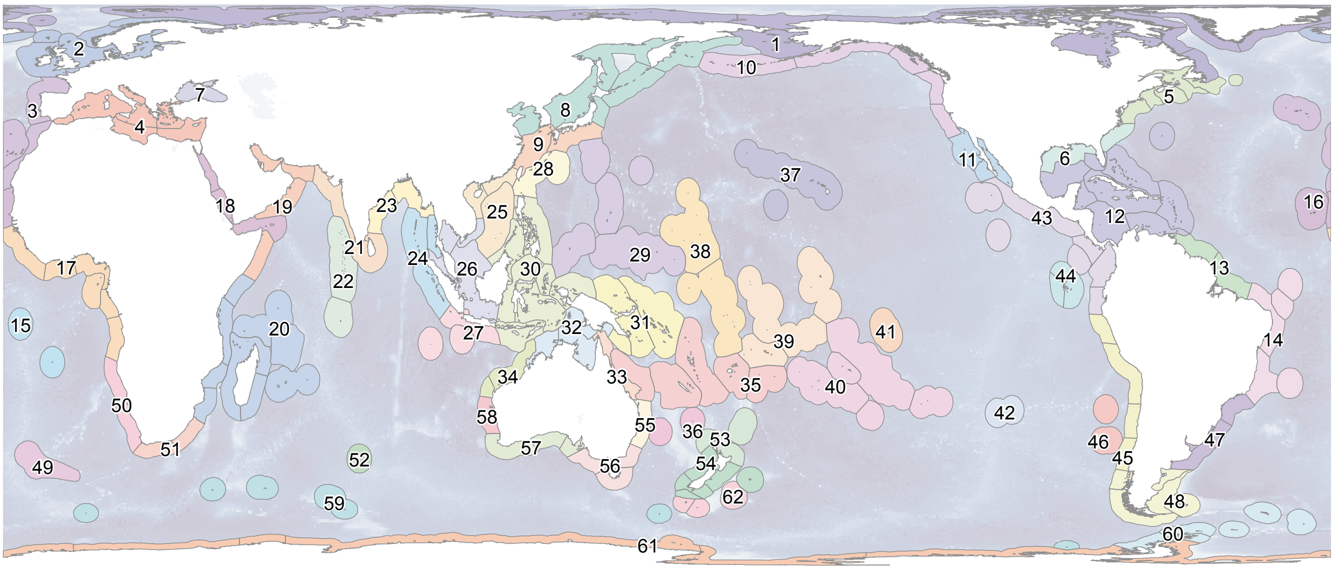
Spalding *et al.* (2007) proposed a marine biogeographic classification for global coastal and shelf areas that is based on global and regional studies of different parts of the world.

Table 3.1 Review of classification schemes in marine environments.

Scheme	Description
Zoogeography of the Sea (Ekman 1953)	One of the first classic volumes originally published in German in 1953, this recognizes, but does not clearly map a number of "faunas", "zoogeographic regions", and "subregions".
Marine Biogeography (Hedgpeth 1957)	This work points back to that of Ekman, but also reviews many other contributors and produces a first global map showing the distribution of the highest level "littoral provinces".
Marine Zoogeography (Briggs 1974)	Perhaps the most thorough taxonomic-based classifications devised, this work still forms the basis for much ongoing biogeographic work. The work focuses on shelf areas and does not provide a biogeographic framework for the high seas. Briggs developed a system of regions and provinces, with the latter defined as areas having at least 10% endemism. These remain very broad-scale, with 53 Provinces in total. The MEOW system (Spalding *et al.* 2007) uses many of the boundaries developed by Briggs to inform its own subdivisions, however the creators of MEOW suggest that the strict definition is both difficult to apply and leads to bias in favour of subdividing species-poor areas and in ignoring major differences in community composition.
Classification of Coastal and Marine Environments (Hayden *et al.* 1984)	An important attempt to devise a simple system of spatial units to inform conservation planning. The coastal units are closely allied to those proposed by Briggs.
Large Marine Ecosystems (Sherman and Alexander 1989)	One of the most widely used classifications, these are "relatively large regions on the order of 200,000 km^2 or greater, characterized by distinct: bathymetry, hydrography, productivity, and trophically dependent populations". There are 64 LMEs globally and they have been devised through expert consultation. These units are not defined by their constituent biotas but in many cases there are close parallels due to the influence of the abiotic characters in driving biotas although this is not always the case. At the present time the system is restricted to shelf areas and, in some cases, to adjacent major current systems and does not include island systems. The MEOW system uses many of the same boundaries as LMEs either for its Provinces or Ecoregions, but in a few areas the fit is poor.
Ecological Geography of the Sea (Longhurst 1998)	This system of broad biomes and finescale "biogeochemical provinces" is focused on abiotic measures. The classification consists of four biomes and 57 biogeochemical provinces. They are largely determined by satellite-derived measures of surface productivity and refined by observed or inferred locations of change in other parameters (including mixing and the location of the nutricline). The direct "measurability" of this system has appealed to a number of authors. It would further appear that some of the divisions lie quite close to lines suggested by taxonomic biogeographers. This system does not strictly follow the surface circulation patterns in a number of areas. Some of the broader-scale biomes cut right across major ocean gyres, splitting in half some of the most reliable units of taxonomic integrity, while the finer-scale units would appear unlikely to capture true differences in taxa, but could perhaps be open to interpretation as finerscale ecoregions.
Ecoregions: the ecosystem geography of the oceans and continents (Bailey 1998)	Bailey has provided much of the critical input into the development of terrestrial biogeographic classification, but his work also provides a tiered scheme for the high seas. The higher-level "domains" are based on latitudinal belts similar to Longhurst, while the finer-scale divisions are based patterns of ocean circulation.
Marine Ecoregions of the World (MEOW; Spalding *et al.* 2007)	This classification divides the world's coastal seas (to 200 m depth) into 12 realms that have a vast array of different habitats and with unique organisms, 62 provinces, that are often delineated by physical features and rich in unique biota, and 232 ecoregions, operating in some ways as self-contained systems with a subset of habitats, often tightly interconnected.
Pelagic Provinces of the World (Spalding *et al.* 2012)	This system is intended to complement the MEOW system by classifying the high seas, into four realms, seven biomes, which are spatially, disjoint but united by common abiotic conditions, and 37 pelagic provinces. Based on the Global Open Ocean and Deep Sea (GOODS) classification system published by UNESCO.
Biogeography of the deep ocean floor (Watling *et al.* 2013)	Twenty-eight global biogeographic provinces proposed for the lower bathyal (14) and abyssal benthos (14) in depths under 800 m and based on the GOODS classification. Delineation of biogeographic provinces was initially hypothesized using oceanographic proxies, and subsequently examined with documented locations of select benthic marine species.

[91] These include Udvardy 1975, Olson *et al.* 2001, and Brooks *et al.* 2006 and 2010
[92] Mora *et al.* 2011
[93] Spalding *et al.* 2007, 2012 and Watling *et al.* 2013
[94] The results of this chapter update and expand on a preliminary analysis by Spalding 2012

Figure 3.2 Nearshore and continental provinces of the world (Spalding *et al.* 2007). The 62 MEOW provinces provide a biogeographic classification for the coastal and shelf waters shallower than 200 metres. For visualization purposes, the boundaries of these provinces are displayed out to 200 nautical miles offshore (or to the 200-m isobath where this lies further offshore), although only those areas out to the 200-m isobath are used in analyses.



Realm	ID	Province
Arctic	1	Arctic
Temperate Northern Atlantic	2	Northern European Seas
	3	Lusitanian
	4	Mediterranean Sea
	5	Cold Temperate Northwest Atlantic
	6	Warm Temperate Northwest Atlantic
	7	Black Sea
Temperate Northern Pacific	8	Cold Temperate Northwest Pacific
	9	Warm Temperate Northwest Pacific
	10	Cold Temperate Northeast Pacific
	11	Warm Temperate Northeast Pacific
Tropical Atlantic	12	Tropical Northwestern Atlantic
	13	North Brazil Shelf
	14	Tropical Southwestern Atlantic
	15	St Helena and Ascension Islands
	16	West African Transition
	17	Gulf of Guinea
Western Indo-Pacific	18	Red Sea and Gulf of Aden
	19	Somali/Arabian
	20	Western Indian Ocean
	21	West and South Indian Shelf
	22	Central Indian Ocean Islands
	23	Bay of Bengal
	24	Andaman

Realm	ID	Province
Central Indo-Pacific	25	South China Sea
	26	Sunda Shelf
	27	Java Transitional
	28	South Kuroshio
	29	Tropical Northwestern Pacific
	30	Western Coral Triangle
	31	Eastern Coral Triangle
	32	Sahul Shelf
	33	Northeast Australian Shelf
	34	Northwest Australian Shelf
	35	Tropical Southwestern Pacific
	36	Lord Howe and Norfolk Islands
Eastern Indo-Pacific	37	Hawaii
	38	Marshall, Gilbert and Ellis Islands
	39	Central Polynesia
	40	Southeast Polynesia
	41	Marquesas
	42	Easter Island
Tropical Eastern Pacific	43	Tropical East Pacific
	44	Galapagos

Realm	ID	Province
Temperate South America	45	Warm Temperate Southeastern Pacific
	46	Juan Fernandez and Desventuradas
	47	Warm Temperate Southwestern Atlantic
	48	Magellanic
	49	Tristan Gough
Temperate Southern Africa	50	Benguela
	51	Agulhas
	52	Amsterdam-St Paul
Temperate Australasia	53	Northern New Zealand
	54	Southern New Zealand
	55	East Central Australian Shelf
	56	Southeast Australian Shelf
	57	Southwest Australian Shelf
	58	West Central Australian Shelf
Southern Ocean	59	Subantarctic Islands
	60	Scotia Sea
	61	Continental High Antarctic
	62	Subantarctic New Zealand

This classification divides the sea into 12 realms that contain 62 provinces, which in turn contain 232 ecoregions (see Figure 3.2). Realms are defined as "very large regions of coastal benthic, or pelagic ocean across which biotas are internally coherent at higher taxonomic levels, as a result of a shared and unique evolutionary history. Realms have high levels of endemism, including unique taxa at generic and family levels in some groups. Driving factors behind the development of such unique biotas include water temperature, historical and broadscale isolation, and the proximity of the benthos"[95].

In this study, we adopt the province scale of this classification to identify gaps in the marine WH network and prioritize consideration of new mWHS. We choose the province scale

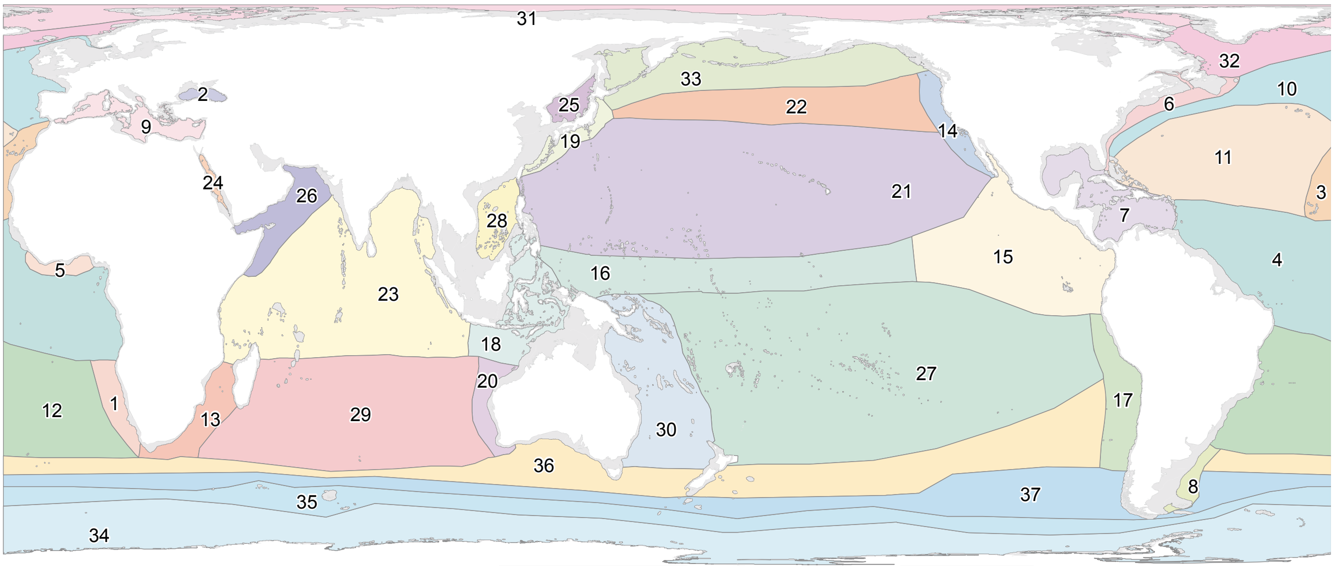
[95] Spalding *et al.* 2007, page 575

because these provinces best match the marine features that were introduced in Chapter 2 and their geographical differentiation. According to the classification scheme, provinces are defined by "the presence of distinct biotas that have at least some cohesion over *evolutionary time frames*. Provinces hold some level of endemism, principally at the *level of species*. Although historical isolation plays a role, many of these distinct biotas have arisen as a result of distinctive abiotic features that circumscribe their boundaries. These may include *geomorphological features* (isolated island and shelf systems, semi enclosed seas); hydrographic features (currents, upwelling, ice dynamics); or *geochemical influences* (broadest-scale elements of nutrient supply and salinity)"[96].

3.2.3.2 Pelagic and deep-sea waters

Off-shelf waters cover the majority of the planet, approximately 66%. Here we use a classification scheme[97], which provides a synthesis classification of offshore waters in the upper 200 m water column and draws both on known taxonomic biogeography and on the oceanographic forces that are major drivers of ecological patterns. This scheme identifies 37 pelagic

Figure 3.3 Pelagic provinces in the off-shelf waters of the world (adapted from Spalding *et al.* 2012). The 37 pelagic provinces presented here provide a biogeographic classification for off-shelf surface waters (upper 200 m of water column). Nearshore and continental shelf areas (shallower than 200 metres; in grey) are covered by the MEOW provinces.



Realm	ID	Province
Atlantic Warm Water	1	Benguela Current
	2	Black Sea
	3	Canary Current
	4	Equatorial Atlantic
	5	Guinea Current
	6	Gulf Stream
	7	Inter American Seas
	8	Malvinas Current
	9	Mediterranean
	10	North Atlantic Current
	11	North Central Atlantic
	12	South Central Atlantic
Indo-Pacific Warm Water	13	Agulhas Current
	14	California Current
	15	Eastern Tropical Pacific
	16	Equatorial Pacific
	17	Humboldt Current
	18	Indonesian Through-Flow
	19	Kuroshio-Oyashio Current
Indo-Pacific Warm Water cont'd	20	Leeuwin Current
	21	North Central Pacific
	22	North Pacific Current
	23	Northern Indian Ocean
	24	Red Sea
	25	Sea of Japan/East Sea
	26	Somali Current
	27	South Central Pacific
	28	South China Sea
	29	Southern Indian Ocean
	30	Southwest Pacific
Northern Cold Water	31	Arctic
	32	Subarctic Atlantic
	33	Subarctic Pacific
Southern Cold Water	34	Antarctic
	35	Antarctic Polar Front
	36	Southern Subtropical Front
	37	Subantarctic

96 Spalding *et al.* 2007
97 Spalding *et al.* 2012

provinces, nested into a system of four broad realms. The system is also divided into seven biomes, which are spatially disconnected but united by common abiotic conditions that create similar communities.

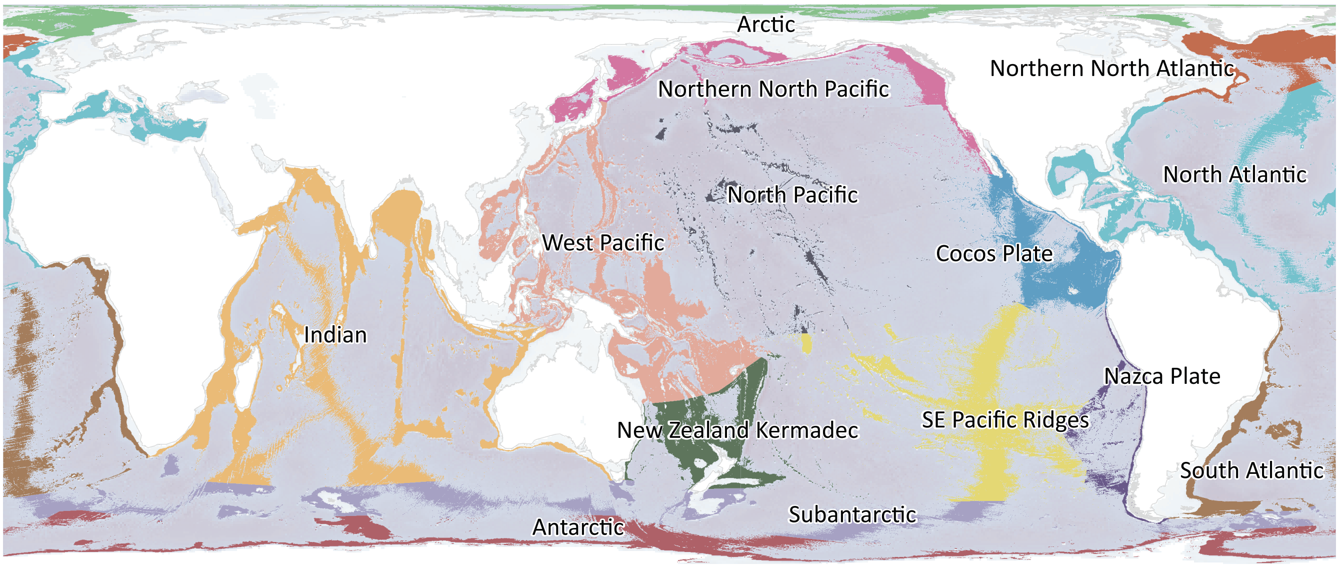
The pelagic provinces scheme[98] we have used does not include benthic habitats or communities. For deep sea waters and the benthic ecosystems they support there is a need for a different classification system that captures the natural values and features of this portion of the global oceans. Deep-sea areas have been sub-divided by a recent classification scheme[99] that proposes global biogeographic provinces for the lower bathyal and abyssal benthos deeper than 800 m (see Figure 3.4). Delineation of biogeographic provinces was initially hypothesized using oceanographic proxies, and subsequently examined with documented locations of select benthic marine species. These biogeographic provinces were first developed in 2009 through an expert consultation workshop to delineate biogeographic provinces in offshore regions – the Global Open Ocean and Deep Sea (GOODS) classification[100]. The GOODS deep-sea classifications were refined by incorporating additional high-resolution hydrographic and organic-matter flux data for the seafloor. This process resulted in the delineation of 14 lower bathyal and abyssal provinces.

3.2.4 Gaps in current mWHS coverage in nearshore and pelagic provinces

The 62 nearshore MEOW provinces provide a useful framework for assessing the coverage of the current mWHS that lie within national waters (coastal and shelf waters shallower than 200 metres) and to identify large marine areas with distinctive biodiversity values that may include sites of OUV that are not yet represented on the World Heritage List. Although the boundaries of these provinces are displayed in the included maps out to 200 nautical miles offshore (or to the 200 m isobath where this lies further offshore), only those areas out to the 200 m isobath were used in the analyses.

Currently, the 46 mWHS do not comprehensively represent the distinct biodiversity and natural values of all 62 global biogeographic provinces (see Figure 3.5 and Table 3.2): mWHS occur in only 34 of the provinces or 55% of the total[101]. Provinces with the highest number of mWHS include the Northern European Seas (five sites), the Tropical East Pacific (four sites), the Tropical Northwestern Atlantic and Western Coral Triangle (three sites each). Eight provinces have two sites each and 22 provinces each have only one site. Twenty-eight provinces[102] (45%) do not contain any mWHS and are

Figure 3.4 Deep-sea provinces of the world. The Watling *et al.* 2013 and GOODS biogeographic scheme resulted in the delineation of 14 bathyal and abyssal provinces. It is important to note that currently there is no classification scheme available for pelagic and deep-sea habitat between 200–800 m.



[98] Spalding *et al.* 2012
[99] Watling *et al.* 2013
[100] Watling *et al.* 2013
[101] Some sites straddle provinces so can occur in two or more provinces
[102] Results differ from Spalding 2012, which identified 24 gap provinces, as the present study does not include the 25 natural and mixed World Heritage sites with significant marine values that are not included in the WHC Marine Programme (see Figure 3.1) but were used in the Spalding 2012 analysis

subsequently referred to as "gap provinces" in this study (see Figure 3.5 and Table 3.3). These 28 gap provinces represent a substantial and distinct proportion of global ocean area and nearshore biodiversity and are thus a primary priority for addressing and enhancing the current biogeographic coverage of mWHS.

Although the number of sites per province is a useful indicator to assess distribution of mWHS, the percentage of the total area of the province covered by the mWHS may provide a better indication of the degree to which significant marine values and features of a province may be captured within the boundaries of the mWHS (see Figure 3.6). Three provinces,

Figure 3.5 Number of mWHS (n = 46) within each province (defined under the MEOW classification, Spalding *et al.* 2007). The results are for coastal and shelf waters shallower than 200 metres but are displayed on province boundaries drawn out to 200 nautical miles offshore (or to the 200-m isobath where this lies further offshore), although only those areas out to the 200-m isobath are used in analyses.

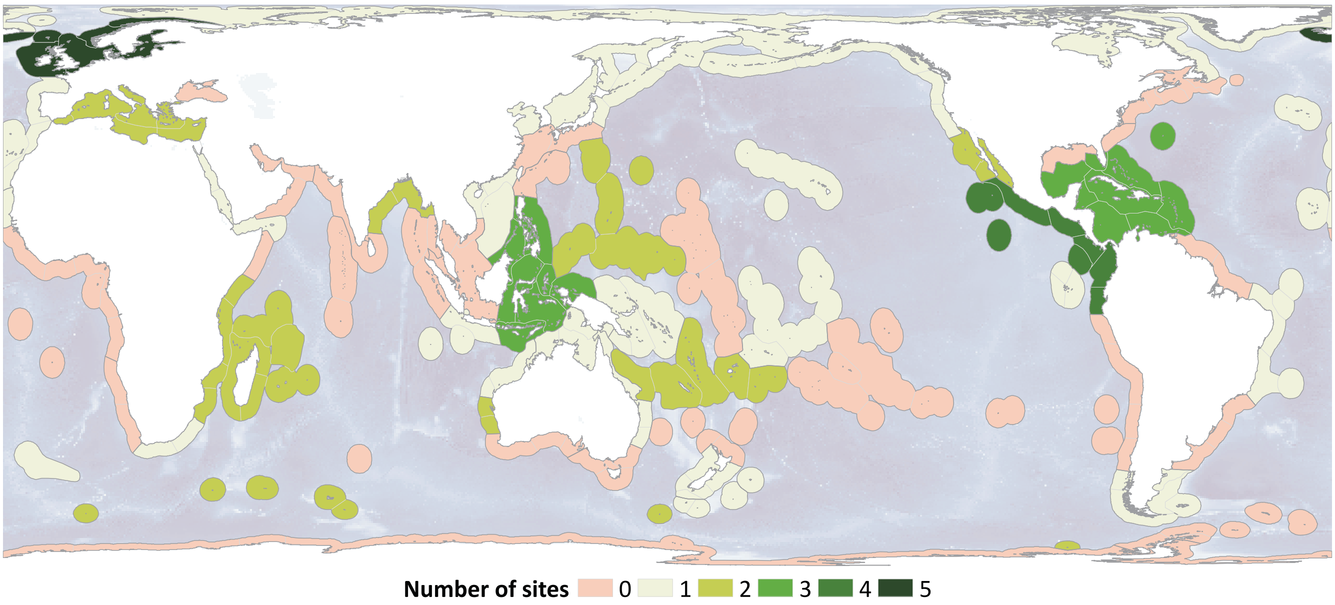


Figure 3.6 Percentage area of nearshore and continental provinces (defined by Spalding *et al.* 2007) covered by marine World Heritage sites. The results presented here are for coastal and shelf waters shallower than 200 metres but for visual clarity, are displayed on province boundaries drawn out to 200 nautical miles offshore (or to the 200-m isobath where this lies further offshore), although only those areas out to the 200-m isobath are used in analyses.

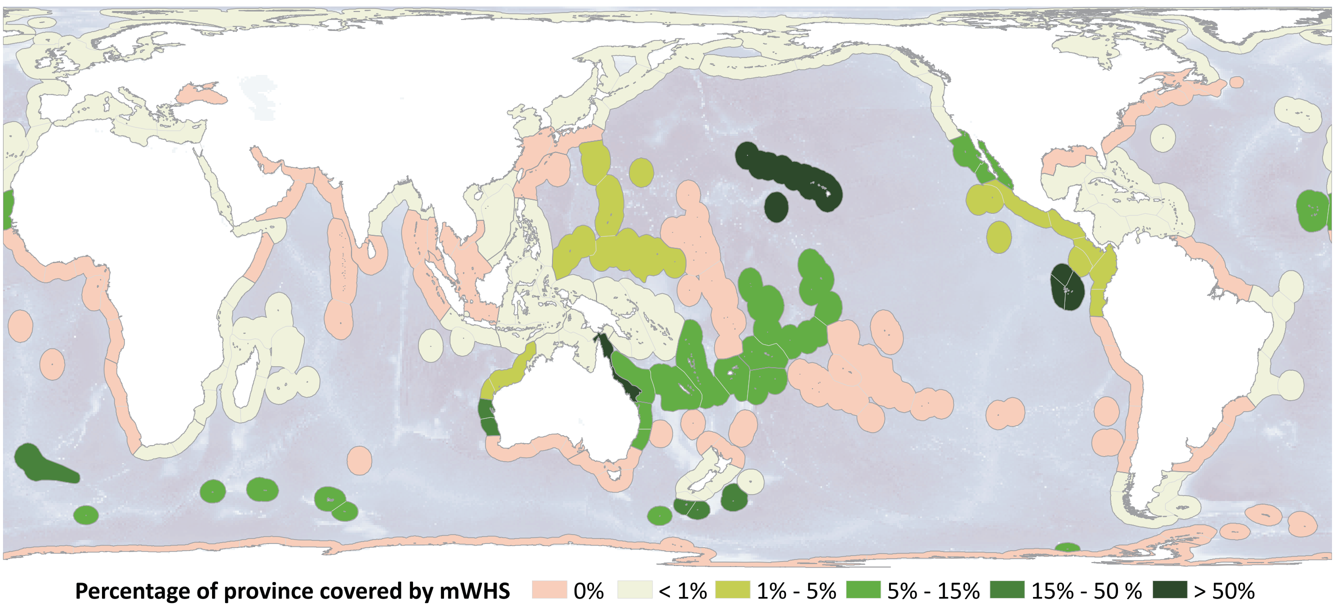


Table 3.2 Summary of the current distribution and coverage of 46 mWHS in provinces defined by the MEOW classification scheme (Spalding *et al.* 2007).

MEOW Province	Province area (km²)	Number of mWHS	Total area of mWHS	Percentage of Province covered by mWHS
Agulhas	122,745	1	31	<0.1%
Arctic	7,592,680	1	9,231	0.1%
Bay of Bengal	289,800	2	766	0.3%
Central Polynesia	16,635	1	1,469	8.8%
Cold Temperate Northeast Pacific	557,407	1	2,337	0.4%
Cold Temperate Northwest Pacific	1,619,423	1	214	<0.1%
East Central Australian Shelf	69,091	1	4,698	6.8%
Eastern Coral Triangle	231,235	1	519	0.2%
Galapagos	16,690	1	16,690	100.0%
Hawaii	31,681	1	20,364	64.3%
Java Transitional	67,266	1	645	1.0%
Lusitanian	307,450	1	339	0.1%
Magellanic	988,434	1	49	<0.1%
Mediterranean Sea	689,715	2	114	<0.1%
Northeast Australian Shelf	292,412	1	244,959	83.8%
Northern European Seas	1,746,815	5	12,185	0.7%
Northwest Australian Shelf	306,313	1	4,911	1.6%
Red Sea and Gulf of Aden	286,347	1	1,234	0.4%
Sahul Shelf	1,322,709	1	0.1	<0.1%
South China Sea	544,909	1	396	0.1%
Southern New Zealand	241,023	1	2,143	0.9%
Subantarctic Islands	93,088	2	6,925	7.4%
Subantarctic New Zealand	36,386	1	8,980	24.7%
Tristan Gough	1,887.0	1	715	37.9%
Tropical East Pacific	239,031	4	4,038	1.7%
Tropical Northwestern Atlantic	1,019,097	3	4,714	0.5%
Tropical Northwestern Pacific	58,438	2	985	1.7%
Tropical Southwestern Atlantic	198,476	1	129	0.1%
Tropical Southwestern Pacific	210,346	2	16,254	7.7%
Warm Temperate Northeast Pacific	186,946	2	12,905	6.9%
West African Transition	73,765	1	6,123	8.3%
West Central Australian Shelf	90,920	2	15,642	17.2%
Western Coral Triangle	986,668	3	1,674	0.2%
Western Indian Ocean	492,743	2	1,040	0.2%

Galapagos, Northeast Australian Shelf, and Hawaii have greater than 50% coverage by mWHS, while three others (the Tristan Gough, Sub-antarctic New Zealand, and West Central Australian Shelf) have high to moderate coverage of 20–40% (see Figure 3.7). The majority of provinces with mWHS (19 of 34 provinces or 56%) however, have less than 1% coverage (see Figure 3.6 and Table 3.2). Consequently, the potential to capture an adequate cross section of the marine values and features in these provinces is relatively low. These provinces need to be considered as a secondary priority for addressing and enhancing the current coverage of mWHS.

Currently, 19 of the existing mWHS cover off-shelf waters (see Figure 3.8), including the Heard and McDonald Islands, Brazilian Atlantic Islands: Fernando de Noronha and Atol das Rocas Reserves, Galápagos Islands, Great Barrier Reef, Cocos Island National Park, Malpelo Fauna and Flora Sanctuary,

Figure 3.7 Marine provinces with more than 1% of their area covered by mWHS. Three provinces, Galapagos, Northeast Australian Shelf, and Hawaii are well covered by World Heritage sites (more than 50% coverage). Additionally the Tristan Gough, Subantarctic New Zealand, and West Central Australian Shelf have high to moderate coverage (40–20%).

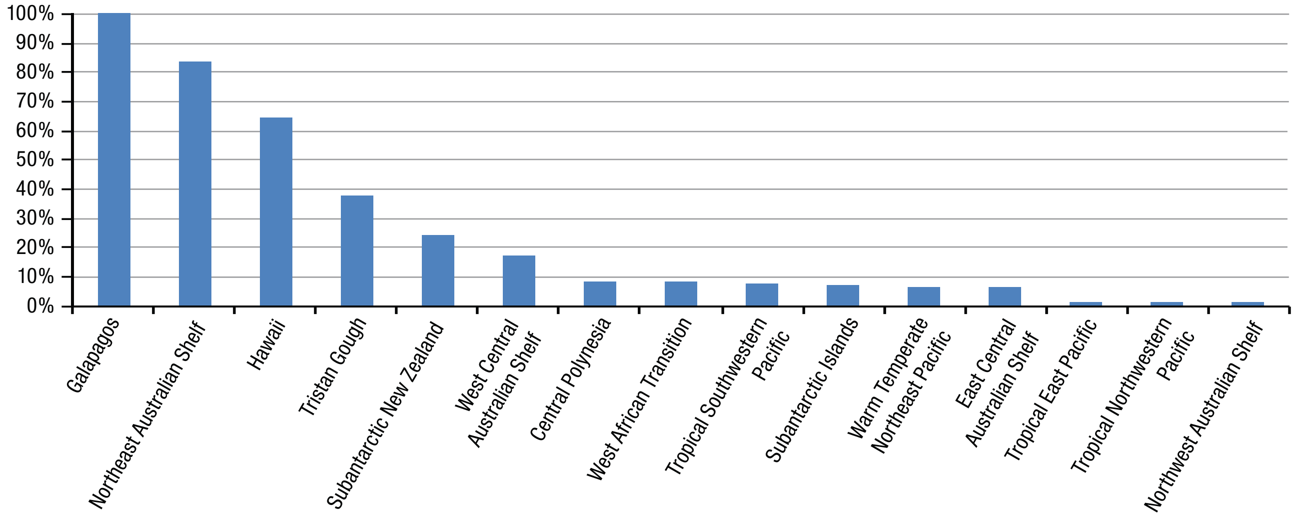
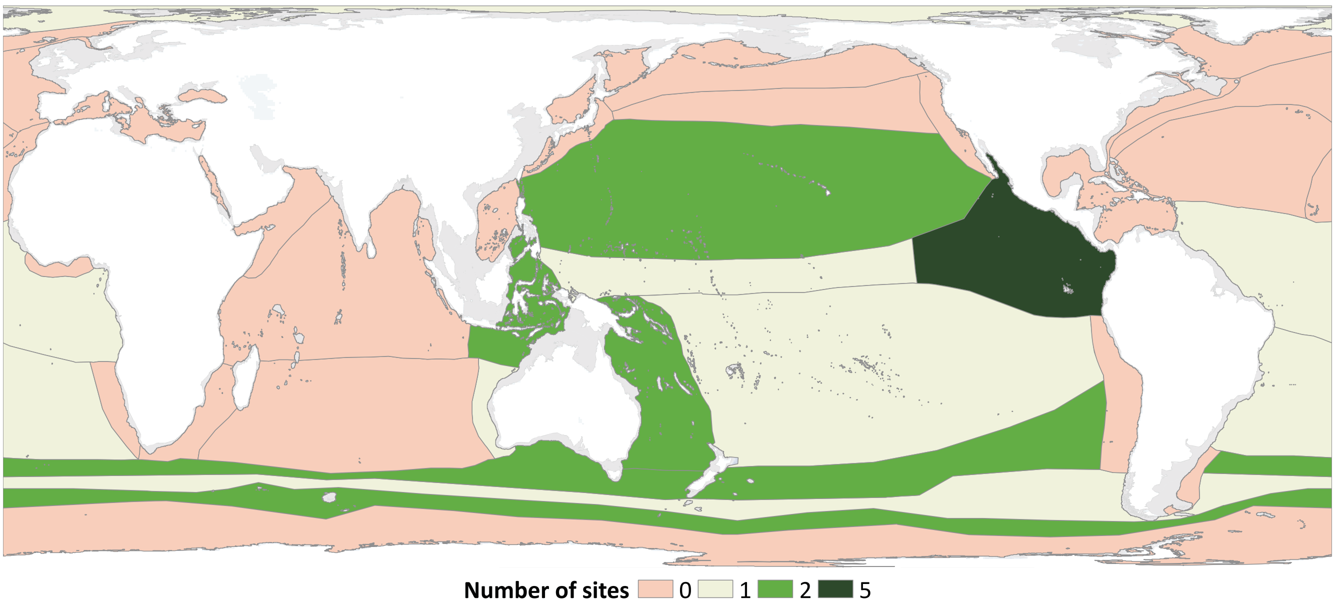


Figure 3.8 Number of mWHS within each pelagic province (Spalding *et al.* 2012). Continental shelf areas (shallower than 200 metres) covered by the MEOW provinces are displayed in pale grey.



Macquarie Island, Phoenix Islands Protected Area, New Zealand Sub-Antarctic Islands, and Papahānaumokuākea[103]. However, our analysis shows that only 13 of the 37 (35%) pelagic provinces contain mWHS (see Table 3.4), and the total area covered by the sites in these provinces is very low (less than 1%) with the exception of the Non-Gyral Southwest Pacific and the Eastern Tropical Pacific with approximately 1.2% covered by mWHS."

Deep-sea provinces must be considered in future analyses that prioritize consideration of off shore sites for marine World Heritage nomination. The 14 deep-sea provinces can be used in concert with other analyses (e.g. predictive habitat modelling and seamount classifications) to help determine where mWHS can potentially be inscribed to capture deep-sea marine features of OUV and designate marine protected areas in the high seas to manage these marine values. It is important to note that

[103] Few of these sites have been designated and are managed explicitly for their off-shelf waters and features

Table 3.3 Overview of the 28 “gap provinces”, nearshore and continental biogeographic provinces (defined by the MEOW classification scheme in Spalding *et al.* 2007) without marine World Heritage sites.

MEOW gap province	Province area (km²)
Sunda Shelf	1,845,151
Cold Temperate Northwest Atlantic	890,193
Warm Temperate Northwest Pacific	665,953
Warm Temperate Southwestern Atlantic	563,194
North Brazil Shelf	505,941
Continental High Antarctic	495,365
Somali/Arabian	393,156
West and South Indian Shelf	389,565
Gulf of Guinea	376,759
Warm Temperate Northwest Atlantic	372,141
Southwest Australian Shelf	335,458
Andaman	315,148
Southeast Australian Shelf	241,497
Black Sea	170,325
Scotia Sea	162,646
Benguela	161,541
Warm Temperate Southeastern Pacific	150,489
Central Indian Ocean Islands	79,350
Marshall, Gilbert and Ellis Islands	49,546
Northern New Zealand	49,349
Southeast Polynesia	47,860
South Kuroshio	42,674
Lord Howe and Norfolk Islands	9,306
Marquesas	4,656
Juan Fernández and Desventuradas	1,826
St Helena and Ascension Islands	1,263
Amsterdam-St Paul	933
Easter Island	716

currently there is no classification scheme available for the pelagic and / or deep-sea habitat between 200–800 m given the data scarcity.

3.2.5 Gap analysis of mWHS using global datasets of marine features

In contrast to terrestrial environments, it is not yet possible to do global analyses of the marine World Heritage network and to identify priority sites using the same algorithms of irreplaceability. A preliminary analysis of features that include coral reefs, seagrasses and mangroves (all tropical ecosystems, section 2.3.3 and Figures 2.2–2.4), seamounts (section 2.2.2 and Figure 2.1), and species richness (sections 2.4.1–2 and Figure 2.5) showed the challenges and pitfalls of using global marine datasets that are currently available. Incompatibilities between the resolution of the datasets and current mWHS boundaries and site sizes, and the tropical and auto-correlated distribution of the three habitats used, resulted in misleading and biased results. Thus we were unable to conduct a comprehensive spatial analysis of marine feature representation and coverage by mWHS. A further problem is that many WH sites on coastlines likely contain significant features, but these are not adequately documented, or not included in the original nomination dossiers (section 3.2.1). Improvements to marine datasets and models in coming years will likely make this possible.

3.3 Prioritizing provinces and sites for potential designation of marine World Heritage in nearshore and offshore waters

In nearshore waters, our analysis of presence and coverage of mWHS has shown that there are 28 provinces (45%) that do not contain any mWHS and are referred to as “gap provinces” in this study (see Figure 3.9 and Table 3.5). These 28 gap provinces represent a substantial and distinct proportion of ocean area and nearshore biodiversity and a priority for consideration for mWHS nomination. Further, 19 of 34 provinces with mWHS have <1% of their area in the sites, suggesting features with potential OUV are either not covered or poorly covered by the current mWHS network (see Figure 3.6 and Table 3.2). Finally, 24 pelagic provinces (65%) do not contain any mWHS (see Figure 3.8 and Table 3.5) suggesting a major biogeographic gap in pelagic and deep-sea waters, as these provinces represent distinct biogeography and constitute approximately 40% of the world’s oceans. Even in the 13 pelagic provinces that do have mWHS, all have very low coverage by area.

Ideally, spatial analyses support the selection of priority sites from what may be a bewildering array of possibilities. Three key concepts of systematic conservation planning can guide the selection of priority sites for biodiversity conservation and their integrity: irreplaceability, vulnerability and representativeness[104]. Irreplaceability (or uniqueness, rarity, naturalness) has been identified as the most important of these for OUV[105], and representativeness the least important[106]. A complementary study for terrestrial World Heritage[107] has thus used irreplaceability as the guiding principle for assessing gaps and identifying potential candidate sites using a wide

[104] Margules and Pressey 2000
[105] Schmitt 2011
[106] Badman *et al.* 2008
[107] Bertzky *et al.* 2013

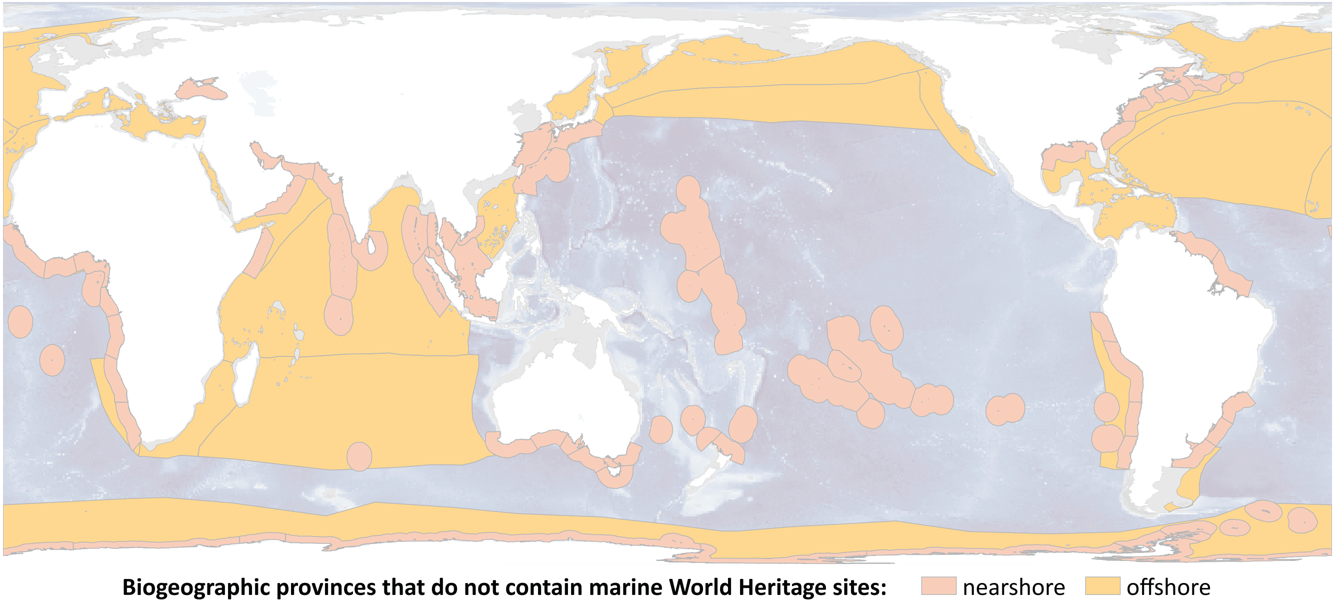
Table 3.4 Summary of current number of mWHS within each pelagic province.

Pelagic province	Province area (km²)	Number of mWHS	Total area of mWHS (km²)	Percentage of Province covered by mWHS
Eastern Tropical Pacific	11,799,017	5	136,651	1.2%
North Central Pacific Gyre	36,331,956	2	344,411	0.9%
Subtropical Convergence	21,872,207	2	2,352	<0.1%
Antarctic Polar Front	14,117,828	2	4,556	<0.1%
Non-gyral Southwest Pacific	7,814,425	2	96,372	1.2%
Indonesian Through-Flow	3,573,997	2	441	<0.0%
South Central Pacific Gyre	78,516,025	1	393,313	0.5%
Subantarctic	16,821,257	1	2,319	<0.1%
Equatorial Atlantic	16,101,195	1	1	<0.1%
South Central Atlantic Gyre	14,770,301	1	1,237	<0.1%
Equatorial Pacific	9,198,066	1	13,420	0.1%
Arctic	7,779,311	1	1,452	<0.1%
Leeuwin Current	1,365,676	1	153	<0.1%
Antarctic	30,523,686	0	0	0.0%
Indian Ocean Monsoon Gyre	19,157,940	0	0	0.0%
Indian Ocean Gyre	18,533,767	0	0	0.0%
North Central Atlantic Gyre	12,187,114	0	0	0.0%
Subarctic Pacific	8,219,637	0	0	0.0%
North Pacific Transitional	7,358,785	0	0	0.0%
North Atlantic Transitional	6,193,817	0	0	0.0%
Subarctic Atlantic	4,300,527	0	0	0.0%
Inter American Seas	3,331,685	0	0	0.0%
Humboldt Current	3,123,960	0	0	0.0%
Somali Current	2,609,832	0	0	0.0%
Agulhas Current	2,117,950	0	0	0.0%
Mediterranean	1,839,108	0	0	0.0%
Canary Current	1,804,980	0	0	0.0%
South China Sea	1,594,687	0	0	0.0%
California Current	1,466,336	0	0	0.0%
Benguela Current	1,342,788	0	0	0.0%
Gulf Stream	1,179,593	0	0	0.0%
Kuroshio	1,063,752	0	0	0.0%
Sea of Japan/East Sea	741,478	0	0	0.0%
Malvinas Current	690,115	0	0	0.0%
Guinea Current	630,337	0	0	0.0%
Black Sea	292,185	0	0	0.0%
Red Sea	229,962	0	0	0.0%

range of spatial analyses. A precondition for these analyses is the availability of spatial data on a global scale on species and ecosystem distributions and status.

However, the sparseness and resolution of spatial data for many marine habitats, specifically the open ocean and deep sea, hinders such spatial analyses for the marine context. Other approaches may therefore be needed to assess gaps in these little studied areas and identify potential candidate sites. Identifying an appropriate list of possible priority sites within these nearshore and pelagic provinces was not possible at the time and scale of this study. However, we outline two

Figure 3.9 Marine biogeographic provinces (nearshore and offshore) provinces that do not contain mWHS.



broad approaches that may guide States Parties and marine conservationists, managers, and scientists to develop processes for identifying priority provinces and identifying priority sites within these provinces.

3.3.1 Data-driven approaches

As mentioned earlier, marine datasets, particularly of biodiversity, are generally very incomplete with respect to global coverage. Thus, we were not able to apply the quantitative approach that has been applied in the terrestrial context[108] to conduct a global assessment of marine systems. Further, with marine science being less advanced than that of terrestrial systems, the knowledge required to establish and interpret global analyses is less well developed. Nevertheless, some marine ecosystems have reasonable datasets with global coverage, and these could be used to prioritize gap provinces and potentially even specific sites (such as marine protected areas) within these provinces. Data on features that were presented in Chapter 2 including species (total number, endemic, threatened), habitats (seamounts, seagrass, saltmarshes, etc.) and oceanographic features (gyres, upwelling, currents, etc.) should be used in this process.

Any assessment should be as comprehensive as possible and consider as many marine features listed in chapter 2 as possible (see Tables 2.1 and 2.3 for summary). Data on threatened species (IUCN Red List) or important areas (EBSAs, marine Key Biodiversity Areas, marine Important Bird Areas, etc.) should, for example, be included in any analysis of biodiversity values for potential OUV (see Box 3.1). Different analyses may have to be undertaken for nearshore/ continental shelf water and offshore / deep waters. It will be important to use relevant marine features when identifying priorities in gap pelagic provinces, as coastal habitats do not aid in prioritizing offshore provinces. For example, seamounts may be an important feature to consider in pelagic and deep sea waters in gap pelagic provinces (see Figure 3.10). These analyses should also examine open ocean features such as gyres, boundary currents, upwelling and productivity zones that serve as important habitats for pelagic and threatened species rather than coastal habitat such as corals. Although an initial analysis could be attempted at a global level based on available and relevant spatial datasets, more comprehensive analyses for priority sites should be undertaken regionally, where higher resolution data on coastal and pelagic marine features with potential OUV are available and the process would be more informative.

3.3.2 Expert-driven approaches

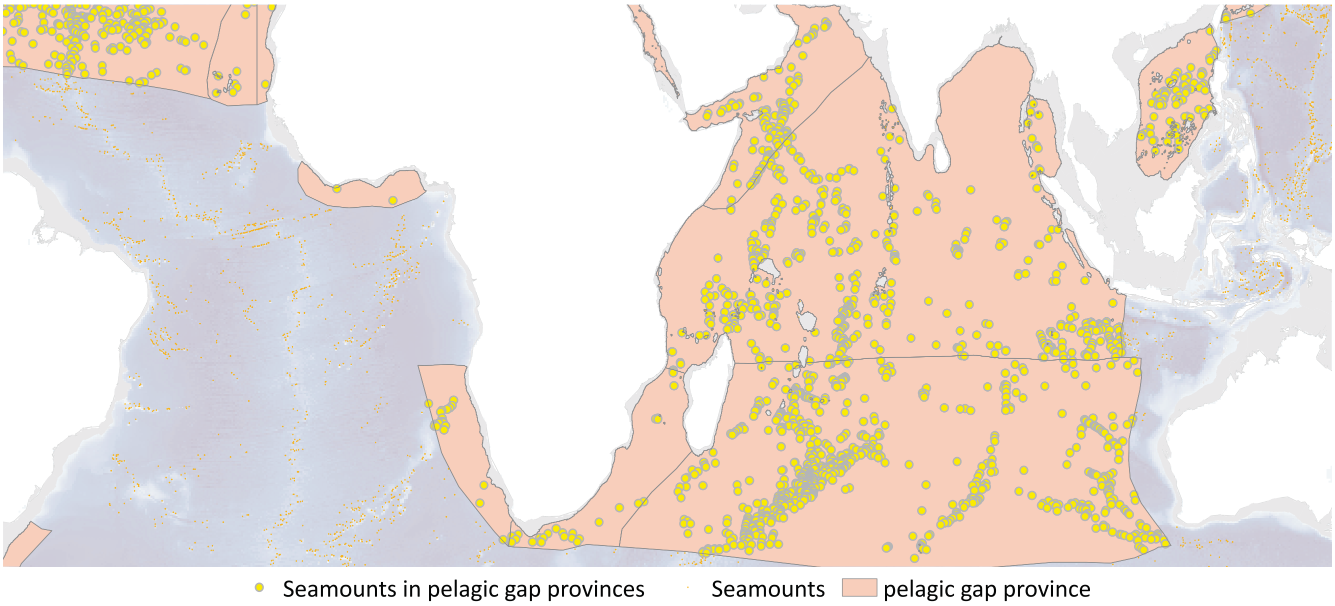
To compensate for deficiencies in global datasets, an expert-driven approach can be used regionally and can emphasize ecosystem-based processes that underpin marine biodiversity and ecosystem functioning at the appropriate scales. This approach is particularly relevant to regions that include provinces with no or low representation of mWHS and where data gaps do not allow data-driven spatial analysis. Three main steps can be followed in this proposed approach:

[108] Bertzky *et al.* 2013

Table 3.5 All biogeographic provinces (nearshore and offshore) that contain negligible (<1%) or no mWHS.

Biogeographic province	Province area (km^2)	Low / Nearshore gap / Offshore gap
Agulhas	122,745	Low
Agulhas Current	2,117,950	Offshore gap
Amsterdam-St Paul	933	Nearshore gap
Andaman	315,148	Nearshore gap
Antarctic	30,523,686	Offshore gap
Arctic	7,592,680	Low
Bay of Bengal	289,801	Low
Benguela	161,541	Nearshore gap
Benguela Current	1,342,788	Offshore gap
Black Sea	170,325	Nearshore gap
Black Sea	292,185	Offshore gap
California Current	1,466,336	Offshore gap
Canary Current	1,804,980	Offshore gap
Central Indian Ocean Islands	79,350	Nearshore gap
Cold Temperate Northeast Pacific	557,408	Low
Cold Temperate Northwest Atlantic	890,193	Nearshore gap
Cold Temperate Northwest Pacific	1,619,423	Low
Continental High Antarctic	495,365	Nearshore gap
Easter Island	716	Nearshore gap
Eastern Coral Triangle	231,236	Low
Guinea Current	630,337	Offshore gap
Gulf of Guinea	376,759	Nearshore gap
Gulf Stream	1,179,593	Offshore gap
Humboldt Current	3,123,959	Offshore gap
Indian Ocean Gyre	18,533,767	Offshore gap
Indian Ocean Monsoon Gyre	19,157,940	Offshore gap
Inter American Seas	3,331,685	Offshore gap
Java Transitional	67,266	Low
Juan Fernández and Desventuradas	1,825	Nearshore gap
Kuroshio	1,063,752	Offshore gap
Lord Howe and Norfolk Islands	9,306	Nearshore gap
Lusitanian	307,450	Low
Magellanic	988,434	Low
Malvinas Current	690,115	Offshore gap
Marquesas	4,656	Nearshore gap
Marshall, Gilbert and Ellis Islands	49,546	Nearshore gap
Mediterranean	1,839,108	Offshore gap
Mediterranean Sea	689,715	Low
North Atlantic Transitional	6,193,817	Offshore gap
North Brazil Shelf	505,941	Nearshore gap
North Central Atlantic Gyre	12,187,114	Offshore gap
North Pacific Transitional	7,358,785	Offshore gap
Northern European Seas	1,746,816	Low
Northern New Zealand	49,349	Nearshore gap
Red Sea	229,962	Offshore gap
Red Sea and Gulf of Aden	286,347	Low
Sahul Shelf	1,322,709	Low
Scotia Sea	162,646	Nearshore gap
Sea of Japan/East Sea	741,478	Offshore gap
Somali Current	2,609,832	Offshore gap
Somali/Arabian	393,156	Nearshore gap
South China Sea	544,909	Low
South China Sea	1,594,687	Offshore gap
South Kuroshio	42,674	Nearshore gap
Southeast Australian Shelf	241,497	Nearshore gap
Southeast Polynesia	47,860	Nearshore gap
Southern New Zealand	241,023	Low
Southwest Australian Shelf	335,458	Nearshore gap
St Helena and Ascension Islands	1,263	Nearshore gap
Subarctic Atlantic	4,300,527	Offshore gap
Subarctic Pacific	8,219,637	Offshore gap
Sunda Shelf	1,845,151	Nearshore gap
Tropical Northwestern Atlantic	1,019,097	Low
Tropical Southwestern Atlantic	198,476	Low
Warm Temperate Northwest Atlantic	372,141	Nearshore gap
Warm Temperate Northwest Pacific	665,953	Nearshore gap
Warm Temperate Southeastern Pacific	150,489	Nearshore gap
Warm Temperate Southwestern Atlantic	563,194	Nearshore gap
West and South Indian Shelf	389,565	Nearshore gap
Western Coral Triangle	986,668	Low
Western Indian Ocean	492,743	Low

Figure 3.10 Example of a potential spatial analysis in gap pelagic provinces that utilizes an offshore feature such as seamounts as a key data layer.



Box 3.1 The use of Key Biodiversity Areas and Ecologically or Biologically Significant Areas in marine systems and for nominating mWHS

The term 'Key Biodiversity Areas' (KBAs) is increasingly being used as an overarching framework to identify areas of global significance for biodiversity. Over the last decades, various approaches to identifying sites of biodiversity significance have been developed[109], for example BirdLife's Important Bird Areas[110], IUCN's Important Freshwater Areas[111] and the Alliance for Zero Extinction sites[112]. These approaches have delivered substantial benefits, such as informing the selection of sites for protection under national and international legislation, being considered in international sustainability performance standards, and being included under multi-lateral environmental agreements[113]. However, they generally focus on one taxonomic group or biome and use different assessment criteria. This has resulted in some confusion among decision-makers as well as duplication of efforts.

At the request of its members, IUCN is leading a wide consultation process to harmonize these approaches and develop a globally agreed methodology to identify KBAs. This consultation is led by the IUCN World Commission on Protected Areas and the Species Survival Commission Joint Task Force on Biodiversity and Protected Areas and builds on existing experience. The KBA methodology[114] is a scientific process, based on a set of transparent criteria and thresholds, and provides guidance to identify areas contributing significantly to the global persistence of biodiversity, at the genetic, species and ecosystem level. It is aimed to be used in all regions and for all biomes (terrestrial, freshwater and marine), but it does not imply any formal designation, specific management scheme or land use regime, as this remains a stakeholder decision.

For marine systems, the Convention on Biological Diversity (CBD) adopted the concept of Ecologically or Biologically Significant Marine Areas (EBSAs) in need of protection in open-ocean waters and deep-sea habitats. EBSAs are identified following seven scientific criteria adopted at the ninth Conference of the Parties to the Convention in 2008[115]. A series of regional workshops are currently being convened by the CBD secretariat to identify EBSAs in marine areas including areas beyond national jurisdiction (ABNJ) using a wide variety of information sources. The identification of EBSAs and ultimately the selection of conservation and management measures come under the jurisdiction of the States and competent intergovernmental organizations, in accordance with international law, including the UN Convention on the Law of the Sea[116].

EBSAs could be regarded as a subset of marine KBAs. Consequently, EBSAs and more broadly, marine KBAs, offer important opportunities to use the World Heritage Convention criteria in evaluating OUV, both nearshore, on the continental shelves and in the high seas and ABNJ, and selecting new mWHS. As EBSAs in ABNJ are offshore, they are particularly relevant to high and deep-sea conservation although these areas may not necessarily fall within the boundaries of EEZs and the current mandate of the World Heritage Convention (see section 4.3).

[109] Langhammer *et al.* 2007
[110] Osieck and Mörzer Bruyns 1981
[111] Holland *et al.* 2012
[112] Ricketts *et al.* 2004
[113] Donald *et al.* 2007, Butchart *et al.* 2012, IFC 2012
[114] For more information about KBAs see: www.iucn.org/biodiversity_and_protected_areas_taskforce
[115] CBD Decision IX/20, Annex I
[116] For more information about EBSAs see: http://www.gobi.org/

1. Identification of the appropriate bio-regional scale at which to apply the assessment (based on biogeographic provinces);
2. Identification of key physical and biological features that distinguish the region compared to others globally (see discussion on marine features in section 2.2); and
3. Identification of sites in the region that have the best of these features, and with the sufficient integrity and scale to meet the criteria of OUV.

We use an illustrative example of such a process undertaken in the Indian Ocean[117]. This process included identifying the regional scope for assessing OUV followed by an expert-driven process and workshop to identify sites with potential OUV.

In Step 1, a global biogeographic analysis of reef-building corals identified biophysical features that correlate with the major regional coral communities in the Indian Ocean[118] and identified the following subregions:

- The Indian Ocean from Sri Lanka westwards is clearly distinct biogeographically from the Central Indo-Pacific, which includes the Andaman Seas (Western Sumatra, Andaman and Nicobar islands, west Thailand and western peninsular Malaysia);
- Within this west, north and central region of the Indian Ocean, the Western Indian Ocean is a clearly distinct core region, with a sister region comprising Sri Lanka, West India and the Maldives, and a subregion defined by the Red Sea, Gulf of Aden, Arabian Seas and the Persian Gulf;
- This pattern of subregions is consistent with the main flow of the South Equatorial Current into the western Indian Ocean from the east, and its subsequent interactions in the north with the seasonally reversing currents of the northwest Indian Ocean.

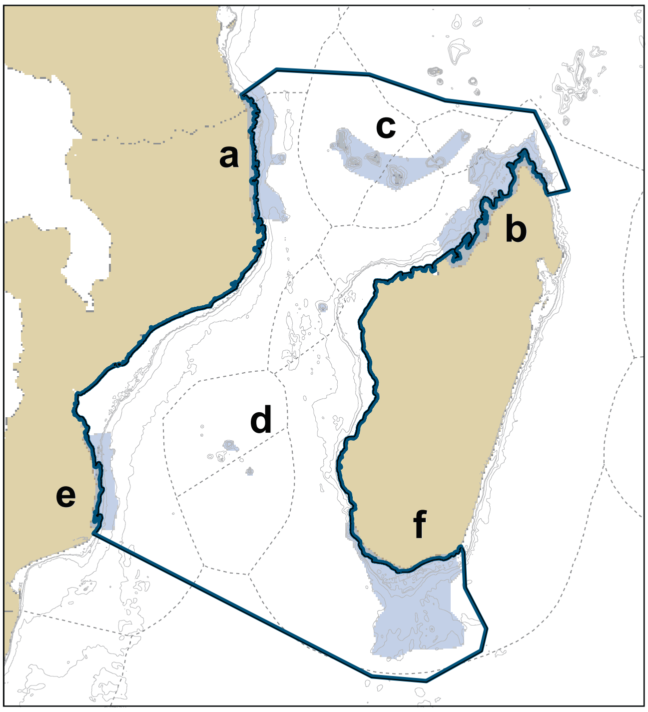
Based on these divisions, the regional study focused on the Western Indian Ocean (WIO), corresponding to the marine province of the same name in the MEOW classification system[119]. While the WIO is not a primary gap province as defined in section 3.2 as it contains two mWHS, the area coverage of these sites is negligible in comparison with that of the marine province (<0.01%) and as such can be considered a secondary gap province.

In Step 2, the study identified features in the WIO relevant to criteria (viii), (ix) and (x) (see section 2.2). First, the study established the global uniqueness of the province on the basis of geological and oceanographic features under criterion (viii). These physical processes confirmed the biogeography and regionalization shown in the MEOW and coral classifications. The principle physical features corresponded to plate tectonics, hotspots, currents and connectivity (Table 2.3). For the biological criteria, the regional analysis followed the standard guidance for assessing OUV, and looked at past usage of criteria (ix) and (x) in World Heritage nominations. In basing its recommendation on past WH nominations, the WIO analysis made assessments of marine features under criteria (ix) and (x) that are inconsistent with the guidance in this thematic study. Consequently references to the OUV in the WIO regional analysis will be revised to ensure consistency.

The third and final step identified a shortlist of sites that support the highest levels of potential OUV within the WIO and concluded that these stand out globally. The geological and oceanographic features that were assessed to be unique globally and to have potential OUV under criterion (viii) identified two large geographic subregions – the Mozambique Channel and the Mascarene Plateau.

A potential serial transboundary site in the Mozambique Channel is illustrated in more detail (see Figure 3.11) to

Figure 3.11 Indicative extent of a potential serial transboundary World Heritage Site in the Mozambique channel (dark blue outline) across multiple EEZs (light lines), with the six constituent areas shown in light blue: a) Quirimbas – Mtwara (Mozambique and Tanzania); b) Northern Madagascar; c) the Comoro Archipelago (Comoros, France); d) the Iles Éparses (Scattered Islands, French Indian Ocean Territory); e) Tofo – Bazaruto, Mozambique; f) Madagascar Plateau (the Deep South) (adapted from Obura *et al.* 2012).



[117] Obura *et al.* 2012
[118] Obura 2012
[119] Spalding *et al.* 2007

provide insight into this type of site, which is likely to become more common as new and large mWHS are designated across national boundaries (see section 2.7). Locations were identified within the Mozambique Channel that express aspects of the geological and/or oceanographic features that make the channel unique globally, combined with biological features best represented at each individual site. The Mozambique Channel is fully contained within the Exclusive Economic Zones (EEZs) of the five countries that border it, all States Parties to the World Heritage Convention. There is thus the possibility for an innovative inter-governmental approach to establish a transboundary serial site in the Channel. Along with the World Heritage Convention, the Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region[120], a well-established intergovernmental convention that all the countries in the region are party to, offers an opportunity to establish the mechanisms necessary for governance of a large serial transboundary site[121].

3.4 Conclusion of Chapter Three

In Chapter Three, we examined the current distribution of marine WH sites, identified biogeographic gaps, and provided guidance on potential approaches to prioritize these gaps for nomination and designation of mWHS in order to achieve a more appropriate global biogeographic representation of Outstanding Universal Value. Currently, there is a relatively small number (46) of WHS that have been inscribed for their outstanding marine values[122], and these marine WHS represent predominantly tropical ecosystems as opposed to temperate and polar ecosystems. A large majority of the world's 62 nearshore biogeographic provinces (47 provinces or 76%) do not contain any mWHS or contain a low (<1%) coverage that is not likely to capture the full range of values and features present in these provinces. Finally, a large proportion of the world's offshore provinces representing 40% of all global oceans do not contain any mWHS.

It is clear from this analysis that distinct marine features from the majority of biogeographic regions of the world have not been nominated and evaluated for OUV and are not currently represented by mWHS. In order to fulfil the World Heritage Committee's Global Strategy of developing a representative, balanced and credible World Heritage List[123], States Parties are encouraged to increase their efforts, with the support of IUCN, the UNESCO World Heritage Centre, and regional and global marine scientists and conservationists, to identify and nominate marine sites of potential OUV, especially in biogeographic regions that are not yet represented, or underrepresented, on the WH List. This thematic study proposes two main approaches, data-driven and expert-driven, to address the gaps in biogeographic representation of mWHS, and provides a foundation to identify priorities and develop nominations of appropriate sites that also meet the rigorous integrity and protection and management requirements of the Convention. The next and final chapter of the Study outlines a roadmap for utilizing these two approaches within the context of the World Heritage Convention, its natural criteria for defining Outstanding Universal Value, their interpretation and application in marine systems, and the gaps in biogeographic provinces that were identified.

[120] http://www.unep.org/NairobiConvention/
[121] It is important to note that the Western Indian Ocean study is a technical recommendation. The relevant States Parties to the World Heritage Convention have not put forward the instruments to pursue World Heritage listing for any of the locations proposed in this study.
[122] Twenty-five other WHS support significant marine features sites but are not officially listed as mWHS according to the UNESCO World Heritage Centre
[123] UNESCO 1994

4. The way forward for marine World Heritage

The *Convention concerning the Protection of the World Cultural and Natural Heritage* was adopted by the General Conference of UNESCO in 1972 with a primary mission to identify and protect the world's natural and cultural heritage considered to be of "Outstanding Universal Value". The present study provides a foundation to progress on the main objective of the 1994 Global Strategy of the World Heritage Committee in the marine environment: establishing a credible and balanced list of World Heritage sites that reflect the wide-ranging diversity of cultural and natural areas of Outstanding Universal Value. This study provides a framework for understanding and interpreting the natural World Heritage criteria, and notes the need to reflect further on the potential of linking natural and cultural heritage in future strategies for marine World Heritage. The study presents 16 broad themes of marine and ocean features to which natural World Heritage criteria might be applied in the development of mWHS. It also maps the current distribution of mWHS (mWHS) globally and uses recently developed classification schemes to highlight broad gaps in the current biogeographic coverage of mWHS.

To summarise the results of assessing the distribution of mWHS: only 46 (4.7%) of 981 existing World Heritage sites are currently recognized for their outstanding marine natural values and, among these, tropical marine habitats are dominant. In nearshore and continental shelf waters, a large proportion of the world's 62 marine biogeographic provinces (28 provinces or 45%) do not contain any mWHS, highlighting major gaps in the representation of different and unique biogeographic areas with potential marine OUV around the world. Furthermore, a significant percentage of the world's 34 provinces with mWHS contain only one site (65%), and in 19 of these 34 provinces, less than 1% of the surface area of the province is contained within mWHS. Adding up the 28 gap provinces, a total of 47 of the 62 nearshore and continental shelf provinces (76%) have low or no coverage by mWHS. In pelagic waters the gap in biogeographic representation is even greater, with only 13 of 37 provinces containing any mWHS, and in no case does the area coverage significantly exceed 1%. This gap amounts to approximately 40% of offshore pelagic waters with no mWHS.

In this final chapter we provide a roadmap to guide future progress that builds on this study and outline two main linked approaches that are necessary to address mWHS gaps in nearshore and offshore waters. These approaches combine: 1) expert and data driven analyses to identify priority provinces and areas globally; and 2) regional expert-driven workshops and studies to identify sites such as MPAs for WH nomination within these priority provinces and areas. Now that gap provinces and those with minimal mWHS coverage have been identified, these gap provinces should be prioritized as areas where sites of Outstanding Universal Value may be identified to lead to a more balanced World Heritage List (however it is noted that not all gap provinces may hold appropriate sites).

In the following sections (4.1–4.3) we recommend specific actions to achieve the WHC's objective of a 'balanced and credible' World Heritage List in relation to marine natural heritage.

4.1 Prioritize nomination of marine features with OUV in gap provinces

This study has identified a number of gap provinces that can prioritize new work on mWHS.

One challenge to applying the World Heritage Convention to the marine environment has been the lack of a clear framework for marine features of potential OUV, and a historical bias in the Convention texts as relates to oceanographic features. The 16 broad marine themes that have been presented in Chapter Two (see Tables 2.1 and 2.3) should be considered by the UNESCO World Heritage Committee, States Parties and the IUCN World Heritage Programme, as a basis to identify, nominate and inscribe sites that contain the most outstanding examples of features included in these themes.

Applying this framework in gap provinces that have been presented in Chapter 3 (see Figure 3.5) will enable a focus on marine features that currently have little or no representation in the current network of mWHS. Furthermore, current Tentative Lists contain a number of sites that have been proposed for their marine features, or may have marine features that were not considered in their initial listing. Sites on the Tentative Lists should be reviewed and marine features of potential OUV identified. Such an exercise could be undertaken by IUCN as technical advice to States Parties or could be undertaken by States Parties, with relevant support of IUCN and UNESCO, as required.

Specific recommendations and next steps recommended to States Parties include:

- Promote the information needs of marine World Heritage in scientific and research communities to ensure the best available data informs decision making for the design of marine protected areas.

- Support revision and re-examination of existing World Heritage sites and sites on the Tentative List with a focus on the 16 marine themes summarized in Table 4.1, to evaluate priority nominations and/or revisions to existing WH sites.

- Support and promote standardized data collection and exchange using Protected Planet and the World Database on Protected Areas in collaboration with IUCN and UNEP-World Conservation Monitoring Centre.

- Support the translation and dissemination of the IUCN World Heritage Programme and UNESCO World Heritage Centre materials and tools to support the development of nominations.

- Promote and disseminate the tools and materials that can support preparation of comparative analyses particularly databases relating to protected areas, threatened species, critical biodiversity areas and marine conservation planning such as IUCN Red List of Threatened Species, IUCN Key Biodiversity Areas, UNEP-WCMC databases and resources, and information on EBSAs provided by the Convention on Biological Diversity.

4.2 Address gaps through both global and regional processes

Prioritization of provinces and sites within these provinces should be informed both from global and regional analyses and processes. Although classification and prioritization schemes of terrestrial systems are relatively well established, similar global marine studies are in their infancy due to a number of factors, including poor data availability. Until these are more highly developed, a regional approach to consideration of marine features is advised, and was presented as a case study in Chapter 3. The process of identifying sites with potential OUV can be guided by global and regional gap assessments complemented by expert workshops involving the relevant countries that are associated with the gap provinces. New proposals for nominations should be supported by spatial analyses of marine features where possible and literature reviews and desktop studies that justify the case.

Ecosystem-based approaches can be used regionally and emphasize processes that underpin marine biodiversity and ecosystem functioning at the appropriate scales. Regional data collection, prioritization, and presentation through workshops can be organized and maps should be produced at the marine province level from better-resolved local and national data sets and compared, when possible, to other province-level assessments globally. Wherever possible, existing global frameworks such as Key Biodiversity Areas (KBAs) and Ecologically or Biologically Significant Areas (EBSAs) should be used as starting points because they have been undertaken with important regional information sources, but need extra consideration of the natural World Heritage criteria to assess OUV.

Specific recommendations and next steps for States Parties, and especially to States Parties with territories in “gap provinces”, include:

- Review planned and existing marine protected areas for potential to be added to national tentative lists, in collaboration with potential partner States Parties for transboundary and serial transnational sites.

- Exchange information and collaborate with neighbouring States Parties and States Parties that share the same or similar marine features to record data necessary to support the development of comparative analyses.

- Encourage collaboration between managers of existing mWHS, those on Tentative Lists, and those under consideration for addition to national Tentative Lists to promote efficiency and cost-effective nominations.

- Fund training workshops and capacity building programmes related to the development of marine World Heritage nomination dossiers.

- Fund and conduct national and larger scale marine biodiversity inventories with a particular focus on the gap provinces and 16 marine themes (summarized in Tables 2.1 and 3.3).

4.3 Identify areas and sites with potential OUV in Areas Beyond National Jurisdiction

The World Heritage Convention is currently not applied to Areas Beyond National Jurisdiction (ABNJs), which constitute about 60–66% of the ocean’s surface, i.e. most of this three-dimensional biome, and which contain a number of unique and exceptional natural heritage values that know no national boundaries. The high seas undoubtedly include areas that would be regarded as meeting the natural World Heritage criteria. This has resulted in a significant gap that States Parties may wish to fill and has the potential to be addressed by developing a specific process for the selection, nomination, evaluation, and management of such mWHS, consistent with international law as reflected in the UN Convention on the Law of the Sea (UNCLOS). Ongoing discussions at the United Nations on a possible new instrument under UNCLOS for conservation and sustainable use of marine biodiversity in ABNJs could provide a possible vehicle to address this gap.

Although high seas and deep ocean areas suffer from a severe lack of information that may impede some analyses of potential OUV, data collection and analysis conducted by experts for the CBD-facilitated regional workshops to describe EBSAs offer a new and rich overview of potential mWHS (see Box 3.1). As no particular mechanism currently exists in the World Heritage Convention for the identification and designation of sites in ABNJ, there is a need for reflection on the use of the World Heritage Convention as a tool to identify marine features of Outstanding Universal Value that relevant States or intergovernmental institutions can conserve and protect multilaterally.

As next steps, IUCN recommends that:

- Current work by IUCN on Key Biodiversity Areas and CBD on EBSAs formally consider Outstanding Universal Value and the criteria of the World Heritage Convention to highlight ABNJ sites with the potential to be nominated as technical guidance to States Parties.

- States Parties engage with discussions relating to Ecologically or Biologically Significant Areas through the Convention on Biological Diversity, and other relevant processes relating to protecting important areas in the high seas or protection of biodiversity on the seabed, in order to explore opportunities for World Heritage protection to be provided in ABNJ.

- States Parties to the World Heritage Convention consider developing an independent process under the World Heritage Convention that is complementary to wider and more complex UNCLOS discussions to select, nominate, and evaluate sites of potential OUV in the high seas. IUCN can provide guidance on this process through its World Heritage Programme, Global Marine and Polar Programme, High Seas Working Group and expert commissions dealing with marine law, species, and protected areas.

4.4 Conclusion of the thematic study: a regionalized approach to a global strategy

As IUCN has emphasized, the key requirement of the WH Convention is that sites can only be inscribed on the WH List if they are of Outstanding Universal Value (OUV). In order to improve its credibility and standing, the WH Convention needs to continue to maintain the highest standards in identifying and conserving outstanding natural heritage sites, particularly with regard to biodiversity values, given the environmental challenges facing the 21st century and the importance of conserving functioning ecosystems for future generations.

As with the recent study on terrestrial World Heritage, this study also concludes there is a need for further work on marine heritage, which is likely most feasible at the regional level, and especially in relation to the identified marine gap provinces. These regional next steps should consider possibilities for the recognition of multiple globally-important sites on the WH List, including via listing as serial sites. Such work could also consider the potential to extend and reconfigure existing WH sites to better represent outstanding biodiversity values and features, and to better protect them from threats, including those associated with climate change. Given the convergence of the conclusions of the studies on terrestrial and marine World Heritage, it appears that a coordinated regionalized approach to further World Heritage nominations should be a key element of global World Heritage strategy. Equally important is the international commitment necessary to protect areas that lie outside the territory, and influence, of any one country as this is a key ecosystem and the main proportion of the marine realm.

IUCN is committed to supporting the global, regional and national actions necessary to better represent and better protect the natural, and cultural, wealth of our shared oceans through the unique opportunities provided by the World Heritage Convention. This study is the starting point for further work to deliver an increased focus on marine World Heritage. It will require many actors to engage and coordinate their efforts to realize the goal of recognizing the marine realm through the work of the World Heritage Convention, and the States Parties that are the signatories to the Convention have the primary responsibility and benefit in this regard.

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