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Asia Pacific Conservation Region
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Report No 2/11

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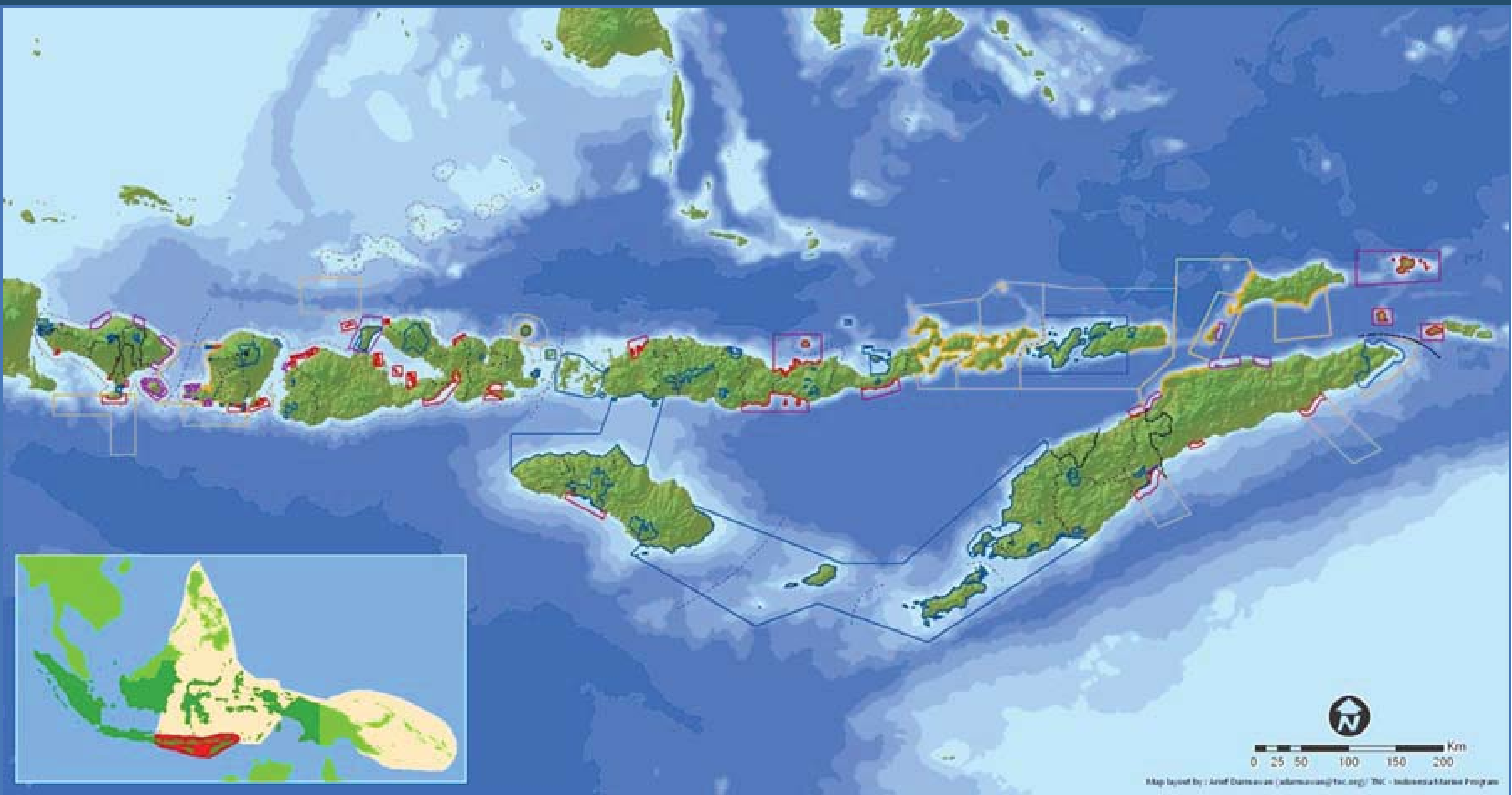

Lesser Sunda Ecoregion, Coral Triangle

Report Compiled By:
Joanne Wilson, Arief Darmawan, Johannes Subijanto,
Alison Green and Stuart Sheppard

Supported by:

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Published by: The Nature Conservancy, Asia Pacific Marine Program

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Suggested Citation:
Wilson, J., Darmawan, A., Subijanto. J., Green, A., and S. Sheppard. 2011. Scientific design of a resilient network of marine protected areas. Lesser Sunda Ecoregion, Coral Triangle. Asia Pacific Marine Program. Report 2/11. 96 pp.

All maps designed and created by Arief Darmawan.

Available from:

Indonesia Marine Program	Indo-Pacific Resource Centre
The Nature Conservancy	The Nature Conservancy
Jl Pengembak 2	51 Edmondstone Street
Sanur, Bali, Indonesia	South Brisbane, Qld 4101 Australia

Or via the worldwide web at:
http://conserveonline.org/workspaces/tnccoraltriangle/documents/resilient-mpa-network-lesser-sunda-ecoregion/

Acknowledgements

The Nature Conservancy (TNC) would like to thank numerous colleagues, partners, stakeholders and community members throughout Indonesia who shared their knowledge of the Lesser Sunda Ecoregion and provided input to the design of the marine protected area (MPA) network. This includes a number of TNC staff, representatives of district, provincial and national governments of Indonesia and Timor-Leste, and other NGO partners. From TNC, Peter Mous initiated and led this project from 2006-2007, Gede Wiadnya provided invaluable technical advice based on his extensive experience and networks in the region, Handoko Adi Susanto provided strong support in the critical final stages of the analysis and public consultation, Rudyanto provided 'behind the scenes' support for GIS analysis. Many thanks to Juliana Tomasouw and Kadek Novianti whose organisational skills ensured our workshops always ran smoothly. Tri Soekirman provided communications support to this project and Jeanine Almany and Maggie Terry assisted with the final layout and proof reading of this document.

The design of the Lesser Sunda MPA network was improved by scientific input from national and international marine conservation experts, and all participants of stakeholder and scientific workshops, training and public consultation meetings. TNC would like to highlight the contributions made by: Benjamin Kahn (Apex Environmental Pty Ltd); Lyndon DeVantier, Gerry Allen, Emre Turak, and Damaris Torres-Pulliza (Synoptika Solutions); Eddie Game (TNC); Didik Santoso (University of Mataram); Jotham Ninef (Universitas Nusa Cendana); Frida Sidik and B. Realino (Institute for Marine Research and Observation); Hendryanto (consultant from NTT); Bintar (Bakosurtanal); I Ketut Sudiarta (University Warmadewa); Evron Asrial (Three Pillars); Isaak Angwarmase (Ministry of Marine Affairs and Fisheries NTT); Umbu Dawa (Arta Wacana Christian University); and Domingoos Mook Soares (Timor-Leste). TNC is grateful to Stuart Campbell from Wildlife Conservation Society who led a team to undertake the groundtruthing of the satellite imagery for seagrass mapping.

This project was made possible through the generous support of the John D. and Catherine T. MacArthur Foundation, TNC's Global Marine Initiative, and TNC's Asia-Pacific Marine Program in partnership with the Indonesian Ministry of Maritime Affairs and Fisheries.

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EXECUTIVE SUMMARY

The Lesser Sunda Ecoregion encompasses the chain of islands and surrounding waters from Bali, Indonesia to Timor-Leste and is one of the 11 ecoregions of the Coral Triangle. This region is of outstanding marine conservation value for its shallow coastal habitats, including coral reefs, mangroves and seagrass, as well as for endangered turtles and cetaceans. Coastal habitats are highly diverse with the seafloor dropping steeply from shallow coral reefs to depths of up to 2000 metres. Consequently, deep sea habitat features like seamounts and underwater canyons occur within kilometres of the coast, creating 'deep sea yet near shore' habitats. This region is characterized by exceptionally strong currents generated by the passage of the Indonesian Throughflow through the narrow channels between the chain of islands.

Coastal reefs and associated ecosystems of the Lesser Sunda Ecoregion have long been threatened by destructive fishing, overfishing, pollution and coastal development. They are now also threatened by climate change impacts including increased sea temperatures, sea level rise, extreme weather and ocean acidification.

Creating networks of marine protected areas (MPAs) is a key strategy to increase the 'resilience' of these ecosystems to climate change impacts by identifying and protecting areas that appear to be the most resilient to climate change; and reducing stresses caused by other anthropogenic threats. Here we have applied and refined principles for designing and managing resilient MPA networks, which have been developed and applied by TNC and partners in other parts of the world.

In this document, we describe the process to develop a scientific design of a resilient network of MPAs for the Lesser Sunda Ecoregion, based on a detailed scientific assessment and an extensive stakeholder consultation process. This process included developing a GIS database of best available information, identifying key conservation features, threats and uses of the area, applying state of the art conservation planning tools and facilitating input from relevant government agencies, local stakeholders and scientific experts though a series of workshops and meetings.

Some key features of this process include:

1. One of the first demonstrations of the application of resilience principles to MPA network design at the ecoregional level.

2. The application of large-scale marine spatial planning in a data deficient area, including innovative approaches such as: a) placing less reliance on computer-based decision support tools; and b) increasing reliance on the use of expert mapping and input from key stakeholders to identify the location of conservation targets, threats and socio-economic and cultural values of the area.

3. An extensive stakeholder consultation process which ensured that local government representatives and stakeholders were able to provide inputs into the design, including expert mapping exercises (two-day workshop with >50 participants), scientific peer review (two-day workshop with 20 participants) and consultation with relevant government agencies in the region (23 meetings with 225 government representatives).

4. The incorporation of existing and proposed MPAs in the region, including the 3.5 million hectare Savu Sea Marine National Park. Therefore, the MPA network design was based on a gap analysis that included the 37 existing and 19 proposed MPAs in the design and identified 44 Areas of Interest (AOIs). AOIs are areas which should be considered for the development of new MPAs in the future to ensure that the coral reefs of the Lesser Sunda Ecoregion are

resilient to local, regional and global threats. The term AOI is used interchangeably with MPA in this report unless specifically stated.

5. Development of a MPA network design that incorporates coastal, shallow marine and 'deep sea yet near shore' habitats. The final design includes 100 protected areas covering 9.7 million hectares — 85 shallow marine and coastal reserves and MPAs for coral reefs, mangroves and seagrass (covering 2 million hectares), the Savu Sea MPA which includes both shallow coastal and deep sea habitats (3.5 million hectares), and 14 larger offshore MPAs (covering 4.2 million hectares) which encompass deep sea yet near shore habitats critical for the highly diverse assemblage of marine mammals that occur in this region.

The scientific design of the Lesser Sunda MPA network and the accompanying information database are excellent resources for national, provincial and district government agencies to guide their coastal and marine planning in the Lesser Sunda Ecoregion. In fact, the Ministry of Marine Affairs and Fisheries (MMAF) have already agreed to adopt the design as the primary reference or 'roadmap' for establishing MPAs in the Lesser Sunda Ecoregion and to include the design in marine and coastal spatial planning at district, provincial and national levels. These products also provide a starting point for support of site-based planning, which includes the design and implementation of individual MPAs.

It is important to note that the MPA network design identified in this report represents the views of scientists and key stakeholders, based on best available information, and that areas identified will meet resilient MPA design criteria while minimizing impact to local communities and other stakeholders.

Since the AOIs identified for potential new MPAs in this design have not been endorsed by governments and local communities, the boundaries of the AOIs, or even their location, may shift in the future as a result of more detailed discussions with governments, local communities and other stakeholders. This has been accounted for in the design process, which allows some flexibility in the size and location of final MPA boundaries in relation to the AOIs.

INTRODUCTION

THE CORAL TRIANGLE

Biodiversity and Ecosystem Services

The Coral Triangle is the epicentre of marine diversity and a global priority for conservation. Covering less than 2% of the world's oceans, it comprises a staggering proportion of the world's biodiversity: 76% of reef building coral species and 37% of coral reef fish species (Figure 1: Veron et al. 2009). Since many of the people who live in the Coral Triangle rely on subsistence lifestyles, the reefs support the livelihoods of over 100 million people (Hoegh-Guldberg et al. 2009).

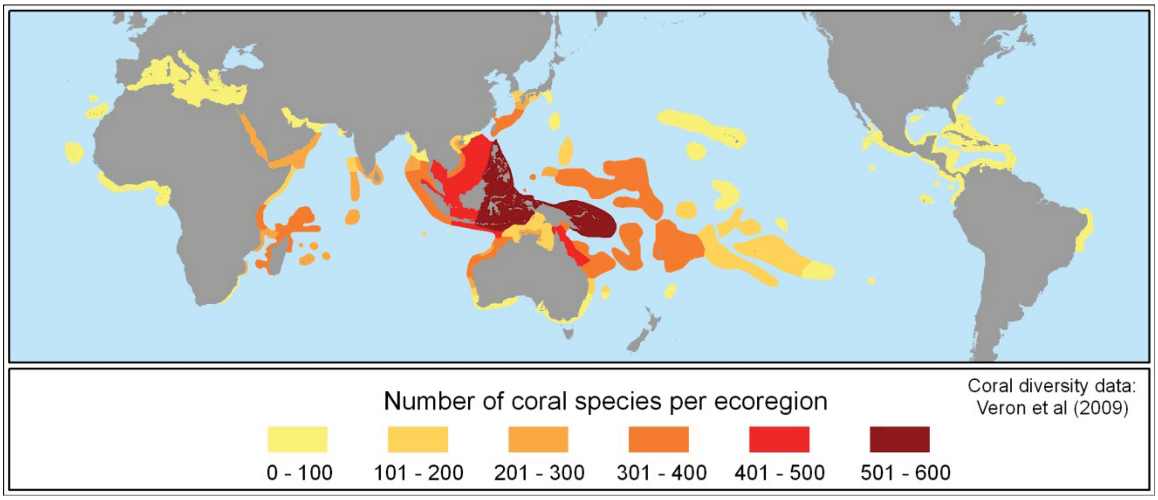

Figure 1. Global biodiversity of reef building corals (Veron et al. 2009).

Boundary, Ecoregions and Functional Seascapes

Recently, the Coral Triangle, its ecoregions and functional seascapes were delineated for conservation (Green and Mous 2008, Veron et al. 2009: Figure 2 and Figure 3).

The Coral Triangle is a large area comprising almost 550 million hectares of ocean and all or part of six countries in Southeast Asia and Melanesia: Indonesia, the Philippines, Malaysia (Sabah), Timor-Leste, Papua New Guinea and the Solomon Islands (Figure 2). It also includes 11 ecoregions and 32 functional seascapes[1] (Green and Mous 2008) (Figure 3). The Lesser Sunda Ecoregion is located in the southwest of the Coral Triangle.

[1] Ecoregions are defined as 'large areas containing geographically distinct assemblages of species, natural communities, and environmental conditions'; and 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' (Green and Mous 2008).

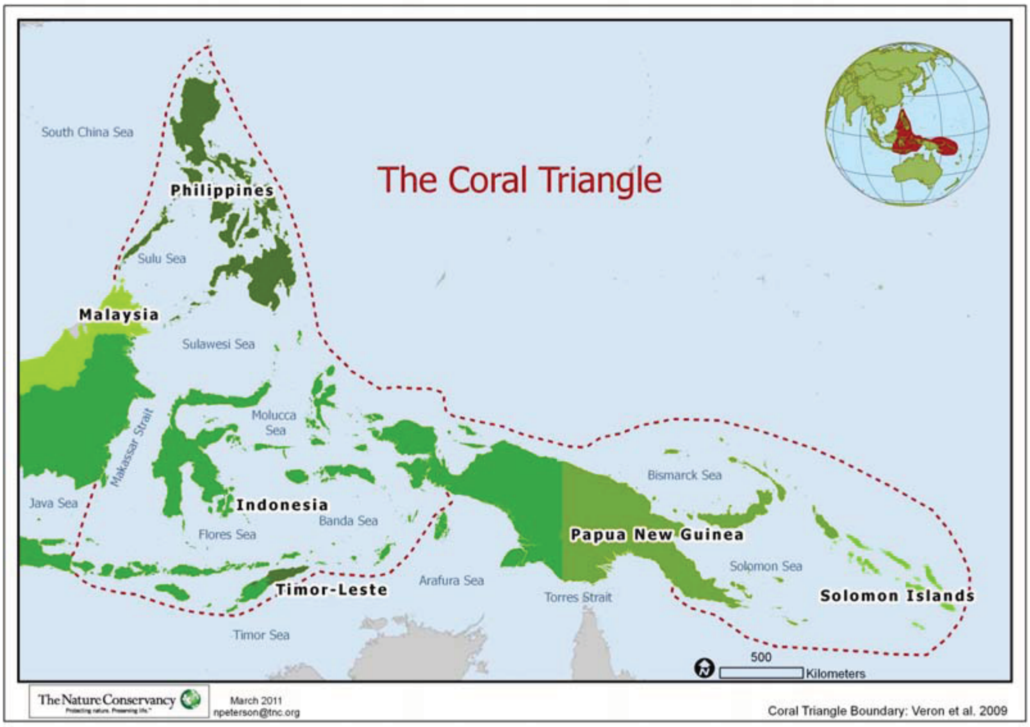

Figure 2. Coral Triangle boundary (Veron et al. 2009).

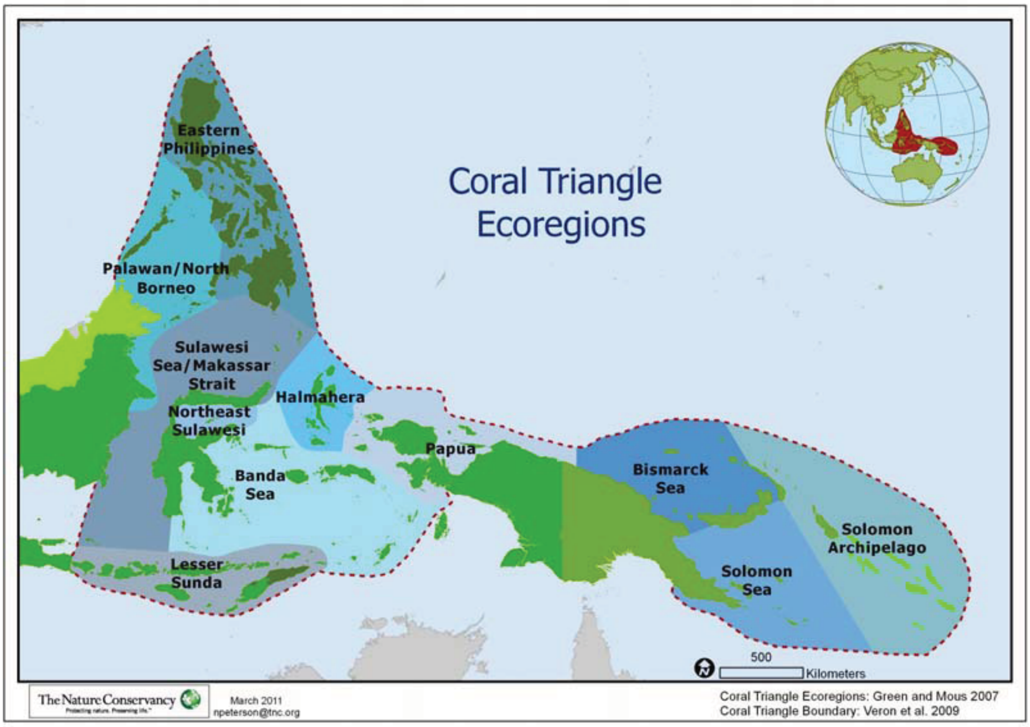

Figure 3. Coral Triangle ecoregions (Green and Mous 2008).

Status and Threats

The world's coral reefs, particularly those in Southeast Asia, are seriously threatened by a variety of direct and indirect anthropogenic threats (Brown 1997, Bryant et al. 1998, Jackson et al. 2001, Halpern et al. 2008, Burke et al. 2011). Of immediate concern are threats to ecosystem health from overexploitation of marine resources, destructive fishing practices, coastal development, runoff from poor land use practices and uncontrolled tourism activities (Bryant et al. 1998, Jackson et al. 2001, Fabricius 2004, Wilkinson 2008, Halpern et al. 2008, Burke et al. 2011). Another issue of concern is the degree to which human activities have influenced the proliferation of other threats, particularly coral diseases and outbreaks of corallivorous crown of thorns starfish (Harvell et al. 1999, 2007, Jackson et al. 2001, Fabricius 2004, Bruno et al. 2007, DeVantier and Done 2007).

Climate change also represents a serious and increasing threat to coral reefs and associated ecosystems of the world (Hoegh-Guldberg 1999, McLeod and Salm 2006, Hoegh-Guldberg et al. 2007, Veron 2008, Burke et al. 2011). Major threats include rising sea temperatures (leading to mass coral bleaching), sea level rise, ocean acidification, an increase in the intensity and frequency of tropical storms and a change in ocean circulation patterns (Hoegh-Guldberg 1999, Hoegh-Guldberg et al. 2007, IPCC 2007).

While recent studies suggest that the coral reefs of Coral Triangle, including Indonesia, may have a relatively good prognosis for surviving the threat of climate change (Hoegh-Guldberg et al. 2007, 2009, Kleypas et al. 2008, Veron 2008), some impacts from rising sea surface temperatures and ocean acidification are inevitable (Hoegh-Guldberg 1999, Hoegh-Guldberg et al. 2007, 2009).

In Indonesia, direct human impacts also continue to pose serious threats to coral reefs, particularly overfishing, destructive fishing practices (blast and poison fishing), coastal development and sedimentation and pollution from land-based sources (Cesar et al. 1997, Pet-Soede and Erdmann 1998, Burke et al. 2002, Burke et al. 2011). The diversity, frequency and scale of these threats have now increased to the extent that many coral reefs have already suffered severe, long-term declines in their diversity, habitat structure and abundance of key species (Pandolfi et al. 2003, 2005, Hughes et al. 2003, Wilkinson 2008, Burke et al. 2011). Figures published recently in Burke et al. (2011) confirm that Indonesia's reefs are among the most threatened in the world. Wilkinson (2008) estimated that in Indonesia, 40% of reefs have been effectively lost and 45% are under threat. Estimates of the number of reefs in Southeast Asia at low threat have decreased from 15% (Wilkinson 2008) to 5% (Burke et al. 2011).

Urgent action is now required to halt or reverse these declines in coral reef health in Indonesia.

MARINE PROTECTED AREAS

Roles and Definitions

Marine protected areas (MPAs), particularly fully protected marine reserves (no-take areas), are a well established tool for marine conservation and sustainable management of marine resources (Lubchenco et al. 2003). Scientific evidence clearly demonstrates their ecological benefits and justifies their immediate application as a central management tool for coral reef conservation and management (Lubchenco et al. 2003).

MPAs are used for both the conservation of biodiversity and sustainable fisheries management (Lubchenco et al. 2003, WCP 2003). By protecting geographical areas, including both resident species and their biophysical environments, MPAs offer an ecosystem-based approach to conservation and fisheries management (Lubchenco et al. 2003).

Consistent with the IUCN definition for protected areas (Dudley 2008), a MPA is defined as 'a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.' This definition encompasses a wide variety of MPAs, including, but not limited to, no-take areas. It also includes a wide variety of governance types for protected areas, ranging from statutory to community managed areas (WPC 2003).

Marine Protected Areas in Indonesia

The Government of Indonesia has demonstrated its commitment to establishing a regional network of MPAs through its leadership in the Coral Triangle Initiative (http://www.cti-secretariat.net/). In 2008, Indonesia fulfilled its commitment to the Convention on Biological Diversity's Program of Work on Protected Areas to create 10 million hectares of MPAs by 2010, with the declaration of the 3.5 million hectare Savu Sea Marine National Park within the Lesser Sunda Ecoregion. Establishing a resilient network of MPAs in the Lesser Sunda Ecoregion will contribute significantly to the Government of Indonesia's next goal of establishing 20 million hectares of MPAs by 2020 (Yudhoyono, 2009).

In Indonesia, MPAs can be established by national, provincial and/or district governments under either Law 31/2004 (fisheries) or Law 27/2007 (spatial planning). These laws allow for multiple uses within the MPA through the application of zoning and management plans. These zones include no go, no-take and sustainable use zones.

An important aspect of MPA design and implementation in Indonesia is to conserve coral reefs and coastal habitats not only for their biodiversity values but to also to support sustainable resource use for the benefit of local people. Destructive and illegal harvesting of reef fish, endangered species and other resources are common throughout the country, leading to habitat destruction and overexploitation of key species. These practices are often tied to the inequitable distribution of wealth, causing detriment to local communities. MPAs can be a focus for management to reduce these threats and create enabling conditions for sustainable industries such as tourism, sustainable fisheries and aquaculture.

In Indonesia and many other parts of the Coral Triangle, local people rely heavily on fishery resources as a source of daily protein and cash income. Therefore it is important that MPAs accommodate sustainable fisheries for local communities and support increased fisheries productivity by improving or maintaining healthy, diverse coastal ecosystems.

Designing Resilient Networks of Marine Protected Areas

Climate change represents a new and emerging threat to coral reefs and associated ecosystems, including Indonesia (see *Status and Threats*), and it is critically important that this is taken into account when MPAs networks are designed and managed. In recent years, principles for designing and managing MPA networks that are resilient to the threat of climate change have been developed (West and Salm 2003, Grimsditch and Salm 2006, McLeod and Salm 2006, McLeod et al. 2009).

Resilience is the ability of an ecosystem to absorb shocks, resist phase shifts and regenerate after natural and human-induced disturbances (Nyström et al. 2000). For coral reefs, it is the ability of reefs to absorb recurrent disturbances (such as cyclones, outbreaks of predators or coral bleaching events) and rebuild coral-dominated systems rather than shifting to macro algal-dominated systems (Marshall and Schuttenberg 2006, Hughes et al. 2007). Coral reef resilience will be increasingly important in the future as disturbances such as coral bleaching are becoming more frequent and severe with climate change (Hoegh-Guldberg 1999).

Over the last ten years, TNC has played a leadership role in developing and applying design principles to ensure that MPA networks are resilient to the threat of climate change (West and Salm 2003, Grimsditch and Salm 2006, McLeod and Salm 2006, Green et al. 2007, 2009, Hinchley et al. 2007, TNC 2009). These principles include:

- addressing uncertainty by spreading the risk through representation and replication of major habitats; protecting critical habitats, particularly those demonstrating strong resilience;
- understanding and incorporating patterns of biological connectivity; and

- reducing other threats (particularly overfishing and destructive fishing and runoff from poor land-use practices).

Lessons learned from these studies are being applied throughout the Coral Triangle, and in many other locations around the world (http://reefresilience.org/Toolkit_Coral/C8_CaseStudies.html).

LESSER SUNDA ECOREGION

Geography

The Lesser Sunda Ecoregion encompasses the chain of islands from Bali in the west to Timor-Leste in the east, north along the Nusa Tengarra Islands and south to Sumba and Rote Islands. It encompasses three Indonesian Provinces (Bali, Nusa Tengarra Barat and Nusa Tengarra Timor), parts of a fourth (Maluku) and the country of Timor-Leste (Figure 4). The Lesser Sunda Ecoregion is a large area, containing 35,802,039 hectares of ocean and 10,886 kilometres of coastline (Green and Mous 2008).

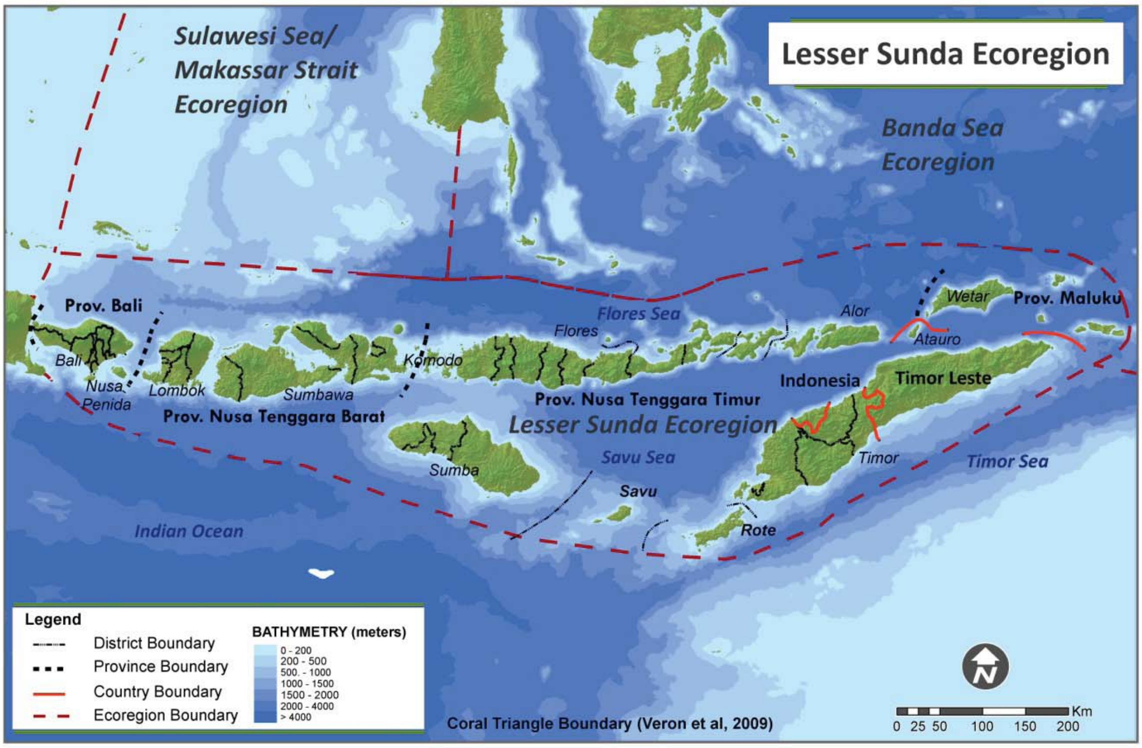

Figure 4. Lesser Sunda Ecoregion showing provincial and national boundaries.

Environmental Conditions and Oceanography

The Lesser Sunda Ecoregion is characterized by exceptionally strong and complex currents generated by the passage of the Indonesian Throughflow through this chain of islands from north to south. The Indonesian Throughflow transports warm water from the north and central West Pacific Ocean to the northeast Indian Ocean via a circuitous route through Indonesia (Gordon and Fine 1996) (Figure 5).

After passing through the Makassar Strait and other corridors between Sulawesi, Halmahera and Papua, the current (15 million m^3/s) exits the Indonesian Archipelago through the narrow straits of the Lesser Sunda Islands (Gordon and Fine 1996; Sprintall et al. 2009). The main passages are Lombok Strait (between Bali and Lombok), Ombai Strait (between Timor-Leste and Solor-Alor) and the southern coast of Timor Island (Sprintall et al. 2004). Minor and shallower passages include Komodo (between Sumbawa and Flores) and Lembata and Pantar Straits in Solor Alor. The predominant flow at these points is one way in a north/south direction with very limited reverse flow mainly at depth (Sprintall et al. 2009). Along the northern coast of the Lesser Sunda islands, the flow is predominantly west to east and along the southern coasts it is east to west (Wyrtki 1961). Strong turbulence is also generated by the passage of these strong currents through narrow straits, around islands, reefs and headlands (Fudge 2007, DeVantier et al. 2008).

The Lesser Sunda Ecoregion is also characterized by seasonal upwellings driven by wind patterns and the steep bathymetry of the region where deep-sea habitats (up to 4000 metres) occur within a few kilometres of the coast (Kahn 2008). Upwelling occurs on the southern side of the island chain in April to May and on the northern side from October to November (Kahn 2008). Coral reefs and other coastal habitats are influenced by these upwellings due to their proximity to the coast. In areas of localized upwelling, water temperatures can be as low as 16°C, influencing the composition of coral and fish assemblages (De Vantier et al. 2008).

Wave exposure also varies greatly in the Lesser Sunda Ecoregion, with southern coasts influenced by high wave energy compared to the northern coasts (De Vantier et al. 2008).

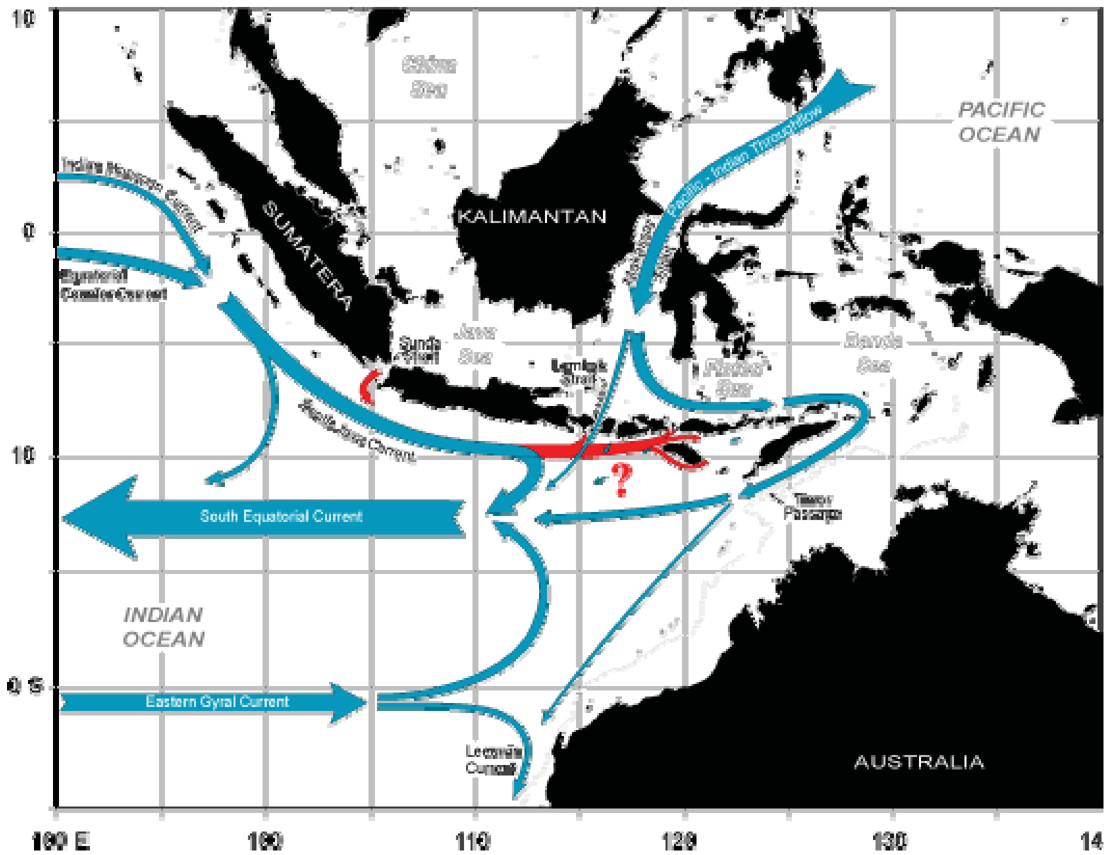

Figure 5. Schematic of Indonesian Throughflow from WOCE Indian Ocean Expedition. Source: (http://tryfan.ucsd.edu/woce_ioe/woce_ioe.htm)

Shallow Coastal Waters

The Lesser Sunda Ecoregion is an important transition zone between Pacific and Indian faunas, with distinct faunal elements, including endemic stomatopods, and distinct foram and coral assemblages (Green and Mous 2008, Veron et al. 2009). In Green and Mous (2008) only one seascape was identified in the Lesser Sunda Ecoregion due to data deficiencies that precluded sub-dividing the ecoregion further at the time. Subsequently, DeVantier et al. (2008) defined ecologically meaningful seascapes within the ecoregion based on a more detailed analysis of existing data and expert opinion.

Veron et al. (2009) noted that the Lesser Sunda Ecoregion was data deficient, but expected that it would contain a high diversity (523 species) of reef building coral. Fish diversity is also high with 1,783 species recorded, 25 of which are endemic to the ecoregion (Allen 2007).

In this ecoregion, environmental factors including availability of suitable habitat and oceanography (upwelling and ocean swell) have a strong influence over the composition of the coral and associated fish communities (De Vantier et al. 2008). Substrate suitable for coral growth occurs along coasts formed by limestone and lava flows from volcanic activity. Other areas of soft black sand beaches also formed by volcanic activity do not offer a suitable substrate for coral reef development.

In areas of suitable habitat, coral composition is influenced by predominantly by southerly ocean swells which result in high energy southern coastlines and more protected northern coastlines. In addition, the occurrence of many local or regional upwelling areas where water may regularly drop to 16°C influences the species composition of both coral and fish communities (De Vantier et al. 2008). Fish communities also vary among western, central and eastern island groups, with many endemic species restricted to one of these regions.

The Lesser Sunda Ecoregion is an important region of the Coral Triangle for endemism, with very high rates of endemism for both corals and fish. In addition to the 25 endemic species of fish, 11 endemic species of coral were identified by Veron et al. (2009), although some have since been recorded in other ecoregions (De Vantier et al. 2008). For both fish and corals, the areas of Bali-Lombok, Komodo and east Flores are of particular importance or potential importance for endemism.

Deep Sea yet Near Shore Habitats and Species

The steep underwater landscape and upwelling-driven productivity of the Lesser Sunda Ecoregion provides a unique habitat for large marine fauna such as whales, dolphins, dugongs, turtles and manta rays. To date, 21 species of marine mammal have been recorded in this region, including the highly endangered blue whale (Kahn 2002, 2004, 2006, pers comm). Some species use the Lesser Sunda Ecoregion as a migratory pathway and are ‘funnelled’ through the narrow straits between the islands or ‘migratory bottlenecks’. Areas of upwelling-driven productivity on both sides of the island chain are critical feeding habitats for both resident and migratory species. Some species prefer deep-sea habitats (e.g., blue whales prefer areas >2000 metres in depth).

The unique combination of these factors in close proximity to each other and to the coast means that this region is one of the most important in the Coral Triangle for assemblages of cetaceans and other large marine fauna. Their proximity to the coast provides opportunities for tourism but also creates risks from coastal pollution, entanglement in fishing nets and injuries from ship strike.

Deep sea yet near shore habitats are currently vastly underrepresented in most ecoregional planning and MPA network initiatives for the Coral Triangle. Recent technological advances have allowed a rapid increase of cost-effective exploration and public interest in the deep sea. This interest has also been coupled with a rapid fisheries expansion and offshore industries targeting deep sea habitats (i.e., seamounts and upwelling zones; deep sea mining). Hence there is a pressing need for improved management and conservation of these sensitive offshore marine habitats. For these reasons it was considered important to incorporate ‘deep sea’ MPAs in the Lesser Sunda MPA network design.

DESIGNING A RESILIENT NETWORK OF MPAS FOR THE LESSER SUNDA ECOREGION

In 2006, TNC discussed a proposal with the Ministry of Marine Affairs and Fisheries (MMAF) to design a resilient network of MPAs for the Lesser Sunda Ecoregion. MMAF were supportive of this proposal, and agreed to:

- adopt the resulting design as the primary reference for establishing MPA networks in the Lesser Sunda Ecoregion; and
- use the design to guide marine and coastal spatial planning at the district, provincial and national levels.

In this report, we describe how a resilient network of MPAs for the Lesser Sunda Ecoregion was designed and presented for use by all levels of government in Indonesia. The design was based on:

- a detailed scientific analysis that required intensive collection, collation and analysis of ecological and socio-economic data and review by Indonesian and international scientists; and
- extensive engagement with key stakeholders (particularly government officials), which was critical both to ensure their needs and interests were addressed and for the subsequent adoption and implementation of the MPA network design.

METHODS

The scientific design of the Lesser Sunda MPA network was developed via a four-step process over three years from 2006-2009. The major steps and timelines for each step are listed in Table 1 and described in more detail below.

Table 1. Key steps in the marine protected area network design process.

Key Steps	Timing
1. Setting objectives, boundaries and MPA network design principles	July 2007 to February 2008
2. Identifying and compiling high priority information	July 2006 to December 2008
3. Assembling a GIS database	July 2006 to February2009
4. Designing a resilient network of MPAs using a decision-support tool with stakeholder inputs	December 2008 to April 2009

SETTING OBJECTIVES, BOUNDARIES AND NETWORK DESIGN PRINCIPLES

The first step was to clearly define project objectives, boundaries and network design principles.

Objectives

The objective of this study was to design a resilient network of MPAs which, if implemented, would protect the marine biodiversity of the shallow marine and coastal waters of the Lesser Sunda Ecoregion and support sustainable use of marine resources for the benefit of communities that depend on them.

In addition, because deep sea habitats are such an important feature in the Lesser Sunda Ecoregion and are closely connected with shallow marine ecosystems, the MPA network was designed to include deep sea yet near shore habitats and species. This is a unique feature of this MPA network since most other ecoregional plans and MPA network designs only encompass coastal near shore habitats.

Since many MPAs have already been established or are proposed by national, provincial and district governments for this ecoregion, this study examined the values afforded by existing and proposed MPAs and identified additional areas for protection to complete a resilient MPA network.

Because the results of this study will be used as the main reference for establishing a network of MPAs in the Lesser Sunda Ecoregion by the MMAF, the network also aims to address existing MPA objectives in Indonesia (Wiryawan et al. 2006), including increasing:

- the quality of key habitats (e.g., coral reefs, seagrass and mangroves),
- the population, reproductive potential and biomass of fish,
- community livelihoods from natural resources,
- local capacity to manage the fish resources, and
- the cohesion between communities and the environment,

Through:

- effective local management of MPAs, and
- regulated community activities in the MPAs.

Boundaries

The boundary of the planning area was defined as the boundary of the Lesser Sunda Ecoregion as defined by Green and Mous (2008), which includes the Indonesian provinces of Bali, West Nusa Tengarra, East Nusa Tengarra, a small part of Maluku province and the country of Timor-Leste.

Network Design Principles

Specific design principles were developed and used to design the MPA network in shallow coastal areas, which considered the biophysical (Table 2) and socio-economic characteristics (Table 3) of the ecoregion.

Table 2. Biophysical MPA design principles for shallow coastal areas.

Design criteria	**Application**
Risk Spreading (representation and replication)	Conserve 20-30 % of shallow marine and coastal habitats (coral reefs, mangroves, seagrass and estuaries) and where possible, include community type within these habitats types (e.g., coral reef zones). Aim to include at least three representative examples of each habitat type in different locations, distributed over a large area to reduce the chance all would be negatively impacted by a single environmental or anthropogenic event at the same time. Consider best available information regarding the condition of major habitat types
Designing for Resilience to Climate Change	Incorporate sites that are more likely to be resistant or resilient to global environmental change. Areas that may be naturally more resistant or resilient to coral bleaching include: • habitats that regularly experience high temperature variability, • areas that experience upwelling and strong currents, • areas that are shaded by coastal vegetation or cliffs, and • areas of high diversity and coral cover.
Protecting Key Sites and Species	Include special and unique sites such as: • permanent or transient aggregations of key fisheries species (fish and invertebrates), • important migratory, breeding, resting and feeding areas for large and vulnerable marine species, and • areas that support species with very limited distribution and abundance, particularly endemic species.
Connectivity within and among MPAs	Aim to include areas that contain a combination of shallow water habitat types (coral reefs, mangroves, estuaries and seagrass) to maintain ecological patterns of connectivity among them. Aim for MPAs to be spaced 100-200 km apart to maintain genetic connectivity. Within MPAs, space no take zones 15-20 km apart to maintain ecological connectivity. Where possible, include entire biological or geomorphic units (e.g., whole reefs). Where entire biological units cannot be included, chose bigger versus smaller areas.

Table 3. Socio-economic MPA design principles for shallow coastal areas.

Design criteria	**Application**
General	• Allow for multiple activities, including sustainable fishing, tourism, aquaculture, education and research. • Minimise negative impacts on existing livelihood strategies and maximise opportunities for alternative incomes.

Design criteria	Application
Cultural	• Respect local and traditional marine resource use and access. • Recognise that local communities play an important role in decision-making and may be custodians over marine resources. • Protect areas of cultural importance.
Fisheries	• Recognise that MPAs can support sustainable subsistence and artisanal fisheries and sustainable commercial/industrial fisheries. Aim to maximise benefits to these fisheries through protection of fisheries habitat, spawning aggregations and creating 'fish banks'. Protect areas and habitats that are important for all life history stages of commercially important fish species and their prey such as spawning grounds, nursery and juvenile habitats. • Recognise that MPAs may provide resources for management (e.g., patrols for illegal fishing), where possible, benefits should be shared among local communities.
Nature-Based Tourism	• Include nature-based tourism areas in, or close to, MPAs where tourism objectives are consistent with the objectives of the MPA (e.g., diving and whale watching to provide income to local communities).
Infrastructure and Industry	• Consider costs and benefits of placing MPAs near major towns and cities (e.g., increased opportunities for enforcement, research and alternative incomes vs. increased use, pollution and loss of habitat with coastal development). • Accommodate existing and planned shipping lanes and port infrastructure (wharves, channels). • Avoid placing MPAs near existing and planned marine mining, oil and gas industries and in the vicinity of areas affected by runoff from land based mine tailing disposal.
Effective Management	• Consider existing and future patterns of resource use to reduce conflicts among existing resource users. • Consider opportunities for co-management with local communities, traditional leaders, stakeholders and relevant government agencies. • Recognize that the benefits of MPAs are strengthened by linking them with broader management strategies to address overfishing and land-based threats that originate from outside the MPAs.

Table 4. Criteria for deep sea yet near shore MPAs.

Design criteria	Application
Protecting Deep Sea yet Near Shore Habitats	• Protect deep-sea yet near-shore habitats that provide critical habitat for oceanic cetaceans and other species, including seamounts, deepwater canyons, straits (migratory corridors) and large persistent pelagic habitats (e.g., upwellings). • Select deepwater areas adjacent to important conservation areas in shallow water. • Select areas identified as high priority in Kahn (2008).

These design principles were based on: criteria for identifying MPAs in Indonesia (Wiryawan et al. 2006); and resilience principles of MPA network design that have been developed (McLeod et al. 2009) and applied in other areas in region including Papua New Guinea (Green et al. 2007, 2009) and Palau (Hinchley et al. 2007). Design criteria for deep sea yet near shore MPAs are provided in Table 4.

IDENTIFYING AND COMPILING HIGH PRIORITY INFORMATION

A list of the specific information needed as data layers to design the MPA network was identified based on the MPA network design principles (Tables 2 and 3). This included base GIS layers such as coastlines, existing and proposed MPAs and coastal reserves, shallow coastal habitats and species and socio-economic factors. Deep sea yet near shore habitats and species were also included in this list because of their very high ecological importance in this region and their proximity to the coastal communities.

Best available information was collected from 2006-2008 by sourcing existing datasets and by generating new datasets through interpretation of satellite imagery, scientific analysis of existing data sets, extraction of spatial data from reports by local consultants, internet sources and expert mapping by stakeholders (see *Designing Resilient Networks of Marine Protected Areas*). A list of all data sets available for the Lesser Sunda Ecoregion is provided in Appendix A.

Base GIS layers

Information regarding key physical features such as coastlines, ecoregion, national, provincial and district boundaries, MPA boundaries, bathymetry (marine), coastal topography (terrestrial), were obtained from relevant government departments in Indonesia including Ministry of Forestry, Ministry of Marine Affairs and Fisheries and Department of Spatial Planning.

Existing and Proposed MPAs and Coastal Reserves

The location and boundaries of existing (gazetted) coastal reserves and MPAs was obtained from relevant government agencies (Ministry of Forestry and MMAF) at district, provincial and national government levels. The location and boundaries of proposed MPAs (identified but not yet gazetted) were obtained from a variety of sources including district and provincial reports and draft spatial plans.

At the beginning of this project in 2006, the Lesser Sunda Ecoregion already contained a 12 MPAs covering 318 000 hectares. During the course of this project an additional 3.8 million hectares of MPAs were created in the Lesser Sunda Ecoregion with the declaration of the Savu Sea Marine National Park (3.4 million hectares) and Pantar Strait MPA (0.4 million hectares).

Shallow Coastal Habitats and Species

Conservation targets include the full range of marine habitats and species that occur in shallow coastal waters of less than 200 meters in depth (Table 5) including coral reefs, seagrass, mangroves and estuaries.

Prior to this study there was insufficient information available on the distribution and classification of shallow coastal habitats and species in the Lesser Sunda at an appropriate scale for MPA network design. Therefore the following studies were undertaken:

- The distribution of seagrass and coral reef extent and zonation was determined through analysis of LANDSAT imagery (Torres-Pulliza 2008). LANDSAT images for this analysis were sourced from the publically available data archive from the Millennium Coral Reef Mapping Project (Andréfouët et al. 2006).

- Coral reef seascapes were identified based on an analysis of best available information on the biodiversity, distribution and endemism of corals, coral reef fishes, mangroves and seagrass (DeVantier et al. 2008). This report also included a classification of coral reefs into four major types based on geomorphic characteristics and exposure.
- Mangrove and estuary distribution was digitized from LANDSAT imagery (1999-2001) by TNC staff through visual interpretation.
- The distribution of bathymetric or geomophological features, marine mammals and other large marine fauna in waters less than 200 metres deep (Kahn 2008).

While habitat is generally used as a proxy for biodiversity throughout this report, there are also some species with either restricted distribution or threatened populations which were also mapped separately (including seabirds, marine mammals, sharks and Napoleon Wrasse) (Table 5). The distribution of these selected coastal species was identified through expert mapping by government representatives or local scientists. Maps of the distribution of these features are provided in Appendix B.

Socio-Economic Factors

Information regarding patterns of resource use and other socio-economic factors which may be supported by or conflict with the development of MPAs was collected with a focus on fisheries, destructive fishing, tourism, aquaculture, coastal development, mining and shipping and ports (Table 5). This information was obtained by hiring local consultants in each province to search government reports and using local networks to find and map relevant information. Additional information was obtained through expert mapping. Maps of the distribution of some of these factors are provided in Appendix B.

Deep Sea yet Near Shore Habitats and Species

The distribution of deep sea yet near shore habitats and species was obtained through an analysis of key bathymetric and oceanographic features and known distributions of large marine species (Kahn 2008). Bathymetric and oceanographic features included seamounts, underwater canyons, satellite islands, migratory pathways for cetaceans and persistent pelagic habitats, i.e., those areas which experience consistent seasonal upwelling. Large marine species include cetaceans, dugongs, turtles, sharks, manta rays and mola mola. The deep sea yet near shore habitats and species used as conservation targets in this analysis are listed in (Table 6). Maps of the distribution of these features are provided in Appendix C.

Assembling a GIS Database

Data were collected as, or converted to, spatially referenced electronic maps (GIS layers), and arranged in a geodatabase in ArcGIS. The database contains a total of 61 themes including conservation and socioeconomic features (Appendix A). Copies of the geodatabase (containing data themes that can be shared with partners) are available for use by partner agencies and organizations in Indonesia. The final GIS database includes data layers obtained through expert mapping exercises documented below.

Table 5. Conservation targets and socio-economic factors for shallow coastal waters.

Category	Conservation target	Description
Shallow Coastal Habitats	Coral reef	Fringing, patch, barrier reefs and atolls with substrate that supports coral growth. Reefs classified into sub-classes based on geomorphology and exposure
	Seagrass	Substrate which supports dense or sparse seagrass growth
	Mangrove	Intertidal and coastal areas where vegetation is dominated by mangrove species
	Estuary	a semi-enclosed coastal body of water with a free connection to the sea and where fresh and marine waters mix.
	Straits	A narrow channel joining two larger bodies of water. May be important as migratory path for cetaceans and other large marine fauna
	Satellite islands	Islands near large landmasses yet located in isolated positions near the 200m contour. Typically have high habitat diversity including coastal and oceanic components
	Persistent pelagic habitats	Pelagic areas that exhibit consistent and / or seasonal upwelling indicated by lower sea surface temperature and increased primary productivity
Species	Distribution	Known distribution of cetaceans, dugongs, turtles, mola mola, whale sharks, manta rays, Napoleon Wrasse in shallow waters
	Feeding and nesting areas	Known locations of nesting sites and feeding areas for turtles and seabirds
	Spawning sites	Location of fish and shrimp spawning sites
Other	Waters in front of terrestrial reserves	Coastal waters more likely to be in a good condition due to low runoff. Opportunities for MPA management due to existing infrastructure and resources
	Dive sites	Areas frequented by dive tour operators and therefore likely to be in good condition
Socio-Economic Factors	Fisheries and aquaculture	Location of fishing villages, important fishing grounds and established pearl and seaweed farms and shrimp ponds
	Destructive fishing	Location of bomb and cyanide fishing and coral harvesting
	Coastal development	Location of coastal cities and towns based on current population estimates
	Tourism	Location of tourism infrastructure including resorts, hotels and pontoons
	Shipping	Location of local, national and international shipping lanes and current and planned port developments
	Mining	Location of marine disposal of tailings or where sediment runoff is associated with mining activity and is likely to affect coastal marine ecosystems

Table 6. Conservation targets and socio-economic factors for deep sea yet near shore areas.

Category	Features	Description
Deep Sea Habitats	Atolls	Ring-shaped reefs with a central lagoon surrounded by deep-seas
	Oceanic islands	Isolated islands surrounded by deep-seas
	Canyons	Steep valleys on the sea floor which often rise sharply towards the continental shelf
	Pinnacles	Underwater 'mountains' defined by less than 1000 m rise from the seafloor
	Seamounts	Underwater 'mountains' defined by a 1000 m or more rise from the seafloor
	Satellite Islands	Islands near large landmasses yet located in isolated positions near the 200 m contour. Typically have high habitat diversity including coastal and oceanic components
	Deep-sea sills	Submarine ridges which can restrict deep water flow between two ocean basins
	Trenches	Extremely deep trenches within the sea floor where there is a convergent tectonic plate boundary or subduction zone
	Migratory corridors – deep	Passages >200 m deep of major ecological and regional conservation importance
	Migratory corridors - shallow	Passages <200 m deep of major ecological and regional conservation importance
	Minor passages	Passages <50 m depth that are important for localized movements of large marine fauna and influence complex oceanographic features including seasonal upwelling
	Extreme habitats	Areas where extreme depth gradients occur over a short distance
	Diverse inshore habitats	Shallow coastal habitats important for inshore marine mammals
Oceanographic Targets	Indonesian Throughflow	Areas strongly influenced by the Indonesian Throughflow
	Persistent pelagic habitats	Pelagic areas that exhibit consistent and / or seasonal upwellings indicated by lower sea surface temperature and increased primary productivity
Species	Large migratory marine life	Sites important for species such as mola mola, mantas and whale sharks
	Large number of cetaceans	Sites where consistent sightings of some whale species occur
	High cetacean diversity	Sites of high cetacean diversity and abundance for residential and migratory species
Social, Cultural and Economic Targets	Transboundary waters	Waters between Indonesia and Timor-Leste with a shared boundary
	Marine tourism	Sites of marine tourism activities including day trips and/or regular live-aboard trips
	Historical significance	Areas with significant traditional or colonial history including Portuguese and Dutch influences
	Cultural significance	Areas where traditional marine mammal hunting is practiced

USING A DECISION SUPPORT TOOL (MARXAN) IN MPA NETWORK DESIGN

The process to design a resilient MPA network in the Lesser Sunda Ecoregion was essentially a gap analysis to identify recommended AOIs for future MPA development based on the existing MPA network, the distribution of key habitats and species and resilient MPA network design principles (Table 2 and Table 3).

This was done through a process which combined detailed scientific analysis and extensive input from stakeholders. Since this process required the consideration of many physical, biological, social and economic factors simultaneously, it was a complex task.

To help with this task, a decision support tool called Marxan (see below) was used, allowing several options for MPA network design to be generated quickly. The results were used to develop draft protected area network designs that were subsequently modified based on input from key stakeholders and scientific experts. The final MPA network design was based on input from staff from key government agencies in each province in Indonesia and from Timor-Leste (Appendix E, G, H).

Using Marxan as a Decision Support Tool

Marxan is a computer based software program that was developed to aid in the design of protected areas and protected area networks (Ball and Possingham 2000, Possingham et al. 2000). It was designed to help synthesize and automate the selection process so that many different scenarios for MPA arrangement can be developed and explored.

Marxan analyses spatial data (GIS format) on the distribution of conservation targets and socio-economic factors. Each conservation target is assigned a goal[2] for representation within the MPA network and socio-economic factors that may affect the conservation value of a MPA, e.g., disposal of mine tailings, or where the development of a MPA would have a significant social or economic impact, e.g., important fishing grounds are assigned a 'cost'.

The planning area is divided into hexagonal planning units. Hexagons are used because they share a boundary with all adjacent units and thus allow the software program greater choice in selecting adjacent planning units with similar features. By overlaying the GIS data over the planning units, each planning unit then contains attributes for conservation targets and 'costs'.

Marxan seeks to identify the most efficient arrangement of selected planning units, i.e., the arrangement which covers the least aerial extent, includes areas with the highest conservation values while simultaneously minimizing the 'cost' or socio-economic impact. Marxan also tries to arrange the selected planning units into groups distributed throughout the planning region. To identify the best arrangement for planning units to meet all these criteria, Marxan analyses the data 'randomly' through 100 runs, where each run considers thousands of iterations and options for planning unit arrangement. Numerous options are produced from each Marxan run, and these can be used to support the development of draft MPA network designs for discussion with stakeholders and communities.

The frequency with which each planning unit is selected during the 100 runs gives an indication of its importance, i.e., planning units selected in every run indicate that this area has a special feature which cannot be easily found elsewhere. The results of the Marxan runs are presented in two ways. 'Sum solutions' produce maps where warm colors (red/orange) indicate areas that were selected most frequently, while cool colors (green and blue) represent areas which were selected less frequently. Less frequently selected areas may still contain important conservation targets, but these targets are

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[2] The ideal percentage representation of each conservation target and subclass in the final MPA network

likely to be common or widespread, which indicates there is some flexibility in choosing areas to represent the conservation targets in that planning unit. 'Best solutions' show the areas which best meet all criteria and are shown in pink.

Marxan was also used as an 'accounting tool' to calculate the representation of each conservation target in the MPA network. Manual checking was used to assess other design criteria such as the distance between MPAs.

Please note that there are slight differences in terminology between Marxan and TNC conservation planning approaches. TNC terminology has been used throughout this report. The main differences are:

TNC target = Marxan conservation feature; and

TNC goal = Marxan target.

<u>Marxan Planning Unit Layer</u>

Marxan was applied to the analysis of all shallow coastal waters in the Lesser Sunda Ecoregion. The offshore boundary extended to the 200 meter depth contour. The inshore boundary was defined as 1 kilometer inshore of the coastline to ensure turtle nesting beaches, mangroves and estuaries were included in the analysis.

This area was divided into 'planning units' which consisted of 32,441 hexagons (each 1 square kilometer) for the Marxan analysis (Figure 6). This arrangement provided sufficient resolution for the analysis, while also ensuring a reasonable processing time for the Marxan analysis.

Marxan was not used to identify deep sea yet near shore MPAs (>200 metres depth) but were delineated manually (see *Deep Sea yet Near Shore*). This was because priority areas were provided in Kahn (2008), and it was considered that the area was too large for the effective application of Marxan.

<u>Conservation Targets and Goals Layer</u>

Each conservation target used in the Marxan analysis was assigned a goal for representation. Goals were assigned to a total of 37 conservation targets which included sub-classes for some conservation targets such as coral reefs classified by geomorphology and exposure (Appendix D). Goals for each target varied depending on the design criteria (Tables 2 and 3), the extent and distribution of each conservation feature and the importance or rarity of the target. For this analysis, we used:

- 30% of each shallow marine habitat (coral reefs, mangroves, seagrass and estuaries) and its sub-class.
- 80% of special and unique areas including confirmed turtle nesting and feeding areas and spawning aggregation sites for fish and shrimp.
- 5% of large scale persistent pelagic habitats (e.g., upwelling), satellite islands, straits
- 80% known distribution of cetaceans and dugongs in shallow coastal waters.
- 50% of areas known to be important for dolphins (identified from expert mapping).
- 5% of areas identified as important to seabirds.
- 100% of small areas identified as important habitat for rare and/or endangered species such as Napoleon Wrasses and sharks.
- 80% of dive sites, since they are likely to be in coral reef areas that are still in good condition (although this still requires confirmation).

- 50% of marine areas in front of (terrestrial) coastal reserves.

Maps of each conservation target are provided in Appendix B and C, and an example of one data layer (coral reefs) is provided in Figure 7.

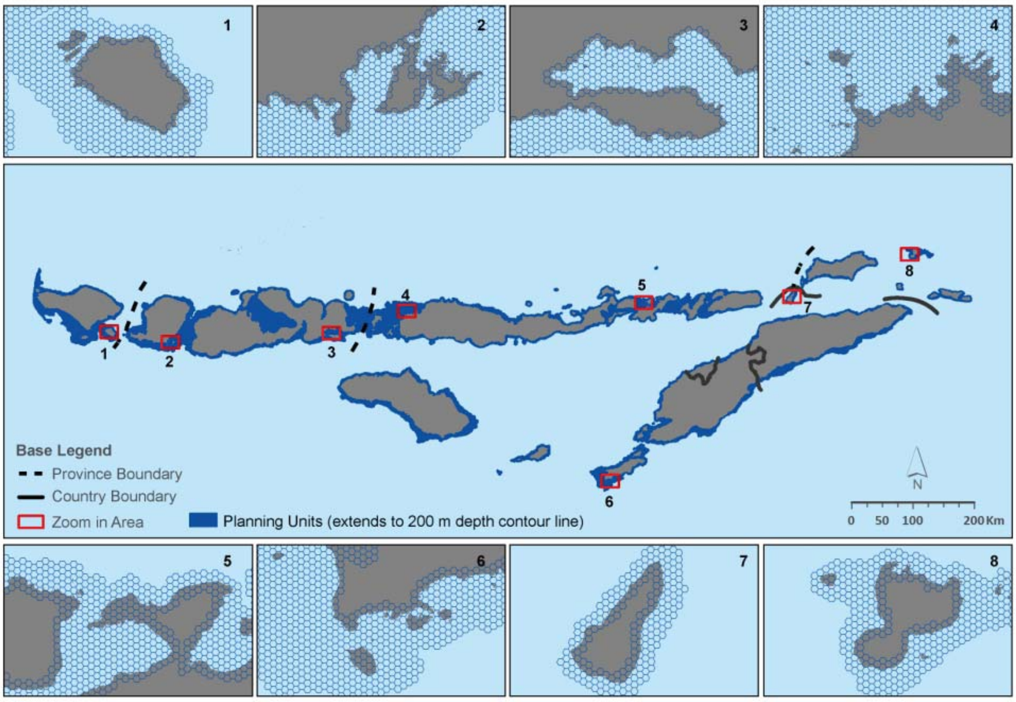

Figure 6. Planning unit layer with provincial boundaries.

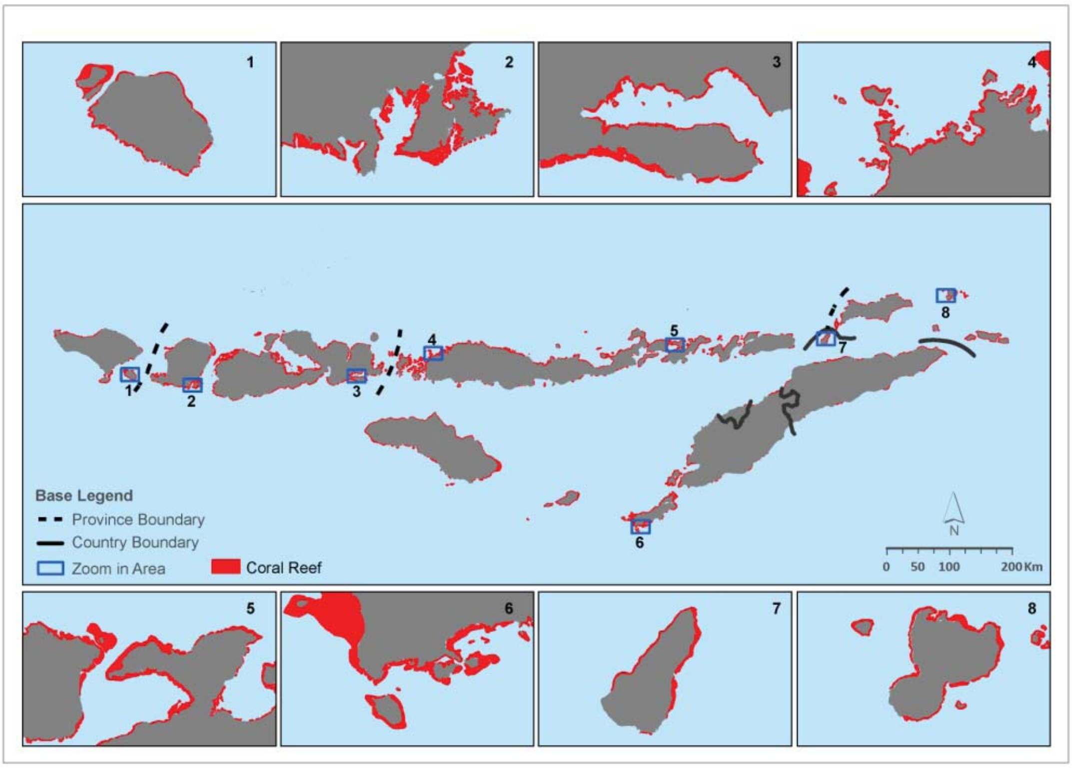

Figure 7. An example of a conservation target data layer: coral reefs.

Cost Layer

In Marxan, a cost layer is used to allow inclusion of socio-economic information which may influence the location of MPAs in the analysis. For the Lesser Sunda analysis, the 'cost' layer was based on socio-economic factors that may affect the conservation value of a MPA, e.g., disposal of mine tailings or where the development of a MPA would have a significant social or economic impact, e.g., important fishing grounds. It was very difficult to generate effective cost layers, because there was so little information available for the ecoregion.

Five cost layers were used in the final analysis (Table 7). Each factor was assigned a score from 1 to 10 which represented the degree of influence on conservation and sustainable use goals, with 1 representing least influence and 10 representing most influence. A total cost score for each planning unit was calculated by adding all the cost scores for each individual planning unit. Total cost scores were converted to a percentage value (ranging between 1 and 100) using the formula:

Cost = total cost from planning unit/maximum total cost score * 100.

The cost score distribution is shown in Figure 8.

Additional information on socio-economic factors which might influence the location of MPAs was also collected, and used to refine the MPA network design 'manually' through discussions with stakeholders. They included:

- location and area of influence of major industries;
- human population centres (major towns/cities);
- important fishing areas; and
- areas with opportunities for sustainable fisheries, tourism and aquaculture.

Table 7. Cost Layers.

Theme	Description	Score	Data Source
Shipping lanes	Shipping lanes recognised at international, national and provincial levels (with 1km buffer zones)	3	Coastal Spatial Plan (NTB) Department of Spatial Planning 2006
Blast fishing	Areas affected by blast fishing (currently or in the past)	7	Stakeholder mapping
Poison fishing	Areas affected by fishing using poisons (currently or in the past)	7	Stakeholder mapping
Coral harvest	Areas where corals are harvested from the wild for the aquarium trade	5	Stakeholder mapping
Seaweed culture	Areas used for seaweed culture with a surrounding buffer of 500m	2	Stakeholder mapping/ field surveys 2008

Data Analysis

Marxan was one method used to help identify areas in the Lesser Sunda Ecoregion of high conservation value and low cost for inclusion in a resilient MPA network. Marxan was used at various stages of the MPA network design. Each step in this process is described in detail below.

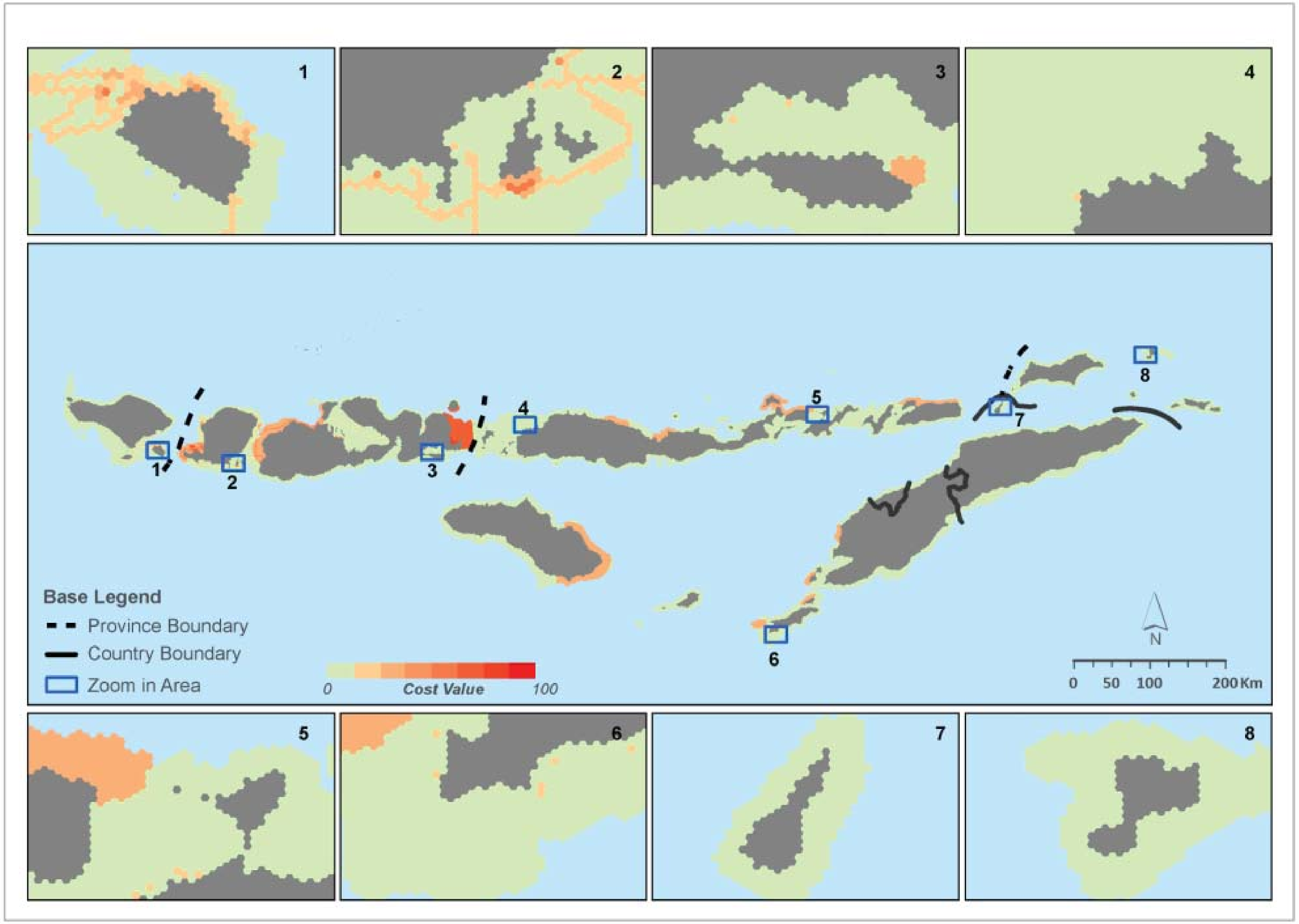

Figure 8. Total cost scores used for the Marxan analysis.

DESIGNING A RESILIENT NETWORK OF MPAS USING A DECISION SUPPORT TOOL WITH STAKEHOLDER INPUTS

PRELIMINARY IDENTIFICATION OF HIGH CONSERVATION VALUE AREAS

Marxan was first used to conduct a preliminary analysis to identify broad scale areas of high conservation value and minimal ‘cost’. For this analysis, we considered the entire Lesser Sunda Ecoregion as one area (with no subdivisions).

Since the aim of this analysis was to identify broad areas of conservation importance, a goal of 60% was used for representation of each major shallow marine and coastal habitat type. The data analysis was also ‘unconstrained’, such that existing or proposed MPAs were not identified in the analysis.

The summed solution for this preliminary analysis is shown in Figure 9. Areas in red indicate the best options for consideration of establishment of MPAs since they identify areas of high conservation value while avoiding areas of high ‘cost’.

These results were presented at a Stakeholder Workshop in December 2008 to facilitate discussion and demonstrate how Marxan would be used in the analysis.

STAKEHOLDER WORKSHOP: STRENGTHENING GOVERNMENT COMMITMENTS AND EXPERT MAPPING

In December 2008, 50 representatives from relevant provincial and national government agencies, NGO partners and other stakeholders participated in a Lesser Sunda Ecoregion MPA network design workshop in Bali (Appendix E).

The workshop objectives were to:

1. obtain consensus from key district, provincial and national government agencies from both Indonesia and Timor-Leste regarding the methods and procedures to use to develop a scientific design of an MPA network (including MPA network design principles); and
2. complete the GIS database through refinement of existing data sets, sourcing any additional ‘missing’ data sets and collecting any new/unpublished information.

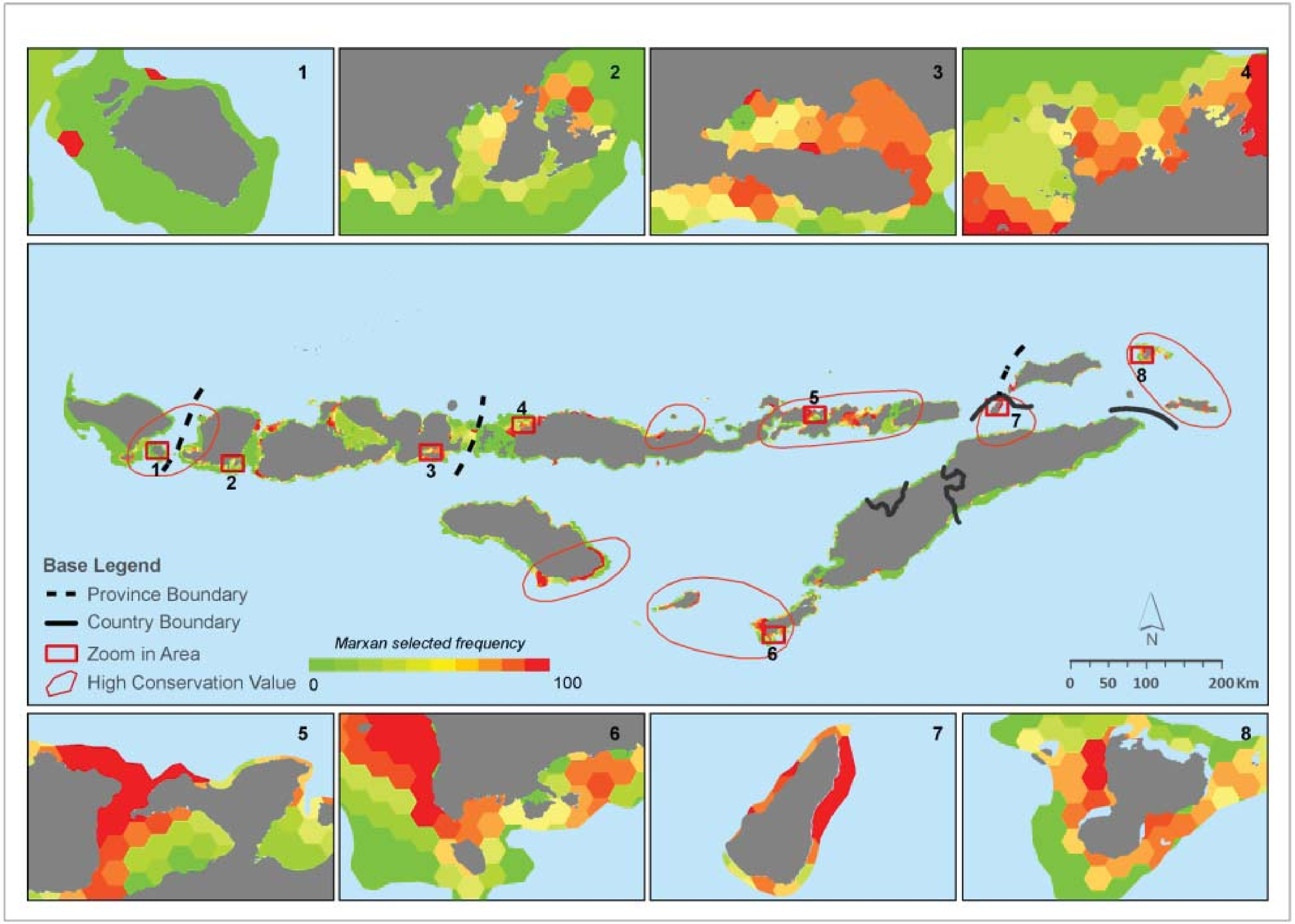

Figure 9. Preliminary identification of areas of high conservation value (red areas).

Strengthening Government Commitments

During this workshop, government representatives from the provincial and national levels of Indonesia and Timor-Leste agreed on the process to identify areas that will serve as the basis for creating a resilient MPA network within the Lesser Sunda Ecoregion, and committed to implementing the MPAs within their jurisdictions. This commitment was formalised in a document which detailed the recommendations from this workshop and was signed by key representatives (Appendix F).

Expert Mapping

As much of the relevant knowledge about the area has not yet been documented, an expert mapping exercise was conducted to document the spatial distribution of important conservation and socio-economic targets based on expert opinion.

Stakeholders were assigned to groups representing country and provincial areas. Large A1/A0 size maps were provided showing the coastline, district boundaries and existing data layers for conservation and socio-economic targets. Colour marking pens were available for participants to identify additional areas of distribution/importance for key conservation targets (habitats and species), threats (e.g., bomb/destructive fishing), areas of resource use (e.g., fishing, aquaculture).

The expert mapping exercise generated an additional 14 data sets. A selection of these data sets, which stakeholders considered reliable and useful for the analysis, was added to the GIS database.

FIRST DRAFT OF MPA NETWORK DESIGN FOR SHALLOW COASTAL WATERS

The first draft of a MPA network design for shallow marine and coastal habitats was developed using Marxan in March 2009. This analysis followed the same approach as that described for the preliminary analysis to identify key conservation values above, with some refinements and modifications to incorporate input received from stakeholders at the workshop.

Key refinements included:

1. New GIS data layers developed from the expert mapping in the Stakeholder Workshop were included in the analysis.
2. Some areas were locked in and out of the analysis. Existing and proposed MPAs were locked in to make sure that they were included in the MPA network design. Areas of traditional whale hunting in Solor Alor were locked out so that they would not be included due to the potential the conflict this would cause with local communities.
3. More refined goals for each conservation target were used (Appendix D).
4. The planning area was divided into three stratification units (hereafter called ‘regions’, see Figure 4): Bali Province, Nusa Tengarra Barat Province (NTB: West Nusa Tengarra) and Timor-Leste with Nusa Tengarra Timor Province (NTT: East Nusa Tengarra / TL: Timor-Leste). These regions were chosen as they align with provincial Indonesian political boundaries with the exception of NTT/Timor-Leste unit. They also reflect the different quality and quantity of data available for developing cost layers and some conservation targets in each province/country.

A Marxan analysis was run for each region individually and the results combined into one map (Figure 10). This map was then used as the first draft of the MPA network design to identify AOIs for consideration as new MPAs in the future. An assessment was also conducted (using Marxan as an accounting tool, as well as manual assessments) to ensure the design addressed the MPA network design principles as far as practicable.

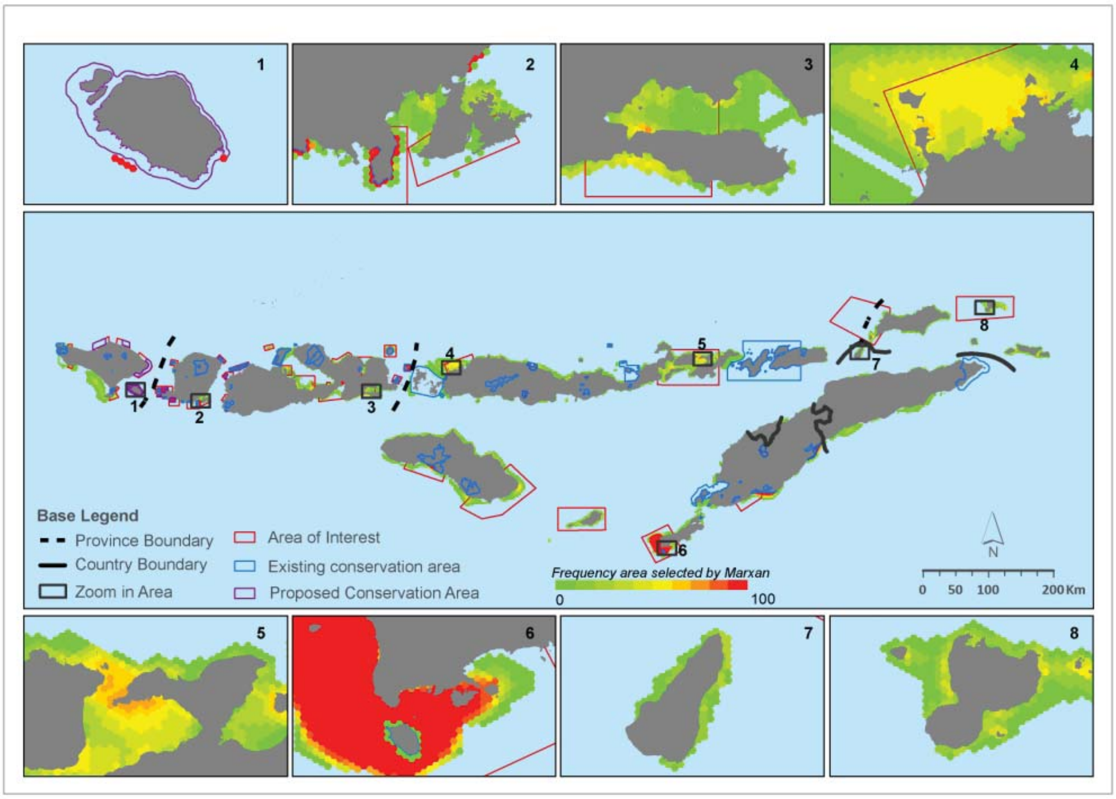

Figure 10. First draft of MPA network design showing existing and proposed conservation areas (MPAs), and AOIs for consideration as new MPAs for shallow marine and coastal habitats.

SCIENTIFIC REVIEW OF MPA NETWORK DESIGN

Local and international scientists were invited to review the first draft of the MPA network design to determine if it met the design criteria and to obtain further scientific inputs into the design. This was because the limited data available for the Lesser Sunda Ecoregion restricted how much Marxan could inform the decision-making process.

In April 2009, a group of 24 experts from the Indonesian government and academic institutions, along with international advisors from TNC, met in Bali for a two-day scientific workshop to review the draft MPA network design (Appendix G).

Images of the Lesser Sunda Ecoregion from Google Earth were projected onto a screen and compared with the GIS data layers and draft MPA network design. Inputs were based on the participants' knowledge of the areas, recent government or community initiatives which would support or hinder MPA development and results of unpublished studies.

Additional data sets were sourced and boundaries and or locations of proposed MPAs and AOIs were modified. In particular, input from Timor-Leste representatives at this workshop identified a number of proposed MPAs, which were digitised and included in the data layer of existing and proposed MPAs.

SECOND DRAFT OF MPA NETWORK DESIGN

Shallow Coastal Waters

A second draft of the MPA network for shallow coastal waters was developed by modifying the boundaries 'manually' based on the inputs of key scientists at the scientific review workshop (Figure 11). Marxan was not used to assist in the design of this second draft MPA network design.

During this process, the MPA design was constantly assessed and refined to ensure that it addressed the MPA network design principles (Tables 2 and 3) as far as practicable (by using Marxan as an accounting tool, as well as manual accounting). For the assessment of the design criteria, all three regions were combined.

This was an iterative process that required moving AOI boundaries, and including new AOIs, until the design principles and goals were met. In particular, boundaries were modified to ensure that biological, socioeconomic and cultural interests had been taken into account.

Deep Sea yet Near Shore Areas

Deep sea yet near shore habitats and species encompass important feeding grounds, migratory pathways and 'bottlenecks' for large marine fauna, and underwater features such as deep sea canyons and seamounts and oceanic atolls and islands (Table 6). Together with the shallow coastal data sets (Table 5), they provide a comprehensive database of all habitats that support the biodiversity and fisheries of the Lesser Sunda Ecoregion.

Deep sea yet near shore AOIs to protect these habitats and species were incorporated into the MPA network design during the development of the second draft of the MPA network for shallow coastal waters. At this stage, much of the information on important deep sea yet near shore habitats and species had been digitized from Kahn (2008).

The boundaries of the deep sea AOIs were determined manually by the following process based on the design criteria in Table 4. In April 2009, a small group of local and international experts identified an additional 14 key areas for inclusion in the MPA network as deep sea AOIs based on Kahn (2008). Where possible, these deep sea AOIs included important deep sea yet near shore habitat, which were adjacent to shallow coastal MPAs to capture a continuum of habitats from inshore reefs to the deep sea. The result was a second draft of an MPA network design that incorporates MPAs for both shallow marine and coastal habitats as well as deep-sea yet near shore habitats (Figure 11).

FINAL CONSULTATION WITH INDONESIAN PROVINCIAL AND TIMOR-LESTE GOVERNMENTS

Once the second draft of the MPA network design had been completed, it was used as the basis for further consultation with government representatives throughout the Lesser Sunda Ecoregion. It was presented to numerous government officials in each of the three Indonesian provinces and Timor-Leste during May and June 2009. The Lesser Sunda team travelled to each provincial capital in Indonesia and the capital of Timor-Leste to meet with as many relevant government agencies as possible, including the Department of Fisheries, Department of Forestry, Department of Spatial Planning, Department of Environment and Department of Tourism. A total of 22 meetings attended by 222 participants were held across the three Indonesian provinces and Timor-Leste. The objective of this exercise was to both raise awareness of the relevant government agencies for the project and upcoming results, and to and obtain final inputs and suggestions on the location of MPAs. This was done with the goal of making sure the design was as locally relevant in each province as possible and aligned with existing spatial or strategic plans. A summary of these meetings is available in Appendix H.

Any changes to the design suggested during these meetings were incorporated manually by modifying the boundaries of the MPAs to reflect the inputs. Marxan and manual checking were used again as accounting tools to confirm that the MPA network design principles were complied with as much as possible (particularly regarding the goals for representation and replication of major habitat types). This process resulted in the Final Lesser Sunda MPA network design (Figure 12).

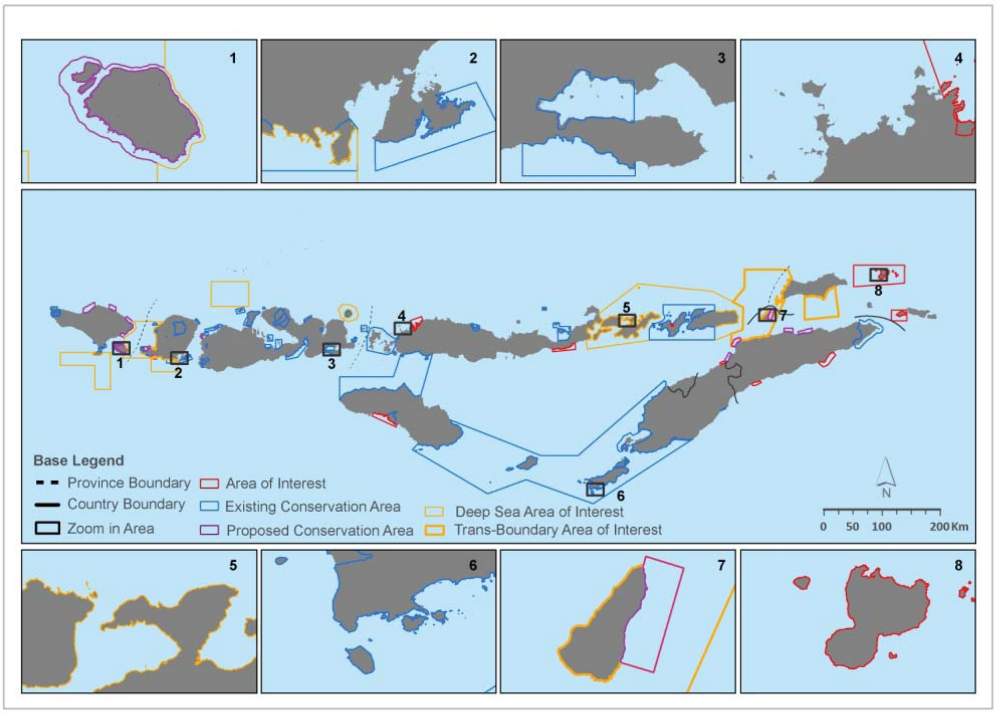

Figure 11. Second draft of MPA network design showing existing and proposed MPAs and AOIs for consideration as new MPAs, for both shallow marine and coastal habitats and deep sea yet nearshore habitats.

FINAL MPA NETWORK DESIGN FOR SHALLOW COASTAL WATERS AND DEEP SEA YET NEAR SHORE AREAS

The final MPA network design for the Lesser Sunda Ecoregion is shown in Figures 12 and 13 and for each region in Figures 14-17. It includes 100 Protected Areas which if declared and managed effectively would create a resilient MPA network for the Lesser Sunda Ecoregion. The MPA network design encompasses a total area of 9.8 million hectares (Table 8) and includes:

- 86 areas encompassing 5.6 million hectares designed to protect shallow coastal habitats and species, including 23 existing coastal reserves, 14 existing MPAs, 19 proposed MPAs and 30 new AOIs identified through this process; and
- 14 areas encompassing 4.2 million hectares to protect deep sea yet near shore habitats and species, of which three areas encompass transboundary waters between Indonesia and Timor-Leste.

The Lesser Sunda Ecoregion MPA network includes:

- 23 terrestrial reserves that are adjacent to the coast and encompass intertidal habitats, such as mangroves or turtles nesting beaches;

- 14 existing MPAs that represent coral reefs, seagrass, mangroves, turtle nesting beaches and associated habitats and species;
- 19 areas that national, provincial or district governments have proposed as MPAs but have not yet been declared;
- 30 additional AOIs[3] that were identified through this analysis; and
- 14 deep sea and transboundary areas of interest — three of which encompass transboundary waters between Indonesia and Timor-Leste.

Table 8. Total area of marine protected area network, and area of each category (existing and proposed reserves and MPAs, AOIs).

Category	Definition	Total area (000' s ha)	Number
	Shallow Coastal Waters		
Existing Coastal Reserves	Existing terrestrial protected areas that are adjacent to the coast which encompass intertidal marine conservation features such as turtle nesting beaches and mangroves	150,000	23
Existing MPAs	Existing MPAs gazetted by the Indonesian or Timor-Leste governments that encompass coral reefs, seagrass, mangroves, turtle nesting beaches and associated habitats and species	4,350,000^	14
Proposed MPAs	Areas that have been proposed as new MPAs by national, provincial or district governments in Indonesia or Timor-Leste governments, but have not yet been formally declared	200,000	19
Areas of Interest AOIs	Coastal areas (<200m depth) identified during this study for inclusion in the Lesser Sunda MPA network to meet resilient MPA network design	900,000	30
Total		**5,600,000**	**86**
	Deep Sea yet Near Shore Areas		
Deep Sea AOIs	Oceanic areas (>200m depth) to protect deep sea habitats and large marine fauna	3,200,000	11
Transboundary AOIs	Three deep sea AOIs that encompass transboundary waters between Indonesia and Timor-Leste	1,000,000	3
Total		**4,200,000**	
Grand total		**9,800,000**	100

^ area of MPAs only includes the component of the protected area that covers marine waters or coastal marine targets such as mangroves. For example Bali Barat National Park encompasses both terrestrial and marine areas but only the marine area is reported here.

[3] The MPAs proposed during this process have been termed 'Areas of Interest' as final boundaries will need to be decided and declared by district, provincial and national governments before they are established as MPAs.

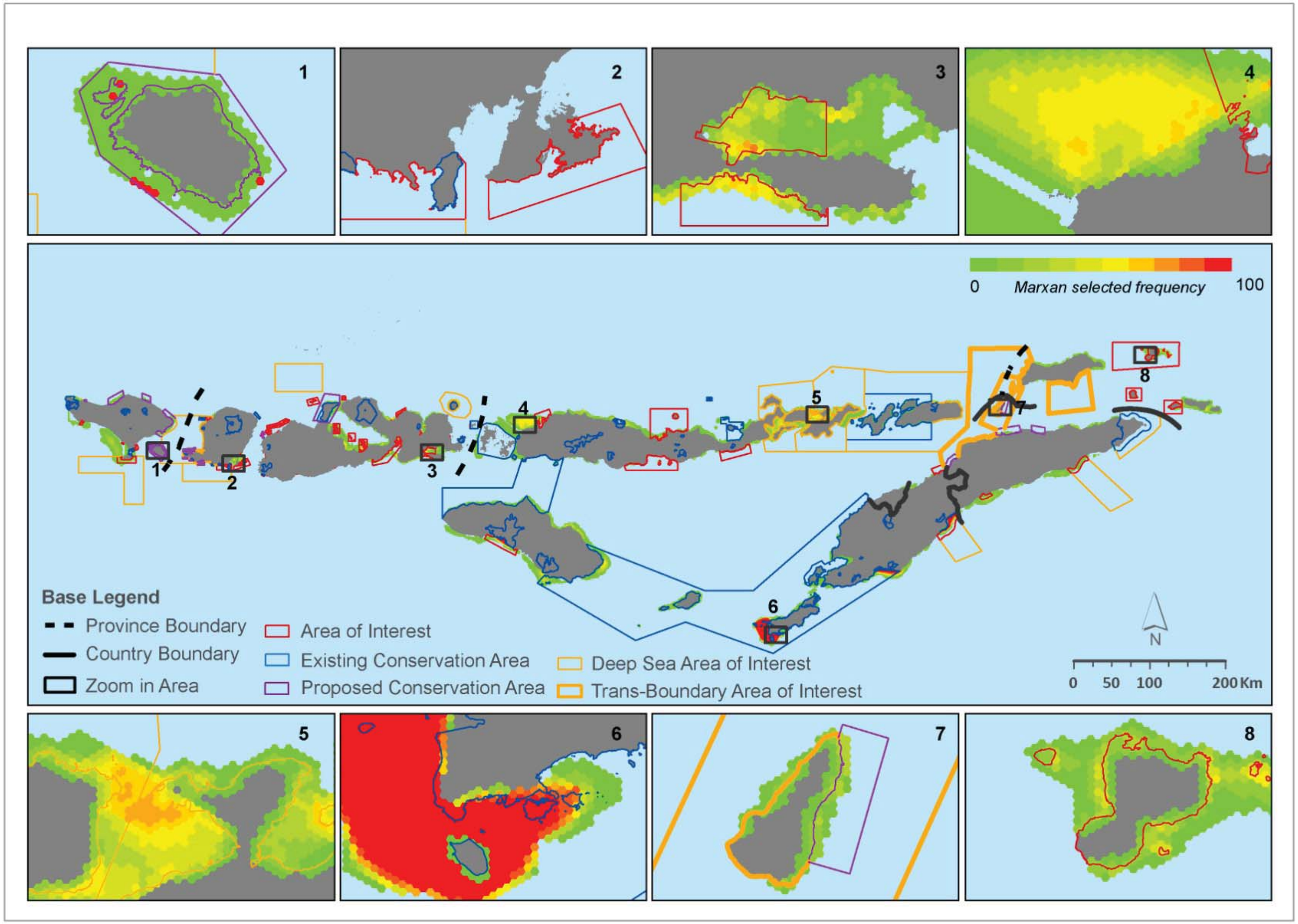

Figure 12. Final MPA network design showing existing and proposed conservation areas (MPAs) and AOIs for consideration as new MPAs, for both shallow marine and coastal habitats and deep sea yet nearshore habitats.

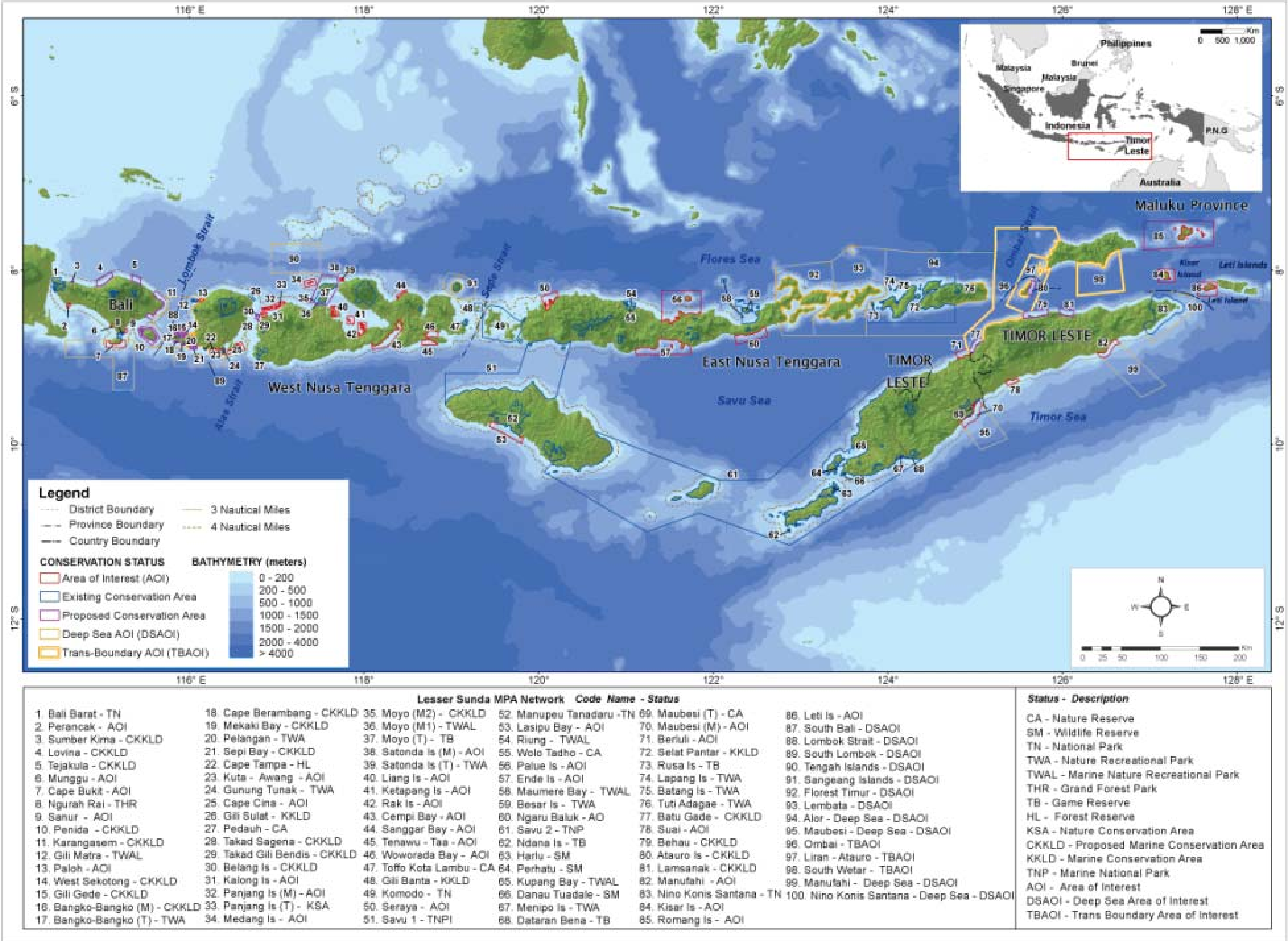

Figure 13. Lesser Sunda MPA network with names and designations for all MPAs and AOIs.

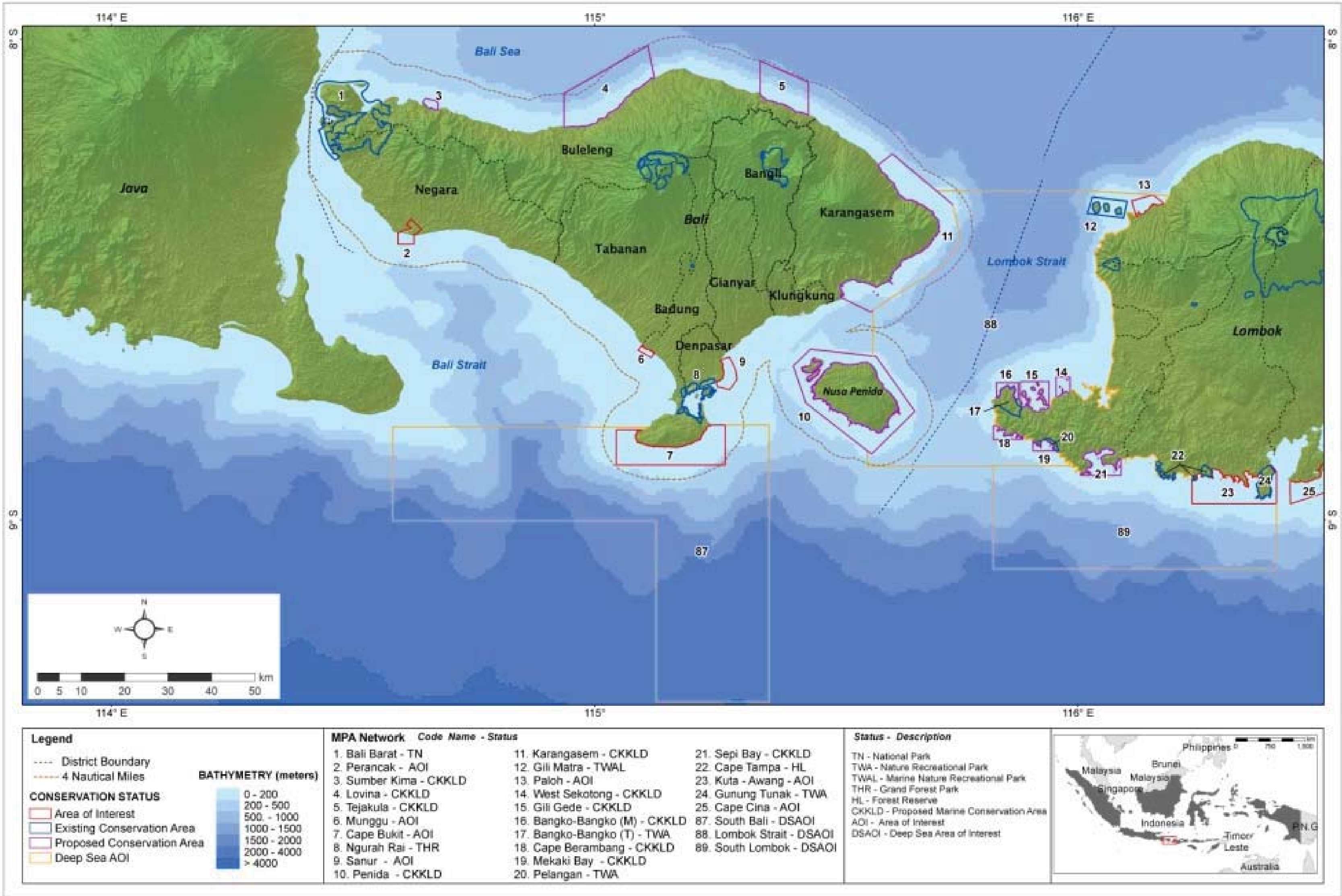

Figure 14. Bali MPA network.

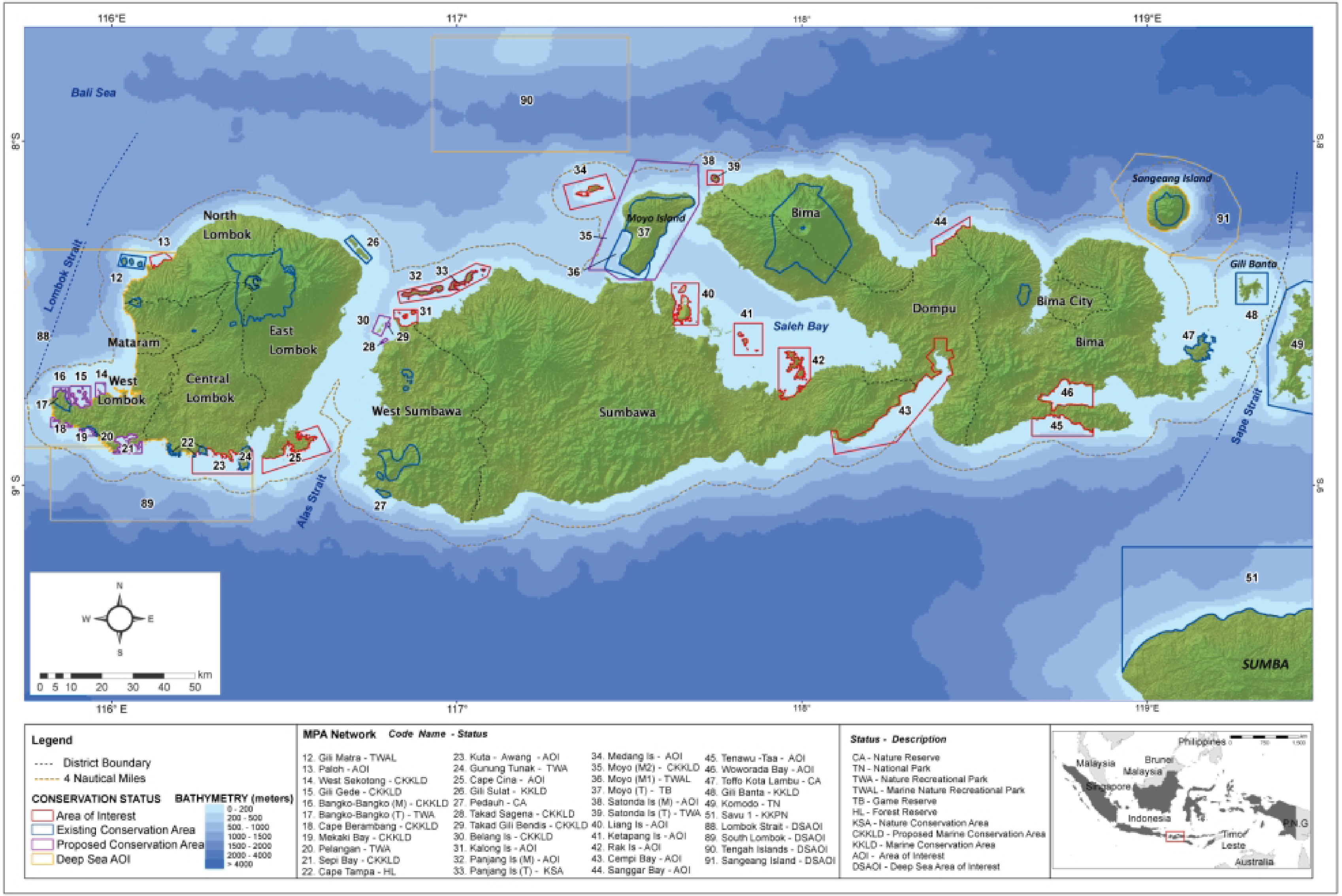

Figure 15. West Nusa Tengarra MPA network.

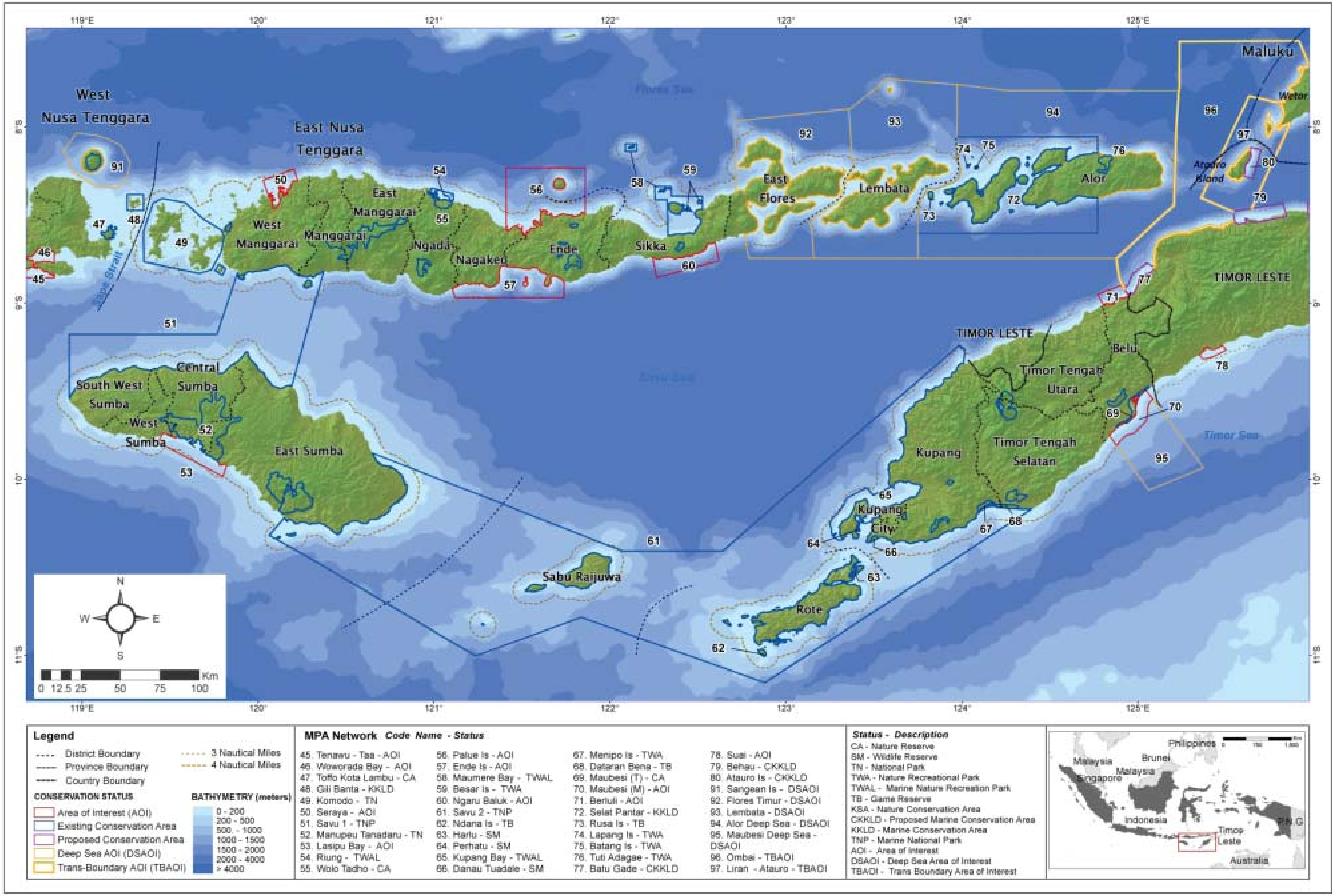

Figure 16. East Nusa Tengarra MPA network.

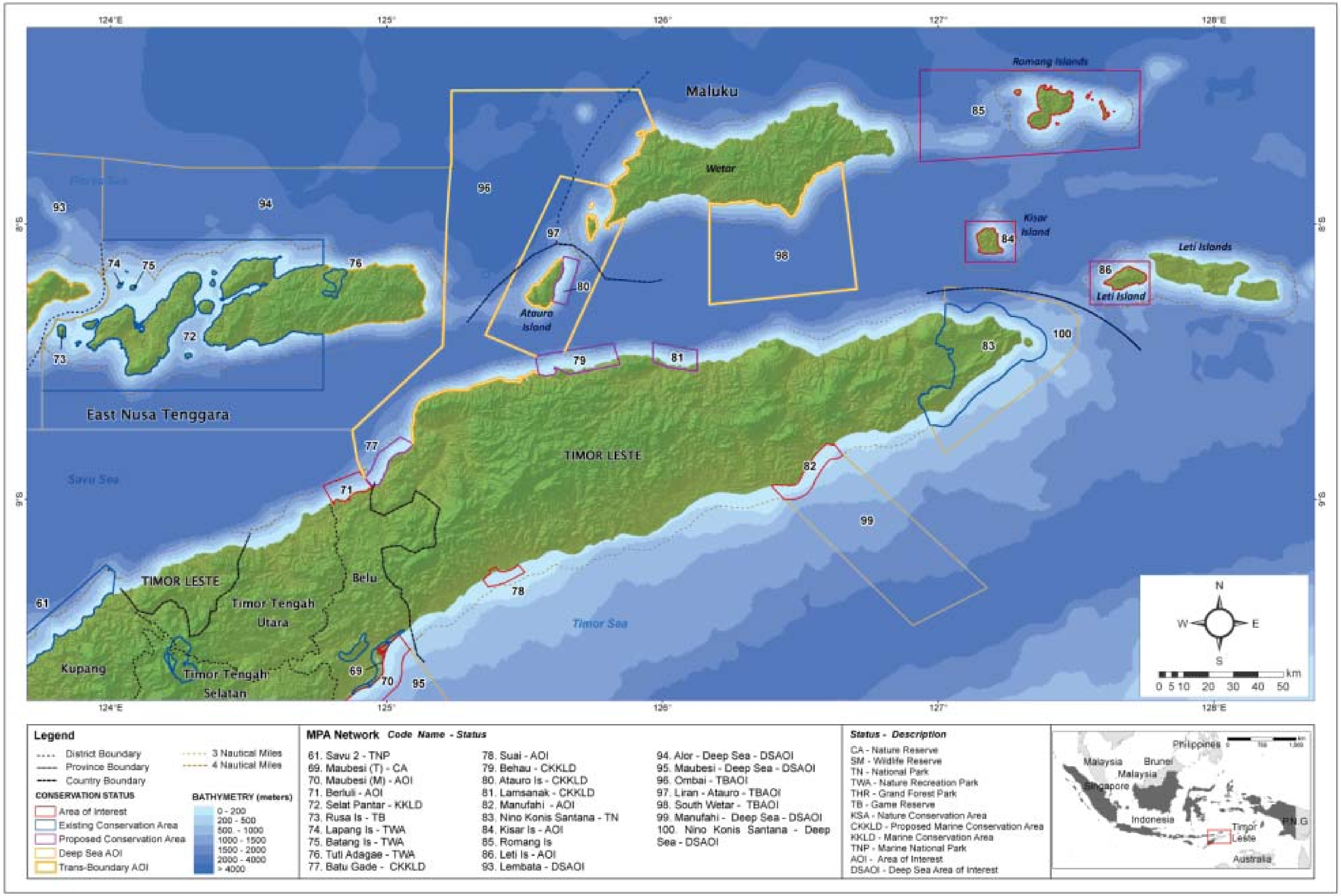

Figure 17. Timor-Leste MPA network.

AN ASSESSMENT OF MPA NETWORK DESIGN CRITERIA

Once the final MPA network design was completed, Marxan and manual checking was used to assess the entire MPA network design to ensure that the design principles and goals in Tables 2, 3 and 4 had been applied successfully, and to confirm that the network objectives would be achieved. Manual accounting confirmed that if these areas are effectively conserved, the MPA network design principles and goals will have been applied successfully and the network objectives will be achieved.

The following is an assessment of how well the final MPA network design meets the MPA design criteria.

Biophysical Design Criteria

Risk Spreading (Representation and Replication)

The final Lesser Sunda MPA network design met, and in many cases exceeded, most criteria for representation and replication of conservation targets, including the goals set for major shallow coastal habitats and species (Figure 18). On this graph the representation of habitats in the Savu Sea is shown separately because, at 3.5 million hectares, this single MPA is four times larger than all other existing MPAs in the Lesser Sunda combined.

The reasons that in some cases, the goals were exceeded include:

1. As all MPAs and shallow coastal AOIs are intended as multiple use areas, a small percentage of the total area of the MPA/AOI will be included in no-take zones.
2. To allow flexibility in the implementation of the MPA network and the delineation of final boundaries of MPAs which may be smaller than the area of the AOIs
3. Where shallow coastal habitats are included in the large deep-sea and transboundary AOIs. These focus of management in these areas is likely to be offshore systems with different regulations from those MPAs/AOIs designed to protect shallow coastal habitats and species.

The main conservation targets represented in each MPA are presented in Appendix I.

Designing for Resilience to Climate Change

In the absence of detailed information regarding areas that appear more resistant or resilient to climate change, we ‘spread the risk’ by including coral reefs exposed to a range of environmental factors. In particular, the MPA network design includes coral reefs exposed to a diverse range of oceanographic influences, such as areas of seasonal upwelling, strong currents, sheltered and exposed reefs and areas of high temperature variability such as reef flats. By doing so it is likely that areas which may be resistant or resilient to increasing sea temperatures caused by climate change (West and Salm 2003, Reef Resilience Toolkit) are captured in the MPA network design.

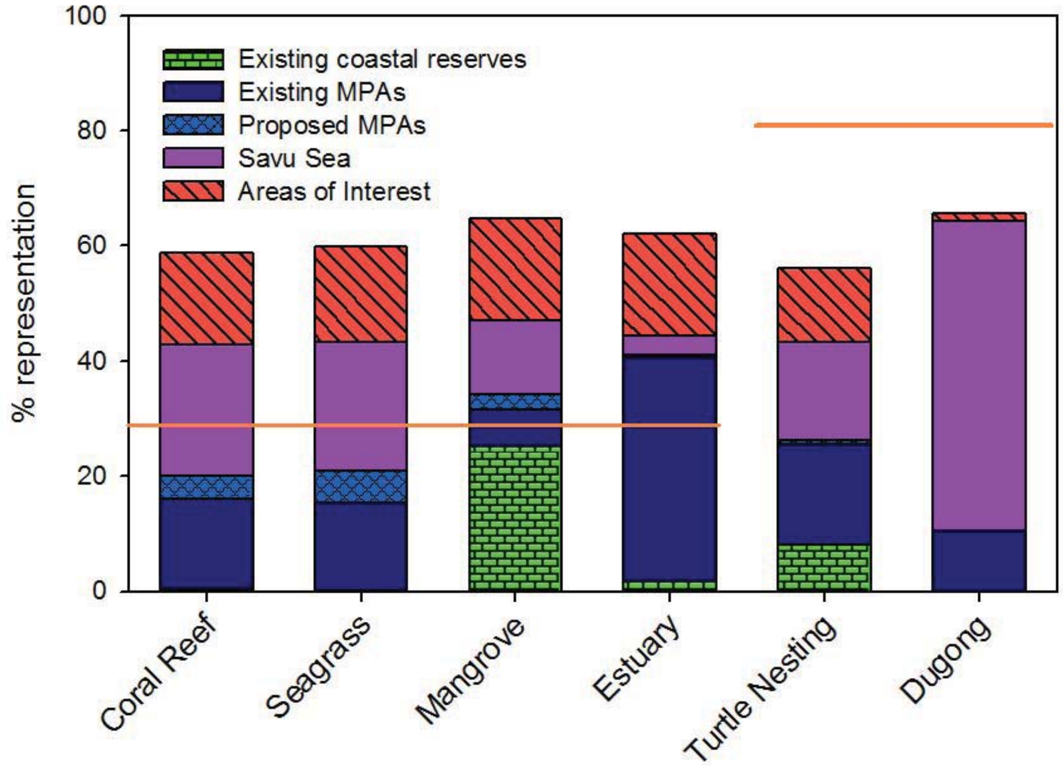

Figure 18. Representation of shallow coastal habitats and species in the final Lesser Sunda MPA network design. Horizontal (orange) lines represent goals for percentage representation.

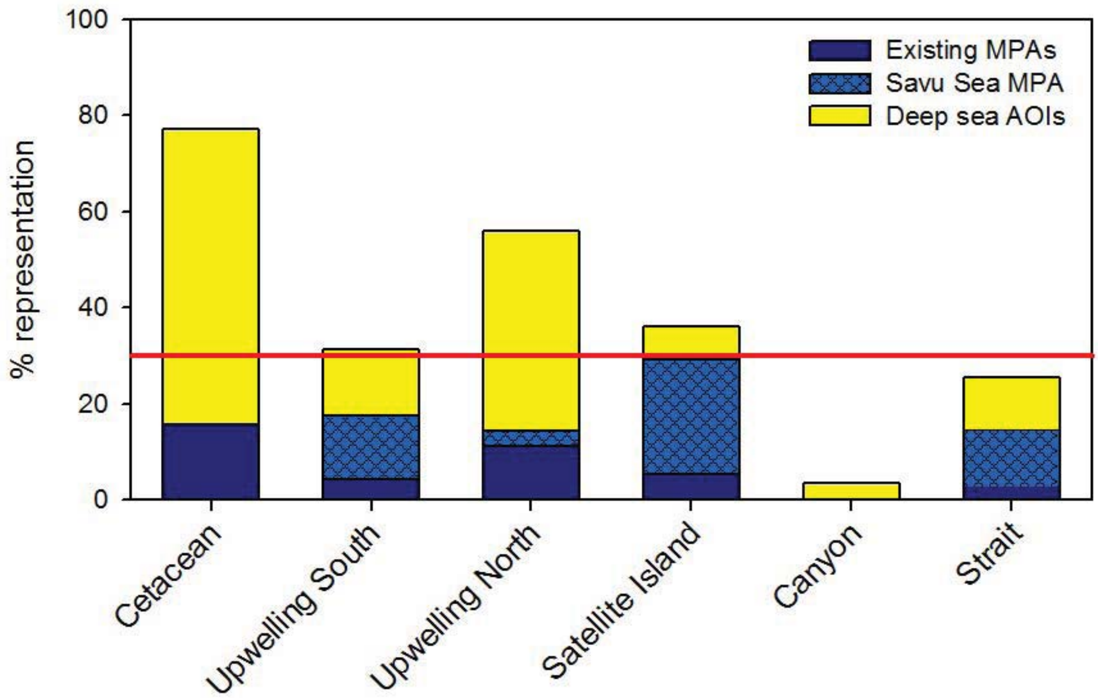

Figure 19. Representation of major habitat categories in the final MPA network design. Horizontal red line shows representation goal.

<u>Protecting Key Sites and Species</u>

Where the location of key sites such as spawning aggregations and turtle nesting beaches was known, they were included in the MPA network. Prior to the declaration of the Savu Sea MPA, almost 30% of turtle nesting beaches were protected in existing coastal reserves and MPAs (Figure 18). The Savu Sea MPA adds another 10% of the known nesting beaches in Lesser Sunda and a number of additional sites are identified for inclusion in MPAs. It is likely that additional turtle nesting beaches will be documented with increased conservation and scientific surveys in this region. Turtle nesting beaches can also be protected through local regulations and patrols through cooperative agreements with local communities. This has been shown to be an effective management strategy in Indonesia.

Dugongs are a very important and highly endangered species in Indonesia. The Savu Sea MPA encompasses around 50% of the known distribution of dugongs in the Lesser Sunda Ecoregion and provides a focus for management of the key threats to dugongs including entanglement in nets, ship strike and loss of (seagrass) habitat.

It is likely there are many other as yet undocumented key sites in the Lesser Sunda Ecoregion for feeding, migration and breeding of large marine species such as turtles, sharks, mantas and marine mammals. As these become known, they should be included in the database and the Lesser Sunda Ecoregion MPA network design should be examined to determine if changes should be made to accommodate this new information or if these sites can be protected through other management mechanisms e.g. community agreements or fisheries management.

Connectivity within and among MPAs

The Lesser Sunda Ecoregion MPA network design achieved the recommended distance between MPAs in an MPA network of 100-200 kilometres for genetic connectivity (McLeod et al. 2009). In addition, where possible whole features (islands, seamounts, atolls, etc.) were included in one MPA, including a 'buffer' around the core AOI. Where this was not possible, we included larger rather than smaller areas.

The strong currents and turbulent mixing in this area indicates a high degree of connectivity, which is an important factor in reef resilience. In addition, the Lesser Sunda Ecoregion receives currents which have passed by reefs of Kalimantan and Sulawesi to the north and so will likely act as a 'sink' for larvae from other coral reefs in Indonesia.

Socio-Economic Design Criteria

Multiple Use

Most existing MPAs have been declared under legislation which allows for multiple uses including fishing, boating, tourism and aquaculture through the application of a zoning plan. All AOIs were designed on this basis to allow for existing and proposed future uses on the assumption that they will also be declared under legislation and regulations which allow for multiple uses. By doing so, the aim is to allow for effective management of existing sustainable resource use activities while discouraging unsustainable uses in ecologically important areas.

Cultural

As far as possible, culturally important areas were considered in the design of the MPA network through consultation with government representatives and stakeholders. It is likely that locally important areas or issues will need to be further documented and considered in the development and implementation of individual MPAs as they are declared.

Fisheries

Fisheries sustainability was considered in the design by including known sites of fish and shrimp spawning grounds in MPAs/AOIs and avoiding important fishing grounds identified through stakeholder consultation and expert mapping. It is anticipated that fisheries sustainability at a local scale will be achieved through the development of management and zoning plans that are based on more detailed local-scale information.

Nature-Based Tourism

Including known dive sites and areas where many conservation features occur in close proximity in MPAs/AOIs provides an opportunity to promote and manage nature-based tourism activities. In addition the inclusion of deep sea yet near shore areas also provides a focus for promotion and management of whale and dolphin watching activities. The high diversity of cetaceans and their proximity to the coast means that this region has very high and as yet unfulfilled potential as a prime whale watching area.

Infrastructure and Industry

The boundaries of the AOIs were modified in relation to information from spatial plans and through stakeholder consultation to avoid areas where infrastructure and industry exists or is proposed. Where possible, and ensuring that sites also met biophysical criteria, the sites of AOIs were also located close to towns or cities where it was considered that the benefits (of opportunities for income generation through tourism, marine education activities and enforcement) would outweigh the negative impact of coastal development.

Effective Management

The location of AOIs also reflects the consideration of opportunities to reduce conflicts among users and where there was opportunity to protect or improve the condition of ecosystems through improved management. By consulting widely with stakeholders in each Indonesian province and Timor-Leste to produce the final draft MPA design, it is hoped that the MPA network design aligns with the wishes of local governments and that their support will facilitate the best chance of effective management. Where possible, shallow coastal AOIs were located in areas close to existing coastal reserves or terrestrial protected areas where management and patrolling facilities may already exist, thereby increasing opportunities for co-management.

Deep Sea yet Near Shore Areas

The inclusion of deep sea and transboundary AOIs greatly increased the representation of deep sea yet near shore habitats and species in MPAs. The representation of cetaceans increased from 16 % in existing MPAs to 78 % and for persistent pelagic habitats (upwelling) the representation increased from 31% to 85% (Figure 19). Other important deep sea features such as seamounts, underwater canyons and straits are also well represented in the deep sea and transboundary AOIs in the MPA network. The location of deep sea and transboundary AOIs was chosen by:

1. expanding the coastal MPA network to include deep sea yet near shore habitats surrounded by waters <200m depth where possible; and
2. identification of deep sea and transboundary MPAs which specifically targeted bathymetric features such as seamounts and canyons as well as areas of known distribution of cetaceans and other large fauna.

DISCUSSION

The Lesser Sunda Ecoregion MPA network design represents the first resilient MPA network design at an ecoregional scale in the Coral Triangle. The Lesser Sunda Ecoregion is a high priority for the Government of Indonesia for both conservation and resource use values. In a recent exercise (Bali, July 2009) to prioritize Indonesia's marine ecoregions for conservation actions, Lesser Sunda was ranked second out of 12 ecoregions in importance (behind the Bird's Head Seascape of Papua) by both independent scientists and the Indonesian government (Huffard et al. 2009).

While the MPA network design process was based on best available scientific information on the distribution of habitats and species and analysis of this information using a conservation planning tool Marxan, much of the MPA network design represents the inputs of over 300 individual experts and stakeholders through an extensive consultation process. Because of this input, the MPA network aligns closely with existing spatial plans and has the best chance of support and implementation by relevant government agencies. Data deficiencies, especially in relation to socio-economic factors, meant that innovative tools such as expert mapping were used to collect information not documented in reports or spatial plans. This information was critical in ensuring that the MPA network met socio-economic criteria.

The 100 protected areas identified in the Lesser Sunda Ecoregion MPA network include and build upon the existing marine and coastal MPAs, and recognizes MPAs proposed by provincial and district governments for designation in the future. Additional areas in both shallow coastal waters and deep sea areas have been identified to meet resilient MPA network design criteria and protect deep sea habitats and species. If implemented, this MPA network would meet resilience principles for MPA network design (based on the best available information at this time).

A special feature of this MPA network is that in addition to 'traditional' shallow coastal MPAs for coral reefs, mangroves and turtle nesting beaches, it also includes deep sea habitats, thereby encompassing the full range of habitats and species in the Lesser Sunda Ecoregion.

It is envisaged that the large deep sea yet near shore MPAs would be managed somewhat differently to the shallow coastal MPAs where (Indonesian) legislation mandates the application of a zoning plan which includes no-take zones. Deep sea habitats and their associated large fauna such as cetaceans, dugongs, sharks and turtles could be protected by providing a focus for management which reduces key threats at critical sites used for aggregation, feeding or migratory 'bottlenecks'. This may include special regulations for fishing gears, shipping, mining and seismic exploration and bans on disposal of mine tailings to these critical and sensitive habitats. The legislative framework for special management of these areas is not yet developed, but the principles could be included in the development of management plans for the recently identified Fisheries Management Areas throughout Indonesia.

This document can be used as a basis for the development of additional MPAs in the Lesser Sunda Ecoregion at the national, provincial and district levels to support the Government of Indonesia's aspirations to declare 20 million hectares of MPAs by 2020 (Yudhoyono 2009), to identify a national MPA network and to support the spatial planning process for coastal areas and small islands. Ideally the MPA network design would be included in spatial plans at the national, provincial and district levels. In East Nusa Tengarra, the MPA network has been included in the draft provincial spatial plan, and in Bali, support for the development of a Bali-wide MPA network is under discussion.

The next step is to develop a strategy for further development and implementation of the MPA network through liaising with the provincial and district governments, identifying revised boundaries of MPAs from AOIs and putting in place governance arrangements and enabling conditions at appropriate scales and locations. As the Lesser Sunda Ecoregion MPA network design was done at a 'coarse' or broad scale, it is recommended that additional consultation and analysis is done at finer scales to refine the MPA network design to ensure any additional MPAs incorporate locally relevant information on biophysical features and also align with the development and resource use aspirations of each local region.

CHALLENGES AND LESSONS LEARNED

Designing an MPA network for the Lesser Sunda Ecoregion provided a number of challenges, some of which were overcome through innovative tools and extensive consultation. However it is expected that others may be better addressed through more intensive surveys and consultation at a local level. The major challenges are addressed below.

Data Limitations

There were significant challenges in obtaining data for the Lesser Sunda Ecoregion at levels of accuracy, scale and extent required for analysis. In particular, little data existed for East Nusa Tengarra Province. Consequently, much of the information (habitat distribution) used in this analysis was collected at a large scale through analysis of low resolution satellite imagery and by incorporating local expert opinion and inputs. Of particular concern was the lack of socio-economic and resource use data in spatial form that could be incorporated into the analysis. Critical information such as maps of fishing grounds important for both local communities and commercial interests were not available. In addition, in many cases, spatial data on resource use patterns in district and provincial spatial plans was only available to TNC in hard copy format. Due to the limitations of time and resources during this project, they could not be digitised and included in the Marxan analysis and were therefore considered 'manually' in the analysis and decision-making processes. It will be important to incorporate local socio-economic and resource use information when considering implementation of the MPA network to ensure the values of a MPA are not compromised by incompatible resource use or development plans in that area.

Another limitation in mapping habitats from low resolution satellite imagery was the limited groundtruthing that could be done due to the remote and uninhabited nature of this region which made accessing reefs and seagrass beds difficult. This means that the confidence in the accuracy of the interpretation of the satellite imagery is not optimal and reinforces the importance of collecting additional information at local scales during further development of the MPA network.

Planning at an Ecoregional Scale

The Lesser Sunda Ecoregion encompassed an extensive area (325,000 square kilometres) including three Indonesian provinces and the country of Timor-Leste. This provided challenges in the geographic scale of data needed, coordinating numerous stakeholders and government representatives, addressing differences in levels of capacity, understanding and support for MPAs, and time taken to travel to remote regions. It also presented funding challenges as consultation involved representatives from multiple agencies from each province and country. Given the resources and time frame for this project it was not possible to consult with representatives at district level throughout the Lesser Sunda Ecoregion.

Incorporating Principles of Resilience

While many of the principles of resilience, such as habitat representation and connectivity, can be applied at the ecoregional scale, the specific factors which are thought to confer resilience to climate change such as upwelling, shading, strong currents and high temperature variability require detailed spatial information on a local scale. As explained earlier, obtaining information on a local scale was not possible during this exercise. Therefore identification of the specific location of these factors in the Lesser Sunda Ecoregion was based on general principles or broad-scale information. It is important that when refining the MPA network design to suit local conditions that information on these factors is obtained at the appropriate scale to help determine final boundaries and identify specific areas for inclusion in the zoning plan for each MPA.

Incorporating Expert and Local Input

The use of 'expert mapping' exercises, liaising with scientific experts and working directly with representatives of key government agencies was highly successful and greatly improved the design of the Lesser Sunda Ecoregion MPA network. These expert mapping exercises are now being used in other MPAs in Indonesia to obtain locally relevant or undocumented information relevant to the design of MPA networks and MPA zoning plans. One of the difficulties encountered in these exercises was to obtain spatially accurate and consistent information. It is recommended that maps used for expert mapping provide information that stakeholders will recognise, such as geographic features, town names and bathymetry contours, to facilitate this process. In addition, group facilitators need to be trained carefully to ensure the data collected is consistent and complete among groups. Obtaining spatially detailed information was difficult, as often participants would identify a large region where, for example, bomb fishing occurred, with no differentiation between smaller areas.

Common Misconception among Stakeholders That MPAs Do Not Allow for Resource Use Activities

One of the common perceptions encountered during consultation was that many government officials and stakeholders mistakenly believed that MPAs would be fully protected and not allow for resource use activities such as boating, fishing, tourism, aquaculture or other sustainable extraction or harvest activities. While this is the case for some existing MPAs, current MPA legislation accomodates multiple use MPAs. It is apparent that government officials and stakeholders in regional areas are not fully aware of this legislation and its regulations which allow for multiple uses in MPAs. Therefore, initially there was some resistance to the location and size of AOIs and the suggestion that they should all be located in areas far from human settlement. This may have been overcome by incorporating a program to raise awareness of the new legislation together with the MPA design process.

Lack of Resources and Skills to Effectively Manage Existing MPAs

Many of the existing MPAs in the Lesser Sunda Ecoregion are not effectively managed due to the lack of resources allocated to, and lack of capacity within, national, provincial and district government agencies responsible for their implementation. Therefore, many agencies highlighted the difficulties of managing the existing MPAs and had not seen demonstrable benefits from MPAs due to the lack of effective management. It is recommended that these issues are addressed as a high priority in the implementation of the MPA network.

IMPLEMENTATION

The Lesser Sunda MPA network design provides a long-term 'roadmap' for the further development of MPAs in the Lesser Sunda Ecoregion in support of the Government of Indonesia's commitment to develop a national MPA network.

High Priority Activities

The highest priority for implementation of this network is to achieve effective management of existing MPAs in the Lesser Sunda Ecoregion. This will require:

1. clearly defined governance arrangements for each MPA which allow for co-management and community involvement in MPA management, e.g., through local patrols,
2. adequate allocation of resources, including funding and infrastructure and its maintenance;

3. a commitment from relevant government agencies for the support of enforcement of MPA management and zoning plans;
4. capacity-building programs for staff in relevant government agencies to build skills in MPA management;
5. the engagement of institutions that could assist with data collection or management such as universities, research divisions of national government agencies, local NGOs and community or stakeholder groups such as conservation groups or fishermen forums; and
6. the development of local partners such as local NGOs and community and stakeholder groups to support MPA implementation.

If the above enabling conditions are achieved for existing MPAs in all Indonesian provinces and the country of Timor-Leste, this will provide a foundation for the declaration and management of additional MPAs to build a resilient MPA network for the Lesser Sunda Ecoregion.

BUILDING A RESILIENT MPA NETWORK

The Lesser Sunda Ecoregion MPA network design provides a basis for the further development of a resilient MPA network. It is anticipated that as more information becomes available, the location and/or size of AOIs may be modified to suit local conditions. However, to maintain the resilient elements of this design, any modifications must still follow the design principles identified in Table 2 and Table 3. For example, if it is decided that a AOI needs to be 'moved', the habitats and species in that MPA need to be documented and areas identified close by that would also contain similar habitats and species. If an AOI cannot be implemented due to local conditions and it includes 100 hectares of coral reef and 50 hectares of mangroves, then an alternative site in close proximity that also contains 100 hectares or coral reef and 50 hectares of mangrove should be chosen. In addition, the alternative MPA must meet connectivity and other criteria such as socio-economic criteria.

The Savu Sea is an example of a MPA that includes deep sea habitats and species. However, in general, deep sea MPAs have not yet been implemented in Indonesia but could be included in the development of management plans for Fisheries Management Areas (FMAs) recently declared by Government of Indonesia. Indonesia has been divided into 13 FMAs and the goal is to manage these areas according to the principles of the Ecosystem Approach to Fisheries Management. The deep sea and transboundary AOIs identified in this report could be included in the FMAs and/or these regions could be identified as a focus for management or regulation of certain activities and land-based inputs.

It is also acknowledged that implementation of the transboundary MPAs will require extensive high level discussions between relevant departments of Indonesia and Timor-Leste. During the process to identify these transboundary MPAs, it was suggested that one or more could be designated a 'Peace Park' and may provide a focus for delineating and agreeing to national boundaries and complementary management of marine resources.

CONCLUSIONS

A resilient MPA network has been designed for the Lesser Sunda Ecoregion in support of the Government of Indonesia's aspirations to identify a national system of MPAs. A total of 100 MPAs covering 9.7 million hectares have been identified through a combination of detailed scientific assessment and extensive expert and stakeholder consultation. The MPA network includes both shallow coastal and deep sea habitats to encompass the full range of ecosystems in the Lesser Sunda Ecoregion. The process to design the MPA network was based on a gap assessment which compared the existing and proposed MPAs with resilient design criteria and identified new areas for future MPA development. There are a number of innovative features of this MPA network design:

- This is one of the first times resilience principles for MPA network design have been applied at an ecoregional scale in a data deficient area.
- The MPA network is designed to support conservation and sustainable use of coastal marine resources and to support the livelihoods of local communities.
- Both shallow coastal habitats and species (e.g., coral reefs, dugongs) and deep sea habitat and species (e.g., migratory corridors for blue whales) are represented in the MPA network. In addition to the 55 existing or proposed MPAs covering 1.2 million hectares for shallow coastal habitats, and the 3.5 million hectare Savu Sea MPA (which includes both shallow coastal and deep sea habitats), an additional 30 MPAs were identified covering 900,000 hectares to meet resilient design principles. A total of 14 additional deep sea MPAs covering 4.2 million hectares were identified to represent the full range of deep sea yet near shore habitats and species. Of these, three encompass waters of both Indonesia and Timor-Leste and are termed ‘transboundary’ MPAs.
- The Government of Indonesia has committed to using this MPA network design as its primary reference for the development of MPAs in the Lesser Sunda Ecoregion.
- Many opportunities were provided for expert and stakeholder inputs, which greatly improved the design and resulted in local ‘buy in’ for implementation of the design.

Implementation of the Lesser Sunda Ecoregion MPA network will be a long-term process. The highest priority for implementation of the MPA network is to ensure effective management of existing MPAs through the provision of sufficient funding, resources and trained staff by relevant government agencies. Further declaration and implementation of individual MPAs requires data collection and consultation at a local scale because the MPA network was based on information collected at an ecoregional scale and therefore could not incorporate important local features or socio-economic factors.

The scientific design of the Lesser Sunda Ecoregion MPA network is an excellent resource for the national, provincial and district government agencies to support the development of marine and coastal spatial plans which incorporate consideration of the impact of climate change.

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APPENDICES

APPENDIX A. LIST OF ALL DATA LAYERS IN LESSER SUNDA GIS DATABASE.

Category	Description	File name	Source	Appendix
Base GIS Layers				
Administrative boundaries	Provincial and district boundaries - Bali	bli_admin_line	Department of Spatial Planning	
	Provincial and district boundaries – West Nusa Tengarra	ntb_ admin_line	Department of Spatial Planning	
	Provincial and district boundaries - East Nusa Tengarra and Timor-Leste	ntt_admin_line	Department of Spatial Planning	
	Coastline - Bali	bli_landdistrict_poly	Department of Spatial Planning	
	Coastline – West Nusa Tengarra	ntb_landdistrict_poly	Department of Spatial Planning	
	Coastline – East Nusa Tengarra	ntt_landdistrict_poly	Department of Spatial Planning	
	Lesser Sunda Ecoregion boundary	lse_ecoregion20080930_poly	TNC	
Existing MPAs and coastal reserves	Boundaries of existing MPAs, coastal reserves and 'areas of interest'	lse_mpanetwork_line lse_mpanetwok_poly	Department of Fisheries and Department of Forestry	
Shallow coastal habitats				
Coral reefs	Coral reef outline	lse_coralreef_poly	Torres-Pulliza 2008	B1
	Reef Scapes		DeVantier et al. 2008	B2
Coral reef classfication – exposure, reef zone	Exposed, North facing fringing and rocky shores	lse_reefscapegeneral_poly	DeVantier et al. 2008	B3
	North influence and semi exposed patch reefs	lse_reefscapegeneral_poly	DeVantier et al. 2008	B3
	Exposed, South influence fringing and rocky shores	lse_reefscapegeneral_poly	DeVantier et al. 2008	B3
	Very sheltered habitats, inlets	lse_reefscapegeneral_poly	DeVantier et al. 2008	B3
Coral reef classification - geomorphology	Deep reef feature	lse_reefscapedetail_poly	Torres – Pulliza 2008	B4
	Forereef slope	lse_reefscapedetail_poly	Torres – Pulliza 2008	B4
	Reef flat	lse_reefscapedetail_poly	Torres – Pulliza 2008	B4
	Reef lagoonal terrace	lse_reefscapedetail_poly	Torres – Pulliza 2008	B4
Seagrass	Sparse to medium	lse_seagrass_poly	Torres – Pulliza 2008	B5
	Medium to dense	lse_seagrass_poly	Torres – Pulliza 2008	B5

Mangrove	Mangrove outline	lse_mangroves_poly	Digitized from satellite imagery	B6
Estuary	Estuary outline	lse_estuary_poly	Digitized from satellite imagery	B6
Straits	Straits outline*	lse_strait_poly	Kahn 2008	C1
Satellite Islands	Offshore islands outline*	lse_satelliteislands_poly	Kahn 2008	C2
Persistent pelagic habitats	Persistent upwelling area on south side of islands*	lse_pphsouth_poly	Kahn 2008	C4
	Persistent upwelling area on the north side of islands*	lse_pphnorth_poly	Kahn 2008	C4
Shallow coastal species				
Distribution	Dugong	lse_dugong_poly	Kahn 2008	B7
	Mola mola	bli_molamola_poly	Kahn 2008	
	Manta Ray	bli_manta_poly	Kahn 2008	
	Blue whale distribution*	lse_cetaceanblue_poly	Kahn 2008	C5
	Byrdes whale distribution*	lse_cetaceanbryde_poly	Kahn 2008	C5
	Humpback whale distribution*	lse_cetaceanhumpback_poly	Kahn 2008	C5
	Sperm whale distribution*	lse_cetaceansperm_poly	Kahn 2008	C5
	Area of high diversity cetacean distribution*	lse_cetaceanhighdiversity_poly	Kahn 2008	C5
	Dolphin distribution	bli_dolphin_poly	Expert mapping	B8
	Shark distribution (West Nusa Tengarra)	ntb_shark_poly	Expert mapping	
	Whale distribution (West Nusa Tengarra)	ntb_whale_poly	Expert mapping	
	Endangered species (Bali)	bli_endangeredspecies_point	Expert mapping	B9
	Endangered species (West Nusa Tengarra)	ntb_endageredspecies_point	Expert mapping	B9
Feeding and nesting areas	Turtle nesting sites	lse_turtlenesting_poly	WWF database, expert mapping	B10
	Imporant areas for turtles	lse_turtleimportantarea_poly	Salm 1980	B11
	Feeding areas for turtles	lse_turtlefeeding_poly	WWF database	B11
	Seabird nesting distribution (West Nusa Tengarra)	ntb_seabirds_poly	Expert mapping	B8
Spawning sites	Spawning sites for fish and shrimp	ntb_spags_poly	Kahn 2008	
Other features				
	Dive sites	lse_divesites_point	Internet searches	B12
	Waters infront of terrestrial reserves	Used buffer from terrestrial reserve boundaries		
Socio-economic				
Fishing and aquculture	Fishing villages (Bali)	Bli_fishingvillages_poly	Department of Fisheries (Bali Province)	
	Fishing villages (West Nusa Tengarra)	Ntb_fishermenvilage_point	Field survey 2008	
	Shrimp ponds (Bali)	bli_shrimppond_poly	Field survey, government reports	

	Shrimp ponds (West Nusa Tengarra)	ntb_shrimppond_poly	West Nusa Tengarra spatial plan (2006-2020)	
	Milk fish pond (West Nusa Tengarra)	ntb_milkfish_pond	Expert mapping	
	Seaweed farming (West Nusa Tengarra)	bli_seaweed_poly	Provincial and district government reports	
Destructive fishing	Areas of bomb fishing (West Nusa Tengarra)	ntb_destructivefishing_poly	Expert mapping	
	Areas of bomb fishing (East Nusa Tengarra)	ntt_destructivefishing_poly	Expert mapping	
Coastal development	District populations	Indonesia_village	National government statistics	
Tourism	Dolphin watching areas (Bali)	bli_dolphinwatching_poly	MMAF Bali	
	Areas where marine sports activities occur (Bali)	bli_marine_sport	Field survey 2008	
	Surfing areas (Bali)	bli_surfing_poly	Expert mapping	
	Coastal tourism area (West Nusa Tengarra)	ntb_marinetourism_poly	Expert mapping	
	Coastal tourism area (East Nusa Tengarra)	ntt_marinetourism_poly	Expert mapping	
Shipping	Ports, harbours and fish landing stations	ls_porttpippiharbour_point	Survey 2008, Provincial govt reports	
	Shipping lanes (Bali)	bli_shippinglanes_line	Department of Spatial Planning	
Mining	Areas of mining in coastal areas (West Nusa Tengarra)	ntb_mining_poly	Expert mapping	
Deep sea yet nearshore habitats and species				
Deep sea habitats	Straits outline*	lse_strait_poly	Kahn 2008	C1
	Satellite islands*	lse_satelliteislands_poly	Kahn 2008	C2
	Oceanic islands	lse_oceanicislands_poly	Kahn 2008	C2
	Oceanic atolls	lse_atolsoceanicreefs_poly	Kahn 2008	C2
	Seamount locations	lse_seamounts_poly	Kahn 2008	C3
	Underwater canyons	lse_canyon_poly	Kahn 2008	C3
	Underwater sills	lse_sills_poly	Kahn 2008	C3
Oceanography	Persistent upwelling area on south side of islands*	lse_pphsouth_poly	Kahn 2008	C4
	Persistent upwelling area on the north side of islands*	lse_pphnorth_poly	Kahn 2008	C4
	Indonesian throughflow	Lse_indonesia_inflow	Kahn 2008	
Species	Dugong	lse_dugong_poly	Kahn 2008	B7
	Mola mola	bli_molamola_poly	Kahn 2008	
	Manta Ray	bli_manta_poly	Kahn 2008	
	Blue whale distribution*	lse_cetaceanblue_poly	Kahn 2008	C5
	Byrdes whale distribution*	lse_cetaceanbryde_poly	Kahn 2008	C5
	Humpback whale distribution*	lse_cetaceanhumpback_poly	Kahn 2008	C5
	Sperm whale distribution*	lse_cetaceansperm_poly	Kahn 2008	C5
	Area of high diversity cetacean distribution*	lse_cetaceanhighdiversity_poly	Kahn 2008	C5

APPENDIX B. MAPS OF SHALLOW WATER CONSERVATION TARGETS.

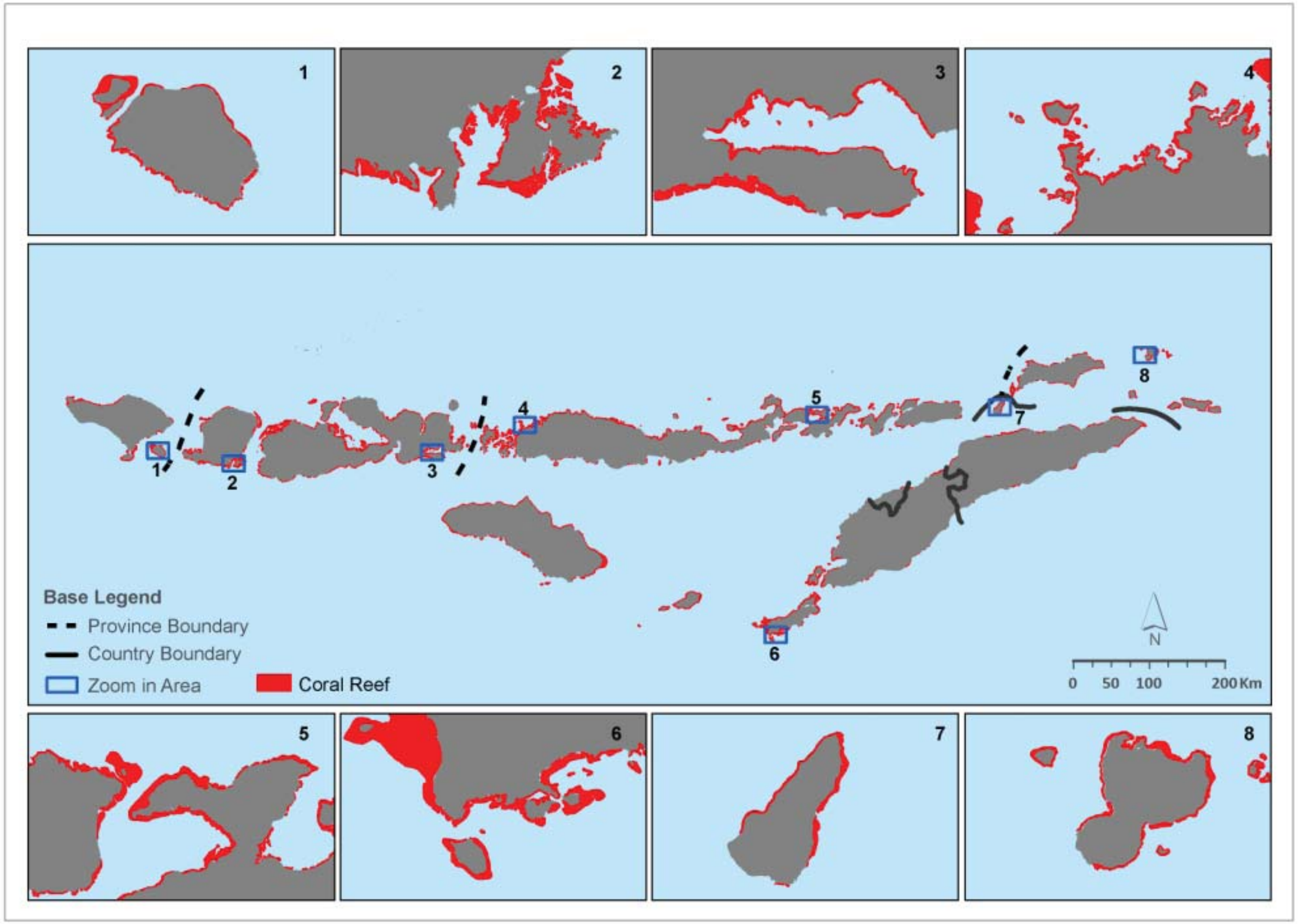


Figure B1. Coral reef extent.

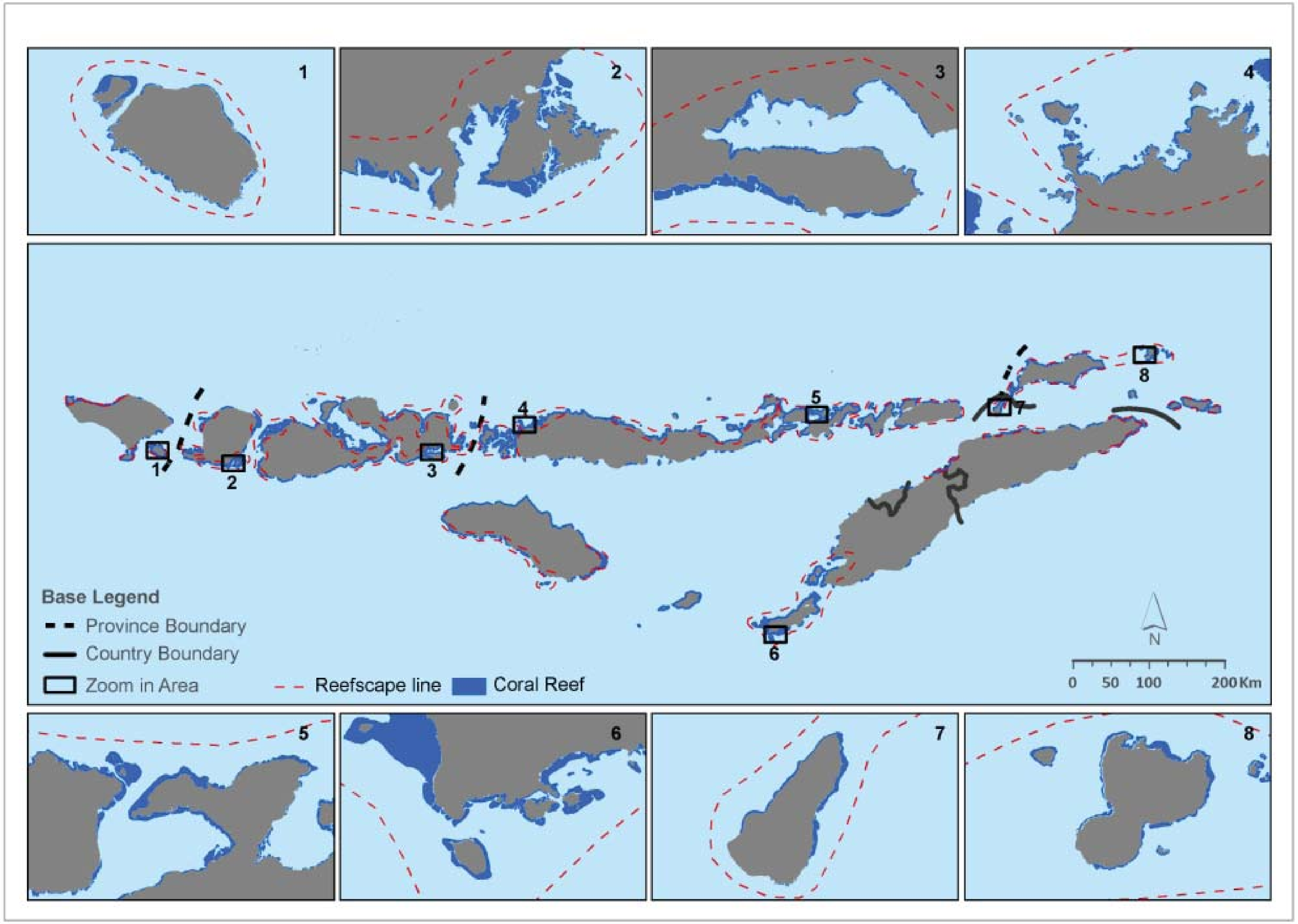


Figure B2. Coral reefscapes.

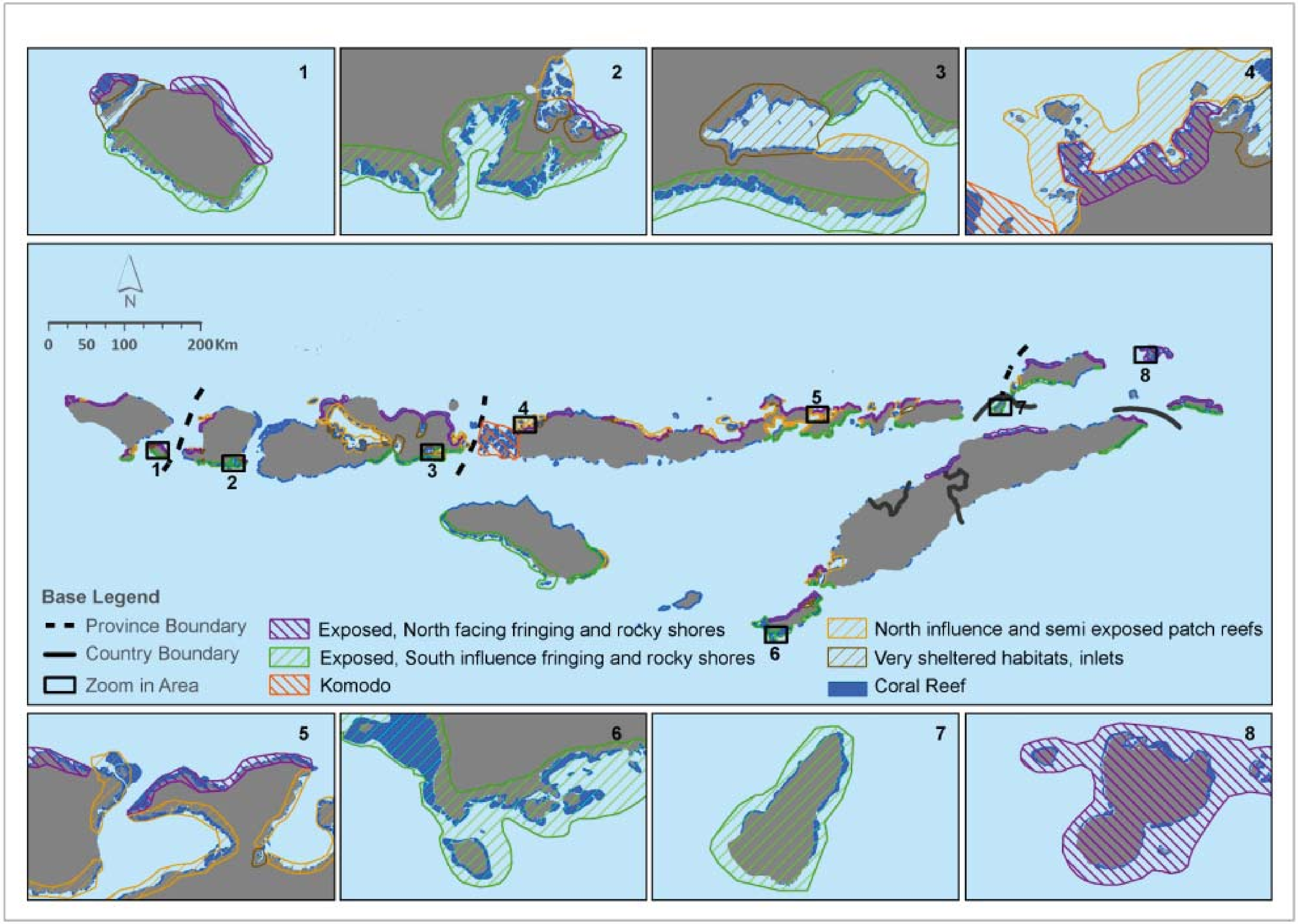


Figure B3. Reef classification – exposure and reef type.

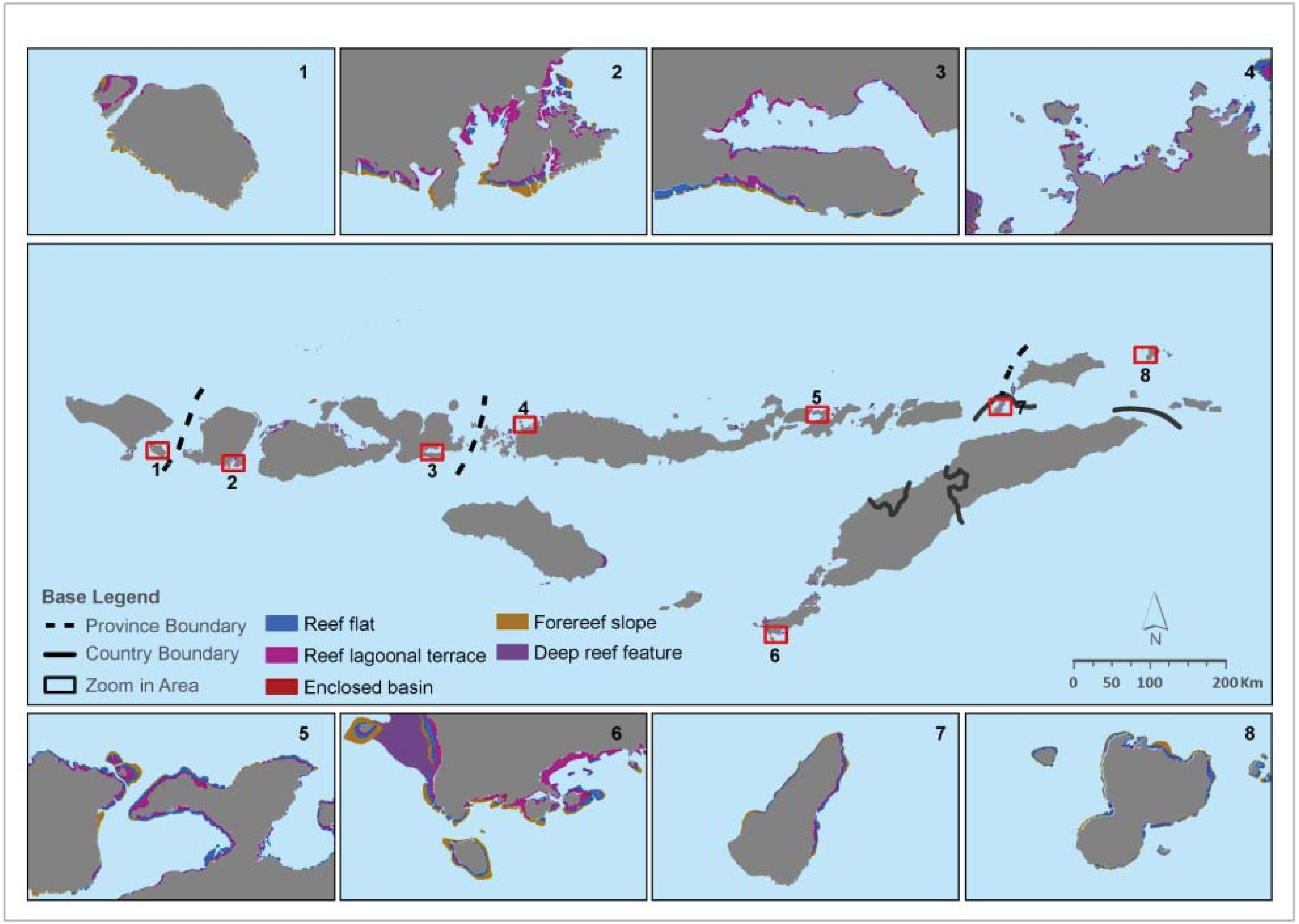


Figure B4. Coral reef classification - geomorphology.

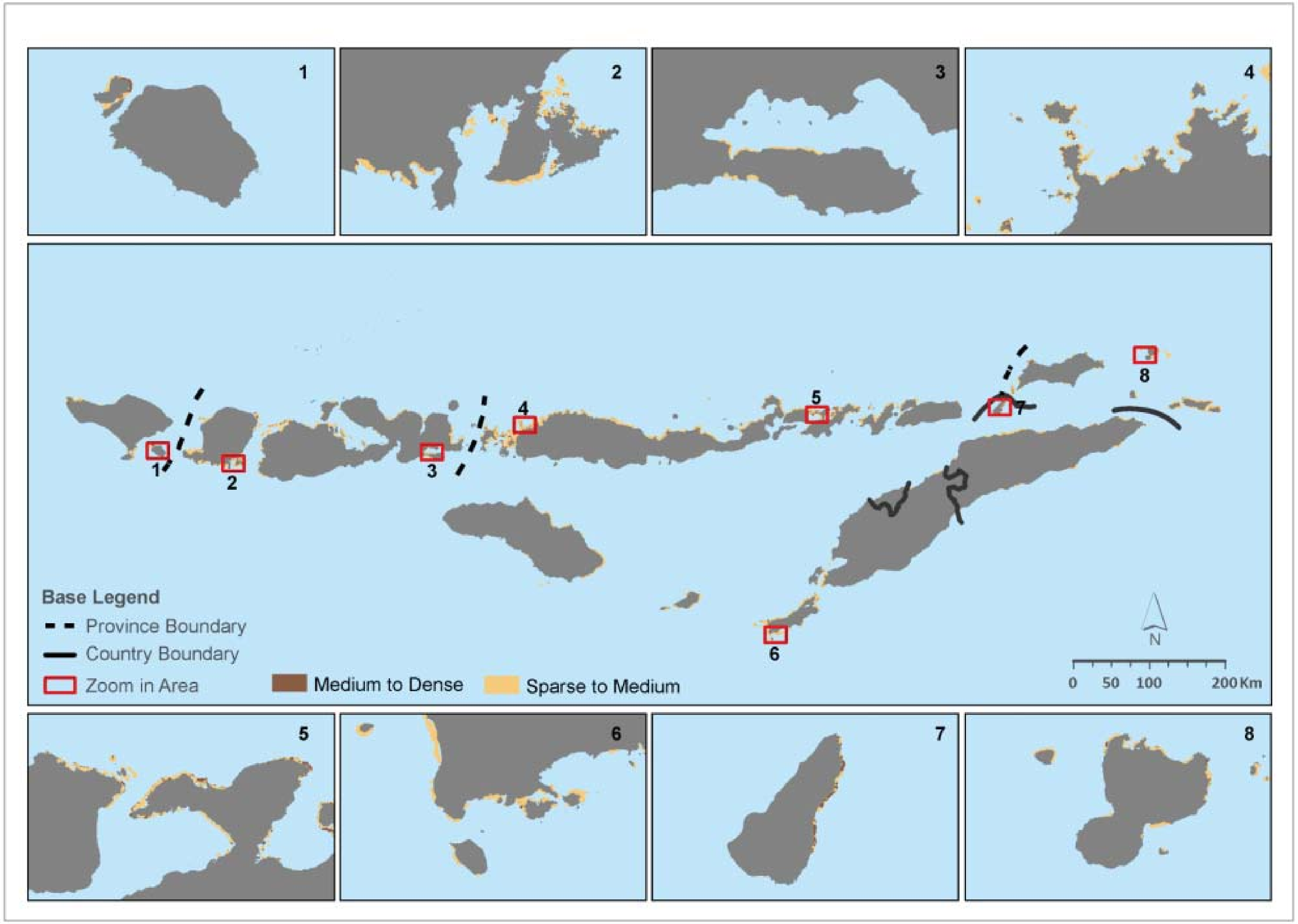


Figure B5. Seagrass extent and classification.

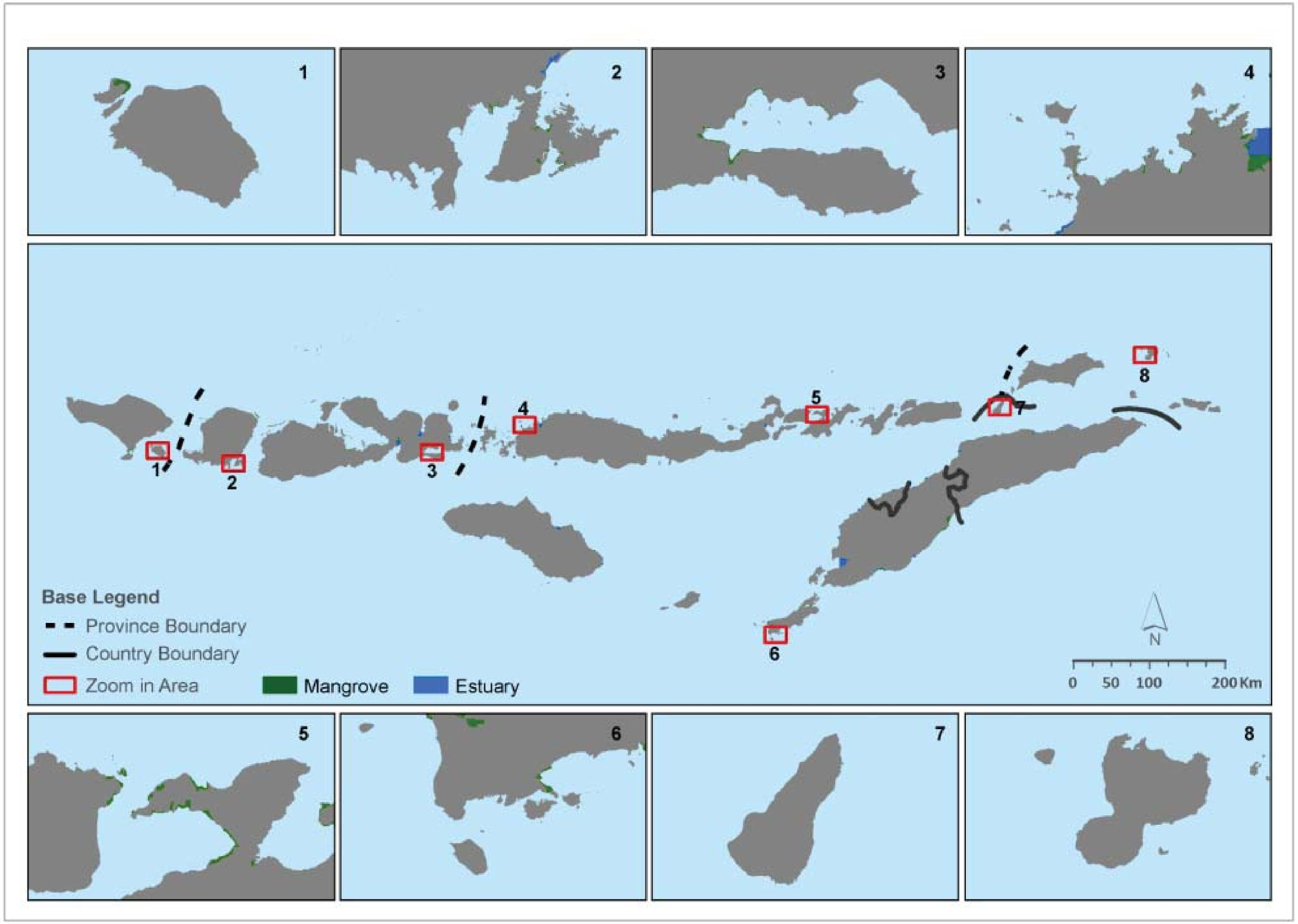


Figure B6. Mangrove and estuary extent.

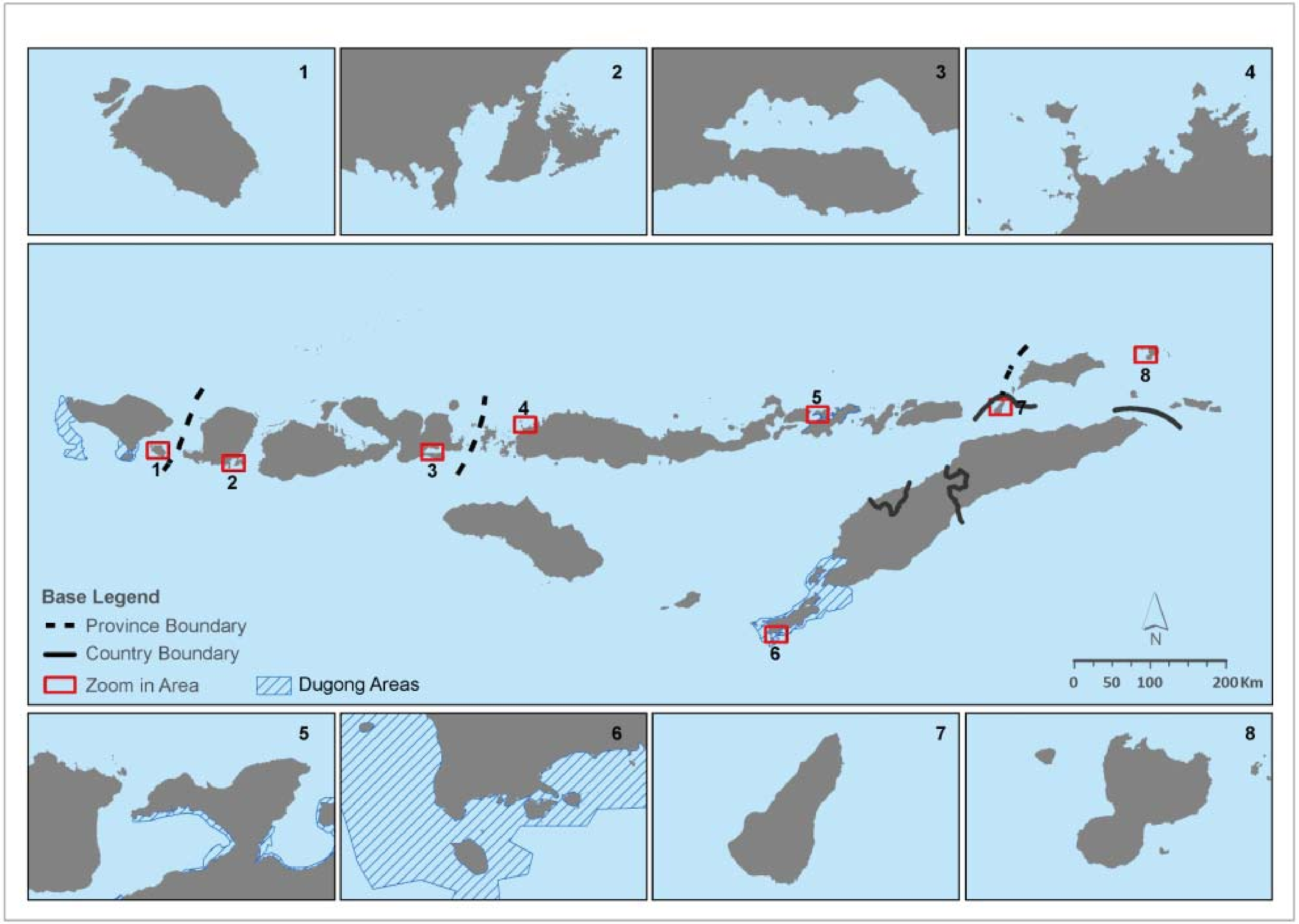


Figure B7. Dugong distribution.

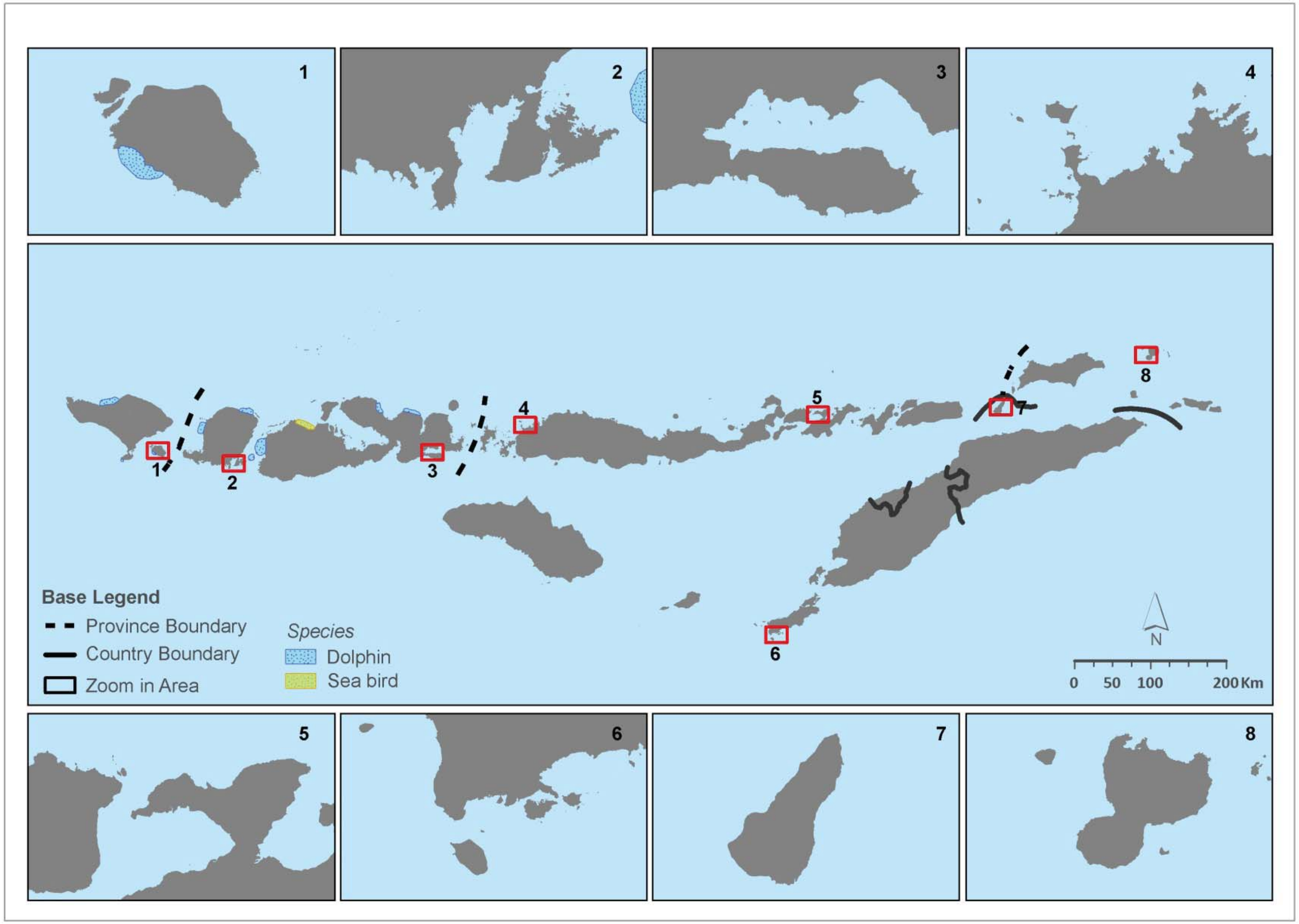


Figure B8. Distribution of dolphins and seabird nesting sites. No information available for East Nusa Tengarra.

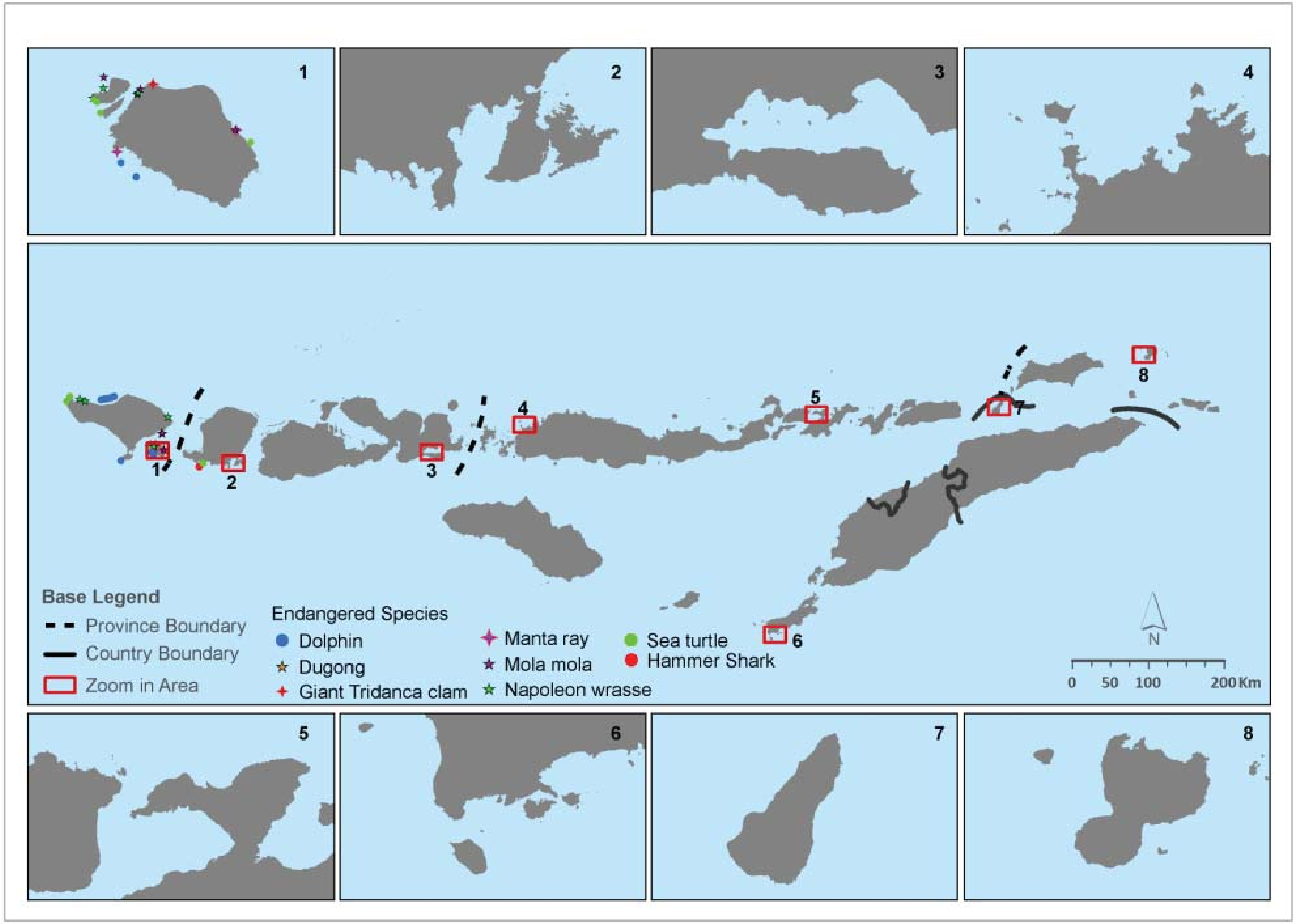


Figure B9. Distribution of endangered, rare and/or protected species from expert mapping and government reports. No information available for East Nusa Tengarra.

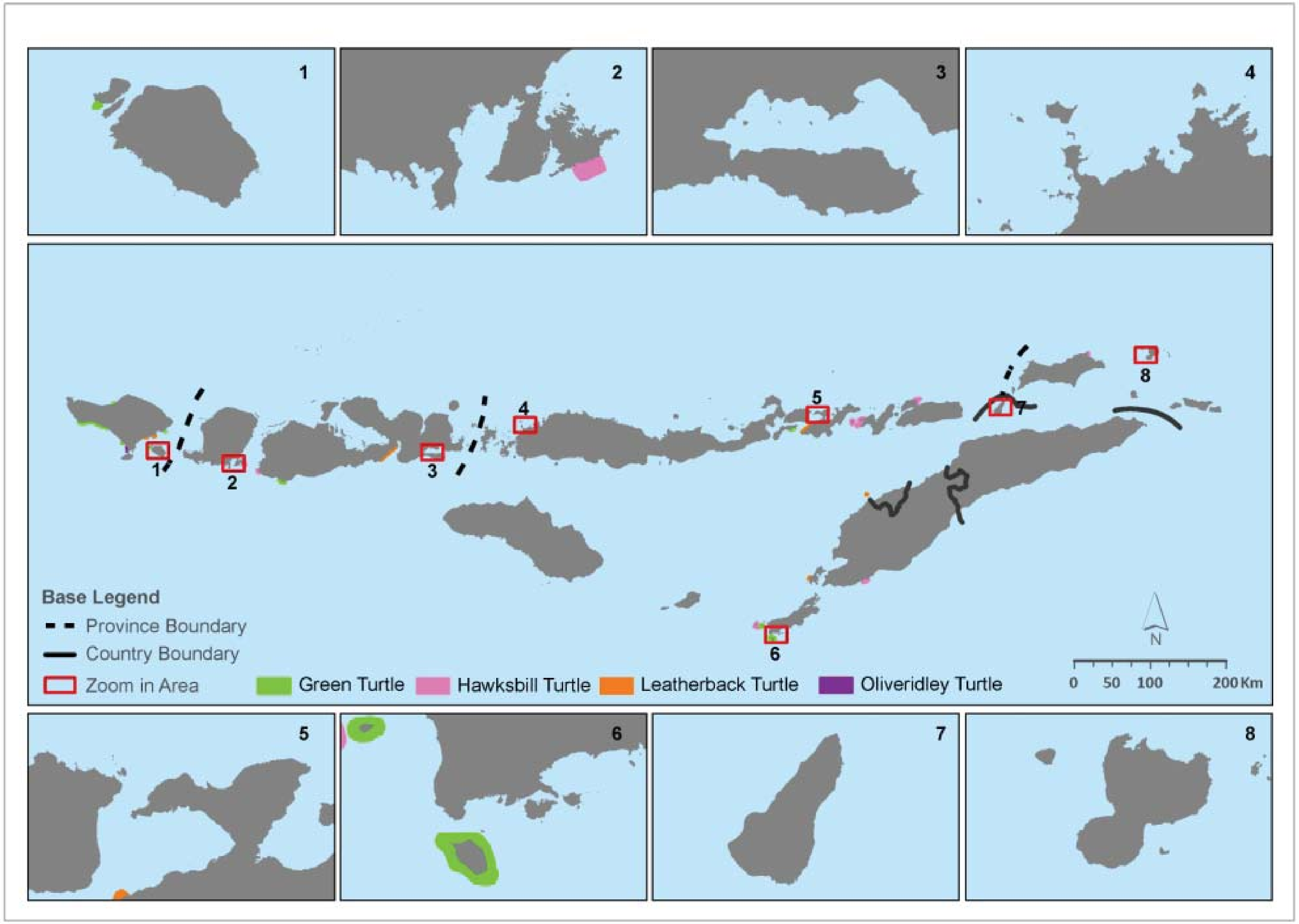


Figure B10. Turtle nesting beaches.

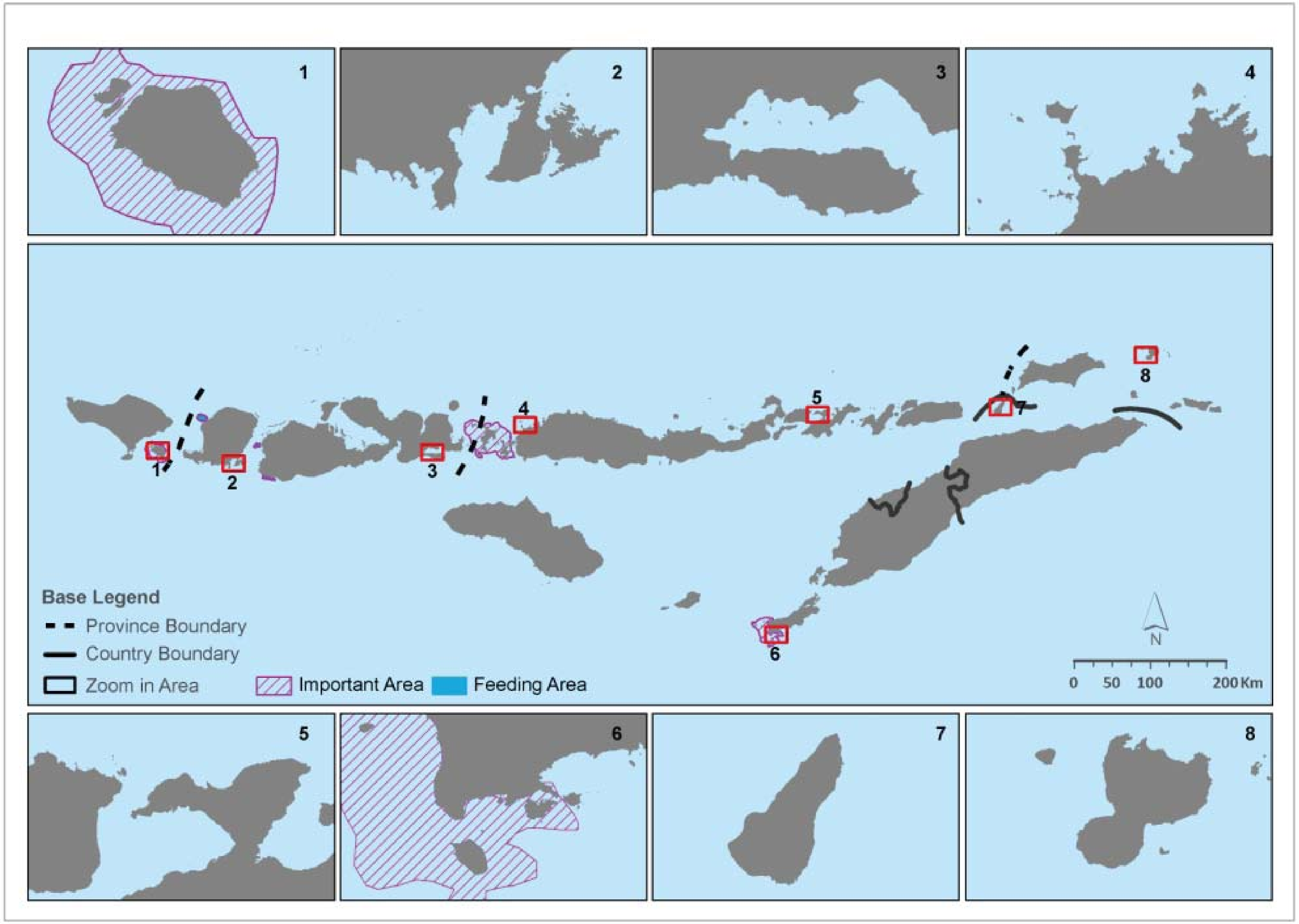


Figure B11. Distribution of turtle feeding areas (WWF Indonesia) and 'important' areas identified in Salm (1980).

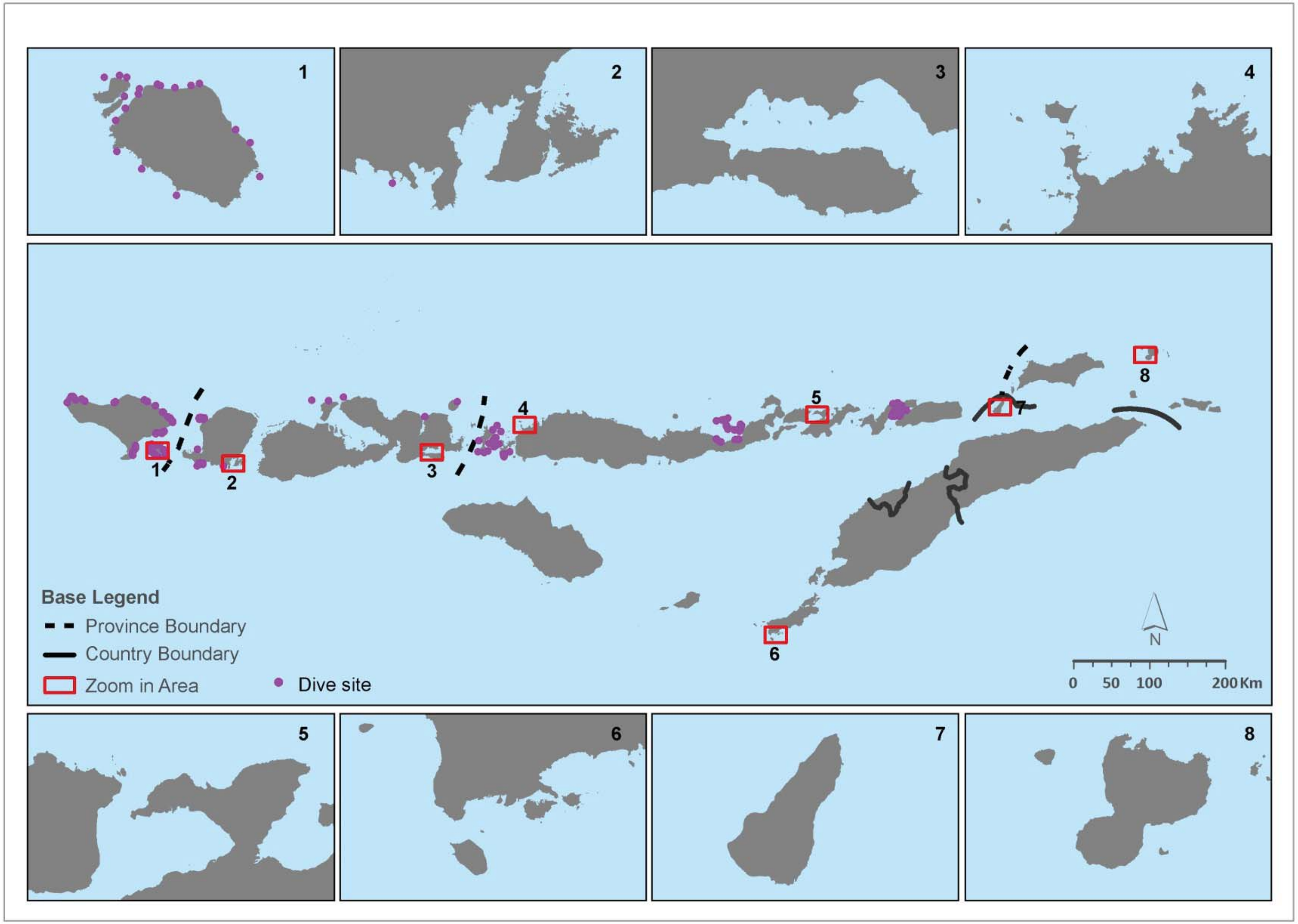


Figure B12. Location of dive sites.

APPENDIX C. DEEP-SEA YET NEARSHORE CONSERVATION FEATURES

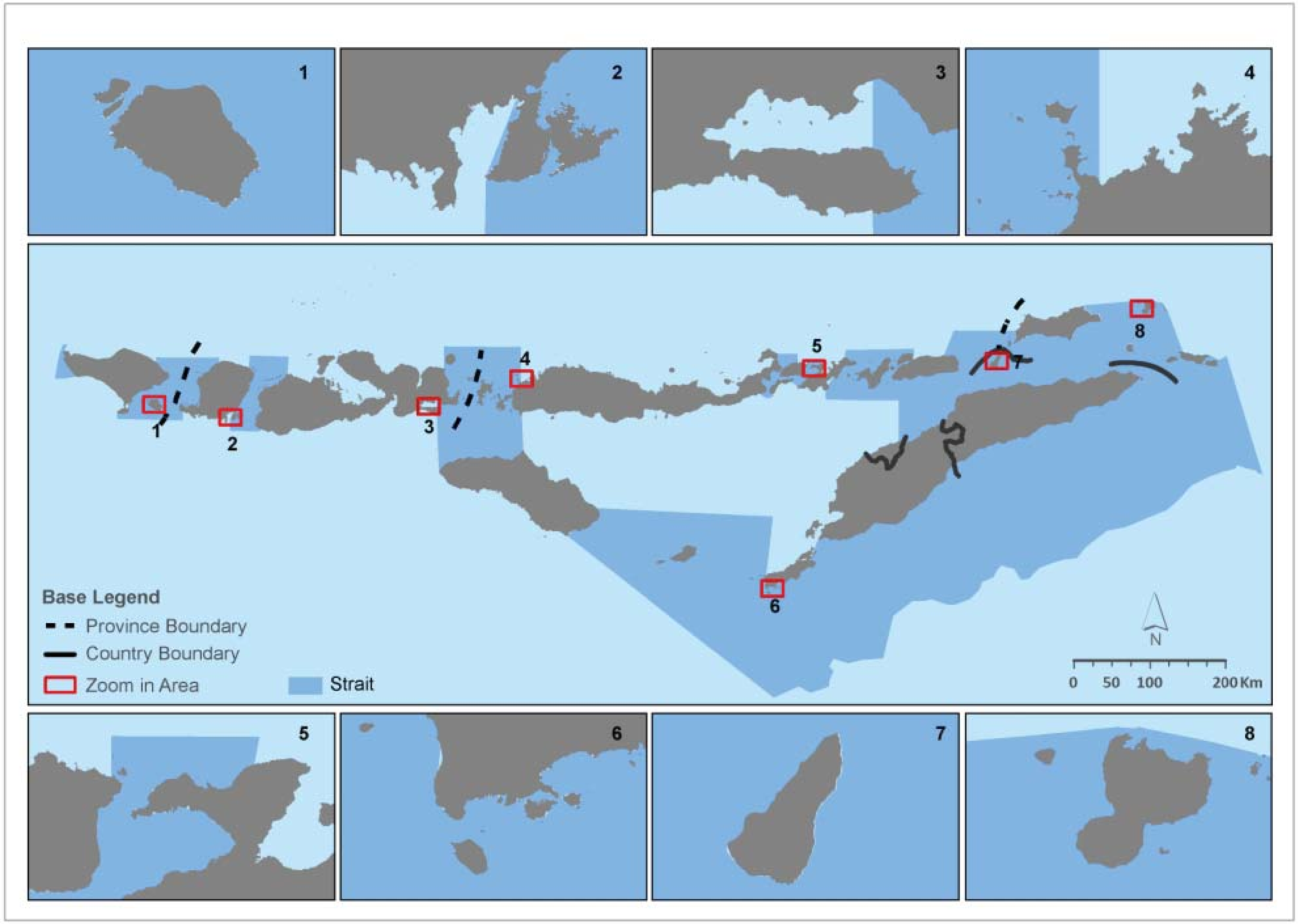


Figure C1. Straits that represent important migratory passages and bottlenecks for cetaceans.

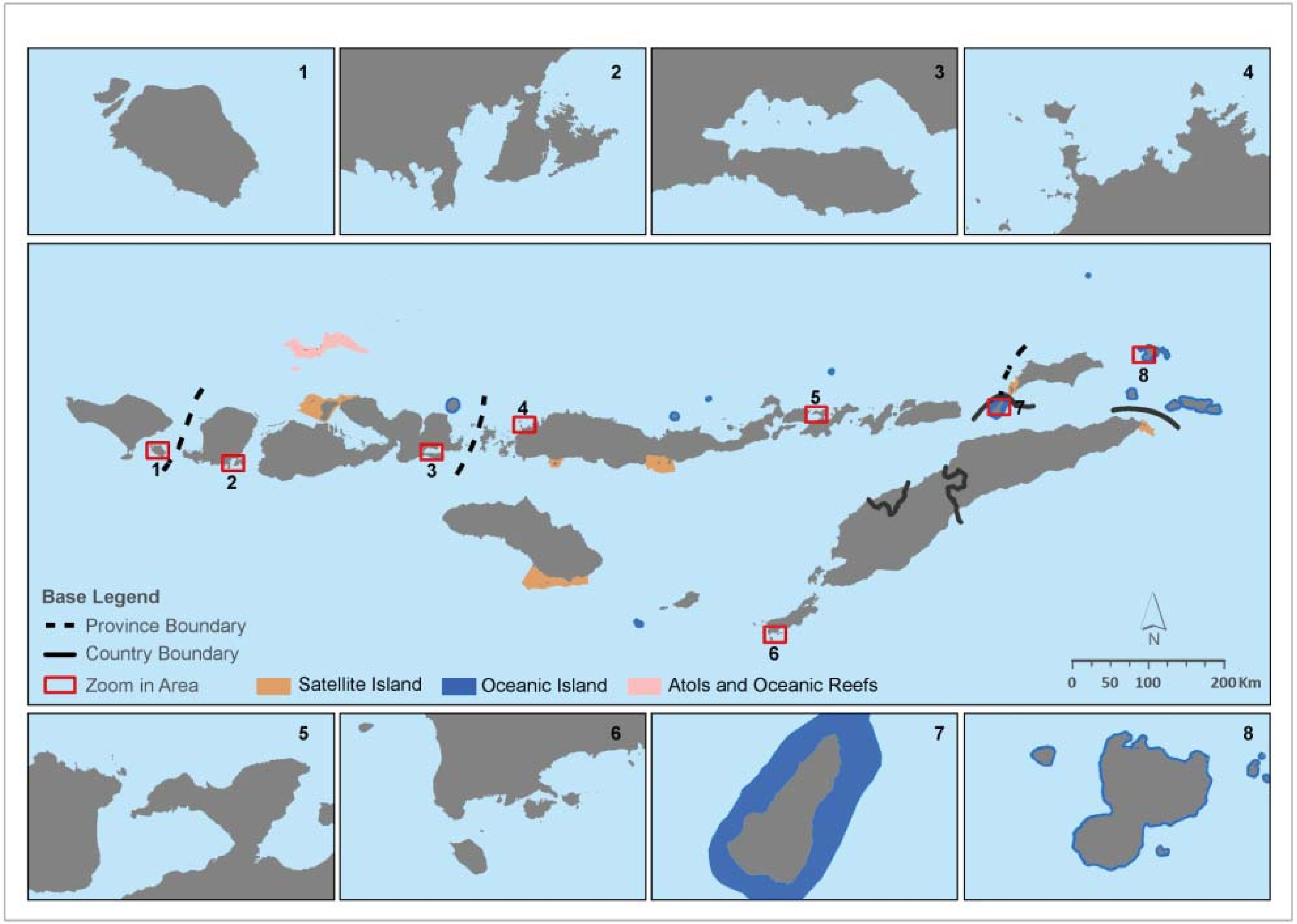


Figure C2. Satellite islands, oceanic island, atolls and reefs.

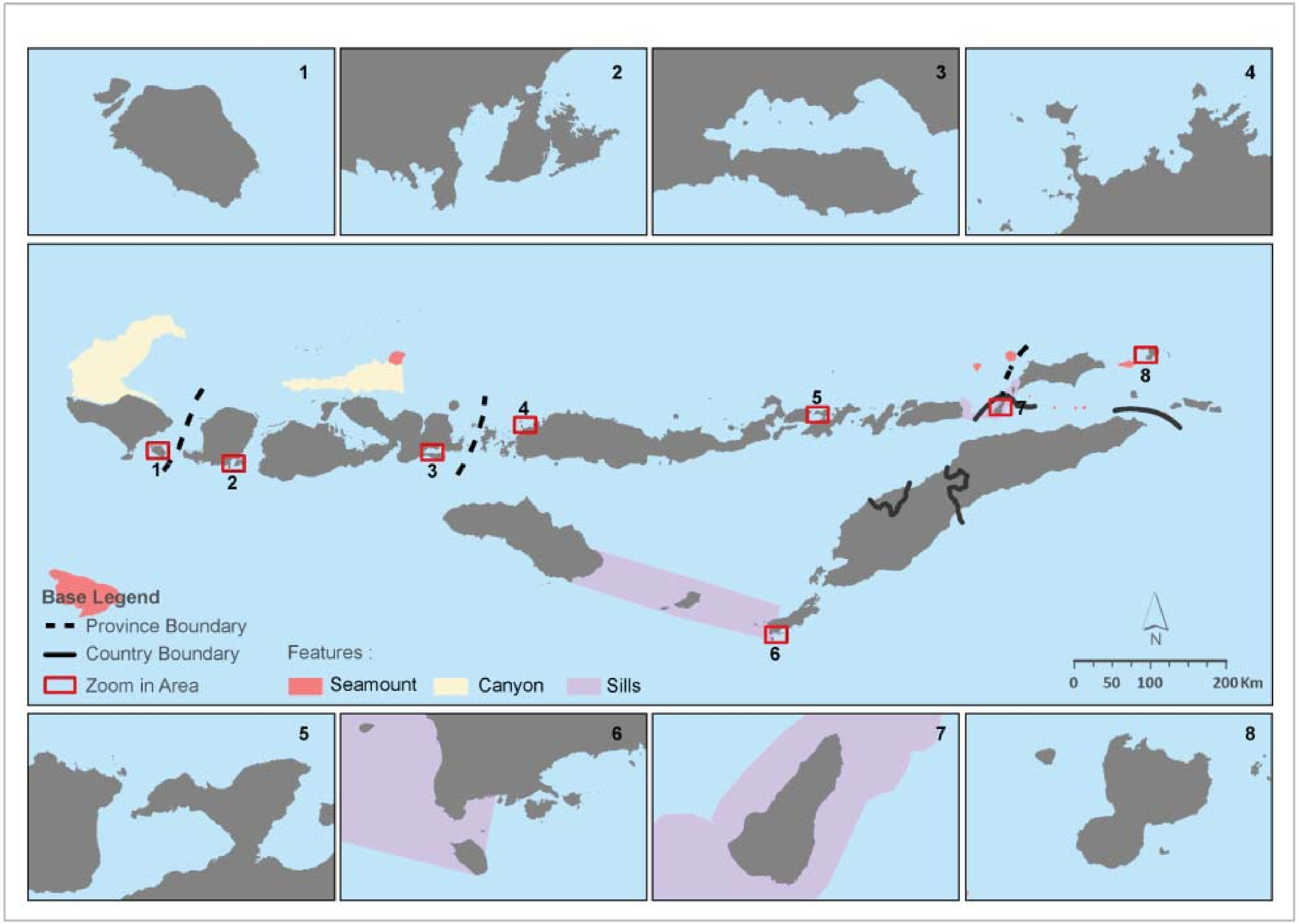


Figure C3. Seamounts, canyons and sills.

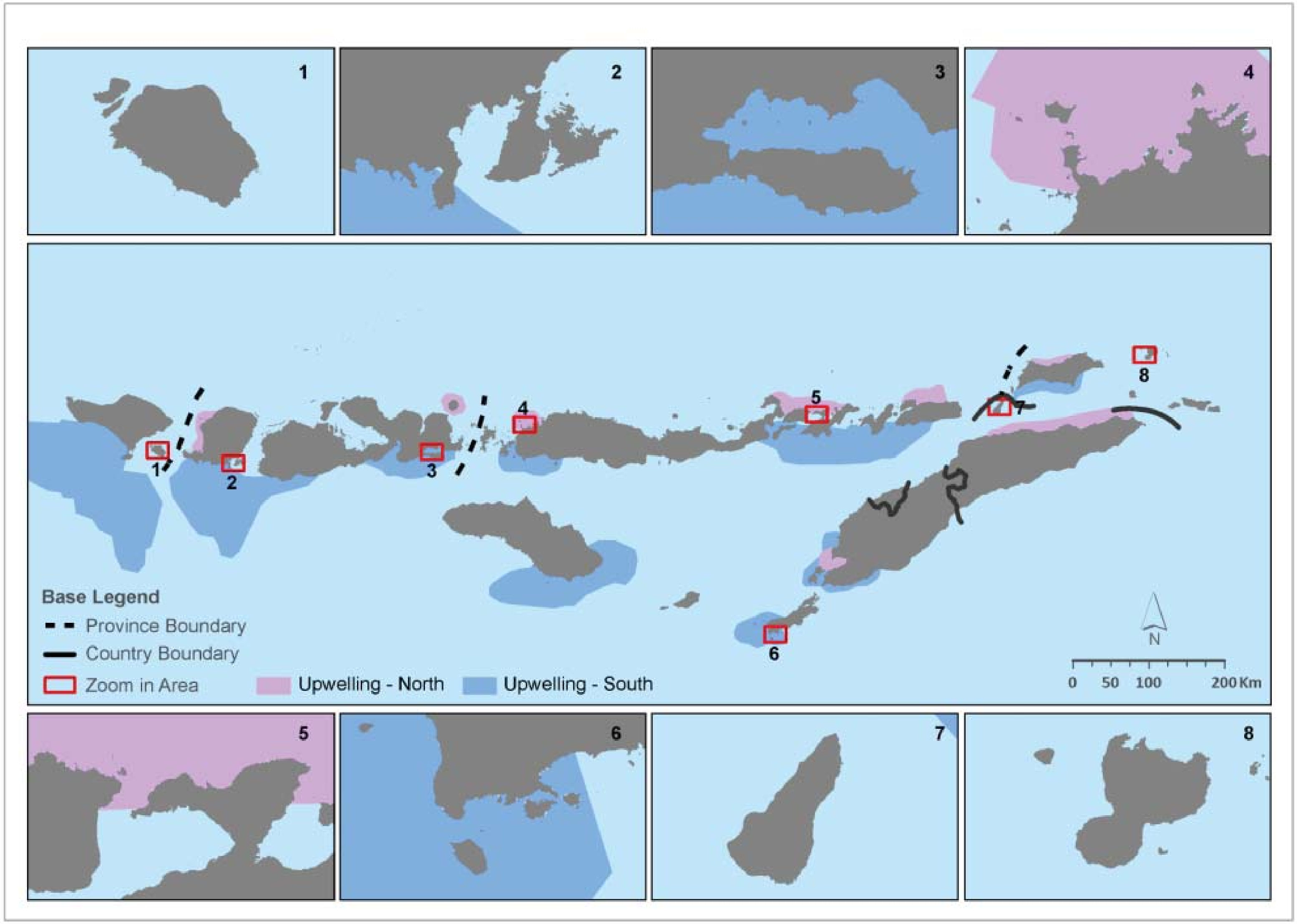


Figure C4. Areas that usually experience upwelling during southern (April to May) and northern (October to November) wind seasons.

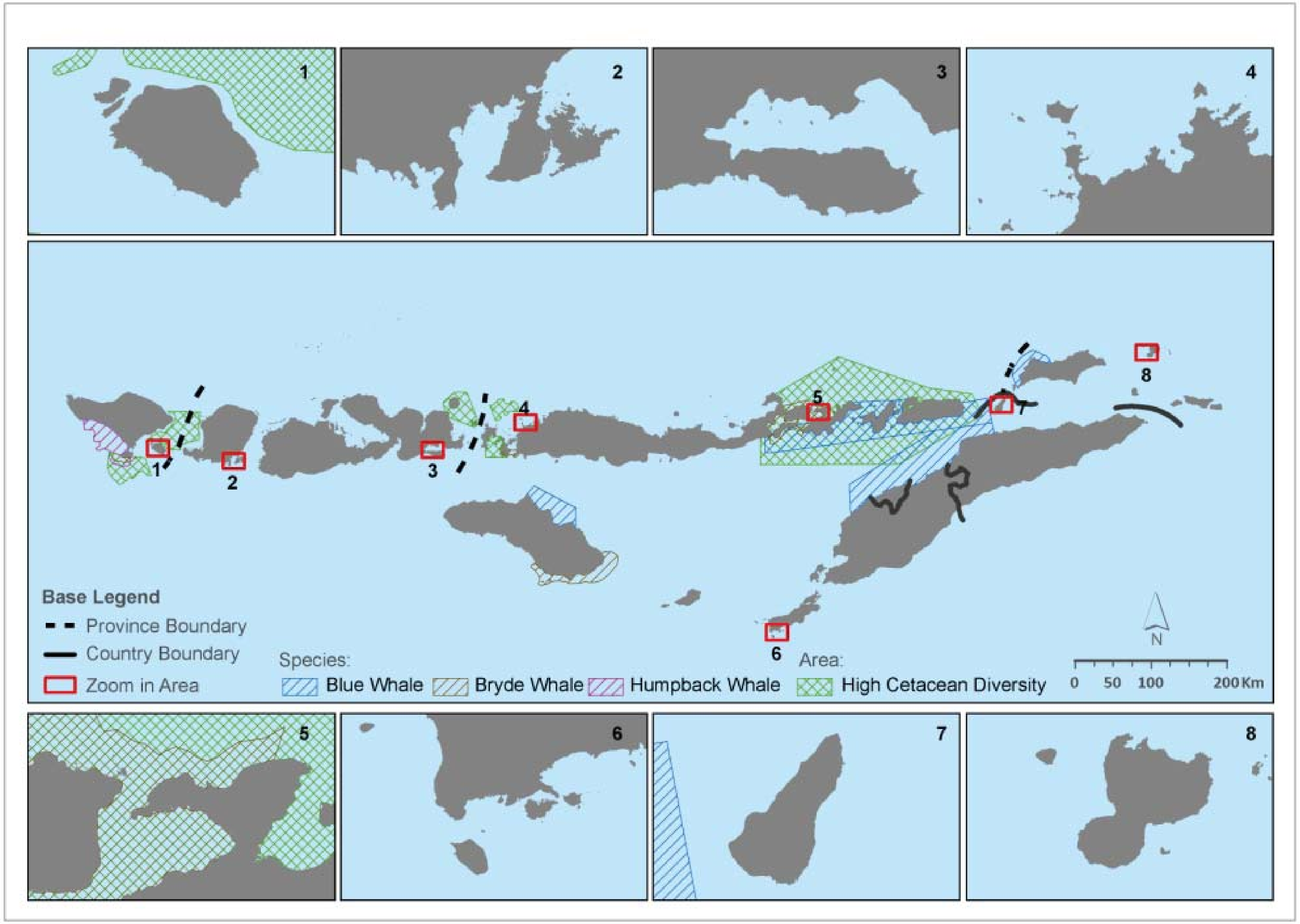


Figure C5. Distribution of large cetaceans.

APPENDIX D. GOALS FOR ALL CONSERVATION TARGETS.

Conservation target	Description	% goal		
		Bali	NTB	NTT
Shallow coastal habitats				
Coral reefs	Coral reef outline	30	30	30
Coral reef classfication – exposure, reef zone	Exposed, North facing fringing and rocky shores	30	30	30
	North influence and semi exposed patch reefs	30	30	30
	Exposed, South influence fringing and rocky shores	30	30	30
	Very sheltered habitats, inlets	30	30	30
Coral reef classification - geomorphology	Deep reef feature	30	30	30
	Forereef slope	30	30	30
	Reef flat	30	30	30
	Reef lagoonal terrace	30	30	30
Seagrass	Sparse to medium	30	30	30
	Medium to dense	30	30	30
Mangrove	Mangrove outline	30	30	30
Estuary	Estuary outline	100	30	30
Straits	Straits outline*	5	5	5
Satellite Islands	Offshore islands outline*		5	5
Persistent pelagic habitats	Persistent upwelling area on south side of islands*	5	5	5
	Persistent upwelling area on the north side of islands*		5	5
Shallow coastal species				
Species distribution	Dugong	80		80
	Mola mola	100		
	Manta Ray	100		
	Blue whale distribution*			5
	Byrdes whale distribution*			5
	Humpback whale distribution*	5		
	Sperm whale distribution*			5
	Area of high diversity cetacean distribution*	5		5
	Dolphin distribution	50	50	
	Shark distribution (West Nusa Tengarra)			
	Whale distribution (West Nusa Tengarra)		5	
	Endangered species (Bali)	30		
	Endangered species (West Nusa Tengarra)		100	
Feeding and nesting areas	Turtle nesting sites	30	80	80
	Imporant areas for turtles			80
	Feeding areas for turtles		80	
	Seabird nesting distribution (West Nusa Tengarra)		5	
Spawning sites	Spawning sites for fish and shrimp	100	80	
Other features				
	Dive sites	80	80	80
	Waters infront of terrestrial reserves		50	

APPENDIX E. PARTICIPANTS AT LESSER SUNDA WORKSHOP DECEMBER 2008.

No.	Name	Position and Organization
National		
1	M. Eko Rudianto	Director of Marine, Coastal and Small Islands Spatial - Ministry of Marine Affairs & Fisheries
2	Agus Dermawan	Director of Conservation and Marine National Park - Ministry of Marine Affairs and Fisheries
3	Ngurah N. Wiadnyana	National Commission of Fish Stock Assessment (*Komnaskajiskan*)
4	Abdul Ghofar	National Commission of Fish Stock Assessment (*Komnaskajiskan*)
5	Wudianto	Marine & Fisheries Research Agency - Ministry of Marine Affairs & Fisheries
6	Yaya Mulyana	COREMAP Program
7	Sutomo	Directorate of Marine, Coastal and Small Islands Spatial - Ministry of Marine Affairs & Fisheries
8	Rofi Alhanif	Directorate of Conservation and Marine National Park - Ministry of Marine Affairs and Fisheries
Bali		
9	A.A.N. Ketut Parwa	Tourism Service of Bali Province
10	Widhi Artha P.	Planning & Development Agency of Bali Province
11	Astari	Marine Affairs & Fisheries Office of Bali Province
12	Ida Bagus Arnaya	Natural Resource Conservation Agency of Bali Province
13	Frida Sidik	Head of Conservation Division - SEACORM, Ministry of Marine Affaris and Fisheries, West Bali
14	B. Realino	Head of Ocean Remote Sensing Division - SEACORM, Ministry of Marine Affaris and Fisheries, West Bali
15	Nuryani Widagti	SEACORM, Ministry of Marine Affaris and Fisheries, West Bali
16	Dati Pertami	SEACORM, Ministry of Marine Affaris and Fisheries, West Bali
17	Elvan Ampou	SEACORM, Ministry of Marine Affaris and Fisheries, West Bali
West Nusa Tenagarra		
18	Mohammad Yunan I. A. Makchul	Head of Marine Conservation and Fisheries Section - Marine Affairs & Fisheries Office of NTB Province Head of Statistic Division - Planning & Development Agency of NTB Province
19	Wihandono Eki Sutopo	Staff of Conservation & Protection Division - Natural Resource Conservation Agency of NTB Province
20	I Gusti Putu Supartha	Data Processor & Programmer - Culture & Tourism Service of NTB Province
21	Mohammad Yunan	Head of Marine Conservation and Fisheries Section - Marine Affairs & Fisheries Office of NTB Province

No.	Name	Position and Organization
East Nusa Tengarra		
22	Nico B. Nuhan	Head of Natural Resource Sub-Division - Marine Affairs & Fisheries Office of NTT Province
23	I.A. Lochana Dewi	Marine Affairs & Fisheries Office of NTT Province
24	Dahlan Makatutu	Head of National Agency for MPA in Kupang - Ministry of Marine Affairs & Fisheries
25	Jotham Ninef	Head of Savu Sea MPA Assessment & Establishment (PPKKL) Team
26	Izaak Angwarmasse	Coordinator of Science - Savu Sea MPA Assessment & Establishment (PPKKL) Team
26	Floridius Dionisius	Head of Marine Spatial & Harbours - Marine Affairs & Fisheries Office of Sikka District
Timor-Leste		
27	Abilio de Deus de Jesus Lima	Secretary of State for Environment - Democratic Republic of Timor Leste (DRTL)
28	Rafael Pereira Goncalves	Chief of Marine Park, Protection & Conservation of Aquatic Resources - DRTL
29	Augusto Fernandes	National Director of Fisheries & Aquaculture, Ministry of Agriculture and Fisheries, DRTL
30	Adalfredo Do Rosario Ferreira	Director of Research and Information - National Directorate of ALGIS, Ministry of Agriculture and Fisheries, DRTL
Non-government organisations		
31	Abdul Halim	Program Manager, TNC Indonesia Marine Program
32	Joanne Wilson	Lead Scientist, TNC Indonesia Marine Program
33	Johannes Subijanto	Portfolio Manager, Lesser Sunda, TNC Indonesia Marine Program
34	Arief Darmawan	GIS specialist, TNC Indonesia Marine Program
35	Gede R. Wiadnya	Training Manager, TNC Indonesia Marine Program
36	Wen Wen	GIS specialist, TNC Indonesia Marine Program
37	Rudyanto	Data manager, TNC Indonesia Marine Program
38	Stephanus Mandagi	Deputy Scientist, TNC Indonesia Marine Program
39	Marthen Welly	Program Leader, Nusa Penida MPA, TNC Indonesia Marine Program
40	Alexander S. Tanody	Policy, Savu Sea MNP, East Nusa Tengarra, TNC Indonesia Marine Program
41	Anton Wijonarno	Conservation Coordinator, Savu Sea MNP, East Nusa Tengarra, TNC Indonesia Marine Program
42	Edwin Bimo	Communications Officer, TNC Indonesia Marine Program
43	Ari Soemodinoto	Monitoring and Evaluation Coordinator, TNC Indonesia Marine Program
44	Juliana Tomasouw	Program Support Officer, TNC Indonesia Marine Program
45	Stuart Sheppard	Data Node Manager, TNC Asia Pacific

No.	Name	Position and Organization
46	Maha Adi	Consultant to TNC
47	Ketut Sarjana Putra	Director of Marine Program, CI Indonesia
48	Tiene Gunawan	Policy and Planning Coordinator, CI Indonesia
49	Scott Atkinson	CI Indonesia
50	Wawan Ridwan	Director of Marine Program - WWF Indonesia

CI = Conservation International, DRTL = Democratic Republic of Timor-Leste, MNP = Marine National Park, SEACORM = Southeast Asia Center for Ocean Research and Monitoring, TNC = The Nature Conservancy.

APPENDIX F. RECOMMENDATIONS FROM LESSER SUNDA MPA WORKSHOP DECEMBER 2008 (ENGLISH TRANSLATION)

Recommendations from
Lesser Sunda Ecoregion
Marine Protected Area Network Workshop

During 18-19 December 2008 in Mercure Hotel, Sanur, Bali, a Workshop for the development of the network of Lesser Sunda Ecoregion Marine Protected Area (*Kawasan Konservasi Laut/*KKL) was held with the aim of presenting the draft design of the network. Presentations by resource persons and discussion by the participants led to the agreement that some follow ups concerning a number of aspects needed to be taken to ensure the development of a comprehensive plan that took into account the inputs from different stakeholders and that was integrated into other planning at different levels for good implementation in support of the national policy for the establishment of Marine Protected Aras. Some of the aspects include:

1. Database

For comprehensive mapping and development of database for the establishment of network of Lesser Sunda Ecoregion Marine Protected Areas, post workshop follow ups include collection of further necessary data and their validation on significant coastal and marine ecosystem and habitat such as coral reefs, mangrove forests, sea-grass beds, spawning aggregation sites, whale and dolphin routes, sunfish, mantas, and the like. Input on such data should be coordinated by the Provincial Offices of the Fishery and Marine Department for further input to the Directorate for Conservation and Marine National Park of the Marine Affairs and Fishery (contact person: Andy Rusandy, email: a_rus2006@yahoo.co.id) and/or The Nature Conservancy – Coral Triangle Center (contact person: Rudyanto, email: rudyanto@tnc.org)

2. **Coordination**

To ensure effective management of the Lesser Sunda Ecoregion Marine Protected Areas, the following follow up actions post workshop are considered necessary:

- Meeting for the finalisation of the Network of Marine Protection Areas for Lesser Sunda Ecoregion and the development of the Networks' management plan following experts' review
- Integration of the development of Lesser Sunda Ecoregion MPA Network in two countries (the Republic of Indonesia and the Democratic Republic of Timor Leste) into the programmes of the respective government institutions at the province/district/city level
- Establish and run a mailing list among the participants of the workshop for the development of network of Lesser Sunda Ecoregion Marine Protected Areas

3. Policy

Development of the policies for the planning and budgeting of Lesser Sunda Ecoregion MPA Network at the national (the Republic of Indonesia and the Democratic Republic of Timor Leste), provincial, and district/city level should be undertaken as a follow up of the workshop for the establishment and management of the said Network.

4. Shared Commitment

For the establishment and management of Lesser Sunda Marine Protected Areas Network, commitment and involvement of all stakeholders shall be necessary, especially the Marine and Fishery Department, the Department for Home Affairs, Forestry Department, and stakeholders in the Lesser Sunda Ecoregion that covers Bali, NTB, NTT and Timor Leste.

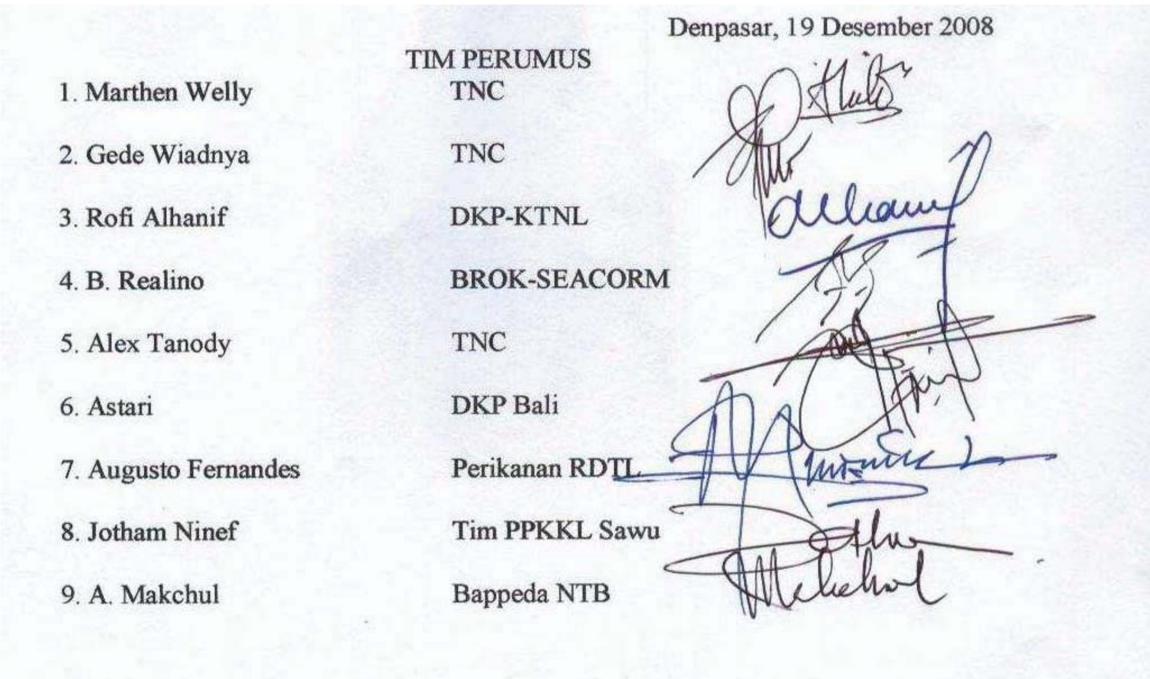
5. Follow up Actions after the Finalisation of Lesser Sunda Ecoregion Network
The following follow up actions have been recommended should the finalisation of the Lesser Sunda Ecoregion network into a map is completed:

- The network should become the reference for the stakeholders in the Lesser Sunda Ecoregion in establishing and implementing the Network in their respective areas
- The network of Lesser Sunda Ecoregion shall be integrated into the spatial planning of each respective areas, especially marine, coastal and small islands spatial planning and to be in line with the Spatial Planning at the national, provincial and district/city level as well as the Fishery Management Plan (*Rencana Pengelolaan Perikanan/*RPP)/Fishery Management Area (*Wilayah Pengelolaan Perikanan*/WPP)
- Periodical meetings among the provinces within the Lesser Sunda Ecoregion should be held, facilitated by the Marine and Fishery Department, to discuss implementation issues and solutions to problems pertaining to the network.
- A coordination body for the network of Lesser Sunda Ecoregion Marine Protected Areas should be established

Denpasar, 19 December 2008

The drafting team:

1.	Marthen Welly	TNC
2.	Gede Wiadnya	TNC
3.	Rofi Alhanif	Ministry of Marine Affairs and Fisheries - KTNL
4.	B. Realino	SEACORM
5.	Alex Tanody	TNC
6.	Astari	DKP Bali
7.	Augusto Fernandes	Fishery Department of Timor-Leste
8.	Jotham Ninef	The Sawu PPKKL team
9.	A. Makchul	Department of Spatial Planning NTB



Denpasar, 19 Desember 2008

TIM PERUMUS

1. Marthen Welly	TNC	
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6. Astari	DKP Bali	
7. Augusto Fernandes	Perikanan RDTL	
8. Jotham Ninef	Tim PPKKL Sawu	
9. A. Makchul	Bappeda NTB	

APPENDIX G. PARTICIPANTS AT SCIENTIFIC EXPERT WORKSHOP – APRIL 2009.

No.	Name	Organization
1	Frida Sidik	SEACORM, Ministry of Marine Affairs and Fisheries, West Bali
2	B. Realino	SEACORM, Ministry of Marine Affairs and Fisheries, West Bali
3	Ngurah N. Wiadnyana	Marine & Fisheries Research Agency - Ministry of Marine Affairs & Fisheries
4	M. Eko Rudianto	Directorate of Marine, Coastal and Small Islands Spatial - Ministry of Marine Affairs & Fisheries
5	M. Saifudin	Directorate General of Marine, Coastal & Small Islands - Ministry of Marine Affairs & Fisheries
6	Ida Bagus Arnaya	Natural Resource Conservation Agency of Bali Province
7	Detty Agustina	Natural Resource Conservation Agency of Bali Province
8	Abdul Ghofar	Diponegoro University, Semarang – Central Java
9	Deny Yusup	Udayana University, Bali
10	Didik Santoso	Mataram University, Mataram – West Nusa Tengarra
11	Jotham Ninef	Universitas Nusa Cendana – Kupang – East Nusa Tengarra
12	Ayub Meko	Kristen Artha Wacana University – Kupang – East Nusa Tengarra
13	Anselmo L. Amaral	Ministry of Agriculture and Fisheries, Timor-Leste
14	Orlando H. Kalis	Ministry of Agriculture and Fisheries, Timor-Leste
15	Ayi Hidayat Ardisastra	WWF – Solor Alor Project
16	Anton Wijonarno	TNC - Savu Sea Project
17	Allison Green	TNC – Asia Pacific Program
18	Edward Game	TNC – Conservation Methods Team
19	Joanne Wilson	TNC – Indonesia Marine Program
20	Johannes Subijanto	TNC – Indonesia Marine Program
21	Gede Wiadnya	TNC – Indonesia Marine Program
22	Arief Darmawan	TNC – Indonesia Marine Program
23	Stuart Sheppard	TNC – Asia Pacific Program
24	Handoko	TNC – Indonesia Marine Program

SEACORM = Southeast Asia Center for Ocean Research and Monitoring, TNC = The Nature Conservancy.

APPENDIX H. RECORD OF FINAL CONSULTATION WITH GOVERNMENT ORGANISATIONS AT PROVINCIAL AND COUNTRY LEVEL IN INDONESIA AND TIMOR-LESTE.

Savu Sea MNP Team – Multi-stakeholder team for the establishment of Savu Sea Marine National Park, BAPPEDA -= Department of Spatial Planning, BLH = Department of Environment, BBKSDA = Department of Natural Resouce Conservation, DKP = Ministry of Marine Affairs and Fisheries, SEACORM = Southeast Asia Center for Ocean Research and Monitoring

A. Government Consultation witgh NTT Province

Date	Meeting with:	Participant	Notes/Inputs
May 26, 2009	Savu Sea MNP Team* (Mr. Jotham Ninef, head)	14 people	Marine area of Maubesi to be an AOI, important for milkfish larvae
May 27, 2009	BAPPEDA NTT (Mr. Danny Suhadi, Kabid and Mr. Gaspar)	15 people	Input for spatial plan of NTT which under revision, GIS data on admin boundaries
	BLH NTT (Mr. Diaz, head of BLHD)	8 people	TNC invited to give a presentation about MPA in the Gemala meeting around mid june in Ngada
	BBKSDA (Mr. Zubaidi Susanto)	10 people	Status of mangroves area need to confirm to local govt.
May 28, 2009	DKP (Mr. Nico Nuhan, kabid and Mr. Izaak Angwarmase)	6 people	Add two AOIs: between Riung and Maumere, and between Sikka and Savu 1
	BKKPN (Mr. Dahlan)	-	

B. Government Consultation with Bali Province

Date	Meeting with:	Participant	Notes/Inputs
June 2, 2009	Bali provincial government reps (Mr. I.B. Wijaya, kabid and Mr. Dewa Dharma)	13 people	Detail report will be very useful for spatial plan
June 3, 2009	SEACORM (Ms. Frida Sidik and Mr. Realino)	6 people	Add an AOI around Perancak area, increase percentage of mangrove, estuary, and turtle nesting
June 5, 2009	DKP Province (Mr. Pancima, secretary and Mr. Suastawa)	3 people	Reschedule meeting to fourth week of June
June 15, 2009	DKP Karangasem (Mr. Nengah Mantha, head)	4 people	No progress on the CKKLD, depends on DKP Jkt
	BKSDA Bali (Mr. Istanto, head, Ms. Detty Agustina)	12 people	Perancak area is important for turtle nesting and mangrove
June 16, 2009	DKP Buleleng (Mr. Nyoman Sutrisna, head)	5 people	Add CKKLD Sumberkima. 3 CKKLD to be declared this year. In line with strategic plan for coastal mgt

C. Government Consultation with NTB Province

Date	Meeting with (c.p)	Participant	Notes/Inputs
June 9, 2009	NTB provincial government reps (Mr, Made Sujana, kabid P4K DKP)	20 people	Importance of community involvement in the MPA mgt and surveillance as well, need assistantship to develop MPA in Lombok Tengah, Sopia Louisa Island will be developed as an MPA of Lombok Barat.
June 10, 2009	BKSDA NTB (Mr. Asep Sugiharta, head of BKSDA NTB)	11 people	Need further observation for southern coastal area of Sumbawa as turtle nesting sites, importance of collaborative mgt and community involvement
	BAPPEDA NTB (Mr. Abel Syamsul)	6 people	Teluk Saleh declared as special area for economic development, one AOI in Teluk Saleh move to north around P. Liang, Add an AOI in southern of Lombok
June 11, 2009	Tourism (Mr. Irfan)	4 people	15 tourism development areas (Perda 9/1989)
	BLH (Mr. Subagyo)	6 people	

D. Government Consultation with Timor Leste

Date	Meeting with (c.p)	Participant	Notes/Inputs
June 3, 2009	NT govt and Charles Darwin Uni reps (Ms. Karen Edyvane and Mr. Guy Boggs)	3 people	Possibility of data sharing with ATSEF
June 4, 2009	Presentations and workshop – results of ATSEF projects for Timor Leste govt.	70+ people	Alternative livelihood and governance as key issues
	Dept. of Agriculture and Fisheries (Mr. Augusto and Mr. Ancelmo)	4 people	Changes of some AOIs, transboundary MPA management
	Apex Pty Ltd (Mr. Ben Kahn)	2 people	Adjustments and additions of deep sea MPAs

APPENDIX I. LESSER SUNDA MPA NETWORK

Table I1. Details of each MPA in Lesser Sunda MPA network including status, designation, management level, size and the main coastal and deep sea conservation targets. No = MPA identification number as per Figures 13-17; Mgt = management; CR = coral reef; SG = seagrass; M = mangrove; Tur = turtle nesting beach; Dug = dugong; UP = upwelling; ST = strait; SC = Satellite island/canyon/seamount/oceanic islands; CT = cetaceans. Size (ha) only includes the component of the protected area that covers marine waters or coastal marine targets such as mangroves. For example Bali Barat National Park encompasses both terrestrial and marine areas but only the size of the marine area is reported here.

Shallow coastal MPAs															
No	Name	Province	Status	Designation	Mgt Level	Size (ha)	Coastal features					Deepsea features			
							CR	SG	M	Tur	Dug	UP	ST	SC	CT
Indonesia - Bali Province															
1	Bali Barat	Bali	Existing	TN	National	17,388 *	x	x	x		x		x		
2	Perancak	Bali	AOI		District	1,691				x		x			
3	Sumber Kima	Bali	Proposed	CKKLD	District	592	x	x							
4	Lovina	Bali	Proposed	CKKLD	District	18,937	x	x		x				x	
5	Tejakule	Bali	Proposed	CKKLD	District	8,601	x							x	
6	Munggu	Bali	AOI		District	431	x			x	x	x			
7	Cape Bukit	Bali	AOI		District	15,128	x	x			x	x	x		x
8	Ngurah Rai	Bali	Existing	THR	National	1,993 *	x	x	x		x		x		
9	Sanur	Bali	AOI		District	2,041	x	x			x		x		
10	Penida	Bali	Proposed	CKKLD	District	18,801	x	x	x	x			x		x
11	Karangasem	Bali	Proposed	CKKLD	District	26,761	x	x		x			x		x
Indonesia - West Nusa Tengarra Province															
12	Gili Matra	NTB	Existing	TWAL	National	2,452 *	x	x		x		x	x		
13	Paloh	NTB	AOI		District	1,730	x	x		x		x	x		
14	West Sekotong	NTB	Proposed	CKKLD	District	1,200	x	x				x	x		
15	Gili Gede	NTB	Proposed	CKKLD	District	3,372	x	x	x			x	x		
16	Bangko-Bangko (M)	NTB	Proposed	CKKLD	District	945	x	x					x		
17	Bangko-Bangko (T)	NTB	Existing	TWA	National	2,419 *	x	x	x				x		
18	Cape Berambang	NTB	Proposed	CKKLD	District	1,017	x					x	x		
19	Mekaki Bay	NTB	Proposed	CKKLD	District	908	x	x				x			
20	Pelangan	NTB	Existing	TWA	National	371 *	x	x				x			
21	Sepi Bay	NTB	Proposed	CKKLD	District	3,215	x	x	x			x			
22	Cape Tampa	NTB	Existing	HL	National	1,019 *	x	x				x			
23	Kuta-Awang	NTB	AOI		District	11,231	x	x				x			
24	Gunung Tunak	NTB	Existing	TWA	National	1,827 *	x					x			
25	Cape Cina	NTB	AOI		District	11,453	x	x	x	x		x	x		
26	Gili Sulat	NTB	Existing	KKLD	District	2,895 *	x	x	x			x			
27	Pedauh	NTB	Existing	CA	National	686 *	x	x		x			x		
28	Takad Sagena	NTB	Proposed	CKKLD	District	175							x		

No	Name	Province	Status	Designation	Level	Size (ha)	Coastal features					Deepsea features			
							CR	SG	M	Tur	Dug	UP	ST	SC	CT
Indonesia - West Nusa Tengarra Province (*continued*)															
29	Takad Gili Bendis	NTB	Proposed	CKKLD	District	170	x						x		
30	Belang Is	NTB	Proposed	CKKLD	District	2,080	x	x					x		
31	Kalong Is	NTB	AOI		District	3,050	x	x	x				x		
32	Panjang Is (M)	NTB	AOI		District	11,172	x	x					x		
33	Panjang Is (T)	NTB	Existing	KSA	National	3,074 *	x	x					x		
34	Medang Is	NTB	AOI		District	10,782	x							x	
35	Moyo Is (M2)	NTB	Proposed	CKKLD	National	51,413	x	x						x	
36	Moyo Is (M1)	NTB	Existing	TWAL	National	7,533 *	x	x						x	
37	Moyo Is (T)	NTB	Existing	TB	National	28,561 *	x	x						x	
38	Satonda Is (M)	NTB	AOI		National	1,915	x							x	
39	Satonda Is (T)	NTB	Existing	TWA	National	438 *	x							x	
40	Liang Is	NTB	AOI		Province	7,710	x	x							
41	Ketapang Is	NTB	AOI		Province	8,945	x	x							
42	Rak Is	NTB	AOI		Province	12,061	x	x	x						
43	Cempi Bay	NTB	AOI		Province	34,510	x		x	x		x			
44	Sanggar Bay	NTB	AOI		Province	3,729	x	x							
45	Tenawu -Taa	NTB	AOI		District	9,575	x	x				x			
46	Woworada Bay	NTB	AOI		District	10,255	x	x	x			x			
47	Toffo Kota Lambu	NTB	Existing	CA	National	3,936 *	x	x					x		
48	Gili Banta	NTB	Existing	KKLD	District	10,253	x			x			x		x
Indonesia - East Nusa Tengarra Province															
49	Komodo	NTT	Existing	TN	National	176,962	x	x	x	x		x	x		x
50	Seraya	NTT	AOI		District	23,472	x	x	x			x			
51	Sawu 1	NTT	Existing	TNP	National	552,787	x	x	x			x	x	x	
52	Manupeu Tanadaru	NTT	Existing	TN	National	75,943 *	x								
53	Lasipu Bay	NTT	AOI		Province	38,439	x								
54	Riung	NTT	Existing	TWAL	National	6,844 *	x	x	x						
55	Wolo Tadho	NTT	Existing	CA	National	5,249 *	x	x	x						
56	Palue Is	NTT	AOI		Province	159,088	x	x	x					x	
57	Ende Is	NTT	AOI		Province	88,876	x	x						x	

No	Name	Province	Status	Designation	Level	Size (ha)	Coastal features					Deepsea features			
							CR	SG	M	Tur	Dug	UP	ST	SC	CT
Indonesia - East Nusa Tengarra Province (*continued*)															
58	Maumere Bay	NTT	Existing	TWAL	National	51,366 *	x	x	x					x	
59	Besar Is	NTT	Existing	TWA	National	6,321 *	x	x	x						
60	Ngaru Baluk	NTT	AOI		District	37,759	x	x							
61	Sawu 2	NTT	Existing	KKPN	National	2,861,863	x	x	x	x	x	x	x	x	
62	Ndana Is	NTT	Existing	TB	National	1,422	x	x		x	x	x	x		
63	Harlu	NTT	Existing	SM	National	601 *	x	x			x				
64	Perhatu	NTT	Existing	SM	National	461 *	x		x		x	x			
65	Kupang Bay	NTT	Existing	TWAL	National	64,830 *	x	x	x	x	x	x			
66	Danau Tuadale	NTT	Existing	SM	National	852 *	x		x		x	x	x		
67	Menipo Is	NTT	Existing	TWA	National	1,516 *			x			x	x		
68	Dataran Bena	NTT	Existing	TB	National	2,129			x				x		
69	Maubesi (T)	NTT	Existing	CA	National	7,392 *			x				x		
70	Maubesi (M)	NTT	AOI		District	29,498			x				x		
71	Berluli	NTT	AOI		District	12,907	x	x	x				x		
72	Selat Pantar	NTT	Existing	KKLD	District	399,223	x	x	x	x		x	x		x
73	Rusa Is	NTT	Existing	TB	National	1,391	x			x			x		x
74	Lapang Is	NTT	Existing	TWA	National	249 *	x	x					x		x
75	Batang Is	NTT	Existing	TWA	National	360 *	x						x		x
76	Tuti Adagae	NTT	Existing	TWA	National	5,576 *	x					x			x
77	Batu Gade	NTT	Proposed	CKKLD	District	12,491	x	x	x				x		
Timor-Leste															
78	Suai	Timor Leste	AOI		National	7,136			x				x		
79	Behau	Timor Leste	Proposed	CKKLD	District	27,934	x	x	x			x	x		
80	Atauro Is	Timor Leste	Proposed	CKKLD	District	10,882	x	x					x	x	
81	Lamsanak	Timor Leste	Proposed	CKKLD	District	15,242	x	x	x			x	x		
82	Manufahi	Timor Leste	AOI		National	18,329	x	x					x		
83	Nino Konis Santana	Timor Leste	Existing	TN	National	125,699	x	x				x	x	x	
Indonesia - Moluccas Province															
84	Kisar Is	Moluccas	AOI		District	25,324	x	x					x	x	
85	Romang Is	Moluccas	AOI		District	278,326	x	x					x	x	
86	Leti Is	Moluccas	AOI		District	32,501	x	x					x	x	

Deep Sea MPAs																
No	Name	Province	Status	Designation	Level	Size (ha)	Coastal features					Deepsea features			
							CR	SG	M	Tur	Dug	UP	ST	SC	CT
87	South Bali	Bali	deep sea	DSAOI	National	270,453	x				x	x	x		x
88	Lombok Strait	Bali	deep sea	DSAOI	National	252,105	x	x		x		x	x		x
Indonesia - West Nusa Tengarra Province															
89	South Lombok	NTB	deep sea	DSAOI	National	133,321	x	x				x	x		
90	Tengah Islands	NTB	deep sea	DSAOI	National	232,605								x	
91	Sangeang Is	NTB	deep sea	DSAOI	National	85,552								x	
Indonesia - East Nusa Tengarra Province															
92	East Flores	NTT	deep sea	DSAOI	National	397,181	x	x	x	x		x	x		x
93	Lembata	NTT	deep sea	DSAOI	National	573,360	x	x	x	x	x	x	x	x	x
94	Alor - Deep Sea	NTT	deep sea	DSAOI	National	800,035	x	x	x			x	x	x	x
95	Maubesi - Deep Sea	NTT	deep sea	DSAOI	National	148,280							x		
Indonesia - Timor-Leste															
96	Ombai		transboundary	TBAOI	transboundary	594,766	x	x	x			x	x	x	x
97	Liran-Atauro		transboundary	TBAOI	transboundary	186,407	x	x				x	x	x	
98	South Wetar		transboundary	TBAOI	transboundary	230,823	x	x				x	x	x	
Timor-Leste															
99	Manufahi - Deep Sea	Timor Leste	deep sea	DSAOI	National	223,648							x		
100	Nino Konis Santana-Deep Sea	Timor Leste	deep sea	DSAOI	National	113,538						x	x	x	

The Nature Conservancy
Protecting nature. Preserving life.™

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