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CONVENTION ON BIOLOGICAL DIVERSITY

CONFERENCE OF THE PARTIES TO THE
CONVENTION ON BIOLOGICAL DIVERSITY
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Items 23 and 27.1 of the provisional agenda*

GLOBAL COASTAL AND MARINE BIOGEOGRAPHIC REGIONALIZATION AS A SUPPORT TOOL FOR IMPLEMENTATION OF CBD PROGRAMMES OF WORK

Note from the Executive Secretary

1. The Executive Secretary is circulating herewith, for the information of participants in the eighth meeting of the Parties to the Convention on Biological Diversity, an update on efforts to develop a comprehensive global marine biogeographic regionalization. This work is particularly pertinent for related discussions under agenda items and 27.1 (protected areas) and 23 (integration of targets into the thematic programmes of work).

2. In relation to item 27.1, the first meeting of the Ad Hoc Open-ended Working Group on Protected Areas, in recommendation 1/1, requested the Executive Secretary to compile a list of existing ecological criteria for identification of potential marine areas for protection and biogeographical classification systems based on submissions received from the Parties, other Governments and organizations. The criteria are addressed in a separate information document, while the present document provides information on existing global classification systems. In relation to item 23, the assessment of progress towards target 1.1 (At least 10% of each of the world's ecological regions effectively conserved) will depend on the availability of an accepted biogeographical classification system of marine and coastal areas globally.

3. The document is circulated in the form in which it was received by the Secretariat of the Convention on Biological Diversity.

* UNEP/CBD/COP/8/1.

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Global coastal and marine biogeographic regionalization as a support tool for implementation of CBD programmes of work

Mark Spalding[1], Helen Fox[2], Nick Davidson[3], Zach Ferdana[1], Max Finlayson[4], Ben Halpern[5], Miguel Jorge[2], Al Lombana[2], Sara Lourie[6], Kirsten Martin[7], Edmund McManus[8], Jen Molnar[1], Kate Newman[2], Cheri Recchia[9], James Robertson[1]

Introduction and overview

Biological diversity varies over geographic space and the field of biogeography describes the form and pattern of this variation. Quite apart from its ecological and evolutionary interest, such biogeographical study has a critical role to play in nature conservation. Efforts to protect the planet's biodiversity require an understanding of how and where species are distributed. By ensuring a good representation of biogeographic units within a system of protected areas we can come close to ensuring that the full spectrum of life on Earth will also be protected.

Biogeographic maps thus lie at the heart of protected areas network planning and coverage assessment, and have been used as a basis for national and regional studies for a number of years. Simple biogeographic analyses have also been undertaken at the global level to assess progress and highlight gaps in the growing coverage of terrestrial protected areas. (The *United Nations List of Protected Areas* has regularly published such assessments back to 1980 (Chape et al. 2003).)

The marine environment has lagged considerably behind the terrestrial in using such biogeographic tools: since the late 1990s a growing number of national and regional scale classifications have been devised for marine conservation planning, but the lack of a single satisfactory global classification is still widely acknowledged. Although broad-scale systems do exist, none provide both a full global coverage and the finescale spatial subdivisions necessary to drive representative area-based conservation planning.

[1] The Nature Conservancy
[2] World Wildlife Fund - US
[3] Ramsar Convention Secretariat
[4] Ramsar Scientific and Technical Review Panel
[5] National Center for Ecological Analysis and Synthesis, USA
[6] Redpath Museum, Montréal, Canada
[7] IUCN - The World Conservation Union
[8] UNEP World Conservation Monitoring Centre
[9] Wildlife Conservation Society

Recognising both the global need and the existence of a large number of incomplete global and regional systems two international nature conservation organisations – The Nature Conservancy (TNC) and the World Wildlife Fund (WWF) – invited a number of other organisations to work with them in reviewing the existing classifications and to develop a synthesised product, a system of Marine Ecoregions of the World (MEOW). This is not a new biogeography, but rather a mosaic of existing, recognised spatial units.

This work is being conducted by a small Working Group and is still in progress. Here a summary of the process and the partners is presented, along with some general commentary about the challenges and limitations, and a draft coverage for coast and shelf areas, with some further commentary on the high seas.

The Marine Ecoregions of the World

The Marine Ecoregions of the World (MEOW) Working Group is co-chaired by TNC and WWF, and includes representatives of the following organisations:

- World Conservation Union (IUCN)
- UNEP World Conservation Monitoring Centre (UNEP-WCMC)
- The Ramsar Convention
- Wildlife Conservation Society (WCS)
- National Center for Ecological Analysis and Synthesis (NCEAS)(USA)
- Redpath Museum (Canada)

These partners have not given a formal endorsement to outputs from the MEOW, but all have expressed their interest in the process and recognise the need for a more comprehensive and widely accepted classification. Their participation is invaluable in the process, adding expertise and a wider perspective in developing a tool for conservation planning.

As the system reaches completion it is intended that it will be used for global level planning purposes. TNC have already begun to utilise the work presented here in preliminary global analsyes. WWF are undertaking internal reviews of the same system with the aim of placing it alongside their existing biogeographic classifications for terrestrial and freshwater ecoregions of the world. The outcomes will be looked at through Ramsar Convention processes as a support tool for the future identification and designation of coastal/marine Wetlands of International Importance (Ramsar sites). This will also form a contribution to the implementation of the CBD/Ramsar Joint Work Plan and in Ramsar's role for CBD as lead implementation partner on wetlands, including coastal/marine wetlands.

The working process

In order to develop a comprehensive global marine biogeographic regionalization that would be appropriate for global and regional marine conservation planning, an outline of the needs and a target output were first formulated. The the bulk of the work then focussed in on two broad tasks: review and synthesis.

It was felt by all partners that a tiered system would be of most value and that units of taxonomic integrity should be the key focus. At the broadest level these would be "Realms", and nested within these a system of "Provinces" and ecological regions or "Ecoregions". The partners also strongly endorsed an approach that utilised the regional expertise represented in the many regional biogeographic subdivisions currently available, while at the same time sought to connect these to existing global systems (see Annex).

Broad guideline definitions for the terminology (Realm, Province and Ecoregion) were discussed in advance of the work to guide the research and review process. Over 130 separate references describing marine biogeographic boundaries were reviewed, together with numerous unpublished reports and communications. For each, efforts were made to elucidate definitions, understand the process of delineation of units, and to obtain or prepare digital versions of existing maps, to aid the comparison of systems.

A major part of the synthesis process took place at a partners workshop in September 2005 where numerous systems were presented and considered on a case by case basis. Following the detailed discussions from this meeting a full draft was prepared of coast and shelf systems and this has since been reviewed by the working group and others.

Definitions

In reviewing numerous existing biogeographic systems at the regional level, as well as the existing global efforts (Annex) it was readily apparent that a wide array of approaches had been used in the development (and hence definition) of existing biogeographic units[10]. At the same time there were strong commonalities to many systems, even when these were drawn up by different methods[11], and only a small number of systems were deemed incompatible for synthesis into the global map.

Following the review process it was considered important to develop new overarching definitions for the terms Realm, Province and Ecoregion being proposed for the MEOW. Such definitions are necessarily broad to cover the different approaches being amalgamated, but aim to provide a clear vision of what is, and is not, meant by the different terms being applied.

Realms

Realms are the largest spatial units and follow the terrestrial concept of realms, described by Udvardy as "continent or subcontinent-sized areas with unifying features of geography and fauna/flora/vegetation"[12]. In the marine environment some realms have been widely recognised by biogeographers for 100 years or more, but there are also a number of challenges, notably relating to the stark differences in biotas in open oceans versus those that depend on the sea floor (even for part of their life history).

The following definition of marine realms is thus proposed:
Very large regions of coastal, benthic or pelagic ocean in which biotas are internally coherent at higher taxonomic levels as a result of a shared and unique evolutionary history. Realms will have high levels of endemism, not only at the species level, but also with unique taxa at generic and family levels in some groups. Driving factors behind the development of such unique biotas include water temperature, historical and broad-scale isolation and the influence (presence or absence) of dependence on the benthos.

For the purposes of the current work a system of coast and shelf realms is proposed, and a system of pelagic realms is under development for the upper water column. The biogeography of the deep benthos

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[10] Some systems are based on known species ranges, using data from one or many taxa and looking for natural breaks in distribution to define boundaries. Others have been derived entirely from abiotic measures, but often focussed on those measures deemed of critical importance for biodiversity. Perhaps the majority of systems considered were themselves review-based and drew boundaries based on a number of biotic and abiotic criteria. In terms of mapping techniques, most use expert judgement to finalise boundaries, but a small number rely entirely on algorithmic approaches.

[11] The similarity of boundaries is quite commonly recorded in biogeographic literature. For example, different taxa often (though not always) mirror patterns observed in other taxa, so systems based on, say, molluscs, may match systems derived from corals or fish. Likewise, biotic patterns are often a direct reflection of physical or chemical patterns in the oceans. Thus systems based solely on temperature and current patterns often produce very similar boundaries to taxonomic systems. In all cases caution was applied in making assumptions about the wider applicability of particular systems, particularly where classifications were solely based on a single taxonomic or abiotic parameter, and efforts were made to review available literature to understand whether such systems appeared to reflect wider biogeographic reality.

[12] Development of this concept has led to a recognition of eight terrestrial realms: Nearctic, Palaearctic, Neotropical, Afrotropical, Australian, Indomalayan, Antarctic and Oceanian. Each represents an area with a shared geologic and climatic history, which in turn has supported the evolution and maintainance of distinct taxonomic groups and biotic assemblages.

remains poorly understood, so it may be necessary in the short term to develop a "fix", such as extending shelf realms down the near-shelf slopes (~1000m) and for the remainder of the oceans using an extension of the surface realms of the open ocean.

Provinces

Nested within the realms are provinces, which are:
Large areas defined by the presence of distinct biotas that may have evolved over evolutionary timeframes. Provinces will hold some level of endemism, at least at the level of species. Although historical isolation will play 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, upwellings, ice dynamics); or geochemical influences (broadest scale elements of nutrients supply and salinity).

In ecological terms provinces are cohesive units likely, for example, to encompass the broader life-history or ecological processes even for many mobile and dispersive species.

The scale at which provinces may be conceived is similar to the spatial units devised by other marine biogeographers. Some, such as Briggs, have tried to develop highly prescriptive definitions (defined as areas with a minimum of 10% faunal endemism). Such a rigorous definition has been avoided here, because in many locations such highly distinctive biotas not be defined by endemism, but may be derived from abiotic influneces. Such abiotic drivers conform closely to the other widely used system of coastal biogeographic units: Large Marine Ecosystems. The system of Provinces proposed here has been fitted closely to these existing systems where possible.

Ecoregions

The smallest-scale units in the present system are ecoregions, which in many areas would represent the "jumping-off point" for field-based conservation planning. Such units have already been used in some areas by some conservation organisations and in MPA network planning. Marine ecoregions are:

Areas of relatively homogeneous species composition that clearly differ in this regard from adjacent systems. This species composition is likely to be determined by the predominance of a small number of ecosystems and/or a distinct suite of oceanographic or topographic features. The dominant biogeographic forcing agents defining the ecoregions vary from location to location but may include: isolation, upwelling, nutrient inputs, freshwater influx, temperature regimes, ice regimes, exposure, sediments, currents, and bathymetric or coastal complexity.

In ecological terms these are strongly cohesive units, sufficiently large to encompass life-history/ecological processes for most benthic, sedentary, non-mobile species. Although some ecoregions may have important levels of endemism, this is not a key determinant in ecoregion identification and definition.

Challenges and limitations

As a liquid medium, the oceans present a number of unique challenges biogeographers:

Paucity of data
The vast area and great depth of the oceans means it is difficult to obtain data (either directly or indirectly) of what is where. Data is based on sampling of only a miniscule fraction of what is in the oceans for just a few brief moments of sampling time. Technology is improving and available information increasing with the consequence that *new information is likely to lead to ongoing revision of boundaries*.

The role of structural habitats

Terrestrial biogeographers frequently use dominant vegetation type to inform the mapping of biogeographic units. In the marine realm there are few such structural habitats (kelp forests, coral reefs, seagrasses and mangroves represent only a fraction of the marine environment). Furthermore, many coast and shelf habitats form complex arrangements of extremely different systems in a patchy, interlocking framework, while oceanic systems are typically vast and homogenous. *Ecoregions do not encompass areas dominated by a single habitat, but rather circumscribe a range of habitats that may occur within their boundaries*.

The three-dimensional medium

The sea offers a three-dimensional living space. This leads to a layering of the biodiversity that adds to the complexity of defining biogeographic units, since different taxa may be operating under very different abiotic and historical influences depending on depth and on access (or not) to the sea floor. For mapping purposes this will probably mean *the development of parallel biogeographic systems, particularly in deep water areas, for the sea floor and overlying water column layers*.

The dynamism of boundaries

There are no fixed lines in the oceans as the fluid medium allows rapid and continual movement of both organisms and abiotic conditions. Boundaries are thus "fuzzy" areas of transition that will typically be 10s or hundreds of kilometers wide. Further complexity is added by the fact that conditions change over a variety of temporal scales, some of which are unpredictable. At any point in time a clear biogeographic boundary may occur in a very different point in space. As a result *any biogeographic boundary should be regarded as an average location for a blurred zone of transition that may shift considerably through time.*

Overlapping Realms

In the current document we only describe a system of coast and shelf realms, however we propose that further systems will be devised for offshore waters. At the same time it is clear that taxa from these systems overlap. Truly pelagic species often frequent coast and shelf waters, and considerable numbers of species that are considered pelagic are actually dependent on the coast and shelf waters for part of their life histories. For this region it must be considered that *there is considerable overlap between the realms of the open ocean and those of the coast and shelf.* Similar observations will arise in offshore benthic systems: the shelf systems have a considerable influence on deeper slope biotas.

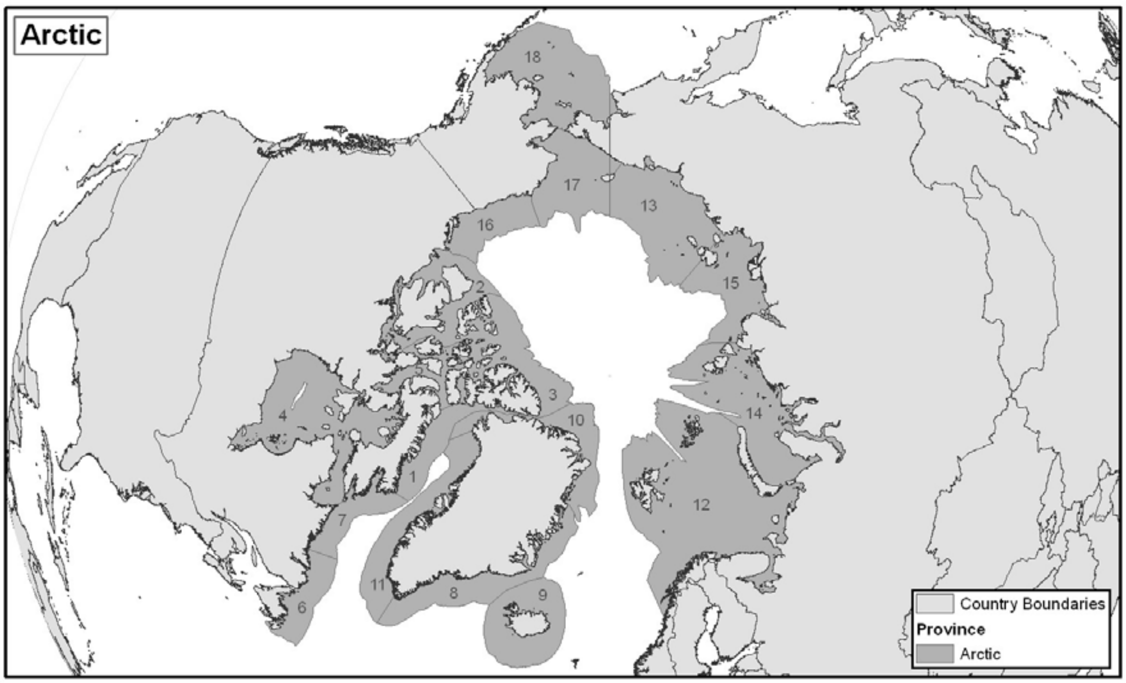
Proposed Realms, Provinces and Ecoregions for Shelf Areas

The following system is still under development and should be considered draft.

The major headings are Realms with maps and lists detailing the Provinces and Ecoregions in each. Although more detailed information is being prepared the key sources are listed as footnotes. These should be seen as indicative only. In many cases these source materials have informed and guided, but may have been further influenced by other publications and/or by expert review.

IMPORTANT NOTE: To improve clarity in the maps, the seaward boundaries have been extended to an approximate 200 nautical mile limit, however these ecoregions only refer to the shelf areas within these limits (defined as extending down to 200m depth contour) which are usually much smaller..

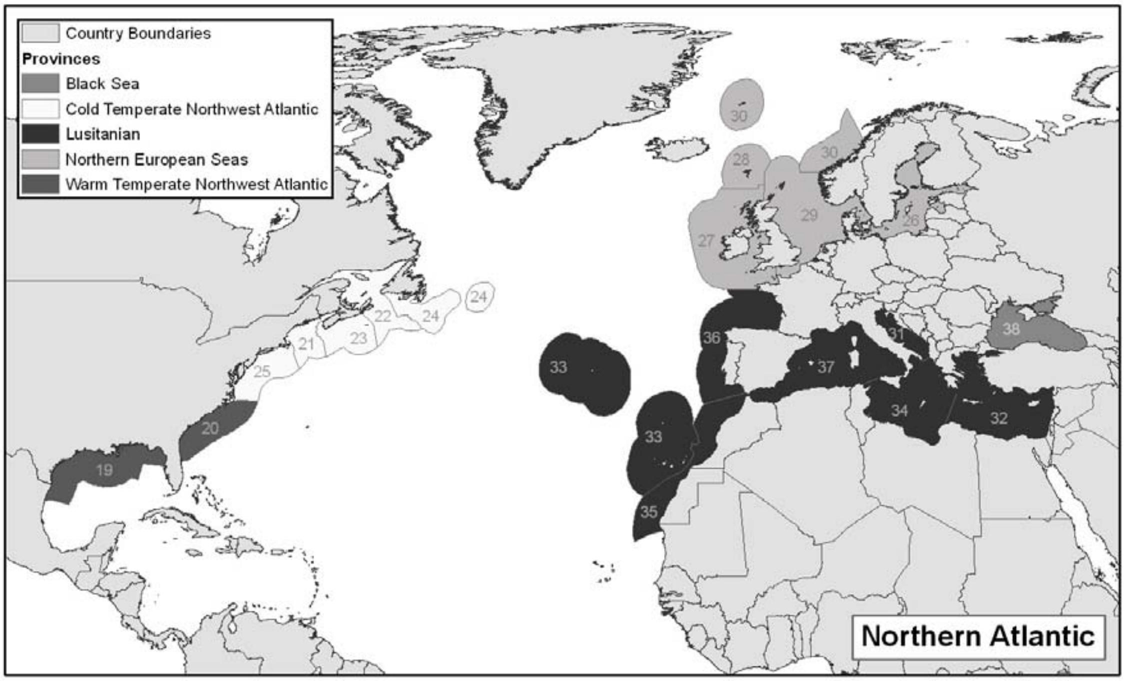
Arctic



Provinces: *none have been identified at the present time.*
Canada: *Fisheries and Oceans Canada (Powles et al. 2004)*
Large Marine Ecoregions form the basis for most other areas (Sherman and Alexander 1989).

1 Baffin Bay - Davis Strait
2 Beaufort-Amundsen-Viscount Melville-Queen Maud
3 High Arctic Archipelago
4 Hudson Complex
5 Lancaster Sound
6 Northern Grand Banks - Southern Labrador
7 Northern Labrador
8 East Greenland Shelf
9 Iceland
10 North Greenland
11 West Greenland Shelf
12 Barents Sea
13 East Siberian Sea
14 Kara Sea
15 Laptev Sea
16 Beaufort Sea - continental coast and shelf
17 Chukchi Sea
18 Eastern Bering Sea

Northern Atlantic



Provinces: *Briggs 1974*
US coasts: *TNC devised ecoregions see for example (Beck and Odaya 2001), Commission for Environmental Co-operation (Wilkinson et al. 2005 near final draft)*
European/Mediterranean: *International Council for the Exploration of the Sea (ICES 2004) with expert review comments incorporated*

Warm Temperate Northwest Atlantic
19 Northern Gulf of Mexico
20 Carolinian

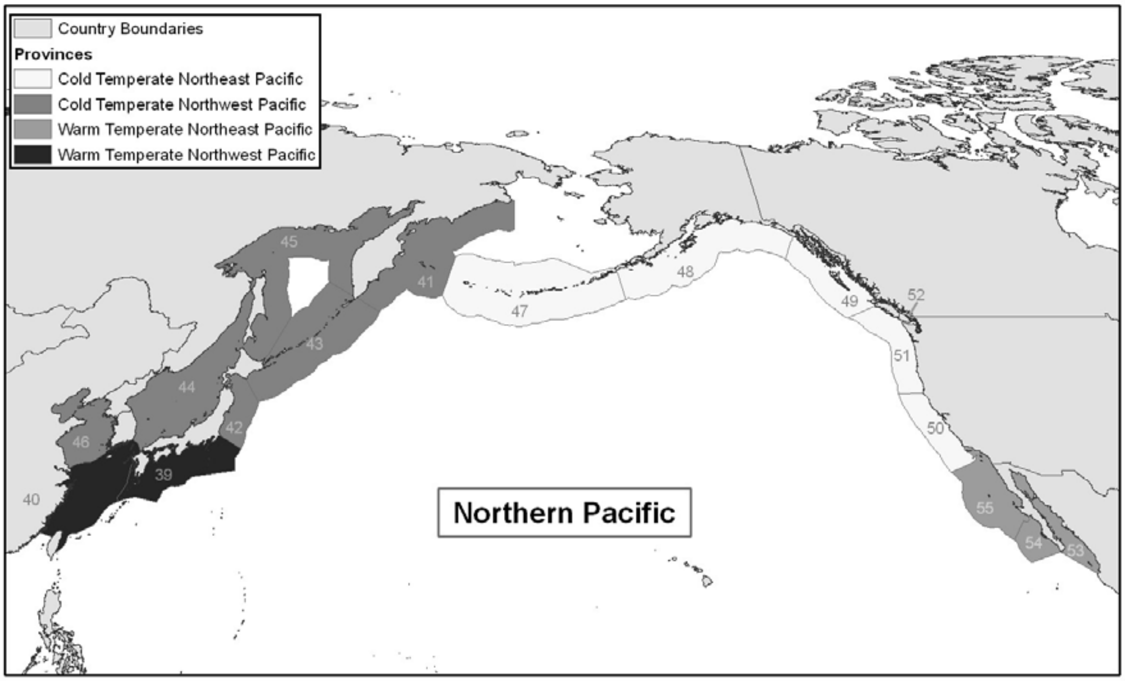
Cold Temperate Northwest Atlantic
21 Gulf of Maine/Bay of Fundy
22 Gulf of St. Lawrence - Eastern Scotian Shelf
23 Scotian Shelf
24 Southern Grand Banks - South Newfoundland
25 Virginian

Northern European Seas
26 Baltic Sea
27 Celtic Seas
28 Faroes
29 North Sea
30 Norwegian Sea

Lusitanian
31 Adriatic Sea
32 Aegean-Levantine Seas
33 Azores Canaries Madeira
34 Ionian Sea
35 Saharan Upwelling
36 South European Atlantic Shelf
37 Western Mediterranean Sea

Black Sea
38 Black Sea

Northern Pacific



Provinces: *Briggs 1974*
East Asia: *Large Marine Ecoregions (Sherman and Alexander 1989).*
North America: *TNC ecoregions, WWF/TNC ecoregion subdivisions (Banks et al. 2000), (Briggs 1974), Commission for Environmental Co-operation (CEC) ecoregions (Wilkinson et al. 2005 near final draft), (Sullivan Sealey and Bustamante 1999).*

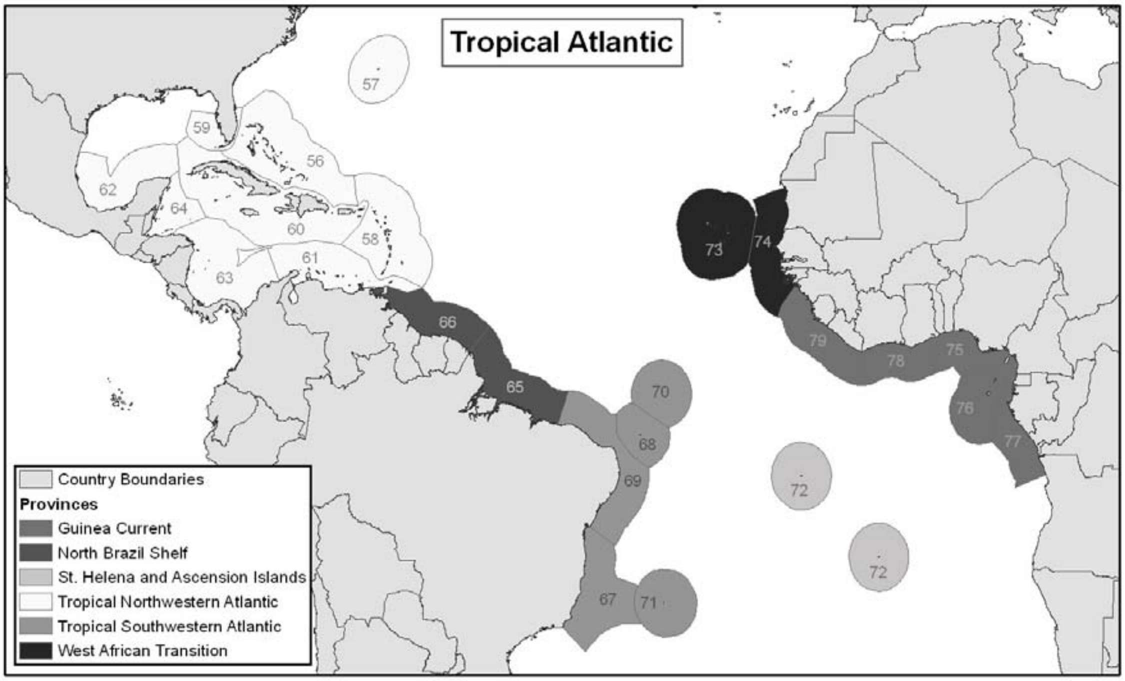
Warm Temperate Northwest Pacific
39 Central Kuroshio Current
40 East China Sea

Cold Temperate Northwest Pacific
41 Kamchatka Shelf and Coast
42 Northeastern Honshu
43 Oyashio Current
44 Sea of Japan
45 Sea of Okhotsk
46 Yellow Sea

Cold Temperate Northeast Pacific
47 Aleutian Islands
48 Gulf of Alaska
49 North American Pacific Fijordland
50 Northern California
51 Oregon, Washington, Vancouver Coast and Shelf
52 Puget Trough/Georgia Basin

Warm Temperate Northeast Pacific
53 Cortezian
54 Magdalena Transition
55 Southern California Bight

Tropical Atlantic



Caribbean: *developed by TNC, in collaboration with regional partners and scientists.*
South America: *(Sullivan Sealey and Bustamante 1999).*
Africa: *WWF 1999*

Tropical Northwestern Atlantic
56 Bahamian
57 Bermuda
58 Eastern Caribbean
59 Floridian
60 Greater Antilles
61 Southern Caribbean
62 Southern Gulf of Mexico
63 Southwestern Caribbean
64 Western Caribbean

North Brazil Shelf
65 Amazonia
66 Guianan

Tropical Southwestern Atlantic
67 Eastern Brazil
68 Fernando de Naronha and Atoll das Rocas
69 Northeastern Brazil
70 Sao Pedro and Sao Paulo Islands
71 Trindade and Martin Vaz Islands

St. Helena and Ascension Islands
72 St. Helena and Ascension Islands

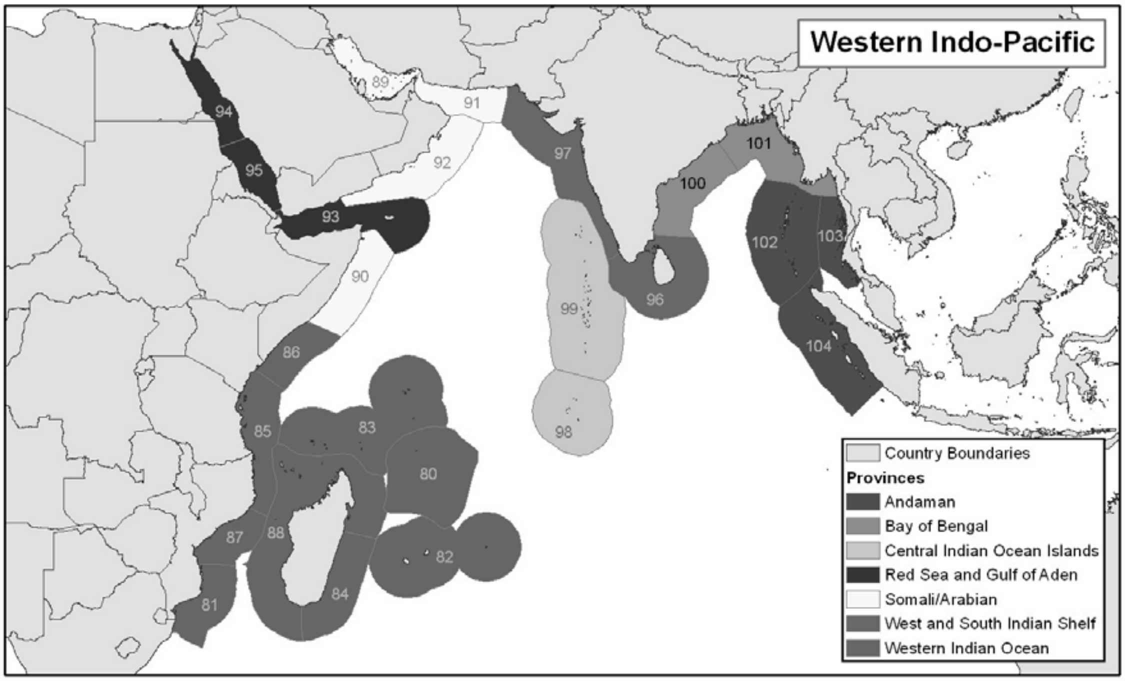
West African Transition
73 Cape Verde
74 Sahelian Upwelling

Guinea Current
75 Gulf of Guinea Central
76 Gulf of Guinea Islands
77 Gulf of Guinea South
78 Gulf of Guinea Upwelling
79 Gulf of Guinea West

Indo-Pacific

Although the Indo-Pacific shows clear coherence as an evolutionary unit, its size, diversity and variation lead us to recommend the subdivision of this unit into three sub-realms.

Western Indo-Pacific



East Africa and Madagascar: *WWF 1999*
Islands: *Allen 2000*
Middle East: *Kemp 2005*
Provinces and ecoregions for the continental coasts of south and southeast Asia have been developed by the MEOW Working Group following a broad literature review and expert consultation.

Western Indian Ocean
80 Cargados Carajos/Tromelin Island
81 Delagoa
82 Mascarene Islands
83 Seychelles
84 Southeast Madagascar
85 East African Coral Coast
86 Northern Monsoon Current Coast
87 Bight of Sofala/Swamp Coast
88 Western & Northern Madagascar

Somali/Arabian
89 Arabian (Persian) Gulf
90 Central Somali Coast
91 Gulf of Oman
92 Western Arabian Sea

Red Sea and Gulf of Aden
93 Gulf of Aden
94 Northern and Central Red Sea
95 Southern Red Sea

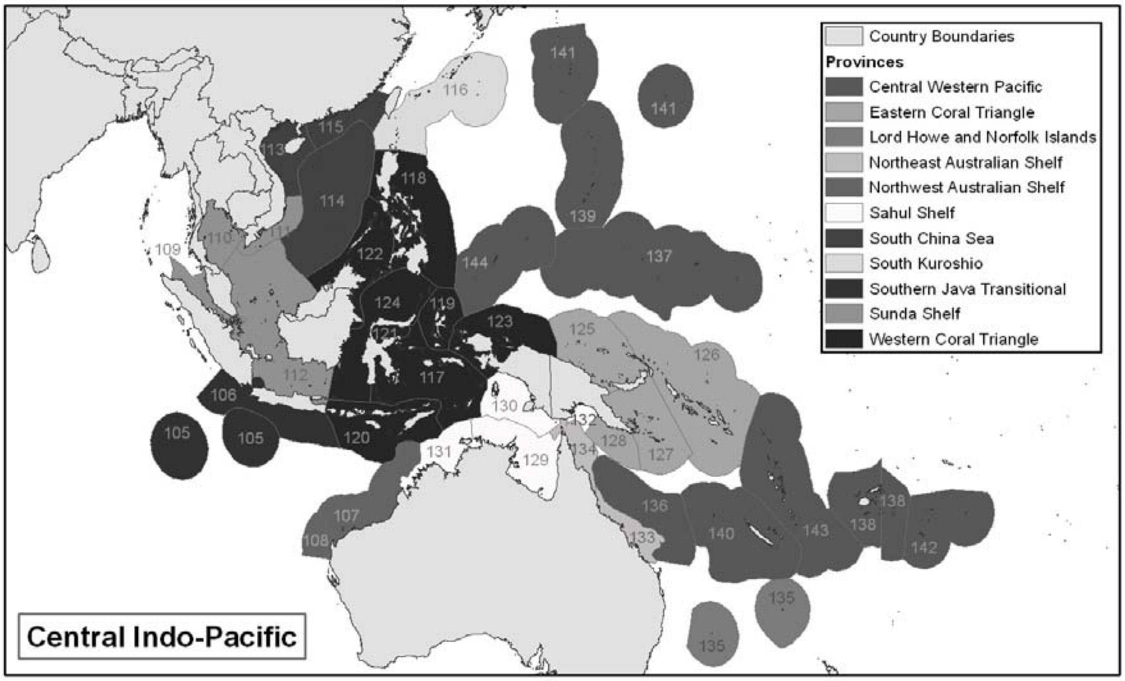
West and South Indian Shelf
96 South India and Sri Lanka
97 Western India

Central Indian Ocean Islands
98 Chagos
99 Maldives

Bay of Bengal
100 Eastern India
101 Northern Bay of Bengal

Andaman
102 Andaman and Nicobar Islands
103 Andaman Sea Coral Coast
104 Western Sumatra

Central Indo-Pacific



Australia: *Provinces match Large Marine Ecosystems and these and ecoregions are derived from the Interim Marine and Coastal Regionalisation for Australia (Thackway and Cresswell 1998).*
Sunda Shelf and South China Sea: *largely informed by an incomplete classification provided in (Kelleher et al. 1995).*
Western Coral Triangle: *drawn up by an expert working group hosted by TNC in 2003 (Green and Mous 2004)*
Pacific Islands: *Allen 2002*

Southern Java Transitional
105 Cocos-Keeling/Christmas Island
106 Southern Java

Northwest Australian Shelf
107 Exmouth to Broome
108 Ningaloo

Sunda Shelf
109 Malacca Strait
110 Gulf of Thailand
111 Southern Vietnam
112 Sunda Shelf

South China Sea
113 Gulf of Tonkin
114 South China Sea Oceanic Islands
115 Southern China

South Kuroshio
116 South Kuroshio Current

Western Coral Triangle
117 Banda Sea
118 Eastern Philippines
119 Halmahera
120 Lesser Sunda
121 Northeast Sulawesi
122 Palawan/North Borneo
123 Papua
124 Sulawesi Sea/Makassar Strait

Eastern Coral Triangle
125 Bismark Sea
126 Solomon Archipelago
127 Solomon Sea
128 Southeast Papua New Guinea

Sahul Shelf
129 Arnhem Coast to Gulf of Carpenteria
130 Arufura Sea
131 Bonaparte Coast
132 Gulf of Papua

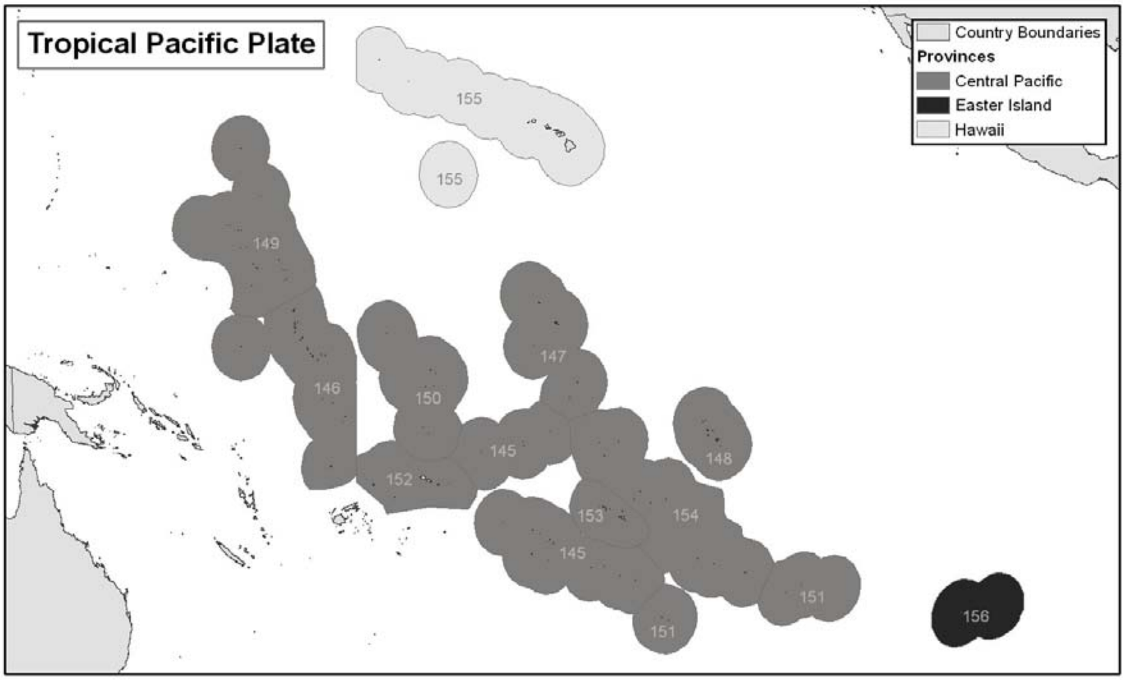
Northeast Australian Shelf
133 Central and Southern Great Barrier Reef
134 Torres Strait Northern Great Barrier Reef

Lord Howe and Norfolk Islands
135 Lord Howe and Norfolk Islands

Central Western Pacific
136 Coral Sea
137 East Caroline Islands
138 Fiji Islands
139 Mariana Islands
140 New Caledonia
141 Ogasawara Islands

142	Tonga Islands	144	West Caroline Islands
143	Vanuatu		

Tropical Pacific Plate



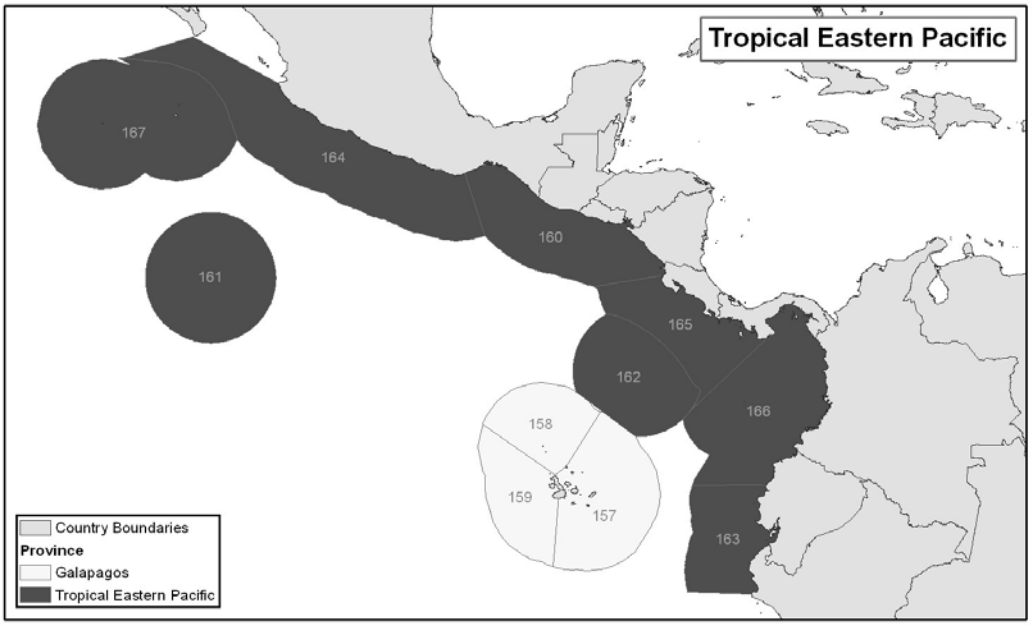
Main source: *Allen 2000*

Central Pacific
145 Cook/Austral Islands
146 Gilbert/Ellis Islands
147 Line Islands
148 Marquesas
149 Marshall Islands
150 Phoenix/Tokelau
151 Rapa-Pitcairn
152 Samoa Islands
153 Society Islands
154 Tuamotus

Hawaii
155 Hawaiian Islands

Easter Island
156 Easter Island

Tropical Eastern Pacific

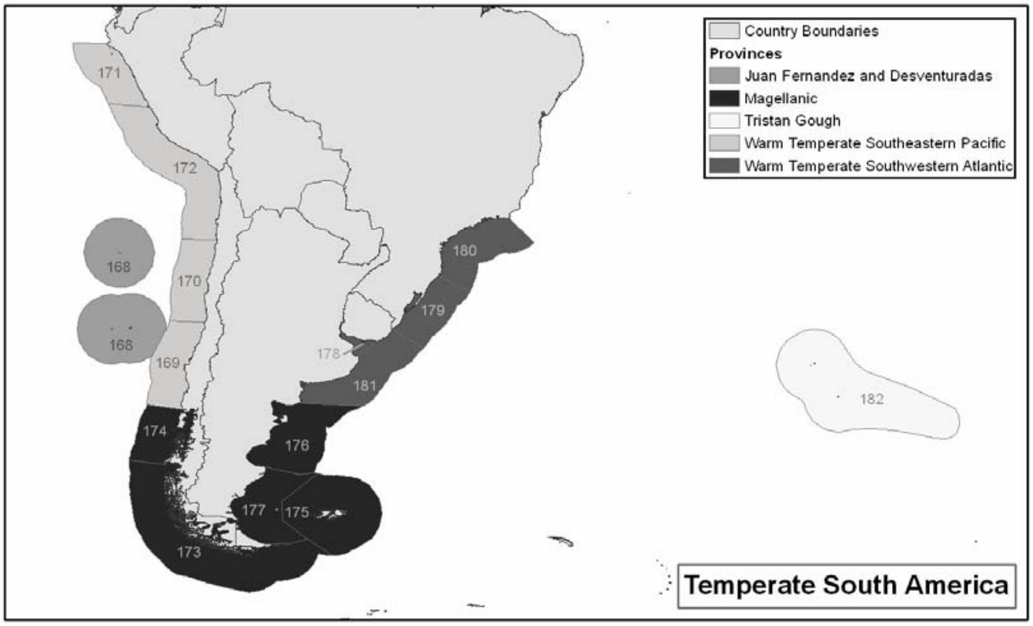


Main source: *Sullivan Sealey and Bustamante 1999*

Galapagos
157 Eastern Galapagos Islands
158 Northern Galapagos Islands
159 Western Galapagos Archipelago

Tropical Eastern Pacific
160 Chiapas-Nicaragua
161 Clipperton
162 Cocos Islands
163 Guayaquil
164 Mexican Tropical Pacific
165 Nicoya
166 Panama Bight
167 Revillagigedos

Temperate South America



Main source: *Sullivan Sealey and Bustamante 1999*

Juan Fernández and Desventuradas
168 Juan Fernández and Desventuradas

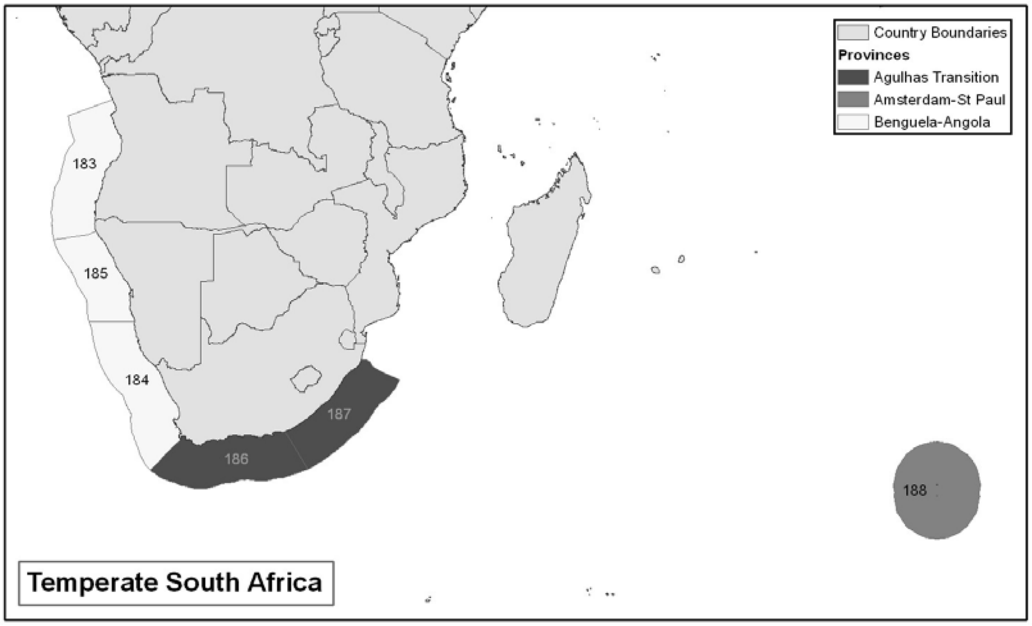
Warm Temperate Southeastern Pacific
169 Araucanian
170 Central Chile
171 Central Peru
172 Humboldtian

Magellanic
173 Channels and Fjords of Southern Chile
174 Chiloense
175 Malvinas/Falklands
176 North Patagonian Gulfs
177 Patagonian Shelf

Warm Temperate Southwestern Atlantic
178 Rio de la Plata
179 Rio Grande
180 Southeastern Brazil
181 Uruguay-Buenos Aires Shelf

Tristan Gough
182 Tristan Gough

Temperate South Africa



Main source: *WWF 1999*

Benguela-Angola

183 Angolan
184 Namaqua
185 Namib

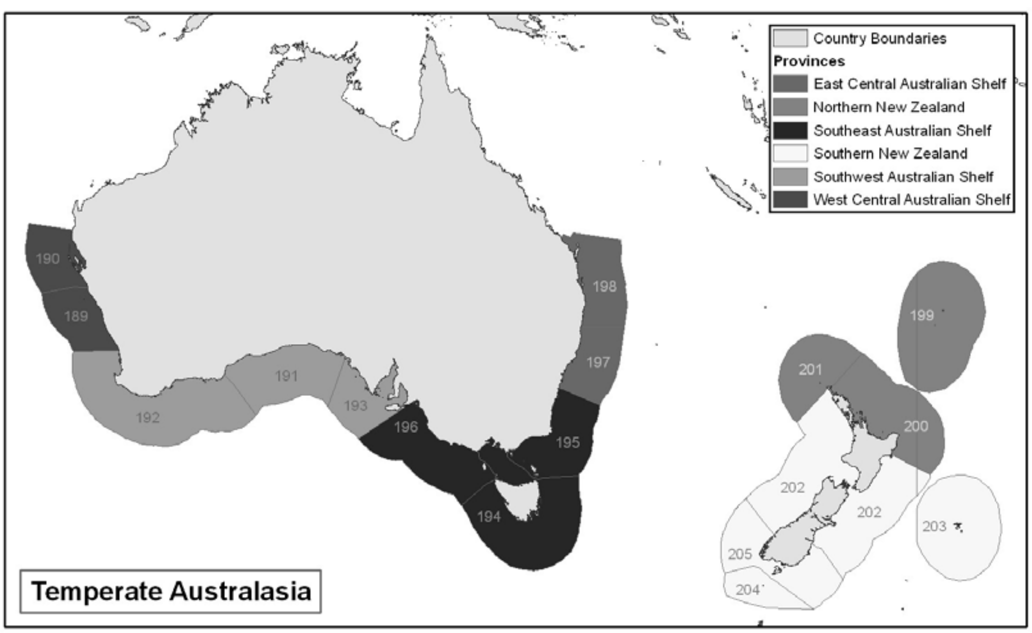
Agulhas Transition

186 Agulhas
187 Natal

Amsterdam-St Paul

188 Amsterdam-St Paul

Temperate Australasia



Australia: *Provinces match Large Marine Ecosystems and these and ecoregions are derived from the Interim Marine and Coastal Regionalisation for Australia (Thackway and Cresswell 1998).*
New Zealand: *NZ Department of Conservation (Walls 1994)*

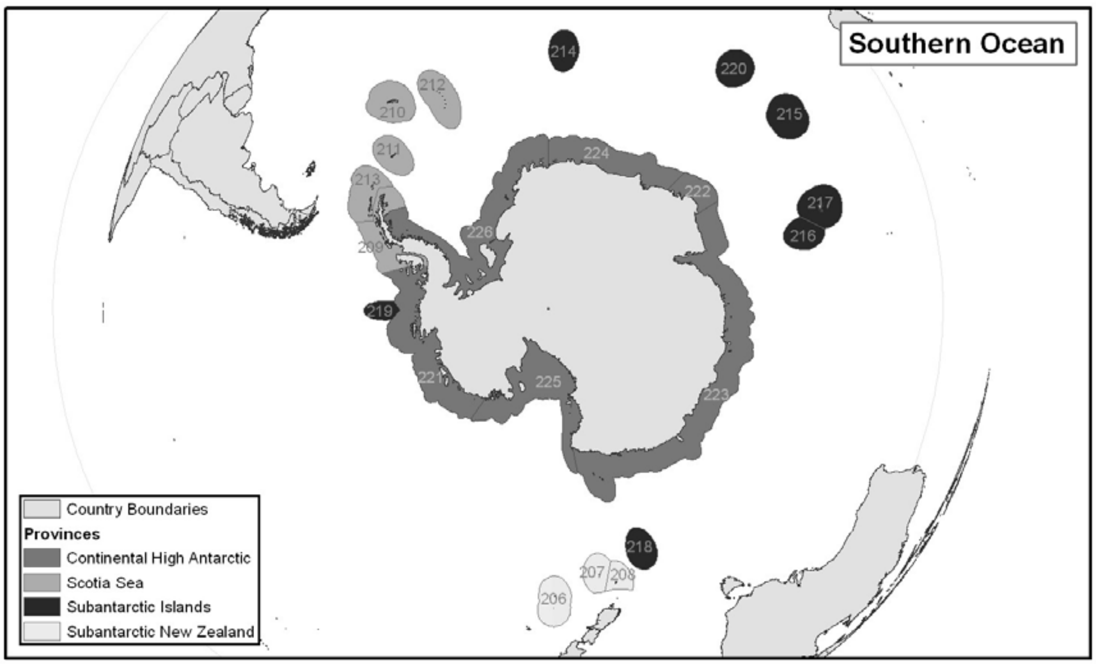
West Central Australian Shelf
189 Houtman
190 Shark Bay

Southwest Australian Shelf
191 Great Australian Bight
192 Leeuwin
193 South Australian Gulfs
194 Bassian
195 Cape Howe
196 Western Bassian

East Central Australian Shelf
197 Manning-Hawkesbury
198 Tweed-Moreton

Northern New Zealand
199 Kermadec Island
200 Northeastern New Zealand
201 Three Kings-North Cape
202 Central New Zealand
203 Chatham Island
204 Snares Island
205 Southern New Zealand

Southern Ocean



Main source: *Katrin Linse of the British Antarctic Survey (Linse et al. in press)*

Subantarctic New Zealand
206 Bounty and Antipodes Islands
207 Campbell Island
208 Auckland Island

Scotia Sea
209 Antarctic Peninsula
210 South Georgia
211 South Orkney Islands
212 South Sandwich Islands
213 South Shetland Islands

Subantarctic Islands
214 Bouvet Island
215 Crozet Islands
216 Heard and Macdonald Islands
217 Kerguelen Islands
218 Macquarie Island
219 Peter the First Island
220 Prince Edward Islands

Continental High Antarctic
221 Amundsen/Bellingshausen Sea
222 East Antarctic Enderby Land
223 East Antarctic Wilkes Land
224 East Antarctica Dronning Maud Land
225 Ross Sea
226 Weddell Sea

High seas biogeography

Moving away from coast and shelf areas dramatic changes occur in. In the benthic and demersal realms, associated with the sea floor, biomass and species diversity per unit area decrease relatively rapidly. These biogeographic patterns mirror those of the adjacent shelf areas, but with gradually shifting influences, most notably with depth. Further from the shelf regions, patterns emerge that bear little or no relation with shelf areas. Such patterns have received little attention and while there is now much interest in the more dramatic ecosystems (seamounts, chemosynthetic communities, deep coral communities), it will be some time before coherent global biogeographies are devised for these systems, and even longer before the relation between these "charismatic" systems and the wider biogeography of the sea floor is established.

By contrast considerable attention has been given to the surface waters of the high seas and a biogeography for the surface pelagic realms will be presented by the MEOW Working Group in the coming months. Here a summary of current thinking is presented.

Pelagic biogeography

From the perspective of biotas and biodiversity, the surface waters of the oceans are notable for their low biomass, low diversity and low levels of endemism. These are linked to the low levels of nutrients available and to the high levels of connectivity and consequent low degree of isolation.

Closer to shelf edges, pelagic biotas are strongly influenced by species that have some link to the benthic and/or shelf systems. In this way, these areas often bear the imprint of the shelf biogeography. For the truly oceanic species that spend their entire life history in the water column, such links are not seen.

Considerable attention has been given to understanding and delineating the biogeography of these pelagic species, including both plankton and fish. In an initial review of over 30 publications, high levels of agreement were observed between authors regarding the driving forces behind biodiversity patterns.

All agree that the most profound influences on biotic patterns are the circulation patterns of surface waters. Such patterns are broadly repeated in all oceans, with latitudinal subdivisions and similar systems repeated in both northern and southern hemispheres. It is in the very large ocean gyre based systems that biotas have sufficient evolutionary longevity for endemic or near endemic species to arise, but even in these the connectivity is considerable.

Variation in biotas at the level of higher taxa is very low, even between hemispheres and between ocean basins. It might thus be expected that there would be few realms, and that these would do little more than reflect the latitudinal separation of "warm" and "cold" biotas. Lower level variance in species compositions, with low levels of endemism, is picked up at sub-basin levels, particularly linked to stable and gyral systems.

A first attempt at synthesising the major biogeographic units for the ocean surface waters used by a majority of pelagic biogeographers is presented below (drawn, *inter alia*, from (Steuer 1933; Bé and Gilmer 1977; Backus 1986; McGowan and Walker 1994; White 1994; Semina 1997; Boltovskoy 1998)

Cold Arctic
Subarctic Atlantic
Subarctic Pacific

Transitional Atlantic
Transitional Pacific

Warm	Northern Subtropical (Central) Atlantic
	Northern Subtropical (Central) Indo-Pacific
	Equatorial Atlantic
	Equatorial Indo-Pacific (with possible separation of Tropical Eastern Pacific)
	Southern Subtropical (Central) Atlantic
	Southern Subtropical (Central) Indo-Pacific
	Transitional Southern Hemisphere
Cold	Subantarctic
	Antarctic

An alternative approach to developing a biogeography for the oceans has been developed by (Longhurst 1998). This system of broad biomes and finescale "biogeochemical provinces" is centred on abiotic measures. 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 appealled to a number of authors. It would further appear that some of the divisions lie quite close to lines suggested by taxonomic biogeographers.

At the same time it should be pointed out that this system does not strictly follow the surface circulation patterns in a number of areas. Some of his 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 finer-scale ecoregions.

It may be possible to devise a system which combines some of the information from Longhurst with more traditional taxonomic based units. Work through the course of 2006 will develop and map a pelagic system for the surface waters and refine this through a process of external review prior to publication.

Conclusions

The seventh meeing of the Convention of Parties of the Convention on Biological Diversity clearly stated the need to improve the global protected areas estate and noted that marine areas were "particularly under-represented" (Decision VII/28 paragraph 17). It recommended the establishment and maintenance of "comprehensive, effectively managed, and ecologically representative national and regional systems of protected areas" by 2012 (VII/28, paragraph 18).

Integral to advancing this process is understanding whether systems of protection are "ecologically representative". For this reason the Ad Hoc Working Group on Protected Areas recommended the review and synthesis of existing biogeographical classification schemes.

The same desire to develop a comprehensive and systematic global biogeography for assessing current global conservation effort and guiding future efforts has been expressed by other groups and was central to the development of the Marine Ecoregions of the World Working Group. Their work has effectively involved the review and synthesis recommended by the Ad Hoc Working Group.

The Marine Ecoregions of the World, presented here only in draft form and restricted to coast and shelf areas, already provides an important base from which to assess the efficacy of the existing global system of marine protected areas (which, to date, are almost entirely restricted to coast and shelf areas). The final system, with completion envisaged by the end of 2006 for coast, shelf and pelagic surface waters (to 1000m) will fill a critical gap for protected areas assessment across much of the ocean.

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Annex: Existing global marine biogeographies

Although this is not a review document, it is critical to acknowledge some of the existing systems that have contributed to the development of global marine biogeography. As mentioned in the introduction, none of these provide sufficient resolution to enable finer-scale assessment and planning, and some do not offer a complete global coverage. Despite these limitations the MEOW system has leant heavily on these works, and indeed has attempted to build a system that can be linked to some of these existing units at different spatial scales. Here we list some of the key global studies and systems that have been widely cited, some of which are in active use.

Zoogeography of the Sea (Ekman 1953)
One of the first classic volumes originally published in German in 1935, this recognises, 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 focusses 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 uses many of the boundaries developed by Briggs to inform its own subdivisions, however it is felt 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 mostly widely used classifications these are "relatively large regions on the order of 200,000 km2 or greater, characterized by distinct: (1) bathymetry, (2) hydrography, (3) productivity, and (4) trophically dependent populations". They have been devised through expert consultation. 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. As shown by the definition these units are not defined by their constituent biotas: although in many cases there are close parallels due to the influence of the abiotic characters in driving biotas this is not always the case. 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.

A Global Representative System of Marine Protected Areas (Kelleher et al. 1995)
Not strictly a classification this is one of the only global efforts to look at global marine protected areas coverage. Contributing authors were asked to consider biogeographic representation in each of 18 areas and this volume provides important pointers to biogeographic literature and potential spatial units.

Ecological Geography of the Sea (Longhurst 1998)
As described above (Pelagic biogeography).

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.