CMS Dugong MOU Standardised Dugong Catch and Bycatch Questionnaire Final Report

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Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats throughout their Range
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Table of Contents

The Why

In brief…

Dugongs are seagrass-dependent marine mammals found in tropical and subtropical coastal waters, broadly coincident with the tropical Indo–Pacific distribution of seagrasses. Their conservation is complicated by fragmented populations distributed over vast ocean areas, substantial changes in life history parameters associated with seagrass availability; high costs of real-time monitoring; and the widespread and pervasive small-scale artisanal nature of the gill-fisheries which cause the greatest mortality.

Dugongs are vulnerable to fisheries, traditional hunting, large-scale losses of seagrass, smaller-scale habitat loss and boat traffic. They form part of important rituals and traditional practices across much of their range and are valued as a protein source in many coastal societies. Given the diverse social, cultural, economic and ecological values attributed to dugongs, their conservation is complicated and challenging.

Entanglement is the predominant threat as dugongs are by-caught in many kinds of fishing gear, in both commercial and artisanal fisheries. However, the magnitude of the impact is largely unquantified in many countries. Little reliable information documents these impacts, particularly because most (~90%) of the dugong's range is in developing countries, which lack the necessary resources to conduct surveys. Knowing where dugongs are and what pressures they are under are critical for conservation, but documenting impacts from fisheries and distributions / abundances of dugong populations in a cost-effective and timely manner present a unique challenge.

The Convention on Migratory Species (CMS) Dugong MoU Secretariat, in partnership with the Marine Research Foundation and a team of global experts, developed a dugong questionnaire which has been implemented at low cost and across large geographical areas. The questionnaire was also designed to collect data on marine turtles and cetaceans and has resulted in a large data set of dugong numbers and distribution across a significant range in the developing world. The results presented herein represent the latest update on dugong numbers since 2002 and provide a glimpse into population trends and the first wide-spread spatial analysis of fishery overlaps and threats.

Rationale – why we did it

In most countries where dugongs occur, numbers are small and most local people believe they are declining. If we wait for scientific data before initiating conservation action, the dugong may have disappeared before we collect the data to see if there is a problem. Most data on the distribution and abundance of dugongs and their habitats are not suitable for designing effective conservation actions. In addition, collecting such

information using scientific techniques such as aerial surveys is beyond the infrastructure, resources and financial capacity of most countries.

An alternative and cost-effective approach is to interview fishers to identify 'dugong trouble spots' where the number of dugongs is low, and the threats to their existence are high. We need to be able to identify the areas where the likelihood of dugongs being killed by hunting, capture in fishing gear and vessel strikes is greatest, so that dugongs can be protected in their key habitats. The conduct of these standardised, culturally-appropriate surveys can be done quickly, efficiently and cost effectively. The relatively low cost can facilitate multiple, "longitudinal" surveys at particular locations to assess changes over time, as well as the collection of comparable data from a number of locations and range states.

Risk is a combination of the likelihood of something happening and the consequences of it happening. The likelihood of a dugong interacting with a fisher in an area generally increases with the number of dugongs and the number of fishers using gear that is known to entangle dugongs. This information on dugongs and threats to their existence can be combined in a geographical information system (GIS) to identify 'dugong trouble spots' as a visualisation tool for communities to assist them in exploring the ways in which the risks to dugongs and their habitats can be reduced. The results of this initiative will enable informed efforts which ensure that there are dugongs, cetaceans, and sea turtles around for future generations.

Dugong Biology 101

The Dugong (*Dugong dugon*), is the sole member of the genus Dugong, which in turn is the only extant species of the Family Dugongidae (Husar 1978, UNEP 2002). These large marine herbivorous sea cows are normally found in the warm tropical and subtropical coastal and inland waters of the Indo-Pacific, broadly coincident with the distribution of seagrasses (Husar 1978). Dugongs consume the whole plant, including the roots if the plant can be uprooted. They prefer seagrasses that are pioneer species (Preen & Marsh 1995), especially species in the genera *Halophila* (which is easy to digest) and *Halodule* (rich in nitrogen and poor in fibers).

The body length in adults is generally 2.5-4.0 metres (m) and corresponding weights are around 250-900 kilograms (kg). Dugong bones are extremely dense (Husar 1978, Nishiwaki & Marsh 1985), and the musculature can represent several hundred kilograms of consumable protein. The juveniles are pale cream in colour, and they darken with maturity to a deep slate gray dorsally and laterally, and slightly paler ventrally. They have hair which is short and sparsely distributed (30-50 millimetres (mm) apart) over the body except for dense bristles on the muzzle. Their nostrils are crescent shaped, approximately 18 mm in diameter and 16 mm apart, on the summit of the head, and are closeable by muscular valves. Their eyes are small, round, and black; and their eyelids have no lashes and close with a sphincter action.

Dugongs exhibit little sexual dimorphism and are sexed on the basis of the distance between the anal and genital apertures, which are almost contiguous in females and several hand spans apart in males (Marsh et al. 1986). Male dugongs also have tusks that erupt several years after gonadal maturity but never protrude more than a few

centimeters from the gums. In addition, the body length of females may be slightly longer than that of males (Marsh 1980).

The growth layers on the tusk, which are like growth rings in a tree, indicate that dugongs have a life span similar to humans and can live up to 70 years. They have a low reproductive rate, short generation cycle, and a high investment in each offspring (Marsh 1995, Marsh 1997, Kwan 2002). Females do not usually bear their first calf until they are at least ten years old and sometimes as late as 17 years old (Marsh 1995), and they bare only one calf at a time, after a pregnancy lasting between 13-15 months. On average, females produce calves only once every two and a half to seven years provided food resources are sufficient for them to build up energy reserves (Marsh 1995, UNEP 2002).

Where they are found…

The dugong's historic distribution spans at least 40 countries and territories that include tropical and subtropical coastal and inland waters from east of Africa to Vanuatu and northward to Japan (**Figure 1**). "Throughout much of its range, the dugong is represented by relict populations separated by large areas where its numbers have been greatly reduced or already extirpated. The dugong is still present at the historical limits of its global range, although there is evidence of a reduction in the area of occupancy within its range. In most parts of its range, the anecdotal evidence suggests that dugong numbers are declining" (UNEP 2002).

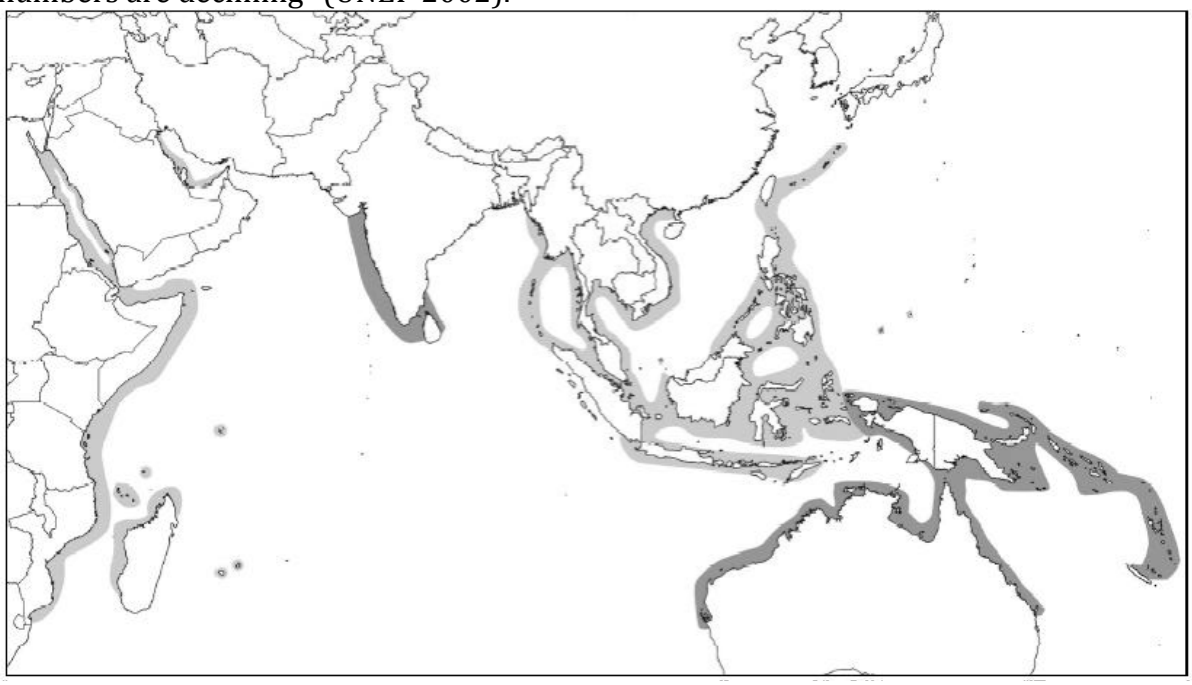

Figure 1: The known range of the Dugong (Source: Marsh 2005)

Dugongs spend the majority of their time in seagrass habitats where they feed, and there is evidence that they use particular habitats for other activities such as calving and mating (Anderson 1981). Shallow waters, such as tidal sandbanks (Marsh et al. 1984) have been reported as important sites for calving, and Anderson (1981) suggested that this may be a strategy to minimise the risk of shark predation (Marsh et al. 1984, UNEP 2002). The highest densities of dugongs are generally seen in water less than (<) 5-10m deep in bays, shallows, island and reef areas which are protected from strong winds and heavy seas, and which also support extensive seagrass beds (Heinsohn et al. 1977, Bayliss 1986, Preen 1995, Preen & Marsh 1995).

Threats they face

Dugongs are vulnerable to two broad classes of impacts: those that kill the animals directly, for example, entanglement in fishing nets, traditional hunting or large-scale losses of seagrass; and those that decrease the calving rate by reducing feeding opportunities, for example, smaller-scale habitat loss or disturbance by boat traffic (Marsh 1997).

Seagrass beds may be destroyed directly by trawling or lost through the effects of disturbances such as dredging, inland and coastal clearing, land reclamation and boat propeller scarring. These activities cause increases in sedimentation and turbidity that, in turn, lead to degradation through smothering and lack of light. Other threats include sewage, detergents, heavy metals, hypersaline water from desalination plants and other waste products (Marsh 2005). In the United Arab Emirates (UAE) for example, a country whose development has been rapid and extensive, the construction of ports and harbours, land reclamation, extensive dredging and introduction of modern fishery techniques and equipment has degraded marine habitats, and impacts upon many species there are evident (AGEDI 2016).

Episodic losses of hundreds of square kilometers (sq km) of seagrass are associated with extreme weather events such as cyclones, hurricanes and floods, and these events can cause extensive damage to seagrass communities through severe wave action, shifting sand, adverse changes in salinity and light reduction. For example, an unusual flood and cyclone event resulted in the near total loss of 1000 sq km of seagrass meadows in Harvey Bay, in eastern Australia, which caused many dugongs to starve and eventually die (Preen & Marsh 1995).

Numerous traditional communities also greatly value dugong meat. In Papua New Guinea, coastal and island people capture dugongs by setting nets across dugong feeding and migration paths (Kinch 2008). In Torres Strait, northern Australia, dugong hunting is considered an important expression of a person's Aboriginality (Smith & Marsh 1990). Dugong meat is also considered an important source of protein and dugong oil is used as a panacea remedy for a variety of illnesses (Smith & Marsh 1990). Dugong harvests at this site are usually seasonal, with highest catch rates reported during Christmas (Tikel et al. 1996). In Palau, more than 20 knowledgeable residents revealed that dugongs are still poached regularly and deliberately, rather than as an opportunistic activity (Marsh et al. 1995). Dugongs were formerly hunted in the Arabian Gulf for their meat, which was considered a delicacy, but this practice has been made illegal in recent years in the UAE, where most dugongs are found (Baldwin 1995).

Interactions between marine mammals (including dugongs) and fisheries have increased in frequency and intensity during the last decades (Marsh et al. 1995, Read 2008) and major adverse ecological impacts of fisheries are closely related to the bycatch of unwanted or untargeted species (Lewison et al. 2004). Accidental dugong entanglement in gill and mesh nets or traps is considered a major, but still a largely unquantified threat, and is identified as a major concern in all subregions (UNEP 2002) of the dugongs' range.

Without a doubt, the largest threat to dugongs is incidental catch in fishing nets (Heinsohn et al. 1976, Hines et al. 2005). Accidental deaths in fishing nets in the Arabian Gulf, Australia, East Africa, East and Southeast Asia, India, the Red Sea, the Pacific Islands and Sri Lanka, and in shark nets near Queensland's swimming beaches have caused significant local reductions in dugong numbers (Heinsohn 1972, Bertram & Bertram 1973, Nair et al. 1975, Husar 1978, Paterson 1979, Nishiwaki & Marsh 1985, Baldwin 1995, Lawler et al. 2002, UNEP 2002, Lewison et al. 2004, Read et al. 2006, Kiszka et al. 2008, Pilcher et al. 2008, Poonian et al. 2009). Significant numbers of dugongs are also killed in the inshore gill-net fisheries of northern Australia, but this has not been quantified. Dugongs are also accidentally drowned in commercial gill-nets, particularly Barramundi nets (Marsh 1988).

Recent evidence has highlighted the potential for coastal fisheries to have significant negative impacts on mortality of non-target species (e.g. Lum 2006, Jaramillo-Legorreta et al. 2007, Peckham et al. 2007, Mangel et al. 2010). Small-scale fisheries occur primarily in developing nations, and their documentation, regulation and management are limited or non-existent (Panayotou 1982, Pauly 2006), precluding an evaluation of their impacts on dugongs and other taxa. The threat is considered major due to the sheer number of boats in these fisheries, but the magnitude of the impact is largely unquantified in many countries (Perrin et al. 2002). Little reliable information documents these impacts (UNEP 2002; Poonian et al. 2009), particularly because much of the dugong's range is in developing countries which often lack the necessary resources to conduct resource- and finance-demanding surveys (Aragones et al. 1997).

Conservation status

The low reproductive rate in dugongs requires that a very high proportion (greater than (>) 95%) of adult animals have to survive each year for a dugong population to be maintained. Population simulations indicate that even with the most optimistic combinations of life-history parameters (e.g. low natural mortality and no human-induced mortality) a dugong population is unlikely to increase more than 5% per year (Marsh et al. 1986, Marsh 1995, Aragones & Marsh 1999). The rate of change of a dugong population is most sensitive to changes in adult survivorship, whereby even a slight reduction in adult survivorship as a result of habitat loss, disease, hunting or incidental drowning in nets, can cause a chronic population decline (Marsh 1995, UNEP 2002). Model simulations show that, if dugong numbers are to be maintained, more than ~95% of adult females alive at the beginning of each year must still be alive at the end of that year. The maximum sustainable mortality from all human impacts is only about 1-2% of adult females per year (Marsh et al. 1986).

Although the dugong is nominally protected through National legislation across virtually its entire range, populations have declined precipitously in the last decades to the point of local extinction across vast swathes of its range. A large (hundreds of thousands) population straddles northern Australia and Papua New Guinea, and a second, substantially smaller population of tens of thousands resides in the southwest corner of the Arabian Gulf. This is in contrast to the estimated few dozen remaining in Palau, the northernmost Pacific population. No dugongs have been reported for Pakistan or Bangladesh in recent years, and those in Malaysia survive in isolated pockets.

The International Union for the Conservation of Nature (IUCN) rates their extinction risk as Vulnerable on a global scale. This risk is based on an inferred or suspected reduction of at least 30-50% over the last three generations (90 years); (Lawler et al. 2002 and describes a taxon that faces a moderate risk of extinction in the wild within 50 years (Marsh 2008).

A recent report on the status of dugongs throughout their range with the assistance of more than 100 experts indicated that dugong populations are declining or extinct in at least one-third of its range, of unknown status in about half of its range and possibly stable in the remainder – mainly the remote coasts of the Northern Territory and Western Australia (UNEP 2002; Marsh 2008).

While the dugong is currently listed globally as Vulnerable on the IUCN Red List™, a more realistic assessment of its status based on regional management units (RMUs) which take into effect movement patterns, genetics and regional geographic barriers (Wallace et. al. 2010) is likely to paint a far more severe picture, whereby most extents of its range would easily qualify for Critically Endangered status with the exception of only the Australian and the Middle East populations.

Programme design background

Possibly the most accurate method to determine bycatch rates across large areas involves the use of independent observers on board fishing vessels to record bycatch per unit effort that can then be extrapolated to the entire fishery to estimate total bycatch (NMFS & USFWS 1998, Kennelly 1999, Rago et al. 2005). Unfortunately, the method is more suitable for industrial fisheries as artisanal fisheries typically comprise

a mix of registered and unregistered boats, lack of space for observers, and are cost-prohibitive given the sheer number of vessels (Moore et al. 2010). Aerial surveys can be used for identifying important dugong habitats and to estimate dugong population, but such surveys are expensive and require extensive logistical support (Marsh & Sinclair 1989, Aragones et al. 1997), likely beyond the typical means of most of the developing countries that comprise the dugong's range (UNEP 2002).

In contrast, interview surveys are considered to be one of the most inexpensive and practical techniques in developing countries (Aragones et al. 1997, Jones et al. 2008). These surveys are most useful when there is little or no information available to establish population status before more intensive assessments are conducted (Marsh & Lefebvre 1994, Kinch 2008) and provide considerable information about the characteristics of artisanal fisheries / mammal interactions of over broad geographic areas. They can also be implemented for a fraction of the cost of other more qualitative questionnaire methods over short periods of time (Aragones et al. 1997, Pilcher et al. 2008, Moore et al. 2010). The surveys can also provide accurate quantitative information about marine mammal and sea turtle bycatch in both artisanal and commercial fisheries when observer data are limited or not feasible to collect (Moore et al. 2010) as well as qualitative information such as dugong occurrences and thus distribution patterns, threats and potential management strategies (Marsh & Lefebvre 1994, Aragones et al. 1997, Kinch 2008, Rajamani & Marsh 2010). The resultant data can be used to highlight priority sites where conservation efforts should be concentrated and to inform future quantitative surveys (Aragones et al. 1997).

As a precursor to this work, techniques to quantify the extent of marine mammal bycatch through rapid interview surveys were developed by Project GLOBAL: Global Bycatch Assessment of Long-lived Species (http://bycatch.env.duke.edu/). Unfortunately, inadequate descriptions of interview methodology and lack of standardised interview protocols meant that data reliability was difficult to assess and results across studies were often not comparable. A follow-up version of this questionnaire, developed in consultation with social scientists and using the lessons from Phase I was used as a starting point for the development of our dugong-specific standardised questionnaire. The interview-based questionnaire used in this programme is based on the first and second editions of the Project Global Rapid Bycatch Assessment, along with aspects of other research protocols in use by James Cook University, San Francisco University, and Community Centered Conservation.

Notably, the questionnaire builds on past efforts by several agencies and programmes, incorporating spatial elements into the process in order to permit spatial analyses of dugong distribution and fishery threats. The data derived via the questionnaire was designed to update the last assessment of dugong numbers (depicted in UNEP 2002), and to provide a glimpse into population trends, along with the first wide-spread spatial analysis of fishery overlaps and threats.

Programme objectives

The goal of this large multinational effort was to determine the distribution of dugongs and their overlap with small-scale fisheries via a custom-tailored questionnaire programme. Armed with this knowledge, the resulting aim was to determine those areas

where there were spatial overlaps, evaluate the severity of these based on dugong numbers and fishery densities, and assign priority rankings for potential conservation hotspot areas.

Limitations - it's mostly a way to determine potential hotspot areas

The questionnaire is by its very nature open to a suite of biases, subjective information, and data transcription errors. In subsequent portions of this report, we acknowledge the limitations of this questionnaire. However, given the number of respondents and the volume of data assimilated, we are confident much of this has been smoothed out. However, it is important to note that the complex analyses of dugong distribution superimposed over density analyses of fishery distribution are meant to serve as indicators of potential hotspot areas in need of further investigation and analysis. In today's age of limited financial and physical resources, this allows management agencies to investigate in more detail those areas in which we have identified potential significant interaction opportunities for dugongs and small-scale fisheries.

The Where

Participating countries

The dugong spatial distribution and fisheries interactions questionnaire was deployed in 18 countries spread across four key geographical zones as follows: Southwest Indian Ocean (Kenya, Madagascar, Mozambique, and Tanzania), South Asia (Bangladesh, India and Sri Lanka), Southeast Asia (Cambodia, Malaysia, Myanmar, Philippines, Thailand and Vietnam) and the Pacific Islands (New Caledonia, Palau, Papua New Guinea, Solomon Islands and Vanuatu). These countries were selected based on a programmatic approach by the CMS Dugong MoU Secretariat to assist the relevant National agencies in meeting in part their obligations under the Conservation and Management Plan, and based on expressions of interest from each country in participating in the broader data collection programme.

Given restrictions on funding, time constraints and local capacity, the questionnaires were not deployed evenly along the coasts of each country, but rather at areas of past knowledge of dugong presence, key known dugong areas, and/or potential dugong areas based on known seagrass distribution (**Figure 2**). Undeniably this creates a certain bias towards areas of known distribution for dugongs, but this was accepted in the face of limited funding and manpower resources. The conservation priorities developed as part of this programme thus represent priorities within those studied areas, and we do not suggest they represent priorities against other non-studied regions.

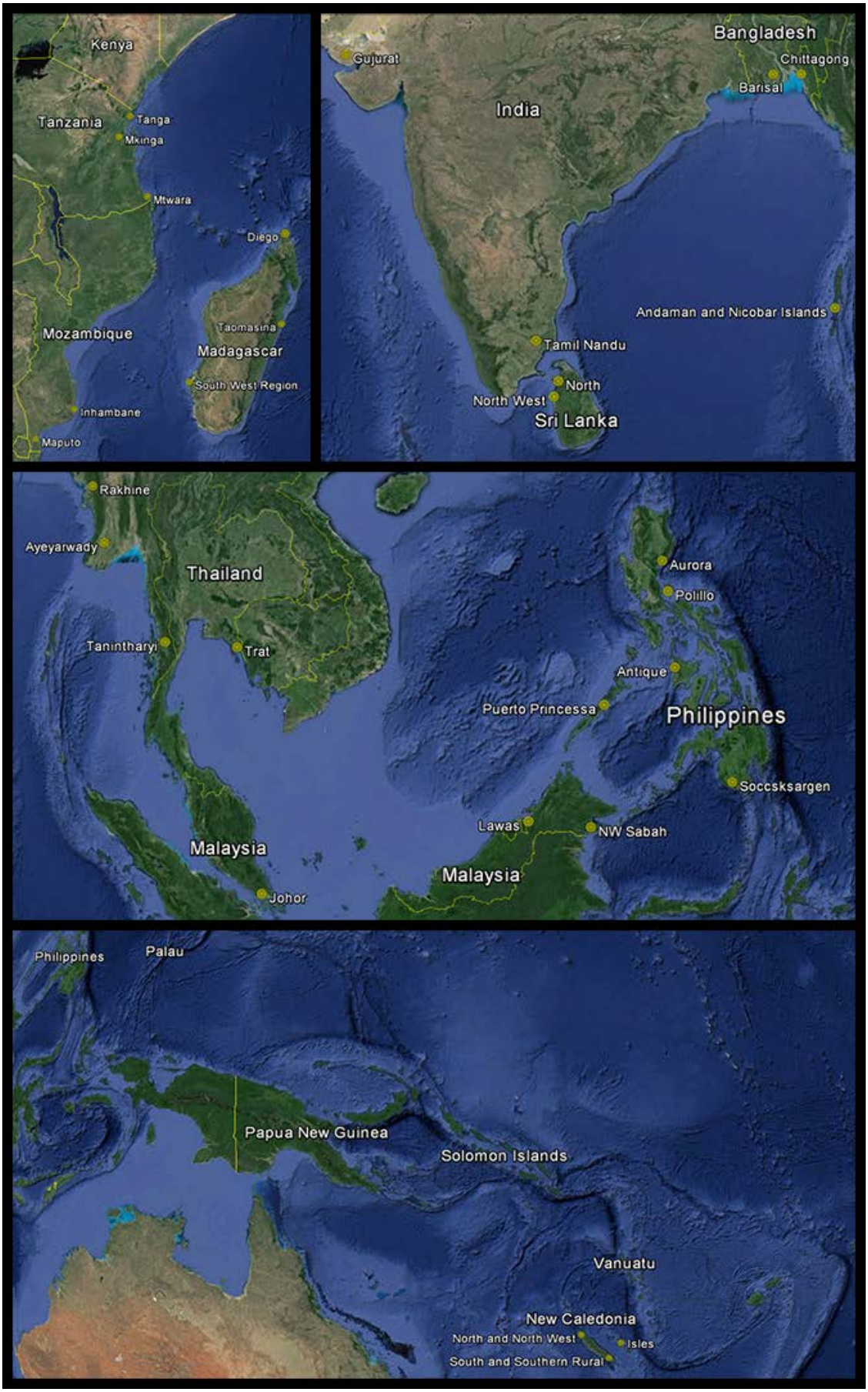

Figure 2: Key implementation areas for the dugong questionnaire

The Who

A team of specialists with varying backgrounds, all of who brought important knowledge and research approaches, contributed to the development of this questionnaire. The process was conceived and coordinated by N. Pilcher and D. Kwan, and N. Pilcher took the lead and overall responsibility for the development of secondary drafts, revisions, and all linked programme materials. The team of specialists comprised (in alphabetical order):

Dr. Kanjana Adulyanukosol
Phuket Marine Biological Center
Dr. Himansu S. Das
Environment Agency Abu Dhabi
Ms. Patricia Z.R. Davis
Community Centered Conservation
Dr. Ellen Hines
Department of Geography and Human Environmental Studies
San Francisco State University,
Dr. Donna Kwan
UNEP Convention on Migratory Species
Prof. Helene Marsh
James Cook University
Dr. Nicolas Pilcher
Marine Research Foundation
Dr. Louisa S. Ponnampalam
Institute of Ocean and Earth Sciences,
University of Malaya,
Dr. John E. Reynolds
Department of Manatee Research Program
Mote Marine Laboratory and Aquarium,

The questionnaire was then deployed via a series of small grant agreements for each country to a team of project leaders, who in turn assembled teams of volunteers and staff members to conduct the interviews. The average funding per project was in the region of USD 5000 per country. The project leaders in the dugong questionnaire programme are listed below alphabetically by country. Where more than one project leader coordinated work in a country these people are listed by last name in alphabetical order within each country. Full contact details for the project leaders are provided in **Appendix I**.

Bangladesh
Andrea D Phillott, *Asian University for Women*
Cambodia
Suy Serywath, *Department of Fisheries*
India
V. Balaji, *OMCAR Foundation*
K. Sivakumar, *Wildlife Institute of India*
Kenya
Mohamed Omar Said, *Kenya Wildlife Service*

New Caledonia

Théa Jacob, *Agence des Aires Marines Protégées*

Madagascar

Ambroise Brenier, *Wildlife Conservation Society*
Patricia Z.R Davis, *Community Centred Conservation*
Claudine Ramiarisoa, *Ministry of Environment and Forests*
Yvette Razafindrakoto, *Ministry of Environment and Forests*

Malaysia

James Bali, *Sarawak Forestry Corporation*
Saifullah Jaaman, *Universiti Malaysia Terengganu*
Nicolas J Pilcher, *Marine Research Foundation*
Loiusa Ponnampalam, *University of Malaya*

Mozambique

Almeida Guissamulo, *University Eduardo Mondlane*

Myanmar

Maung Maung Lwin, *Department of Fisheries*

Palau

Joshua Eberdong, *Bureau of Marine Resources*

Papua New Guinea

Vagi Rei, *Department of Environment and Conservation*

Philippines

Angelita Viloria, *Biodiversity Management Bureau*
Arnel Yaptinchay, *Marine Wildlife Watch of the Philippines*

Solomon Islands

Tia Masolo, *Ministry of Environment, Climate Change and Meteorology*

Sri Lanka

Asanka Abayakoon, *Dilmah Conservation*
Arjan Rajasuriya, *IUCN Sri Lanka*
Shamen Vidanage, *IUCN Sri Lanka*

Tanzania

Lindsey West, *Sea Sense*

Thailand

Kanjana Adulyanukosol, *Phuket Marine Biological Center*
Kongkiat Kittiwattanawong, *Phuket Marine Biological Center*

Vanuatu

Vatu Molisa, *Department of Environmental Protection*
Trinison Tarivonda, *Department of Environmental Protection*

Vietnam

Phan Hong Dung, *Research Institute for Marine Fisheries*

The How

The birth of the CMS Dugong MOU Standardised Dugong Catch and Bycatch Questionnaire

As noted above, the Convention on Migratory Species (CMS) Dugong MoU Secretariat, in partnership with the Marine Research Foundation (MRF) and a team of global experts, developed the CMS Dugong MOU Standardised Dugong Catch and Bycatch Questionnaire (questionnaire) to be implemented at low cost and across large geographical areas. The questionnaire was also designed to collect data on marine turtles and cetaceans, and can be adapted to various other marine or freshwater species. Indeed, the questionnaire is already providing baseline information for eight developing countries in the Dugong and Seagrass Conservation Project funded by the Global Environment Facility (GEF); it is being used widely across the Caribbean in a manatee study; and has been used to study river dolphins in Peru.

The multi-disciplinary panel tasked with developing the tool ensured that the questionnaire design would be widely applicable to differing regions and conservation challenges while being scientifically sound and culturally-sensitive. The questionnaire protocols were reviewed by a number of social science and bycatch assessment experts to determine appropriate language and ensure scientific rigor. The questionnaire was then field-tested in three countries and further refined prior to dissemination, and has undergone fine-tuning since it was first launched in 2010. The final revision of the questionnaire was undertaken in late 2012 following input from a number of users.

The questionnaire comprises 106 questions, of which the last six are internal questions to the interviewer that relate to respondent confidence, knowledge and accuracy. These are used to provide a layer of quality control on the data sets. Questions address the personal background of the respondent, the fishery (or other employment form), and finally numbers, trends, and locations of dugongs, sea turtles and cetaceans as known by the respondent. It also includes a data table for sightings of all marine fauna, which are drawn onto maps during the interview. This spatial component is one of the key strengths of the process, as when used properly it captures locations of fishing pressure and seagrass distribution. Interviewees each get a relevant-scale, clean map on which to mark fauna records and their fishing areas, eliminating bias. A code number on the questionnaire itself links maps and sighting tables.

Excel spreadsheet

A standardized Excel spreadsheet was developed into which data can be uploaded, with constrained fields controlled via filters to minimize data entry error. Locked formula cells process the data in real time and construct 27 different graphical and numerical outputs in a standardized form so that data are similarly interpreted from location to location. Graphical outputs relate to respondent demographics, fishing vessel and gear types, dugong numbers and trends, and perceptions of changes and importance of dugongs by the respondents. Users are unable to edit the graphs, but are able to copy their data into a new file and analyse separately or more thoroughly should they wish.

Google Earth uploads

All spatial data collected on individual code-linked maps were uploaded into Google Earth ™ by project leaders and their staff. Point location data such as dugong sightings were uploaded as Placemarks and all polygon data such as the shape and size of fishing areas and seagrass beds were uploaded as Polygons. Users simply had to reproduce the locations outlined by fishers on paper maps into the corresponding electronic maps. All Placemarks and Polygons were named following the questionnaire with an unique code number. Users were also were guided in setting up project-specific directories for storing both data sets, and these were then transmitted to the Marine Research Foundation in Malaysia for quality control checks, synthesis and spatial analysis.

ArcGIS

All spatial data were imported into ArcGIS 10.2 (www.esri.com) for analysis. Point location data for dugongs were analysed using the Kernel Density Analysis toolkit. The seagrass bed areas were collated using the Join function in the Spatial Analysis toolkit to avoid duplication, as more than one fisherman recording seagrass bed data in one particular place does not mean that there is duplicate seagrass at that location. Density analysis of the fishery areas was optimized through first combining the numerous layers via the Geodatabase tool and subsequently determining overlaps within the attribute tables using Excel 2013 ™. The corrected attribute table was then returned to ArcGIS for spatial density analysis of fishery overlaps. The final step in the process entailed overlaying density plots for dugongs and density grids for fishing pressure. Given that within ArcGIS each of these processes results in hundreds of thousands of cells, each with a density value, and each value then being linked mathematically to the corresponding cell in the second density layer, the final process often consumed two days of processing on a standard desktop computer per graphic. The analysis also took into account the distance of dugongs to fishing and seagrass areas, as at times dugongs may be migrating or moving between feeding areas, rather than residing in that area. The overlaps between high density dugong areas and high fishing density areas were then broken down into three colour-coded categories representing High to Low priority for further investigation.

Project manual

A Project Manual was developed to explain the project rationale and introduce the CMS Dugong MOU Standardised Dugong Catch and Bycatch Questionnaire. It discusses such topics as interview methods and techniques, data integrity, questionnaire design effort and efficiency, stratified and random sampling, field data collection and control, and how to link graphics to table data and survey numbers. Other chapters address uploading graphics and spatial data as well as creating and exporting Google Earth layers to GIS, and basic GIS analyses once all data are uploaded.

Project timing

The project started with an initial workshop in Thailand in April 2010 that led to the Southeast Asia regional sub-programme. This was followed by a subsequent training workshop in Australia for the Pacific Islands sub-component and another in Madagascar for the Southwest Indian Ocean sub-component during August 2010. A final training

workshop for South Asia was held in June 2011 in India. A smaller training session for the Philippines was held in Malaysia in July 2011.

Response periods varied widely, with some countries providing feedback within three months and others taking over 1 ½ years to return data sets for inclusion in the overall analyses. Subsequent quality control and correspondence with project leaders on anomalous or missing data sets consumed another six months, while overall final analysis was spread over another six months. Much of this revolved around the spatial analysis and GIS processes.

The Outcome

The questionnaire was deployed in 18 countries spanning four key geographic areas (East Africa, South Asia, Southeast Asia and the Pacific) with 6153 respondents. The results of the surveys provide the latest information on the distribution and abundance of dugong populations in these areas, while identifying and mapping areas of important dugong habitat such as seagrass beds, and assessing the relative risks to distinct populations from fisheries.

The numbers of questionnaires to be deployed by each team leader were not prescribed in advance, but rather were left to each agency to determine based on logistical constraints, numbers of fishing vessels, and known dugong areas. The number of questionnaires deployed in each country varied widely, broadly reflective of levels of commitment, co-funding, and logistics. The largest number of questionnaires deployed was in India with 2017 questionnaires deployed and covered an extremely large geographical area. In contrast, the Vanuatu deployed the smallest amount of questionnaires being 12, due to changes in personnel and abandonment of the project shortly after inception. A summary of response rates per country and colour-coded by region is provided in **Table I.**

Table I: Number of questionnaires deployed by country.

Country	Questionnaires deployed
Kenya	75
Madagascar	295
Mozambique	146
Tanzania	206
Sri Lanka	239
Bangladesh	68
India	2017
Cambodia	200
Thailand	622
Vietnam	400
Myanmar	151
Malaysia	580
Philippines	240
Palau	201
PNG	350
Solomon Islands	109
New Caledonia	254
Vanuatu	12
Total	**6153**

Degree of project implementation and impact on findings

Not every country implemented the project completely or provided the results in accordance with the Project Manual. Some countries implemented the questionnaire but did not return any of the spatial data (e.g. Cambodia), while others conducted their own analyses and did not return the spatial data in the format required (e.g. Lawas, Malaysia). One country (Papua New Guinea) conducted its own assessment, which was not compatible or comparable with the CMS Dugong MOU Standardised Dugong Catch and Bycatch Questionnaire. A summary of project implementation is provided in **Table II**.

Table II: Degree of implementation of the programme by country/region.

Country	Region	Tool Deployed	Data provided in Excel	Sighting data provided as *.kmz	Fishing data provided as *.kmz	Seagrass data provided as *.kmz
Bangladesh	Chittagong	Yes	Yes	Yes	Yes◆	Yes
	Barisal	Yes	Yes	Yes	Yes◆	Yes
Cambodia	Kep	Yes	No	No	No	No
	Kamp	Yes	No	No	No	No
	Sihanouk	Yes	No	No	No	No
	Koh Kong	Yes	No	No	No	No
India	Andaman & Nicobar	Yes	Yes	Yes	Yes	Yes
	Gujarat	Yes	Yes	Yes	Yes	Yes
	Tamil nadu	Yes	Yes	Yes	Yes	Yes
Kenya	Kipini	Yes	Yes	No	No	No
	Kinyaole	Yes	Yes	No	No	No
New Caledonia	Country-Wide	Yes	Yes	Yes	Yes	Yes
Madagascar	Diego	Yes	Yes	Yes	Yes	Yes
	South West Region	Yes	Yes	Yes	Yes	Yes
	Taomasina	Yes	Yes	Yes	Yes	Yes
Malaysia	Banggi	Yes	Yes	Yes	Yes	Yes
	Johor	Yes	Yes	Yes	Yes	Yes
	Lawas	Yes	Yes	No	No	No
Mozambique	Inhambane	Yes	Yes	No	No	No
	Maputo	Yes	Yes	No	No	No
Myanmar	Ayeyarwady	Yes	No	No	No	No
	Rakhine	Yes	No	No	No	No
Palau	Country-Wide	Yes	Yes	No	No	No
Papua New Guinea	Daru	No	No	No	No	No
	Kimbe	No	No	No	No	No
	Madang	No	No	No	No	No
	Manus	No	No	No	No	No
Philippines	Aurora	Yes	Yes	Yes	Yes	Yes
	Antique	Yes	Yes	Yes	Yes	Yes

	Polillo	Yes	Yes	Yes	Yes	Yes
	Puerto Princesa	Yes	Yes	Yes	Yes	Yes
Solomon Islands	Ysabel	Yes	Yes	Yes	No	Yes
Sri Lanka	North	Yes	Yes	Yes	Yes◆	Yes
	Northwest	Yes	Yes	Yes	Yes◆	Yes
Tanzania	Mkinga	Yes	Yes	Yes	Yes	Yes
	Mtwara	Yes	Yes	Yes	Yes	Yes
Thailand	Trat	Yes	Yes	Yes	Yes	Yes
Vanuatu	Malekula	Yes★	Yes❖	No	No	No
Vietnam	Bai Tu Long	Yes	Yes	No	No	No
	Con Dao	Yes	Yes	No	No	No
	Phu Quoc	Yes	Yes	No	No	No

Notes:

Yes◆	Fishing data provided as point data, not polygons
Yes★	Only 12 questionnaires deployed
Yes❖	Only sightings table returned, not the questionnaire data

Facts and figures

It is impractical and illogical to provide an interpretation of the results from all surveys combined, as these are broadly distributed across national borders, regions, and even ocean basins. The data occasionally precluded an overall synthesis within each country given the geographical extents and the limitations on coverage. Therefore the section below summarises at a regional level a selection of facts and figures derived from the programme, noting that there is broad variability in the findings. Relevant National level analyses are provided in **Appendix II**. A tabular summary of key findings is presented in **Tables III-VI**.

Regional analyses

Southeast Asia

Data available for: Malaysia, Philippines, Thailand, Vietnam

Respondents: >75% of the respondents' parents were fishers and just under 65% of their grandparents were also fishers. More than half of the respondents had been fishing for >20 years. 97% of the respondents were males. Most of the respondents were 26-75 years old (just under 90%), but ~65% of them were 26-50 year old. Over 60% of the respondents claimed that fishing was their only income-generating activity.

Boats & Gear: Half of the boats used were 5-10m in length and the majority were motorised (~95%). The fishing activity remained roughly constant all year through, ranging from just under 80% of fishers active in August to 85% in May. The primary catch for ~40% of the fishermen was fish, and just over 30% claimed that their primary catch was shrimp. The most commonly used equipment for of the fishermen was gillnets, with 25% of them using hooks and lines. >70% of the fishermen affirmed to tend their nets at all times, and 40% were tended during the day. >65% of the nets were deployed as sinking nets where dugongs are more likely to be encountered while foraging. 65% of the nets were 51-500m in length. About 50% were 11-100m in width and <5m deep.

Dugongs: 55% of the respondents knew what a dugong was. Most dugong encounters occurred while fishing (45%) or in transit to fishing areas (<25%), but >15% were found netted (which is the highest percentage amongst regions, along with the Southwest Indian Ocean). 10% of the fishermen estimated the dugong population in key areas to comprise 2-10 individuals, while almost 80% were unsure. 20% claimed that the trend in net capture of dugongs showed a decrease but 70% were unsure. More than half of the dugongs were allegedly released alive but 25% were also reported as discarded (dead). More than half of the respondents who encountered dugongs had caught 1-2 in the past year, while >15% had caught >10 dugongs in the past 5 years. The majority of fishermen affirmed that dugongs were not hunted in their own village (>80%) or in others (>65%), indicating dugong mortality is mostly incidental in nature.

Perceptions: Just under 30% of the respondents claimed that the trend in dugong population showed a decrease, while 60% were unsure. Only 40% believed that dugongs may face extinction and 60% affirmed that dugongs were not important to marine ecology or were unsure. Most of the fishermen thought it was legal to catch a dugong (70%) and 15% thought it was legal to catch one by accident. Just under 45% said that there were no enforcement or that this was infrequent, while 60% said that there were no penalties or that they were infrequently levied.

Pacific Ocean

Data available for: New Caledonia, Palau, Solomon Islands, Vanuatu

Respondents: Just under 75% of the respondents' parents and only about 60% of their grandparents were fishers, which is the lowest proportion of fishing history across all the regions, suggesting that it is a new activity for some families. 65% of the respondents had been fishing for ~20 years but this includes 40% that had been fishing for only <10 years and this suggests that fishermen in this area were slightly less experienced than in other regions. 75% of the respondents were male and this region had the highest proportion of female fishers. Most of the respondents were 26-75 years old (>80%) but the largest age group was 26-50 years (>50%). Only 30% claimed that fishing was their only income-generating activity, meaning that fishing was less of a key activity than it was for other regions. This might be biased sampling but does include a lot of respondents for whom agriculture was the main income-generating activity.

Boats & Gear: >95% of the boats used were motorised, increasing the risk of injury and disturbance for dugongs, and >40% of those boats were 5-10m in length. The fishing activity indicated a peak during June, July and August (100% of respondents), with the lowest activity recorded in October and December (50%). The primary catch for 95% of the fishermen was fish. The most commonly-used equipment was hook & line (45%), beach seines (20%), along with more infrequent use of purse seines and gillnets (both just under 15%). Amongst gillnets, >80% of the nets were tended at all times, and about half of them were tended during the day only. Just over 85% were deployed at the surface. >80% of the nets were 51-500m in length. 50% of the nets were 11-100m in width and <5m deep.

Dugongs: 95% of the respondents knew what a dugong was. Most dugong encounters occurred during fishing (just over 50%) or in transit to fishing areas (just over 40%). About half of the respondents estimated the dugong population in key areas to be about 2-10 individuals. Just under 30% of the fishermen claimed that the trend in net capture of dugongs was decreasing, while half of them were unsure. More than half of the respondents had encountered a dugong at least once in the past year. >60% of dugongs were released alive but 30% were reported as eaten. >60% of the fishermen who encountered dugongs caught 1-2 in the past year, and just under 30% caught >10 in the past 5 years. The majority of fishermen affirmed that dugongs were not hunted in their own village (>55%), but around 50% claimed that they were hunted in other villages.

Perceptions: About 45% of the respondents claimed that the trend in dugong populations showed a decrease and <30% were unsure, suggesting that most of the respondents were aware of the dugong population's history. >80% believed that dugongs may face extinction and >90% affirmed that they were important to marine ecology, indicating that they know the value of dugongs to marine environments. Most of the fishermen thought it was legal to catch a dugong on purpose (>80%) and only 15% thought it was legal to catch one by accident. Only 30% said that there were no enforcement or that this was infrequent, indicating an improvement in enforcement levels over other regions, but just fewer than 60% said that there were no penalties or that they were infrequent.

Southwest Indian Ocean

Data available for: Kenya, Madagascar, Tanzania

Respondents: >70% of the respondents' parents were fishers and >60% of their grandparents were also fishers. >65% of the respondents had been fishing for ~20 years. 94% of the respondents were male, and just below 65% of them were 26-50 years old; none were <15 years old. Around half of the respondents claimed that fishing was their only income-generating activity.

Boats & Gear: 80% of the fishermen used boats of 2-10m in length and just over 70% of the boats were non-motorised. The fishing activity remained stable all year although there was a slight peak in December (>85% of respondents). The lowest levels of fishing activity were recorded in November (<80% of respondents). The primary catch for >90% of the fishermen was fish. They mostly used hook & lines (20%) as well as gillnets (20%) and long lines. Just under 80% of the fishermen tended their nets at all times, but only 40% of the nets were tended during the day when dugongs are likely most active. Slightly less than half of the nets were deployed as sinking nets. 90% of the nets were >51m in length and the majority were 11-100m in width.

Dugongs: >65% of the respondents knew what a dugong was. Most of the dugong encounters were during fishing (>35%) or in transit to fishing areas (30%) and only <5% were found stranded, but over 15% were found entangled in nets. Some 10% of the respondents estimated the number of dugongs in key areas to be 1-10, but >85% were unsure how many dugongs might be present in these areas. Only half of the dugongs were reportedly released alive. 40% of the fishermen claimed that the trend in net captures of dugongs showed a decrease, but >40% were unsure. 70% of the fishermen who encountered dugongs reported that they caught 1-2 in the past year, and >10% said that they caught >10 dugongs in their whole lifetime. Most fishermen alleged that dugongs were not hunted in their own village (>80%) or in other villages (>70%) suggesting most of the take is accidental.

Perceptions: Just below 40% of the respondents claimed that the trend in dugong populations showed a decrease and over 40% were unsure. >35% of the respondents believed that dugongs may go extinct while >70% affirmed that dugongs were important to the marine environment. Most of the fishermen thought it was legal to catch a dugong on purpose (70%) and 35% thought it was legal to catch one by accident. Just under 50% said that there were no enforcement activities or that they were infrequent, while 40% said that there were no penalties or that they were infrequently levied.

South Asia

Data available for: Bangladesh, India, Sri Lanka

Respondents: >95% of the respondents' parents and just below 80% of their grandparents were fishers. >70% of the respondents had been fishing for =<30 years, with 30% for 11-20 years. 98% were male and 65% of the respondents were 26-50 years old. >65% claimed that fishing was their only income-generating activity.

Boats & Gear: >70% of the boats used were motorised, and half of them were only 5-10m in length. The fishing activity showed a peak from December to March and the lowest activity was recorded for the months of June and July. The primary catch for >90% of the fishermen was fish. About 40% of the fishermen used gillnets and 30% used hook & line. >45% of the nets were tended at all times, and only 10% were tended during the day only. >65% of the nets were deployed at the water surface. The majority of nets used were 51-500m in length (75%) and 11-100m in width (55%).

Dugongs: >85% of respondents knew what a dugong was. Most of the dugong encounters occurred while fishing (35%) and in transit to fishing areas (>40%). >20% of the respondents estimated the dugong population in key areas to be about 2-10 individuals and >60% were unsure. Only 40% of the dugongs were released alive. A large number of respondents had never seen a dugong. Of those that had, half claimed that the trend in the net captures of dugongs was decreasing, but >40% were unsure. Just under 90% of the respondents who encountered dugongs had caught 1-2 in the past year, while >10% caught >10 dugongs in the past 5 years. Most fishermen alleged that dugongs were not hunted in their own village (>80%) or in other villages (>70%).

Perceptions: <40% claimed that the trend in dugong populations was decreasing and 45% said they were unsure. >35% believed that dugongs may face extinction and 75% believed that they were important to the marine environment. Most of the fishermen thought it was legal to catch a dugong on purpose (>70%) and 35% thought it was legal to catch one by accident. Just under 50% said that there were no enforcement or that it was infrequent, while 40% said that there were no penalties or that they were infrequent (similar to the data for the Southwest Indian Ocean).

Data summary tables

Given the (often) extreme variation between data sets at both National and provincial or geographic scales (within country), summaries per country or larger subregions do not provide the most accurate reflection of data sets acquired during this project. For this, we detail in the following tables (**Tables III-VI**) the summaries of key demographic, fishing gears and levels of hunting, dugong sightings, and trends in captures. Graphic representation of selected findings for a representative site are depicted in **Figures 3 to 11**.

Table III: Fisher demographics by country and region.

Country	Region	Age			Gender		Background		
		Average fisher age	Min fisher age	Max fisher age	% Male	% Female	% Fishers	% Family history	Avge # years fishing
Bangladesh	Chittagong and Barisal	34.0	19.0	90.0	100.0	0.0	100.0	83.6	15.3
India	Andaman and Nicobar	40.0	15.0	85.0	99.3	1.0	N/A	N/A	24.2
	Gujurat	35.0	13.0	75.0	95.0	5.0	97.0	91.0	20.1
	Tamil Nandu	41.0	14.0	75.0	95.2	4.8	N/A	N/A	24.1
Kenya	Kipini & Kinyaole	34.0	18.0	74.0	70.0	30.0	64.7	54.5	13.2
Madagascar	Diego	35.0	16.0	63.0	90.0	10.0	78.4	54.5	13.2
	South West Region	48.0	24.0	71.0	100.0	0.0	76.6	100.0	26.6
	Taomasina	44.0	22.0	69.0	100.0	0.0	96.0	90.1	21.6
Malaysia	Johor	47.0	16.0	80.0	98.4	1.6	100.0	87.3	27.2
	Lawas	45.0	19.0	82.0	96.3	3.7	100.0	N/A	27.2
	NW Sabah	42.0	18.0	80.0	97.2	2.8	99.4	100.0	19.1
Mozambique	Inhambane and Maputo	38.0	18.0	73.0	100.0	0.0	97.2	N/A	N/A
Myanmar	Ayeyarwady and Rakhine	50.0	22.0	80.0	100.0	0.0	98.2	42.6	23.9
	Tanintharyi	45.0	20.0	86.0	96.0	3.1	89.6	58.5	20.8
New Caledonia	Isles	41.0	23.0	66.0	83.3	16.7	33.3	76.7	11.7
	North (NE and NW)	45.0	19.0	75.0	72.0	28.0	25.0	83.0	23.4
	South (S and S rural)	43.0	18.0	84.0	75.0	25.0	35.8	75.8	18.9
Philippines	Antique	49.0	17.0	89.0	94.0	5.9	80.9	86.7	25.4
	Aurora	44.0	16.0	74.0	95.5	4.5	N/A	59.5	21.1
	Polillo	48.0	18.0	79.0	100.0	0.0	89.4	81.4	23.4
	Puerto Princessa	45.0	23.0	74.0	96.2	3.8	73.1	60.0	21.5
Solomon Islands	Ysabel	42.0	20.0	63.0	97.4	2.6	100.0	97.4	5.2
Sri Lanka	North	45.0	19.0	78.0	98.9	1.1	91.7	99.4	24.8
	North West	43.0	18.0	70.0	99.0	1.0	92.4	96.2	30.7
Tanzania	Mkinga	45.0	17.0	83.0	90.2	9.8	89.3	85.2	19.2
	Mtwara	44.0	19.0	90.0	92.5	7.5	91.0	83.0	18.0
	Tanga	41.0	18.0	91.0	96.6	3.4	100.0	66.3	16.4
Thailand	Trat	46.0	17.0	70.0	93.2	6.8	92.2	82.2	23.4

Table IV: Dugong sightings data and tends by country and region.

Country	Region	Sightings							
					When a dugong was last seen				
		% seen dugong	% seen fishing	% seen in transit	% Last saw <1 year ago	% Last saw 1-2 years ago	% Last saw 3-10 years ago	% Last saw >10 years ago	% know dugong areas
Bangladesh	Chittagong and Barisal	16.4	70.0	50.0	60.0	0.0	40.0	0.0	21.9
India	Andaman and Nicobar	36.0	71.1	59.9	14.6	23.3	32.3	29.8	23.1
	Gujurat	2.3	57.1	14.3	0.0	0.0	14.3	85.7	50.0
	Tamil Nandu	60.6	34.6	81.1	26.8	11.4	24.8	37.0	14.9
Kenya	Kipini & Kinyaole	42.4	64.0	76.0	44.8	13.8	17.2	24.1	42.9
Madagascar	Diego	18.2	50.0	0.0	25.0	0.0	25.0	50.0	0.0
	South West Region	46.8	54.5	13.6	10.5	0.0	15.8	73.7	38.6
	Taomasina	49.3	62.2	48.6	29.4	5.9	0.0	64.7	0.0
Malaysia	Johor	64.3	45.7	54.3	28.6	15.6	22.1	33.8	58.9
	Lawas	53.7	50.0	24.1	11.5	5.8	21.2	61.5	41.7
	NW Sabah	33.6	45.8	38.3	20.9	4.4	27.5	47.3	19.8
Mozambique	Inhambane and Maputo	90.1	75.0	53.9	47.1	23.5	21.0	8.4	72.1
Myanmar	Ayeyarwady and Rakhine	54.5	76.7	0.0	34.5	17.2	17.2	31.0	30.0
	Tanintharyi	19.8	36.8	0.0	11.8	11.8	52.9	23.5	0.0
New Caledonia	Isles	50.0	60.0	33.3	40.0	6.7	46.7	6.7	46.7
	North (NE and NW)	85.0	44.7	57.6	53.8	7.7	28.2	10.3	71.0
	South (S and S rural)	92.5	37.8	50.5	59.8	9.3	21.5	9.3	82.5
Philippines	Antique	100.0	58.2	14.9	27.7	12.8	22.3	37.2	91.8
	Aurora	99.1	48.1	5.6	25.2	6.5	21.5	46.7	90.7
	Polillo	93.6	45.5	15.9	9.8	2.4	14.6	73.2	48.9
	Puerto Princessa	92.3	45.8	41.7	40.9	9.1	13.6	36.4	91.7
Solomon Islands	Ysabel	100.0	63.2	28.9	80.0	2.9	11.4	5.7	83.8
Sri Lanka	North	91.7	53.0	70.5	53.1	5.6	14.8	26.5	49.4
	North West	39.0	43.9	2.4	4.9	2.4	58.5	34.1	23.8
Tanzania	Mkinga	43.2	50.0	17.1	2.6	0.0	5.3	92.1	30.1
	Mtwara	34.0	14.9	19.4	4.5	1.5	9.1	84.8	19.3
	Tanga	31.8	50.0	25.0	0.0	0.0	3.9	96.1	2.7
Thailand	Trat	20.5	53.3	40.0	25.0	0.0	37.5	37.5	14.3

Table V: Numbers and trends of dugong captures in fishing nets.

Country	Region	Catches								
					Caught last year			Caught in last 5 years		
		% caught last year	% last 5 years	% in a life	% that caught 1-2	% that caught 3-10	% that caught >10	% caught 0 in last 5 years	% caught 1 in last 5 years	% caught 2-10 in last 5 years
Bangladesh	Chittagong and Barisal	0.0	0.0	2.2	N/A	N/A	N/A	100.0	0.0	0.0
India	Andaman and Nicobar	1.7	3.1	11.6	100.0	0.0	0.0	96.9	3.1	0.0
	Gujurat	0.0	0.0	33.3	N/A	N/A	N/A	100.0	0.0	0.0
	Tamil Nandu	0.0	10.0	60.0	N/A	N/A	N/A	90.0	10.0	0.0
Kenya	Kipini & Kinyaole	6.7	50.0	70.0	66.7	33.3	0.0	50.0	30.0	20.0
Madagascar	Diego	0.0	0.0	12.5	100.0	0.0	0.0	100.0	0.0	0.0
	South West Region	0.0	0.0	20.0	N/A	N/A	N/A	80.0	20.0	0.0
	Taomasina	0.0	0.0	0.0	N/A	N/A	N/A	100.0	0.0	0.0
Malaysia	Johor	3.0	10.9	15.4	100.0	0.0	0.0	89.1	10.9	0.0
	Lawas	3.7	7.5	21.4	66.7	33.3	0.0	92.5	7.5	0.0
	NW Sabah	1.5	2.9	9.2	80.0	20.0	0.0	97.1	29.3	0.0
Mozambique	Inhambane and Maputo	1.4	1.5	3.0	100.0	0.0	0.0	98.5	1.5	0.0
Myanmar	Ayeyarwady and Rakhine	26.3	50.0	N/A	N/A	N/A	N/A	50.0	41.7	0.0
	Tanintharyi	1.4	13.8	100.0	100.0	0.0	0.0	86.2	13.8	0.0
New Caledonia	Isles	0.0	66.7	13.3	N/A	N/A	N/A	93.3	6.7	0.0
	North (NE and NW)	4.7	9.5	12.5	25.0	75.0	0.0	90.5	7.1	0.0
	South (S and S rural)	4.6	4.5	19.1	100.0	0.0	0.0	95.5	2.7	0.0
Philippines	Antique	5.9	29.5	56.7	92.9	7.1	0.0	70.5	24.8	0.0
	Aurora	5.6	8.2	25.8	60.0	40.0	0.0	91.8	6.1	0.0
	Polillo	0.0	7.3	5.3	75.0	25.0	0.0	92.7	2.4	0.0
	Puerto Princessa	8.0	9.5	23.8	11.1	0.0	0.0	90.5	9.5	0.0
Solomon Islands	Ysabel	10.7	48.0	37.0	50.0	50.0	0.0	52.0	40.0	0.0
Sri Lanka	North	2.3	31.1	55.1	83.3	16.7	0.0	68.9	17.7	0.0
	North West	0.0	7.7	37.9	N/A	N/A	N/A	92.3	7.7	0.0
Tanzania	Mkinga	6.8	78.9	12.9	66.7	33.3	0.0	92.1	7.9	0.0
	Mtwara	4.5	50.0	10.3	50.0	50.0	0.0	50.0	50.0	0.0
	Tanga	1.3	2.7	2.9	N/A	N/A	N/A	97.3	2.7	0.0
Thailand	Trat	0.0	1.4	1.4	N/A	N/A	N/A	98.6	1.4	0.0

Note: Text in red denotes cases in which there were fewer than 20 respondents.

Table VI: Details of fishing, hunting and dugong trends reported by fishers.

Country	Region	Fishing			Hunting		Dugong Trend	
		% use gillnets	% gillnets tended	% gillnets during day	% know hunters	Avge Number of hunters	% say decreasing	% say increasing
Bangladesh	Chittagong and Barisal	39.3	57.1	100.0	31.3	N/A	16.7	10.0
India	Andaman and Nicobar	40.7	6.6	55.2	7.7	3.0	43.9	1.2
	Gujurat	65.0	99.0	85.7	0.0	N/A	100.0	0.0
	Tamil Nandu	68.3	0.0	37.4	10.5	N/A	58.1	1.0
Kenya	Kipini & Kinyaole	32.4	90.5	91.7	3.8	4.0	56.7	6.7
Madagascar	Diego	10.8	N/A	50.0	46.2	2.0	7.7	46.2
	South West Region	10.1	N/A	50.0	35.6	20.0	18.2	0.0
	Taomasina	25.0	88.9	88.2	10.1	1.0	52.5	0.0
Malaysia	Johor	61.4	69.4	92.2	11.8	N/A	42.5	2.3
	Lawas	62.4	90.6	90.6	24.1	3.4	34.9	0.0
	NW Sabah	20.0	81.0	52.5	5.9	1.0	13.2	1.9
Mozambique	Inhambane and Maputo	16.7	92.8	98.6	88.2	N/A	21.3	50.0
Myanmar	Ayeyarwady and Rakhine	N/A	N/A	N/A	18.9	N/A	57.7	7.7
	Tanintharyi	N/A	N/A	N/A	0.0	N/A	77.8	0.0
New Caledonia	Isles	N/A	N/A	N/A	10.3	7.5	23.3	20.0
	North (NE and NW)	35.0	100.0	82.4	61.8	8.7	51.0	14.0
	South (S and S rural)	23.3	92.9	82.1	48.7	4.8	45.8	10.0
Philippines	Antique	21.3	100.0	100.0	2.7	N/A	20.0	60.0
	Aurora	15.2	96.4	56.7	9.7	4.7	73.4	21.1
	Polillo	42.6	83.3	100.0	13.5	N/A	34.8	28.3
	Puerto Princessa	38.5	88.9	90.0	2.0	N/A	30.4	34.8
Solomon Islands	Ysabel	15.8	N/A	75.0	51.4	13.6	24.3	54.1
Sri Lanka	North	67.4	52.7	74.9	40.8	4.4	73.3	10.2
	North West	72.4	75.6	100.0	0.0	N/A	34.3	0.0
Tanzania	Mkinga	15.5	64.3	77.8	15.1	2.7	55.1	2.6
	Mtwara	19.9	65.2	52.3	11.0	3.3	37.2	4.7
	Tanga	36.9	63.6	67.7	11.0	1.7	4.9	1.4
Thailand	Trat	74.0	48.1	81.5	0.0	N/A	12.5	4.2

Note: Text in red denotes cases in which there were fewer than 20 respondents.

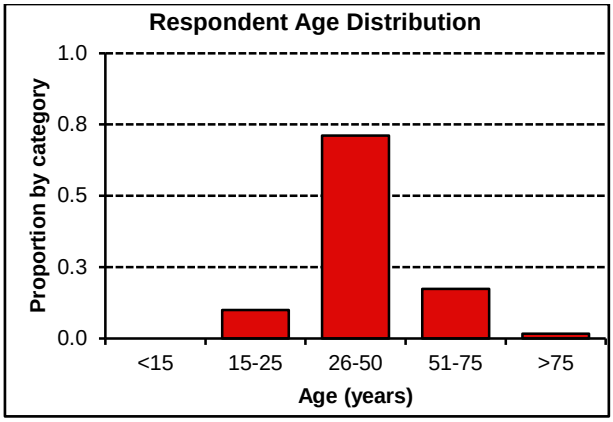

Figure 3: Sample graphic output of data analysis: Respondent age distribution in Sabah, Malaysia.

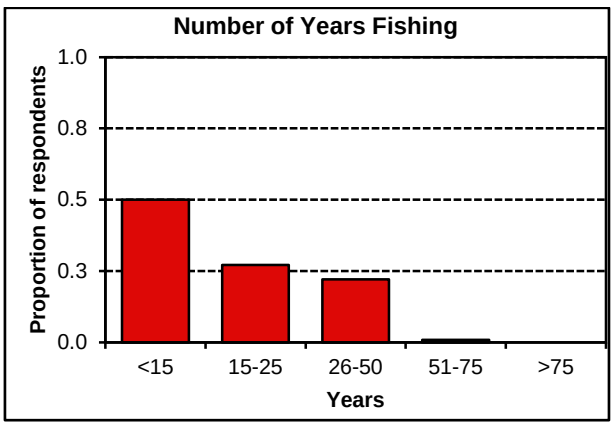

Figure 4: Sample graphic output of data analysis: Number of years of experience for fishers in Sabah, Malaysia.

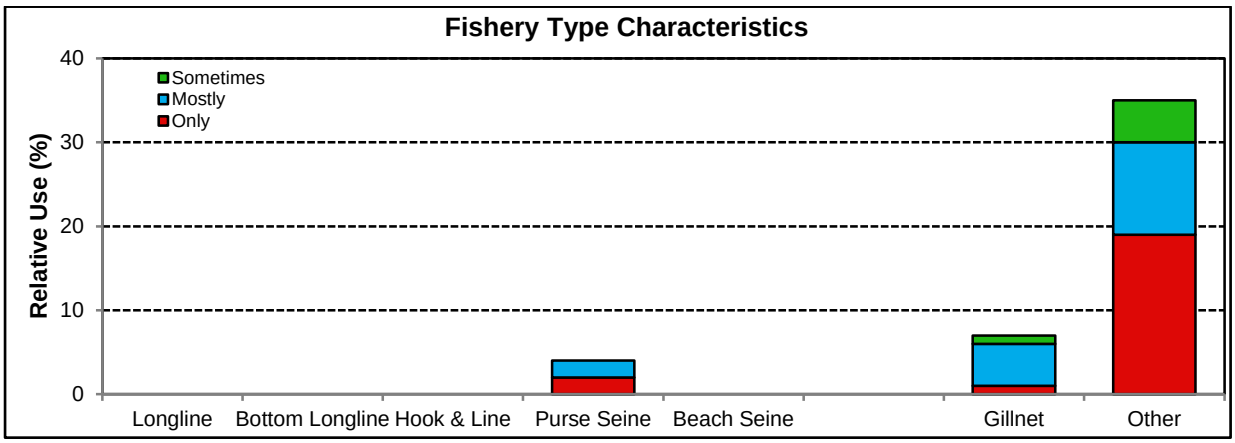

Figure 5: Sample graphic output of data analysis: Breakdown of types and proportion of fisheries in Sabah, Malaysia.

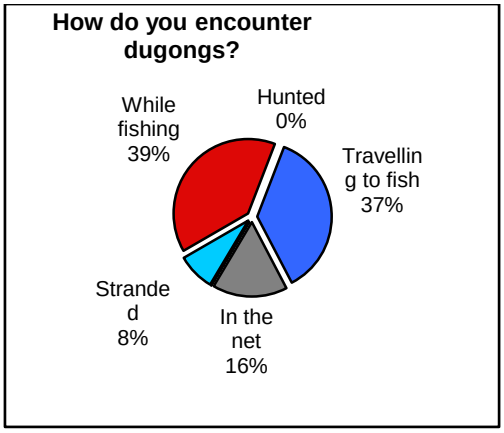

Figure 6: Sample graphic output of data analysis: Encounter types for dugongs in Sabah, Malaysia.

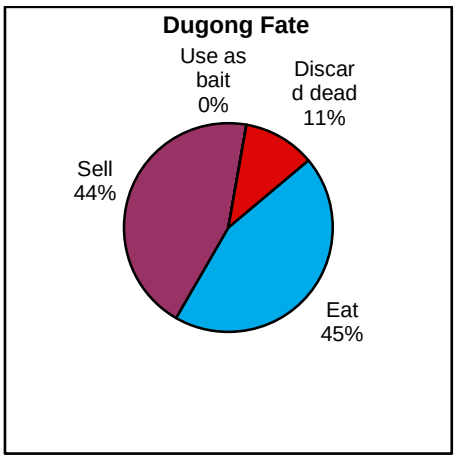

Figure 7: Sample graphic output of data analysis: Fate of dugong interactions in Sabah, Malaysia.

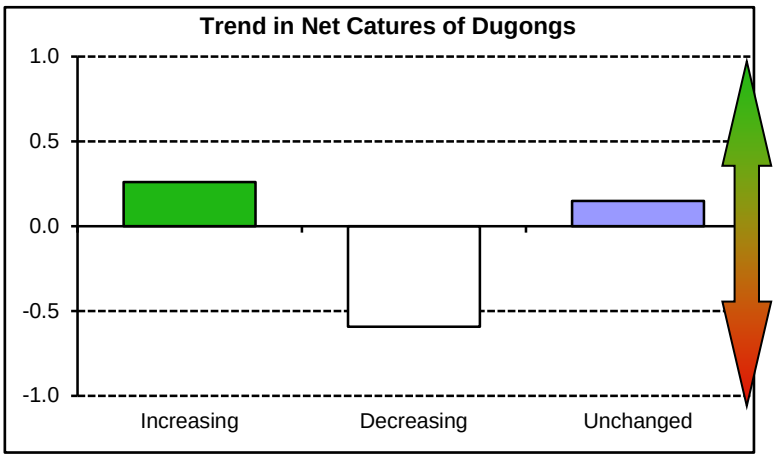

Figure 8: Sample graphic output of data analysis: Trend in actual net captures over time in Sabah, Malaysia.

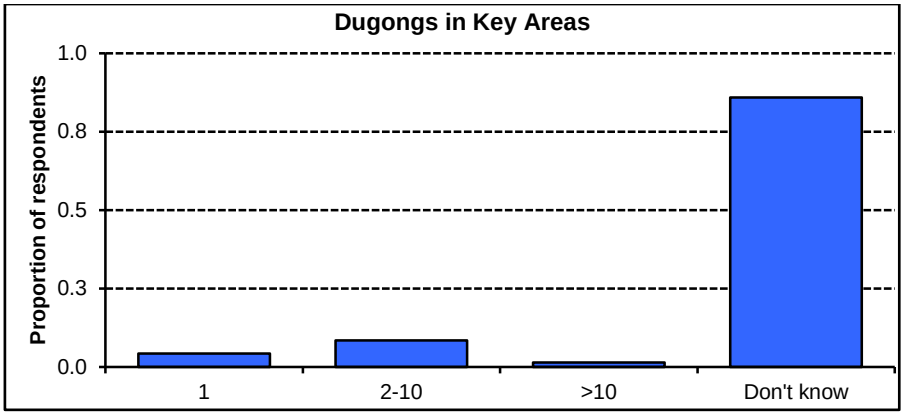

Figure 9: Sample graphic output of data analysis: Numbers of dugongs through to reside in key areas in Sabah, Malaysia.

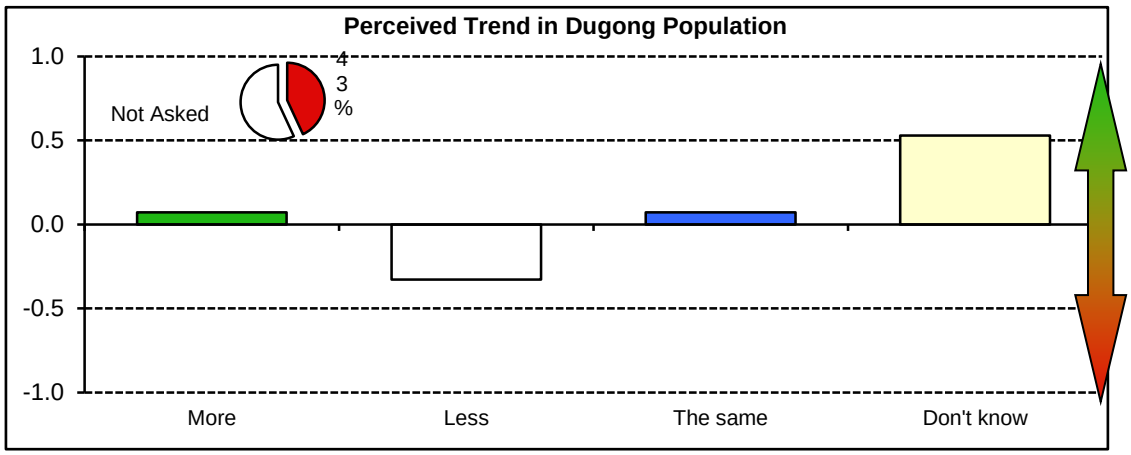

Figure 10: Sample graphic output of data analysis: Perceived trend in dugong population size for Sabah, Malaysia.

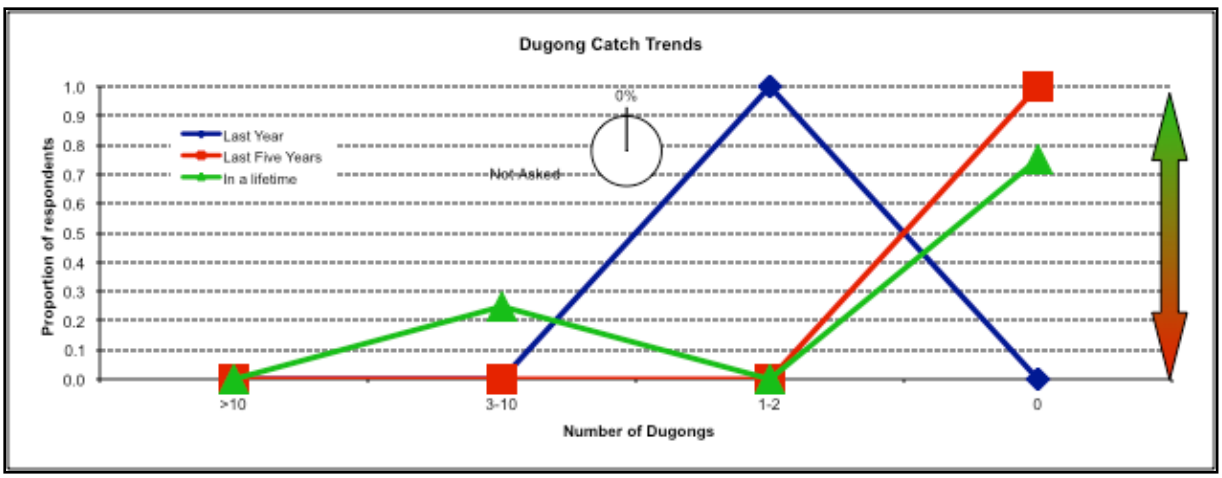

Figure 11: Sample graphic output of data analysis: Trends in dugong captures in Sabah, Malaysia.

Priority areas as determined by GIS analysis

The following series of graphics (**Figures 12 to 33**) depict the dugong density analysis (typically the top left panel), the fishing density analysis (typically the top right panel), the actual locations of dugong sightings broken down by sighting year, along with reported seagrass areas (typically the bottom left panel) and an overall prioritisation of potential areas of concern, or 'hotspot areas' created by overlaying dugong density and fishery density in each country.

Where the geographical scales are extremely large, (e.g. Andaman and Nicobar Islands; New Caledonia) and substantial detail is lost due to graphic sizes, these are provided at larger scales, with the two small-scale maps provided in **Appendix III** for comparison. Where graphics are missing it is because the relevant data for that graphic were unavailable. Where either dugong density or fishing density were unavailable, an overall hotspot analysis was not feasible and these are also not presented.

All charts were drawn using the WGS1984 datum over a Universal Transverse Mercator projection, with scales in kilometres (km). Dugong densities are provided in number of dugongs per sq km, while fishing density is provided as percentages of fishing overlap.

Bangladesh

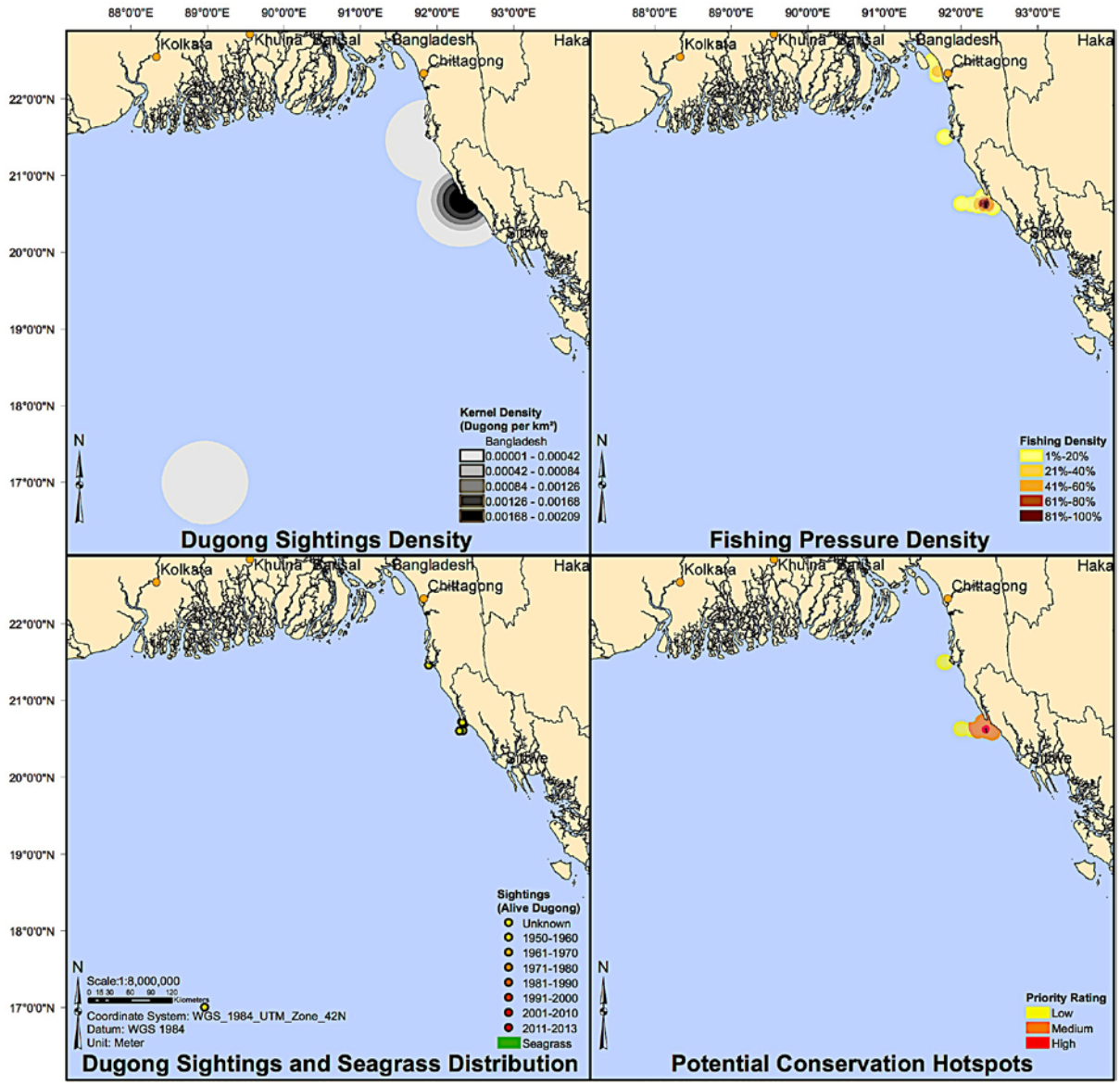

Figure 12: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Bangladesh.

Notes: (1) Fishing data was provided as point data and was extrapolated into possible radius of fishing areas based on boat type and size. (2) Priority rankings are based on sightings and fishing pressure overlaps irrespective of sighting date, and in Bangladesh the sightings for dugongs were in the past at an undetermined date and thus the priority areas may no longer be relevant.

Gujarat, India

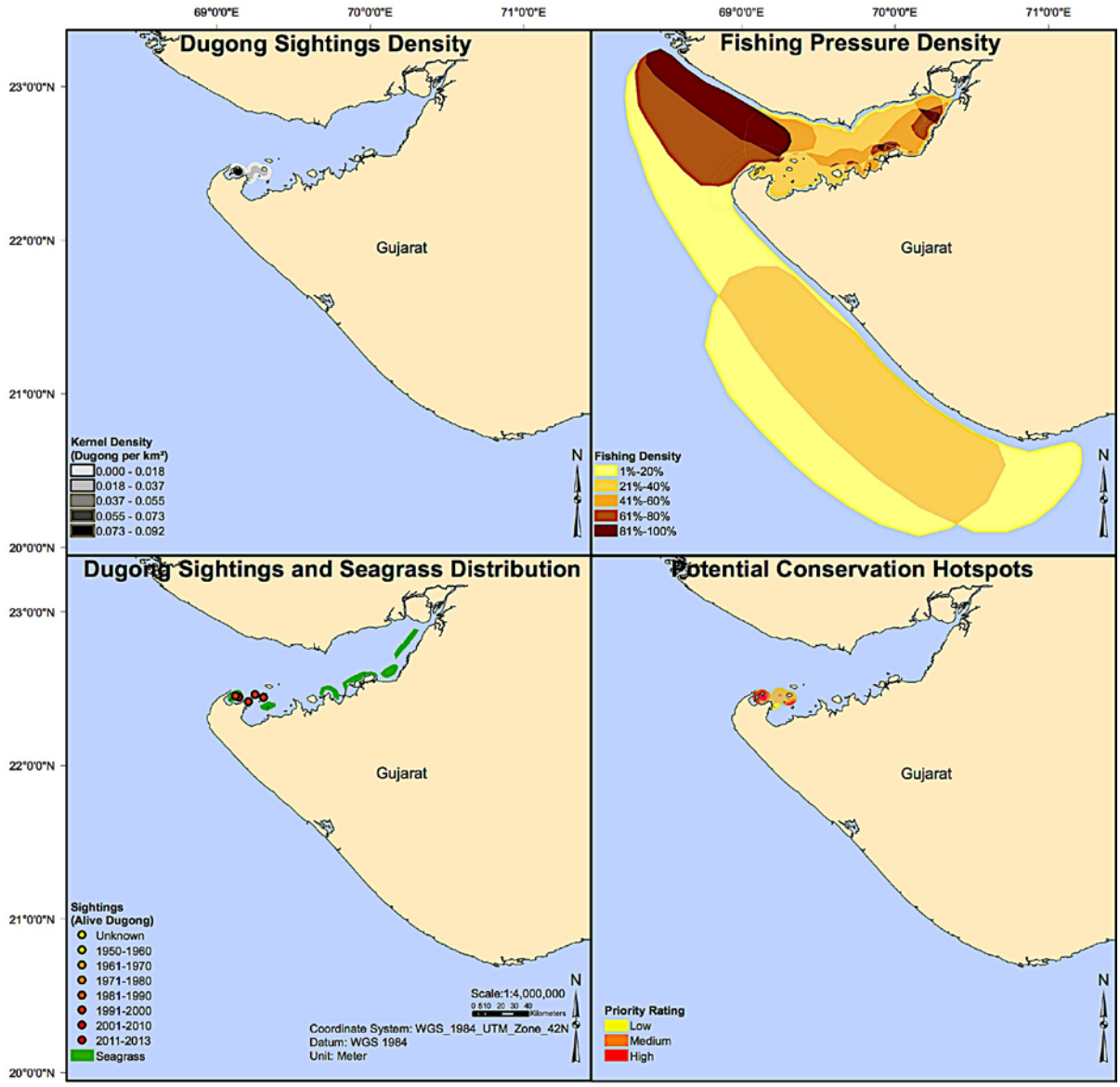

Figure 13: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Gurarat, India.

Tamil Nadu, India

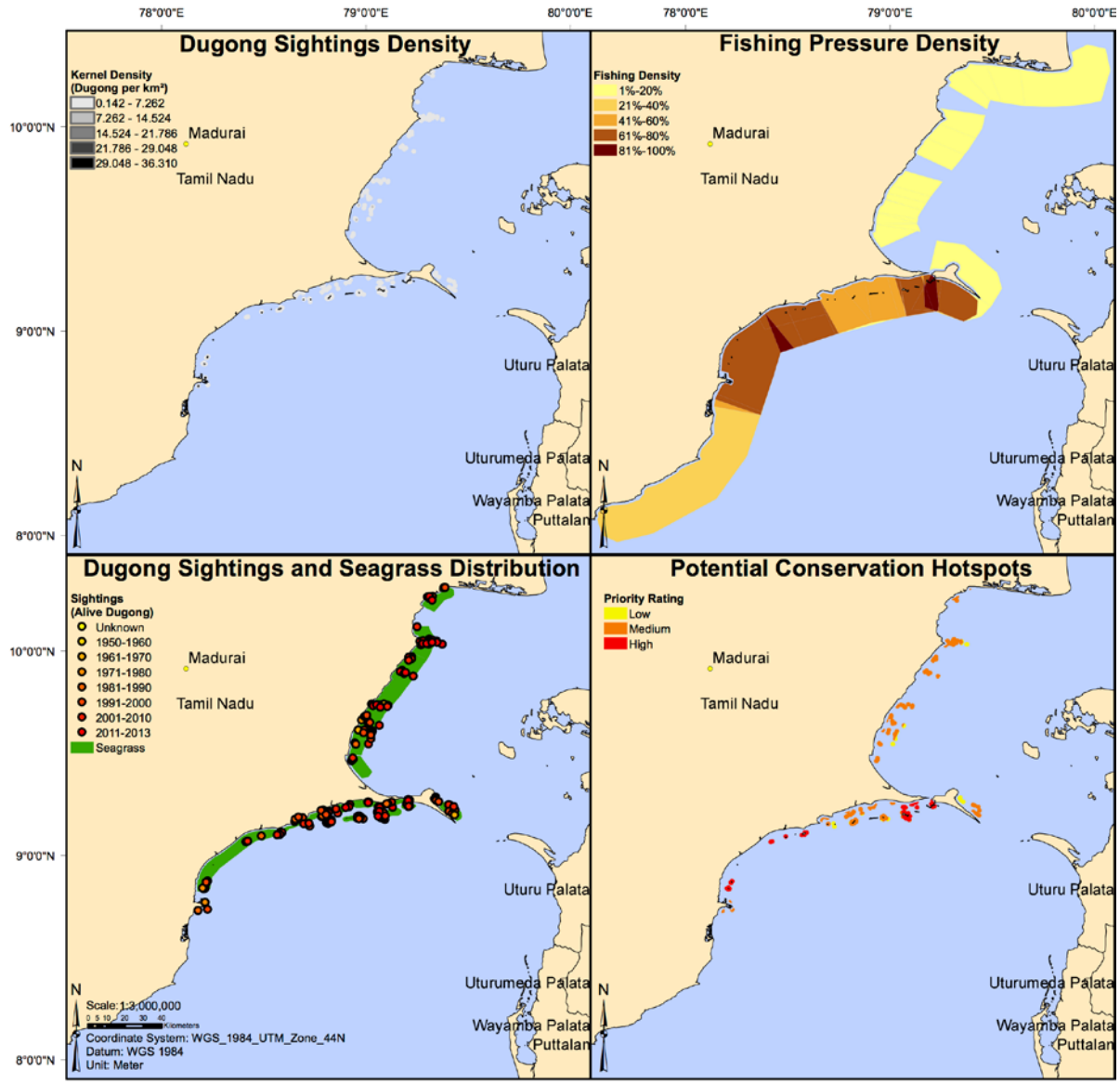

Figure 14: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Tamil Nadu, India.

Note the number of recent dugong sightings in this region.

Andaman Islands, India (a)

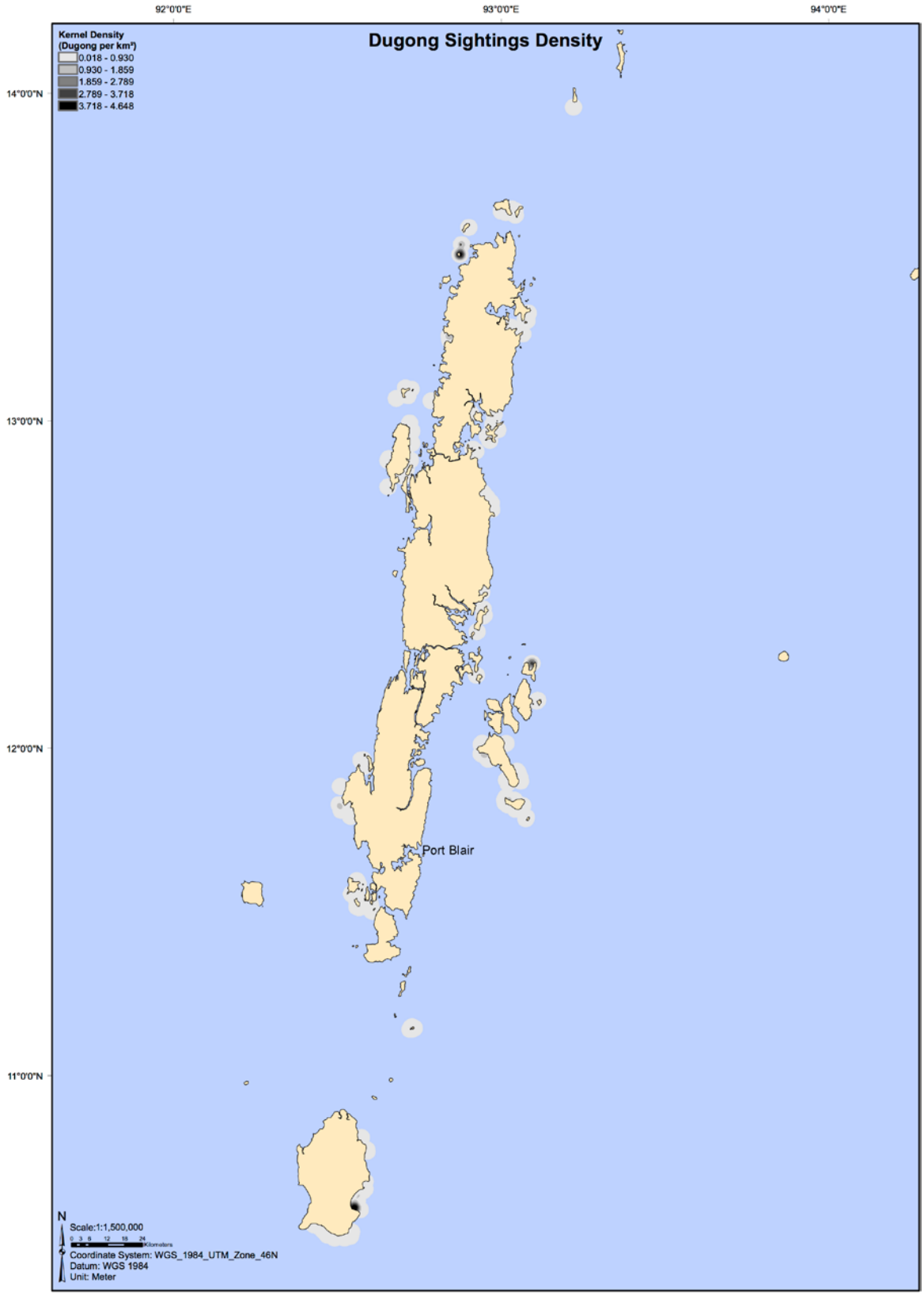

Figure 15a: Dugong density analysis for the Andaman Islands, India.

Andaman Islands, India (b)

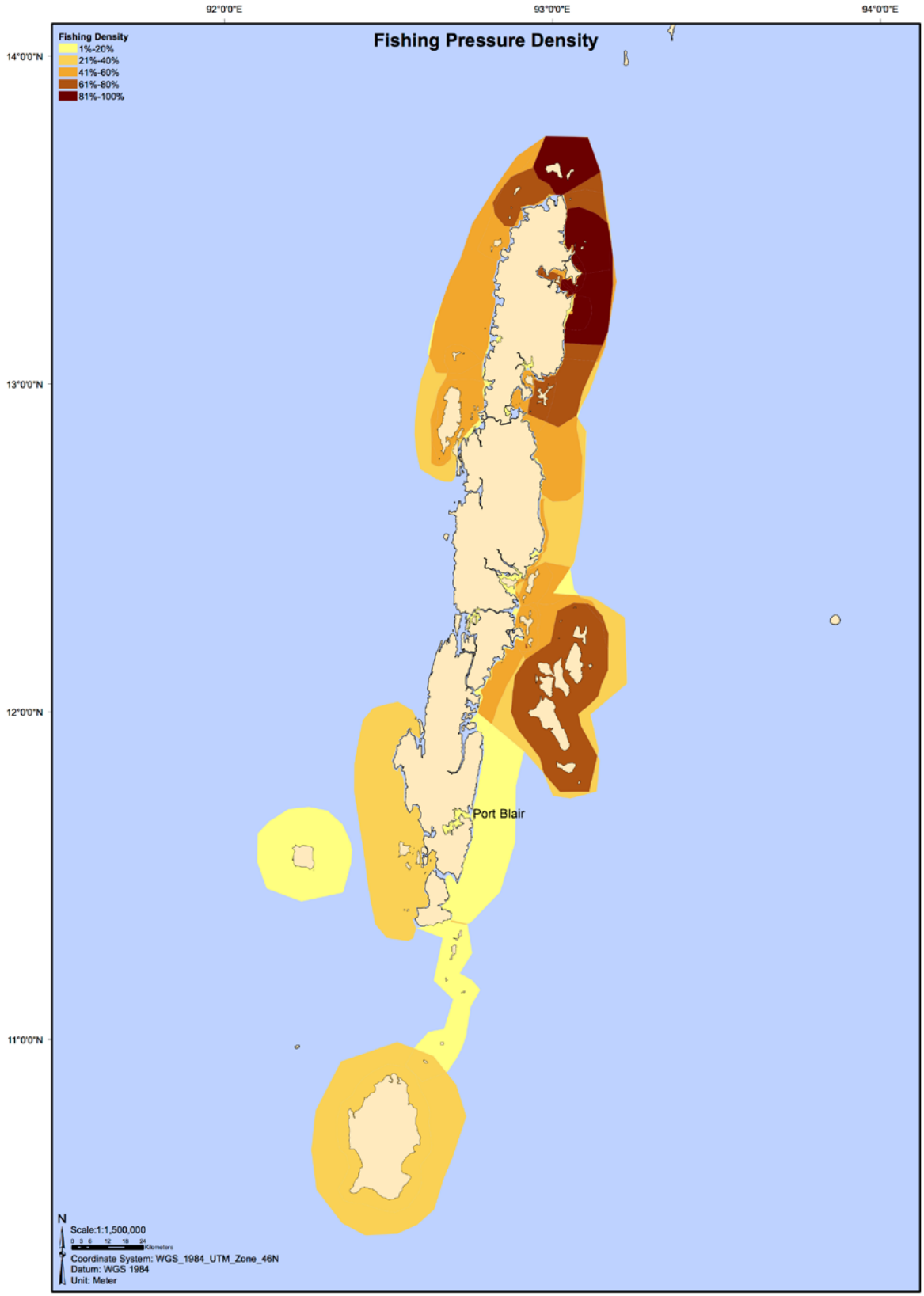

Figure 15b: Fishery density analysis for the Andaman Islands, India.

Andaman Islands, India (c)

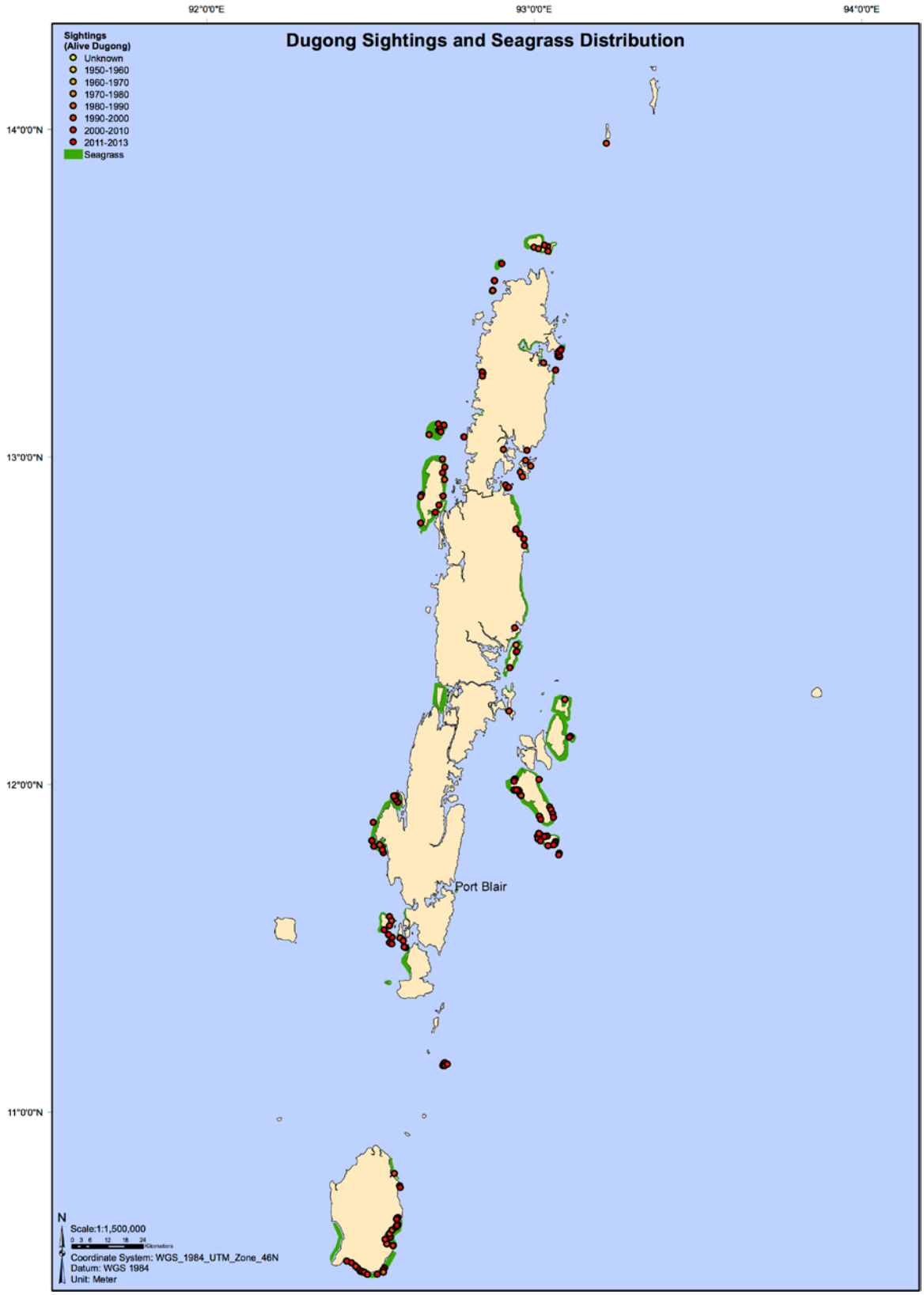

Figure 15c: Dugong sightings and seagrass distribution in the Andaman Islands, India.

Andaman Islands, India (d)

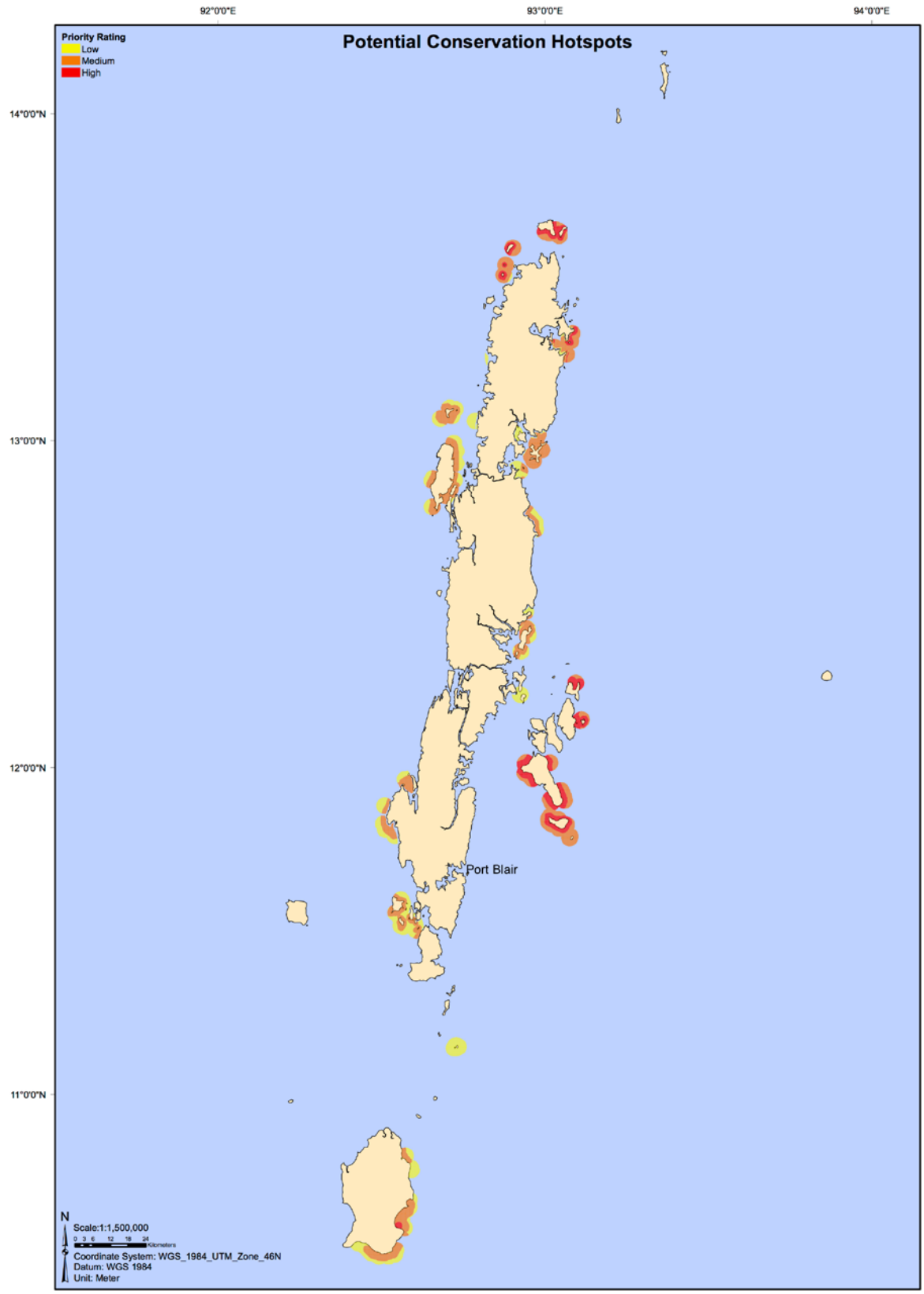

Figure 15d: Priority area identification for the Andaman Islands, India.

Nicobar Islands, India (a)

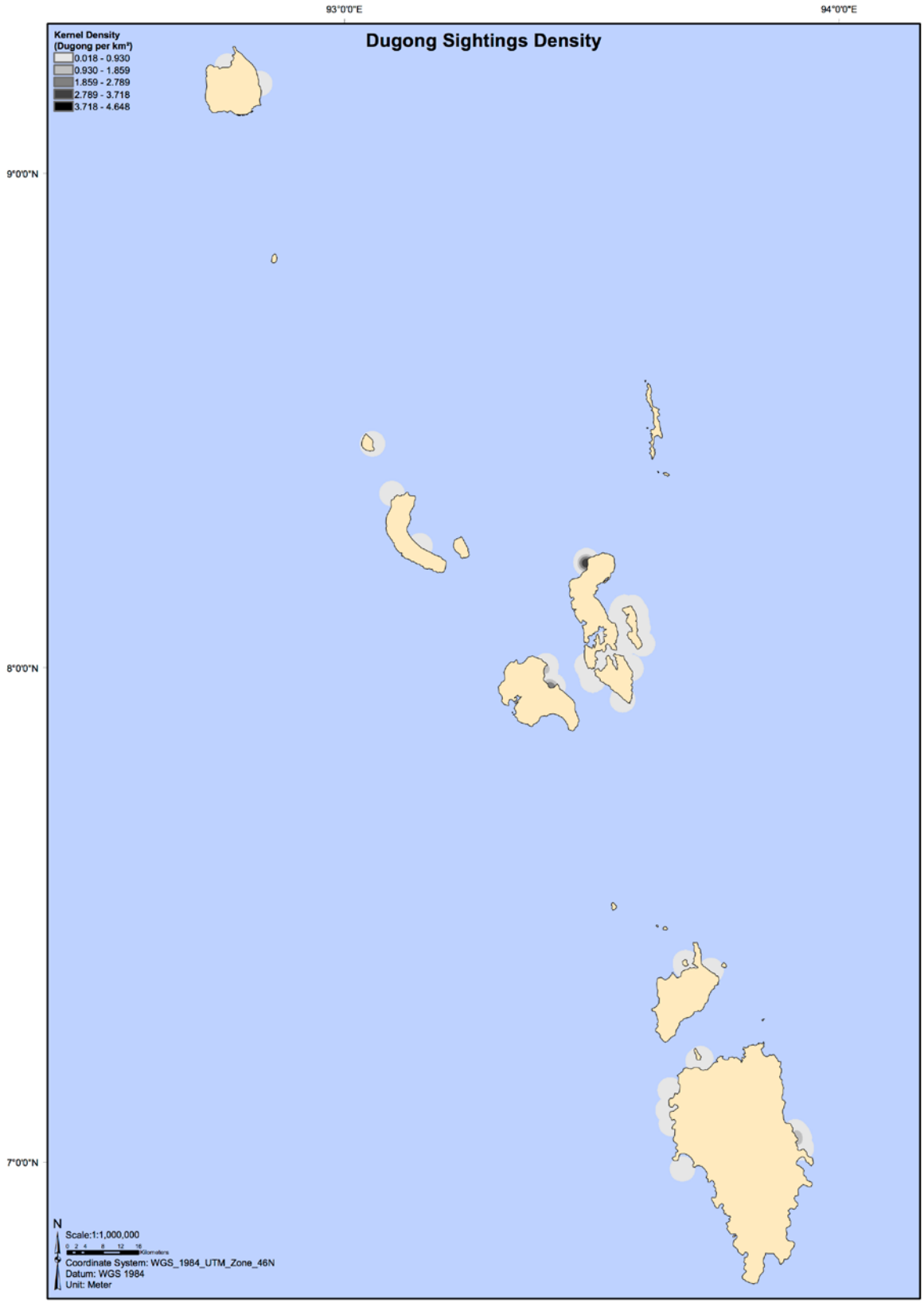

Figure 16a: Dugong density analysis for the Nicobar Islands, India.

Nicobar Islands, India (b)

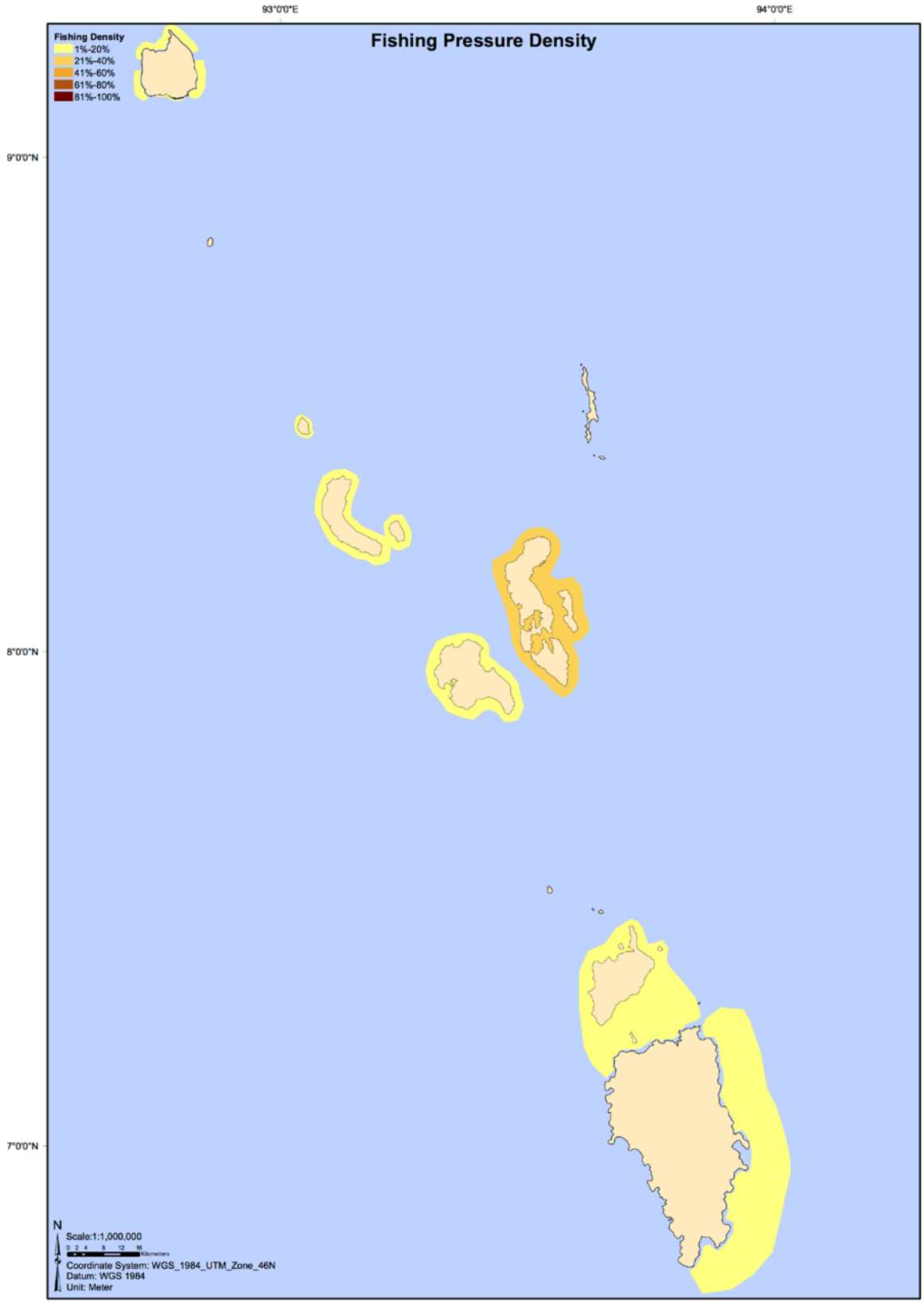

Figure 16b: Fishery density analysis for the Nicobar Islands, India.

Nicobar Islands, India (c)

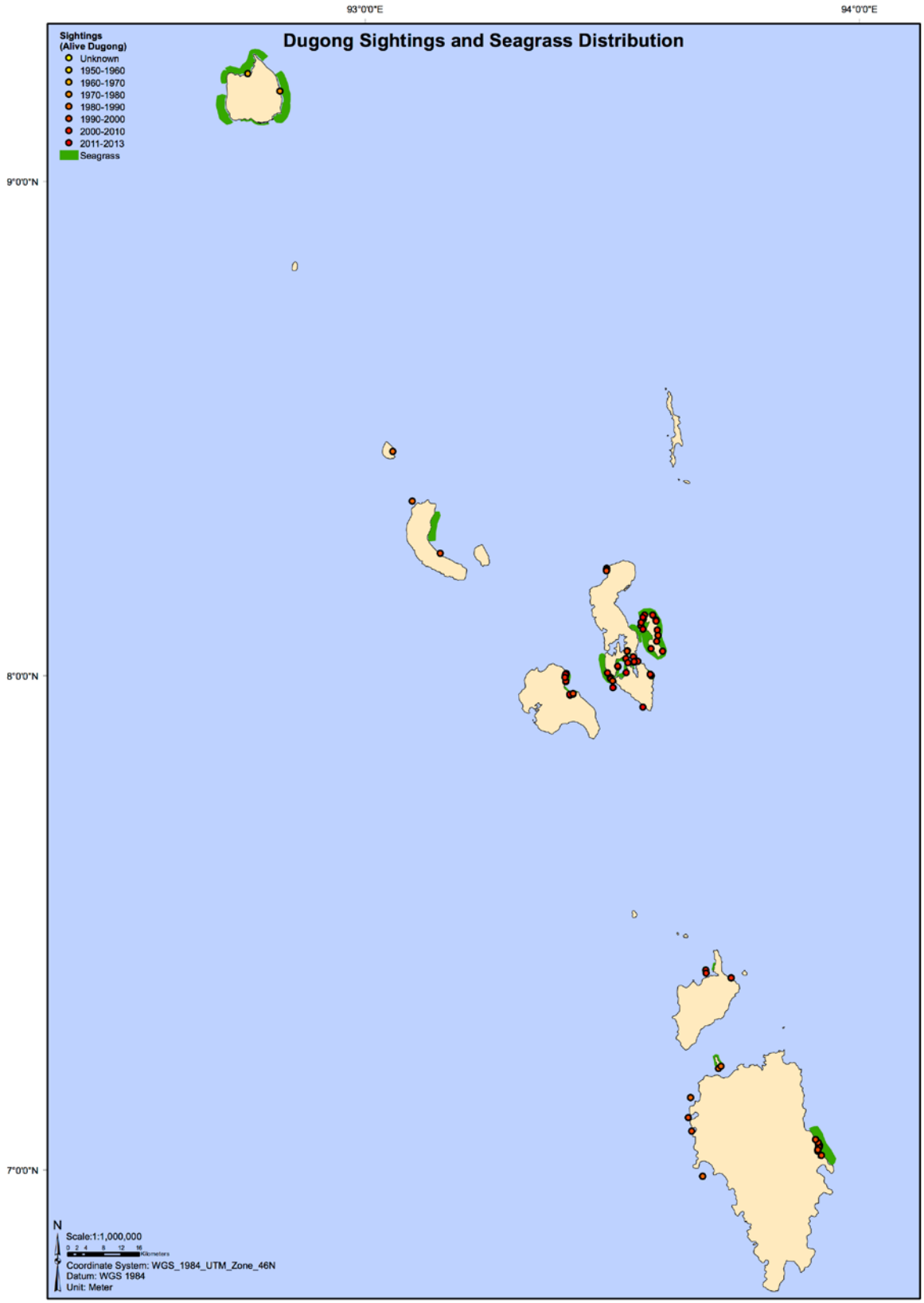

Figure 16c: Dugong sightings and seagrass distribution in the Nicobar Islands, India.

Nicobar Islands, India (d)

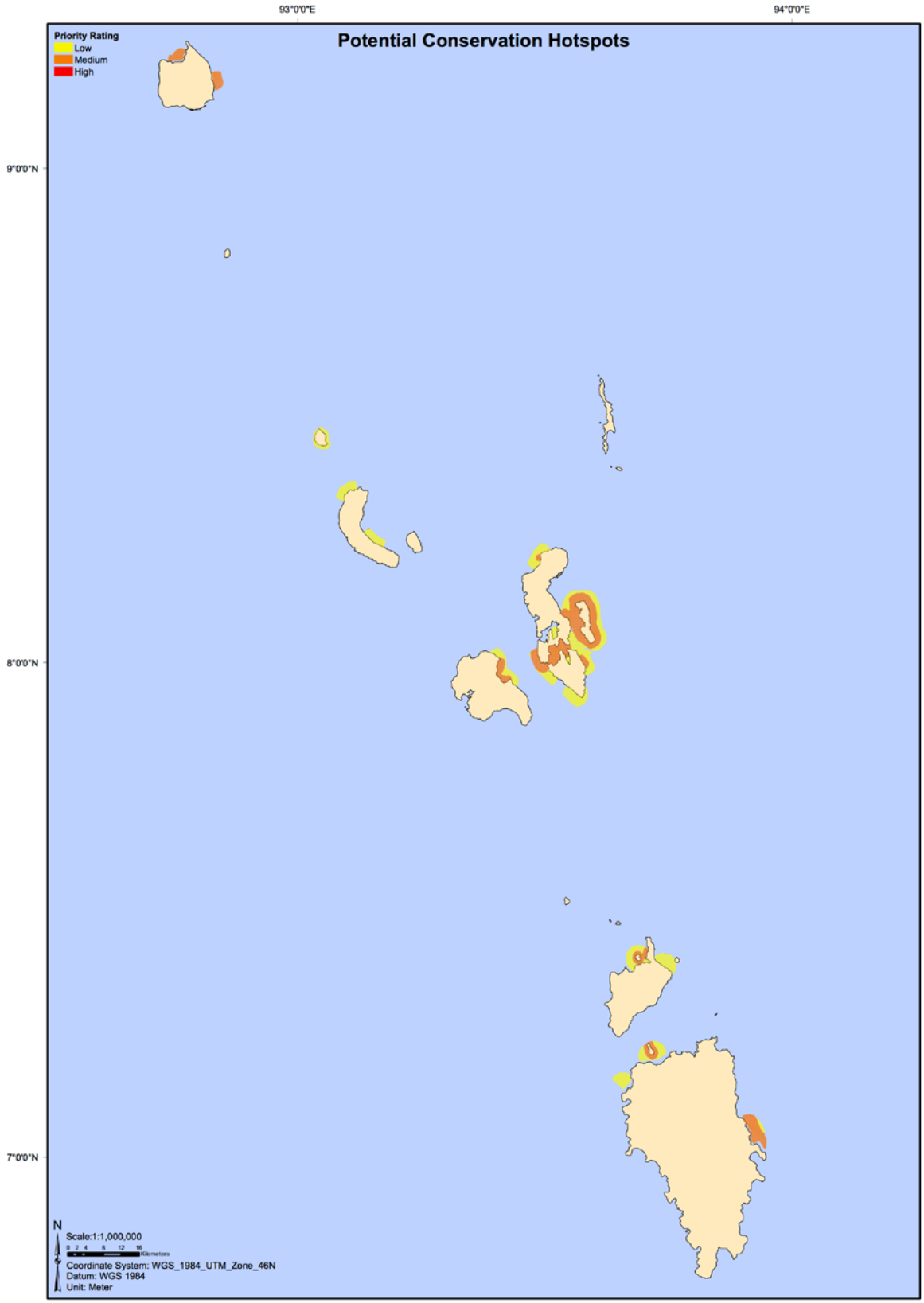

Figure 16d: Priority area identification for the Nicobar Islands, India.

Johor, Malaysia

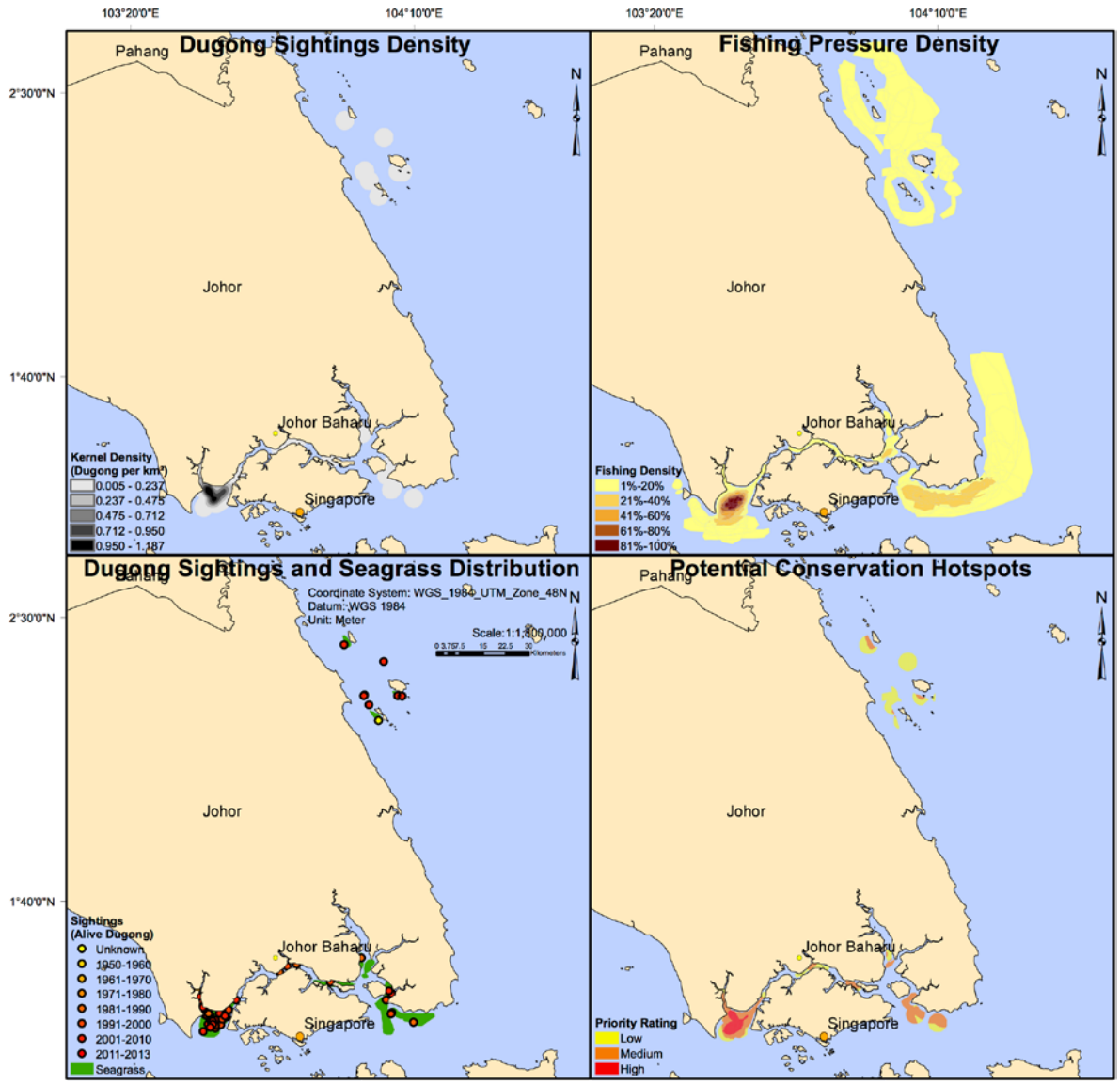

Figure 17: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Johor, Malaysia.

Antsiranana, Madagascar

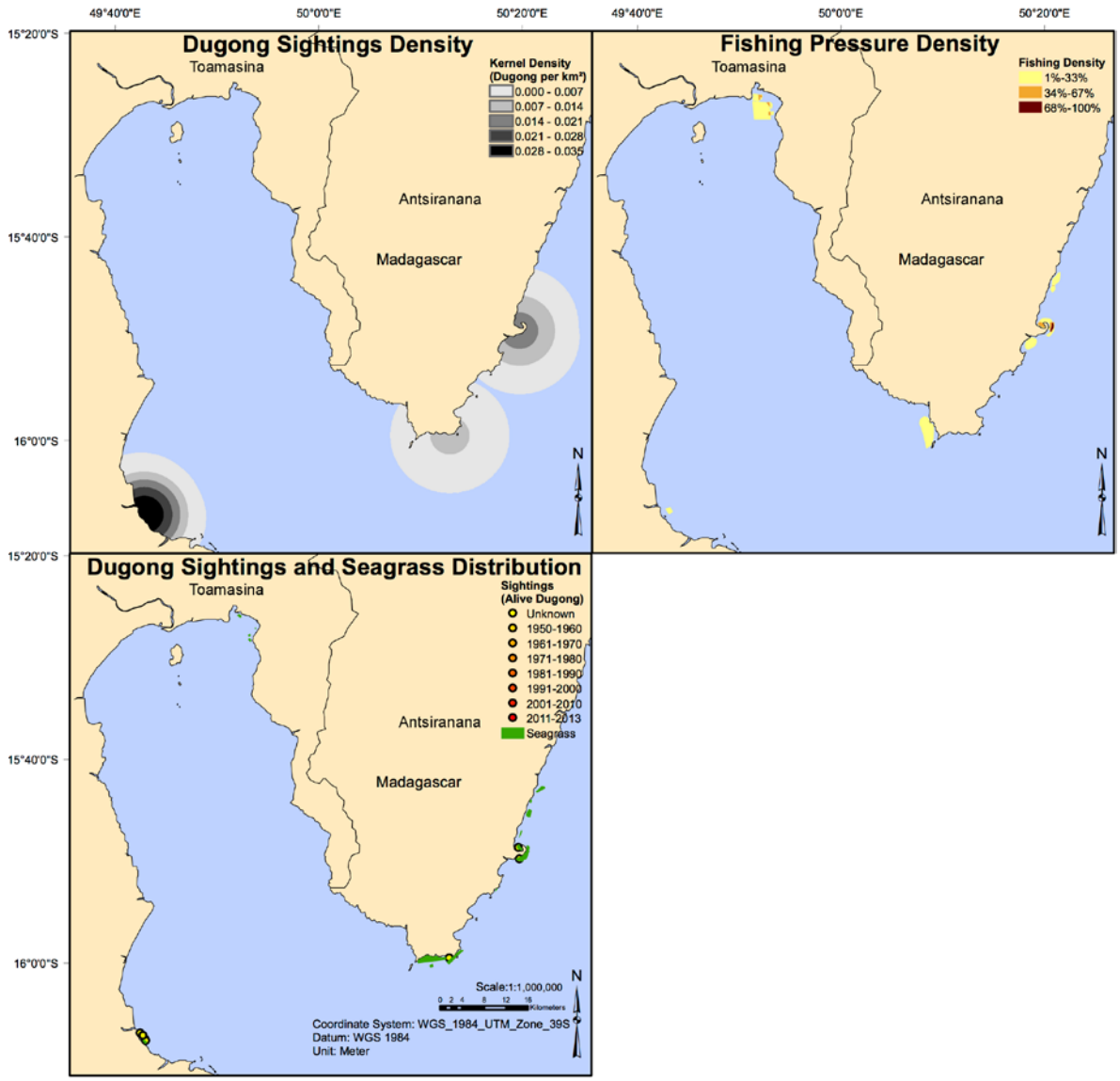

Figure 18: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Ansiranana, Madagascar.

North Sabah (Borneo), Malaysia

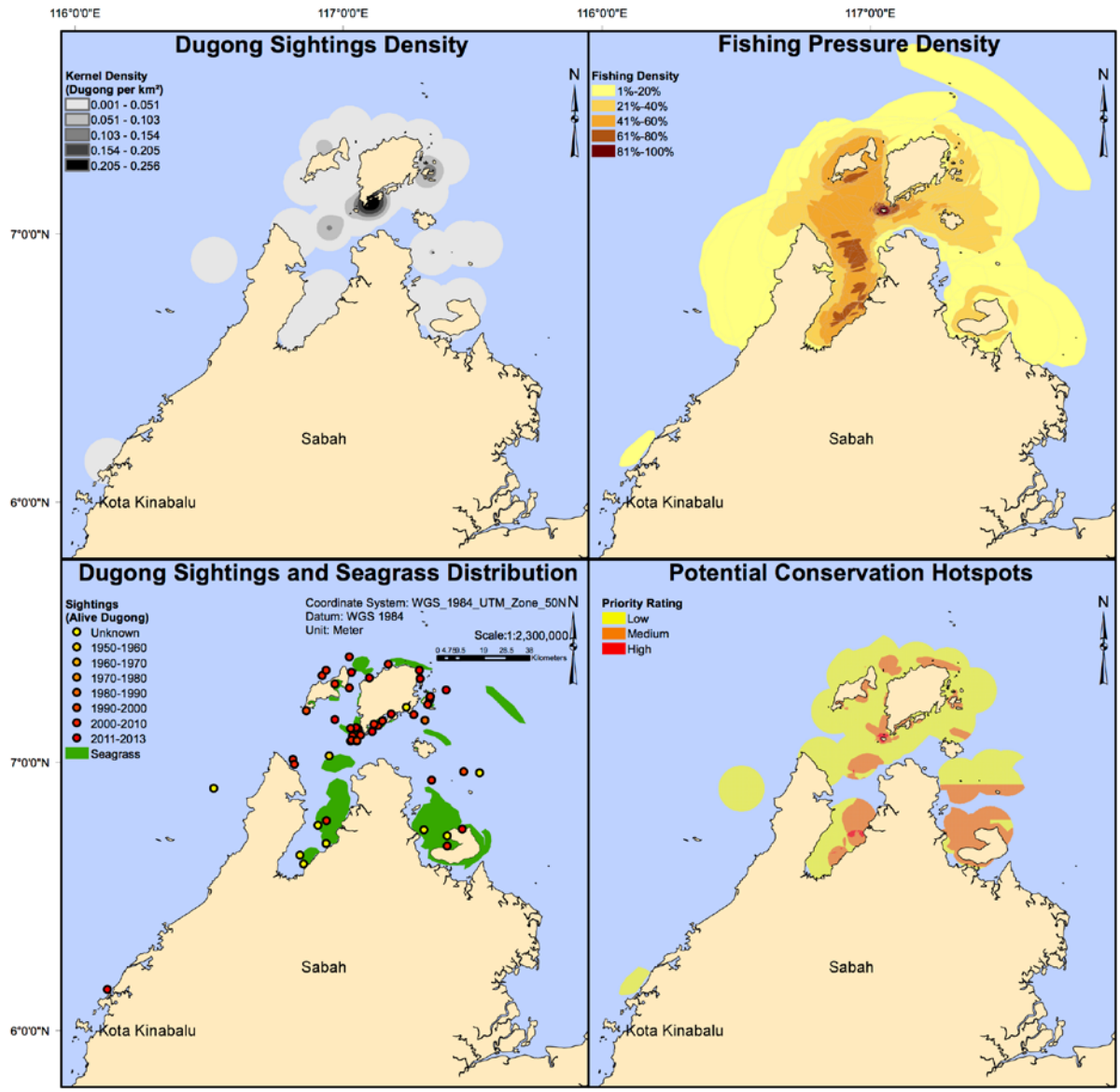

Figure 19: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for North Sabah (Borneo), Malaysia.

New Caledonia (a)

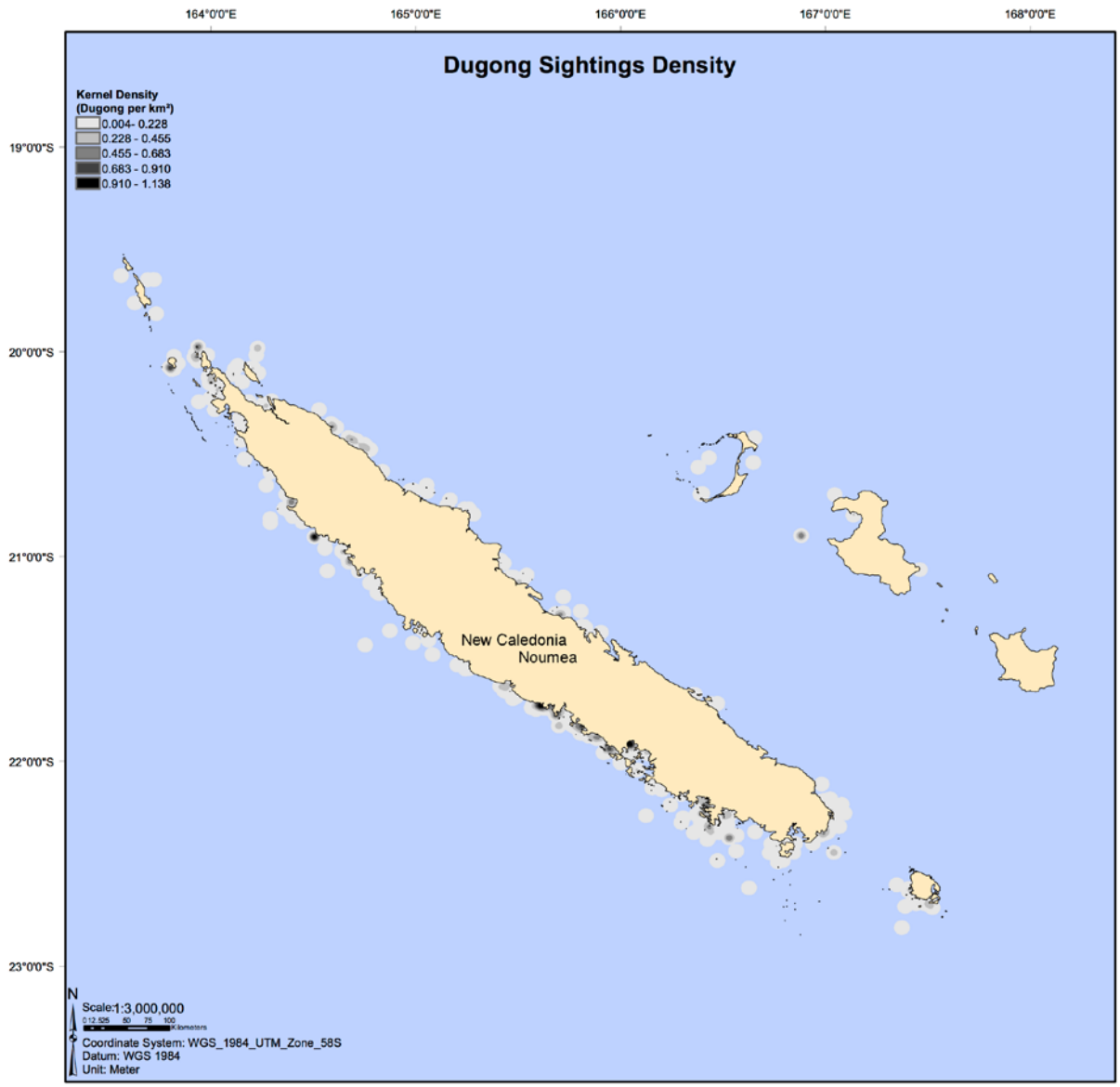

Figure 20a: Dugong density analysis for New Caledonia.

New Caledonia (b)

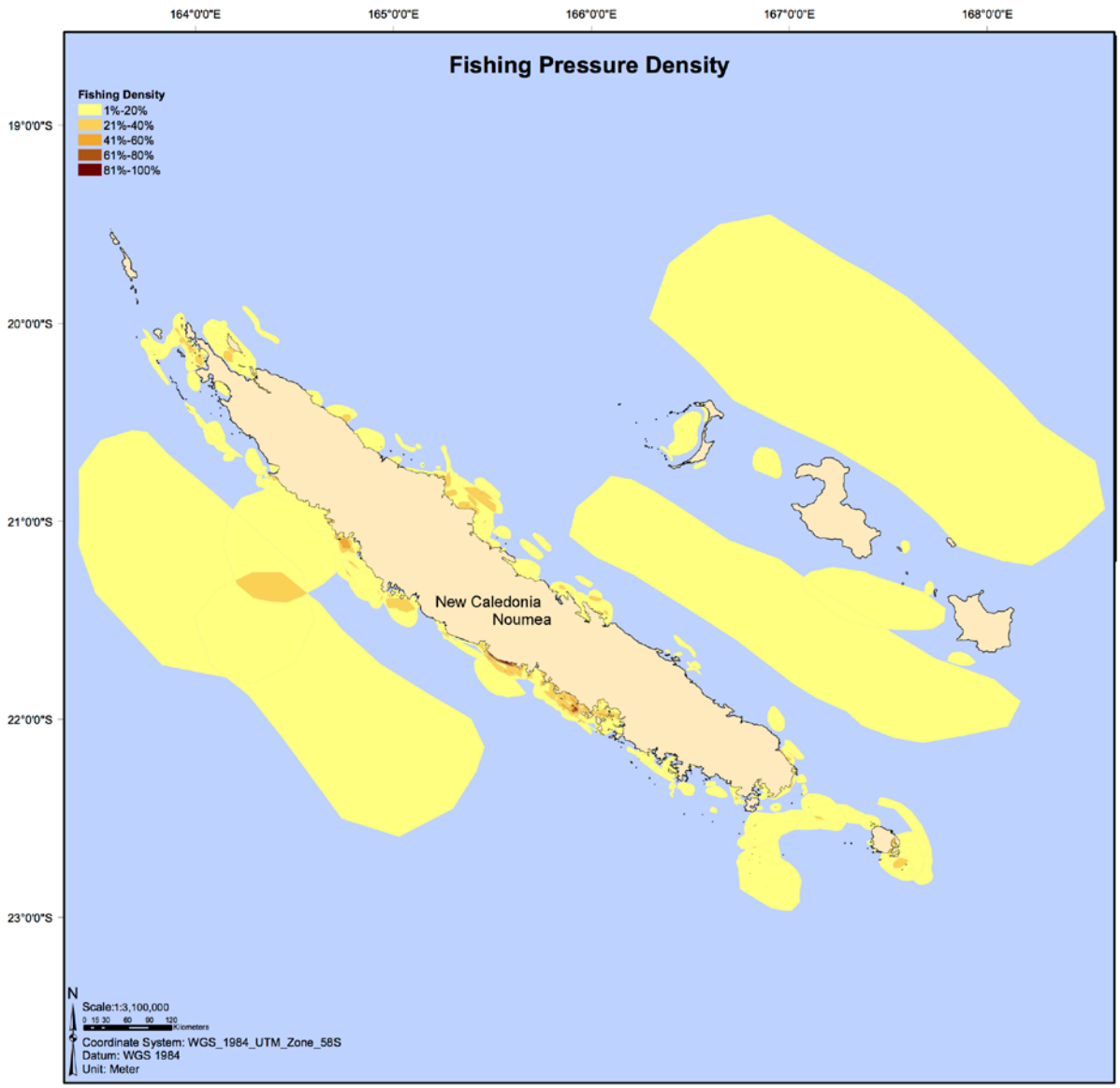

Figure 20b: Fishing area density analysis for New Caledonia.

New Caledonia (c)

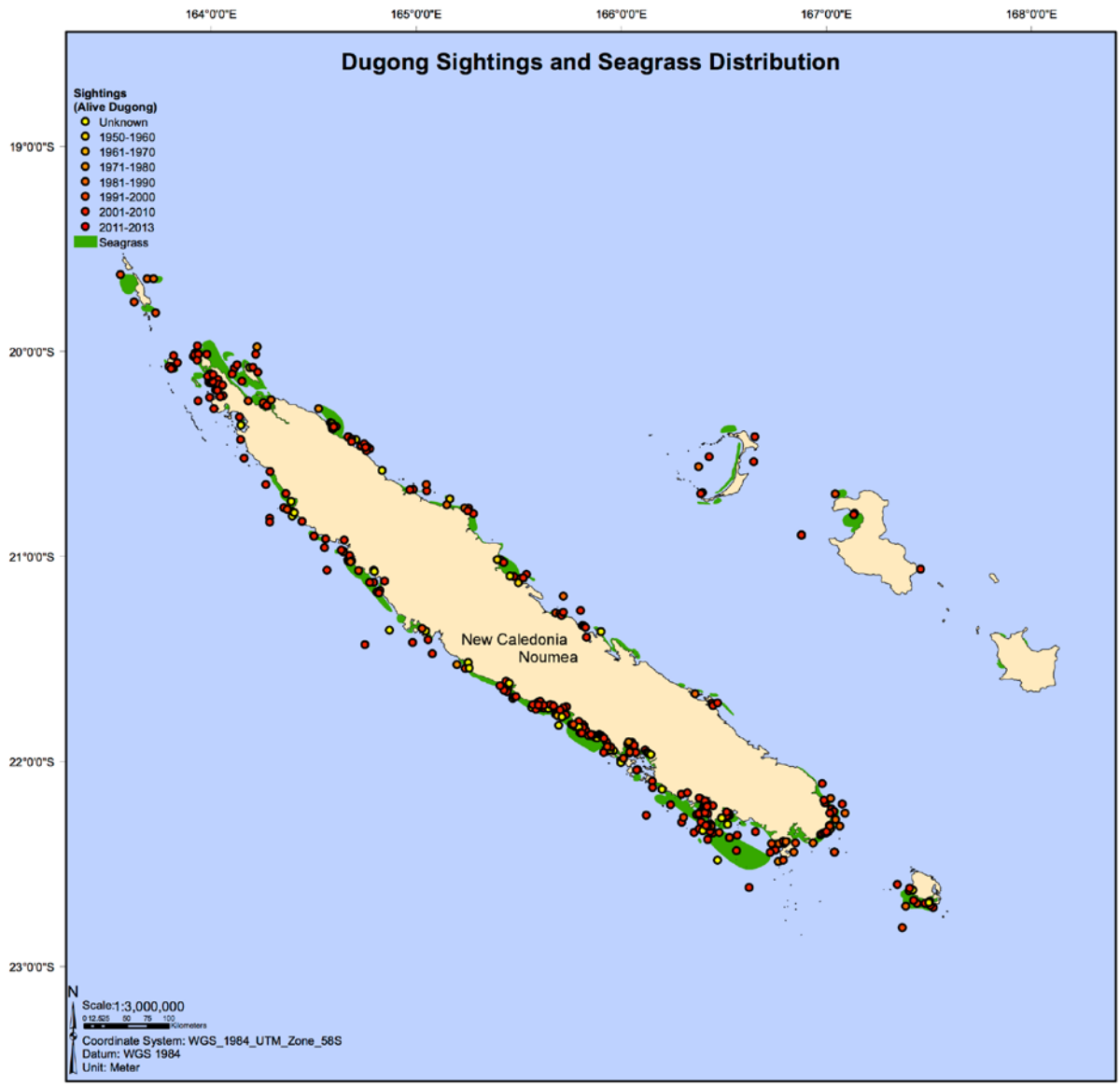

Figure 20c: Dugong sightings and seagrass distribution in New Caledonia.

New Caledonia (d)

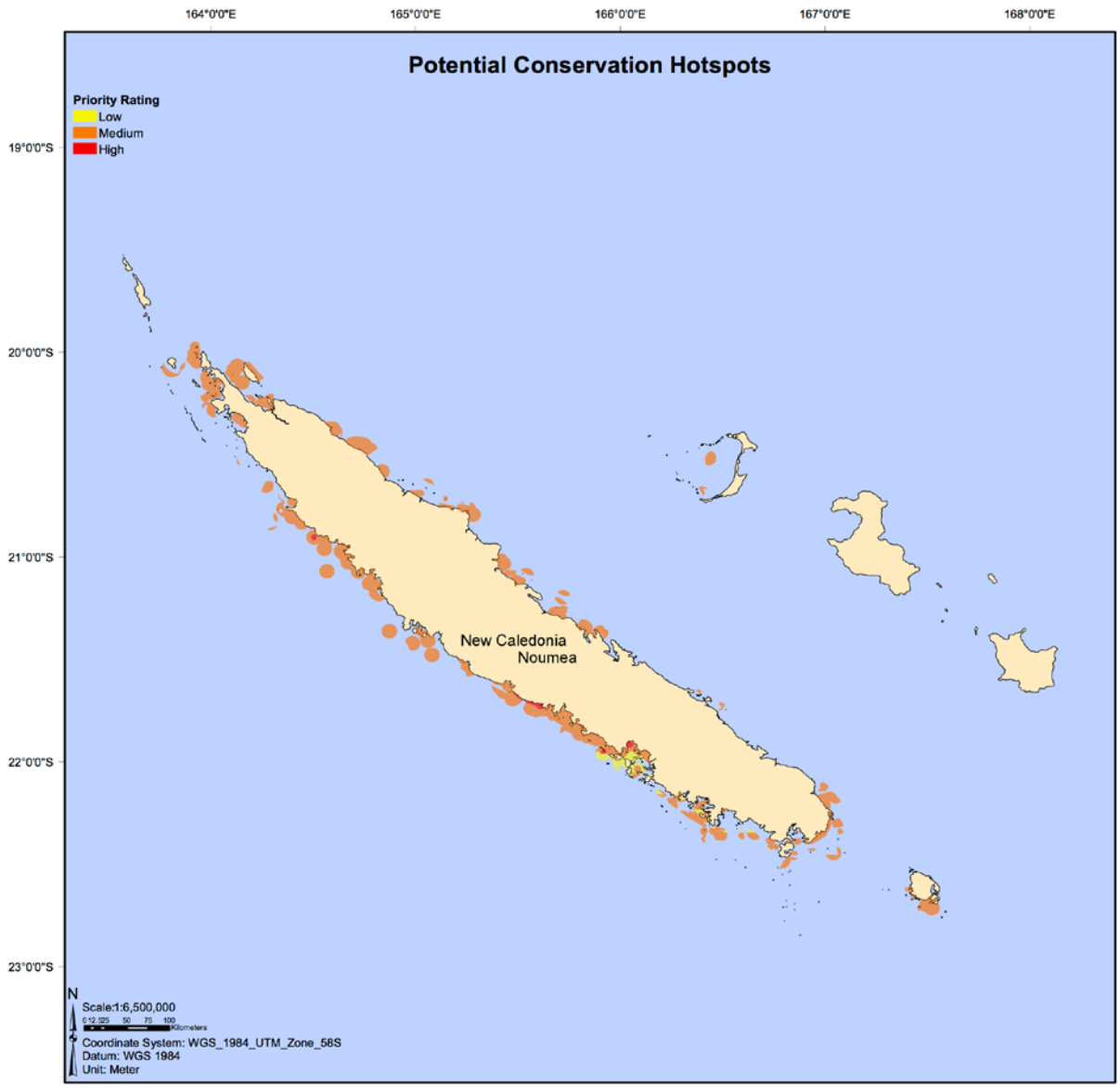

Figure 20d: Priority area identification for New Caledonia.

Palau

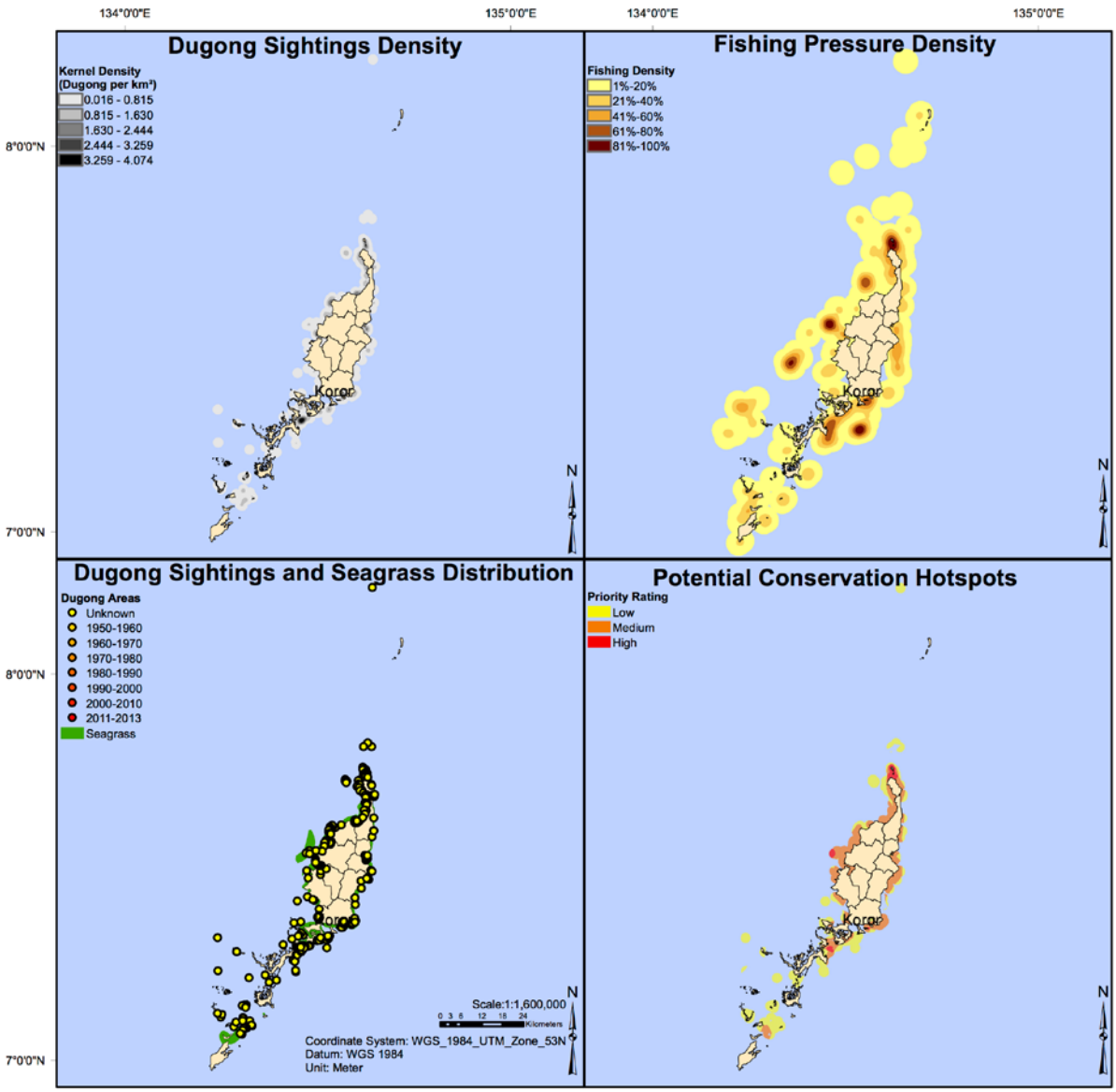

Figure 21: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Palau.

Antique, Philippines

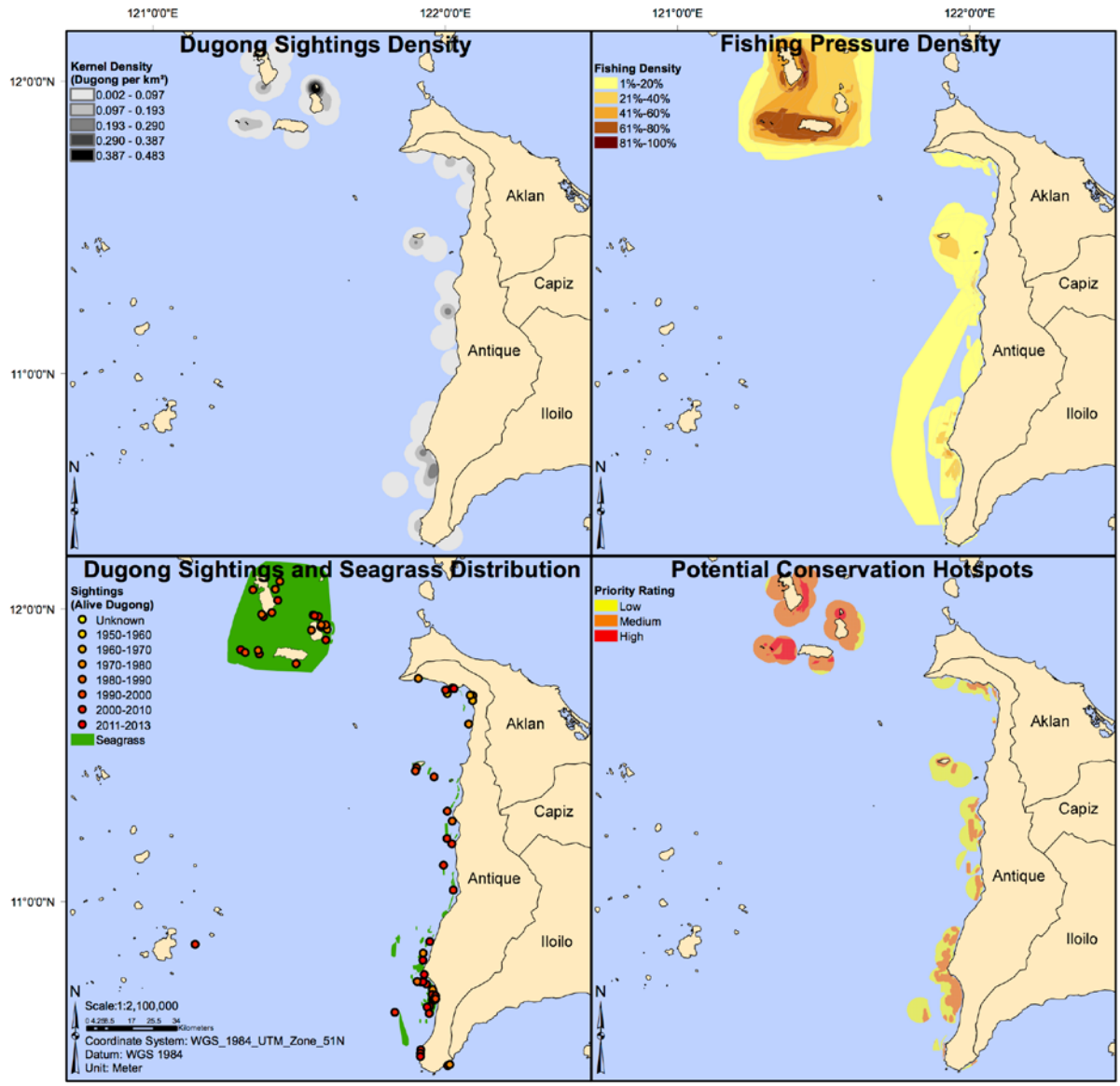

Figure 22: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Antique, Philippines.

Aurora, Philippines

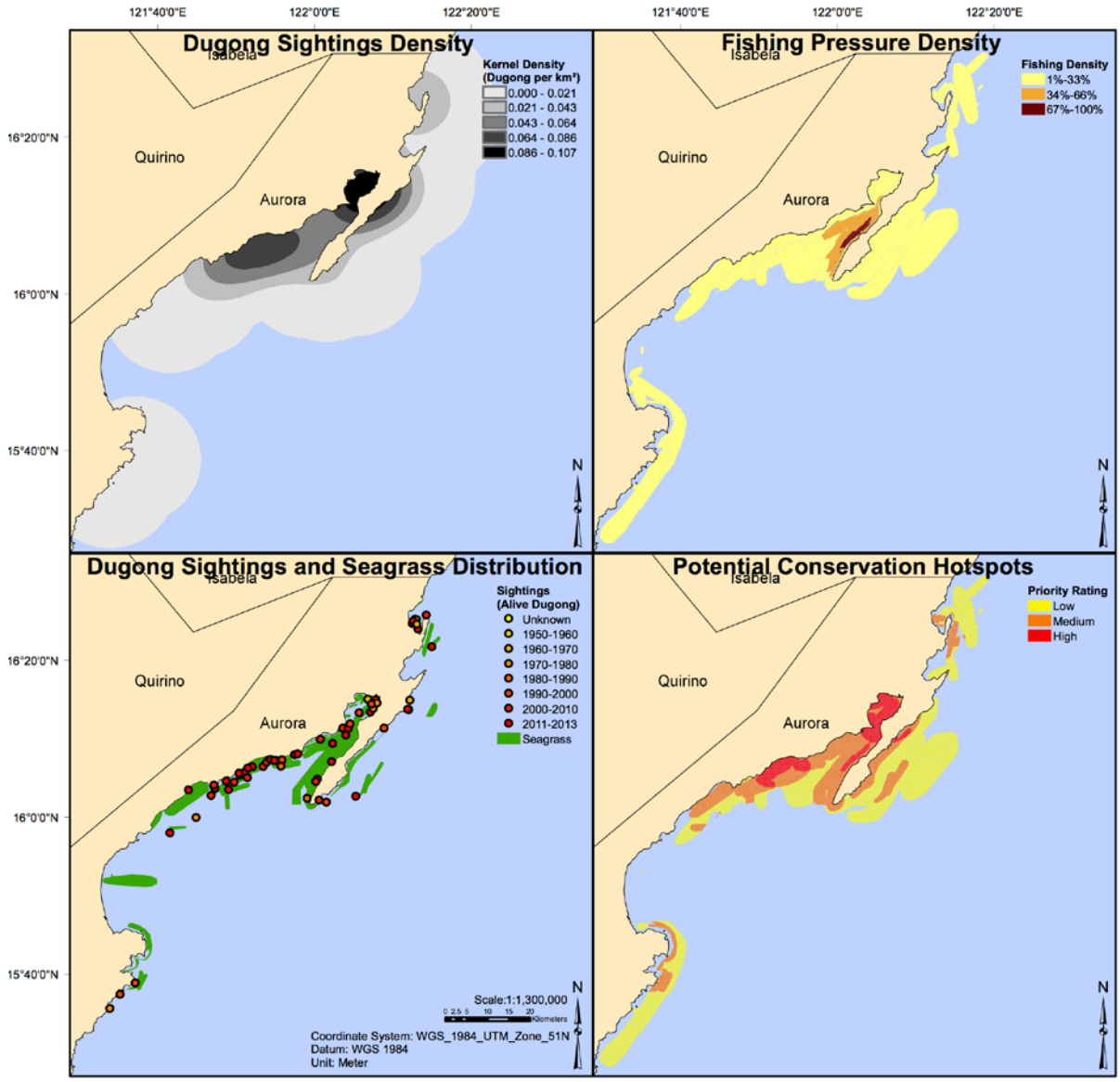

Figure 23: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Aurora, Philippines.

Polillo, Philippines

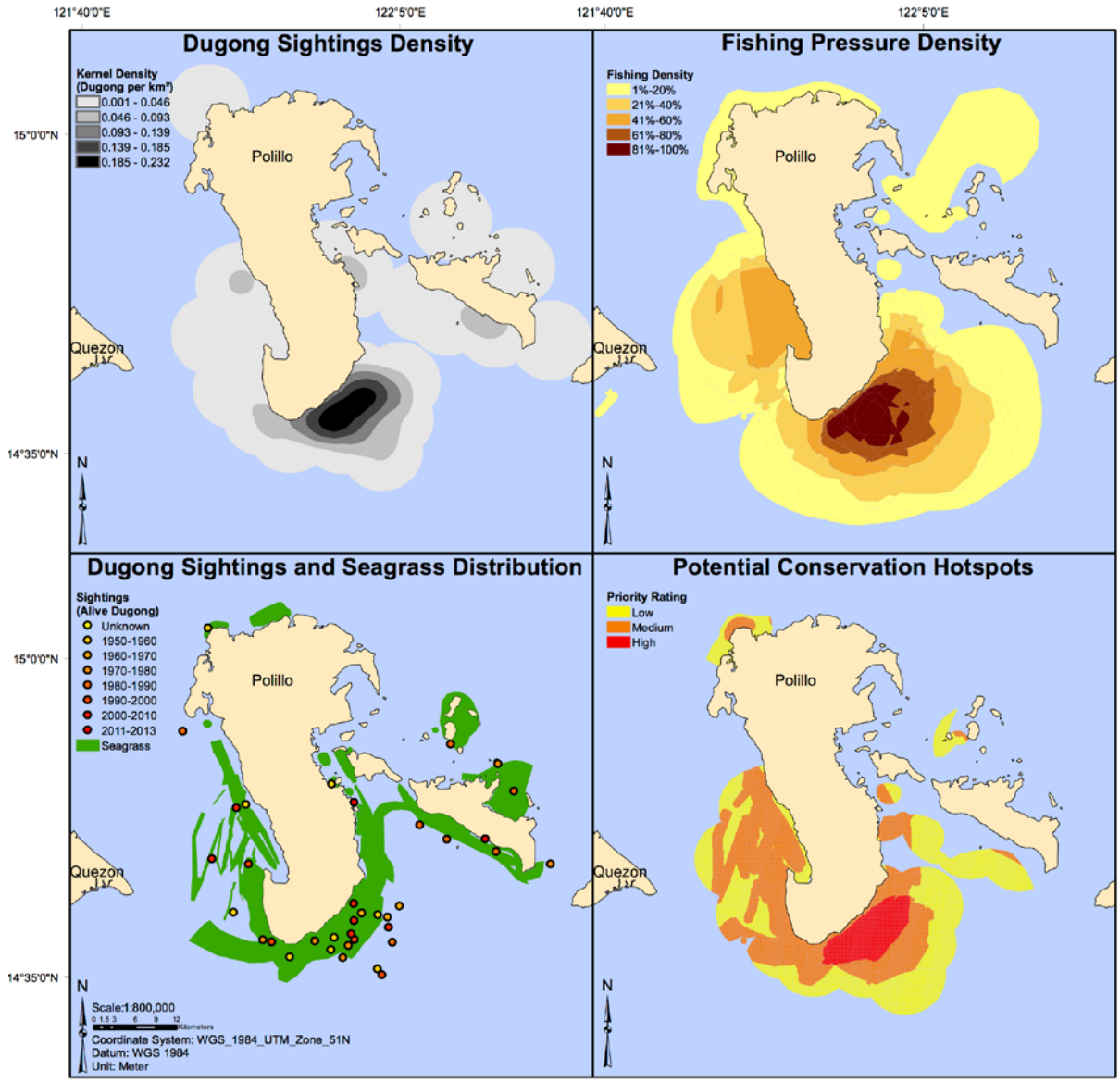

Figure 24: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Polillo, Philippines.

Puerto Princesa, Philippines

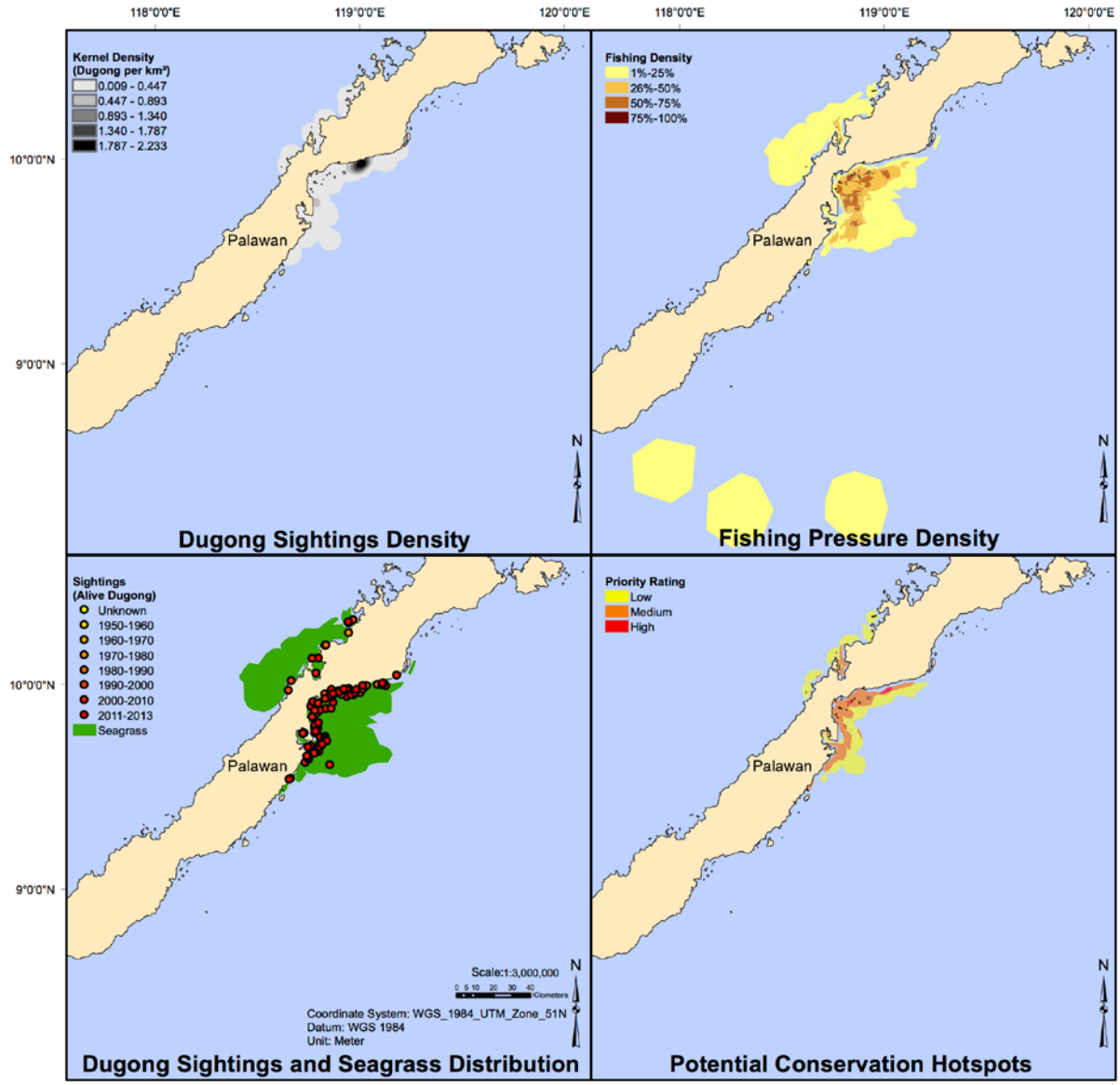

Figure 25: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Puerto Princesa, Philippines.

Solomon Islands

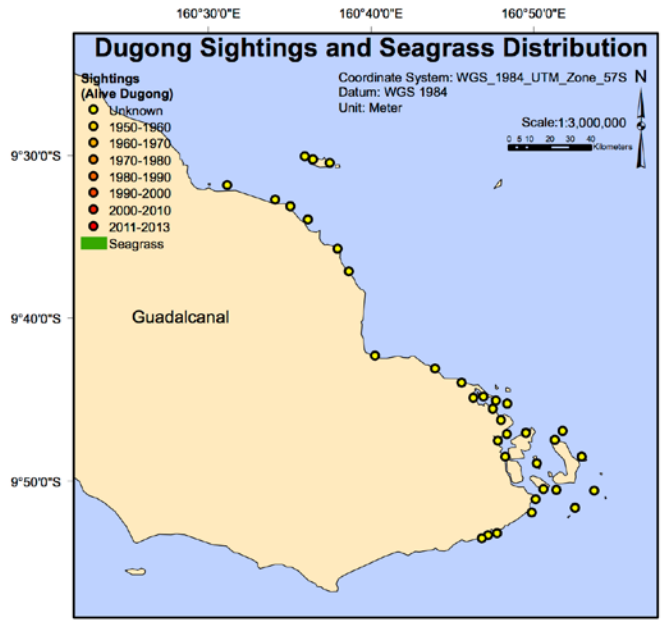

Figure 26: Dugong and seagrass distribution in Ysabel, Solomon Islands.

Note: No spatial data was provided for fisheries or seagrasses.

North Sri Lanka

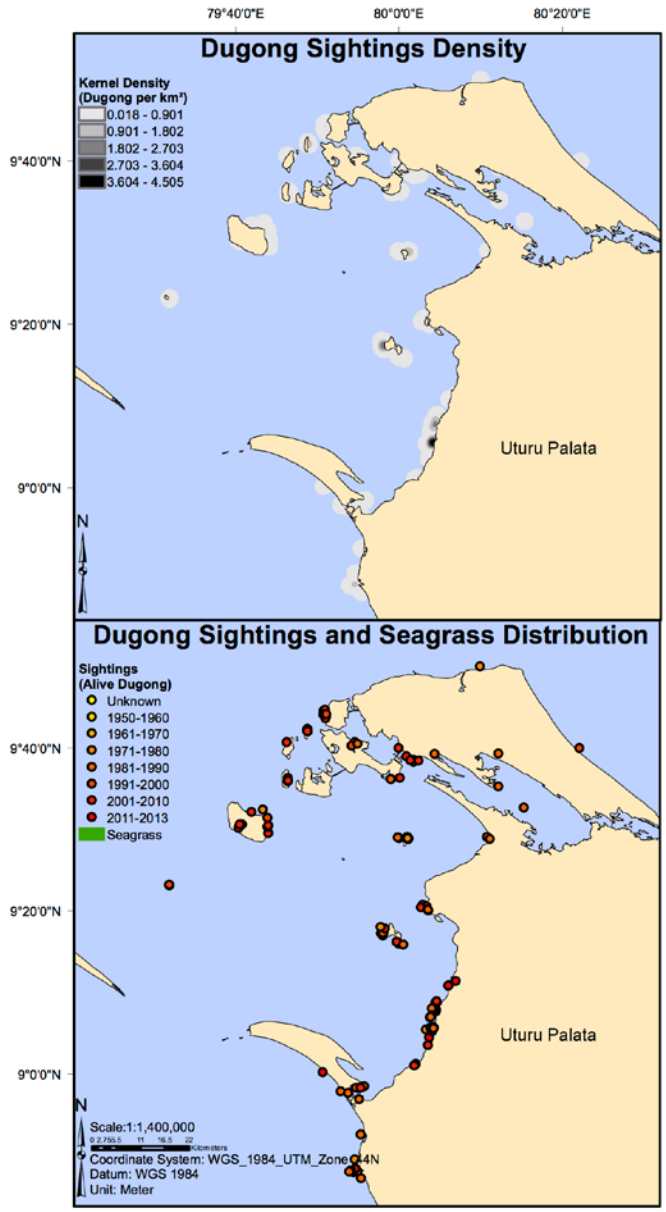

Figure 27: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for North Sri Lanka.

Note: No spatial data was provided for fisheries or seagrasses.

Northwest Sri Lanka

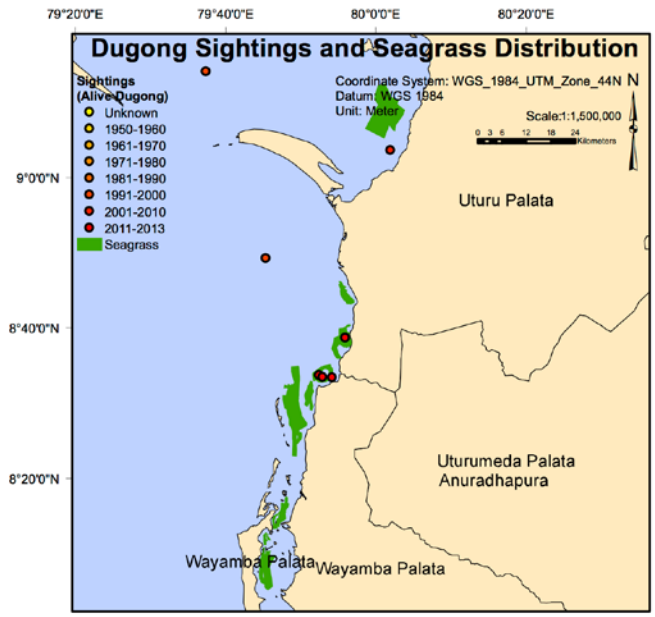

Figure 28: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Northwest Sri Lanka.

Note: No spatial data was provided for fisheries.

Mkinga, Tanzania

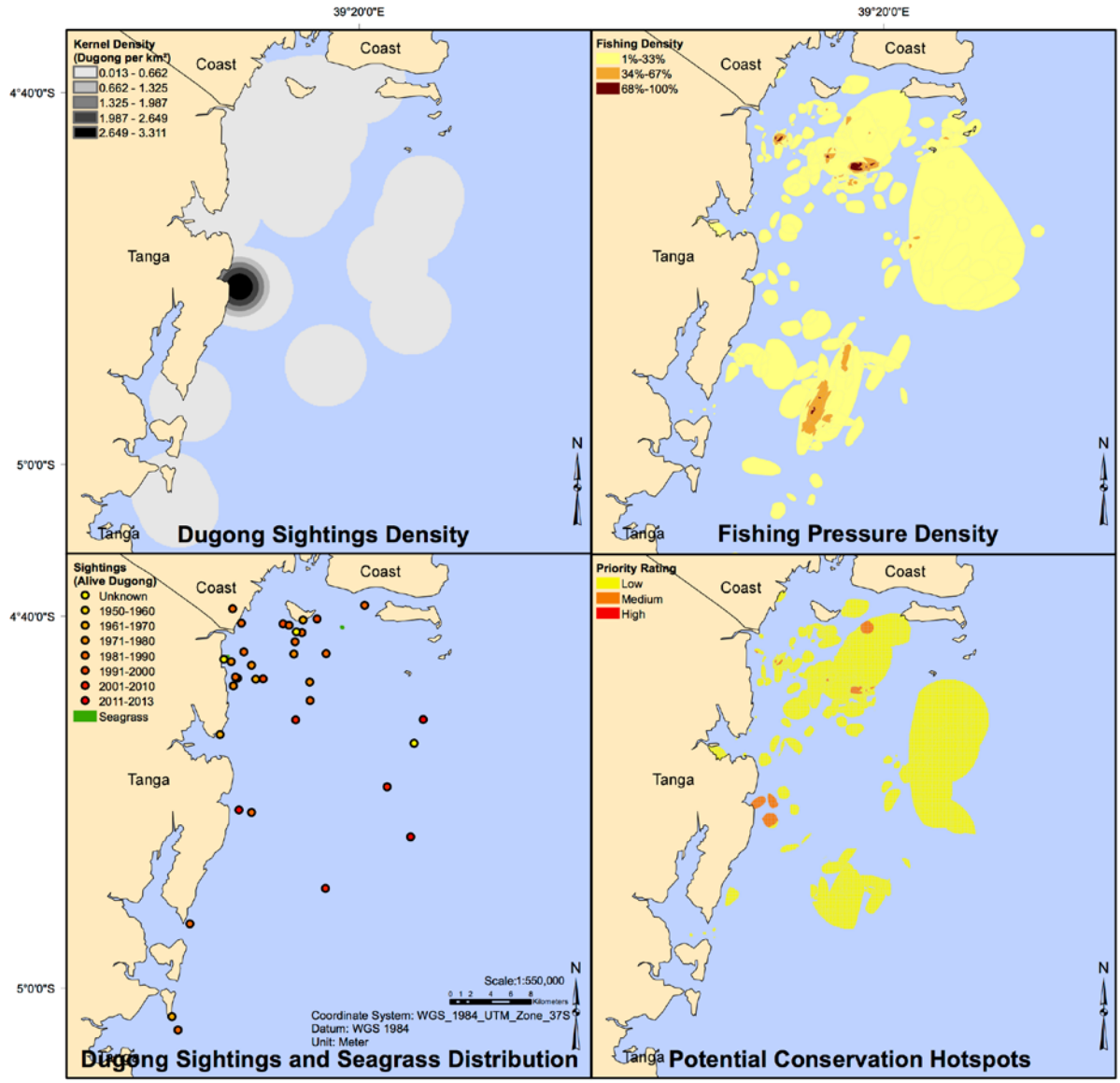

Figure 29: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Mkinga, Tanzania.

Mtwara, Tanzania

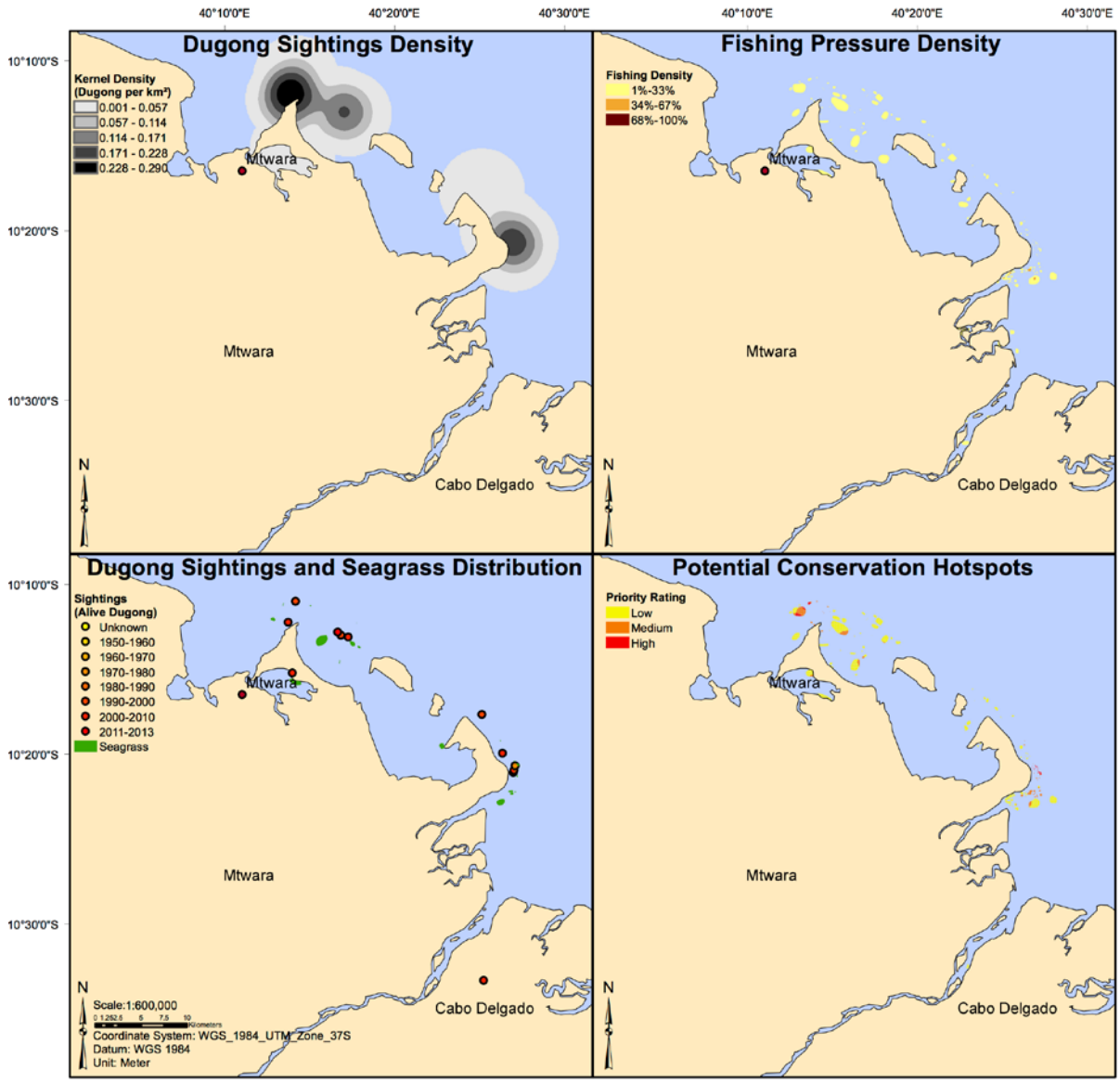

Figure 30: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for Mtwara, Tanzania.

North Andaman Sea Coast, Thailand

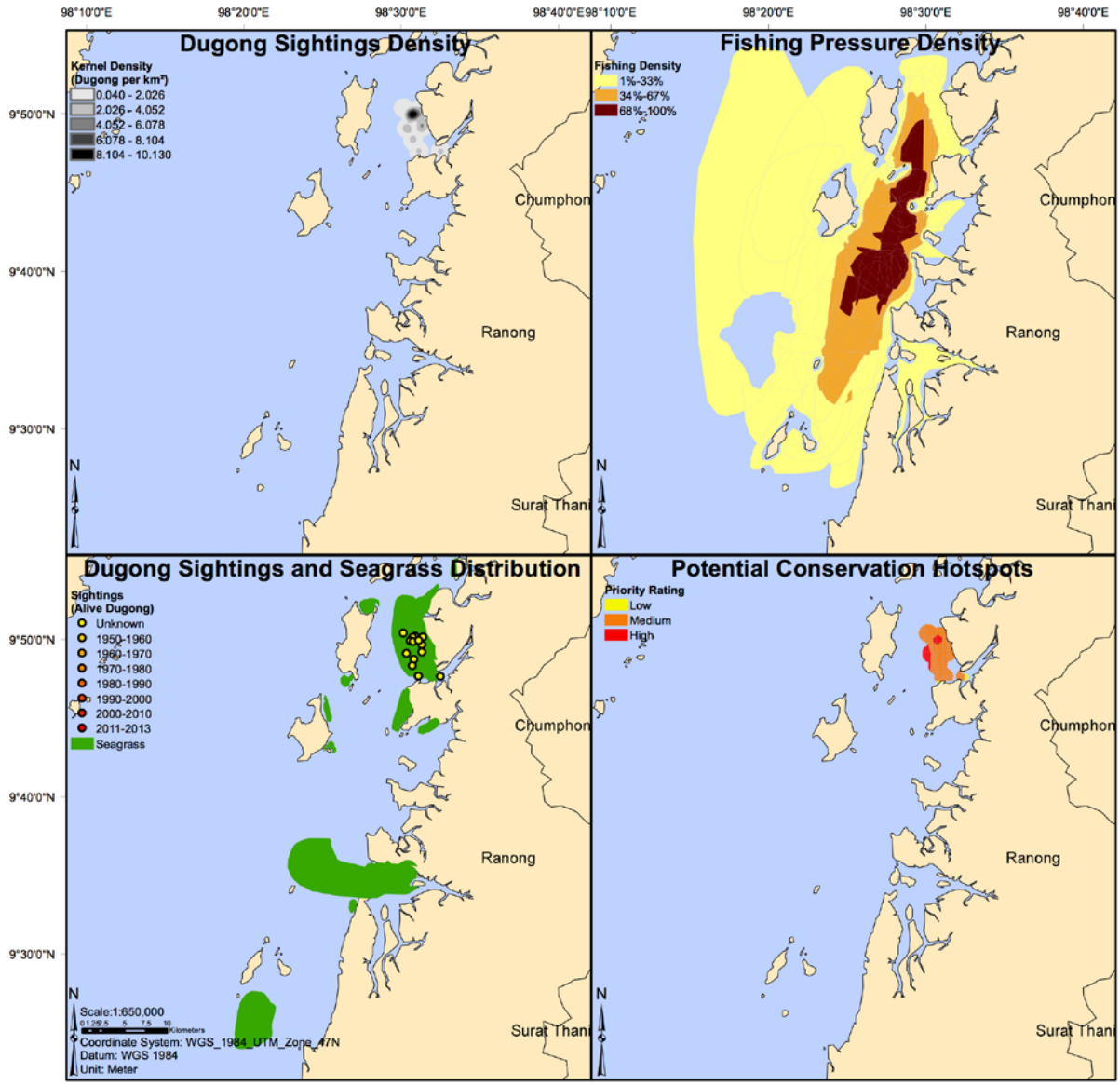

Figure 31: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for the North Andaman Sea Coast, Thailand.

Mid Andaman Sea Coast, Thailand

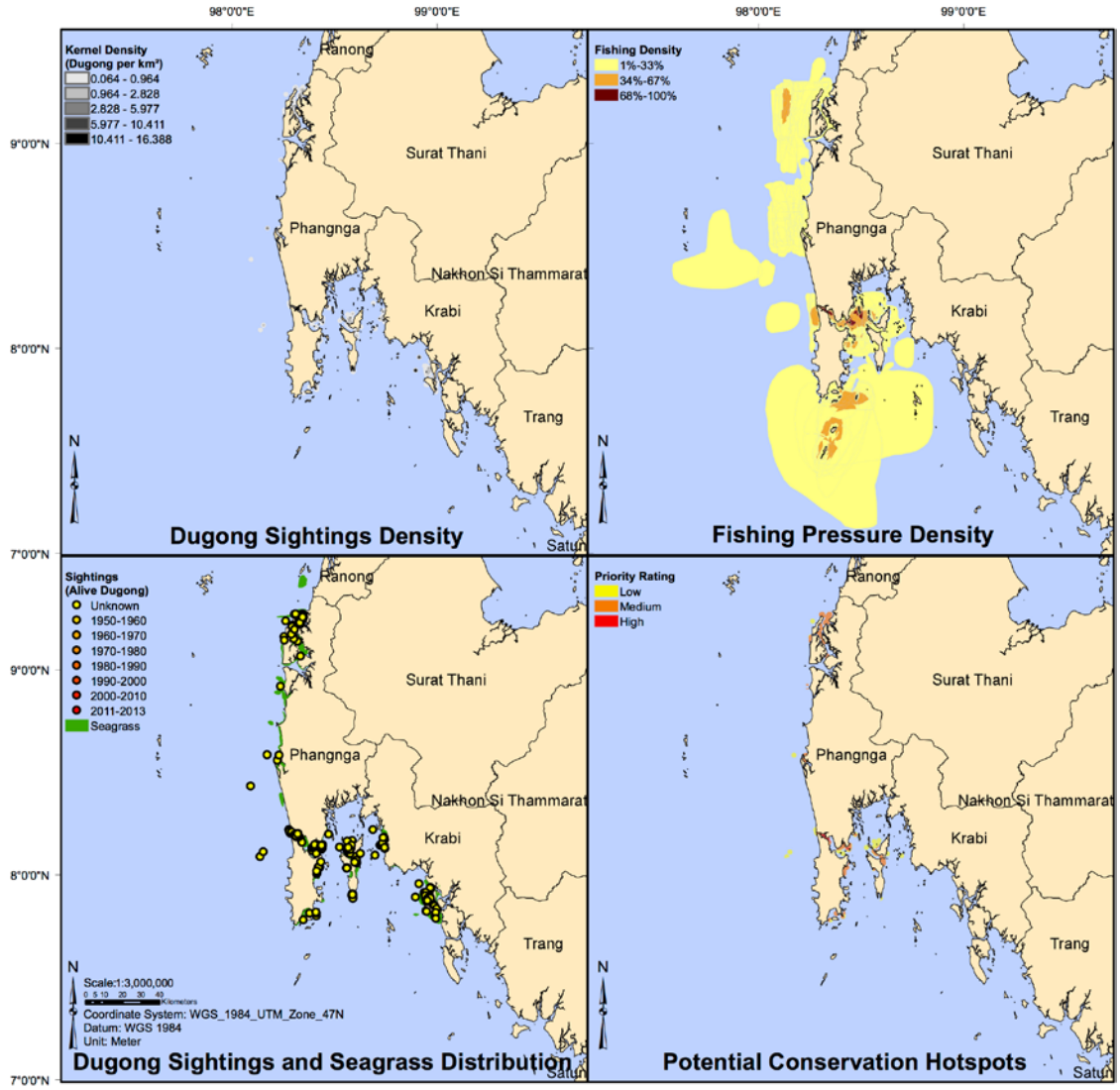

Figure 32: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for the Mid Andaman Sea Coast, Thailand.

South Andaman Sea Coast, Thailand

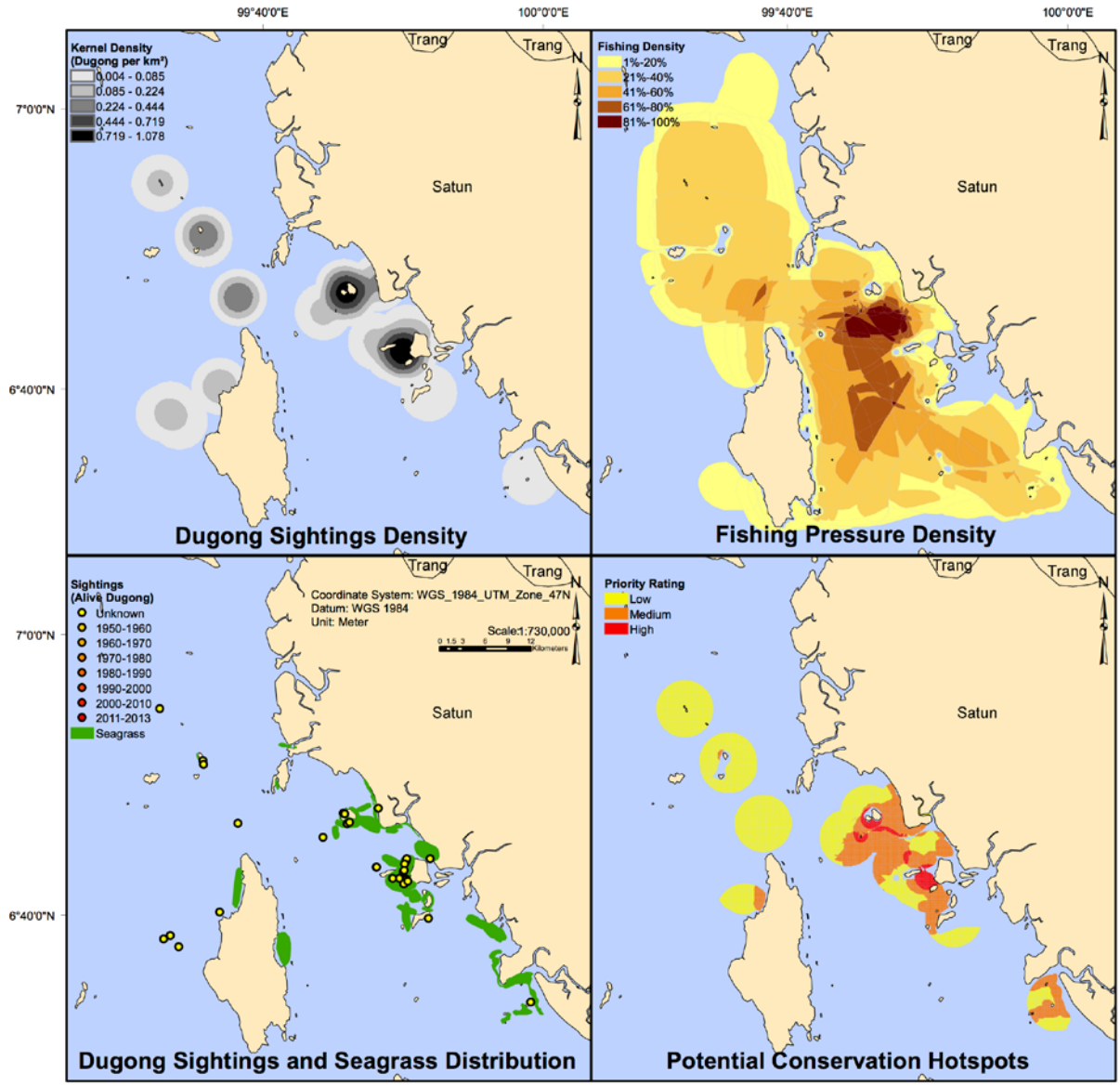

Figure 33: Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for the South Andaman Sea Coast, Thailand.

The End

Deliberations on the value of the programme

The questionnaire programme resulted in a rapid, low cost, low technology and easy-to-implement process for addressing information needs across the dugong's range. The average expense per country on deploying teams to conduct the interviews, analyse and enter data was around USD5000. Much of this was used for transport to and from remote survey sites, as staff costs were kept to a minimum by using volunteers and graduate students as interviewers. However some countries did not use the maps, and others adapted the questions and did not follow the prescribed format. Others used their own analysis methods and summarized dugong locations prior to submitting the reports, each of these resulting in incompatibility with other programme results. Thus an important lesson learned was that volunteers and graduate students who are not experienced require further training to provide compatible results. Overall, the questionnaire provided useful and contemporary data on small-scale fisheries and the locations, trends and numbers of dugongs that can be used by managers and decision makers.

The delay between implementation of the programme and a final report of all findings (this report) was due to the large volume of data assimilated by the project, and the voluntary nature of the analysis process. We suggest that the project be implemented and analysed at a country or even within-country level to expedite data acquisition and reporting. The Project Manual has been revised to include the complete GIS analysis protocols.

This is the latest update on dugong numbers, trends in captures and evidence of fisher-dugong interactions for a large part of the world that was previously unstudied in a systematic fashion, and provides a stepping stone to more focused research in those areas where dugongs were found to exist and where fishery pressures were high.

The issue of data quality

Given the nature of the questions and the variability in responses, potential bias and respondent misinformation, the programme was not envisioned to provide absolute numbers and precise locations of fishing areas and dugong hunting grounds. Rather, the questionnaire programme provided a rapid, low cost solution to dugong and fishery data acquisition which is scientifically robust, with a spatial analysis component that results in an identification of 'hotspot' areas where dugongs and fisheries overlap and where resource-scarce programmes might invest further efforts.

These data along with the graphic outputs of the Excel sheet and the GIS analysis can be used to highlight priority areas for further detailed study and assessments. The value of the work has already been demonstrated in the buy-in from the eight countries engaged in the GEF Dugong and Seagrass Conservation Project and the CMS Dugong MoU Secretariat plans to use the results of the questionnaire in other countries such as India, Myanmar and Thailand to develop pilot projects that determine incentives for fishing communities to manage fishing interactions with dugongs.

One of the largest issues in the implementation of this programme was the lack of standardization in the manner in which the programme was implemented at the local level. These differences in implementation of the programme created substantial gaps in the overall data analysis.

Where should we go from here

This project has provided a glimpse into dugong distribution and fishery overlaps across a large proportion of the dugong's geographical range, and in many cases the first data of its kind for those areas surveyed. The hotspot analysis provides a prioritization of sorts of those areas of heightened interest, where additional research is warranted. The data sets also provide an opportunity to examine the trends in dugong populations at a greater regional level than was previously possible, for instance by analyzing trends in dugong captures over time, such as that provided in **Figure 34**. This graphic makes use of advanced features of GIS analysis to georeference the sites at which dugong captures are increasing (indicated by the red segments), decreasing (green segments) of remaining the same (yellow segments). The graphic illustrates that trends in net captures are increasing at an alarming rate in Palau, for instance, suggesting this location is urgently in need of programmes to address net captures.

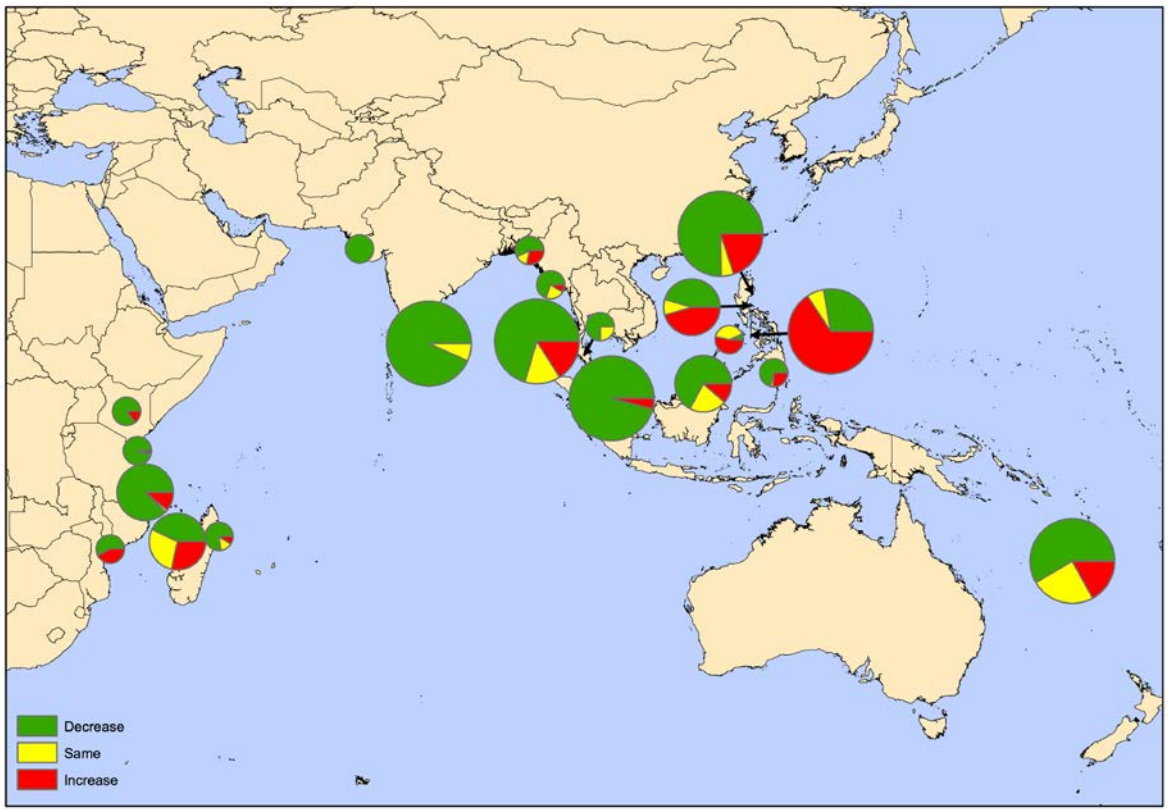

Figure 34: Trends in dugong captures in fishing gear across all recorded years, scaled by numbers of dugongs encountered at each location: Small pie charts <50 dugongs; Medium pie charts 50-100 dugongs; Large pie charts >100 dugongs.

We acknowledge that a decreasing trend in net captures is likely to be directly linked to shrinking populations, and a suite of additional analyses are warranted to further interrogate the data sets available through this programme.

The project has highlighted areas of interest, but has also highlighted the need for adequate training and strict contractual / reporting requirements so that project partners undertake all aspects of the programme. The provision of all of the spatial data by those countries that failed to submit these on time would have strengthened the results of the overall programme substantially.

At the same time, we recognise that there is a wealth of information contained in the data sets which were returned, and recommend that these be made available to scientists and researchers to extract additional detailed findings.

We suggest that as a next step for the CMS Dugong MOU Standardised Dugong Catch and Bycatch Questionnaire is to consider providing support for acquiring data from the gaps in these data sets, at both regional level (Northwest Indian Ocean, Pakistan, Somalia) and at National levels (the project only investigated known dugong areas rather than entire coastlines), and also work with project partners to address the missing data sets evident following the synthesis provided herein.

We also suggest that this report and data sets be widely distributed to further the understanding of dugong population trends and distribution, and overlaps with small-scale fishery pressures.

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Appendix II: National-level summary analysis of questionnaire data

Bangladesh

Respondent Charts: 80% of respondent's parents were fishers and 63% of their grandparents were also fishers. Most of the fishers >25 years old. The majority of respondents had been fishing >10 years. All respondents claimed fishing to be their livelihood. >50% of respondents claimed that fishing was their main activity, and 47.6% said it was their only income-generating activity.

Boat & Gear Charts: Inboards and outboards were used by the majority of fisher. All respondents fished from July to October. The primary catch was a mixed catch of fish and shellfish. The main fishing method was the longline method.

Dugong Charts: Most respondents did not know what a dugong was. Dugong encounters were during fishing or in transit. Less than half of dugongs were released alive.

Perceptions Chart: 20% of respondents believed dugongs might go extinct, and only 9.6% believed they were important to marine ecology. Over half of the respondents did not know if it was legal to catch dugongs.

India

Respondent Charts: >70% of respondents had fished >10 years. The majority of respondents were >25 years. >90% of respondents claimed fishing to be their only income-generating activity.

Boat & Gear Charts: >50% respondents had boats >5m in length with inboard engines. The least fished months were April through July. The primary catch of the persons involved was fish. The most used fishing gear was gillnets of <50m in length, and 11-100m in width. The majority of these nets were tended.

Dugong Charts: All respondents asked were aware of what a dugong is, and all said dugong captures had decreased. Most of the dugongs seen were encountered while fishing; the rest were either stranded or in transit. None of the respondents were aware of dugong hunters in their village or other villages.

Perceptions Chart: Nobody involved in the questionnaire knew the legality of capturing dugong, or if they might go extinct. A third of the people interviewed believed dugongs were not important.

Kenya

Respondent Charts: >50% of respondents had fished for >10 years, and the majority >25 years old.

Boat & Gear Charts: >50% of boats used by the fisher were non-motorised and >2m in length. October and December were the two most fished months. The main fishing gear used by respondents was longlines. The gill nets of the fishers interviewed were tended >80% of the time. Most of these nets were 51-500m in length, and 11-100m in width.

Dugong Charts: >50% of respondents knew what a dugong was, but most had never seen a dugong. The dugongs that were encountered were mainly encountered in transit or while fishing. >50% dugongs were released alive.

Perceptions Chart: >40% of the fishers interviewed thought dugongs might go extinct, and the majority believed dugongs were important. Most of the respondents thought it was legal to catch dugongs.

Madagascar Antongil

Respondent Charts: >70% of respondents had fished for >10 years. The majority of respondents were >25 years old. >90% of respondents claimed fishing to be their only income-generating activity.

Boat & Gear Charts: One respondent had a motorized boat. >60% of respondents were fishing every month. The most used fishing gear was purse seines. The gill nets used by the fishers interviewed were mainly tended and used during the day. All nets used were between 50-500m in length, and either <5m or 11-100m in width.

Dugong Charts: Most dugongs were encountered by respondents while fishing or in transit. >30% of respondents ate the dugongs that they caught. 15% of the respondents were aware of hunters in their village and 5% were aware of hunters in other villages.

Perceptions Chart: >75% of respondents believed that dugongs were important, but 48% believed dugongs might go extinct. The majority of those interviewed thought that it was legal to catch dugong.

Madagascar West

Respondent Charts: All respondents had >10 years of fishing experience. The majority of respondents were >25 years old. 51% of fishers interviewed claimed that fishing was their only income-generating activity.

Boat & Gear Charts: All boats used by the respondents were 2-10m in length, and all of these boats were non-motorised. Respondents fished the same amount throughout the entire year. The most commonly used fishing method was the hook & line method. All gillnets used by respondents were tended.

Dugong Charts: >50% of fishers interviewed knew what a dugong was. The fishers most commonly encountered dugongs while fishing. The majority of dugongs caught by the respondents were discarded. 36% of the respondents were aware of dugong hunters in other villages, while 2% were aware of hunters in their village.

Perceptions Chart: 14% of respondents believed that dugongs may face extinction. The majority of respondents believed that dugongs were important. Less than half of the respondents believed that catching dugongs was legal. >80% of the respondents claimed that enforcement patrols were never carried out.

Malaysia - Johor

Respondent Charts: >80% of respondents had fished >10 years. The majority of respondents were >25 years old. 55% of fishers claimed fishing to be their only income-generating activity.

Boat & Gear Charts: >50% of the boats used by respondents were boats with outboard engines between 5-10m long. Fewer respondents fished during December and January. The main catch by the fishers interviewed was fish; followed by mixed catch. The main

fishing gear used by the respondents was gillnets. These nets were tended 68% of the time.

Dugong Charts: >90% of respondents said they knew what dugongs were. Most of the dugongs encountered were encountered in transit. Over half of dugongs released alive. 4% of respondents knew of dugong hunters in their village and 8% knew of hunters in other villages.

Perceptions Chart: The majority of fishers interviewed thought it was legal to catch dugongs.

Malaysia - Lawas

Respondent Charts: >30% of respondents had fished for <10 years. 90% of the fishers surveyed were >25 years old. >50% said fishing was their only income-generating activity.

Boat & Gear Charts: The majority of boats used by respondents had outboard engines. The primary catch by the respondents was fish, and the most commonly used fishing gear was gill nets. Over half of these nets were tended. The majority of these nets were set at night. There was no discernable fishing seasonality because >80% of the respondents were fishing every month.

Dugong Charts: >70% of respondents did not know what a dugong was. The dugongs that were encountered by the persons interviewed were mostly encountered while fishing or caught in their nets. The majority of dugongs were released alive.

Perceptions Chart: 58% of the respondents thought catching dugongs was legal. >80% of respondents believed penalties were never imposed or imposed infrequently.

Malaysia - NW Sabah

Respondent Charts: The majority of fishers interviewed were between the ages of 26-50. Of the interviewed fishers, only 58% had been fishing for >10 years. 55% of the fishers claimed fishing as their only income-generating activity.

Boat & Gear Charts: The majority of boats used had outboard engines. The most commonly used method of fishing was the hook & line method. There was no discernable seasonality.

Dugong Charts: >50% of the persons interviewed knew what a dugong was. The respondents most commonly saw dugongs while fishing or in transit. The majority of dugongs were released alive. <6% of respondents were aware of hunters in their village or in other villages.

Perceptions Chart: The majority of respondents believed dugongs may face extinction. <50% of respondents believed dugongs were important to marine ecology.

Malaysia – SW Sabah

Respondent Charts: >90% of respondents had fished for >10 years. The majority of respondents were >25 years old. 62% of respondents claimed fishing to be their only income-generating activity.

Boat & Gear Charts: The majority of boats used were 5-10m long and had outboard engines. There was no discernable seasonality of the fishers, as over 80% were fishing during each month. The primary catch by the surveyed fishers was shrimp. The most commonly used fishing method was gillnets, and the length of the net was most commonly 51-500m. These nets were tended >80% of the time.

Dugong Charts: <50% respondents knew what a dugong was. Dugongs were most commonly encountered by the respondents while fishing or netted. Dugongs were released alive 41% of the time. >25% of respondents were aware of hunters in their village or in other villages.

Perceptions Chart: 27% of the persons interviewed believed that dugongs may go extinct. Less than half believed that dugongs were important. >80% of respondents thought it was legal to catch dugongs. Most fishers that were interviewed believed enforcement patrols were carried out infrequently.

Mozambique

Respondent Charts: >70% of respondents had fished >10 years. The majority of respondents were >25 years. 75% of respondents claimed fishing to be their only income-generating activity.

Boat & Gear Charts: >50% of the boats used by respondents were non-motorized boats and 2-10m long. The months with the least respondents fishing were September, October, and November. The most common used method of fishing by the fishers interviewed was a beach seine, followed by the hook & line method. The primary catch by the respondents was fish. Gillnets used by the respondents were tended >50% of the time.

Dugong Charts: The majority of the respondents knew what a dugong was. The fishers that participated in the questionnaire mostly encounter dugongs while fishing or in transit. 95 respondents claimed to have seen dugongs in the past year. 65% of the dugongs were released alive. <10% of the persons interviewed claimed they knew of dugong hunters in their village or in other villages.

Perceptions Chart: The dugong population was perceived by respondents to have increased. >85% believed dugongs were important and 40% believed it was illegal to catch dugongs.

Myanmar

Respondent Charts: >70% of respondents had fished for >10 years. The majority of respondents were >25 years old. >50% claimed fishing to be their only income-generating activity.

Boat & Gear Charts: The majority of boats used by respondents were boats with inboard engines and >5m in length. The least fished months by the fishers interviewed were May through August. The primary catch by the persons interviewed was fish, and the main fishing method used was a purse seine.

Dugong Charts: >70% of respondents did not know what a dugong was. Most of the dugong encounters were during fishing. 60% of dugongs were released alive.

Perceptions Chart: <20% of respondents thought that dugongs were important and >50% perceived that enforcement patrols were never carried out.

New Caledonia

Respondent Charts: >50% of respondents had fished for >10 years. The majority of respondents were >25 years old. >60% claimed fishing was not their main income-generating activity.

Boat & Gear Charts: The majority of boats used by the respondents had outboard engines. The least fished months were the months between October to December and thee primary catch was fish. They mostly used the hook & line method but the gillnets were also used and were tended over 80% of the time.

Dugong Charts: >50% of the respondents knew what a dugong was. Most of the dugongs encountered were during transit. Dugongs were released 60% of the time, and eaten 30% of the time. 30% of respondents were aware of dugong hunters in their village, while 20% were aware of dugong hunters in other villages.

Perceptions Chart: >80% believed that dugongs may face extinction. The majority of fishers interviewed believed it was legal to catch dugongs.

Philippines - Aurora

Respondent Charts: >50% of the respondents had fished >10 years. The majority of respondents were >25 years old. >50% of respondents claimed fishing to be their only income-generating activity.

Boat & Gear Charts: The majority of boats used were 2-10m long and the majority had inboard engines. The least fished months were July, August, and September. The primary catch of those interviewed was fish. The main methods of fishing used were the longline and hook & line methods. The gill nets used by the interviewed fishers were tended over 65% of the time.

Dugong Charts: >90% of respondents were aware of what a dugong was. Most of the dugongs were encountered by the fishers surveyed while fishing. Most of the dugongs were released alive. <5% of the respondents interviewed knew of dugong hunters in other villages.

Perceptions Chart: The majority of the respondents believed there was a decrease in the population of dugongs. >80% of the respondents believed that dugongs might face extinction. >75% believed that dugongs were important. >90% believed that hunting dugongs was legal.

Philippines - Polillo

Respondent Charts: >70% of respondents had fished for >10 years. The majority of respondents were >25 years old. < 30% of respondents claimed fishing to be their only activity.

Boat & Gear Charts: The majority of boats used by respondents were >5m long with inboard engines. The least fished months were June and August. The most commonly used method of fishing was the hook & line method.

Dugong Charts: >90% of respondents were aware of what a dugong was. The respondents encountered dugongs most commonly while fishing. The fishers interviewed claimed there were more net captures of dugongs than previous years. The majority of dugongs were released alive. >10% of respondents were aware of dugong hunters in other villages.

Perceptions Chart: >30% of persons interviewed believed that the population of dugongs has decreased. The majority of respondents believed that dugongs might face extinction. >90% of respondents believed that catching dugongs was legal.

Philippines Antique

Respondent Charts: >60% of respondents had fished for >10 years. The majority of respondents were >25 years old. >75% of respondents claimed fishing to be their only income-generating activity.

Boat & Gear Charts: The majority of boats used by respondents were >5m long. The main method of fishing was the hook & line method. There was no discernible seasonality.

Dugong Charts: >90% of the respondents knew what a dugong was. Most of the dugong encounters were during fishing or in transit. Over the past year, 30 respondents had encountered dugongs, and four of those respondents claimed to see dugongs once a month or more frequently. The majority of dugongs released alive.

Perceptions Chart: 30% of respondents believed the dugong population was increasing. >80% of respondents believed dugongs may face extinction, while 76% believed dugongs were important.

Sri Lanka - North

Respondent Charts: >80% of respondents had fished for >10 years. The majority of respondents were >25 years old. >90% of respondents claimed fishing to be their only income-generating activity.

Boat & Gear Charts: The majority of boats used by the fishers interviewed had outboard engines and were 5-10m long. None of the respondents fished during August or September. The main fishing method used was the gillnet method. These nets were tended >65% of the time, and were mainly used during the day. The majority of the gill nets used by the fishers interviewed were set at the bottom. Their primary catch was fish.

Dugong Charts: 80% of respondents knew what a dugong was. The respondents most commonly encountered dugongs while in transit or fishing. There were 22 respondents that claimed to see dugongs throughout the past year, and 21 of those respondents claimed they had seen several. 97% of respondents said that there were less net captures of dugongs. The dugongs were most commonly eaten. >50% of respondents were aware of dugong hunters in their village, and 23% were aware of hunters in other villages.

Perceptions Chart: The majority of respondents believed that the dugong population has decreased, and the majority also believed that dugongs may face extinction. All

respondents agreed that dugongs were important. >80% of subjects surveyed believed catching dugongs was legal.

Sri Lanka - Northwest

Respondent Charts: >90% of respondents had >10 years fishing experience. The majority of respondents were >25 years old. > 90% of respondents claimed fishing to be their only income-generating activity.

Boat & Gear Charts: The majority of boats used by the fishers interviewed had outboard engines and were 5-10m long. The least fished months were August and September. The most commonly used method of fishing was gillnet. These nets were tended >50% of the time.

Dugong Charts: The majority of respondents knew what dugongs were. The fishers surveyed most commonly encountered dugongs while in transit. In the past year, 20 respondents claimed to see dugongs. >35% of dugongs were released alive. Fishers interviewed claimed that there were less net captures of dugongs.

Perceptions Chart: 46% of respondents believed the population of dugongs has decreased.37% believed that dugongs may face extinction, and 36% believed dugongs were important. The majority of fishers interviewed believed it was legal to catch dugongs. >50% of respondents claimed that enforcement patrols were infrequently carried out.

Tanzania - Mkinga

Respondent Charts: >40% of respondents had fished < 10 years. The majority of respondents were >25 years old. > 60% claimed fishing to be their only income-generating activity.

Boat & Gear Charts: The majority of boats used by the fishers interviewed were >5m in length. The primary catch was fish. The most used method of fishing was the gill net. These nets were tended >60% of the time.

Dugong Charts: 40% of respondents knew what a dugong was. Dugongs were most commonly encountered whilst trapped in fishing nets. The majority of respondents claimed that there were less net captures of dugongs. >48% of dugongs were released alive. 9% of respondents were aware of dugong hunters in their village, while 7% were aware of dugong hunters in other villages.

Perceptions Chart: The majority of respondents believed the dugong population has decreased. <20% believed that dugongs might go extinct, and 70% believed that dugongs were important >65% of respondents believed that it was legal to catch dugongs. The majority of respondents claimed that enforcement patrols were carried out infrequently.

Tanzania - Mtwara

Respondent Charts: >60% of respondents had fished >10 years. The majority were >25 years old. >65% claimed fishing was not their only income-generating activity.

Boat & Gear Charts: The majority of boats used by the respondents were non-motorised boats and 2-5m in length. The least fished months were January, February and March. The most common fishing method used was the longline method. The primary catch by the fishers interviewed was fish.

Dugong Charts: <50% of respondents knew what a dugong was. Dugongs were most commonly encountered while netted or when hunted. 46.5% of caught dugongs were released alive. 8% of interviewed fishers were aware of dugong hunters in their village, and 4% were aware of dugong hunters in other villages.

Perceptions Chart: 21% of respondents believed that dugongs may go extinct. The majority of respondents believed that dugongs were important. >50% believed that catching dugongs was legal. >50% claimed that penalties imposed by enforcement agencies were infrequent.

Thailand

Respondent Charts: >78% of respondents had at >10 years of fishing experience. The majority of the respondents were >25 years old. 70% of fishers interviewed claimed fishing to be their only income-generating activity.

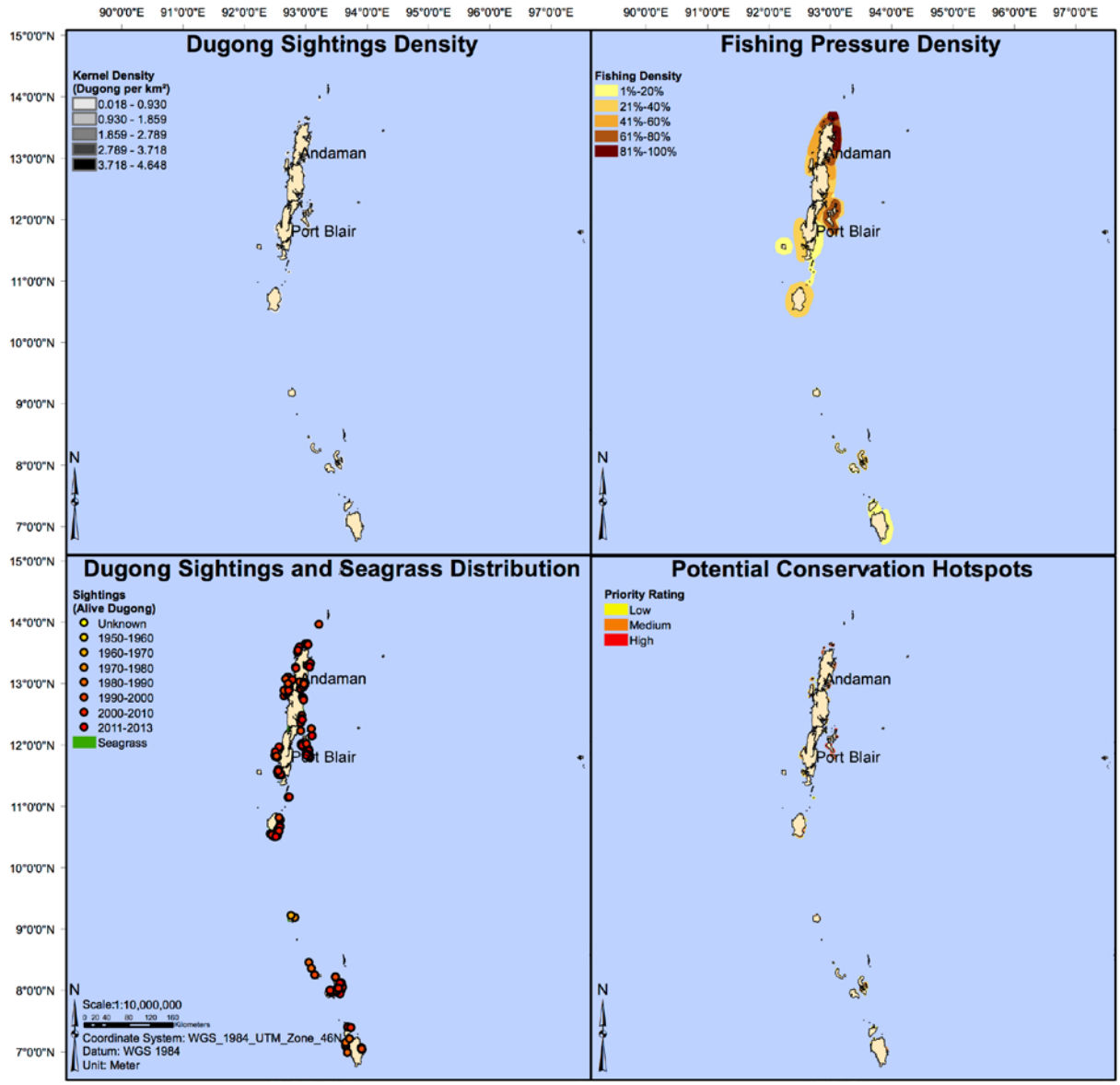
Boat & Gear Charts: The majority of boats used were between 5-10m in length and had either an inboard or outboard engine. The least fished months were June through to September. The main catch was crab, and the main fishing method used was gill net. These nets were tended less than half of the time, and 38% were set both day and night.

Dugong Charts: >60% of respondents did not know what a dugong was. Half of the dugongs encountered were while fishing. Only 3 respondents reported dugong sightings in the past year. The majority of dugongs were released alive.

Perceptions Chart: <10% of respondents of the questionnaire believed that dugongs may face extinction. >50% believed dugongs were important. The majority of the respondents believed that catching dugong was legal.

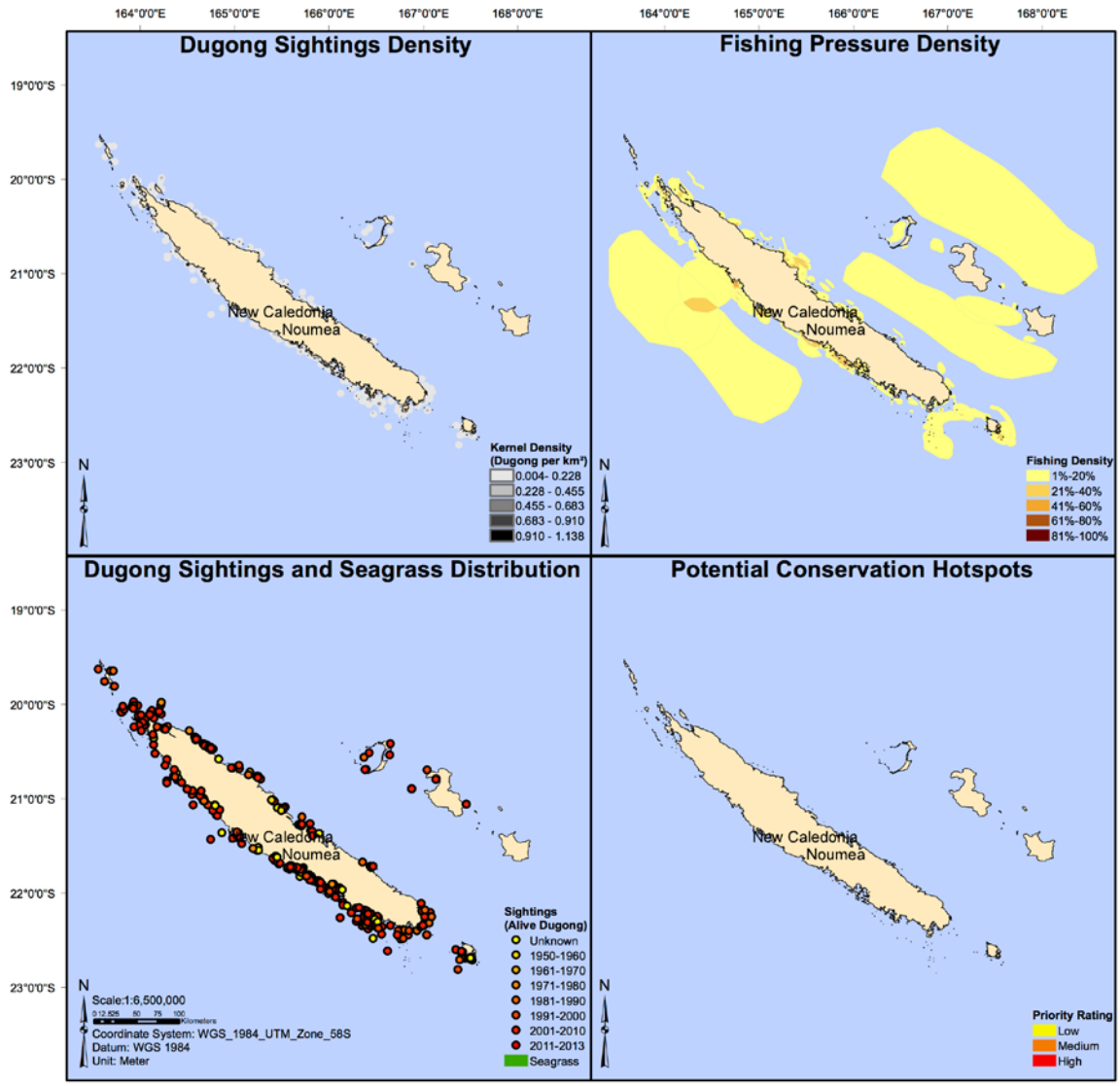
Appendix III: Small-scale fishery overlap graphics

Andaman & Nicobar Islands



Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for the Andaman and Nicobar Islands, India.

New Caledinia



Dugong and fishery density analysis, sightings and seagrass distribution, and priority area identification for New Caledonia.

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