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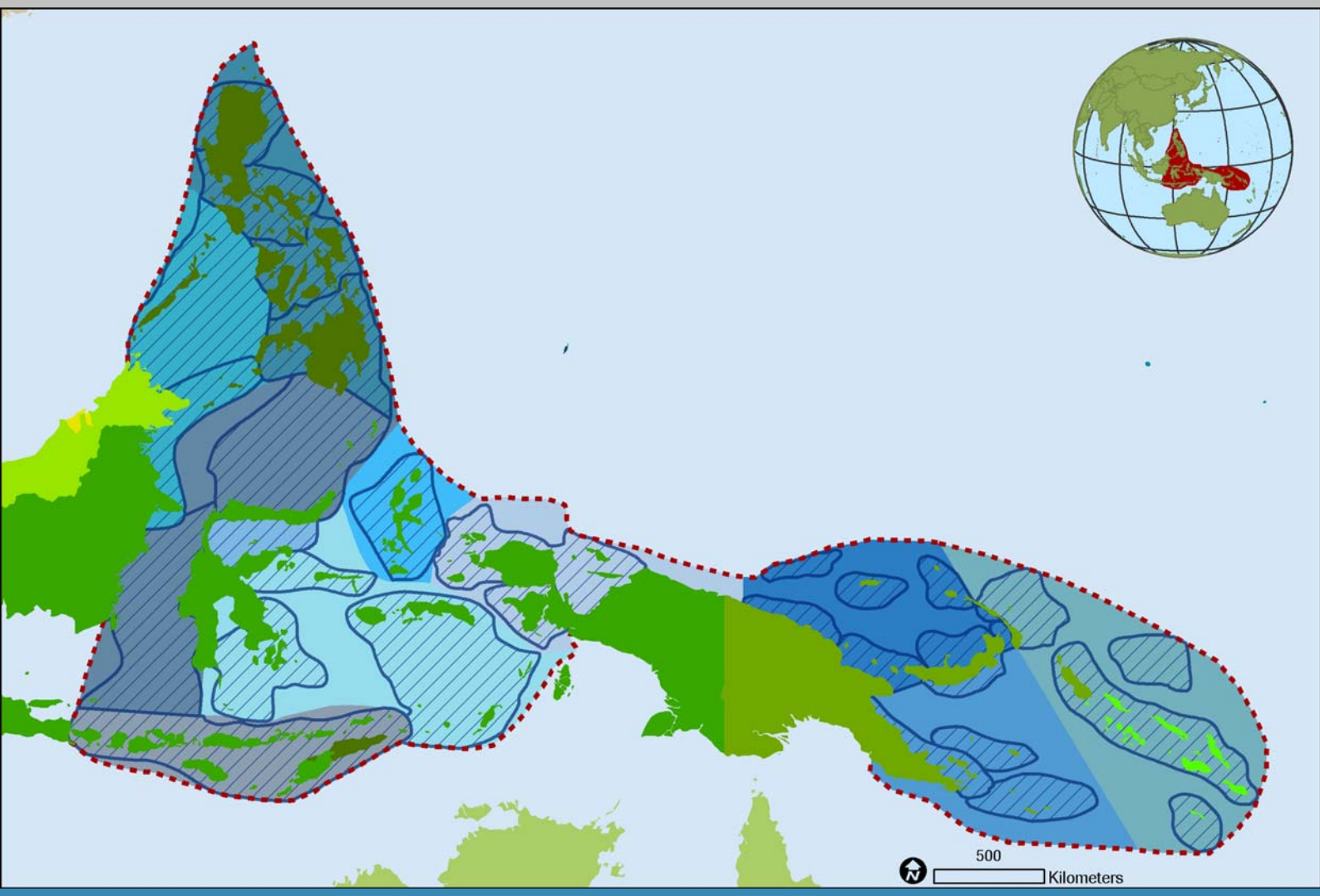
September 2008
TNC Coral Triangle Program
Report No 1/08

Delineating the Coral Triangle, its Ecoregions and Functional Seascapes

VERSION 5.0



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Published by: The Nature Conservancy, Coral Triangle Program

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Suggested Citation:
Green A.L. & Mous P.J. 2008. Delineating the Coral Triangle, its Ecoregions and Functional Seascapes. Version 5.0. TNC Coral Triangle Program Report 1/08. 44 pp.

Available from:

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Indonesia

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1 Executive Summary

The Coral Triangle is the epicenter of marine diversity, and a global priority for conservation. The Coral Triangle, its ecoregions and functional seascapes are delineated for conservation purposes based on best available biological and physical information. The process involved an expert workshop and subsequent advice from 30 international and local scientists, managers and conservationists, including world experts on corals, reef fishes and other invertebrates.

The boundary of the Coral Triangle (Figure A) is delineated based on species diversity (corals, reef fishes and other invertebrates), habitat type and diversity, oceanography, geomorphology, bathymetry, sea level fluctuations, and river discharge. It comprises all or part of six countries in Southeast Asia and Melanesia: Indonesia, Philippines, Malaysia (Sabah), Timor Leste, Papua New Guinea and the Solomon Islands.

Figure A. Coral Triangle boundary

Ecoregions are defined as “large areas containing geographically distinct assemblages of species, natural communities, and environmental conditions”. Eleven ecoregions are delineated (Figure B), which will be used as the basis for conducting ecoregional conservation assessments to identify priority areas for conservation.

Functional seascapes are defined as “areas within a wider ecoregion within which there is some geographic or ecological distinctiveness, but over a smaller area that maybe more suitable for the application of management measures such as networks of marine protected areas”. Thirty-two functional seascapes are delineated (Figure C) based on their geographic integrity, connectivity, environmental factors, and shared ecological characteristics.

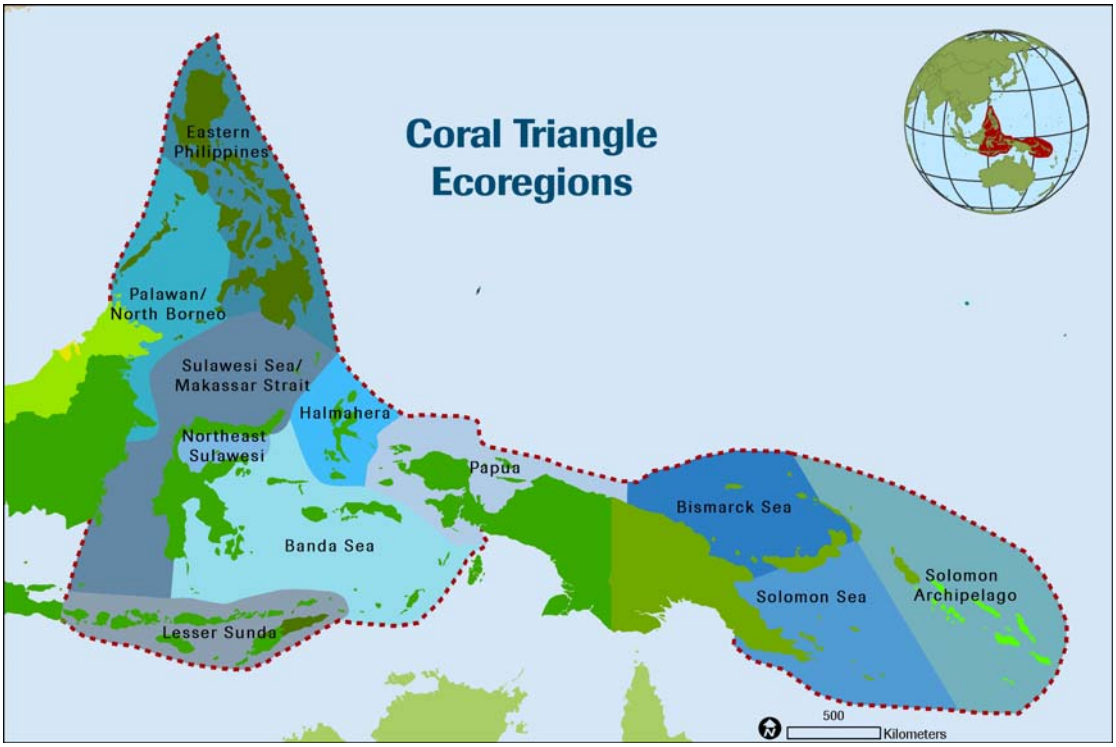

Figure B. Coral Triangle ecoregions

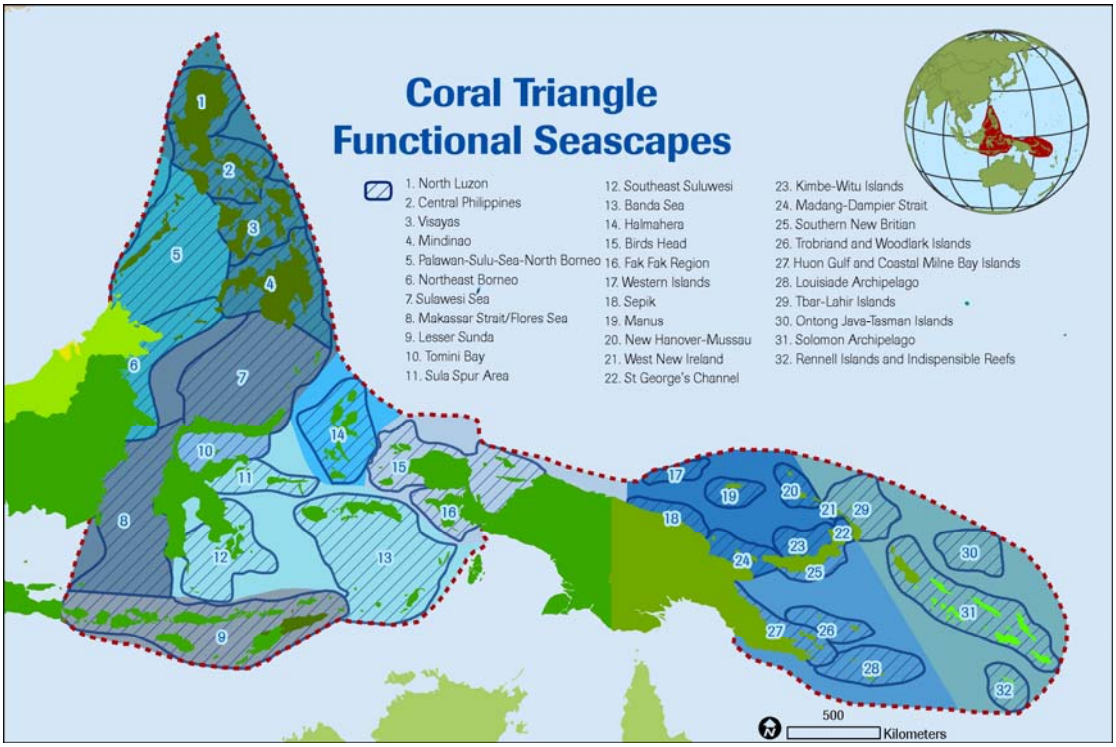

Figure C. Coral Triangle functional seascapes

This is a living document that has and will be updated as new information becomes available. This version includes minor changes to the boundaries of the Coral Triangle, its ecoregions and functional seascapes to be consistent with the Coral Triangle boundary delineated by Veron et al (unpubl. data) and Allen (2007) based on a recent scientific analysis of coral and reef fish biodiversity data. A version history is included to document these and other changes to the report (Annex 2).

Summary statistics (surface areas and coastlines) of the Coral Triangle, its ecoregions, and functional seascapes are provided in Annex 1.

2 Introduction

The global center of marine diversity is known to zoogeographers as the Indo-Australian Archipelago, the East Indian Triangle (Briggs 1999, Allen 2000, Briggs 2005a,b) and, more recently, the Coral Triangle (Werner & Allen 1998, reviewed in Hoeksema 2007). The location of the Coral Triangle is a matter of scientific debate, although most scientists agree that it is located in Southeast Asia and Melanesia, centered on Eastern Indonesia and the Central Philippines (reviewed in Hoeksema 2007).

The coral reefs of Southeast Asia are severely threatened by human activities with more than 80% of reefs at risk from overfishing, destructive fishing practices, and runoff from poor land use practices (Burke et al 2002). By comparison, threats are lower and reefs tend to be in better condition in Melanesia (Bryant et al 1998, Wilkinson 2004).

Over the last 10 to 15 years, The Nature Conservancy has taken conservation action at a number of sites in Southeast Asia and Melanesia. The most comprehensive site-based marine conservation program is at Komodo National Park in Indonesia, where the Conservancy abated destructive fishing practices by supporting the Park authority with planning, financing, awareness raising, surveillance, and alternative livelihood projects. While site based conservation programs such as Komodo National Park can address local threats such as overfishing, destructive fishing practices and issues related to poor land use practices, additional broad scale strategies are now required to address the threat of climate change.

Climate change represents a serious and increasing threat to coral reefs and associated ecosystems around the world (Hoegh-Guldberg 1999; Hoegh-Guldberg et al. 2007). Major threats include rising sea temperatures leading to mass coral bleaching events, rising sea levels threatening coastal habitats (e.g. mangrove forests), and changes in ocean chemistry that may have serious consequences for calcifying organisms such as corals (Hoegh-Guldberg 1999, McLeod and Salm 2006, Hoegh-Guldberg et al. 2007, IPCC 2007).

Over the last few years, The Nature Conservancy and partners have developed principles for designing and managing networks of marine protected areas (MPAs) that are resilient to the threat of climate change (West and Salm 2003, Grimsditch and Salm 2006, McLeod and Salm 2006). The Conservancy was also one of the first to implement these principles by designing a resilient network of MPAs in Kimbe Bay, Papua New Guinea (Green et al 2007). Lessons learned from this experience are now being applied to the design of resilient MPA networks throughout the Coral Triangle, and around the world.

Resilient MPA network design requires a comprehensive approach to selecting priority sites for conservation. The Conservancy's framework for priority setting is usually conducted at the ecoregional level (typically covering tens of thousands to several hundred thousand square kilometres), where systematic conservation planning is used to select a portfolio of sites for conservation action (Groves 2003).

Functional seascapes are smaller areas (generally thousands to tens of thousands square kilometers), nested within ecoregions, where connectivity within functional seascapes is higher than connectivity with surrounding areas. Given their smaller size and high degree of connectivity, functional seascapes provide a practical unit for marine conservation, including the design and implementation of resilient networks of MPAs.

Recently, The Nature Conservancy identified the Coral Triangle as a global priority for conservation. In order to use the Coral Triangle, its ecoregions and functional seascapes as conservation planning units, their boundaries must be clearly delineated. In 2003, The Nature Conservancy convened a group of scientific experts at the Coral Triangle Center in Bali Indonesia, and asked them to use the best available information to achieve consensus on the boundaries of the Coral Triangle, its ecoregions, and functional seascapes.

These boundaries were designed specifically for conservation planning, and were not intended to provide new biogeographic insights. Furthermore, data were incomplete for many locations, and comparisons among different locations were problematic. Consequently, these boundaries were considered a hypothesis for future research, rather than a final product.

Over the last five years (2003 to 2008), these boundaries have been modified and refined as new information became available. The most significant modification was the expansion of the eastern side of the Coral Triangle to include the Solomon Islands.

This document provides a detailed description of the methods used to delineate the Coral Triangle, its ecoregions and functional seascapes. The results provide a blueprint for conservation in the Coral Triangle.

3 Methods

3.1 Expert workshop

Our approach was to bring together 20 local and international scientists with expertise in oceanography and coral reef biogeography (see 8. Participants) at an expert workshop held at The Nature Conservancy's Coral Triangle Center in Bali, Indonesia from April 30 to May 2, 2003. They were tasked with delineating ecologically meaningful boundaries for the Coral Triangle, its ecoregions, and functional seascapes within Indonesia. Before these areas were delineated, definitions for each planning unit were discussed and criteria for boundary delineations defined. Representatives of partner organizations were invited to solicit their input and create a wider understanding of this process.

Rather than trying to apply the same criteria to each planning unit, experts were given the flexibility to apply varying criteria to delineate boundaries. Where experts differed in opinion on the location of a section of a boundary, the issue was discussed and a single boundary identified based on the strongest criteria and best available information. A senior scientist took notes on which criteria were applied to each boundary. A computer with GIS software and digitized coastlines and bathymetric data of the area was connected to an LCD projector to allow for real-time digitizing of information provided by the participants. Sketch maps submitted by participants were also digitized using GIS software. Important digital information available during the workshop included the distribution of coral reefs, the Reefs at Risk database, vegetation types, and the geology of Southeast Asia.

3.2 Subsequent expert advice

During the workshop, the Solomon Islands were identified as a priority area for a Rapid Ecological Assessment, to determine if they should be included in the Coral Triangle. This assessment has now been completed, which demonstrated that the Solomon Archipelago is an area of high biodiversity that should be included in the Coral Triangle (Green et al 2006).

New boundaries for the eastern side of the Coral Triangle, its ecoregions and functional seascapes, were delineated to include the Solomon Islands based on expert advice (see 8. Participants) on the biological and physical characteristics of this area from June to August 2005. Advice was sought from:

- Scientific experts on corals and coral reef fishes, who have experience working in both Papua New Guinea (PNG) and the Solomon Islands. Many of these scientists also participated in the first phase of delineating the Coral Triangle (see 3.1 Expert Workshop).
- Knowledgeable staff in The Nature Conservancy's Pacific Island Countries Program and local partners, who have extensive knowledge of PNG and the Solomon Islands.
- Results of previous planning and priority setting exercises for the Bismarck-Solomon Seas ecoregion (WWF 2003), and the Bismarck Sea ecoregion (Calderon in prep).

Subsequent expert advice (see 8. Participants) was also received regarding:

- Modifying the western boundary of the Coral Triangle to exclude Brunei.
- Adding functional seascapes for the northern Coral Triangle.
- Minor changes to the Coral Triangle, its ecoregions and functional seascapes to be consistent with the Coral Triangle boundary delineated by Veron et al (unpubl. data) and Allen (2007) based on a recent scientific analysis of coral and reef fish biodiversity data.
- Minor changes to the eastern boundary of the Lesser Sunda ecoregion.

4 Coral Triangle Boundary

4.1 Expert workshop

4.1.1 Definition

Based on the best available scientific information, the Coral Triangle is defined as the center of marine biodiversity, which is characterized as an area where more than 500 coral species and a high biodiversity of fishes and other invertebrates are likely to occur in each ecoregion. It includes:

- Portions of two biogeographic regions (Indonesian-Philippines Region, and Far Southwestern Pacific Region: Veron 1995); and
- All or part of five countries: Indonesia, Philippines, Malaysia (Sabah), East Timor, and Papua New Guinea.

4.1.2 Criteria

The primary criteria used to delineate the Coral Triangle were:

- High species biodiversity (where in excess of 500 coral species, a high biodiversity of reef fishes, forams, fungid corals, and stomatopods are likely to occur in each ecoregion) and habitat diversity; and
- Oceanography (currents).

Where insufficient data was available on the primary criteria, the following criteria were also used:

- Geomorphology (type of coastal structure);
- Bathymetry (shallow continental shelf, ocean trenches);
- Sea level fluctuations (on a geological time scale);
- Habitat type (coral reef, exposed coast etc); and
- River discharge.

Criteria specifically excluded:

- Socioeconomic factors;
- Plate tectonics; and
- Volcanic influences (that maybe more relevant for defining smaller scale areas).

4.1.3 Delineation

The boundaries of the Coral Triangle are depicted in **Figure 1** and described in **Table 1**.

4.1.4 Areas excluded from the Coral Triangle

- Vietnam, Japan, and the Great Barrier Reef were not included because coral biodiversity is expected to be less than 500 coral species in each ecoregion.
- The Spratly Islands were not included, because the limited anecdotal information available indicated that the high biodiversity of the Coral Triangle does not extend west to this area.

- Palau was not included for the following reasons: (1) Best available information indicates that coral biodiversity is less than 400 species (recorded to date); (2) fish biodiversity is not as high in Palau as in the Indo-Malayan archipelago (Allen 2003, Myers 1999); and (3) main Indonesian currents and water masses do not extend to main Palauan Islands. However, the following arguments were brought forward to include Palau: (1) faunal affinities between the western equatorial Pacific (including Palau) and the Togean Islands, Sulawesi (Wallace et al 2000, pers. comm.); (2) high fungid coral diversity (Hoeksema pers. comm.); and (3) proximity of Helen Reef (Southwest Islands, Palau) to the Halmahera Eddy. As more information on the biogeography of the Indo-Malayan archipelago and the Pacific islands become available, the delineation of the Coral Triangle in this area may need to be revised.
- The Nicobar and Andaman Islands (west of Coral Triangle) were not included because they have much lower coral and foram diversity (fungid diversity is comparable to Sumatra).
- The far west tip of Sumatra was not included because while anecdotal information indicates that this is a good area for diving (good water quality), there is no data available on biodiversity.
- Pulau Seribu was not included because there is good data available for this area, which indicates that biodiversity is lower than in the Coral Triangle. However, it is important to note that human activities may have altered the pattern of biodiversity in this and other areas (i.e. some stomatopod species appear to have disappeared from here).

4.1.5 Differences in boundaries based on different taxa

Even though the boundaries of the Coral Triangle were based primarily on high coral biodiversity (where more than 500 species are expected to occur in each ecoregion), this area is nearly identical to the area of greatest biodiversity for coral reef fishes. In contrast, the boundaries may have been different if they had been based primarily on other taxa (see review in Hoeksema 2007). Two examples discussed during the workshop were:

- If the boundaries had been based primarily on foram species diversity, the Coral Triangle would have extended further north to include Japan. However, Japan was not included due to the lower coral diversity in that area (<500 coral species).
- If the boundaries had been based on mangrove biodiversity, they would have extended further west and south (to include northern Australia) and not as far North.

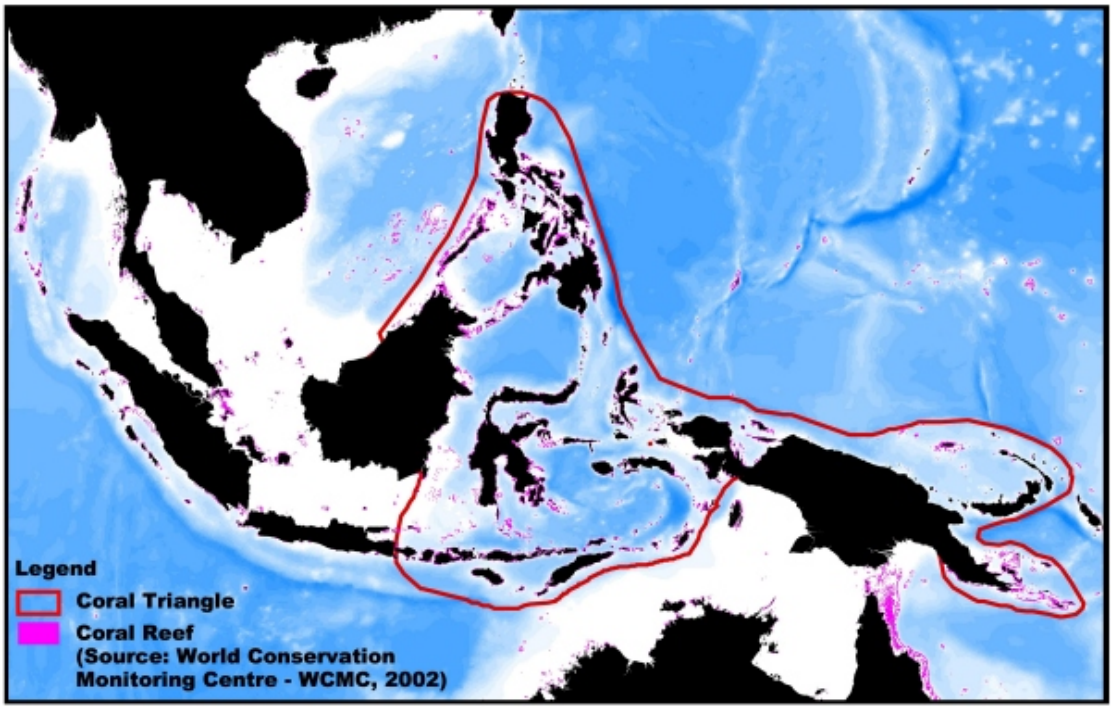

Figure 1. Coral Triangle boundary as delineated by the expert workshop in 2003.

Figure 2. Coral Triangle boundary as delineated by the expert workshop in 2003, and modified based on subsequent expert advice from 2005 to 2008.

Table 1. Description of the Coral Triangle boundaries as delineated by the expert workshop in 2003, and criteria used to define each boundary section.

(Note: please read boundaries in sequence).

Boundary	Criteria
Starting on the southwest coast of Papua and extending south and west along the southern side of the Sunda, Sumba, Timor and Kei Islands to the southeastern end of Java	Based on biodiversity. bathymetry and oceanography (follows the contours of the Arafua Shelf, excluding the Arafua Sea and Aru Island). It was unclear whether Timor should be included on the basis of biodiversity, and a decision was made to include it on the basis of its proximity to better studied areas.
Extending north from the northeastern tip of Java (Banyuwangi) to the southeast side of Kalamantan, and then north along the eastern coast of Kalimantan	This boundary is based on biodiversity and bathymetry: it follows the eastern edge of the Sunda shelf and the eastern coast of Kalimantan, where biodiversity is higher than to the west. Water movement is also more restricted on the eastern side of this line.
Extending northeast from the northwestern side of Kalamantan towards the Philippines	No biodiversity information was available for this area. The starting point on the northwest side of Kalimantan was based on the presence of a continental shelf and fringing reefs in that area.
Extending north along the western side of Palawan Island, Philippines	This boundary is based on oceanography. There was insufficient biological data available to extend the boundary further west on the basis of biodiversity. Limited anecdotal information available suggests that the area of high biodiversity in the Coral Triangle may not extend west to Spratly Islands.
Extending north to the northern part of Luzon Island along the western side of the Philippines	This boundary does not extend to the top of Luzon Island, because limited available information indicates that this is an area of low diversity (due to exposed coastlines and cold water temperatures). This boundary is likely to be moved further south along the island of Luzon when more information becomes available.
Extending south from Luzon Island along the eastern side of the Philippines and Halmahera Island, Indonesia	This boundary is based on patterns of biodiversity, oceanography and bathymetry (the boundary follows the western side of Mindanao Trench).
Extending from east of Halmahera Island across the north side of Papua and Papua New Guinea, extending as far east as the Bismarck Sea and its islands.	This boundary is based primarily on coral biodiversity and oceanography (including the Bismarck Sea).
Extending south from the Bismarck Archipelago (following the New Britain Trench) to include the Milne Bay Area and the Louisiade Archipelago, and continuing west to include Motupore Island.	This boundary is based primarily on patterns of coral biodiversity and bathymetry. The western extent of the boundary in the Gulf of Papua marks the western boundary of reef development due to river inflow in the area (deltaic area).

4.2 Subsequent expert advice

4.2.1 Eastern expansion to include the Solomon Islands

After completion of the Solomon Islands Marine Assessment, the boundary of the Coral Triangle was moved further east to encompass the main island chain in the Solomon Islands (**Figure 2**). The boundary was also extended to include other areas in PNG and the Solomon Islands, which are likely to form part of the Solomon Archipelago ecoregion (**Figure 6**; see also **Figure 7**) including:

- Ontong Java and associated reefs north of the main island chain, and Rennell Island and Indispensable Reefs south of the main island chain in the Solomon Islands; and
- Offshore reefs and atolls east of New Ireland in PNG (Tabar, Lihir, Tanga, Feni, Green, and Malum Islands, and Lyra Reef), which comprise the northeast portion of the Bismarck-Solomons Archipelago.

The Santa Cruz Islands southeast of the main Solomon Island Chain (**Figure 7**) were not included, since they are remote from the Solomon Archipelago and are unlikely to form part of the same ecoregion.

As a result of these modifications to the eastern boundary of the Coral Triangle, the boundary now coincides more closely with that used to delineate the eastern extent of the Bismarck Solomon Sea ecoregion defined by WWF (2003: **Figure 3**).

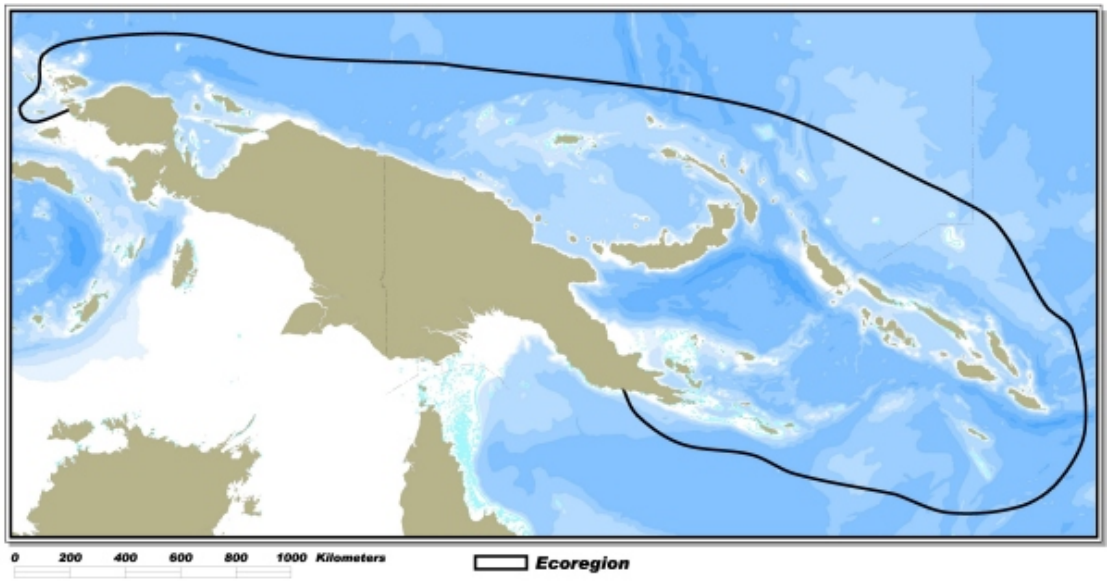

Figure 3. Bismarck Solomon Seas ecoregion boundary (WWF 2003).

4.2.2 Modification to the western boundary to exclude Brunei

Very little biological information is available for the northwest coast of Borneo. At the expert workshop, the western boundary of the Coral Triangle was drawn based on physical characteristics of this area, specifically: the presence of a continental shelf and fringing reefs in Brunei, and their proximity to high diversity reefs in Sabah with no apparent barrier in between (there is a barrier reef complex that extends along the northwest side of Borneo from Sabah to Brunei). There is no major reef development along the coast of Borneo southwest of Brunei.

While the biodiversity of this area is not well known, recent scientific advice suggests that the coral reefs of Brunei have lower biodiversity than the reefs of Sabah and should not be included in the Coral Triangle (Allen 2007, Veron et al unpubl. data). Preliminary surveys indicate that the Pulau Banggi region at the northernmost tip of Borneo may represent the westernmost area of the Coral Triangle (Hoeksema et al in prep).

On this basis, the boundary was moved northeast along the northwest coast of Borneo to coincide with a distinctive physical feature (Tansong Simpank) on the northwest tip of Borneo and the western boundary of the Sulu Sea, thereby excluding the portion of the South China Sea previously included along the northwest coast of Borneo (including Brunei) and including the Palau Bangaii region of Sabah.

4.2.3 Modifications to be consistent with recent scientific analyses of coral and reef fish biodiversity data

Minor changes were made to the Coral Triangle boundary to be consistent with the Coral Triangle boundary delineated by Veron et al (unpubl. data) and Allen (2007) based on a recent scientific analysis of coral and reef fish biodiversity data.

5 Ecoregions

5.1 Expert workshop

5.1.1 Definition

An ecoregion is defined by WWF, and adopted by this group, as: “a large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions”. The boundaries of an ecoregion are not fixed or sharp, but rather encompass an area within which important ecological and evolutionary processes most strongly interact.

5.1.2 Criteria

The primary criteria used to identify ecoregions were:

- Geographically distinct areas;
- Distinct natural communities and species; and
- Environmental conditions (e.g. currents, sea surface temperatures, salinity, bathymetry).

Though workshop participants agreed on these criteria, it was difficult to apply them to subdivide the Coral Triangle into ecoregions because much of the required information on natural communities and species was not available. The best available information was the draft ecoregion map prepared for coral reef fishes by Dr Gerry Allen (**Figure 4**). These ecoregions were based on biological factors (primarily the presence of highly localized endemic fish species) rather than physical oceanographic factors.

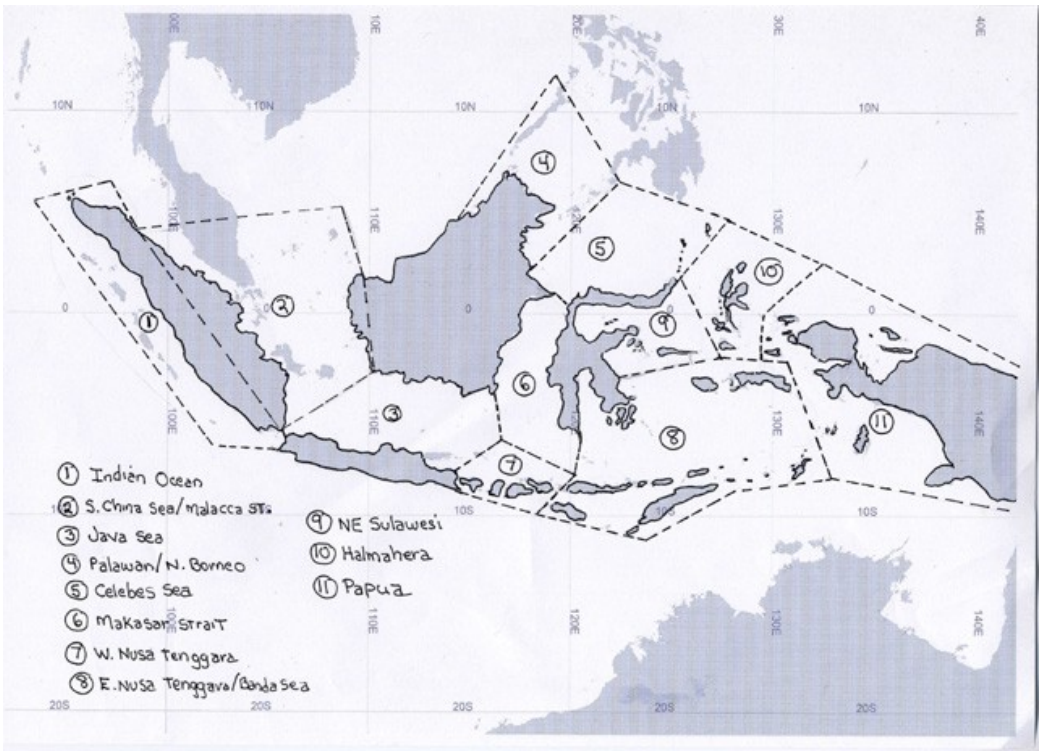

Figure 4. Draft marine ecoregions of Indonesia based on the distribution of coral reef fishes (Allen, unpubl data).

The workshop participants agreed to use coral reef fishes as the basis for delineating the ecoregions of the Coral Triangle because:

- the data were considered to be of high quality;
- the data encompassed a relatively large number of locations in the Coral Triangle;
- there were no comparable datasets available for other taxa; and
- there are more fish species and endemics than for other taxa (e.g. corals, forams etc), which allows for a higher level of resolution among ecoregions (see below).

Furthermore, Roberts et al (2002) analyzed the geographic distributions of 2000 species of coral, lobsters, mollusks, and fishes, which are the main indicator groups utilized to date. They found fishes to be by far the best "flagship" for showing overall trends of endemism and general biodiversity, particularly at local and regional scales. This is because numerous fishes have limited dispersal capabilities and consequently have relatively restricted geographic distributions. Birds have been similarly used for rallying support for terrestrial conservation (Stattersfield et al. 1998). Like their avian counterparts, fishes are finely adapted to a complex combination of environmental factors, of which food and shelter are particularly important. Therefore, the local or regional fish community provides a useful gauge of both habitat and overall species diversity.

5.1.3 Delineation

Working from Allen's ecoregional classification based on reef fishes (**Figure 4**), workshop participants agreed to adopt the following process:

1. Modify the ecoregions where there was convincing evidence to do so based on other biological (e.g. other taxa such as corals, forams, stomatopods etc) and/or physical (e.g. currents and water masses) information.
2. Delineate ecoregions for areas of the Coral Triangle (Papua New Guinea and the Philippines) that were not included in Allen's ecoregionalisation using coral data as the primary criteria, since it was the best available information for those areas (in the absence of the fish data).
3. Send the revised ecoregions to Dr Allen for comment, who was unable to attend the workshop, to produce a consensus view among the workshop participants and Dr Allen.

Allen (unpubl data) proposed 11 ecoregions in Indonesia based on coral reefs fishes (**Figure 4**). Eight of these ecoregions are located within the Coral Triangle as defined by this workshop, and were included in this assessment: Palawan/North Borneo; Celebes Sea; Makassar Strait; West Nusa Tenggara; East Nusa Tenggara/Banda Sea; Northeast Sulawesi; Halmahera; and Papua. The other three were outside the Coral Triangle (Indian Ocean, South China Sea/Malacca Strait; and Java Sea), and were excluded from this assessment.

Four ecoregions were added to encompass the areas not included in the Allen's fish ecoregions, using corals as the primary criteria for selection. They were: Bismarck Sea (in the absence of biological data for the area, the western boundary of this ecoregion was located at the mouth of the Mamberamo River); Milne Bay Area; Southeast PNG; and Eastern Philippines (including Mindanao, Visayas, and Luzon). The Eastern Philippines was considered distinct in terms of reef morphology and coral diversity (areas with complex morphology have high coral diversity, but the rest have lower coral diversity than Palawan).

The results of this analysis are summarized in **Figure 5** and **Table 2**.

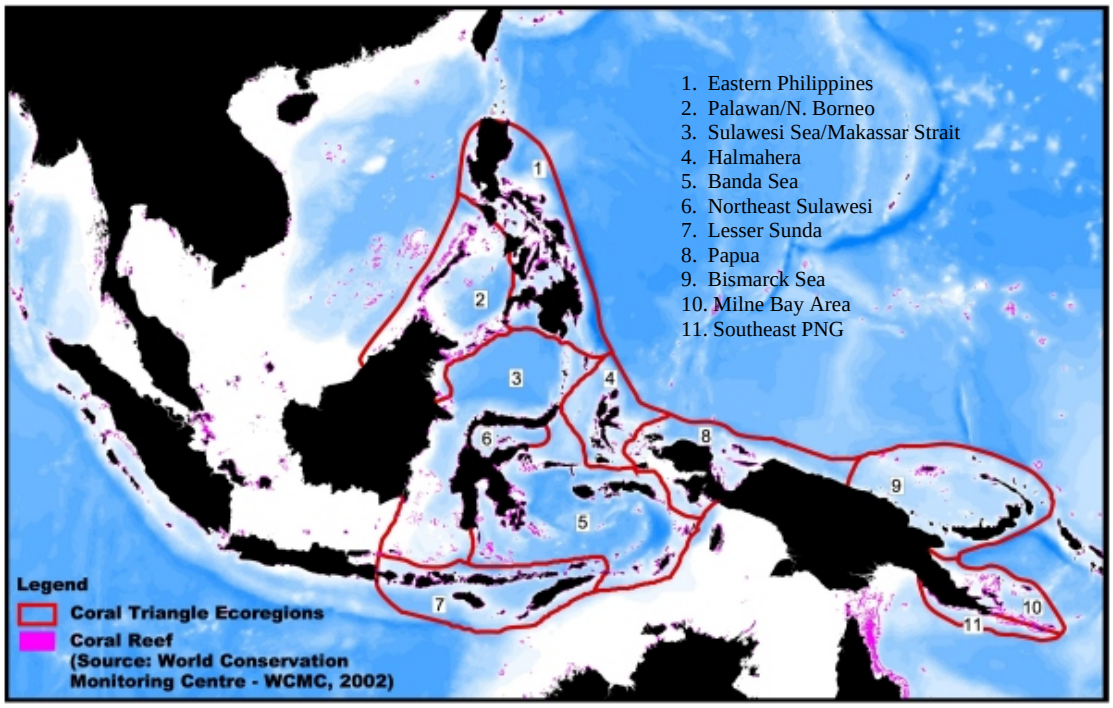

Figure 5. Coral Triangle ecoregions as delineated by the expert workshop in 2003.

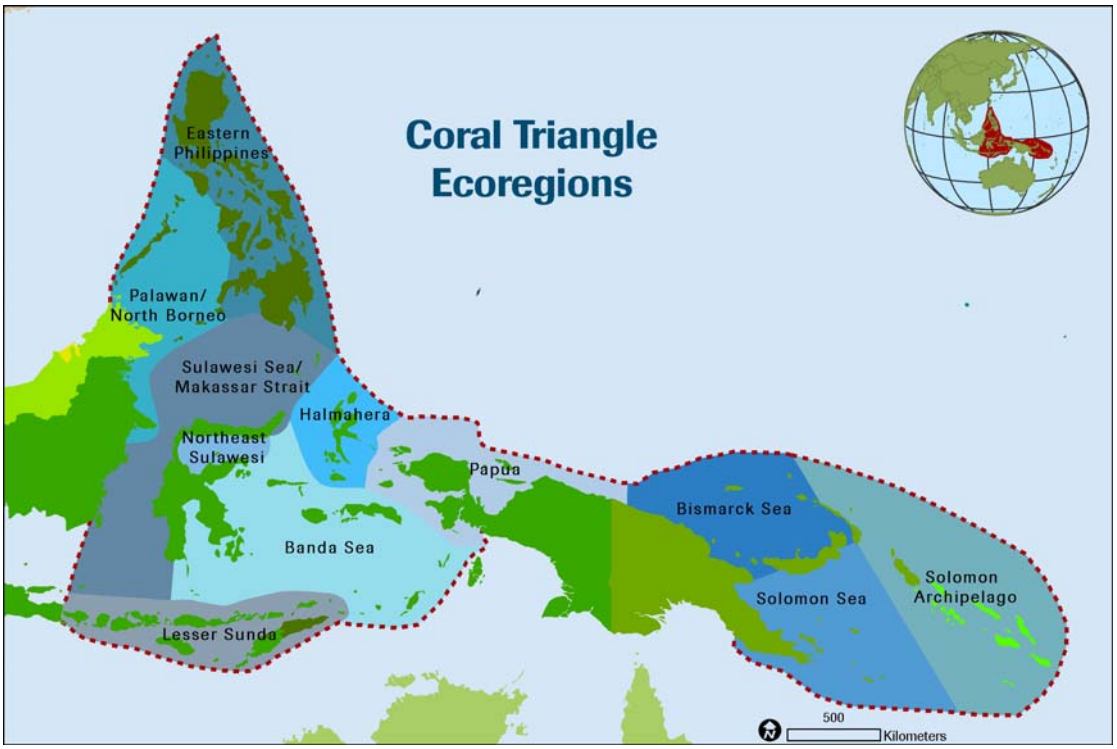

Figure 6. Coral Triangle ecoregions as delineated by the expert workshop in 2003, and modified based on subsequent expert advice from 2005 to 2008.

Table 2. Modifications to the ecoregions proposed by Allen (unpubl data), and the rationale for these modifications (cf. **Figure 4** and **Figure 5**).

Modification to ecoregion(s)	Rationale
Join two ecoregions: Celebes Sea and Makassar Strait.	*Oceanography*: strong current flow (Indonesian throughflow) between Sulawesi Sea and Makassar Strait.
	Biology: Limited biological data based on stomatopods indicates good genetic exchange between these two areas.
Split East Nusa Tenggara/Banda Sea ecoregion in two ecoregions: north and south of the Lesser Sunda, Sumba, Timor and Kei Islands. The southern part of the ecoregion should then be combined with the West Nusa Tenggara ecoregion to form the Southern Transition Zone. [1]	*Environmental conditions*: The southern side of these islands is an important transition zone with the Indian Ocean, which encompasses a wide range of environmental conditions, including high energy/exposed areas and strong currents.
	Oceanography: There are different water masses north and south of these islands. Water moves from north to south through the straits between the islands, but there is not a lot of water exchange in the opposite direction.
	Biological: The transition zone has distinct faunal elements, including endemic stomatopods, and distinct foram and coral assemblages (low coral diversity due to high exposure and currents).
	Note that some participants felt that further field research should be conducted to assess whether the Banda Sea ecoregion should be divided in an Eastern and Western part.
Modify NE Sulawesi ecoregion to include Tomini Bay only, and include the rest in the Banda Seas ecoregion.	Tomini Bay is a localized area of endemism. Banggai Islands also have endemic species (different to those in Tomini Bay), but it is unclear how far south they extend. This requires further investigation, and the Banggai islands should remain part of the Banda Sea ecoregions for now.
Move the boundary of the Papua region further east to exclude the Kei Islands	*Geography*: These islands are attached to other two strings of islands to the west and north (i.e. they are part of outer Banda Arch).
Move the northern border of W Nusa Tenggara ecoregion (now Southern Transition Zone) further south to exclude the Postiljon/Sablana Islands.	These islands appear to be more closely connected to the other islands in the southern Makassar Strait.
Modify the southern boundary of Palawan/North Borneo ecoregion to follow the natural boundaries (trench)	*Bathymetry*

[1] While this southern area may be a distinct ecoregion in the Coral Triangle, it is recognized that the entire ecoregion is not captured here (it extends further south into Indian Ocean, with links to northwestern Australia, which was not included in Coral Triangle due to its lower diversity).

5.2 Subsequent expert advice

5.2.1 Revised ecoregions for the eastern Coral Triangle

Three ecoregions were identified for the eastern side of the Coral Triangle (Papua New Guinea) in the expert workshop (**Figure 5**). Two of these ecoregions have been retained with some modifications (**Figure 6**, see also **Figure 7**):

- Bismarck Sea: The southern and eastern boundaries have been moved further north and west respectively, to coincide with the large islands of New Britain and New Ireland. As a result, this ecoregion now comprises the area enclosed by the north coast of the main island of New Guinea, and the offshore island arch of New Britain, New Ireland, and Manus and associated reefs and islands, known as the Bismarck Sea. The southern boundaries across the Dampier Strait and St George's Channel were placed at the southern end of these major channels, since the reef types are known to change at Cape Merkus at the southern end of the Dampier Strait (southwestern end of New Britain), with a similar pattern observed for St George's Strait. The areas previously included in this ecoregion to the east of New Ireland and south of New Britain, have now been included in the Solomon Archipelago and Solomon Seas Ecoregions respectively.

- Milne Bay Area: The eastern extent of the Milne Bay Area Ecoregion has been moved further east to include Pocklington Reef, which is likely to have closer affinities to the Milne Bay Area than with the Solomon Islands. The northern boundary of this ecoregion was also moved further north to coincide with the island of New Britain, based on current information for the area (AIMS 2005). As a result, the southern coast of New Britain and the northern part of the Solomon Sea are now included in this ecoregion. The southern boundary was also moved further south to include the entire Louisiade Archipelago in this ecoregion. This was consistent with this area being designated as a functional seascape (**Figure 9**), which should not be divided among ecoregions. Since this ecoregion has now been expanded beyond the Milne Bay Area, its name has been changed to the Solomon Sea Ecoregion.

The third ecoregion identified in the expert workshop, Southeast PNG (**Figure 5**), has been incorporated in the Solomon Seas ecoregion (see 4. Coral Triangle above).

A new ecoregion has been added for the Solomon Archipelago (**Figure 6**), which includes the main island chain (from Makira in the south to Bougainville in the north) and three offshore island groups (see **Figure 7**):

- Ontong Java and associated reefs north of the main island chain, and Rennell Island and Indispensable Reefs south of the main island chain in the Solomon Islands; and

- Offshore reefs and atolls east of New Ireland in PNG (Tabar, Lihir, Tanga, Feni, Green, and Malum Islands, and Lyra Reef), which comprise the northeast portion of the Bismarck-Solomons Archipelago.

The delineation of the Solomon Archipelago ecoregion was largely based on the Solomon Island Marine Assessment (Green et al 2006), which surveyed most of the main island chain (except Bougainville). The other islands and reefs were included because they appear to be part of the same ecoregion as the survey area, due to their proximity and the absence of an apparent natural barrier between them. However, it is important to recognize that there are strong faunal similarities between the Solomons Archipelago and Solomon Sea Ecoregions (**Figure 6**), and these ecoregions may be combined in future (pending further studies).

5.2.2 Modification to the Palawan/North Borneo ecoregion

The southwest boundary of this ecoregion (**Figure 5**) was modified (**Figure 6**) to coincide with the new western boundary of the Coral Triangle (**Figure 2**) as described in Section 4.2.2 (modification to the western boundary to exclude Brunei).

5.2.3 Modifications to be consistent with recent scientific analyses of coral and reef fish biodiversity data

Minor changes were made to the Coral Triangle ecoregions to be consistent with new Coral Triangle boundary (see Section 4.2.3) as delineated by Veron et al (unpubl. data) and Allen (2007) based on a recent scientific analysis of coral and reef fish biodiversity data.

5.2.4 Minor changes to the eastern boundary of the Lesser Sunda ecoregion

Minor changes were made to the eastern boundary of the Lesser Sunda ecoregion, because it bisected Pulau Moa in Kepulauan Leti (**Figure 5**), which includes Pulau Leti, Pulau Moa and Pulau Lakos. This boundary was moved further east to include all of this island group (**Figure 6**), based on the bathymetry and hydrodynamics of the area.

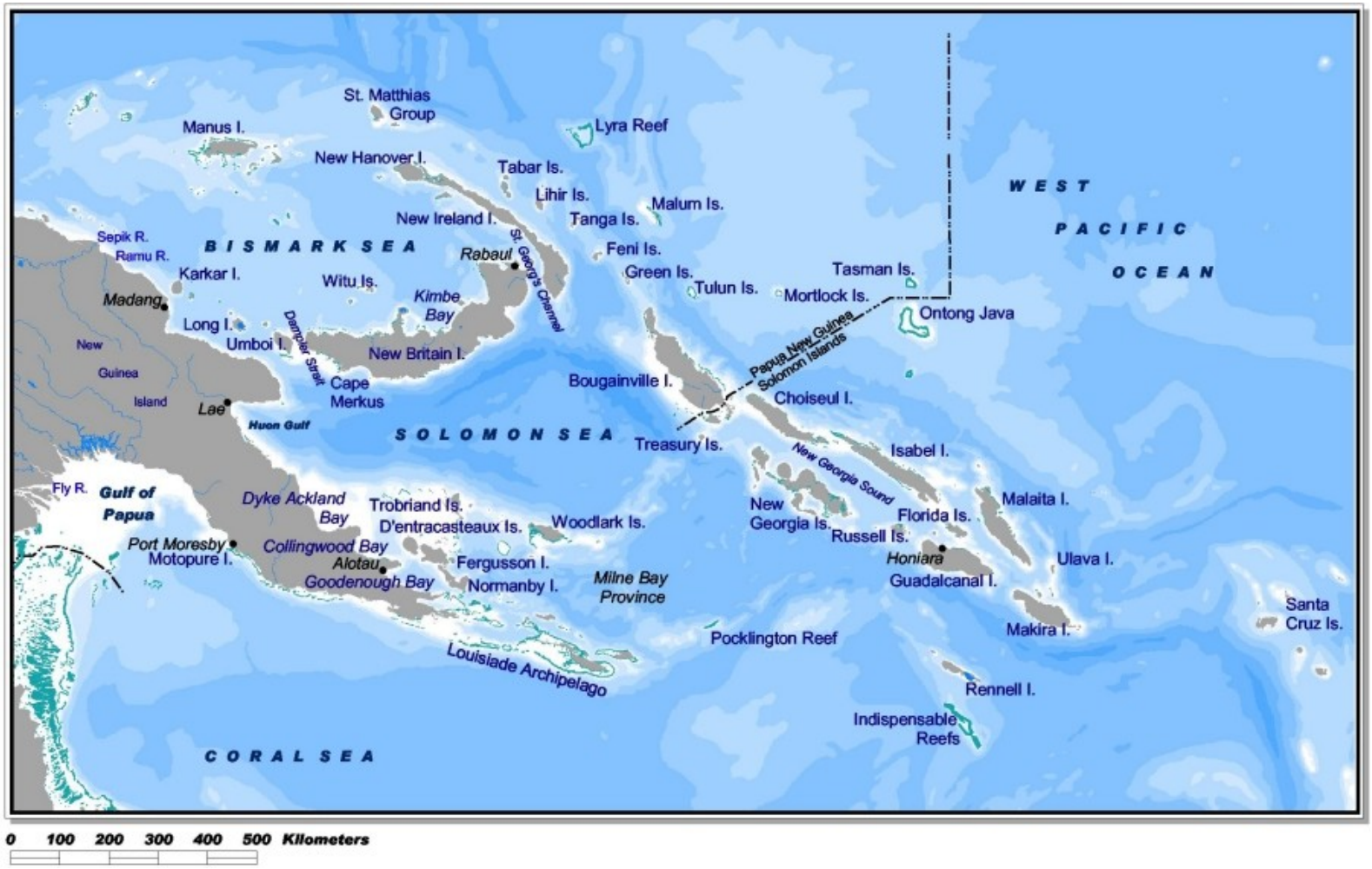

Figure 7. Geographic features of the eastern side of the Coral Triangle.

6 Functional Seascapes

6.1 Expert workshop

During the expert workshop, functional seascapes were identified for the ecoregions within Indonesia.

6.1.1 Definition

Functional seascapes were defined in the workshop "Coral Bleaching Targeted Research" hosted by the Australian Institute of Marine Science and CRC Reef Research Center (March 2002) as "areas within a wider ecoregion within which there is some geographical or ecological distinctiveness, but over a smaller area that maybe more suitable for the application of management measures such as MPA networks".

6.1.2 Criteria

The primary criteria used to identify functional seascapes were:

- Geographic integrity (contiguous areas with similar habitats, communities and species);
- Good connectivity within areas (within and among ecosystems)[2];
- Environmental factors that may help explain how species are distributed. or that may be required for biological values to continue to survive under normal ranges of variability (e.g. wave or current energy regimes)
- Shared ecological characteristics among sites within the functional seascape (such as particularly high biodiversity, or the importance of the area for a particular species group)
- Scale: 100s of kilometers across
- Areas comprising coral reefs and associated ecosystems.

Socioeconomic and political factors will be considered later in the conservation planning process (during ecoregional assessments and MPA network design).

6.1.3 Delineation

Eleven functional seascapes were delineated in Indonesia (
Figure 8, **Table 3**).

[2] The intention during the delineation process was to define areas where connectivity within the seascape is higher than connectivity with surrounding areas. Because of the high connectivity in the marine environment, it is not always possible to define planning units that comply fully with this design principle. For instance, the Sulawesi Sea is highly connected with the Makassar Strait because of the Indonesian throughflow, and therefore a separation between the Sulawesi Sea and the Makassar Strait is somewhat arbitrary. Tomini Bay, however, is fairly well contained, as demonstrated by differences in endemism between Tomini Bay and the adjacent Banggai Islands.

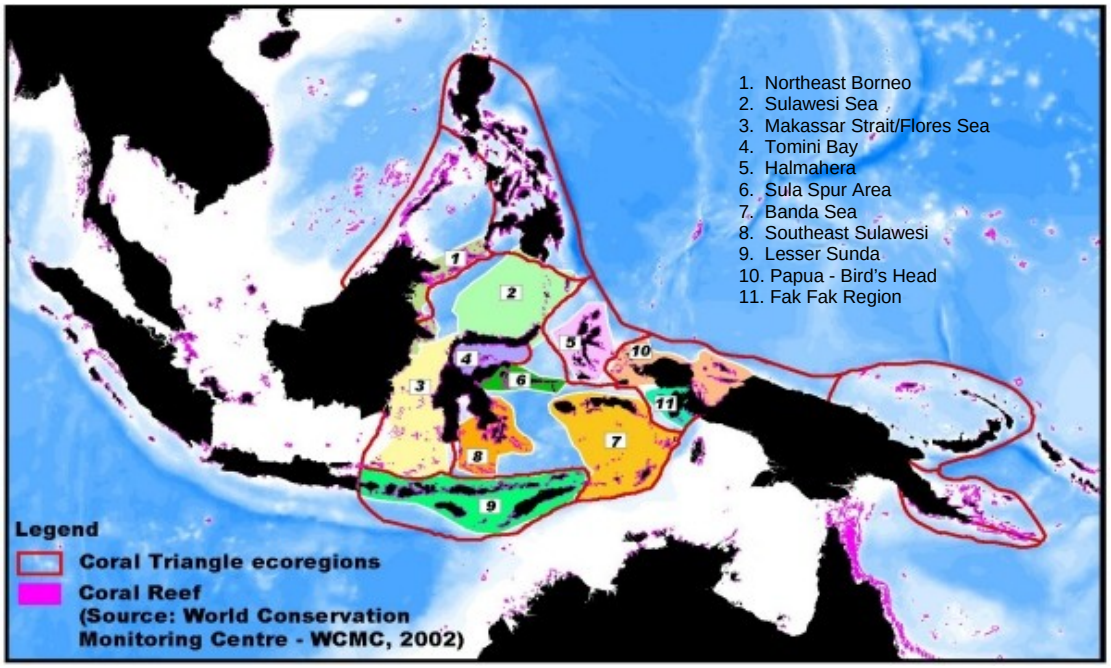

Figure 8. Functional seascapes in Indonesia as delineated by the expert workshop in 2003.

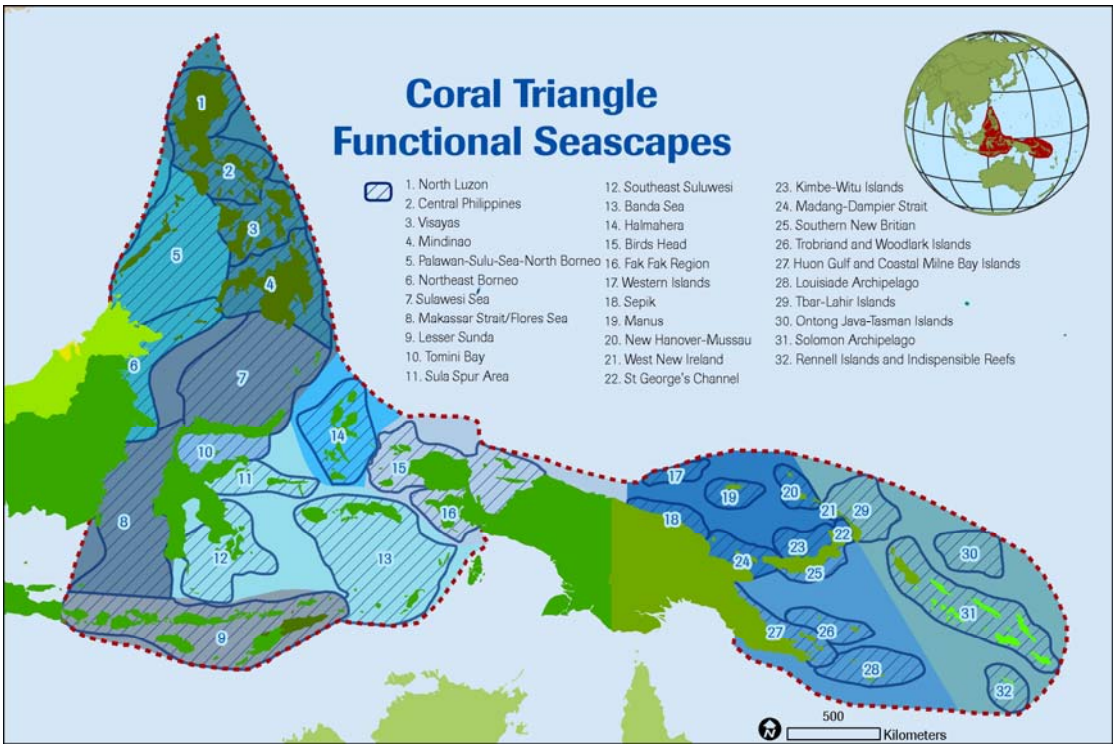

Figure 9. Functional seascapes for the Coral Triangle as delineated by the expert workshop in 2003, and modified based on subsequent expert advice from 2005 to 2008.

Table 3. Functional seascapes in Indonesia, and criteria used for their delineation, as delineated by the expert workshop in 2003.

Functional seascape	Criteria
Northeast Borneo	*Geographic integrity* based on Borneo coastline, adjacent islands and bathymetry (shelf edge). Area includes: - Part of the east coast of Kalamantan and Sabah (includes Tawitawi Island, which is the border between these two countries) - Offshore Islands: Derawan and Berau Islands, Sulu Archipelago - Natural southern boundary defined by large river mouth (Mahakam River) *High connectivity:* - Continuous coastline - Likely one way connectivity with major currents from north to south (Indonesian throughflow) - Also inshore countercurrents moving north and connecting reefs on either side Mankalihat Peninsula - Gyre in Sulawesi Sea *Environmental factors*: Upwelling *Ecological characteristics:* - High species diversity - High habitat diversity with a variety of reef types (atolls, barrier and fringing reefs) including a unique habitat type (marine lakes) - One of most important green turtle nesting areas in the world - Sightings of whale sharks by fishermen
Sulawesi Sea	*Geography integrity:* North Sulawesi coastline up to and including Sangihe and Talaud Island Chains, and as far north as southern tip of Mindanao Island (Philippines) *Ecological characteristics:* - Very important area for cetaceans - Coelacanths - Dugongs - Pelagic fish populations - Very high habitat diversity ranging from very protected straits to upwelling areas, volcanic slopes, steep wall drop-offs, lagoons, coastal fringing reefs - Bunaken National Park has steep reef drop-offs with high diversity of sponges, soft corals and ascidians
Makassar Strait/Flores Sea	*Geographic integrity*: includes east Kalamantan, Makassar Strait, Southwest Sulawesi, and Flores Sea. Specific areas include: - Postiljon/Sablana - Baling Balingan/Paternoster Islands/Northern Sunda Shelf Barrier Reef - Spermonde/Sangkarang Archipelago *High connectivity:* - Strong current running north to south via Indonesian throughflow - Some east to west flow also - Very long contiguous coastline *Ecological characteristics:* - Cetacean migration through straits - Rich species diversity due to onshore/offshore gradients and environmental factors - High habitat diversity: river mouths, carbonate shelf barrier reef systems, huge Halimeda banks

Functional seascape	Criteria
Tomini Bay	*Geographic integrity*: natural unit within a bay *High connectivity* within and among ecosystems: - large contiguous reefs - oceanography (currents) *Ecological characteristics* - high species diversity and endemism (Togean Islands) - variety of reef types (atolls, barrier and fringing reefs)
Halmahera	*Geographic integrity:* - Halmahera and adjacent islands - Unsure whether to include Tifore Island (included for now) *High connectivity:* - Strong currents - Current patterns suggest that Halmahera and the Papua - Bird's Head seascape are linked (see below) *Environmental factors* - Extensive small islands - Chain of volcanoes and seamounts on southwest side - East side very exposed to Pacific Swell - Southwest side very protected (and very different coral communities) *Ecological characteristics* - High habitat diversity because high variation in environmental factors (see above) - Unique feature in Kao Bay: very deep, restricted water flow, bordering on anoxic, frequent red tides - Whale sharks in Kao Bay - Fish and stomatopod endemic species - Coral diversity unknown, but expected to be high
Sula Spur Area (including Banggai Islands)	*Geographic integrity:* - Central Sulawesi coast and adjacent islands - Sula Spur Area and Banggai Islands *Environmental factors:* - Complex coastline on Banggai Islands - Taliabu Island runs east west, and is hit by monsoons from both directions. - Geologically active: major earthquake in 2000 *Ecological characteristics:* - Habitat diversity (including highly enclosed bays and marine lakes on south side of Taliabu Island) - Two endemic species of fish (one a mouth brooding cardinal fish) - High coral diversity (cf. survey by Conservation International in this area).
Banda Sea	*Geographic integrity*: Banda Sea and Islands (Seram and Beru, Banda and Kei Islands) *Connectivity*: unclear *Environmental factors*: upwelling and downwelling area in Banda Islands *Ecological characteristics* - Anecdotal reports (by dive operators) of one of the largest fish spawning areas in Indonesia at Pulau Koon - Banda Islands have a fairly low habitat and species diversity (based on REA) - This functional seascape may be very important for Cetaceans

Functional seascape	Criteria
Southeast Sulawesi	*Geographic integrity*: southeast coast of Sulawesi and offshore islands. *High connectivity*: very complex currents (presume good mixing in this area) *Ecological characteristics:* - High density of reefs - High diversity of reef types - High species diversity - Major migration corridor for Cetaceans.
Lesser Sunda	*Geographic integrity*: transition zone where Indian Ocean and Indonesian faunas mix. *Good connectivity*: complex currents *Environmental factors*: Highly variable environment - High energy - Upwellings - High temperature variation *Ecological characteristics:* - Extremely high habitat diversity - High species diversity and endemism - Cetacean migration corridors. - Manta aggregations - Transient fish spawning aggregations - Reefs resilient to bleaching - Turtle nesting sites
Papua - Bird's Head	*Geographic integrity*: - Northwest coast of Papua and adjacent islands. - Boundary between Gebe and Gag Islands based on limited information: fish data (G. Allen unpubl data), current data (see below); the islands are also thought to be geologically different. *High connectivity:* Currents predominately run east to west via the south equatorial current until they run into Halmahera and form the Halmahera eddy. Therefore, this seascape is well connected to the Halmahera Seascape (but the connection between Raja Ampat and Cenderawasih is higher). A minor part of the south equatorial current also flows south through Gebe and Gag Islands (via a deep channel between these islands) to the southern part of this seascape. Cenderawasih Bay is important connection between PNG reefs and Raja Ampat. *Environmental factors:* - The whole area is a transition zone between the Pacific Ocean and Indonesian Seas - Strong gradient in exposure - Geologically active: Cenderawasih area was affected by a major earthquake in mid to late 1990s *Ecological characteristics:* - Very high habitat diversity. - Raja Ampat has very high species diversity and a high level of endemism: - It is the area with the highest biodiversity in the Coral Triangle (75 % of the world's coral species found here), and 5-6% of all coral species found here have not been found anywhere else. - Cenderawasih Bay is less well-studied, but may be similar to Raja Ampat. - Biggest leatherback nesting areas in the world in the North of Bird's Head.

Functional seascape	Criteria
Fak Fak Region	*Geographic integrity:* southwest Papua around large Baerau-Bintuni Bay *Connectivity and environmental factors*: - Big tides ~2m vertical tide difference; dominated by tidal currents in Bay - Huge freshwater outflow in Baerau-Bintuni Bay *Ecological characteristics:* - Data on reef systems are scarce, but anecdotal reports from dive tourism industry indicate that reefs are in good condition. More information may become available in near future due to BP environmental assessments - Baerau open coral reef area - Bintuni extensive mangroves - Sightings of cetaceans

6.2 Subsequent expert advice

6.2.1 Addition of functional seascapes for the eastern Coral Triangle

Sixteen functional seascapes were identified on the eastern side of the Coral Triangle in PNG and the Solomon Islands (**Figure 9**, **Table 4**), using the same criteria applied during the expert workshop (see 6.1.2 Criteria above). Geographic locations referred to in **Table 4** are provided in **Figure 7**.

6.2.2 Addition of functional seascapes for the northern Coral Triangle

Functional seascapes were not delineated for the northern Coral Triangle during the expert workshop. They have subsequently been defined based primarily on advice provided for coral reef fishes by Dr Gerry Allen (unpubl. data), taking into account endemic species integrity, regional/provincial boundaries that reflect commonality of habitat based on geography (i.e. natural island grouping), and the delineation of areas at an appropriate scale for MPA network design (G. Allen pers. comm.).

Five new functional seascapes were identified for two northern ecoregions: Eastern Philippines and Palawan/North Borneo (**Figure 6**). They were: North Luzon, Central Philippines, Visayas, Mindanao and Palawan-Sulu Sea (**Figure 9**). Another functional seascape, Northeast Borneo, was identified for the Palawan/North Borneo Ecoregion during the expert workshop (**Figure 8**, **Figure 9**). Functional seascapes have now been identified for all ecoregions throughout the Coral Triangle.

6.2.3 Modifications to be consistent with recent scientific analyses of coral and reef fish biodiversity data

Minor changes were made to the functional seascapes (**Figure 8**, **Figure 9**) to be consistent with the new ecoregional boundaries (Section 5.2.3) modified to be consistent with the new Coral Triangle boundary (Section 4.2.3) as delineated by Veron et al (unpubl. data) and Allen (2007) based on a recent scientific analysis of coral and reef fish biodiversity data

6.2.4 Minor changes to the eastern boundary of the Lesser Sunda functional seascape

Minor changes were made to the eastern boundary of the Lesser Sunda functional seascape (**Figure 8**, **Figure 9**) to coincide with the changes made the eastern boundary of the Lesser Sunda ecoregion (Section 5.2.4).

Table 4. Functional seascapes, and criteria used for their delineation, in Papua New Guinea and the Solomon Islands based on expert advice in 2005.

Functional seascape	Criteria
Sepik River Area	North coast of PNG influenced by outflows from large river systems (Sepik & Tamu Rivers).
Western Islands	Oceanic coral atolls on the northwest side of the Bismarck Sea.
Manus Island Group	Large island and associated volcanic and coral atolls. Strong oceanic influences from the Bismarck Sea, with some influence of the Western Pacific Ocean.
Madang-Dampier Strait	North coast of PNG that experiences oceanic influences from the Bismarck Sea, and major currents from the Dampier Strait (exchanging water with the Solomon Sea).
New Hanover-St. Matthias Group	Large islands and associated volcanic and coral atolls that experience oceanic influences from both the Bismarck Sea and Western Pacific Ocean.
Kimbe-Witu Islands	Coastal and offshore reefs that experience oceanic influences from the Bismarck Sea, but are not influenced by currents from the major straits either side of New Britain (Dampier Strait and St. George's Channel).
West New Ireland	Narrow fringing reefs in calm protected waters of the Bismarck Sea, which experience little oceanic influence and no major currents.
St George's Channel	Strongly influenced by currents in major strait between Bismarck and Solomon Seas. Also experience volcanic influences in some locations, particularly around Rabaul.
South New Britain	Coastal fringing reefs in very deep water close to shore, along the southern side of the island of New Britain and the northern side of the Solomon Sea and Solomon Trench. Influenced by coastal rivers and streams.
Huon Gulf & Milne Bay Coastal Areas	Coastal reefs of the northeastern side of the southeast peninsula of the main island of New Guinea, extending from Lae to Alotau, and including the Huon Gulf; Dyke Ackland, Collingwood and Goodenough Bays; Fergusson and Normanby Islands, the D'entrecasteaux Islands, and the inshore islands off the eastern point of the peninsula (Basilaki, Sideia etc).
Louisiade Archipelago	Offshore reefs off the eastern tip of the southeast peninsula of the main island of New Guinea, which experience strong oceanic influences from both the Solomon and Coral Seas.
Trobriand & Woodlark Islands	Offshore reefs with strong oceanic influences from the Solomon Sea
East New Ireland	Offshore reefs and atolls in the Western Pacific, east of New Ireland.
Ontong Java-Tasman Island	Oceanic atolls with high disturbance regimes.

Functional seascape	Criteria
Solomon Island Chain	Main island chain in the Solomon Archipelago, characterized by large volcanic islands, fringing and barrier reefs, and large straits with major currents (e.g. New Georgia Sound)[3].
Rennell Island & Indispensable Reefs	Oceanic Coral Sea reefs with a high disturbance regimes (including cyclones).

[3] The southern part of the main Solomon Island Chain (Makira, Malaita and Guadalcanal) experiences a higher disturbance regime (including cyclones) than further north and west along the chain. This area may prove to be different in future, when further information becomes available.

7 Participants

7.1 Expert workshop

Participants in the expert workshop were (in alphabetical order):

Muhammad Barmawi, The Nature Conservancy, Coral Triangle Center (CTC)

Rafael Calderon, The Nature Conservancy, Pacific Island Countries Program

Rili Djohani, The Nature Conservancy, CTC

Mark Erdmann, Natural Resources Management Program (USAID funded)

Alison Green, The Nature Conservancy, Global Marine Initiative

John Guinotte, Australian Institute of Marine Science (AIMS)

Adbul Halim, The Nature Conservancy, CTC

Bert Hoeksema, Naturalis, The Netherlands

Bill Marsden, COREMAP

Peter Mous, The Nature Conservancy, CTC

Yvonne Patina, MMAF/COREMAP

Willem Renema, Naturalis, the Netherlands

Rod Salm, The Nature Conservancy, Global Marine Initiative

Ketut Sarjanaputra, WWF Indonesia

Stuart Sheppard, The Nature Conservancy, Pacific Island Countries Program

Agoes Sriyanto, PHKA Jakarta, Ministry of Forestry

Suharsono, LIPI

Emre Turak, Marine Consultant

John Veron, Australian Institute of Marine Science

Budi Wiryawan, The Nature Conservancy, East Kalimantan

The Nature Conservancy wishes to thank Dr Gerry Allen who generously made his data available to workshop participants. Dr Gerry Allen, despite being unable to attend, contributed substantially to this report. The Conservancy also wishes to thank Dr Carden Wallace for sharing her knowledge of coral diversity and biogeography.

7.2 Subsequent expert advice

Experts who provided subsequent advice from 2005 to 2008 were (in alphabetical order):

Gerry Allen, Marine Consultant

William Atu, Then Nature Conservancy, Solomon Islands

Arief Darmawan, CTC

Peter Doherty, Australian Institute of Marine Science

Alison Green, The Nature Conservancy, Global Marine Initiative

Bert Hoeksema, Naturalis, The Netherlands

Benjamin Kahn, Apex Environmental

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Rod Salm, The Nature Conservancy, Global Marine Initiative

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Andrew Smith, The Nature Conservancy, Pacific Island Countries Program

Peter Thomas, The Nature Conservancy, Pacific Island Countries Program

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Walain Ulaiwi, The Nature Conservancy, Kimbe Bay Project, PNG

John Veron, Australian Institute of Marine Science

Joanne Wilson, CTC

Alan White, The Nature Conservancy

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Unpublished data:

Corals (Charlie Veron, Emre Turak and Lyndon DeVantier)

Coral reef fishes (Gerry Allen)

Forams (Willem Renema)

Fungid corals (Bert Hoeksema)

Stomatopods (Mark Erdmann)

Annex 1. Surface areas and coastlines of the Coral Triangle, its ecoregions, and functional seascapes

Prepared by: Nate Peterson (npeterson@tnc.org) September 2008.

Input data sources:

- Landmass used to calculate coastline: Shuttle Radar Topography Mission (2000), U.S. Geological Survey Center for Earth Resource Observation and Science (EROS)
- Continental shelves were calculated using depth less than 200 meters from Smith & Sandwell (1997) global ocean bathymetry map, the most complete, high-resolution image of sea floor topography currently available. The map was constructed by blending depth soundings collected from ships with detailed gravity anomaly information obtained from the Geosat and ERS-1 satellite altimetry missions.
- Coral Triangle ecoregions and functional seascapes were based on this report.

Table A1-1. Approximate coastline and surface area for each ecoregion in the Coral Triangle.

Ecoregion	Coastline (km)	Surface Area Shelf (<200m, km2)	Surface Area Deep Water (>200m, km2)	Total Surface Area (km2)
1. Eastern Philippines	24,319	119,770	319,547	439,317
2. Palawan/North Borneo	19,684	153,206	307,241	460,447
3. Sulawesi Sea/Makassar Strait	10,035	158,140	603,619	761,759
4. Northeast Sulawesi	2,556	25,356	44,704	70,060
5. Halmahera	5,203	30,800	191,194	221,994
6. Banda Sea	15,380	88,400	796,753	885,153
7. Lesser Sunda	10,886	40,812	317,208	358,020
8. Papua	18,284	102,009	246,783	348,792
9. Bismarck Sea	6,872	24,051	447,527	471,578
10. Solomon Sea	7,308	63,654	515,435	579,089
11. Solomon Archipelago	12,109	37,184	858,839	896,023
TOTAL	**132,636**	**843,382**	**4,648,849**	**5,492,231**

Table A1-2. Approximate coastline and surface area for each functional seascape in the Coral Triangle

Functional Seascape	Coastline (km)	Surface Area Shelf (<200m, km2)	Surface Area Deep Water (>200m, km2)	Total Surface Area (km2)
1. North Luzon	5,052	2,067	8,320	49,145
2. Central Philippines	9,319	7,965	43,903	95,518
3. Visayas	13,663	8,054	44,095	79,065
4. Mindinao	6,866	5,864	22,148	118,634
5. Palawan-Sulu-Sea-North Borneo	11,954	8,860	93,753	317,657
6. Northeast Borneo	11,077	10,862	59,414	117,311
7. Sulawesi Sea	8,187	3,100	13,225	326,796
8. Makassar Strait/Flores Sea	6,370	6,203	111,956	297,510
9. Lesser Sunda	10,966	10,877	40,805	312,432
10. Tomini Bay	4,259	2,545	25,345	69,845
11. Sula Spur Area	7,326	3,371	17,499	62,537
12. Southeast Suluwesi	7,773	5,016	32,043	143,067
13. Banda Sea	6,371	5,982	27,244	358,356
14. Halmahera	5,490	5,200	30,592	130,011
15. Birds Head	11,964	10,965	72,306	165,819
16. Fak Fak Region	6,371	5,917	19,348	37,435
17. Western Islands	263	236	1,541	26,344
18. Sepik	1,398	1,251	3,308	35,247
19. Manus	917	903	6,125	37,126
20. New Hanover-Mussau	2,106	1,156	2,606	34,683
21. West New Ireland	1,120	173	161	3,743
22. St George's Channel	3,200	496	797	7,256
23. Kimbe-Witu Islands	2,185	1,005	4,228	41,765
24. Madang-Dampier Strait	4,555	1,611	4,952	48,519
25. Southern New Britain	2,404	933	1,791	23,108

26. Trobriand and Woodlark Islands	870	831	14,859	49,502
27. Huon Gulf and Coastal Milne Bay Islands	3,405	3,024	24,804	50,297
28. Louisiade Archipelago	1,163	1,084	14,742	86,610
29. Tbar-Lahir Islands	1,776	1,091	4,812	84,660
30. Ontong Java-Tasman Islands	178	206	2,850	71,775
31. Solomon Archipelago	10,346	10,518	27,414	193,267
32. Rennell Islands and Indispensible Reefs	238	260	1,957	43,984
TOTAL	**127,626**	**778,943**	**2,740,080**	**3,519,023**

Annex 2. Version history

Version 0 (October 2003).

Workshop report, reviewed by the participants

Version 1 (April 2004)

1. A drawing error in the Palawan - North Borneo ecoregion was corrected: the southern boundary was moved from Berau River to southern Tanjung Mangkalihat.
2. In Version 0 boundaries of ecoregions and functional seascapes were not fully aligned. Although the argument can be made that ecological boundaries are only meaningful at a certain spatial scale and that it may therefore be acceptable for boundaries at a higher spatial scale (ecoregions) *not* to align with boundaries at a lower spatial scale (functional seascapes), for planning purposes it makes more sense to align the boundaries. So the following adjustments were made:
    a. Sulawesi Sea boundary section of the Northeast Borneo functional seascape was aligned with the Palawan / North Borneo ecoregion.
    b. Southern Davao (Philippines) boundary section of the Sulawesi Sea / Makassar Strait ecoregion was aligned with the Sulawesi Sea functional seascape border.
    c. Manado-Lembeh Strait boundary section of the Sulawesi Sea / Makassar Strait ecoregion was aligned with the Sulawesi Sea functional seascape border.
    d. Southwestern section of the Makassar Strait / Flores Sea functional seascape was aligned with the Sulawesi Sea / Makassar Strait ecoregion border.
    e. Northwestern boundary section of the Papua ecoregion was aligned with the Papua - Bird's Head functional seascape border.
    f. Ecoregion boundary section between Seram Island and the Papua - Bird's Head, as well as the northeastern boundary section of the Banda Sea functional seascape were slightly adjusted to fill out open species between polygons.
3. Detailed threats to biodiversity and industries that were provided for two functional seascapes only in Version 0 were removed from Version 1.
4. The document was reformatted and the Chapters 1 and 0 were added.

Version 2 (September 2004)

1. Includes preliminary inclusion of the Solomon Islands (adjusting Figures 1, 3, 4 and Table 1) since the Solomon Islands Marine Assessment confirmed that this archipelago should be included in the Coral Triangle due to its high biodiversity (Green et al 2006).

Version 3 (December 2005)

1. Includes preliminary revision of the eastern side of the Coral Triangle, following a marine assessment of the Solomon Islands (Green et al 2006) and subsequent expert advice.
2. "Bird's Head functional seascape" was renamed to Papua – Bird's Head functional seascape.
3. Annexes 1 and 2 added.

Version 3.1 (February 2006)

1. Provides a more detailed revision of the eastern expansion of the Coral Triangle, its ecoregions and functional seascapes to include the Solomon Islands.
2. Document outline restructured.

Version 4 (September 2007)

1. Brunei was excluded from the Coral Triangle, which also resulted in a modification to the western boundary of the Palawan/North Borneo ecoregion.
2. Functional seascapes were added for the northern Coral Triangle (Eastern Philippines and Palawan/North Borneo ecoregions).
3. Values presented in Annex 1 were revised. A more detailed dataset of coastlines and land masses was used resulting in significant changes to all values, particularly coastlines. Values for the Coral Triangle boundary and Eastern Philippines ecoregion have also changed due to the exclusion of Brunei from the Coral Triangle, and values were added for the new functional seascapes for the northern Coral Triangle.

Version 5 (September 2008)

1. Minor changes to the Coral Triangle boundary, its ecoregions and functional seascapes to be consistent with the Coral Triangle boundary delineated by Veron et al (unpubl. data) and Allen (2007) based on a recent scientific analysis of coral and reef fish biodiversity data.
2. Minor changes to the eastern boundary of the Lesser Sunda ecoregion.
3. Values presented in Annex 1 were revised to be consistent with the new boundaries, and to use a different dataset to calculate land area (and therefore coastline and water area) that was more consistent with other data layers.

The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

The Conservancy's Coral Triangle Program supports coral reef conservation in Indonesia, Philippines, Malaysia (Sabah), Timor Leste, Papua New Guinea and the Solomon Islands.

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