

Marine Conservation *in Myanmar*

Current knowledge and research recommendations



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Myanmar Ministry of
Livestock and Fisheries



Wildlife Conservation Society
Myanmar



Myanmar Marine
Science Association



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Myanmar Program

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FOREWORD

Tremendous marine resources bless Myanmar and these resources have benefited our Union since ancient times. Unfortunately these resources are coming under increasing pressures. We know that the sustainable use of our marine resources will enable our people to continue to benefit from our seas, beaches, mudflats and mangroves.

As we are reminded in this report we know a great deal about our marine environment. There is a rich history of marine research through our Department of Fisheries and our marine science university programs. Bringing this information together in one place provides a strong foundation for our future actions to build upon. It is also clear that there is still much more work to do.

The future wealth of many of our citizens will be closely tied to our use of marine resources. As this report shows there is a very wide range of habitats, species, and products that will need to be conserved so that future generations can still benefit from this great wealth. Some of these products can be managed for long term use while others, such as Sharks and Rays have already been over used and must now be protected to ensure our marine ecosystem remains intact.

It is the responsibility of all citizens to work towards conserving the country's resources. We need to try new approaches including marine protected areas managed with local communities as well as working with the Myanmar Fisheries Federation to manage our fish stocks to sustain our fishing industry. I now look to the future for carefully planned development and conservation to be supported by the Government and our international partners to ensure that we benefit from our marine riches long into the future.



U Khin Maung Aye
Union Deputy Minister
Ministry of Livestock, Fisheries and Rural Development
Republic of the Union of Myanmar

FOREWORD

For over twenty years the Wildlife Conservation Society has supported the conservation of Myanmar's rich natural resources. Over these years much of our work has focused on forests and the people who use forests for their livelihoods and up until now our work in the marine realm has been relatively limited. In the past we have focused on studying and conserving the whales and dolphins of Myanmar's coastal waters and along the Ayeyawady River.

This report begins a new chapter for WCS's cooperative relationship with the Myanmar government, especially the Ministry of Livestock, Fisheries and Rural Development and the Department of Fisheries.

Myanmar's vast marine resources are an integral part of Myanmar's future development. Our country is already heavily dependent on fish and other marine products for our daily livelihoods as well as for lucrative export markets. The stunning beauty of our islands, beaches and coral reefs is rapidly becoming the basis of a growing tourism industry that will provide thousands of new jobs; while healthy coastal habitats such as mangroves and mudflats continue to protect us from natural disasters and the rising risks of climate change.

Unfortunately, many of the resources that have supported coastal communities and industries for generations are no longer sufficient to meet the country's needs. Now is the time for a dramatic shift in how these resources are utilized. We must find new opportunities to conserve and improve the management of these important resources before they are lost to all. I hope this report finds a wide audience and will serve as one step on the road to a better future for Myanmar.



U Than Myint
Country Program Director
Wildlife Conservation Society
Myanmar Program

အကျဉ်းချုပ်

ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံတော်သည် ရှည်လျားသည့် ပင်လယ်ကမ်းရိုးတန်းများနှင့်အတူ အက္ခရာ အရင်းအမြစ်များ ပေါကြွယ်ဝစွာ ပိုင်ဆိုင်ထားခြင်းမှာ အလွန်ကံကောင်းပါသည်။ ယခင်က ကမ္ဘာ့အထီးကျန် နိုင်ငံဖြစ်ခဲ့ရာမှ ယခုအခါ ဒီမိုကရေစီနိုင်ငံအဖြစ်သို့ အသွင်ကူးပြောင်းနေ၍ နိုင်ငံတကာမှ ရင်းနှီးမြုပ်နှံမှုများလည်း တဖြည်းဖြည်း တိုးတက်လျက်ရှိပါသည်။ အဆိုပါ ပြောင်းလဲမှုများကြောင့် အက္ခရာအရင်းအမြစ်များအား ပိုမိုထုတ်ယူ သုံးစွဲလာနိုင်သည့် အလားအလာများ ပိုမိုမြင့်မားလာနိုင်သကဲ့သို့ နိုင်ငံတကာ၏ အကူအညီများဖြင့် ထိန်းသိမ်း ကာကွယ်ရေးလုပ်ငန်းများ၊ သုတေသနလုပ်ငန်းများနှင့် ထိန်းသိမ်းရေးဥပဒေပြုလုပ်ငန်းများကို ပိုမိုအရှိန်မြှင့် ဆောင်ရွက်လာနိုင်မည့် အခွင့်အလမ်းများလည်း ရှိနေပါသည်။

နိုင်ငံတော်အစိုးရဌာနများ၊ တက္ကသိုလ်နှင့် သုတေသနဌာနများနှင့် အစိုးရမဟုတ်သည့် အဖွဲ့ အစည်းများသည် အက္ခရာဝါဒီဝါဒီမိုးစုံမိုးကွဲများနှင့် ယင်းတို့၏နေရင်းဒေသများအကြောင်း လေ့လာ ဆန်းစစ်မှုများကို ကျယ်ကျယ်ပြန့်ပြန့် ဆောင်ရွက်ခဲ့ကြပါသည်။ အဆိုပါလေ့လာတွေ့ရှိချက်များ၏ အချို့တစ်စိတ်တစ်ပိုင်းကိုသာ နိုင်ငံတကာအဖွဲ့ အစည်းများမှတစ်ဆင့် ဒေသတွင်းနှင့် နိုင်ငံတကာ အစည်းအဝေးများတွင် ကျယ်ကျယ်ပြန့်ပြန့် တင်ပြခဲ့ကြပါသည်။ သို့သော် အက္ခရာဝါဒီပုံဆိုင်ရာ လေ့လာမှုအများစုမှာ ပုံနှိပ်ထုတ်ဝေနိုင်ခဲ့ခြင်းမရှိ၍ အဆိုပါသတင်းအချက်အလက်များကို ရှာဖွေ ရယူရန် မလွယ်ကူပါ။ မြန်မာ့ပင်လယ်ပြင်ရှိ အက္ခရာဝါဒီမိုးစုံမိုးများနှင့် ယင်းတို့၏ နေရင်းဒေသ အခြေအနေများကို လေ့လာဆန်းစစ်မှု အနည်းငယ်သာ ဆောင်ရွက်နိုင်ခဲ့ပါသေးသည်။

မြန်မာနိုင်ငံ၏ အက္ခရာဝါသယံဇာတများ၏ လက်ရှိအခြေအနေများကို နားလည်သိရှိနိုင်ရန်နှင့် အနာဂတ်တွင် ဆောင်ရွက်နိုင်မည့် အက္ခရာဝါဒီဆိုင်ရာ ထိန်းသိမ်းရေးလုပ်ငန်းများအတွက် အခြေခံ အုတ်မြစ်ချမှတ်နိုင်ရန် အက္ခရာဝါဒီဝါဒီမိုးစုံမိုးကွဲများနှင့် နေရင်းဒေသများကို လေ့လာမှုပြုလုပ် ထားသည့် စာတမ်း (၆၀၀) ကိုစုဆောင်းခဲ့ပါသည်။ အက္ခရာဝါဒီနေရင်းဒေသများအတွက် ရရှိနိုင်သည့် ပထဝီဝင်သတင်းအချက်အလက်မ ပျားကိုလည်း စုဆောင်းရယူခဲ့ပါသည်။ အသစ်ရရှိသည့် ဂြိုဟ်တု သတင်းအချက်အလက်များကိုအခြေခံကာ ထိန်းသိမ်းရေးအတွက် အထူးအရေးပါသည့် အက္ခရာ နေရင်းဒေသနှစ်ခု၏ ပျံ့နှံ့မှုအခြေပြမြေပုံများကို ပြုစုခဲ့ပါသည်။ ဖော်ပြပါ အရင်းအမြစ်များမှ သတင်း အချက်အလက်များနှင့် တွေ့ရှိချက်များကို ယခုအစီရင်ခံစာတွင် အကျဉ်းချုပ်ကာ ဖော်ပြထား ပါသည်။

အက္ခရာပတ်ဝန်းကျင် ထိန်းသိမ်းရေးဆိုင်ရာ ဥပဒေစနစ်များကို ပြန်လည်သုံးသပ်ထားပြီး အဓိက ပါဝင်ဆက်နွယ်သူများကို အကျဉ်းချုပ်ဖော်ပြထားပါသည်။ အက္ခရာဆိုင်ရာ ထိန်းသိမ်းရေးနှင့် သုတေသနလုပ်ငန်းများကို ဦးစားပေးရွေးချယ်နိုင်ရန် ပါဝင်ဆက်နွယ်သူများအားလုံးကို ဖိတ်ကြား ကာ အလုပ်ရုံဆွေးနွေးပွဲ တစ်ခုကို ကျင်းပခဲ့ပါသည်။ ထို့အပြင် ရခိုင်နှင့်တနင်္သာရီ အက္ခရာ ဆက်စပ်ဧရိယာနှစ်ခုကို ဦးစားပေး ထိန်းသိမ်းရေး ဆက်စပ်ဧရိယာများအဖြစ် ဖော်ပြထားပါသည်။

ရရှိလာသည့် ကွဲပြားစုံလင်သော သတင်းအချက်အလက်များအပေါ်အခြေခံကာ မြန်မာနိုင်ငံ၏ အက္ခရာဆိုင်ရာ ထိန်းသိမ်းရေးအတွက် အနာဂတ်လုပ်ငန်းစဉ်များတွင် ထည့်သွင်းစဉ်းစားသင့်သည့် အချက်များကို အကြံပြု တင်ပြထားပါသည်။

မြန်မာနိုင်ငံ၏ အက္ခရာဆိုင်ရာ ထိန်းသိမ်းရေးလုပ်ငန်းများကို အမြင်ချင်းဖလှယ်ခြင်း၊ စဉ်းစား ဆင်ခြင်ခြင်းနှင့် စီမံချက်များ ပူးပေါင်းရေးဆွဲခြင်းတို့ဖြင့် အက္ခရာအရင်းအမြစ်များကို ထိရောက်စွာ စီမံခန့်ခွဲ ထိန်းသိမ်းနိုင်ကြမည် ဖြစ်ပါသည်။ ယင်း၏အကျိုးဆက်များမှာ မြန်မာနိုင်ငံ လုပ်သား ပြည်သူများ၏ လူနေမှုဘဝများ၊ စီးပွားရေးနှင့် ကျန်းမာရေးများအတွက် စဉ်ဆက်မပြတ် အထောက်အပံ့များအဖြစ် တည်ရှိနေမည် ဖြစ်ပါသည်။

EXECUTIVE SUMMARY

The Republic of the Union of Myanmar is fortunate to have a long coastline that supports rich marine communities. The country is undergoing a rapid transition from one of the world's most isolated countries to an emerging democracy allowing for increased international investment. This change may bring increased demands on marine resources along with opportunities for improved conservation, research and legislation measures through international co-operations.

Myanmar's government departments, academics and NGOs have conducted numerous studies on a wide range of the country's marine resources and habitats. Subsets of this information have been presented at regional and international meetings and are shared more broadly through international organisations. However, many studies of Myanmar's marine life have never been published and remain difficult to access. And few assessments have been conducted to determine the status of marine species and habitats.

To understand the current state of marine resources in Myanmar and to lay a foundation for future marine conservation activities, we compiled over 600 papers and reports relating to the country's marine biodiversity and habitats. We also gathered existing GIS data on marine habitats and generated distribution maps for two critical marine habitats based on newly available satellite datasets. Information and findings from these sources are summarized in this report.

We provide a summary of stakeholders and review the legal structures that relate to the marine environment. We conducted a stakeholder workshop to identify priorities for research and conservation activities. We also describe the two marine priority "Conservation Corridors", namely the Rakhine and Taninthayi Marine Corridors.

From this diverse set of information, we have generated recommendations for future marine conservation activities in Myanmar.

Through informed, thoughtful and coordinated planning, marine resources in Myanmar may be effectively managed and conserved in order to continue to support the livelihoods, economy and health of the people of Myanmar.

ACRONYMS

ADPC	Asian Disaster Preparedness Center	MEI	Myanmar Environment Institute
APFIC	Asia-Pacific Fishery Commission	MERN	Myanmar Environment Rehabilitation-conservation Network
ASEAN	Association of Southeast Asian Nations	MFF	Mangroves for the Future
BANCA	Biodiversity and Nature Conservation Association	MFF	Myanmar Fishery Federation
BOBLME	Bay of Bengal Large Marine Ecosystem	MPA	Marine Protected Area
CBD	Convention on Biological Diversity	MSAM	Marine Science Association, Myanmar
CBNRM	Community-Based Natural Resource Management	MAPDRR	Myanmar Action Plan for Disaster Risk Reduction
CIT	Community Involvement in Tourism	MoE	Ministry of Education
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora	MoU	Memorandum of Understanding
CoL	Catalogue of Life	MOECAF	Ministry of Environmental Conservation and Forestry
CR	Critically Endangered	MoHT	Ministry of Hotels and Tourism
CTA	Classification Tree Analysis	MLFRD	Ministry of Livestock, Fisheries and Rural Development
DD	Data Deficient (IUCN Red List Category)	NBSAP	National Biodiversity Strategy and Action Plan
DEC	Department of Environmental Conservation	NGO	Non-Governmental Organization
DoF	Department of Fisheries	NOAA	National Oceanic and Atmosphere Administration
ECoSuisse	Europe Conservation Switzerland	NPOA	National Plan of Action
EEZ	Exclusive Economic Zone	NT	Near Threatened (IUCN Red List Category)
EIA	Environmental Impact Assessment	NWCD	Nature and Wildlife Conservation Division
EN	Endangered (IUCN Red List Category)	OBIS	Ocean Biogeographic Information System (OBIS)
FAO	Food and Agriculture Organization of the United Nations	OLI	Operational Land Imagery
FD	Forest Department	PADI	Professional Association of Diving Instructors
FREDA	Forest Resource Environment Development and Conservation Association	RCA	Rakhine Coastal Region Conservation Association
FFI	Fauna and Flora International	SEAFDEC	Southeast Asian Fisheries Development Center
GA	General Administration	SIA	Social Impact Assessment
HIA	Health Impact Assessment	SMA	Special Management Area
IOSEA	Indian Ocean and South-East Asian region	TED	Turtle Excluder Device
INGO	International Non-Governmental Organization	UNEP	United Nations Environment Programme
ITIS	Integrated Taxonomic Information System	UNDP	United Nations Development Programme
IUCN	International Union for the Conservation of Nature	USD	United States Dollar
IUU	Illegal, Unreported and Unregulated (fishing)	VCP	Village Consultation Process
JICA	Japan International Cooperation Agency	VU	Vulnerable (IUCN Red List Category)
KBA	Key Biodiversity Area	WoRMS	World Register of Marine Species
LC	Least Concern (IUCN Red List Category)	WCS	Wildlife Conservation Society
LIFT	Livelihoods and Food Security Trust Fund	WS	Wildlife Sanctuary
LNGO	Local Non-Governmental Organization		
MBCIV	Myanmar Biodiversity Conservation Investment Vision		

INTRODUCTION



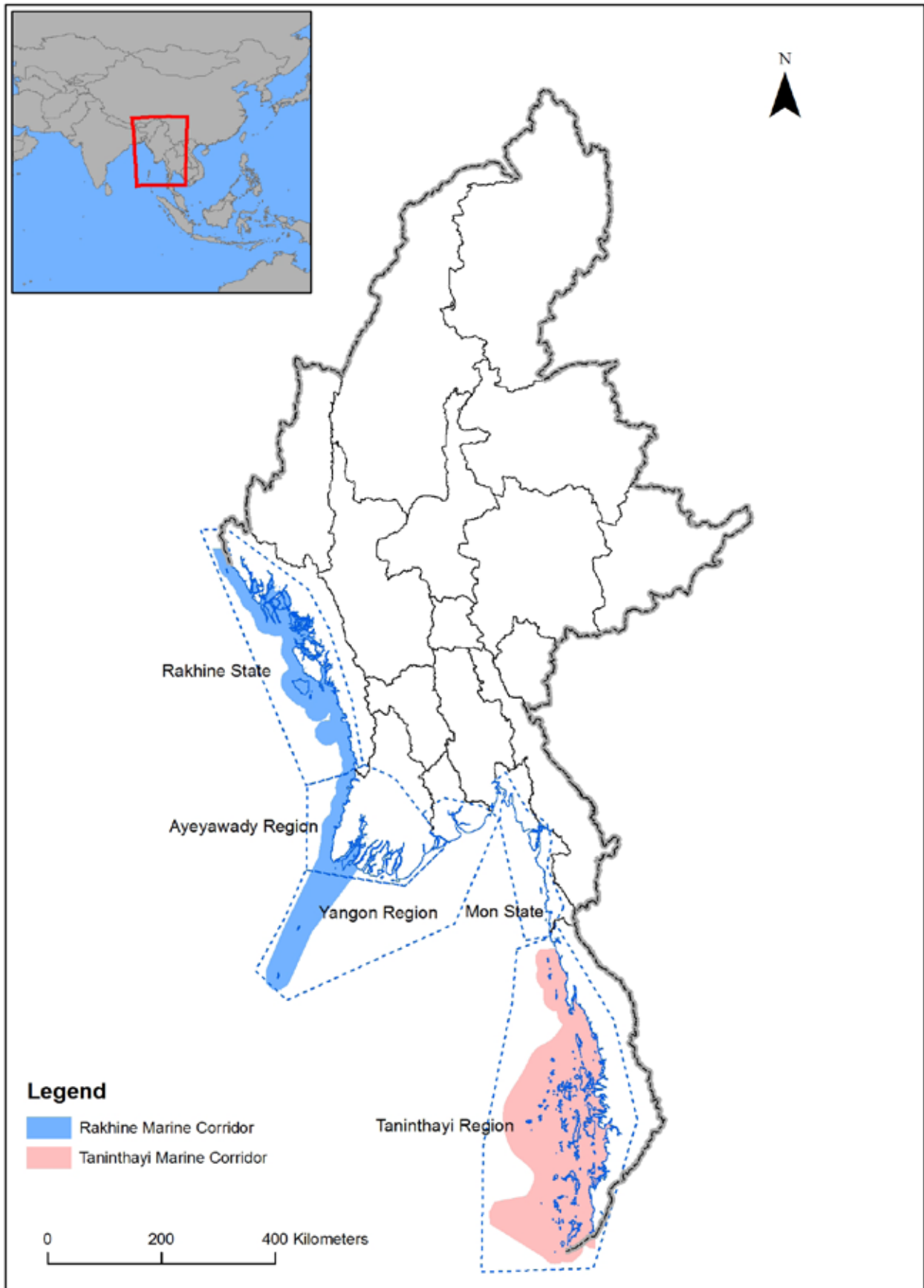


Figure 1. Priority marine Conservation Corridors as identified within the Myanmar Biodiversity Conservation Investment Vision. The Rakhine Marine Corridor in the north includes the coast of Rakhine State, the western coast of Ayeyawady Region and some isolated islands of Yangon Region. The Taninthayi Marine Corridor includes the coasts and islands of Taninthayi Region.



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Myanmar's main coastline of approximately 2400 km is, perhaps, the most intact coastline in all of mainland Southeast Asia. The three main coastal areas, from north to south, are the Rakhine Coast (from the mouth of the Naaf River in the very north of the country to Mawtin Point, about 740 km), the Ayeyawady Delta region (from Mawtin Point to the Gulf of Mottama, about 460 km) and the Taninthayi Coast (from the Gulf of Mottama to the mouth of the Pakchan River in the very south, about 1,200 km), plus the coastlines of more than 1700 islands. These waters are thought to harbor some of the world's most important marine biodiversity. Myanmar's nearshore areas and offshore islands provide habitat for populations of globally threatened marine turtles. In the northwest, vast seagrass beds and a large portion of Southeast Asia's remaining mangrove forest provide critical habitat for a range of species, while the southern waters of the Myeik Archipelago in the Taninthayi Region are noted for their rich coral reefs. Despite the presumed intact nature of the marine biodiversity in this area, few assessments have thus far been done to determine the status of marine species and habitats. Existing documentation on the current understanding of critical marine life and ecosystems in the country had yet to be consolidated. Fisheries provide the dominant live-

lihoods in many of these coastal regions, the extent and sustainability of which is unknown.

A workshop conducted by the Wildlife Conservation Society (WCS) in January 2012 identified the coastal areas of southern Taninthayi Region and a portion of the entire Rakhine Coast as important "Conservation Corridors" that encompass and link Key Biodiversity Areas (KBAs) (Wildlife Conservation Society, 2013) (Figure 1).

To understand the current state of marine resources in the country and to lay a foundation for future marine conservation activities, we compiled over 600 papers and reports describing studies that have been primarily conducted by Myanmar scientists on the country's marine biodiversity and habitats. In each of the two priority corridors we performed simple ecological assessments, habitat mapping, participatory mapping and stakeholder interviews. The habitat ground truthing contributed to the development of a GIS database focusing on the coastal habitats of Myanmar. We also conducted a stakeholder workshop to identify priorities for research and conservation activities. From this diverse set of data we have generated recommendations for future marine conservation activities in Myanmar.



ACTIVITIES



LITERATURE REVIEW

Throughout the early months of 2013 we visited several libraries and spoke with various researchers and government officials in an attempt to compile as many documents and studies, produced by researchers, that relate to the marine environment in Myanmar.

We targeted libraries at universities that have programmes that study marine systems, namely Yangon University, Dagon University, University of Mawlamyine, Patheingyi University and Myeik University with a focus on their Marine Science, Zoology, Botany and Chemistry departments. We also visited Diamond Jubilee Hall (also known as Sein Ya Tu Hall) of Yangon University. The building contains the national repository of Doctor of Philosophy theses. References found at universities include departmental reports and theses by candidates for Master of Research, Master of Science and Doctor of Philosophy degrees. Some government reports were collected from the Department of Fisheries (DoF). Various references were also shared with us through private libraries, such as that of U Tint Tun of the Marine Science Association, Myanmar (MSAM), which reflects many decades worth of study and collection. References were also found through intensive online searches. In most cases, these digitally available papers are reports for conferences and commissions and articles from peer-reviewed journals. Online libraries such as university libraries and the Online Burma/Myanmar Library were also consulted.

In many cases we knew of studies that have indeed been conducted but of which we were, unfortunately, unable to find copies. Often findings remain in the grey literature and, over the years, some documents have been misplaced or have been destroyed by mould or book-boring insect larvae.

All references have been catalogued within the newly created Myanmar Marine Reference Database, which is a searchable database. Most entries include an abstract plus keywords, species lists and location data, when available. This database will be shared with researchers in a digital form and available online. As rare copies of past research surface and new documents are written, the database can be updated.

The names and spellings of Myanmar's districts, villages and features, such as rivers and islands, have changed throughout modern history. In this report, we have attempted to use the modern, currently accepted names. When appropriate, we also include

the names as they occurred in the original reference in parentheses.

FIELD VISITS

In January and February 2013, small research teams visited Thandwe District of Rakhine State and the northern islands of the Myeik Archipelago in Taninthayi Region (Figures 2 and 3). Teams were composed of Myanmar biologists with a range of specialties in marine science including knowledge of fisheries, corals, sea cucumbers, seagrass and dugongs, as well as experience in conducting socio-economic interviews. A GIS expert also accompanied the team.

Together the team collected point data on habitats to inform the GIS data layers, a process known as ground truthing. These data were collected using two methods. A clear bottom bucket placed on the surface of the water allowed the team to clearly see the benthic community from the boat. By using the bucket along with a GPS unit and a depth sounder, the team could evaluate quickly the habitat type, provide a broad description and determine both depth and GPS position from the boat. This approach allowed for fast, broad sampling over large areas.

A slower, more meticulous approach involved using a 1m² quadrat made from plastic pipe and weighted to drop to the substrate. We chose areas to target for sampling, such as a large patch of a particular habitat and sampled along a transect line crossing the area, dropping the quadrat at a set number of fin kicks apart. At each sampling point we determined substrate type, dominant benthic cover, degree of coverage, depth and GPS position and took photos to check benthic coverage and make species identifications, where possible. We did not concentrate our efforts on detailed species collections since other researchers in Myanmar have already conducted intensive taxonomic studies of specific marine groups developing species lists. However, we did create species lists for various taxa seen and easily identified during the spot surveys as well as taxa caught by local fisheries.

Also, at both locales, semi-structured and informal surveys were made of various stakeholders.

SPECIES LISTS

Nomenclature, Species

Certain fields of biological study involve describing, naming and classifying species. As more is learned about species through taxonomic and genetic studies, species are often renamed and reclassified. In this report, wherever possible, we have used the currently accepted name for a species, often alongside the original name that was used when recorded by a scientist within Myanmar. We have referred to reputable online resources as our source for the up-to-date consensus on currently accepted names for various taxa: FishBase for all fish names; Algae-Base for all algae names; the IUCN Red List for the marine species listed there; the Food and Agriculture Organization (FAO) website for other target marine fisheries; and the Catalogue of Life (CoL), the Ocean Biogeographic Information System (OBIS), the World Register of Marine Species (WoRMS) and the Integrated Taxonomic Information System (ITIS) for all other marine taxa.

BOX 1 | IUCN Red List Categories v. 2013-1

EX	EXTINCT
There is no doubt that the last individual in the taxon (a species or group of species) has died.	
EW	EXTINCT IN THE WILD
The only living individuals in the taxon are living in captivity or were born in captivity.	
CR	CRITICALLY ENDANGERED
Evidence shows that the taxon has an extremely high risk of extinction in the wild.	
EN	ENDANGERED
Evidence shows that the taxon has a very high risk of extinction in the wild.	
VU	VULNERABLE
Evidence shows that the taxon has a high risk of extinction in the wild.	
NT	NEAR THREATENED
The taxon is not in a threatened category, but is likely to move into a threatened category in the near future.	
LC	LEAST CONCERN
The taxon is not in a threatened category. It is widespread and abundant.	
DD	DATA DEFICIENT
The taxon has been well studied, but there is not enough information about its distribution and population.	
NE	NOT EVALUATED
The taxon has not been studied to decide which category it belongs to.	

IUCN Red List

The International Union for Conservation of Nature (IUCN) maintains a comprehensive list of the conservation status of threatened animal and plant species called the IUCN Red List of Threatened Species. Each species on the list is classified under one of eight categories according to its status, trends and extinction risk. The Red List has become the international standard for species extinction risk and is used by numerous governmental and non-governmental organisations. We report on the IUCN Red List Categories for species in this report based on version 2013-1.

In this report, we leave the designation blank if a species has not yet been assessed for the IUCN Red List.

Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The Convention protects roughly 5,000 species of animals and 29,000 species of plants from over-exploitation through international trade. The species are listed under three CITES appendices according to how threatened they are by international trade. They include some whole groups (such as primates, cetaceans, marine turtles, parrots, corals and orchids) but, in certain other cases, include only a species, a subspecies or a geographic population. CITES operates through subjecting international trade in selected species to certain controls. All imports, exports, re-exports and introductions of species covered by the Convention need to be authorized through a licensing system. Each Party to the Convention must designate a Management Authority in charge of administering that licensing system and one or more Scientific Authorities to advise them on the effects of trade on the status of the species. Myanmar became a party to CITES in 1997.

In terms of the marine environment, CITES classifications have been made for cetaceans (dolphins and whales), dugongs, birds, marine turtles, the saltwater crocodile, sharks and rays, sawfish, seahorses, the Humphead wrasse, giant clams, certain cephalopods, black coral and hard corals (Convention on the International Trade in Endangered Species, Web page). When possible, we report the CITES category for a species and list the most conservative category listed.

Species Occurrence in Myanmar

For this report, the occurrence of a species in Myanmar is classified as “confirmed” when we

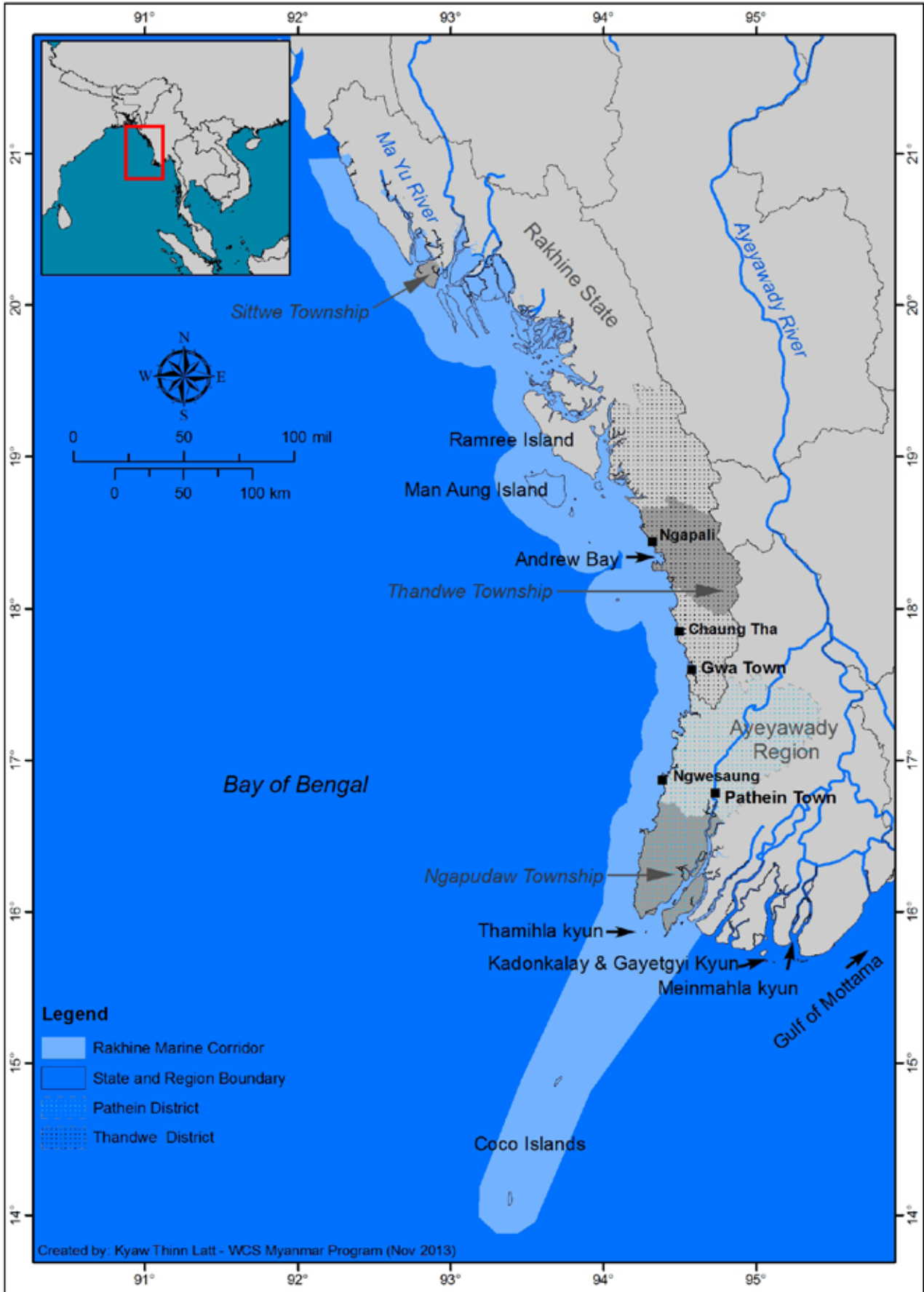


Figure 2. Villages, townships, islands and geographic features of the Rakhine Coast and Ayeyawady Delta that are mentioned in this report.

BOX 2 | CITES Categories

Appendix I Species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances.

Appendix II Species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival.

Appendix III Species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade.

can be confident in the identification. For mammals, “confirmed” is used when researchers have been able to make an unambiguous diagnosis through notes from live sightings, photographs, or the examination of skeletal remains. For other taxa where samples can be more easily collected for examination, “confirmed” is used when a researcher has reported a species and its known distribution includes Myanmar.

“Probable” is assigned to a species that is considered likely to be in Myanmar based on its known global distribution pattern. For mammals, there might be unconfirmed local reports, but not a known, confirmed sighting. For other taxa, the distribution includes Myanmar but we do not know of a record for the species, or the distribution shows that the species has been reported in nearby waters and a researcher has reported it in the country. Deeper reviews of collections, theses and publications would be able to confirm some species identifications and elevate their classification from “probable” to “confirmed”.

“Possible” is assigned to species where there is some uncertainty whether it occurs in the area. The species might in fact have been reported by a researcher in Myanmar but the current known distribution does not include the country or nearby waters. This discrepancy can be a result of changing knowledge with time and improving identification resources. For example, some older guidebooks do not differentiate the Common bottlenose from the Indo-Pacific bottlenose dolphin but there is now a better understanding of the divergence of these two similar mammals. Recent surveys have only encountered the Indo-Pacific dolphin so earlier sightings of the Common dolphin are, perhaps, questionable.

Species that have been identified in Myanmar but are not reported in the region by authoritative sources such as CoL, OBIS, WoRMS, the FAO, FishBase, AlgaeBase and the IUCN Red List are reported as “unlikely” or are simply not included in the species

lists in this report.

These lists are similar in content with those in the Myanmar Biodiversity Investment Vision’s lists of Myanmar’s IUCN Red Listed species (Wildlife Conservation Society, 2013), although they also include additional species that are not on the IUCN Red List.

STAKEHOLDER WORKSHOP

On 7 June 2013, we held a stakeholder workshop titled “Marine Biodiversity and Conservation for the Sustainable Development of Taninthayi” at the Myeik Hotel in Myeik. The workshop aimed to identify the priorities for research, protection and sustainable development of Myanmar’s rich coastal resources. The meeting brought together a wide range of stakeholders including university faculty, retired academics, students, INGOs, LNGOS and government officials from the FD, the DEC, the DoF and the Navy. Fifty-six invitees attended along with many students and academics of Myeik University. See Appendix 20.

Opening remarks were given by U Tin Soe (Minister for Forest and Mines, Taninthayi Region Government), U Mya Than Tun (DoF) and U Than Myint (WCS Myanmar). Presentations by Ms. Katherine Holmes (WCS), Dr. Nang Mya Han (Myeik University), U Mya Than Tun (DoF) and U Tint Tun (MSAM) provided pertinent background information.

BOX 3 | Questions discussed in the breakout sessions of 20-40 persons:

- What are the priorities for future marine research?
- What are the priorities for protection in the marine realm?
- What are the priorities for sustainable development?

TOURISM SURVEY

Starting in late February 2013, we conducted surveys of SCUBA diving tourists and dive guides who were based out of Ranong (Figure 3) and were diving in Myanmar. Through this process, we determined what dive tourists value most on their dive trips. We reasoned that some of this information might be of use to the Myanmar government as the country now looks to develop eco-tourism ventures.

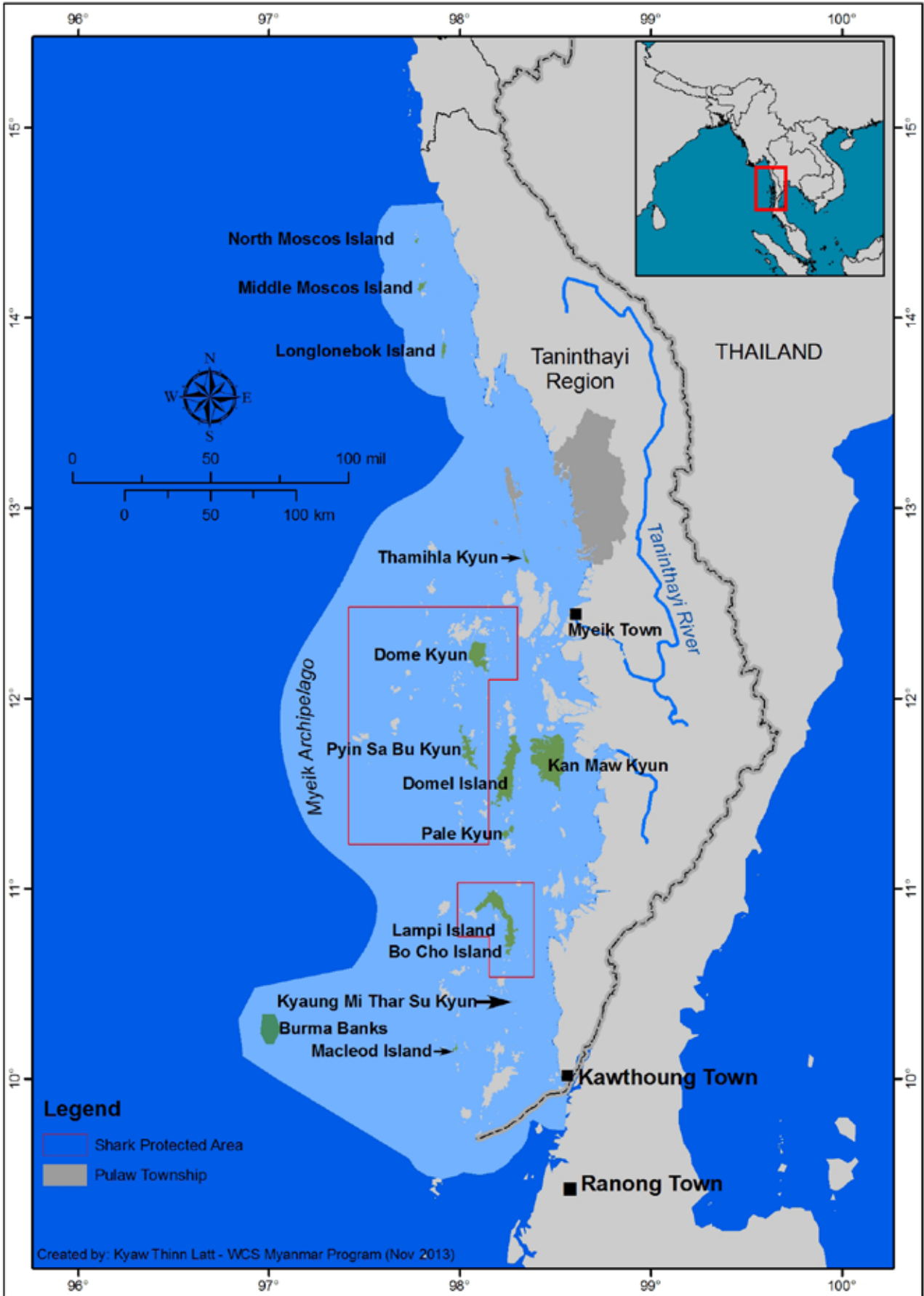


Figure 3. Villages, townships, islands and geographic features of the Taninthayi Marine Corridor and nearby areas that are mentioned in this report.

The information could also help guide the government in marketing and development decisions.

Also, these tourists and dive guides visit areas of Myanmar not easily accessible to local researchers for study. Their observations therefore provide, for example, a useful snapshot on aspects of southern Myeik archipelago's reef health and major stressors. And, through interviewing dive guides who have visited Myanmar for up to seven dive seasons and as far back as 2005, we could learn what changes they have observed over time.

Two standardized questionnaires were developed to target tourists and dive guides who were diving in Myanmar's Myeik Archipelago in early 2013. Surveys contained a variety of question styles to allow for clear analyses of data as well as opportunities for less-directed answers through open-ended questions. Surveys were carried out on diving boats and on land in Ranong, Ko Chang and Ko Phayam, Thailand. One survey was also administered in Myanmar to a dive guide at Macleod Island in the Myeik Archipelago (Figure 3).

The survey was undertaken with guides and tourists from three Ranong-based dive companies: A-One which is Thai-owned, Smiling Seahorse which is owned by a French couple and Aladdin Dive Safari which is owned by a German man and Dutch woman. A fourth Ranong-based company, Andaman International Dive Center, was not included in the survey efforts. It was, however, included in calculations on tourist numbers. Dive operations in Phuket also enter Myanmar waters, though less frequently. We were unable to include these companies in this study. These operations include Santana Diving, Sunrise Divers, MV Sai Mai, as well as private charter boats.

HABITAT MAPPING THROUGH REMOTE SENSING

Initially we accessed global data sources available online through the UNDP's World Conservation Monitoring Centre including the 2010 Global Distribution of Coral Reefs (IMaRS-USF & IRD, 2005a, b; UNEP-WCMC *et al.*, 2010), the 2011 Global Distribution of Mangroves USGS (Giri *et al.*, 2011a), and the 2005 Global Distribution of Seagrasses (Short, 2005). These data are informative on a global scale but are too coarse for local-level analyses. For example, the 2005 Global Distribution of Seagrasses (Short, 2005) includes only large areas of seagrass and misses many of the small and medium patches of seagrass habitat in the country; Lampi Island's

largest seagrass meadow of 28 ha was not revealed by their image analyses and does not appear within the dataset.

We visited two areas in the country — Thandwe District in the Rakhine Coast and the northern islands of the Myeik Archipelago of the Taninthayi Coast (Figures 2 and 3) — where we collected data through habitat surveys that could be used in training site development for habitat mapping.

A number of satellite images and vector datasets were used to generate finer-scale habitat maps for this review. The most important was Landsat 8's Operational Land Imager (OLI) imagery. This dataset consists of nine spectral bands with a spatial resolution of 30 meters for bands 1 to 7 and 9, and has a new band 1 (coastal blue) useful for coastal and aerosol studies. Our mapping used thirteen Landsat 8 OLI tiles captured during January and February of 2014 covering the Rakhine and Taninthayi Marine Corridors. This time period matches the season during which our in situ data were collected. In addition to this field data, a second set of observations by Tint Tun & Bendell (2010) were used. These data were collected in 2008 along the coasts of Lampi Island and neighboring islands in the southern portion of the Taninthayi Marine Corridor (Tint Tun & Bendell, 2010). These two datasets were used for training site development.

In preparation for image analysis, the Landsat imagery was radiometrically corrected, a process that converts the raw information captured by the sensor into interpretable values corresponding to elements on the ground. Since both marine corridors have a heterogeneous seascape due to variations in water quality, bathymetry, substrate type, and habitat composition, each was divided into six distinct study areas in a north-south fashion in order to capture the wide variation in habitat composition found in this direction. Land area in the imagery was identified and removed from analysis using a band combination of the red (band 4), near-infrared (NIR) (band 5), and short-waved infrared (SWIR) (band 6).

The training sites for seagrass, coral reefs and other marine habitats were developed separately for each study area based on either available field data or visual exploration using publicly available high resolution imagery from Google Earth and Flash Earth as well as Landsat band combinations. The false color composite with coastal blue (band 1), red (band 4) and NIR (band 5) bands was determined to be the best band combination for training site development to differentiate submerged habitats. Plots of the training sites' spectral signatures were analyzed

and compared to each other and with true signatures from the literature (Guild *et al.*, 2003; Maheswari, 2013).

Among the different classification methods tested, the Classification Tree Analysis (CTA) was determined to be the most accurate. CTA is a powerful classification method due to the transparent and intuitive nature of its method and results. It is also a non-parametric classifier meaning it is ideal for non-normally distributed data such as coral and seagrass habitats. Landsat bands 1 - 5 were used as input to the CTA. The resulting classification was contextually edited based on knowledge of the study area and the habitats' biophysical characteristics. Two decision rules were defined for the contextual editing, (a) redefining improbable classes and (b) filtering to remove isolated instances of habitats.

The resulting classification tree indicated that Landsat 8 OLI's coastal blue band (band 1) was influential in the classification process and provides an additional level of spectral separability compared to earlier Landsat sensors.

Classifying marine habitats in the Taninthayi and Rakhine Marine Corridors presented similar difficulties including signal obstruction by suspended sediment and atmospheric conditions, limited classi-

fiability area, spatial resolution of the data, and spectral separability of the classes. The marine habitat in both corridors was heavily obstructed by suspended sediment and to a lesser extent, clouds and haze. In order to control for the presence of suspended sediment, a separate class was identified in the satellite imagery. In the case of clouds and haze, these areas were identified in the classification process and combined with the water class since they were solely present over deeper areas of water where no seagrass or coral could be identified. Classification was also hindered by natural light attenuation in water, which leads to seagrass and coral being indistinguishable from other habitat beyond depths of 15 m (Mumby & Edwards, 2002; Wabnitz *et al.*, 2008). This difficulty was controlled for by developing classification training sites along the depth gradient. It is important to note that this depth limitation as well as signal obstruction create a limited classifiable area. This may account for under estimation of coral reefs and seagrass beds in our classification. Although highly valuable, the Landsat 8 OLI spectral and spatial resolution present difficulty in that multiple classes may be present in a single 30 m² pixel and habitats may be spectrally indistinguishable using the 6 visible and infrared bands. Despite the thorough visual validation included in the study, this can result in confusion among classified habitats.



FINDINGS



SCIENTIFIC RESEARCH

The earliest published treatises on Myanmar's natural history were written by Francis Mason, a missionary and naturalist who moved to Dawei (Tavoy) in 1830 where he oversaw a training college for local preachers. His extensive review of the region's flora and fauna was first published in 1852 (Mason, 1852) and was followed by an improved second edition (Mason, 1860) and a posthumous, expanded third edition (Mason, 1882). John Anderson was a curator and then superintendent of the Indian Museum in Calcutta who, starting in 1864, made collection expeditions to the Myeik (Mergui) Archipelago (Duncan *et al.*, 1889a, b) and upper Burma (Anderson, 1878). He, along with a team of naturalists, conducted comparative studies on the anatomies of many taxa found in the region. The books published by these two naturalists recorded foundational knowledge on the biodiversity of Myanmar and included various marine species.

Modern scientific research of Myanmar's marine resources is richer than many may have realized. Thus far WCS and MSAM have been able to collect over 600 references, including 348 theses, relating to Myanmar's marine resources that cover an expansive range of taxa and topics. We have abstracts for more than 95% of these and full text for more than a third of the references. Much of the information is not easily accessible since the unpublished reports and theses by masters and PhD students are housed in under-resourced university libraries.

Meanwhile, the main sources of government-collected information on marine resources are reports in both English and Myanmar language that are often difficult to locate. Many government officers now share their information outside of their institutions through presentations at meetings and workshops. Increasingly, digital forms of these presentations are being distributed as an effective way to share findings.

The Myanmar Academy of Arts and Science, created in 1999 under the Ministry of Education, is a valued national organisation for nurturing research in the natural and social sciences. It is comprised of experts from across a range of academic fields. The academy conducts seminars every two years and publishes the Journal of the Myanmar Academy of Arts and

Science (Myanmar's Ministry of Education website). Prior to this, the country conducted yearly meetings as the Burma Research Congress. Many of the papers presented at these meetings include the foundational studies of Myanmar's marine life. Some universities also produce self-published journals, such as the Myeik University Research Journal, where their researchers can publish their work.

Unfortunately, digital versions of many volumes of these journals are not yet easily accessible online for the international community. Due to strong restrictions over the past few decades, few Myanmar scientists have been able to publish their work in peer-reviewed international journals. These problems have effectively limited meaningful dialogue with the wider, scientific community. This, along with funding and other restrictions, has influenced negatively the nature and scope of the marine research conducted in the country. We were able to find less than 70 articles in international journals that focused on aspects of marine life of Myanmar.

Students have favoured studies that focus on nearshore habitats that are easily accessible such as mangroves (11% of theses) over those habitats that require greater finances and technical skills for study such as coral reefs (3% of theses). They have also tended to focus their studies on lab-based descriptive work, specifically anatomy, histology and morphology (31% of theses) and taxonomy and systematics (18% of theses). They have also concentrated on local-level inventories of species of various taxa (19% of theses). Research that requires expensive laboratory equipment and supplies has not been conducted in the county; for example, not one thesis abstract, including taxonomic studies, incorporated genetics.

Broader-scale concepts such as ecology (9%), conservation (4%) and management (2%) may be touched on within some theses but are only rarely focal points. Review-type publications on various marine and conservation issues appear in peer-reviewed international journals and often are co-authored by foreign researchers in collaboration with local scientists. Over 25% of these journal articles explicitly mention conservation in their abstracts reflecting on the part of the international community a high level of capacity or interest in marine research

relating specifically to conservation. The interest in conservation as a topic of study is growing locally as expressed in the discussions held with university academics and students of marine science during this review and as reflected by scientists' growing attention to the intersection of their respective areas of biological study with conservation issues. Examples of the latter case are Nang Mya Han's (2009b, 2011a, b) reviews of management issues in the Myeik Archipelago. Also, researchers are increasingly able to attend regional conferences that focus on the identification, monitoring and conservation of particular taxa that receive high conservation attention such as sharks, marine turtles, cetaceans, sea grasses, corals and mangroves.

University department heads and lecturers consistently express a need for improved capacity allowing for broader research. They suggest that working with foreign researchers will allow for capacity build-

ing and that increased resources will allow them to expand the nature of their research and be more engaged in international scientific dialogue (Rector Dr. Htay Aung, Dr. Khim Maung Swe and Dr. Maung Maung Gyi, *pers. comm.*).

One possible facilitating body for this could be a Marine and Coastal Resources Research Centre. Myanmar's National Biodiversity Strategy and Action Plan (2011) included establishing such a centre among the activities within its "Five-year Action Plan Toward Sustainable Management of Coastal, Marine and Island Ecosystems" and university academics are strong proponents of the idea (Dr. Nang Mya Han, *pers. comm.*). To our knowledge, no formal plans have yet been drawn up for this centre.

MARINE HABITATS

With a coastline of 2400 km plus numerous offshore islands and several large estuarine, delta systems, Myanmar possesses a diversity of coastal habitats including coral reefs, mangroves, mud flats and sandy beaches.

MANGROVES

Extensive mangroves exist on the soft shores where major rivers meet the coast. These rivers include the Ayeyawady, Sittaung and Salween in the Ayeyawady Delta and Gulf of Mottama. Along the Rakhine and Taninthayi Coasts there are smaller but still significant areas of mangroves. Within Southeast Asia and the Pacific, Myanmar had the fourth-largest expanse of mangroves after Malaysia, Bangladesh and Papua New Guinea (Ohn, 1992).

Myanmar's mangrove ecosystems are considered part of the Indo-Pacific plant region and share many of the same species with other countries of the region. The main families of mangroves of Myanmar include Avicenniaceae, Combretaceae, Euphorbiaceae, Rhizophoraceae, Sonneratiaceae and Sterculiaceae. The type of mangrove forest is

controlled by the frequency, duration and depth of inundation by water as well as by salinity levels (Nay Win Oo, 2004). There are some differences in species distributions and compositions between mangroves of the three major coastal areas (see Appendix 1). *Rhizophora* spp. are more abundant in Taninthayi's mangrove stands and *Avicennia latana* is found only in the Taninthayi Region (Kyaw Tint *et al.*, 2012a).

Mangroves are the most studied marine system in the country. Forty-one theses were identified during the literature review for this report and dozens of studies and reports on the state of Myanmar's mangroves, often with a particular focus on the Ayeyawady Delta region, are widely available online (Food and Agriculture Organization, Web page-d).

Estimates on mangrove cover have varied between sources based on different approaches, time frames, and data used in their calculations (Hexacorallians of the World, Web page; Maung Maung Kyaw, 2012; National Biodiversity Strategy and Action Plan, 2011; Platt *et al.*, 2014). Authors of this report have classified mangrove cover for the two priority marine corridors through remote sensing based on the most recent Landsat 8 data, as summarized in the Rakhine and Taninthayi Marine Corridor sections.



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Mangroves are often removed along coastal areas to improve access to the ocean. In this area of Chaung Tha, fish drying tables are interspersed with a few remaining mangrove trees. Homes along the coast will not be adequately protected by this stand during a storm surge.

Despite the differences in area calculations, it is clear that Myanmar's mangrove forests have been considerably depleted and degraded over the last few decades from charcoal production, agricultural expansion and conversion to fishponds, shrimp ponds and rice paddies (Aye Aye Min, 2011; Hnin Khaing Aye, 2006, 2007; Ohn Mar Myat Oo, 2008; Thanda Win, 2011). Spatial analysis of forest cover change revealed that mangroves are experiencing some of the highest rates of habitat loss in the country with 20% loss of mangrove habitat in the Ayeyawady over ten years between 1990 and 2000 (Leimgruber *et al.*, 2005). A review of encroachment into original mangrove areas as of 2010 by Maung Maung Kyaw (2012) is summarized in Table 1. In the Ayeyawady Region, a striking 92% of the mangrove forests has been affected across all forms of encroachment. Rakhine has lost 42%. Taninthayi's mangroves have fared better, losing only 2.5% (Kyaw Tint *et al.*, 2012a). However this final statistic may be questionable since it varies from data presented through the BOBLME project, which states that Taninthayi mangroves are experiencing a decline of 2.5% per

annum rather than total area loss of 2.5% as of 2010 (Angell, 2004).

Where mangroves still form contiguous cover, there may be enough potential for natural regeneration and recovery, but this would require protection from further encroachment and fragmentation. In other areas, replanting methods would need to be used to encourage any recovery as part of a management plan. Mangroves protect riverbanks from erosion and coastal areas from the impacts of major storms. Reforestation has taken place with local mangrove species such as *Avicennia officinalis* and *Sonneratia apetala* along vulnerable riverbanks.

The mangroves of the Ayeyawady were also devastated by Cyclone Nargis in May 2008, which damaged 80% of natural mangrove forests as surveyed by the FD. Natural regeneration has been high, and recommendations were made to reforest the coastal strip and prevent further conversion (Kyaw Tint *et al.*, 2012a). In particular, the FD recommended that a coastal strip of about five miles wide be replanted

Table 1. Encroachment of mangrove forests in Myanmar as of 2010. Source: Kyaw Tint *et al.* (2012a), adapted from a publication by Maung Maung Kyaw (2012).

State/Region	Original mangrove area (ha)	Encroachments in mangrove stands (ha)			Remaining mangrove area (ha)
		Agriculture	Fisheries and Others	Total	
Rakhine State	167,483	22,269	47,695	69,964	97,519
Ayeyawady Region	296,448	107,615	163,985	271,600	24,848
Taninthayi Region	195,103	3,600	1,426	5,026	190,077
Total	659,034	133,484	213,106	346,590	312,444

and protected from future conversion and that trees be planted within 100 m on either sides of large streams to minimize bank erosion and protect coastal dwellers from strong winds and waves (Kyaw Tint *et al.*, 2012b).

The FD has reacted to this loss of mangrove through implementing mangrove management projects (see Table 2). Around the 1990s, returning control of management rights and responsibilities for village forests to the villages became seen as important by Myanmar's policy makers and, in 1995, the FD initiated their Community Forestry Instruction, which promotes the use of community forestry approaches (Kyaw Tint *et al.*, 2011). In recent years, the FD has been applying their Integrated Management Approach that aims to integrate ecosystem conservation with development needs through raising conservation awareness while rehabilitating degraded habitats (Ei Thandar Bol, 2013).

In the Ayeyawady Delta the "Integrated Mangrove Rehabilitation Project through Community Participation" started in 2007 in cooperation with JICA and is working to establish community forestry, create research plantations and construct nursery centres. By 2011, the project had established 537 ha of

research mangrove plantations and 284 ha of community forests as well as constructed four extension centres across four forest reserves, established an agro-forestry project and piloted an oyster farming initiative.

In Rakhine State, the "Sustainable Community-based Mangrove Management in Wunbaik Reserve Forest" project, working in cooperation with the FAO, has conducted socio-economic and fishery resource surveys, workshops and training sessions in order to integrate mangrove ecosystem development with community development (Ei Thandar Bol, 2013). In addition, degraded mangrove forests are being replanted and Community Forests established by the local NGOs BANCA and MERN in Kyaukphyu and Thandwe Districts of the Rakhine Coast (Kyaw Tint *et al.*, 2012a).

The FD will soon be establishing a Mangrove Conservation Division (Forestry Department, *pers. comm.*).

Myanmar's known species of woody mangroves are summarized in Appendix 1.

Table 2. Establishment of mangrove forest plantations in recent years. Source: Ei Thandar Bol (2013).

Year	Rakhine	Ayeyawady	Taninthayi	Total
2009-2010	400	3,000	0	3,400
2010-2011	15	2,450	100	2,565
2011-2012	200	1,500	0	1,700
Total	615	6,950	100	7,665

CORAL REEFS

Coral reefs are among the most biodiverse systems in the world and are threatened worldwide. A global analysis conducted by Reefs at Risk determined that, as of 2011, globally, 36% of all reefs are classified as threatened by overexploitation, 30% by coastal development, 22% by inland pollution and erosion and 12% by marine pollution. When these threats are combined, 58% of the world's reefs are at risk (Burke *et al.*, 2011).

The reefs of Myanmar have not been well studied and, as such, the species diversity and health of these systems are poorly known. The main structural animals, corals, and some of the plants and animals that live on reefs during some portion of their lifecycles (fish, marine turtles, crustaceans, molluscs, sea-

weeds, etc.) are discussed in the sections below.

Coral reefs are well developed around the islands of the Myeik Archipelago and the Burma Banks of the Taninthayi Coast (Figure 3). Fringing reefs surround the islands and species composition can vary dramatically between sites, with certain sites maintaining dominant species that capitalize on species-specific preferences relating to water clarity, depth and exposure. In the Burma Banks, reefs form close to the edge of islands with steeply pitched walls, in between small chains of islands and on submerged pinnacles (K. Holmes, *pers. obs.*). Along the Rakhine Coast, reefs are less developed and often consist of small patches of corals growing directly on rocky bottom substrate (K. Holmes, *pers. obs.*). Reefs in the Ayeyawady Region are restricted to the offshore islands of Coco and Preparis (Figure 2) that are suf-

ficiently removed from the high sediment loads from the delta.

Coral reefs support rich communities of reef fish and invertebrates and are highly valued by tourists. As such, reefs are vitally important for sustaining local fisheries and may become increasingly important for Myanmar as tourism develops, in particular within the Myeik Archipelago.

Coral bleaching occurs when environmental stressors cause corals to eject the symbiotic algae living in their tissues. Without these algae, corals turn white and, if the algae aren't reabsorbed from the surrounding water in the near-term, the corals will die. Bleached corals were seen on the reefs of the Myeik Archipelago in 2013 by research divers (U Zau Lunn, *pers. comm.*), SCUBA divers (tourism survey, Appendix 18) and researchers of this study. The degree and distribution of bleaching have not yet been adequately assessed but it appears that this is a widespread and very concerning issue facing the reefs of southern Myanmar. There are a range of triggers that can cause corals to bleach including increased water temperatures, pollution and disease. It is not yet known what is causing reefs in southern Myanmar to bleach.

Myanmar's reefs are also threatened by blast fishing, a simple and destructive fishing method that uses explosives to blow up areas of reef. In addition to killing a few target fish, this method generates tremendous bycatch by killing all other animals in the reef area and destroys reef structures that can take years to recover, if at all. BANCA and FFI staff noted extensive damage from dynamite fishing during reef surveys in northern Myeik Archipelago (U Zau

Lunn, *pers. comm.*), as did SCUBA divers in southern Myeik Archipelago (tourism survey, Appendix 18).

Reefs are also damaged by trawling operations that illegally enter into restricted areas too close to shore. Strict guidelines prohibit the use of mechanized fishing gear within five nautical miles of the Rakhine Coast and ten nautical miles of the Ayeyawady Delta and Taninthayi Coasts. Even so, trawlers still sometimes operate too close to shore, dragging reefs and seagrass beds, destroying these habitats (Aung Hlaing Win & Maung Maung Lwin, 2011).

Corals are also harvested, cleaned and dried for sale in the curios trade. Corals are CITES-protected (Appendix II) which means that their international trade is controlled. It is illegal for foreign tourists to carry coral products out of Myanmar and into another CITES-signatory country without special permission. Most tourist shops and tourists are unaware of these laws and the impacts the coral trade has on healthy reefs.

An additional threat to reefs was noticed during the course of this study. The relatively isolated reefs of the Burma Banks are covered with large patches of a species of colonial invertebrate called a coral-limorph, which was possibly *Rhodactis howesii*. The presence of these invertebrates indicate that these reefs are likely going through a phase shift in which the dominant organisms (corals) are being replaced by another set of organisms resulting in degradation of the habitat. We cannot be certain of what is causing this shift but various reasons have been proposed for similar shifts, including increased human disturbance, pollution or reductions, through overfishing,



Coral skeletons, along with shells, are cleaned, dried and sold to visitors at tourist destinations such as Chaung Tha Beach.

in coral reef organisms that serve a major ecological function. At Palmyra, an atoll in the Pacific, disturbances caused by a shipwreck resulted in an extensive *R. howesii* invasion (Work *et al.*, 2008). It is possible that these invasions in Myanmar result from either anchor damage from fishing and dive boats or from overfishing of grazing fish. This report is the first to note the prevalence of this organism on these reefs.

There are no protection measures specific to coral reefs in Myanmar. There are three marine conservation areas in the country that encompass coral reefs within their area. The Thamihla Kyun Wildlife Sanctuary is off the Ayeyawady Coast and two others (the

Moscov Islands Wildlife Sanctuary and the Lampi Marine National Park) are on the Taninthayi Coast (Figure 6). However these areas have few, if any, reef conservation protection measures in place to make any impact on reef conservation. Another wildlife sanctuary, the Meinmahla Kyun Wildlife Sanctuary in the Ayeyawady, is in a low, flat delta area that is not able to support healthy reef communities.

The various species of fish, algae, and invertebrates (including corals) that inhabit Myanmar's reefs are described in subsequent sections of this report.

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Invasive corallimorphs carpet areas of reef in the southern Myeik Archipelago.

SEAGRASS BEDS

Seagrass beds form important roles in tropical coastal ecology. The beds are a key habitat for certain life phases of many species of fish. In particular, they are often the nursery grounds for various juvenile fish that shift to other marine habitats as they develop. The beds are also feeding grounds for invertebrates, marine turtles and dugongs. And their root-like stems stabilize the sea bottom.

Some limited research attention has been given to Myanmar's seagrasses. At least five theses dedicated to nearshore seagrasses have been completed and additional studies focusing on their consumers, such as dugongs and marine turtles, have documented their distribution and importance (Ilangakoon, 2007; Tint Tun, 2011; Tint Tun *et al.*, 2009). Seagrass beds of varying sizes are found along the Rakhine and Taninthayi Coasts. None are found off the Ayeyawady Delta and Mottama regions where the water is too turbid from the enormous sediment discharges from

river systems (Soe Htun *et al.*, 2001). Recent studies in the Southeast Asia region are now attempting to understand better the drivers that govern their presence in the different regions where they occur, including estuaries, back-reefs and the poorly-studied fore-reef and deeper water areas (Ooi *et al.*, 2011).

The largest seagrass meadow by Lampi Island was estimated to be 28 ha, and dugongs have left their marks of clearly-defined feeding trails in dense patches of *Halophila ovalis* (Tint Tun & Bendell, 2010).

Species composition differs slightly between the two regions. The family Hydrocharitaceae includes the most dominant genera (*Halophila*) of both coastal regions and the family Cymodoceaceae (genera *Halodule* and *Syringodium*) is more common on the Rakhine Coast (Soe Htun *et al.*, 2001). It has been reported that *Cymodocea rotundata* occurs only on the Taninthayi Coast (Soe Htun *et al.*, 2009b) but two recent studies have also encountered it in the Magyi

area of the Rakhine Coast (Thaung Htut, 2011; Win Yadana Htay, 2010). Similarly, *Cymodocea serrulata* had only been documented on the Rakhine Coast (Soe Htun *et al.*, 2009b) but studies around Lampi Island of the Taninthayi Coast (Figure 3) have now documented it there as well (Tint Tun & Bendell, 2010). Another species, *Halophila minor*, has thus far only been documented in studies around Lampi Island (Beffasti, 2010) but its currently known global distribution does not extend into Myanmar (IUCN, Web page; Soe Htun *et al.*, 2009b). Further confirmation or additional documentation might firmly establish its validity on the list of Myanmar species. See Appendix 3 for a list of seagrasses encountered in Myanmar.

The seagrass beds of other ASEAN countries have been disturbed or destroyed for a wide range of development-related activities including creation of aquaculture ponds, salt production, ports, urban development, mining, waste disposal and recreation. Various actions have been taken by authorities and NGOs to slow this destruction and mapping is now being used to inform management.

Seagrasses are unable to thrive in areas where sediment and nutrient loads are so high that they impact water clarity, attenuating light below levels needed for seagrass growth and survival (Boer, 2007). In Myanmar, seagrasses are unable to establish in the Ayeyawady Delta due to the high sediment loads entering from the river systems. In the other coastal areas, there are few natural stressors and Soe Htun *et al.* (2009b) have reported that much of the seagrass areas have remained in near-pristine, climax conditions. In contradiction, some other local experts in recent years have reported that seagrass beds have been severely disturbed along Myanmar's coast. Researchers have noted the increased prevalence of "baby trawlers", especially after the loosening of enforcement on their inshore use following Cyclone Nargis in 2008. These operations undoubtedly damage seagrass beds as ocean floor is scraped for shrimp but the degree of these impacts has not yet been evaluated. Mining activities near coasts or estuaries may also be a major threat to sensitive seagrasses through increased sediment loads.

Soe Htun *et al.* (2009b) have suggested that areas of seagrass beds dominated by *Cymodocea serrulata* in the Rakhine and *Cymodocea rotundata* of the Taninthayi coastal regions should be assigned conservation status due to their uniqueness within the country.

MUD FLATS

Intertidal mudflats can be closely associated with mangroves and are often found alongside mangrove stands. In areas that are particularly dynamic, such as the Gulf of Mottama (Figure 2), turbulence and turbidity create areas of shifting sand and mud flats where mangroves are unable to take root.

The mudflats of Myanmar have not yet been well studied or documented. We were able to find only three theses that studied mudflat communities directly, though there are likely more to be found and new efforts to map mudflats are underway by NGOs such as FFI. Tun Tun Zaw (2012) characterized the sediments of the mud flats found at and near the shorelines of the Thanlwin River mouth.

These habitats support a rich species of invertebrates [such as the polychaetes studied by Si Thu Hein (2011)], all of which form the prey base for birds. As such, mudflats are of particular importance for shorebirds that use them as feeding and roosting areas over their migration routes. Among water birds in Myeik Township, mud flats support greater species diversity over freshwater ponds (Soe Soe Than, 2012).

We were unable to conduct field investigations of mud flats for this review.

SAND FLATS

Sand flats are the least studied marine habitat in Myanmar. Local people collect some fauna such as bivalves and sand worms (*Sipunculus nudus*) for subsistence. *S. nudus* worms are collected when water levels are low and are used to prepare a much-loved dish in the Taninthayi Region (U Tint Tun, pers. obs.).

ROCKY SHORELINE

Rocky shores found along both the Rakhine and Taninthayi coasts provide subsistence fisheries for local communities. Octopuses, oysters, seashells and chitons can be gleaned from water pools and rock faces. Studies have been conducted on the rock oysters that are found in this habitat (Htay Aung, 1987, 2011; Htwe Nyunt, 1996; Thi Thi Lay, 1983).

MARINE ORGANISMS

MAMMALS

Myanmar's coastal and offshore waters support marine mammals within the order Cetacea (the whales, dolphins and porpoises), one species in the order Sirenia (sea cows) and a small number of freshwater otters that sometimes occur in coastal marine habitats. Myanmar's marine mammals were first documented scientifically during the British colonial time (Anderson, 1878; Mason, 1852, 1860). Recent research has been conducted on marine mammals in Myanmar by university departments, DoF, WCS and MSAM. Two marine mammals, Irrawaddy dolphins (*Orcaella brevirostris*) and dugongs (*Dugong dugon*), have been protected under Myanmar's Protection of Wildlife and Conservation of Natural Areas Law since 1994 under the category "completely protected".

Cetaceans (Whales, Dolphins and Porpoises)

In scientific classification, the order Cetacea has two extant suborders: the baleen whales (*Mysticeti*) and the toothed whales (*Odontoceti*), which include sperm whales, beaked whales, dolphins and porpoises. However, non-specialists will often logically group them based on size: the larger whales and the smaller dolphins. In Myanmar, whales are called *nga wun*, *nga wun gyee*, *wai la* or *wai la nga*, whereas dolphins are called *linn shuu*, *lann shuu*, *labine* or *lann phai* (Tint Tun, 2006).

Whales were documented by Captain Lloyd who named a bay "Whale Bay" in the Myeik (Mergui) Archipelago (east of Kan Maw (Kisseraing) Kyun) because it supported many whales and it was the only area where he saw them in the country (Mason, 1852) (Figure 3). Anderson (1878) made the first scientific description of the Balaenoptera edeni and named it after Sir Ashley Eden, a former British High Commissioner in Myanmar (Burma). The 37 ft (11 m) whale stranded itself 20 miles (32 km) up the Thaybyoo (Thebyu) Creek off the Gulf of Mottama (Martaban) (Figure 2). In this work he also identified another partial specimen from an 84 ft long (25 m) animal collected from an island just south of Ramree (Ramri) Island of Rakhine State (Figure 2) as a Blue whale (*Balaenoptera indicus*, or the currently ac-

cepted name *B. musculus*).

Whale skeletons have been preserved and articulated for display at a number of institutions in Myanmar, including at the Marine Science Department of Patheingyi University, the University of Mawlamyine, the Department of Zoology of Dawei University, the Marine Science Department of Myeik University, the DoF in Yangon and the Yangon Zoological Gardens. However they have yet to be systematically inventoried.

Recent strandings of interest include an individual of the rare Longman's beaked whale (*Indopacetus pacificus*) that has been buried near its stranding site on the western coast of the Gulf of Mottama in Kyauktan Township in 2005 (Figure 2). Photographs confirmed the species identification (Dr. Colin D. MacLeod, *in litt.*). There have been no other reports of sightings of this species in Myanmar and its global distribution is not fully known. A 63 ft long (19 m) Blue whale was found in January 2006, stranded three miles from Ahlup Village in the Paung Township of Mon State. Its skeleton is on display at the University of Mawlamyine and the skeleton of a Blue whale found in 1987 in Andrew Bay (Thabyugyaint) (Figure 2) is on display at the Yangon Zoological Gardens (Smith *et al.*, 1997). A Strap-toothed beaked whale (*Mesoplodon layardii*) was found stranded in the Ayeyawady Delta in February 2011, more than 5000 km outside of its normal range in the southern hemisphere. This occurrence was considered an anomaly and not an extension of the species' distribution (Aung Myo Chit *et al.*, 2012).

Whales can be of important cultural significance in Myanmar. Many fishermen in southern Myanmar believe that sighting a whale while at sea reflects the disapproval of maritime celestial beings for a person's actions, thoughts or statements and people will throw rice and water into the sea to ask for forgiveness. U Shin Gyee is the guardian spirit of marine waters and seagoing vessels are in his charge. A shrine to him in Myeik includes many whale jaw bones that are lashed together and offerings are often made there when boats are launched. Some fishermen also use whale jaw bones as ornaments on their boats (Tint Tun, 2006).

There is a range of traditional beliefs around dolphins. In southern Myanmar, some local people and fishermen believe dolphins will save people in trouble at sea (Tint Tun, 2006). One explained that dolphins are *nat nga* (celestial fish) and the horizontal position of their flukes was created to distinguish them from other fish (Tint Tun, 2006). While some people of Myaybone, in northern Rakhine State, are scared to be sprayed by water from the blowhole of the Indo-Pacific humpback dolphin — whose local name, *a nu* translates to “leprosy” (U Tint Tun, *pers. comm.*) — cast net fishermen in the Ayeyawady River regard dolphins as their parents since the mammals indirectly provide money for their family as do their own parents (U Tint Tun, *pers. comm.*).

Modern surveys of populations of whales and dolphins in coastal waters include the Taninthayi Coast (Nang Mya Han, 2008; Smith & Aung Myo Chit, 2011; Smith & Mya Than Tun, 2008), the Rakhine Coast (Smith & Aung Myo Chit, 2011; Smith *et al.*, 1997) and the Ayeyawady Delta (Smith & Aung Myo Chit, 2011; Smith *et al.*, 2007). Commonly encountered species include the Bryde’s whale, Indo-Pacific finless porpoise, and Irrawaddy, Indo-Pacific humpback and bottlenose, Pantropical spotted, and Spinner dolphins (Nang Mya Han, 2008; Smith & Aung Myo Chit, 2011; Tint Tun, 2005). Cetacean catches at fish landing sites and markets were investigated in Myeik and Dawei (Tint Tun, 2006), a study which further confirmed the presence of Spinner, Indo-Pacific humpback and bottlenose dolphins and Indo-Pacific finless porpoises, and which highlighted issues of hunting, the sale and consumption of meat and the incidental catches of these species. Commonly encountered species include the Irrawaddy

Indo-Pacific humpback and bottlenose, Pantropical spotted and Spinner dolphins.

It is not yet clear whether there are differences in coastal cetacean populations occurring along Myanmar’s three coastal areas. Most studies have confirmed that species of toothed whales have been seen across the three regions. Colour pattern differences have been noted between humpback dolphins observed in the far south and in the north of the country (Smith & Aung Myo Chit, 2011). The sighting of an aggregation of over 100 Indo-Pacific humpback dolphins feeding near Diamond Island in the Ayeyawady Delta may indicate that this open estuarine area is particularly suitable for this species (Smith & Aung Myo Chit, 2011).

One particular dolphin species, the Irrawaddy dolphin (*Orcaella brevirostris*), is found in the tidal areas associated with freshwater inputs of all three regions (Nang Mya Han, 2008; Smith *et al.*, 1997; Smith & Mya Than Tun, 2008). The species is also found in the upper reaches of the Ayeyawady (Irrawaddy) River, from where it obtains its common name. As with most river populations of the Irrawaddy dolphin, the primary threat to coastal populations is incidental killing from gillnet entanglement.

Coastal populations of other species of dolphins are similarly threatened primarily by entanglement in fishing gear. A survey of the Myeik Archipelago of the Taninthayi Coast counted more than 2500 gill netters and longliners, 1300 squid jiggers and 500 stern trawlers along a survey trackline of less than 1000 km. Concentrations were particularly high in



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Whale skeletons are displayed in many areas of the country, including this Bryde’s whale skeleton in the Myeik University’s Marine Science Museum.

shallow nearshore waters and in a bay where sightings of Irrawaddy dolphins and Indo-Pacific finless porpoises were made (Smith & Mya Than Tun, 2008). Fishermen along the Rakhine Coast reported dolphin deaths from entanglement in gill nets. Many fishermen claimed that they would release a dolphin if found alive, but there are few incentives to save the animal because the carcass can be rendered for oil, which can be sold for medicinal purposes (Smith *et al.*, 1997). The fish landing sites study revealed that dolphins are caught unintentionally through entanglement in purse-seines, beach-seines, gill nets and longlines as well as intentionally hunted using harpoons (Tint Tun, 2006). Drifting gill nets are likely the most hazardous fishing gear to small cetaceans.

A no-fishing zone was established by monks of the Namada Pagoda and Monastery along three miles (4.8 km) of the Ma Yu River of the Rakhine Coast (Figure 2) (Smith & Aung Myo Chit, 2011). Although not legally gazetted, this restriction is observed by local fishermen because of their respect for the head monk. During a census of fishing gear, no activity was seen in the zone while plenty of fishing activities were seen outside the zone. This zone is just downstream of a channel confluence and, therefore, provides ideal conditions for Irrawaddy dolphins (Smith & Aung Myo Chit, 2011).

Species of priority conservation interest in the coastal waters of Myanmar include the Irrawaddy dolphin and the Indo-Pacific finless porpoise due to their status in the IUCN Red List as Vulnerable. Other species under going taxonomic revision and potentially also of conservation interest include the *chinensis* and *plumbea* types of Indo-Pacific humpback dolphins *Sousa chinensis* (Mendez *et al.*, In press; Mendez *et al.*, 2013) and the small form of Bryde's whales occurring in the northern Indian Ocean (Kershaw *et al.*, 2013) The nearshore distribution of the small form of Bryde's whale – which places these animals in environments heavily used by humans – also makes the conservation of this species a priority in Myanmar. For a list of cetaceans of Myanmar see Appendix 4.

In recent years, Myanmar scientists have attended local training courses coordinated through WCS and DoF (Smith, 2005). They have also been involved in regional workshops that aim to train biologists on identification and research techniques used broadly to study cetaceans. One recent course, “Survey Techniques for Marine Mammals” (Phuket Marine Biological Centre, October 2012), introduced two lecturers from the University of Mawlamyine to techniques, such as acoustic tracking, that require equipment, budgets and additional technical train-

ing that are not available at local institutions (Rector Dr. Htay Aung, *pers. comm.*).

Dugongs

In Myanmar, dugongs (*Dugong dugon*), are known as *ye wet* which translates as “water pig” and *asye thu ma* which translates as “mermaid” (Tint Tun *et al.*, 2009). Some fishermen do not distinguish between dugongs and dolphins (Smith & Aung Myo Chit, 2011), while others believe that they are a transitional phase between dolphins and pigs (U Tint Tun, *pers. comm.*).

In 2005, researchers conducted the first dedicated dugong survey, based on interviews with local communities covering areas of the Rakhine Coast (Tint Tun & Ilangakoon, 2006) and the Myeik Archipelago. This work was important since previous global assessments and conservation action plans did not adequately include Myanmar among its lists of countries with dugongs (Marsh, 2002).

Dugongs have been reported along the Rakhine and Taninthayi Coasts, but not in the Ayeyawady Delta since it does not support the seagrass areas required by the animals for feeding (Figure 4) (Nang Mya Han, 2009a; Tint Tun, 2010).

The IUCN Red List currently categorizes dugongs as Vulnerable (IUCN, Web page) and the Convention on Migratory Species lists the dugong in Appendix II, which means that the conservation of the species would benefit from international cooperative activities organized across the dugong's migratory range.

Myanmar was one of the first signatory states to sign “The Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats throughout their Range” (United Nations Environment Programme, 2007). As of February 2013, 26 countries have signed this MoU which is designed to facilitate national level and trans-boundary actions that will in turn lead to the conservation of dugong populations and their habitats (United Nations Environment Programme, 2007).

Dugongs are not largely targeted by fishermen in Myanmar, though some Moken people from southern Myanmar explained that if a dugong is seen or stranded, they will kill and eat it (Hines *et al.*, 2007). In Man Aung of the Rakhine Coast (Figure 2), fishermen admitted to hunting dugongs with harpoons in the past, but also claimed that they are no longer targeted (Tint Tun & Ilangakoon, 2008). However some people from the area said that the

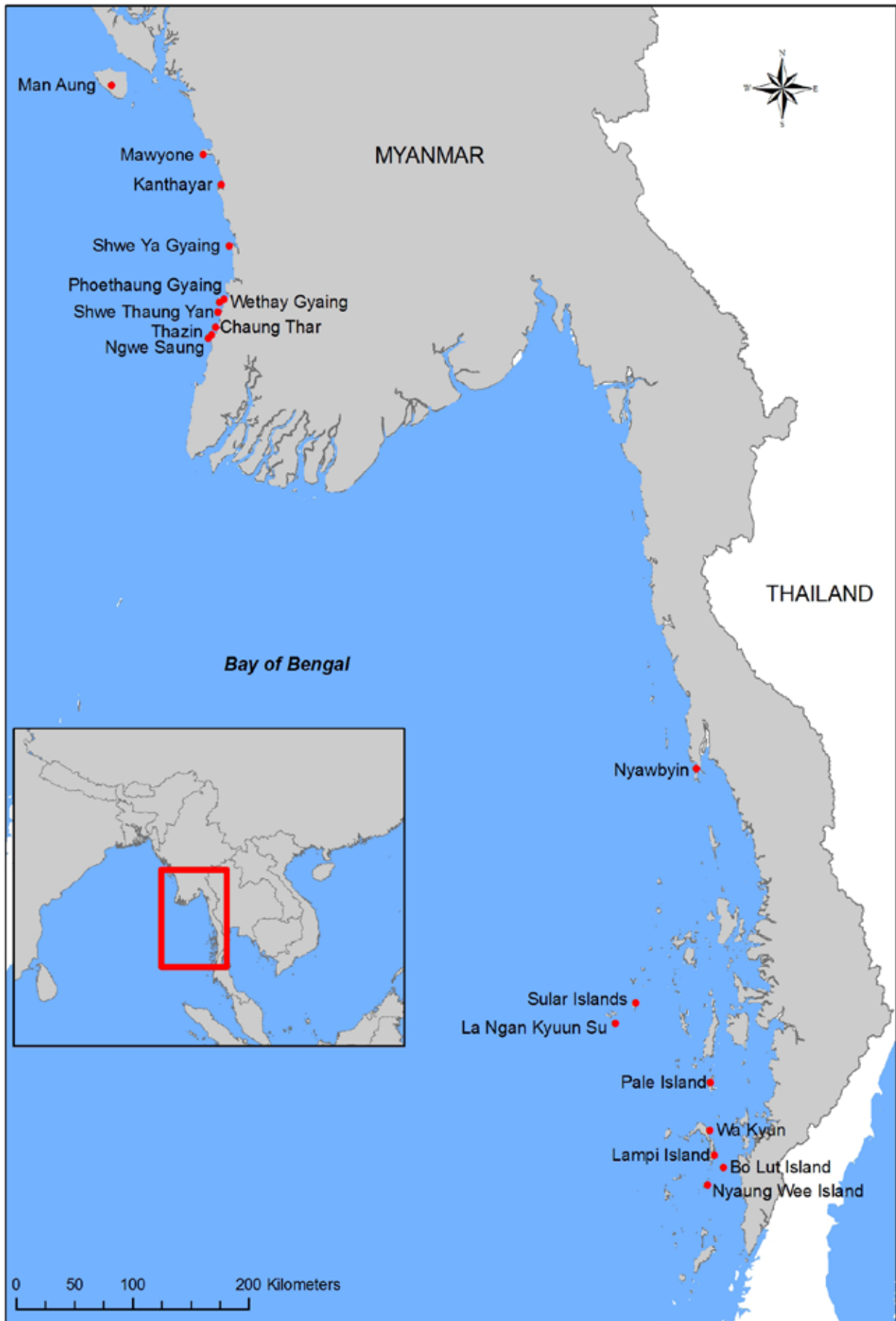


Figure 4. Localities from where dugongs (*Dugong dugon*) have been recorded along Myanmar's coast. Adapted from: Nang Mya Han (2009a) and Tint Tun (2010).

meat from dugongs tastes better than pork (Tint Tun & Ilagankoon, 2008). Interviews in southern Myanmar revealed no medicinal uses derived from dugongs (Hines *et al.*, 2007), while people of Man Aung Island feel that dugong body parts can help cure afflictions including diarrhea and warts, and a local book explains that the dugong tusk has strong medicinal properties (Tint Tun *et al.*, 2009).

The local DoF has conducted active education campaigns in Man Aung Island and fishermen are indeed aware that the animals are both rare and are under protection from the government and that they must release a dugong if it is found alive in their nets (Tint Tun & Bendell, 2010). Unfortunately, accidental mortality through entanglement in fishing nets is reported still to occur in the area (Tint Tun & Bendell, 2010) and is likely the main threat to dugongs in the country.

Otters

Freshwater otters, most likely the Smooth otter *Lutra perspicillata* or the Small-clawed otter *Aonyx cinerea*, have been reported in coastal habitats of Pyin Sa Bu Kyun (Bentinick Island), Poni (Pocock Island), Kyaung Mi Thar Su Kyun (Cat and Kitten Island), Bo Cho (Pu Nala) Island and Thit Yar Wa Village near the town of Myeik (Figure 3). There are no known studies of otters in Myanmar.

REPTILES

Marine Turtles

Nesting marine turtles are known from several locations along Myanmar's coast and offshore islands (Thorbjarnarson *et al.*, 2000b). In 2001, Myanmar became a signatory state to the "Memorandum of Understanding on Conservation and Management of Marine Turtles and their Habitats of Indian Ocean and South-East Asia" (Indian Ocean and South-East Asian region [IOSEA], 2009). The distribution of the five species of marine turtles across Myanmar's States and Regions is summarized in Table 3. See Appendix 5 for a summary of the marine turtles of Myanmar and the corresponding IUCN Red List Status for each species.

Since 1905, marine turtles have been protected under Myanmar (Burma) laws. On paper, the Fishery Act protected all species of marine turtles for conservation purposes through protecting hatching areas and legislation was strengthened further in

1924 through the FD (Agriculture) Notification No. 1/1924. In February 1993, the Ministry of Livestock and Fisheries issued Notification No. 2/93 relating specifically to sea turtle conservation (Myint Pe, 2003).

Prior to 1986, the DoF leased beaches for egg collection. From 1986 to 1996 the egg collection programme was run through local fishing communities, which were required harvesters to leave one-third of the eggs to hatch, though compliance with these regulations was almost non-existent (Thorbjarnarson *et al.*, 2000b). After 1997, the DoF declared all offshore turtle nesting beaches as fully protected and created a conservation programme in collaboration with SEAFDEC and the IOSEA Technical Support and Capacity-Building Programme.

Programme activities involve nest-monitoring, establishment of hatcheries to incubate transplanted nests, and even the relocation of villages to reduce the impact on nesting turtles (Thorbjarnarson *et al.*, 2000b).

Turtle eggs are still collected illegally for local consumption and are also sent to and sold illegally at urban markets. Marine turtles can drown in shrimp trawls, become entangled in fishing gear and die after eating ocean trash such as plastic bags. Turtles are also caught for their meat. It is unclear the degree to which trawlers use Turtle Excluder Devices (TEDs) and gill nets are cited as a major source of death through drowning (Aung Hlaing Win & Maung Maung Lwin, 2011). In the waters around Lampi Marine National Park, fishermen identified long lines, dynamite fishing and commercial trawling as the primary threats to mature turtles. And egg harvest at Lampi Island's six nesting beaches is high (Platt *et al.*, 2014).

BOX 4 | DoF and SEAFDEC's objectives for marine turtle conservation and management

- Preserve and restore developmental, feeding and nesting habitats
- Make nesting beaches acceptable to turtles by eliminating, through technology, legislation and public information, the impact of artificial lighting
- Clean beaches and control predators
- Minimize pollution of the marine environment
- Increase public awareness and participation in marine turtle conservation through public education

Table 3. The distribution of five marine turtle species within Myanmar. Adapted from: Aung Hlaing Win & Maung Maung Lwin (2011).

Scientific Name	Common Name	State/Region				
		Rakhine	Ayeya.	Yangon	Mon	Tanin.
<i>Caretta caretta</i>	Loggerhead turtle	X				
<i>Chelonia mydas</i>	Green turtle	X	X	X	X	X
<i>Lepidochelys olivacea</i>	Olive ridley turtle	X	X	X	X	X
<i>Dermochelys coriacea</i>	Leatherback turtle	X	X	X		X
<i>Eretmochelys imbricata</i>	Hawksbill turtle	X	X	X		X

In 2004, the DoF in collaboration with SEAFDEC conducted trials and demonstrations of TEDs with shrimp trawlers in Thandwe District of Rakhine State (Food and Agriculture Organization, Web page-a) (Figure 2) but they have not yet been adopted.

Most of the small, recently-formed islands off the mouth of the Bogale River of Bogale Township in Ayeyawady Region are used by marine turtles for nesting. Most nesting is by Olive ridley turtles (70%), followed by Loggerhead turtles (20%) and Green turtles (10%). According to the DoF, the total number of nests in the region is currently about 300 annually, indicating a drastic reduction in regional turtle populations during this century. Kadonkalay Kyun (Figure 2) is the largest island at 2.6 km² and continues to lengthen. Approximately 180 turtle nests are found each year along the eastern shore. Gayetgyi Kyun (Figure 2) formed about 30 years ago and supports about 80 turtle nests annually. Nests are also found on nearby, newer, smaller islands (Thorbjarnarson *et al.*, 2000b). Starting in approximately 2001, nesting marine turtles have been tagged and regularly monitored at these Islands (Ko Myint, 2005, 2007, 2009; Maung Maung Lwin, 2007).

Thamihla (Thameehla) Khun near Mawtin Point of Ayeyawady Region was designated a wildlife sanctuary in 1970 (Figure 2). A turtle hatchery was established on the island in 1986 and 1987. A number of studies have been conducted on the hatchery and nesting populations (Kay Thi, 2009; Kay Thi *et al.*, 2011; Ko Myint, 2007, 2009; Limpus, 2012; Maung Maung Lwin, 2009a, b). Unfortunately, despite the management actions of recent decades, there continues to be an alarming long-term decline in marine turtle nesting populations (Limpus, 2012). Based on egg collection data from the late 1890s (Maxwell, 1911b), interviews with a local person on collections in 1932- 1941 (Limpus, 2012), a report on egg production in the late 1990s (Thorbjarnarson *et al.*, 2000b) and two decades of turtle nesting censuses by the DoF, Limpus (2012) summarized the long-term

declines as follows:

- Green turtle nesting numbers have declined from thousands of nesting females per year — approximately 5,000 according to Maxwell (1911b) — to a few tens of females at Thamihla Island.
- Olive ridley turtle nesting numbers have declined from thousands of nesting females per year — approximately 3,750 according to Maxwell (1911b) — to a few tens of females at Thamihla Island.
- Hawksbill turtles, which nested in the hundreds at the turn of last century, are now approaching extinction as a nesting species in Myanmar.

Moscicos Island Wildlife Sanctuary in the Dawei District of Taninthayi Region supports the main, known Hawksbill nesting area of Myanmar. DoF started studying the Hawksbill populations of Longlonebok Island (South Moscos) around 2005 (Figure 3). They have also been conducting awareness and education activities and prohibiting the use of harmful fishing gear (Soe Thant & Maung Maung Lwin, 2011).

Three species (Leatherback, Green and Hawksbill) are moderately abundant in the waters of Lampi Marine National Park, however nesting is not high. Recent interviews of local fishermen suggest that only around 20 trackways are typically sighted per year across the island's six nesting beaches (Platt *et al.*, 2014). Considering the low number of nests and high degree of egg harvest, it's highly unlikely that recruitment is currently occurring in the park.

The DoF State/Regional and District level offices distribute questionnaires and "Tag Wanted" posters to help with data collection efforts. Their efforts to obtain feedback from fishers has been challenged by a number of issues including the fishermen's reticence to share information on catches because they fear prosecution (Aung Hlaing Win & Maung Maung Lwin, 2011).

Despite strict laws, extensive research activities, outreach efforts and hatchery operations, Myanmar's marine turtles remain in peril. Limpus (2012), posits that if management of marine turtles does not improve, Myanmar's breeding turtle populations will be extirpated within a few decades.

Estuarine Terrapins

The Mangrove terrapin, *Batagur baska*, inhabit mangrove swamps, coastal rives and estuaries from India to Malaysia and Indonesia (IUCN, Web page). The closely-related Southern river terrapin, *B. affinis*, is known to occur in southern Thailand, Cambodia, southern Vietnam, peninsular Malaysia, Indonesia and Cambodia (Iverson, 1992; Praschag *et al.*, 2007). These two river turtles once inhabited coastal estuaries and shared nesting beaches with marine turtles in Myanmar. Populations of both species have declined dramatically throughout their ranges due to harvesting of adults and eggs, clearance of mangroves and destruction of nesting habitat (Das, 1997; Moll & Moll, 2004; Moll *et al.*, 2009). The IUCN Red List lists *B. baska* as Critically Endangered (IUCN, Web page).

Mangrove terrapins were once common in the Ayeyawady Delta (Maxwell, 1911a; Theobald, 1868) but this population was extirpated by egg collecting (Thorbjarnarson *et al.*, 2000a). Field surveys in 2004 revealed small populations of the species in scattered locations in Mon State, Taninthayi Region and Ayeyawady Region (Platt *et al.*, 2008). However, surveys in 2014 by the same researchers added to a growing body of evidence suggesting that extant populations of *B. affinis* and *B. baska* no longer occur in Myanmar (Platt *et al.*, 2014).

Crocodiles

The Estuarine crocodile (*Crocodylus porosus*) was once widespread and abundant in the swamps of Myanmar (Thorbjarnarson *et al.*, 2000a). Their numbers have declined precipitously over the past 50 years as a result of commercial hunting for skins, collecting to stock crocodile farms and loss of habitat through the conversion of wetland habitats for agricultural use. Extant populations persist only in the Meinmahla Wildlife Sanctuary of the lower Ayeyawady Delta (Figure 2). This is one of the few extant populations in mainland Southeast Asia. Surveys in 1999 and 2003 revealed that the remaining population was robust and likely to increase and continued monitoring was recommended (Thorbjarnarson *et al.*, 2006). Even so, the sanctuary has

received little attention in recent years and the current status of this important, remaining population is unknown.

Recent surveys in Lampi Marine National Park suggest that *C. porosus* is now extirpated from the island, most likely as a result of chronic egg collection and harvesting of the adults (Platt *et al.*, 2014). However, recovery of *C. porosus* in the park could be possible with effective conservation measures, given the proximity of potential source populations on the Tanintharyi mainland and other islands in the Myeik Archipelago (Platt *et al.*, 2014).

The Myanmar government established the Thaketa Crocodile Farm in 1978 in a suburb on the eastern outskirts of Yangon (Aung Moe, 1993). From 1978 to 1999, over 4000 crocodiles were collected from the wild to stock the farm (Thorbjarnarson *et al.*, 2006) likely from Rakhine State and the lower Ayeyawady Delta (Caughley, 1980; Thorbjarnarson *et al.*, 1999). Originally the farm was intended for commercial skin production, tourism, and conservation and research, however, once hatchlings started to be produced in 1982, it became apparent that commercial skin production was not economical and emphasis shifted to the production of founder stock for farms in other countries (Platt *et al.*, 2013). The farm has minimal conservation value since it does not support the viability of wild populations and was a major drain on wild populations at its outset. Furthermore, three Siamese crocodiles (*C. siamensis*) were once introduced to the farm and it is not known if these individuals hybridized with *C. porosus* stock. All the farms' crocodiles, except wild-caught founders, must be regarded as potential hybrids. As such, none of the farmed crocodiles should be released into the wild without prior genetic screening to eliminate hybrid individuals (Platt *et al.*, 2013).

MARINE FISHES

Fish are an important component of the diet of Myanmar's people and are economically vital. The Myanmar government estimates that the fisheries and aquaculture sector employs over 2.6 million people full and part-time.

Small-scale fisheries are generally very close to shore and use low technology approaches for subsistence and some income generation that support local fishermen and their families. This includes gleaning, cast nets and spearguns.

Myanmar's inshore fishery targets areas that are



within five nautical miles from shore along the Rakhine Coast and ten nautical miles from shore for the Ayeyawady and Taninthayi's Coasts. Boats fishing in these areas can be no more than 30 ft long and use engines of no more than 25 horsepower. Typical fishing gears used by these fishers include drift nets, gill nets and longlines. In 2009-2010, a total of 11,681 fishing vessels (including 7981 mechanized and 3700 non-mechanized) were documented by the DoF (Kyaw Tint *et al.*, 2012b).

The offshore fishery extends from the inshore boundary out to the edge of Myanmar's Exclusive Economic Zone (EEZ), which is 200 nautical miles from shore. These fishers use larger boats and gear including bottom trawls, purse seines, surrounding nets, drift nets and longlines. Offshore fishing is managed through a grid of 140 fishing grounds, each a block of 30 x 30 nautical miles (Figure 5).

The major fish landing sites in the country are at Thandwe of the Rakhine Coast; Pazuntaugh, Nyaungdan and Annawa close to Yangon; and Mawlamyine, Myeik and Kawthoung of the Taninthayi Coast (Figure 5). Seasonal fishers also operate their boats from many smaller landing sites along the coasts.

Marine fish production more than doubled from 926,070 tonnes in 2001 to 2,123,460 tonnes ten years later in 2011 (Food and Agriculture Organization, Web page-c). Fishes are the most studied taxa of marine fauna in Myanmar with the major focus

on species compositions in target zones — coastal (Kyaw Kyaw Htay, 1985; Thet Myat Lwin, 2006), offshore (May Soe Thu, 1997; Thet Thet Myaing, 2006) and deep sea (Kyaw Kyaw Htay, 2010) — as well as along the three main coasts — Rakhine (Nu Mya Than, 1983), Ayeyawady (Nyein Phyu The', 2005) and Taninthayi (Tin Tin Win, 1992). Most of the fish species specifically identified by scientists in Myanmar are summarized in Appendix 6. As of 2010, the top ten fisheries exports were Rohu (*Labeo rohita*), Hilsa (*Tenualosa ilisha*), tiger prawns, White pomfret (*Pampus argenteus*), live crabs, live eels, dried prawns, pink fish, Tigertooth croaker (*Otolithes ruber*) and ribbonfish. In 2010, fisheries production over all fishery products was 3.92 million tonnes of which 2.61 million tonnes (53%) were marine. Over 2009-2010, Thailand was the greatest importer of Myanmar's finfishes, importing 108,511 tonnes of marine and freshwater fishes, followed by Kuwait, China and Singapore. Exported fishery products accounted for 10% of the total production in 2009-2010.

DoF and SEAFDEC have investigated pelagic fisheries through joint surveys in 2004 and 2007. These revealed that swordfish (*Xiphias gladius*), Yellowfin tuna (*Thunnus albacares*), Striped marlin (*Kajikia audax*) and Indo-Pacific sailfish (*Istiophorus platypterus*) inhabit Myanmar's offshore waters (Kyaw Tint *et al.*, 2012b). In November 2013, surveys of the Rakhine and Taninthayi Coasts were conducted from the research vessel Dr. Fridtjof Nansen and the findings are expected to help the MLFRD update

abundance data for the country's marine fishery resources.

National levels of fish consumption was calculated to be 46 kg per person per year over 2009-2010 (Department of Fisheries, 2010).

Thus far, the main trade in ornamental fish for the aquarium trade has focused on Myanmar's fresh water fish.

Certain marine fish have been given priority status based on their economic importance and threat level. The BOBLME has given priority to Hilsa shad (*Tenualosa ilisha*), Indian mackerel (*Rastrelliger kanagurta*) and sharks for research and conservation efforts. The Myanmar Biodiversity Conservation Investment Vision also suggests priority be give to these same species as well as the Four-finger thread-fin (*Eleutheronema tetradactylum*) (Wildlife Conservation Society, 2013).

Sardines and Anchovies

Sardines and anchovies are an important offshore fishery of the Rakhine Coast. The season is dictated by the rains since it is too difficult and dangerous to fish during the monsoon season and not enough fish can be caught to cover fuel and labour costs. Fish are caught at night using purse seine nets that are 600 taung (900 ft) long by 150 taung (225 ft)

deep with a ½" mesh. Usually a large boat of up to 50 ft long with a 25 horsepower engine, and a smaller 30 ft long boat, work together to encircle schools of fish. The catches are dominated by anchovies (50-70%) followed by sardines (30-50%) and the composition of the catches change during the season. A sharp decline was noticed by local fishermen between 2004 and 2005 (Stakeholder interviews).

Hilsa Shad

Hilsa shad are anadromous — they spend most of their lives in the ocean and swim up large rivers to spawn. People fish the adults from the marine environment as well as juveniles during their migration from the rivers to the sea. The species is particularly valued by the people of India, Bangladesh and Myanmar where is a prized food fish. They have additional cultural value for some Hindu peoples in the region. India, Bangladesh and Myanmar have been implementing the Hilsa research and conservation activities of the BOBLME project. It is the second-greatest fishery export from Myanmar at 10,968 tonnes in 2010-2011, down from 17,006 tonnes in 2009-2010. Both the catch and the average fish size are decreasing, indicating that the stock is overfished. Hilsa have been widely investigated in Myanmar including studies of their morphometrics, population dynamics and fishery biology (Cho Cho Mar, 1988; Druzhinin & Phone Hlaing, 1972; Hlaing Hlaing Oo, 2012; Kalayar Win Maung, 2007; Khaing



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Sardines and anchovies are an important target fishery of the Rakhine Coast. Often other fish species are also caught at the same time.

Myat Myat Htwe, 2012; Kyu Kyu Than, 1978; Lei Lei Khine, 2007; Maw Maw Than, 1991; Min Thu Aung, 2006; Moe Sapai, 1998; Mya Marlar Chan Tun, 1977; Saw Nanda, 2000; Thet Myat Lwin, 2006; Tin Oo, 1983).

fisheries biology and population dynamics of Indian mackerel have been studied by Myanmar scientists (Cho Cho Mar, 1988; Hnin Zar Htwe, 2012; Honey Shwe, 2012; May Soe Oo, 1994; Min Thu Aung, 2006; Moe Sapai, 1998; Saw Nanda, 2000; Thet Swe, 1987; Thet Thet Myaing, 2006).

Indian Mackerel

Mackerel are caught by purse seines during the dry season (around October to May) with December reported to be the height. The anatomy,

Four-finger Threadfin

The Four-finger threadfin (*Eleutheronema tetradactylum*) is not well-studied in Myanmar

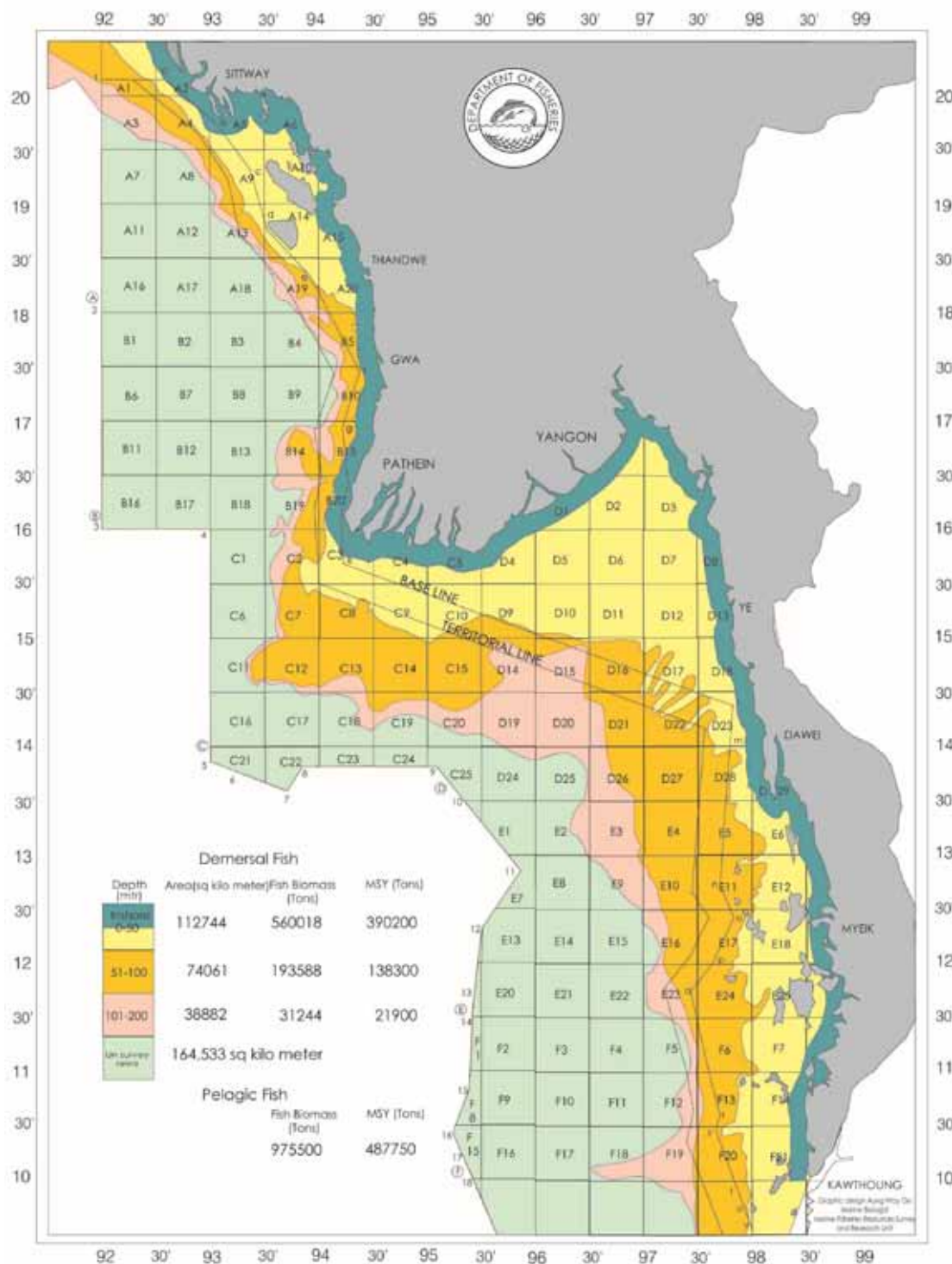


Figure 5. Myanmar's fishing grounds and landing sites. Source: Myanmar DoF.

despite its being a target fish in the country. It was one of the top three species contributing to catch in a study of fishing gear in Taninthayi Region by Min Thu Aung (2006).

Sharks and Rays

Sharks, rays and skates compose the subclass of Elasmobranchii of the class Chondrichthyes, the cartilaginous fishes. Sharks and rays are suffering globally. With the onset of industrial fishing over the past 60 years, their populations have been globally depleted and, of the shark and ray species assessed by scientists for IUCN, 30% are Threatened or Near Threatened with extinction (IUCN, Web page).

Between 26 and 73 million sharks are killed every year to feed the demand for fins to be used in shark fin soup (Clarke *et al.*, 2006), a delicacy in some parts of Asia. And, because most sharks mature late and produce very few young over their lifetime, their populations are slow to recover from overfishing (Stevens *et al.*, 2000). Most sharks are at the top of marine food chains and studies have shown that their presence has important effects on species compositions and health of habitats such as coral reefs, because of the influence they have on prey dynamics (Bascompte *et al.*, 2005; Mumby *et al.*, 2006; Steven-son *et al.*, 2007).

Several studies exist on Myanmar's sharks produced by DoF (Maung Hla & Thein Thein Kyi, 2012) and university staff and students (Khaing Khaing Thein, 2008; Kyi Win, 1978; Maung Maung Winn, 1974; San San Khine, 2010). Fewer studies have targeted rays with only a few theses and reports addressing this taxon (Maung Hla & Thein Thein Kyi, 2012; Maung Maung Winn, 1974; San San Khine, 2010). Many of the known and suspected shark and ray species of Myanmar are summarized in Appendix 7. Skates have not been documented among the studies.

No recent studies have focused on sawfishes in the country but it's possible that Myanmar is one of the few countries to still harbor significant populations of sawfish. Four species are known to have historically occurred in this region: Green sawfish (*Pristis zijsron*), Largetooth sawfish (*P. pristis*), Dwarf sawfish (*P. clavata*) and Narrow sawfish (*Anoxypristis cuspidata*) (Harrison & Dulvy, 2014). Dwarf sawfish are very rare and there are no recent confirmed records of this species from the region.

Some studies report that, in Myanmar, sharks and rays are not directly targeted by fishers but are a

BOX 5 | Reasons that motivated Department of Fisheries to take action:

- Sharks are the most biologically vulnerable creatures in the ocean
- Sharks grow slowly, mature late and bear few young
- Some shark species do not reproduce until they are over 25 years old
- Sharks play the important role of top predator in ocean ecosystems
- Sharks play a role in keeping the ocean balance

secondary catch, essentially “bycatch” of fisheries that use longlines, gillnets, trawls, and purse seines that target finfishes. Vast numbers of fins have been sighted on drying platforms near major fish landing sites and it is not clear if they are targeted or bycatch.

Myanmar does not yet have shark and ray identification guides for research but the DoF has relied on regional resources provided through SEAFDEC and FAO (Ahmad & Lim, 2012). However the DoF has produced outreach materials such as posters that emphasize the role of sharks in ocean ecosystems as part of their public awareness programmes.

Myanmar exports shark products, but it does not currently report shark and ray catches to the FAO (Lack & Sant, 2011) although they may be lumped under other broad categories such as “marine fishes”. According to available trade data, Myanmar currently exports approximately 270 tonnes per year of shark products (Lack & Sant, 2011).

Diver surveys conducted during this review revealed a consistent perception of dramatically decreasing shark sightings in the southern Myeik Archipelago. Dive guides who have dived in Myanmar since 2005 (three guides) and 2007 (three guides) all reported decreased shark sightings in 2013. Even the five dive guides who only started diving in the area in 2011 each noted a recent drop in shark sightings. That same survey showed that shark sightings currently average one shark every 23.4 diver-hours in the water (see Appendix 18). Similarly, researchers surveying in the Myeik Archipelago in early 2013 saw no sharks in the islands during more than three months of diving (Zau Lunn, *pers. comm.*).

Whale sharks can occasionally be seen in the waters near Ngapali of the Rakhine Coast (Figure 2) and near Thamihla Kyun in Myeik Archipelago (Figure 3) (Tint Tun, *pers. comm.*). Whale sharks are pro-

tected under Notification No. 2/2001, which forbids people from catching, harassing, killing, possessing, selling, buying and exporting Whale sharks. If accidental entanglement in fishing gear occurs, the animal must be released immediately.

In order to address shark conservation needs, the DoF issued Notification No. 2/2004 (5 May, 2004) and created two Shark Protected Areas in Taninthayi of 1706 km² and 11,734 km².

Shark sanctuaries or parks are not considered a panacea in the conservation of sharks as fishing is often still permitted and there rarely exists the necessary enforcement to render them effective (Davidson, 2012). In 2012, the experts who gathered for the Myanmar Biodiversity Conservation Investment Vision (MBCIV) workshop that evaluated KBAs agreed that both shark protected areas need more information in order to assess their priority value (Wildlife Conservation Society, 2013).

However, as targeted fishing for shark is illegal in the country, it is unclear how restrictions differ inside the two Shark Protected Areas in the Myeik Archipelago. It is also unclear if any patrolling or effective enforcement has been applied within the protected areas.

The DoF has started the process of drafting a National Plan of Action (NPOA) for shark conservation.

It is important to note that these current objectives for the NPOA deal with how shark fisheries are monitored and how captured sharks are utilized but they do not include a key objective of reducing their capture. Also, there are currently no sustainable fisheries for sharks and rays in any developing country (Rachel Graham, *pers. comm.*) so this first objective may not be realistic.

There are several challenges that could affect how successfully the NPOA is implemented. There is insufficient institutional knowledge and experience needed for conducting necessary taxonomic work, financial support is limited, cooperation with fishers and landing site owners may be limited and landed sharks are often missing heads and other body parts that are useful for making identifications. Moreover, key biological information is incomplete, shark trading goes unreported to relevant local authorities leading to a poor understanding of shark marketing channels and data in only one year (2004) has been collected thus far (Maung Hla & Thein Thein Kyi, 2012).

In early 2013, CITES Conference of the Parties 16 supported listing five species of sharks under Appendix II, thus impacting international trade. The Oceanic whitetip Shark, Porbeagle, and three species of hammerheads along with both species of manta rays – all classified as Threatened with extinction on the IUCN Red List – have been added to CITES Appendix II. Of these species, all but the Porbeagle are found in Myanmar's waters. The new listing requires monitoring of trade and an assessment by the exporting country that any trade in a listed species showing it does not threaten its status.

SEAFDEC, which provides a range of support to fishery departments in the region have responded with some valid concerns relating to the training and data needed for countries to be able to establish non detriment findings for listed species and implement effective species identification, export screenings and enforcement (Southeast Asian Fisheries Development Center, 2013). Recognizing that implementation of the listings will take some preparation for CITES countries, Parties decided that the inclusion in Appendix II should be delayed by 18 months, until 14 September 2014.

BOX 6 | NPOA stated objectives

- To ensure the sustainable use of sharks and rays
- To assess threats to shark and ray populations and to provide special attention to the threatened populations
- To minimize unutilized incidental catches, waste and discards from shark and ray captures
- To encourage the full use of dead sharks
- To facilitate the identification and reporting of species-specific biological and trade data and collaboration with biologists in the gathering of these data
- To facilitate improved species-specific catch and landings data and monitoring of sharks and rays catches
- To improve and develop a framework for establishing research, management and educational initiatives for sharks and rays and economic alternatives to their fisheries



Shark fishing is illegal in Myanmar but sharks are still caught and their fins removed and dried to be sold for shark fin soup.

Finfish Aquaculture

Net cage culture is conducted in the Myeik Archipelago and Gwa Township of the Rakhine Coast (Food and Agriculture Organization of the United Nations, 2003; Tin Win, 2002). As of 2010 there were six marine net cage finfish culture farms of the Taninthayi Coast (Department of Fisheries, 2010). Primary species for commercial culture are the Duskytail grouper (*Epinephelus bleekeri*), the Orange-spotted grouper, (*E. coioides*), the Malabar grouper (*E. malabaricus*) and the Greasy grouper (*E. tauvina*) (Food and Agriculture Organization of the United Nations, 2003) but other species of groupers and snappers may be opportunistically reared as well. Seabass (*Lates calcarifer*) is similarly farmed in some areas of the Ayeyawady Delta region.

Grouper is one of the three main aquaculture exports of Myanmar (after shrimp and on par with crab). They are exported either live from Myeik for the live reef fish trade to Hong Kong or chilled. Juveniles are wild-caught by fishermen, often around the full moon using feathered hooks or traps (Food and Agriculture Organization of the United Nations, 2003), while fry are lured and collected using rock mounds, brush piles, brush lures and fish traps (Tin Win, 2002). The fish are grown in floating net cages and ponds.

Production of marine fish through aquaculture is quite small compared with production of shrimp through aquaculture or production of wild caught

marine fish. First reported in 2008, FAO reported exports of 135 tonnes of marine fish valued at USD418,000 which has remained level through to 2011 with 140 tonnes valued at USD630,000 (Food and Agriculture Organization, Web page).

SEA AND COASTAL BIRDS

Myanmar hosts an incredible diversity of birdlife with over 1100 species known from the country. The variety of habitats along its extensive coastline holds over 80 species that are primarily confined to coastal areas. Many of these species are poorly known because of relatively low survey effort across this huge area. Where surveys have been conducted, a wealth of new information has been obtained. This includes the discovery of large numbers of the Critically Endangered Spoon-billed sandpiper (*Eurynorhynchus pygmeus*). This species was not known from the country until the early 2000s and it is now known that Myanmar supports one of the largest remaining populations of this species in the world.

Seabirds

There are relatively few records of true seabirds, Procellariiformes, from Myanmar. This is rather surprising considering the large amount of sea travel needed to visit the country in historical times. According to Smythies (2001), only a single species of Procellariide has been recorded. The Wilson's storm-



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Plain-pouched hornbills (*Aceros subruficollis*), which inhabit the islands of the Myeik Archipelago, are considered Vulnerable by the IUCN Red List.

petrel (*Oceanites oceanicus*) was recorded in large numbers by Davison off the Moscos islands. This species has not been recorded again in the country but there is an ambiguous record of a storm petrel from August 1959 in the Royal Navy Bird Watching Society database (Royal Navy Bird Watching Society, Web page) that could refer to this species or Swinhoe's storm-petrel (*Oceanodroma monorhis*). Recent observations from neighbouring countries, especially India and Malaysia, suggest that many more species could be occurring in Myanmar waters. These include Joaquin's petrel (*Bulweria fallax*) and Streaked (*Calonectris leucomelas*), Wedge-tailed (*Puffinus pacificus*), Flesh-footed (*P. carneipes*) and Short-tailed (*P. tenuirostris*) shearwaters. The location of a submarine canyon off the Rakhine coast could potentially serve as an important feeding area for these poorly known species and should be carefully surveyed to understand the ecology of Procellariids in Myanmar's waters.

A variety of primarily pelagic bird species have been recorded as vagrants to Myanmar. The Red-billed tropicbird (*Phaethon aethereus*) was reported by Davison in Smythies (2001) from Kawthong (Point Victoria) and Mawtin Point (Cape Negrais). Robson (2008) also lists the White-tailed tropicbird (*P. lepturus*) as occurring but the exact location is not mentioned. Smythies reports that a Brown booby (*Sula leucogaster*) was collected by Oates in Tanthayi (Tenasserim) while a Red-footed booby (*S. sula*) was found exhausted in the Bay of Martaban in 2012 (Ko Lay, *in litt.*) (Figure 2). There is also a recent record of Great frigatebird (*Fregata minor*),

also from the Bay of Martaban area (Thet Zaw Nang, *pers. comm.*). All these species are considered to be vagrants to much of mainland Southeast Asia but they may regularly feed in Myanmar's offshore waters. Their occurrence may also be under-recorded because of the relatively small number of observers currently active in the area.

Shorebirds

The group of birds along Myanmar's coasts that have received the most survey effort in recent years are the Charadriiformes. This is primarily linked to the work of BANCA, Birdlife, the Royal Society for the Protection of Birds and others on the Critically Endangered Spoon-billed sandpiper, which are now known to winter in substantial numbers in the Bay of Martaban and along the Rakhine coast (Pain *et al.*, 2001; Zöckler *et al.*, 2010) (Figure 2). Other species of conservation concern found along the Myanmar coast include the Black-tailed godwit (*Limosa limosa*), Asian dowitcher (*Limnodromus semipalmatus*) and Eurasian curlew (*Numenius arquata*), which are all listed as Near Threatened as well as the Endangered Nordmann's greenshank (*Tringa guttifer*) (IUCN, Web page). All of these species are primarily winter visitors to the Myanmar coast, traveling thousands of kilometers from their breeding areas in northern Asia and many of them occur at a much broader range of sites than the Spoon-billed sandpiper. Further survey effort is needed to understand their true status and distribution in the country.

Two other species of shorebird, the Near Threatened Malaysian plover (*Charadrius peronii*) (IUCN, Web page) and the Beach thick-knee (*Esacus neglectus*) are restricted to sandy beach areas in the south of the country. These habitats are likely to be dramatically impacted by the expansion of beach tourism in the area and this will negatively affect the breeding success of both of these species as has already happened elsewhere in the region (Birdlife, Web page).

While not a true shorebird, the Great-billed heron (*Ardea sumatrana*) is another species restricted in Myanmar to undisturbed outer islands along the Taninthayi coast. This species has declined substantially within Southeast Asia and increased development and poorly planned tourism may also negatively impact this species in Myanmar.

Gulls, Terns, Skimmers and Skuas

Several species of gull winter along the Myanmar coast and other species are likely to be found considering this group's propensity to wander widely on their wintering grounds.

Primarily pelagic species that have been recorded in Myanmar as vagrants include the Brown noddy (*Anous stolidus*), Sooty tern (*Onychoprion fuscata*), and Pomarine jaeger (*Stercorarius pomarinus*). Records from elsewhere in the region suggest that these species could be common in offshore waters and a number of additional species could likely occur including the Bridled tern (*O. anaethetus*) and Parasitic (*S. parasiticus*) and Long-tailed (*S. longicaudus*) jaegers. Again the paucity of records for these species in Myanmar is likely due to a lack of observer effort rather than truly low populations.

Numerous species of terns are found along the Myanmar coast and many of these species, such as the Common (*Sterna hirundo*), Gull-billed (*Gelocbelidon nilotica*), Whiskered (*Chlidonias hybridus*), White-winged black (*C. leucopterus*), Lesser crested (*Thalasseus bengalensis*) and Caspian (*Hydroprogne caspia*) terns, are only winter visitors to the area. Further work is needed to understand what species are resident and where important breeding locations are found. This could include Little (*Sternula albifrons*), Black-naped (*Sterna sumatrana*), Great crested (*T. bergii*) and potentially Roseate (*S. dougallii*) terns.

Of greatest concern in Myanmar are the populations of three rapidly declining species primarily restricted to breeding on inland rivers. The River tern (*S. aurantia*), Black-bellied tern (*S. acuticauda*) and Indian

skimmer (*Rynchops albicollis*) have all experienced catastrophic declines within Myanmar with the Black-bellied tern and Indian skimmer potentially extinct as breeding species within the country. Reports of 28 Indian Skimmers in mangroves on the Rakhine coast in 2008 (Zöckler, *in litt.*) suggest that the area could be an important wintering range for this rapidly declining species. Further work is needed to determine if either species of river nesting tern is also using these coastal habitats.

Offshore Islands

As well as the broad range of bird species that primarily use coastal areas for feeding and nesting, there are a few species that are particularly restricted to offshore islands. These include a suite of nomadic frugivores that are rarely encountered on the mainland, which are likely to be impacted by a similar range of threats to the species already mentioned. The Myeik Archipelago is home to some of the largest known concentrations of Plain-pouched hornbill (*Aceros subruficollis*) in the world. This species makes seasonal movements across the Isthmus of Kra (the narrow neck of southern Myanmar and Thailand that connects the Malay Peninsula to the Asian mainland) from northern Taninthayi to the northern most states of Malaysia (Kedah, Perak and Kelantan) (Wells, 2007). Further study is needed to fully understand the ecological needs of this species and to understand the complex links between roosting and foraging sites on offshore, forested islands and evergreen forests on the mainland as well as seasonal movements.

The offshore islands also host a number of poorly understood species of pigeon including the Pale-capped pigeon (*Columba punicea*), Nicobar pigeon (*Caloenas nicobarica*), Cinnamon-headed green-pigeon (*Treron fulvicollis*), Large green-pigeon (*T. capellei*) and Pied imperial-pigeon (*Ducula bicolor*). Similar to the hornbills, these species travel widely in search of fruit and their exact ecological needs in relation to breeding and feeding sites are still poorly understood (Wells, 2007). The Myeik Archipelago is likely to support substantial numbers of these species but no surveys have been conducted to date. The most well-known species on the offshore islands of Taninthayi are the group broadly known as edible nest swiftlets. These groups of birds are renowned for their edible nests made from the birds' saliva that are sold for considerable sums of money all across Asia to make soup. While local residents historically managed natural nesting areas in caves on offshore islands, they are increasingly attracting the species

to nest in abandoned buildings and purpose-built structures on the mainland to increase production and facilitate easier harvests. The species composition in Taninthayi could involve at least three separate species, all very difficult to distinguish from one another in the field without seeing the characteristics of their nests. The Black-nest (*Aerodramus maxima*), Edible-nest (*A. fuciphaga*) and Germain's (*A. germani*) swiftlets are all reported to occur within Myanmar. True Edible-nest swiftlets are likely to be restricted to offshore islands within the Myeik Archipelago while Germain's swiftlet is by far the most abundant species using man-made structures for nesting and now providing the bulk of the edible nests sold in Myanmar (Poole, 2010).

Mangroves

The extensive mangroves along both the Taninthayi and Rakhine coasts are likely to support a series of mangrove-dependent species. Many of these species are relatively widespread throughout South-east Asia but several are of high conservation importance. These include the poorly understood and Endangered Masked finfoot (*Heliopais personata*), which are known to breed in mangroves in Bangladesh and historically wintered in mangroves in Thailand. This species' shy and retiring nature makes it very difficult to locate and considerable effort would be needed to understand its distribution in coastal Myanmar. Two other globally Near Threatened species likely to have considerable populations in coastal Myanmar are the Brown-winged kingfisher (*Pelargopsis amauroptera*) and Mangrove pitta (*Pitta megarhyncha*) (IUCN, Web page). These species are likely to be disturbed by increased development and habitat degradation along both coastlines.

The Cocos Islands

The Cocos Islands are found off the southwestern tip of Myanmar (Figure 2) and are home to a suite of endemic species restricted to the Andaman chain of islands further south. The Andaman green-pigeon (*Treron chloropterus*), Andaman coucal (*Centropus andamanensis*) and the Near Threatened Andaman drongo (*Dicrurus andamanensis*) are likely to still occur, but the globally Vulnerable Nicobar scrub-fowl (*Megapodius nicobariensis*) (IUCN, Web page) may already have been extirpated if it ever occurred naturally on the islands (Robson, 2008). These islands have not been surveyed in recent times and it is unclear if healthy populations of any of these species still remain. Additional surveys are needed

before the area is further impacted. There are currently a number of proposals to develop the islands for tourism although, at present, transport to the islands is extremely limited making rapid development unlikely in the short term.

The sea and coastal birds of Myanmar are summarized in Appendix 8.

CRUSTACEANS

The subphylum Crustacea, order Decapoda, includes the lobsters, crabs and shrimps.

San Aung & Hla Htay (1986) generated a list of fish, prawns, shrimps and lobsters caught during bottom trawl surveys conducted in 1979 and 1980. Similarly, species caught in a bottom trawl survey in 2007 were reported by Thapanand-Chaidee *et al.* (2008). Crabs and shrimp made up 9% and 4%, respectively, of the invertebrate catches (Thapanand-Chaidee *et al.*, 2010). Species compositions of crustaceans have been reported by Htay Aung (2004) and Maw Maw Myint *et al.* (2004) (Myeik Archipelago); Khin Wai Hlaing (2012) (Mon State); and Aye Aye Khine (2000) (Rakhine Coast).

Decapod crustaceans are caught by artisanal fishermen using shrimp gill nets (also called trammel nets), push nets (for *Acetes* shrimps), tidal set bag nets, stake nets and traps while commercial offshore fisheries use bottom otter trawlers that target primarily shrimp (Htay Aung, 2004). However, push nets are illegal under national fisheries laws since they damage benthic habitats.

Prawns and Shrimps

Shrimps are among the most important fishery resource in Myanmar. Species of both freshwater and marine shrimp are caught and farmed for both local consumption and export.

In the marine realm, a range of fishing methods target different species of shrimp. For example, the commercial bottom trawlers in Myeik catch, primarily, *Penaeus monodon*, *P. semisulcatus*, *Metapenaeus ensis*, *M. affinis* and *Metapenaeopsis stridulans*. A number of different gear types are used by local fishermen, which capture a range of species. Push nets are used along the coast to catch *Acetes* shrimps. The bagnet fishery catches can vary between different regions and tend to catch a subset of a diverse number of species (Htay Aung, 2004). Trammel nets are used close to shore throughout the coastal waters

between the islands of the Myeik Archipelago (Htay Aung, 2004). Larger catches tend to be made from May to August (Stakeholder interviews).

Ngapi, a beloved Myanmar fish paste, is made from *Acetes indicus* shrimps that are partly dried and pounded into a paste with salt.

Marine shrimp fishing effort and catch increased after 1996 when the country's market-oriented economic policy was instituted. In Myeik, the number of fishing vessels and shrimp landings peaked in 2000-2001. After then, the number of vessels leveled off at around 268, but landings declined through to 2004 (Htay Aung, 2004), which could suggest that shrimp stocks were beyond their carrying capacity to sustain existing efforts. However, over the ten year period from 2001 to 2011 official FAO data for all of Myanmar recorded an increase in wild caught marine shrimp tonnage from 27,973 to 94,207 (Food and Agriculture Organization, Web page-c).

Bycatch from commercial shrimp fishing is a major concern since various non-target species are unintentionally captured and killed as bycatch. Numerous species of finfish are caught in trawlers (Maw Maw Than, 1991) and marine mammals are susceptible to entanglement in trammel nets (Reeves *et al.*, 2013) such as those used in the Myeik Archipelago (Htay Aung, 2004).

Important commercial shrimp species vary in their

habitat requirements. The whole range of nearshore habitats, such as estuaries, seagrass beds, mangroves and coral reefs, are used by at least one of the commercially important species of shrimp at some point in its lifecycle. Researchers have documented the species composition of the shrimps and prawns of various regions along the coast of Myanmar. This includes the Patheingyi District on the Rakhine Coast (Aye Aye Mon, 2006; Mar Mar Cho, 2006); the Ngazun River mouth in Patheingyi District (Gayder Kittim Ku, 2009; Khin Nwe Mu, 1980); the Ayeyawady region (Nant Nay Chit Latt, 2009); Mon State in the northern part of the Taninthayi Coast (Htay Aung, 1982; Khin Wai Hlaing, 2012; Than Than Soe, 2012); the Taninthayi River estuary near Myeik (Htay Aung, 2004; Kathi Khine Soe, 2011); and in the Myeik Archipelago of Taninthayi

Coast (Maw Maw Myint *et al.*, 2004) (Figures 2 and 3). Myanmar scientists have also researched the biology of important shrimp species intensively (Htoo Thant, 1987; Khin Htwe Yi, 2000; Khin Khin Htay, 1998; Khin Myint Zin, 1984; Myo Nandar Myint, 2012; Nwe Nwe Ni, 1998; San San Yi, 1997; Swe Swe Myint, 2007; Than Htaike, 1999).

To conserve wild shrimp populations, the DoF issued Notification No. 3/95 (23 March, 1995), which states that the capture, transport, storage, sale and retaining of gravid (with eggs) female shrimps are all prohibited. Fishermen are required to release living female gravid shrimps that have become entangled in fishing gear.

Because of the high demand for shrimp, people throughout Asia have turned to shrimp farming for economic development. Virtually all marine-farmed shrimp are in the genus *Penaeus*. Shrimp farming started in Myanmar in the mid-1970s. People in northern Rakhine State would trap and hold juvenile shrimp in large intertidal areas that supported abundant juveniles (Food and Agriculture Organization of the United Nations, 2003). Since then, there has been substantial encouragement by the government to expand farming operations through training and loan programmes, and organisations like the FAO have contributed to hatchery development, UN agencies have initiated small-scale farms and private aquaculture farms have been established. Shrimp production from aquaculture has increased nearly



Dried prawns and shrimps, shown here along with other dried fish, are important to the traditional diet of Myanmar people as well as a major component of the country's trade exports.

ten-fold from 5,473 tonnes in 2001 to 51,207 tonnes ten years later (Food and Agriculture Organization, Web page-c).

The largest area of shrimp farming is in Rakhine State, followed by Ayeyawady Region and Yangon Region, respectively (Food and Agriculture Organization of the United Nations, 2003). In Myanmar, various researchers have studied aspects of intensive and integrated farming systems (Food and Agriculture Organization of the United Nations, 2003; Okamoto, 2008; Thiri Tun, 2010). Recently, Joffre & Moe Aung (2012) conducted a detailed value chains analysis of prawn farming in Rakhine State that outlined the range of drivers (including high mortality, high costs and impacts from cyclones) that led to a low yield in 2011-2012 and the abandonment of ponds.

In many shrimp farms, mangroves have been converted to aquaculture ponds and there is concern that without proper protection and planning, shrimp farming is leading to dramatic deforestation of mangroves (Aye Aye Min, 2011; Hnin Khaing Aye, 2006, 2007; Ohn Mar Myat Oo, 2008; Thanda Win, 2011) and impacting native animal populations (Khaing Khaing Kyi, 2010). The practice also creates acid sulphate soils (Food and Agriculture Organization of the United Nations, 2003) which can have a range of destructive effects on fish and plant life and is toxic to mangrove trees, making restoration of former shrimp ponds extremely difficult. The productivity of existing shrimp farms that were developed in mangrove areas is low and, in some cases, may be less than the fishery productivity values from the original mangrove stand (Food and Agriculture Organization of the United Nations, 2003). Poor farming practices have also introduced diseases, such as the White spot syndrome virus, into farmed populations and the effects on wild populations is unclear (Food and Agriculture Organization of the United Nations, 2003).

One possibility for rehabilitation of abandoned shrimp ponds is applying aquasilviculture techniques. "Aquasilviculture" is a multiple use approach that promotes the co-existence of fishery species and mangrove tree species in a semi-enclosed system while still allowing for the ecosystem services provided by mangroves (Baconguis, 1991). Typically, ponds are flooded and mangroves are replanted and the remaining 20 - 30% of the area is used to create deeper ponds along the dikes

for brackish water aquaculture. Aquasilviculture is practiced in some parts of the Philippines and training was recently provided for some constituents of SEAFDEC.

See Appendix 9 for a summary of marine prawn and shrimp species encountered and thought to exist in Myanmar along with their corresponding current IUCN Red List statuses.

Lobsters

Spiny lobsters of the genera *Panulirus* and *Thenus* live in reefs and rocky areas that provide crevices where they hide during the day. They are caught mainly by traps and bottom set gill nets as well as by free-diving.

A commercial spiny lobster fishery started in 1995 with the export of live lobsters to China and the lucrative fishery has grown dramatically. Increasing fishing efforts have resulted in declines in catch and, increasingly, juveniles are landed (Stakeholder interviews).

The species composition of lobsters has been documented for various regions along the coast of Myanmar: Sittwe of northern Rakhine (Aye Aye Khine, 2000); Chaung Tha of the southern end of the Rakhine Coast (Aye Nyein Thu, 2010); Myeik (Maw Maw Myint *et al.*, 2004); Mon State of the northern part of the Taninthayi Coast (Hnin Ei Soe, 2011); trawls offshore of the Taninthayi Coast (San Aung & Hla Htay, 1986); and Myeik Archipelago (Htay



Spiny lobsters are bought by trading companies and held in pens, like this one in Don Nyaung Hmaing Village in the Myeik Archipelago, and then are exported live to overseas markets.



Many people buy fresh fish from the smaller landing sites along Ngapali beach during the sardine and anchovy season.

Aung, 2004) (Figures 2 and 3). See Appendix 10 for a list of Myanmar's lobster species.

Panulirus ornatus, found along both the Rakhine and Taninthayi Coasts, is the most valued species by the Chinese market since it is larger and more robust than the other species of rock lobster (Hart, 2009). Other colourful species (*P. homarus* and *P. longipes*) are also valuable, while the less colourful species, *P. versicolor* and *P. polyphagus*, are of the lowest value since they don't look as beautiful on a banquet table (Hart, 2009).

A number of other species of lobsters are likely to be present in Myanmar (IUCN, Web page) but they have not been thoroughly documented or studied unlike the economically important spiny lobsters.

The DoF has designated the coastal area near Anansan village in Thanbyuzayat Township in Mon State as a lobster refuge (Figure 3) (U Tint Tun, *pers. comm.*).

Crabs

The mud crabs, *Scylla serrata* and *S. olivacea*, are found in mangrove swamps and can be hooked from their burrows and caught with baited traps. Intensive studies of mud crab biology and fisheries have been conducted by many researchers (Hla Hla Win, 2009; Kyi Kyi Maw, 2007; Mie Mie Sein, 2006b; Saw Htoo Baw, 1978; Thinzar Lwin Lwin, 2011).

Mud crabs are cultured in mangroves and mud flats of the Rakhine Coast, Ayeyawady Delta region and Taninthayi Coast. Crabs are caught in the wild and

are kept in ponds or in cages kept in river systems and are fattened for six to seven months with chopped fish, shrimps and agricultural byproducts. The practice is less destructive than shrimp farms since habitats are not destroyed (Tin Win, 2002).

Soft-shelled crab is cultured at the Doung Koo Maw farm off of Myeik. Mud crabs (*S. serrata*) are caught using traps in mangrove areas during the full moon period. They are kept in containers held on rafts in brackish water and fed and monitored until they moult, at which time they are transferred to fresh water to prevent their shells from hardening. They are mainly exported to Japan and Malaysia (Food and Agriculture Organization of the United Nations, 2003).

Another mangrove crab, *Sesarma bidens* (currently named *Perisesarma bidens*), is salted and exported to Thailand.

Crab is one of the top ten export fisheries products of Myanmar. Annual production of crabs only started being reported in 2008 when it was estimated at 4584 tonnes valued at USD22,920,000. It had decreased to 1,500 tonnes valued at USD8,925,000 by 2011 (Food and Agriculture Organization, Web page-c). In 2010-2011, 19,500 juvenile mud crabs were released as part of a DoF stocking programme (Kyaw Tint *et al.*, 2012b).

In Myeik, people use bagnets to catch crabs of the species *Portunus pelagicus*, *P. sanguinolentus* and *Charybdis feriata*. Frog crabs, *Ranina ranina*, are caught off sandy bottoms using gill nets fixed to a frame. A fishing ground for these crabs was discovered in Myeik in 2000 and it has since become an



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The Pharaoh cuttlefish is commonly seen on the deep reefs off islands of the Myeik Archipelago. A male will mate with a female and carefully guard her from other males while she deposits packets of fertilized eggs into crevasses in the reef.

established fishery (Htay Aung, 2004).

Studies have also been made of non-fishery but ecologically important crabs such as hermit crabs (Mg Mg Gyi, 1993) and the horseshoe crab (Thi Thi Mar, 2009).

The species composition of crabs has been documented for various regions along the coast of Myanmar: Mangroves in Gwa of the Rakhine Coast (Thanda Win, 2011); the Mangroves in the Ayeyawady Delta (Thet Su Mar, 2010); Myeik (Maw Maw Myint *et al.*, 2004); and trawls offshore of the Taninthayi Coast (San Aung & Hla Htay, 1986) and Myeik Archipelago (Htay Aung, 2004) (Figures 2 and 3). See Appendix 11 for a list of Myanmar's crab species.

MOLLUSCS

The molluscs are the largest marine phylum and are highly diverse, demonstrating a wide variety of body forms. In Myanmar, molluscs are important components of both commercial and artisanal fisheries. Some studies have, unsurprisingly, focused on the commercial squid fishery or pearl industry. However students and academics of Myanmar's universities have also conducted studies of some of the less commercial groups (such as the marine snails) so there is some foundational knowledge on the composition of marine molluscs in the country. See Appendices 9 to 11, which summarize many of the known mollusc species identified in Myanmar's waters.

The cephalopods are characterized by bilateral body symmetry, a prominent head and a set of tentacles and include the squids, octopuses, cuttlefish and nautilus. Jar San (2011) generated a species list of cephalopods for Mon State that is likely representative for the Taninthayi Coast. And some comparative anatomy has been conducted across the groups (Khin Myat Myat Tun, 2000).

All cephalopods believed to be in Myanmar's waters are summarized in Appendix 12.

Squids

The squid fishery is extremely important in Myanmar, both for local people as well as on a commercial scale. Artisanal squid fishing is common among the Moken people who fish from their small dugout canoes either alone or in groups. They tend to fish when the moon is near full to be able to see by its light. They also fish for squids during the day (Tint Tun, *pers. comm.*). In contrast, large commercial boats use light to lure squids. They equip their boats with lines of light bulbs and fish at night during periods when the moon is barely visible. In this way, their lights shine bright in the dark night and the squids will concentrate around their boats.

Squids are the most dominant invertebrate species in Myanmar's offshore waters. In a study of marine fishery resources from bottom trawls, squids were the second-most common catch by weight after a non-target species of lizardfish and made up nearly 50% of the invertebrate catch by weight (Thapanand-Chaidee *et al.*, 2010). However, studies such as this

are not enough to make accurate stock assessment of this important resource.

In a review of squid landings, Thin Thin Maw (2009), identified *Euprymna berryi* in Myanmar, which is outside of this species' FAO-reported distribution (Food and Agriculture Organization, Web page-b).

Octopuses

Octopuses are collected by local people for food or, when possible, sold to local restaurants and hotels. Myanmar researchers have studied aspects of octopus anatomy and morphology (Jar San, 2011; Khin Myat Myat Tun, 2000; Kyi Bin, 1979). In addition to those that have been confirmed, at least two additional species probably also occur in the country (Food and Agriculture Organization, Web page-b) (see Appendix 12).

Cuttlefish

Cuttlefish have been studied by only a few researchers in Myanmar. This group is unique among the cephalopods for their hard, brittle internal structure known as the cuttlebone. They are not a targeted fishery and it's not clear the degree to which they are consumed in the country.

They have been included in inventories of cephalopods (Jar San, 2011; Thin Thin Maw, 2009) and

have been subjects of anatomical studies (Khin Myat Myat Tun, 2000; Su Su Khin, 1992; Wai Wai Kan Oo, 1982). Wai Wai Kan Oo (1982) studied the anatomy of a cuttlefish species, *Sepia esculenta*, whose distribution as reported by the FAO does not yet include Myanmar.

In a study of marine fishery resources from bottom trawls, cuttlefish made up over 10% of the invertebrate catch by weight (Thapanand-Chaidee *et al.*, 2010).

Nautilus

Shells of the chambered nautilus, *Nautilus* spp. and *Allonautilus* spp., are well-known collectables and a variety of products are made from their shells. Specimens of *Nautilus pompilius* have been documented in Thailand (Global Biodiversity Information Facility, Web page) near the border with southern Myanmar. These reports have led researchers, such as De Angelis (2012) to suggest that the species might possibly be native to Myanmar as well and their presence might be confirmed in the future.

Shellfish

Myanmar supports highly diverse communities of marine gastropods and bivalves, which include clams, oysters and other molluscs with pairs of hinged shells. Because marine shells have attracted wide global and historical interest of collectors,



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Commercial squid boats fish at night using lights to attract squids alongside their boats.

much is known about their taxonomy and various books review the distributions of many species in the world and regionally [for example, see Abbott (1991) or Abbott & Dance (2000)].

Within Myanmar, species lists have been generated for much of the coastline of the country by Soe Thu (1980) and Mar Lar Myo Sein (1982). Since then, other studies have focused on documenting the nearshore species compositions of particular areas: Chaung Tha of the Rakhine Coast (Nan Nwe Nwe Aye, 1998; Sandar Win, 2009, 2011; Sandar Win & Khin Maung Swe, 2011; Soe Than, 2006), the coastal area of Mon State (Naung Naung Oo, 2012), Thandar Island of the Myeik Archipelago (Soe Soe Aye, 2009), the mudflats around the town of Myeik (Phyu Phyu Than, 2012) and offshore communities (Phyu Phyu Khin Win, 1990).

Thesis students have also investigated the taxonomy of the family *Neritidae* (Aye Thida Thein, 1982) and the anatomies of the commercial trochus shell (*Tectus niloticus*) (Hla Hla Aye, 1996) which is an important source of mother of pearl and the spider conch (*Lambis lambis*) (Mya Mya Htwe, 1995) whose unique shell can be sold as curios.

Local people collect a variety of shellfish for food. They are gleaned from pools, rocks and shallow reefs and collected opportunistically from reefs by free divers as they also hunt for lobsters and other target species. A large number are sold to tourists, either as simple, cleaned shells or modified into crafts and souvenirs. This “curios” market is well-developed in Myanmar with complex chains of suppliers, buyers, artists and sellers (Stakeholder interviews) that have not yet been well-documented in reports and publications. The impact of harvesting shells has not been

studied in Myanmar and is not well-understood for most species in the world.

Giant clams (of the genus *Tridacna*) are collected, particularly in the Myeik Archipelago, on the same fishing trips when local fishers are targeting a range of species including sea cucumbers and other clams (Nang Mya Han, 2012).

Shells are also ground up and used as an additive in chicken feed to strengthen their egg shells.

Many of the bivalves and gastropods that have been documented in Myanmar’s waters are summarized in Appendices 13 and 14. Undoubtedly there are many more species than included in these lists.

Nudibranchs

Nudibranchs are a particular group of animals of the class *Gastropoda* that, unlike marine snails, are soft-bodied with no shell in the adult stage. Nudibranchs are admired for their striking colours and forms. They are not edible and they have no direct economic worth but SCUBA diving tourists value seeing them. There have not been any studies or documentation of this group of animals in Myanmar. During this study, five species were encountered and there are likely many more species in Myanmar’s waters (see Appendix 14).

Bivalve and gastropod species of Myanmar are summarized in Appendices 10 and 11.



Nudibranchs, such as this *Chromodoris geminus*, are common on the reefs of Myanmar.

Pearl Oysters

Pearls can be cultured in marine oysters of the genera *Pinctada* and *Pteria* and fresh water mussels of the genus *Hyriopsis*. In 1954, a private Japanese-Myanmar joint pearl culture venture was started on Domel Kyun in the Myeik Archipelago (Figure 3) to produce South Sea pearls from the Gold-lipped pearl oyster, *Pinctada maxima*, which is common in southern Myanmar. After two years, the farm was relocated to nearby Pearl Island (Pale Kyun) (Figure 3). The farm was nationalized in 1963 and after 1988, when Myanmar became a market-oriented economy, it eventually became the Myanmar Pearl Enterprise (MPE) under the Ministry of Mines and opportunities arose for more producers (Tint Tun, 1998). Currently there are both local and foreign joint pearl ventures in Myanmar (Kay Thwe Htwe, 2006).

Before nationalization, pearl seeding — inserting a small “seed” inside the mantle onto which the oyster will deposit layers of nacre, creating a pearl — and harvest were conducted only by Japanese experts and the techniques were kept secret. Once the Japanese left, biology teachers from Rangoon (Yangon) University (U Hia Aung, U Myint Tun, U Htia Aung and U Khin Nyunt) developed seeding techniques. The peak of the market was in 1990 when proceeds from pearl sales were estimated at more than five million US dollars (Tint Tun, 1998).

The supply of wild oysters is erratic so pearl oysters are produced by the hatchery at Pearl Island (Maung Bo, 2004). Myanmar researchers have studied various aspects of the biology of *P. maxima* including anatomy (Tint Tun, 1984), spawning and rearing conditions (Kay Thwe Htwe, 2006, 2007; San San Aye, 2007; Tint Tun, 1989) and the cause of mass mortalities (Tint Tun, 2000).

All fishing is prohibited within three nautical miles of Pearl Island according to DoF Notification No. 7/93 (29 July 1993).

ECHINODERMS

Echinoderms include sea cucumbers, sea stars and sea urchins, discussed below. Other echinoderms that are less economically important, including feather stars and brittle stars, are not reviewed here but have been documented by Duncan *et al.* (1889b).

Sea Cucumbers

Sea cucumbers, also called *bêche-de-mer*, are slow moving, cylindrical invertebrates with few defenses. Each species has a particular habitat preference and species can be found in deep and shallow waters and on coral reefs, in seagrass beds and along the intertidal zone. Nearshore, intertidal species are particularly easy to collect and often contribute to small-scale, artisanal fisheries in developing countries. Deeper water sea cucumbers are collected by free divers or divers using compressed air. They also use simple fork-ended rods to collect the animals.

Sea cucumbers are boiled, dried (by sun or smoke) and exported mainly for use in Chinese cuisine or traditional medicines. Fishing takes place in the dry season from October to April when the waters are calmer and, presumably, when it's easier to dry the product. In Taninthayi, there are buying centres in Myeik and Kawthoung and the products are sent to Yangon or Ranong in Thailand (Figure 3), and then on to major markets in Japan, Korea, China and Singapore. The species range in value with the highest-valued species fetching as much as 100,000 kyats/kg of dried weight, which is currently worth more than USD100. *Holothuria scabra* and *H. lessoni* are common, high-valued species. A species of *Synaptula* fetches the highest price but is rare. In Myanmar, sea cucumbers are found most commonly in the Myeik Archipelago where the species composition has been well-documented (Bo Bo Kyaw, 2012; Nang Mya Han, 2012; Yee Yee Htwe, 2009). There are fewer animals along the Rakhine Coast (Nang Mya Han, 2012), which supports a smaller fishery.

Although sea cucumbers have been harvested in Myanmar for centuries, the industry has undergone rapid expansion with the opening of Chinese markets in the 1980s and there was a boom in the industry in the 1990s in Southeast Asia, including Myanmar (Tint Tun *et al.*, 2008). The increasing demands of the market and lack of regulations have led to uncontrolled exploitation of the resource. Sea cucumber stocks have been overexploited in many countries and some have placed temporary moratoriums on their harvest to allow populations to recover. It is unclear what the current level of harvest pressure and status of sea cucumber stocks are in Myanmar.

Sea cucumber species that are found in Myanmar are summarized in Appendix 15. Two species identified within this study are new records for Myanmar.



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The Crown-of-thorns starfish is abundant on reefs in the southern Myeik Archipelago. The impact of this destructive species in Myanmar has not yet been assessed.

Sea Urchins

Sea urchins are collected by local people for their roe (eggs), which can be eaten.

Starfish

Starfish are dried and sold at souvenir shops. The Crown-of-thorns (*Acanthaster planci*) is a destructive species of starfish that eats corals and has ravaged reefs in the region. They are abundant on reefs in southern Myeik Archipelago at all of the sites marked on Figure 6 (this study) but no one has yet studied their impact in the country.

Echinoderm species of Myanmar, except sea cucumbers, are listed in Appendix 16.

CORALS

Of the 267 species that Veron (2000) shows likely to exist in Myanmar waters, most of these species (99.6%) are shared with the nearby Coral Triangle, a region of high coral diversity that encompasses the waters of Indonesia, Malaysia, the Philippines and Papua New Guinea (Veron *et al.*, 2009). A smaller, but still substantial, portion of these coral species (75.7%) is also shared with the Western Indian Ocean. Only one coral species is shown as inhabiting only the waters edging the Bay of Bengal: *Acropora rudis* is believed to be limited to a belt

through Thailand, Myanmar, India, Sri Lanka and the Maldives (Veron, 2000).

Due to various influencing factors such as evolutionary history, circulation patterns and habitat diversity, coral species-level diversity is highest within the Coral Triangle. In areas stretching north of this region, diversity drops off but still remains high when compared with other regions of the world. It is unsurprising, therefore, that species diversity is higher in the lower latitudes of Myanmar.

A number of studies have documented the species composition of corals at various coastal sites in Myanmar (Aung Phyo Oo, 2012; Cherry Aung, 2009a, b; Han Ni Linn, 2010; Mya Than Tun & Tint Tun, 2002; Obura *et al.*, 2014; San San Win, 1993; Soe Tint Aung, 2010; Tin Myo Aung, 2010; War War Soe, 2008; Zarni Ko Ko, 2012). Coral taxonomy and species distributions are evolving areas of knowledge. OBIS (Web site) shares data on record distributions and WoRMS (Web site) provides information on the changing taxonomy and the currently recognized species names. Drawing from these sources, an updated list of predicted and known coral species compositions of the three coastal areas is summarized in Appendix 2. Only corals of the Class Anthozoa are included. Coral Families are also being rethought taxonomically based on genetic analyses. There are disputes concerning the reclassification of species within the traditional Families Faviidae, Mussidae, Oculinidae, Pectiniidae, Poritidae, and Siderastreaeidae. We chose to organize this species list using the

same Family groupings as most of the coral researchers referenced to allow for minimal confusion.

Note that this list contains only those species that the authors of this report are confident likely occur in Myanmar's waters. It does not include all the species identified by researchers since, for some of these species, the current known distribution does not include Myanmar or nearby waters, or we were unable to find references that confirmed their distributions. Further study will help to confirm species identifications, broaden this list and reveal range extensions. Also note that, with evolving taxonomic understanding, many species once known under one name have been reclassified and are now known under another name and some species have been combined. Records include 356 species of 76 genera.

Among these records, we include 42 species that have not yet been encountered in the studies conducted in the country but whose known ranges indicate that they likely occur in Myanmar's waters. Conversely, eight species that were identified by at least one Myanmar researcher but whose ranges reported in Veron (2000) and data records included in the OBIS database do not include Myanmar, have been considered probable and may represent range extensions for those species. Further collections and taxonomic studies will therefore likely confirm range extensions and document additional species in Myanmar.

Species distributions within Myanmar are influenced not only by latitude but also by sedimentation patterns. *Favites* spp., *Favia* spp., *Pocillopora* spp., and *Pavona* spp. seem to be tolerant of high sedimentation while *Symphyllia* spp., *Lobophyllia* spp., *Galaxea* spp., *Montipora* spp. and *Pories* spp. are prominent in areas with lower levels. *Millepora* spp., *Heliopora* spp., *Hypnopora* spp. and *Turbinaria* spp. are found in clear waters (Cherry Aung, 2009a). Very few species are found in the Ayeyawady Delta region since sedimentation levels are so high.

Alterations in the physical parameters that corals experience can cause colonies to die and species distributions to change over time. If sedimentation levels increase in portions of the Rakhine or Taninthayi coasts, corals will die off and species biodiversity will decrease. Of particular concern in Myanmar is coral bleaching which appears to be becoming widespread. Coral bleaching occurs when increases in sedimentation, temperature, pollution or disease stress corals causing them to eject the symbiotic algae living in their tissues. Without these algae, corals turn white and die. Bleached corals were seen on the reefs of the Myeik Archipelago in 2013 by research divers

(U Zau Lunn, *pers. comm.*), SCUBA divers (tourism survey, Appendix 18) and researchers of this study. The degree and distribution of bleaching have not yet been adequately assessed.

There are two main ways corals are directly, physically damaged in Myanmar — blast fishing and trawling. Blast fishing became common in Myanmar in the 1990s and is still witnessed in the Myeik Archipelago (see tourism surveys in Appendix 18). Trawlers that operate too close to shore and over reefs can drag up corals, killing the colonies and destroying the habitat. Corals that have been broken apart and pulled to the surface cannot survive. Plus corals have a very slow growth rate, so pieces remaining after severe damage often cannot grow fast enough before seaweeds outcompete them for space.

SEAWEEDS

Algae is a diverse group of aquatic plants that range in size from microscopic, unicellular organisms to multicellular forms that can be as large as giant kelps which can reach 65 m long. The term “seaweed” is a non-formal term that refers to macroscopic, benthic marine algae. The chlorophyll compositions in the tissues of seaweeds influence their colours and these colours are used to classify the seaweeds into three major groups — red algae, green algae and brown algae.

Seaweeds have been well-documented in Myanmar. Some short species lists were compiled by Martin (1871) and then it was more than 100 years later when the next scientific attention was given to them (Kyi Win, 1972). We collected more than 60 reports, publications and theses that include seaweeds as their foci. These are summarized in Appendix 17. There have been a number of recent, detailed reviews for each of the major groupings, including habitats and their local and global ranges (Mya Kyawt Wai *et al.*, 2009a; Soe Htun *et al.*, 2009a; Soe Htun *et al.*, 2009c; Soe Htun *et al.*, 2009d; Soe Htun *et al.*, 2009e; Soe Htun *et al.*, 2009f; Soe Pa Pa Kyaw *et al.*, 2009c). In some cases, known global distributions shared in the OBIS database implied that a species would not likely be found in Myanmar but multiple researchers in the country identified it. The authors of this report are unable to assess the probability of whether these records represent valid range extensions. Further study and review by qualified specialists will allow confirmation of various seaweed range extensions and data from Myanmar's seaweed specialists should be shared with global marine databases for inclusion.

Seaweeds are farmed commercially in many regions of the world. They are sold for food and for extractions of agar and carrageenan, both of which are gelling agents that have a range of uses. The technology used is wide ranging from the simple harvest and management of naturally occurring batches to complex culturing facilities. In Myanmar, people use low-technology approaches. Algae are attached to nets or strings that are fastened to a floating line tied between anchored poles that have been pushed into the bottom. This is done in shallow water near to the shoreline. Multiple lines can be arranged in rows (Win Htin, 1989).

Seaweed culture experiments have been conducted by Myanmar scientists since the 1960s and the first factory to produce carrageenan and agar from *Hypnea* and *Gracilaria* was established in 1979 in Thandwe District of the Rakhine Coast (Figure 2). *Enteromorpha*, *Catenella* and *Sargassum* have been grown to produce Japanese nori (Win Htin, 1989). Currently there is seaweed farming in the Myeik Archipelago. In 1989 it was estimated that at least 1,500 tons of dried, raw seaweed was produced in Myanmar each year (Win Htin, 1989).

Sometimes important habitats such as mangrove stands and seagrass beds are removed in nearshore

areas to create seaweed farms, though this impact is likely small in Myanmar. One of the main potential problems with seaweed farming is that the lack of protocols and restrictions can lead to the introduction of commercially interesting species from elsewhere that may become invasive with a range of difficult-to-predict impacts including uncontrolled growth. For example, a commercially desirable seaweed species, *Eucheuma denticulatum*, was introduced for farming in Kiribati. It has since grown out of control and is choking coral reefs, fouling fishing nets and impacting fish catches (New York Times, 2008). Similarly, the alga *Kappaphycus alvarezii* was introduced for commercial cultivation in southern India and within a decade it smothered the reef of the Gulf of Mannar Biosphere Reserve (Chandrasekaran *et al.*, 2008) and the same genus is spreading rapidly over reef in Kaneohe Bay in Hawaii (Conklin & Smith, 2005).

There is currently no legislation regulating aspects of seaweed culture in Myanmar (Mya Than Tun *pers. comm.*).



STAKEHOLDERS

GOVERNMENT

Department of Fisheries (DoF)

The Department of Fisheries (DoF) falls under the Ministry of Livestock, Fisheries and Rural Development (MLFRD) and is responsible for the management of Myanmar's fisheries and coastal resources. As of 2010, livestock and fisheries accounted for 7.6% of the country's gross domestic product (Department of Fisheries, 2010). The DoF has a number of directorates including Capture Fisheries, Aquaculture, Research and Development and Administration. The DoF national headquarters are based in Nay Pyi Taw and States/Regions and Districts have smaller administrative offices.

BOX 7 | The 6 key responsibilities that guide DoF activities:

- The conservation and rehabilitation of fishery resources
- The promotion of fisheries research and surveys
- Collection and compilation of fishery statistics and information
- Provision of fisheries extension services;
- Supervision of fishery sectors
- Ensuring the sustainability of fishery resources

(Myanmar Ministry of Livestock and Fisheries, 2008b)

The DoF issues licenses, evaluates sites for aquaculture, produces fingerlings for sale to the aquaculture industry, advises the MLFRD on fisheries matters, acts as an inspection body for trade, administers auctioning of Leasable Freshwater Fisheries and water bodies for aquaculture, provides training, and communicates with stakeholders.

A Monitoring, Control and Surveillance programme for fishery management generates statistics that are published in national reports by the Myanmar Ministry of Livestock and Fisheries (2008a, b); My-

anmar Ministry of National Planning and Economic Development (2010) and the Department of Fisheries (2010) and are shared with global organisations who can collate and share the data more broadly (see FAO, 2013).

The DoF is involved in research programmes on endangered species and ecosystems such as marine turtles and Irrawaddy dolphins. They oversee some conservation areas such as the marine component of the Thamihla Kyun Wildlife Sanctuary and the Khaing Thauung Island Reserve Forest and work closely with stakeholders to manage these areas. They are also the management authority for two Shark PAs.

The DoF performs the role of Myanmar's scientific authority for aquatic species for CITES.

Department of Environmental Conservation (DEC)

In 2012, the Ministry of Forestry was reorganised to become the Ministry of Environmental Conservation and Forestry (MOECAF) reflecting a growing awareness of the importance of addressing environmental issues in the country. Soon after a new department, the Department of Environmental Conservation (DEC) was created. The DEC will be responsible for an ambitious range of activities including implementing environmental conservation policies, designing and implementing monitoring programmes, prescribing environmental quality standards, conducting activities relating to waste management and conducting Environmental Impact Assessments (EIAs).

Forest Department (FD)

The Forest Department (FD) also falls under MOECAF and is responsible for the management of forests, including mangrove forests, though some mangroves are ceded to the DoF for possible aquaculture development. The FD is also the key implementing agency for the designation and management of protected areas in the country. The FD is Myanmar's management authority, enforcement authority, and scientific authority for non-aquatic species for CITES.



Ministry of Education (MoE)

Myanmar's Ministry of Education (MoE) oversees all formal education in the country from basic to higher education. The ministry supervises the implementation of educational programmes and sets educational policies.

Ministry of Hotels and Tourism (MoHT)

Myanmar's Ministry of Hotels and Tourism (MoHT) oversees and legislates aspects of Myanmar's burgeoning tourism sector. MoHT has worked with NGOs, such as WCS, on developing ecotourism activities.

Navy of the Union of Myanmar

The naval branch of Myanmar's armed forces operates more than 122 vessels. The Navy patrols Myanmar's water and enforces maritime laws for the country. The navy is mandated to enforce various marine fisheries laws, in particular those relating to offshore fishing.

State/Region Governments

Six of Myanmar's 14 States and Regions border the eastern edge of the Bay of Bengal and many of

their peoples have livelihoods connected with marine systems. These are: Rakhine State, Ayeyawady Region, Yangon Region, Bago Region, Mon State and Taninthayi Region.

RESEARCH AND EDUCATION

Myanmar Academy of Arts and Science

The Myanmar Academy of Arts and Science was created in 1999 under the MoE and is comprised of experts from across a range of academic fields. The academy conducts regular seminars and publishes the Journal of the Myanmar Academy of Arts and Science.

Universities

The country's first Marine Biology programme was established in 1973 at the University of Mawlamyine in Mon State on the Taninthayi Coast. It was upgraded to become a Marine Science Department in 1986. Most of the senior marine scientists in the country were trained here. The university has a field station at Setse. This station was established in 1985 as a high-tech aquaculture facility through funding from the UNDP project, "Strengthening of Marine Science Teaching at Moulmein College" (UNESCO, 1985). By 1995, the university was no longer able to support the high maintenance and

electrical costs and the facility began its decline into disrepair. Tanks are now cracked and water filtration and pumping systems are inoperable so aquaculture research can no longer be conducted. However its facilities are still used by the university as a field station that hosts undergraduate field courses.

Two more marine programmes stemmed from the original at Mawlamyine, which allowed research to expand to other areas of Myanmar's coast. Patheingyi University in the Ayeyawady Region has a Marine Science Department with a field station on the Rakhine Coast just south of Shwe Tharyin. This station has good access to a range of marine habitats and hosts seven to ten day courses at the end of each semester. Myeik University, also with a Marine Science Department, is on the Tanintharyi Coast, close to the islands of the Myeik Archipelago. It has a large Marine Science Museum and hopes to host the future Marine and Coastal Resources Research Centre.

Yangon is the oldest university in the country and its students and staff conducted many of the original studies of Myanmar's marine life. It is home to Diamond Jubilee Hall that contains the national depository of PhD Theses. Other universities have Zoology, Botany and Chemistry departments whose staff and students are able to conduct marine-related research, including the Universities of Bago, Dagon, Dawei and Sittwe.

Phuket Marine Biological Centre (PMBC), Thailand

The Phuket Marine Biological Centre (PMBC), established in 1966, is one of the older and more established marine research centres in the region. Regional workshops are often hosted there and, in recent years, Myanmar scientists have had the opportunity to attend training workshops at the centre. In 2010 and 2012, Myanmar teachers have attended courses on coral and marine mammals, respectively.

LOCAL NON-GOVERNMENTAL ORGANIZATIONS (LNGOS)

Marine Science Association, Myanmar (MSAM)

The Marine Science Association, Myanmar (MSAM) is open to all graduates of marine science in Myanmar. MSAM's work focuses on research, conservation and the sustainable development of coastal areas. MSAM collaborates with Marine Science Departments at Mawlamyine, Patheingyi and Myeik Universities along with marine science alumni. MSAM collaborated with WCS Myanmar in

producing this review.

Myanmar Environment Rehabilitation-conservation Network (MERN)

The Myanmar Environment Rehabilitation-conservation Network (MERN) is a network of 16 Myanmar LNGOs with a range of foci and experience. MERN projects are implemented jointly by member NGOs and focus mainly on environmental conservation and rehabilitation linked with community development relating to food security and livelihood development. In the marine realm, MERN instigated the Coastal Livelihood and Environmental Assets Restoration in Rakhine (CLEAR) project to improve mangrove forests and livelihoods in villages in Thandwe District. In 2012, MERN co-hosted the workshop "Conservation and Sustainable Management of Coastal and Marine Ecosystems in Myanmar" alongside IUCN and MFF.

Biodiversity and Nature Conservation Association (BANCA)

The Biodiversity and Nature Conservation Association (BANCA) conducts a range of projects relating to nature including surveys, watershed development, establishing forest plantations and access to drinking water. BANCA partnered with Europe Conservation Switzerland (ECoSwiss) for a series of studies of Lampi Island and is currently partnering with FFI to conduct surveys of coral reefs in the Myeik Archipelago.

Livelihoods and Food Security Trust Fund (LIFT)

The Livelihoods and Food Security Trust Fund (LIFT) aims to improve the food and livelihood security of poor and vulnerable people in Myanmar. LIFT works in areas where food poverty is high, including the Ayeyawady Delta and Rakhine State.

Rakhine Coastal Region Conservation Association (RCA)

The Rakhine Coastal Region Conservation Association (RCA) conducts awareness raising for the conservation, rehabilitation and sustainable use of Rakhine's mangroves and conservation of marine turtles. It also works on community forestry activities and wild elephant conservation.

Rakhita

Rakhita is an environmental NGO based in the Rakhine Coast. In recent months, it has run a five-day land-planning workshop in Ngapali of the Thandwe District (Figure 2).

Forest Resource Environment Development and Conservation Association (FREDA)

The Forest Resource Environment Development and Conservation Association (FREDA) is an NGO with a focus on the forestry sector of Myanmar. FREDA is composed of more than 400 members including foresters, botanists, agronomists, zoologists, veterinary scientists, hydro-geologists, engineers, timber businessmen, journalists and artists. In the marine realm, FREDA has worked with communities that rely on mangrove resources.

Myanmar Environment Institute (MEI)

The Myanmar Environment Institute (MEI) provides training courses in environmental science and management and in conducting EIAs.

The Ecosystem Conservation and Community Development Initiative (ECCDI)

The Ecosystem Conservation and Community Development Initiative (ECCDI) works on sustainable forest ecosystem management, which includes the establishment of mangrove plantations.

INTERNATIONAL NON-GOVERNMENTAL ORGANIZATIONS (INGOS), BILATERAL AID AGENCIES, AND INTERNATIONAL ORGANIZATIONS

Wildlife Conservation Society (WCS) Myanmar

The Wildlife Conservation Society (WCS) was the first international conservation NGO to work in Myanmar, establishing a program in 1993. WCS's Myanmar Program has memorandums of understanding with both MOECAF and MLFRD and has worked with the DoF for over ten years to develop and manage the DoF's first freshwater protected area, the Ayeyawady Dolphin Protected Area on the mainstream Ayeyawady River upstream of Mandalay. The WCS Myanmar Program has worked with MSAM and the WCS Global Marine Conservation

Program to conduct this review.

Fauna and Flora International (FFI)

Fauna and Flora International (FFI) works in Myanmar through collaborations with the local NGO, BANCA. Projects have focused on conducting biodiversity assessments and conservation status reviews and strengthening local civil society organizations to protect biodiversity through protected area management. The NGO recently conducted surveys of reefs in the Myeik Archipelago using the protocols of another international NGO, Reef Check.

Istituto Oikos

Istituto Oikos, an Italian NGO that works in developing countries to promote environmental conservation as tool for socio-economic development. In 2011, Oikos has worked in collaboration with the FD and BANCA at Lampi Marine National Park and recently published a detailed review of Myanmar's Protected Areas (Istituto Oikos, 2011).

International Union for the Conservation of Nature



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(IUCN)

IUCN hopes to start working in Myanmar in the near future alongside the BOBLME Project and in collaboration with MFF on a multi-stakeholder coalition to support and guide national and international conservation efforts in the Myeik Archipelago. In 2012, IUCN, MFF and MERN hosted the workshop “Conservation and Sustainable Management of Coastal and Marine Ecosystems in Myanmar”.

Japan International Cooperation Agency (JICA)

The Japan International Cooperation Agency (JICA) has worked in Myanmar on a range of projects relating to health and economic development. Relevant to the marine realm, the organisation collaborated with MOECAF on the Ayeyawady Delta Integrated Mangrove Rehabilitation and Management Project.

Mangroves for the Future (MFF)

Mangroves for the Future (MFF) promotes investment in coastal ecosystems for sustainable management and uses mangroves as a flagship ecosystem because of their important roles in coastal livelihood and security. MFF has not yet started to work in the country but, as one of its “outreach countries”, Myanmar is invited to regional events and meetings. MFF plans to work alongside IUCN on coastal management issues in Myanmar. In 2012, IUCN, MFF and MERN hosted the workshop “Conservation and Sustainable Management of Coastal and Marine Ecosystems in Myanmar”.

The Wetlands Alliance

The Wetlands Alliance is an association of agencies that view wetlands and aquatic resources as an entry point for poverty alleviation initiatives in Southeast Asia. It engages with partner organisations in Thailand, Vietnam, Laos and Cambodia and, in recent years, has visited projects in Myanmar with an aim to establish a presence in the country.

WorldFish

In September 2012, Worldfish and the DoF commenced the four-year project “Improving Research and Development of Myanmar’s Inland and Coastal Fisheries (MYFish)”. The project is first gathering data on the state of fisheries and aquaculture in Myanmar and then plans to develop management

capacity and help develop fisheries and small-scale aquaculture to increase the productivity of this sector.

Worldview Myanmar Limited

Worldview Myanmar Ltd. Is a nonprofit organization affiliated with Worldview International Foundation. The NGO’s mission includes assisting Myanmar’s sustainable growth through sharing practical approaches and providing information to policy makers on sustainable development. The organization is currently focusing on projects focusing on nectar production from *Nypa* palm, tissue culture for orchid production, solar light testing and mangrove rehabilitation.

REGIONAL BODIES***Bay of Bengal Large Marine Ecosystem (BOBLME) Project***

The BOBLME Project engages all eight nations that rim the Bay of Bengal, namely the Maldives, India, Sri Lanka, Bangladesh, Myanmar, Thailand, Indonesia and Malaysia. The project aims to lay the foundations for a coordinated programme of action designed to improve the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries. The executing agency is the FAO Regional Office for Asia and the Pacific, based in Bangkok, and the FAO is also involved in project components directly relating to fisheries and resource management. Principal funding is from the Global Environment Facility (GEF), the government of Norway, the Swedish International Development Agency, FAO, participating governments and the National Oceanic and Atmosphere Administration (NOAA). The project had a total estimated budget of USD 31 million for an initial period from September 2008 to August 2013, though a no-cost extension has been requested to an anticipated date of March 31, 2015. The National Inception Workshop was held in Myanmar in early 2010 and since then Myanmar experts have attended and contributed to a number of workshops focusing on a range of topics including policy reviews, trans-boundary issues, Hilsa fisheries, fisheries and aquaculture assessments, fishery statistics, coastal management, responsible fisheries training and climate change. Partners to the project who are active in Myanmar include the Government of Myanmar, IOSEA, SEAFDEC, and WorldFish. A vast number of project reports are available through its website

(Bay of Bengal Large Marine Ecosystem Project, Web page).

Food and Agriculture Organization (FAO) Asia-Pacific Fishery Commission (APFIC)

APFIC is a regional fisheries body of the FAO. APFIC was founded in 1948 and merged with the Indian Ocean Fisheries Commission in 1999. Its main objective is “to promote the full and proper utilization of living aquatic resources of the Asia-Pacific area by the development and management of fishing and culture operations and by the development of related processing and marketing activities in conformity with the objectives of its members”. The commission reviews the state of resources and makes recommendations, carries out programmes and conducts training to increase the efficiency and sustainability of fisheries and aquaculture. Myanmar is among its 21 members. Many of the statistics collected by Myanmar’s DoF on the country’s production from marine and freshwater fisheries and aquaculture are processed, housed and shared through the APFIC and FAO (see FAO, 2013). Myanmar is in FAO Fishing Area 57 and the sub-area 57.1 that encompasses all of the Bay of Bengal.

Southeast Asian Fisheries Development Center (SEAFDEC)

Myanmar is one of eleven SEAFDEC member countries, joining in 1999. The Center, established in 1967, is mandated “to develop and manage the fisheries potential of the region by rational utilization of the resources for providing food security and safety to the people and alleviating poverty through transfer of new technologies, research and information dissemination activities”. The center supports training activities, technical assistance, research and publications relating to fisheries development in the region through four technical departments: the Training Department, the Marine Fisheries Research Department, the Aquaculture Department and the Marine Fisheries Resources Development and Management Department. The center also aims to be a unified voice for fisheries issues in the region (Southeast Asian Fisheries Development Center, 2013).



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Women living in coastal areas often make a living through processing fish. This woman from Chaung Tha is spreading fish to dry in the sun.



Ice factories provide this essential commodity for offshore fishing boats that may fish far from shore for many days.

FISHERS AND SUPPORTING SECTORS

Gleaners

A number of marine resources can be caught close to shore. This is often done by women and children who are able to collect marine life for food when the tides and timing is good. Octopuses, oysters, seashells and chitons can be gleaned from water pools and rock faces. These can be eaten at home or sold. We met enterprising children collecting sardines and anchovies around the boats at landing sites, which they sold to local households.

Nearshore Fishers

Nearshore fishing includes a range of gear and target fish. Traps are used to catch lobsters. Push nets are used to catch wild shrimp. Cast net fishers catch small fish in shallow waters. Spear fishermen may walk or use a boat to target rich reef habitats. The small catches would feed families that night. In areas such as Thandwe, where there are other employment opportunities, nearshore fishing can be supplementary to primary sources of income. For more serious fishermen, small crews may head out for the day to target a lucrative fishery and other species are caught opportunistically. For example, we interviewed four fishermen on a 25ft boat with a longtail style engine in Thandwe who showed us their typical one-day catch. They caught seven spiny lobsters (their target), which were sold to a broker for export and supplemented the catch with group-

ers, triggerfish, butterfly fish, one sea cucumber and egg cowries. The DoF estimated there were 13,788 powerboats and 17,054 boats without engines used for fishing in Myanmar in 2010 (Department of Fisheries, 2010).

Offshore Fishers

Offshore fishers in Myanmar include longliners that target pelagic fish all along the coast. Squid fishers are common along the Taninthayi Coast. Large commercial boats with crews of several men head out on multi-day trips and use lights to lure squids. Bottom trawlers' primary targets are prawns or finfishes. Anchovy and sardine fishers using purse seine nets are common off areas of the Rakhine Coast. The DoF estimated the number of offshore vessels in Myanmar at 2205 in 2010 (Department of Fisheries, 2010).

Foreign Fishers

Myanmar's fisheries law has explicitly allowed for the use of their marine resources by neighbouring countries. According to official data, from 2004 to 2011, 250 to 300 foreign boats per year fished in Myanmar bringing in an estimated USD12 million per year in taxes. However, fishing rights for foreign boats expired on March 31, 2014 and the parliament banned foreign fishing vessels starting in April 2014 in an effort to reverse declines in fish stocks (Ocean Biogeographic Information System,



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Local boat owners of Rakhine State have adapted boats so they can take tourists out on fishing and snorkeling trips.

Web page). According to MFF, in the 2013-2014 fiscal year, an estimated 40 foreign fishing vessels were operating in the country (Ocean Biogeographic Information System, Web page).

Fish Processors

A huge range of people are involved in fish processing. These include women and men who clean and dry fish and invertebrates along the coasts. Techniques, approaches and scale of these operations vary by the level of organisation involved and the species being processed.

Semi-nomadic Ethnic Peoples

The peoples known in Myanmar as the Salone or Moken are part of a larger group of semi-nomadic Austronesian peoples who live along the coasts and islands of the Andaman Sea, including the islands of the Myeik Archipelago. They are highly dependent on marine resources, which they collect and catch for food and barter with at markets. Some of the Moken are still nomadic and live on hand-made wooden boats. During the rainy season, they shelter in temporary stilt houses on the lee side of islands and repair their boats.

Myanmar Fishery Federation (MFF)

The Myanmar Fishery Federation (MFF), a national level organisation with a membership of over 700 companies and 27,000 individuals, is mandated to encourage and promote fishing industries. MFF aims to promote the socio-economic life of member entrepreneurs and fishery communities,

share information on economic policies and fishery technologies and advocate on behalf of the fishing industry, among other objectives. There are nine associations under MFF that deal with particular industries, namely, shrimp, fish, exporters, aquaculture feed, marine fisheries, freshwater capture fisheries, crabs, eels and ornamental fish.

SUPPORTING INDUSTRIES

Industries that support the needs of fishers are indirectly dependent on marine resources. Carpenters, gear suppliers, ice factories and cold storage facilities are all critical players in the fishing industry in Myanmar. As of 2010, there were 11 and 19 cold storage facilities and 39 and 26 ice plants in Rakhine State and Taninthayi Division, respectively (Department of Fisheries, 2010).

Exporters

Exporters connect local fishers with foreign markets. A wide range of marine products is exported from Myanmar. These include live lobsters and groupers, prawns, shrimps and crabs.

TOURISM STAKEHOLDERS

Marine Activities Tourism Operators

Currently there are only two commercial SCUBA diving operations in Myanmar. The Myanmar Andaman Resort on Macleod Island in the southern Myeik Archipelago is a remote resort with dive facilities. Another dive shop, Ngapali Water Sport

Center in Thandwe opened in February 2012 (Figure 2). Both of these shops are co-owned by A-One Diving, a Thai-owned company based in Ranong, Thailand (Figure 3).

The Rakhine Coast area has not been promoted as a dive destination so currently few divers head to the area explicitly for diving. The Ngapali shop tends to run three to four snorkeling or dive trips per week in the high season (November to the end of April). The manager is concerned about the state of the reefs and is trying to encourage fishermen to not drop their anchors on the reef or throw rubbish in the ocean.

Dive tourists primarily visit Myanmar on live-aboard dive boats of businesses based in Thailand. They enter the country in Kawthoung and primarily visit the southern islands of the Myeik Archipelago and the Burma Banks.

Local entrepreneurs have also developed small-scale businesses that take tourists out to nearby spots for fishing and snorkeling excursions.

Tourism Service Providers

At government-sanctioned tourism areas, a range of businesses that serve tourists have been developed by local people as well as foreign partnerships. At Ngapali Beach, Chaung Tha and Ngwesaung (Figure 2) where local economies are intimately tied to tourism, seafood (both locally caught and brought in from other areas) dominates restaurant menus, long strips of hotels line the beach and shops sell souvenirs including items made from marine products. Other sites along Myanmar's coast also support some tourism but currently it is less marine-focused.

Curios Producers

There is a large network of people within Myanmar that create and sell curios made from marine products. These are sold mainly at tourist destinations. These include both areas of the country where there is intensive marine-related tourism such as Ngapali Beach, Chaung Tha and Ngwesaung (Figure 2) as well as at many of the temples and other destinations in the country. They are sold to both national and international visitors.



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A woman in Chaung Tha makes necklaces and other crafts from shells to sell to tourists.



LEGAL FRAMEWORK

Myanmar's "Fisheries Law" was first created in 1905 and updated in 1954. This law was repealed in 1989 and substituted by the "Law Relating to the Rights of Foreign Fishing Vessels".

Three other fishery laws followed, namely the "Aquaculture Fisheries Law" in 1989, the "Myanma Marine Fisheries Law" in 1990 (amended in 1993) and the "Freshwater Fisheries Law" in 1991.

The introduction of trawling in the coastal waters of Myanmar in the 1980s led to conflicts between traditional fishermen and trawling operations that necessitated amendments to the "Law Relating to the Rights of Foreign Fishing Vessels" to provide a more comprehensive legal framework to manage fisheries. Amendments in 1993 strengthened the legal framework relating to marine and freshwater fisheries, aiming to:

- Provide more revenue through fishery taxation
- Protect natural fishing resources
- Ensure equitable allocation of fishery resources
- Obtain accurate fishery data
- Strengthen activities to reduce conflict among fishing communities

Mangroves are impacted by legislations around forestry management. The "Forest Law" of 1992 replaced the colonial-era "Burma Forest Act and Rules" of 1902.

The "Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law" of 1994 repealed the "Wild Life Protection Act" of 1936. This law focuses on the protection and conservation of wildlife, endangered species and habitats. Wildlife is classified under three categories of protection under section 15 of the law, namely (i) completely protected, (ii) normally protected and (iii) seasonally protected. Section 37 of this law makes it an offence for any person to kill, hunt or wound a completely protected wild animal without permission; possess, sell, transport or transfer a wild animal or any part thereof without permission; or export a wild animal or plant without the permission of the Director General.

All of these laws are reviewed in detail by Tsamenyi (2011).

The "Myanmar Environment Conservation Law" was recently enacted in March 2012. Recently drafted Environment and Conservation Rules prescribe the duties of the National Environment Conservation Committee, the MOECA and the Environmental Conservation Department; and outline environmental standards, the processes surrounding EIAs and guidelines.

Various regulations have been issued by the Government of Myanmar within the main body of particular laws and in the form of notifications.

Marine Turtles

Under the 1905 Fishery Law it was forbidden to trespass in turtle nesting areas without official consent (11/1905). Under Agriculture Notification No. 1/2005 (1924), it is forbidden to trespass within three miles of a turtle hatching area and turtle eggs cannot be eaten. Notification No. 2/93 specifies that all turtles caught accidentally must be released, marine turtles cannot be consumed, TEDs must be used on trawling gear in all fishing areas and damaged fishing gear cannot be thrown into the ocean.

Crabs

Notification No. 8/94 established size limits for crabs for export (length 6.15 cm) and controls their trade under section No. 35 of the Aquaculture Law. Notification 9/94 defines measuring systems for crabs and sets limits.

Prawns

Notification No. 3/95 prohibits trade gravid marine penaeid species of prawns, which cannot be caught, exported, sold, killed or kept in captivity unless permitted by the Director General of DoF. If accidental catch occurs, they should be released immediately. Species under protection are *Penaeus*

monodon, *P. indicus*, *P. merguensis*, *P. semisulcatus* and *P. japonicus*. Another notification, No. 2/95, outlines similar regulations for important freshwater prawns, *Macrobrachium rosenbergii* and *M. malcolmsonii malcolmsonii*.

Lobsters

It was reported in a local newspaper that a coastal area near Anansan Village in Thanbyuzayat Township, Mon State, has been designated as a lobster refuge by the DoF.

Hard Clams

Hard clam collection is prohibited during their reproductive season, 1 January to 31 March, every year at two areas totaling 20 acres at the confluence of Kye River and Tapochaung River in Pulaw Township, Myeik District, Taninthayi Region (Figure 3). Small clams of less than 20 mm cannot be collected at all in the areas.

Groupers and Sea Bass

Notification No. 2/2006 states that the capture, killing, transportation, storage and retention of and any disturbance relating to groupers bearing

eggs is prohibited during their reproductive season, 1 July to 30 September, every year. This includes species of the genera *Epinephelus*, *Cromileptes* and *Cephalopholis*. The same regulations are applied for sea bass (*Lates calcarifer*) from 1 January to 31 March.

Sharks

DoF Notification No. 2/2004 established two no-shark-fishing areas around Dome Kyun and Lampi Islands of the Myeik Archipelago in the Taninthayi Region (Figure 6, numbers 120 and 121). The larger, northern area is 11,734 km² and the smaller area around Lampi Island is 1705 km².

Whale Sharks

Under Notification No. 2/2001, it is forbidden to catch, harass, kill, possess, sell, buy, export or transport Whale sharks (*Rhincodon typus*) anywhere in Myanmar waters. If accidental entanglement in fishing gear occurs, the animal must be released immediately.



Fishermen will often abandon damaged fishing gear. This is illegal because the gear can continue to catch and kill fish. This fish trap was left on a reef in the Myeik Archipelago.

Pomfret

To minimize the bycatch of small pomfret of less than 100 grams, Notification No. 2/2013 legislates a closed season for use of bag nets from 1 April to 31 May every year.

Offshore Fishing Closed Season

On 30 March 2013, Notification No. 3/2013 was created, declaring that offshore fishing vessels were prohibited from fishing during the height of shrimp reproductive season from 1 June to 15 July of 2013. However, within a month of issuing the law the DoF announced that 75% off registered fishing vessels could continue fishing during the closed season.

Fishing Gear

Some fishing gears that are destructive to the environment and marine resources are banned. Banned gear includes pair trawling; electric fishing; fishing using poisons, chemicals and explosives; and push nets. Fishery Inspectors are authorized to seize banned gear under the “Law relating to the Fishing Rights of Foreign Fishing Vessels 1989” and the “Myanmar Marine Fisheries Law”.

Mangroves

Under the “Forest Law” of 1992, the Ministry of Forests (now MOECF) can declare public lands as Reserved Forests or Protected Public Forests for mangrove conservation.

Community Co-Management

A major shift toward community management of forest resources occurred in the mid 1990s with the issuance of the Community Forestry Instructions by the FD in response to widespread forest degradation and increased demand for forest products and services. The document guides participatory resource management and impacts management activities in mangrove and other forest systems (Kyaw Tint *et al.*, 2011).

In the fisheries sector, a joint FAO and DoF project in Bogale Township in 2011 allowed village fishery societies to organize the management of 16 tender fisheries. This close cooperation of the DoF and the State Government is setting a valuable precedent

for fisheries co-management in the country that is unlike what has been seen in other sectors. Currently there is no particular provision for fisheries co-management in Myanmar’s existing fisheries laws nor regulations relating to community participation in fisheries management.

This project has enabled communities to gain management authority to parts of the fishery through the declaration of some fishery areas as Special Management Areas (SMAs) by the DoF. In these areas, all laws, notifications, directives, rules, and regulations still apply but additional management measures may be introduced by communities who have been given rights to manage fishery resources within their boundaries. The DoF may declare that these SMAs are governed by communities that are being assisted by a formal project (Livelihoods and Food Security Trust Fund, 2013).

The term “fisheries co-management” implies that communities and the State work together versus other commonly used terms such as “community fisheries management”, which implies that communities are solely responsible for the management of their fisheries, within the boundaries of the law.

Closed Fishing Areas

DoF has restricted fishing in various fishing grounds, including portions of A20, B15, B20, B10 of the Rakhine Coast; ten nautical miles from the shore line of C3 and C4 in Ayeyawady Region; in two fishing grounds (D23 and in D28 on the east side of the centreline between North Moscos island and Middle Moscos island) in Mon State (Figures 3 and 5); and in two fishing grounds (E11 and E17) in Taninthayi Region (Figure 5).

Notification No. 5/94 declared a no-fishing area around Lampi Island of Bokpyin Township of Taninthayi Region (latitude 10°41.5’N to 10°59.3’N and longitude 98°4.9’E to 98°18.3’E). Fishing is prohibited from the low water line to two nautical miles out. Notification No. 7/93 declared a no-fishing area around Pearl Island of Bokpyin Township, Taninthayi Region (latitude 11°10’N to 10°59.3’N and longitude 98°12’E to 98°22’E). Notification No. 1/99 declared a no-fishing area in Kawthoung Township of Taninthayi Region (latitude 10°00’N to 11°00’E and longitude 95°17’E to 98°30’E). Two Shark Protected Areas have been declared in the Myeik Archipelago of the Taninthayi Region under Notification No. 2/2004 (see Figure 3).

Protected Areas

In Myanmar, protected areas are usually legally pronounced through Notifications. Protected areas that have a marine component and have formal protected status through the national government are as follows:

1. Moscos Island — PA Notification No. 188/28 (September 1, 1928)
2. Thamihla Kyun Wildlife Sanctuary — PA Notification No. 289/70 (1 December 1970)
3. Meinmahla Kyun Wildlife Sanctuary — PA Notification No. 91/93 (5 January 1993)
4. Lampi Marine National Park — PA Notification No. 40/96 (20 August 1996)
5. Two Shark Protected Areas — PA Notification No. 2/2004 (5 May 2004)

Management Zones

Under international law, Myanmar's Exclusive Economic Zone (EEZ) extends to 200 nautical miles from shore. Under the current national laws, fishing activity in Myanmar is controlled by a licensing and registration system designed to control both vessel and gear types. Two fishing zones have been established through a licensing scheme whereby zones are designated for specific fishing gear, classes of fishing vessels and ownership. This is an attempt to provide equitable allocation of resources and reduce conflicts between traditional and commercial fishers. Commercial fishing vessels, such as trawlers and fish purse seiners, are prohibited from fishing within five nautical miles of the Rakhine Coast and ten nautical miles of the Ayeyawady Delta and Taninthayi Coasts.

Trawlers often fish illegally in nearshore waters, which can lead to conflicts between inshore and offshore fishers. A recent proposal urging the government to oversee and prohibit trawlers operating in the inshore fishing areas was submitted to the fifth regular session of Myanmar's House of Nationalities (called the Amyotha Hluttaw) on 22 October 2012 and was approved by the parliament with a majority vote (Kyaw Tint *et al.*, 2012b).

Stakeholders have pointed out that the definition of coasts within the "Myanma Fishery Law" does not adequately address whether island coasts are included along with the mainland coasts in defining these zones. The law defines "Myanma Marine Fisheries Waters" as "the waters along the sea coast of Myanmar from the high tide mark toward the open sea, the waters on the seaside of the straight line drawn

from one extreme end of one bank to the extreme end of the other bank of the river and creek mouths, the waters from the said high tide mark to the end of the Exclusive Economic Zone" and the inshore and offshore zones are divided by their distance from the sea coast – five nautical miles off the Rakhine Coast and ten nautical miles off the Ayeyawady Delta and Taninthayi Coasts. The "Territorial Sea and Maritime Zones Law" of 1977 provides straight baselines that "have been drawn between fixed points on the mainland, on islands or rocks" and includes a schedule with GPS points. The map of this baseline is provided in the document "The Law of the Sea; Baselines: National Legislation with Illustrative Maps" (United Nations Office for Ocean Affairs and the Law of the Sea, 1989) and it clearly encompasses all of the islands of the country.

Fishing Licenses

Under the "Myanma Marine Fisheries Law", inshore fishers, people intending to collect other marine products for sale and sport fishing businesses are required to obtain a license from the officer in charge of the DoF of the respective Township. Offshore fishers similarly need a license from the DoF of the relevant State or Region. Foreign fishers are allowed to access Myanmar's resources under the Foreign Investment Law and need to apply for a license to the Director General of the DoF.

Fisherman Registration

Every fisher must be registered and anybody working, living or staying on a fishing vessel must have a fisher's registration card.

Fishing Vessels

Under the "Myanma Marine Fisheries Law", building of or importing a fishing vessel from abroad for offshore fishing requires prior approval from the DoF.

Foreign Fishers

Myanmar's fisheries law allows for the extraction of marine resources by neighbouring countries under the "Foreign Investment Law" and the "Law Relating to the Fishing Rights of Foreign Fishing Vessels". Fishing rights for foreign boats expired on 31 March 2014 and the parliament banned foreign fishing vessels starting in April 2014 in an effort to

reverse declines in fish stocks.

Importing and Exporting

The “Fisheries Notification on Prohibition of Fish Importing” lists fish species that may not be imported, exported, sold or kept in captivity without permission of the Director General of the DoF.

Output Control

Currently, there are neither Individual Transferable Quotas nor Total Allowable Catch regulations in Myanmar’s fisheries sector.

Taxes

Import tax on shrimp exported to China was removed at the beginning of 2004 to promote trade between Myanmar and China. Shrimp exports to Japan from Myanmar are taxed at more than 20% by value of total shrimp exports from Myanmar.

International Conventions

Myanmar is legally bound by a number of international conventions that relate to conservation, including:

- London Amendment to the Montreal Protocol (London, 1992) — Accession 1993
- Convention for the Protection of the World Cultural and Natural Heritage (Paris, 1972) — Acceptance 1994
- Convention on Biological Diversity (Rio de Janeiro, 1992) — Ratified 1994
- CITES (Bonn, 1979) — Accession 1997
- United Nations Framework Convention on Climate Change (New York, 1992) — Accession 2003
- Convention on Wetlands (Ramsar, 1971) — Ratified 2005
- Amendment to the Montreal Protocol (Copenhagen, 1994) — Accession 2009



Table 4. List of Marine Key Biodiversity Areas in Myanmar. Source: Wildlife Conservation Society (2013) and Wildlife Conservation Society (Web page). See Figure 6 for a map of the areas.

Map #	KBA Name	National Protection Status	Authority	State / Region	Key Species
110	Oyster Island		?	Rakhine	Hawksbill turtle, Green turtle
106	Nantha Island		?	Rakhine	Hawksbill turtle, Green turtle, Loggerhead turtle
104	Myebon		GA	Rakhine	Irrawaddy dolphin, Spotted dolphin (?), Green turtle, Olive ridley turtle
30	Kyaukphyu (Wun-bike)		FD	Rakhine	Hawksbill turtle, Green turtle, Olive ridley turtle, Mangrove spp.
97	Manaung Kyun		GA	Rakhine	Dugong, Hawksbill turtle, Green turtle, Loggerhead turtle
98	Maw She		GA	Rakhine	Dugong, Hawksbill turtle, Green turtle, Loggerhead turtle, Olive ridley turtle
107	Ngwe Saung		?	Ayeyawady	Dugong, Hawksbill turtle, Green turtle
79	Great Coco Island		GA	Ayeyawady	Leatherback turtle, Green turtle, Loggerhead turtle, Olive ridley turtle
127	Thamihla Kyun Wildlife Sanctuary		NWCD	Ayeyawady	Irrawaddy dolphin, Green turtle, Loggerhead turtle, Olive ridley turtle
91	Khaing Thaung Island	Reserve Forest	DoF	Ayeyawady	Olive ridley turtle, Mangrove spp.
87	Kadonkani	Reserve Forest	FD	Ayeyawady	Mangrove spp.
86	Kadongalay Island		DoF	Ayeyawady	Irrawaddy dolphin, Green turtle, Loggerhead turtle, Olive ridley turtle
37	Meinmahla Kyun Wildlife Sanctuary	Notified Protected Area — Terrestrial	NWCD	Ayeyawady	Irrawaddy dolphin, Hawksbill turtle, Olive ridley turtle, Salt water crocodile, Mangrove spp.
78	Gayetgyi Island		DoF	Ayeyawady	Irrawaddy dolphin, Green turtle, Loggerhead turtle, Olive ridley turtle
119	Pyindaye	Reserve Forest	FD	Ayeyawady	Olive ridley turtle, Salt water crocodile (?), Mangrove spp.
102	Moscov Wildlife Sanctuary	Notified Protected Area — Terrestrial	FD	Taninthayi	Indo-Pacific finless porpoise, Hawksbill turtle, Leatherback turtle, Green turtle, Olive ridley turtle, Mangrove spp.
105	Myeik Archipelago		GA	Taninthayi	Irrawaddy dolphin, Dugong, Indo-Pacific finless porpoise, Hawksbill turtle, Leatherback, Green turtle, Mangroves spp., Whale shark
121	Shark Protected Area	Notified Protected Area — Aquatic	DoF	Taninthayi	Unknown
120	Shark Protected Area	Notified Protected Area — Aquatic	DoF	Taninthayi	Unknown
77	Burma Banks		?	Taninthayi	Leopard shark
32	Lampi Marine National Park	Notified Protected Area — Terrestrial & ASEAN Heritage Park	NWCD	Taninthayi	Dugong, Hawksbill turtle, Leatherback turtle, Green turtle

PROTECTED AREAS AND MARINE CONSERVATION AREAS

Myanmar's Protected Area system was introduced in the 1980s and the "Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law" was enacted in 1994. The Myanmar "Forest Policy" of 1995 set a target of 5% of total land area to fall under protection and MOECAF increased that goal to 10% in 2000. Protected areas are often legally designated through Notifications.

There are several different designations of existing natural areas under the Wildlife Law including "Scientific Reserve", "National Park", "Marine National Park", "Nature Reserve", "Wildlife Sanctuary" and "Geo-physically Significant Reserve". However, the distinction on the ground is not always clear and the degree of enforcement is variable.

Some conservation areas with marine coverage have been established, however, there is a considerable gap of representation of marine ecosystems, when compared with terrestrial systems in the country (Wildlife Conservation Society, 2013). Of the 43 FD officially-recognized protected areas in Myanmar in 2011 (Isituto Oikos, 2011), only four (9%) have marine elements. Two additional marine conservation areas, both Shark Protected Areas with no additional distinguishing names, have since been created.

Of the four protected areas with marine elements reviewed by Isituto Oikos (2011), all also have a terrestrial aspect to them and at least three are considered "Notified Protected Areas – Terrestrial" (Wildlife Conservation Society, 2013). The Meinmahla Kyun Wildlife Sanctuary of the Ayeyawady, established in 1993, is in a low, flat delta area that supports abundant mangroves and is administered by the Nature and Wildlife Conservation Division (NWCD) of the FD. Thamihla Kyun Wildlife Sanctuary, established in 1970 in the Ayeyawady, is governed by the NWCD. However, there is a strong marine component to the conservation activities that take place there and the DoF oversees those undertakings (Wildlife Conservation Society, Web page). The sanctuary supports populations of Green, Loggerhead and Olive ridley turtles as well as the Irrawaddy dolphin. Moscos Island Wildlife Sanctuary of Taninthayi Region, established in 1928 and under the jurisdiction of the FD, supports Indo-Pacific

finless porpoises and four of Myanmar's five marine turtle species, but mainly the terrestrial portion of the island is under protection (Isituto Oikos, 2011).

The fourth, Lampi Marine National Park, is administered by the NWCD and is also an ASEAN Heritage Park. Established in 1996, it encompasses Lampi Island, several smaller nearby islands and the surrounding waters, totaling 274 km². The seabed between the island and the mainland is no deeper than 24 m. The shoreline is rocky with bays, inlets and sandy beaches. The inland forest is mainly an evergreen forest and the coastal habitats include mangroves, seagrass beds and coral reefs. Lampi Island is particularly well-studied with field surveys between 2008 and 2010 led by the Myanmar Environmental Project managed by Istituto Oikos and BANCA with support from ECoSwiss (Befasti, 2010; Myint Sein & Bo Ni, 2009; San Tha Tun *et al.*, 2008; Saw Han Shein *et al.*, 2010; Tint Swe *et al.*, 2011; Tint Tun, 2010, 2011; Tint Tun & Aung Myint Oo, 2008; Tint Tun & Bendell, 2010; Tint Tun *et al.*, 2008). However, there is no management plan in place for Lampi and its settlements of approximately 3,000 people (Associated Press, 2014). Dynamite fishing, encroaching trawlers, poor waste management, and a range of unsustainable practices have degraded the area. Istituto Oikos is working to developing ecotourism opportunities, enact a draft management plan, and train park rangers who were posted there by the FD starting in 2013 (Associated Press, 2014).

The two Shark Protected Areas are in the Myeik Archipelago and are extremely large at 1706 km² and 11,734 km² (Figure 6). Little is known about what key conservation species are found in these waters or the effectiveness of these reserves.

It is well-recognized that Myanmar's existing protected areas are susceptible to overexploitation of biological resources and there is a need to improve management effectiveness (National Biodiversity Strategy and Action Plan, 2011). Myanmar Agenda 21, the blue print for natural resource management in the country, includes strengthening protected area management as an important measure for biodiversity conservation (National Biodiversity Strategy and Action Plan, 2011).

PROTECTED AREAS

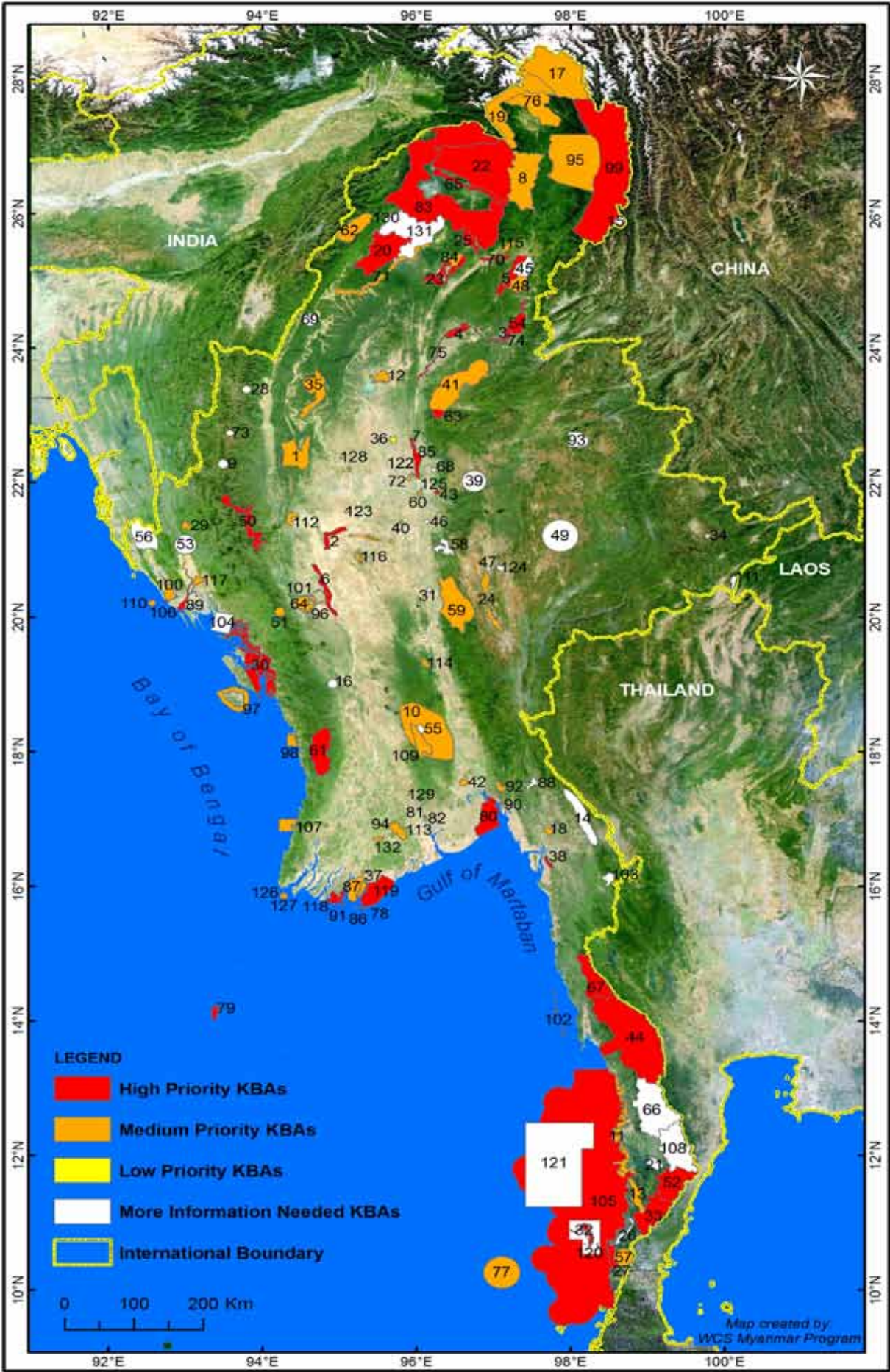


Figure 6. Key Biodiversity Areas of Myanmar. Source: Wildlife Conservation Society (2013). See Table 4 for the details on each area.

Under the Convention on Biological Diversity's (CBD) new Strategic Plan for Biodiversity 2011-2020, Aichi Target 11 calls for parties to protect "10 percent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services". However, protected areas can range greatly in their level of effectiveness (Sciberras *et al.*, 2013). The area under protection alone gives no indication of whether areas are "effectively and equitably managed, ecologically representative and well connected systems ... and integrated into the wider landscapes and seascapes" (CBD, 2010).

The effectiveness of any protected area is based both on ecology (e.g. the responses of species and habitats to management actions) and human behaviour (e.g. how well people are able to implement the management strategies). No critical assessment of the effectiveness of the Shark Protected Areas has yet been conducted, however anecdotal information suggests that enforcement and adherence to regulations are low. Similarly, the Lampi Marine National Park does not yet have effective adherence to conservation measures. No management or operational plan was prepared when Lampi was designated in 1996 and, since then, human settlements inside and outside the protected area have grown considerably (Isituto Oikos, 2011). Recognizing this issue, in 2009 Isituto Oikos and BANCA initiated consultations among stakeholders with the intention to launch a process for developing a management plan. The project

conducted workshops and focus group discussions leading to the workshop "Conservation and Sustainable Management of Lampi Marine National Park" in 2010 (Isituto Oikos, 2011). To our knowledge a management plan has not yet been prepared and approved. Although fishing is, technically, prohibited within the park boundaries, subsistence and commercial fishermen use a range of gear and target a variety of resources inside. Plus fishing practices that are illegal throughout the country, such as offshore fishers targeting near shore areas and fishing with dynamite, are also reported to occur within park boundaries (Isituto Oikos, 2011).

The FD has been using a management approach that combines environmental management with economic development in community forestry areas, including mangrove areas.

All of Myanmar's protected areas were included within the MBCIV (2013) assessment of Key Biodiversity Areas (KBAs). KBAs accommodate different management responsibility including government, private, community-led and joint management. All current KBAs which are wholly or partially marine are listed in Table 4 along with their national status, responsible management authority, size, priority as determined through the MBCIV process, location and the key species of conservation priority that they support. Numbers in Table 4 match the numbering on the map of KBAs, Figure 6.



TOURISM

Marine-related tourism to date has been limited within Myanmar and will likely transform dramatically in the years to come. In recent years, the primary seaside areas designated for tourism have been Chaung Tha, Ngwesaung and Ngapali beaches, all along the Rakhine Coast (Figure 2). The Ministry of Hotels and Tourism (MoHT) has begun preparing for a surge in tourism through developing their Responsible Tourism Policy (Ministry of Hotels and Tourism, 2012) and their Policy on Community Involvement in Tourism (CIT) (Ministry of Hotels and Tourism, 2013).

MoHT's Policy on CIT (2013) reflects the Ministry's stance that community involvement needs to be an integral part of a strategy for tourism promotion from local to national levels. The policy provides a framework for communities to gain access to tourism opportunities, action points and standards. An advisory committee is responsible for the amendment of the plans and for ongoing revision of existing activities. The policy specifically highlights the relationship of tourism with the promotion of the country's biodiversity and includes the sustainable

management of the environment, natural resources and biodiversity conservation within the CIT service standards.

The MoHT has circulated directives to the private sector connected with coastal beach resorts with the aim to encourage sustainable development of coastal areas in line with MoHT laws; ensure sustainability of natural resources; preserve and conserve the environment; create job opportunities for local people; promote leisure and recreation for domestic and international tourists; and ensure the safety and serenity of tourists. MoHT guidelines include the following for building and operations that serve the tourism sector:

- Must be a minimum distance of five meters from the point of the highest tide
- Not to exceed two stories and not be higher than the tallest tree nor higher than ten meters above sea level
- No other massive construction is allowed along the beach areas
- Architecture and construction materials need to



© Katherine Holmes/WCS

A wide variety of seafood, locally caught as well as brought in from other areas of Myanmar, is sold at restaurants and hotels, especially in tourist areas such as Chaung Tha and Ngapali Beach, pictured here.



In tourist areas, local villagers sell wildlife curios such as these framed lobsters.

be especially chosen for the beach areas

- Allocate car-parking area with greenery
- Avoid the construction of high walls or fencing, which may block beach views.
- No digging of beach sand
- Land allowance of five meters for road construction within the hotel environs of every 500 meters for the accessibility of visitors to the beach areas
- Apply for license to operate hotel and beach resorts in accordance with the Procedures and Orders relating to the Myanmar Tourism Law
- Adhere to the rules and regulations issues by the MoHT regarding cultural norms, natural environment and environmental greening facilities, safety and security, child wise recreational activities, entertainment, emergency management, crisis communication, etc.

Chung Tha and Ngwesaung, 20 km apart, are both in Ayeyawady Region, though outside of the delta area on the Rakhine Coast (Figure 2). Tourism developed after the construction of major bridges, allowing easier access (Kyu Kyu Khin, 2005). They are both five hour drives from Yangon and, as such, tourism is dominated by domestic tourists. The areas were chosen for tourism development based on their expansive beach areas and proximity to Yangon. Most tourists visit the area primarily for land-based activities such as walking and biking the beaches, eating seafood and shopping.

Ngapali beach of Rakhine State is targeted to both international and national tourists. Currently international tourists are granted visas limited to 28 days to explore Myanmar. Based on stakeholder interviews, these tourists tend to first travel to other

primary tourist destinations in the country such as Bagan, Inle Lake, Mt Kyauktiyo and various pagodas and may come to Ngapali at the end of a trip for only two to three days. These tourists tend not to explore the marine environment and instead spend the days relaxing on the beach and eating seafood. The area supports rich and diverse fisheries. Nearshore coral reefs are rocky with low coral cover and diversity and only a small fraction of tourists may take day trips to snorkel or fish. Recently (2012) a dive shop opened in the area allowing the first commercial access to SCUBA diving in the region. A more in-depth discussion of tourism specific to that area can be found in the Rakhine section of this report.

In recent years tourists have accessed the marine environments of southern Myanmar either through boat operators based in Thailand, or by staying at the isolated Myanmar Andaman Resort on Macleod Island in the Myeik Archipelago. The nature of tourism in this region is likely to change dramatically. The land border between Thailand and the Taninthayi area of Myanmar has recently become more open; investors have been purchasing land in the Myeik Archipelago for tourism developments; and those who have been diving in Thailand are increasingly interested in visiting the more isolated reefs of southern Myanmar.

Surveys of these tourists and tourism operators have revealed that, of marine animals, Myanmar's dive tourists most highly value seeing sharks, pelagic fish and reef fish. Dive tourists come to the country specifically because they expect to see sharks, rays, big fish, healthy reefs and beautiful landscapes as well as visit isolated locations (compared with other locations such as Thailand). However, in early 2013, sightings of sharks, rays and marine turtles were

rare. Total sightings could be averaged across the total number of dives or diver-hours of the survey respondents. Divers saw only one shark for every 28 dives (= one shark every 23.4 diver-hours); one ray for every 6 dives (= one ray every 5.0 diver-hours); and one marine turtle for every 31 dives (= one turtle every 25.5 diver-hours).

Dive guides who had worked in Myanmar in previous years and returning divers noted that populations of sharks, large fish and marine turtles were decreasing; there was more abandoned fishing gear and rubbish at the dive sites; and algal cover has been increasing. While first-time tourists also noted trash, evidence of blast fishing and abandoned fishing gear and were disappointed to see other dive boats at what they expected to be isolated spots.

However, despite these issues, most tourists said they would still recommend Myanmar as a dive destination. This is mainly to do with the underwater beauty, still healthy corals and a sense of isolation in a remote area. Demand for diving in Myanmar continues to grow. Thailand-based dive operators planned to expand the number of trips they offer to southern Myanmar in the 2013/2014 season. This will likely mean that their clients will see many other divers and dive boats in Myanmar and this will impact their clients' sense of isolation.

More details on findings from this survey can be found in Appendix 18.



TOURISM

HIGH PRIORITY MARINE CORRIDORS

In January 2012, over 80 of the country's environmental experts from civil society and government assembled to discuss the current state of Myanmar's biodiversity and used international criteria to identify and prioritize 132 Key Biodiversity Areas (KBAs). These sites are defined as areas holding significant populations of species of high conservation concern. Because connectivity is required to ensure that the full range of environmental services continue to function, these KBAs were grouped together within "conservation corridors". Fifteen conservation corridors were revised and updated taking into account connectivity among KBAs, safeguarding against the impacts of climate change and maintaining ecological processes, among other factors (Figure 7). These corridors allow for conservation planning that considers connectivity and resource impacts beyond the borders of nationally designated protected areas. Two marine conservation corridors were highlighted: The Taninthayi Marine Corridor and the Rakhine Marine Corridor (Wildlife Conservation Society, 2013).

RAKHINE MARINE CORRIDOR

Description

The Rakhine Marine Corridor extends along the entire coasts of Rakhine State and the western coast of Ayeyawady Region with a point extending out to and surrounding the Coco Islands (Figure 2). The corridor covers an area of 40,698 km². The continental shelf is narrow and deep and has a few inlets.

In the Ayeyawady Region, there are three townships with borders along the Rakhine Coast: Ngapudaw, Pathein and Thabaung Townships (Figure 2).

Rakhine State has 347 islands, Ayeyawady Region has 137 islands and Yangon Region has only 3, though not all of these islands are contained within the Rakhine Marine Corridor. The upper portion of the Rakhine coastline is shallow with deltas while further south it is generally rocky. The narrow continental shelf contains two large islands — Ramree and Man Aung (Figure 2).

Key Biodiversity Areas

Of the 132 KBAs in the country, there are six marine KBAs in the Rakhine Marine Corridor: Oyster Island, Nantha Island, Myebon, Kyaukphyu, Manaung Kyun and Maw She. Official protected status has not yet been established for any of these (Wildlife Conservation Society, 2013).

Stakeholders

Stakeholders that are relevant to marine conservation activities in the Rakhine Marine Corridor include most of the national level government bodies reviewed in the Stakeholder section of this report. Stakeholders of particular relevance to this area are the Rakhine State's and Ayeyawady Region's Government bodies; local fishers, processors and exporters who rely on fisheries; the Marine Biology Department of Pathein University; the Rakhine Coastal Conservation Association; Rakhita; hotels, restaurants, tour guides and curios shops that rely on the tourism industry; tourists; and local communities.

Fisheries

The major fish-landing site of the Rakhine Coast is at Thandwe (Figure 5). An important fishery along this coast is the anchovy and sardine fishery in the dry season.

Aquaculture

Prawn farming is particularly prevalent in Rakhine State. As of 2012, extensive prawn production systems were widespread with a range of farm sizes including local small, medium and large scale farms of up to 50 ha and very large, private investor farms of up to 200 ha. In recent years, Rakhine's prawn farms have experienced high mortality rates, and local farms' yields were low and even negative in some cases. This has led to the decline in prawn farming in recent years and, in some townships, more than 50% of the prawn ponds have been abandoned (Joffe & Moe Aung, 2012).

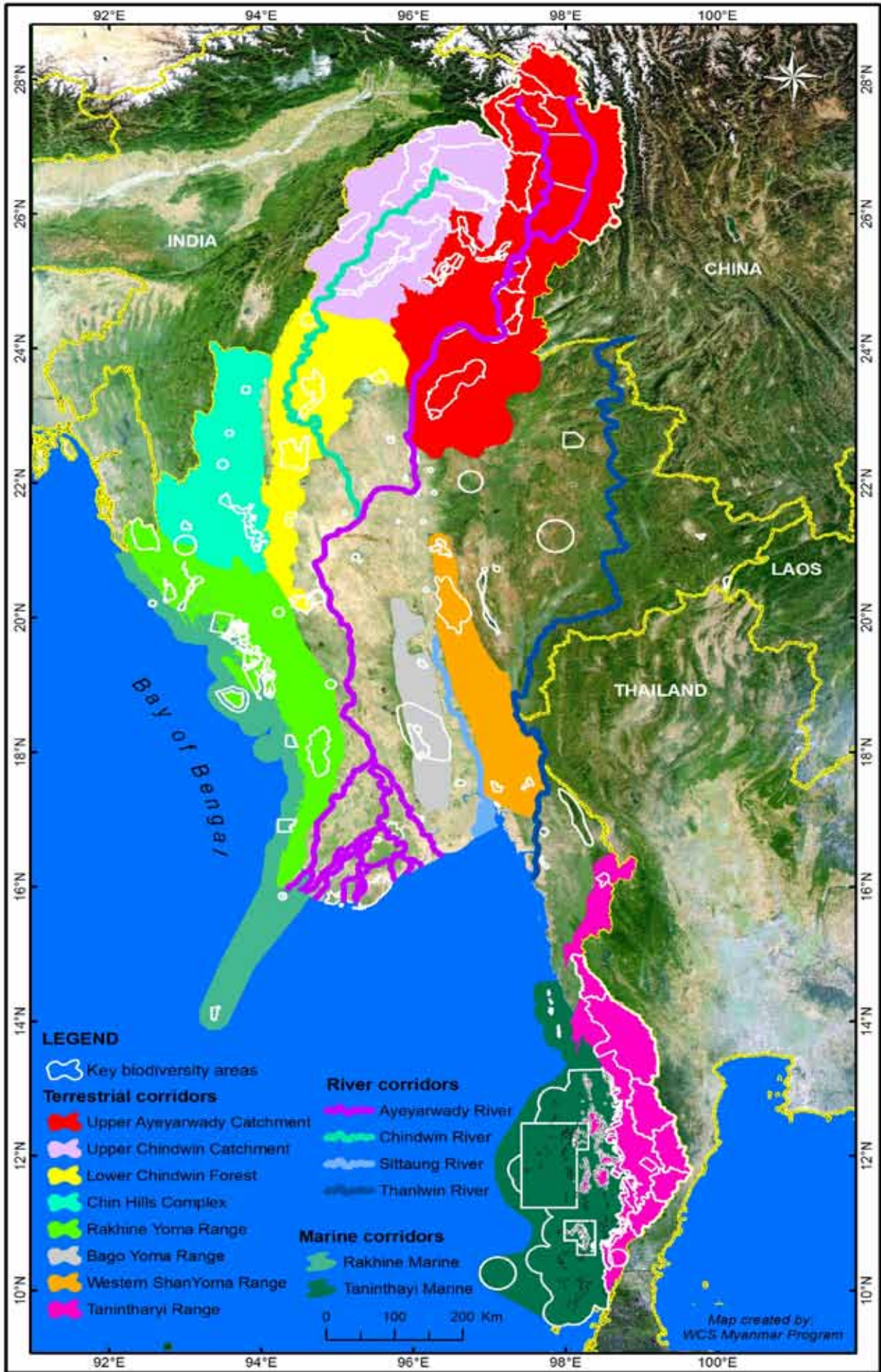


Figure 7. Myanmar's Conservation Corridors. Source: Wildlife Conservation Society (2013).

Habitats

Our classification and mapping of coral and seagrass, and mud flat habitats in the Rakhine Marine Corridor was accomplished using a Classification Tree Analysis with Landsat 8's visible and infrared bands (1-5) along with distinct training sites for both habitat classes in each study area.

Of the 40,698 km² of marine habitat contained within the Rakhine Marine Corridor, 912 km² were classified as coral (Figure 8). This coverage is more than two times greater than coral coverage we initially calculated from the coarser Millennium Coral Reef Assessment data set (2010) from UNEP-WCMC. The Rakhine Marine Corridor's reefs are less developed and support lower biodiversity than those in the Taninthayi Marine Corridor but they still support important target fisheries such as reef fish and spiny lobsters.

Also within the corridor, we classified 1042 km² as seagrass (Figure 8), and only 14 km² as mud flats (not shown).

The 2011 USGS Global Distribution of Mangroves (Giri *et al.*, 2011a) data suggests that the Rakhine State supports 1381.7 km² of mangroves (Figure 8). Note that this coverage is only for the State and not the entire corridor. There are thin areas of coastal mangroves along the Ayeyawady's west coast within the Rakhine Marine Corridor that aren't included in this calculation. This is equivalent to 138,170 ha which falls between the "original" and "remaining" areas of Rakhine State's mangroves as reported by Maung Maung Kyaw (2012) (see Table 1). This discrepancy may be due to the USGS' approach not having the sensitivity and ability to distinguish levels

of encroachment. Based on assessments of mangrove encroachment by Maung Maung Kyaw (2012), Rakhine had lost approximately 42% of its original mangrove habitat to encroachment by 2010. Mangrove conservation will be a growing issue in this region where the loss of ecosystem services provided by mangroves may be severe. Note that we did not conduct a new Classification Tree Analysis on mangrove habitats for this review.

Research Efforts

Our general understanding of the marine systems within the Rakhine Marine Corridor is stronger for the southern portion. Of the 368 theses we collected and documented, 266 included a geographic focus that we could determine to at least township level. Within the Rakhine Marine Corridor, this research focused around Sittwe Township in the north with nine theses (3.4%). The same number of theses were conducted in Thandwe Township (nine theses, 3.4%), which is centrally located. The greater proportion of theses focused on marine life in Patheingyi Township (38, 14.3%) and Ngapudaw Township (11, 4.1%) both of which are on the Rakhine Coast of the Ayeyawady Region (Figure 2). Other townships along the coast were the focus of only up to two theses. It is unsurprising that many student research projects have been conducted on the coasts and estuaries of Patheingyi Township since this is where Patheingyi University is based. Of the theses conducted in Sittwe, all were by students of the University of Yangon. Other studies and reports include northern areas of the coast but we have not been able to code every report for geographic coverage.



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Tourism and fishery activities exist side-by-side along Ngapali Beach of the Rakhine Coast. Here fish are being dried on strips of blue mesh next to a hotel serving local and international tourists.

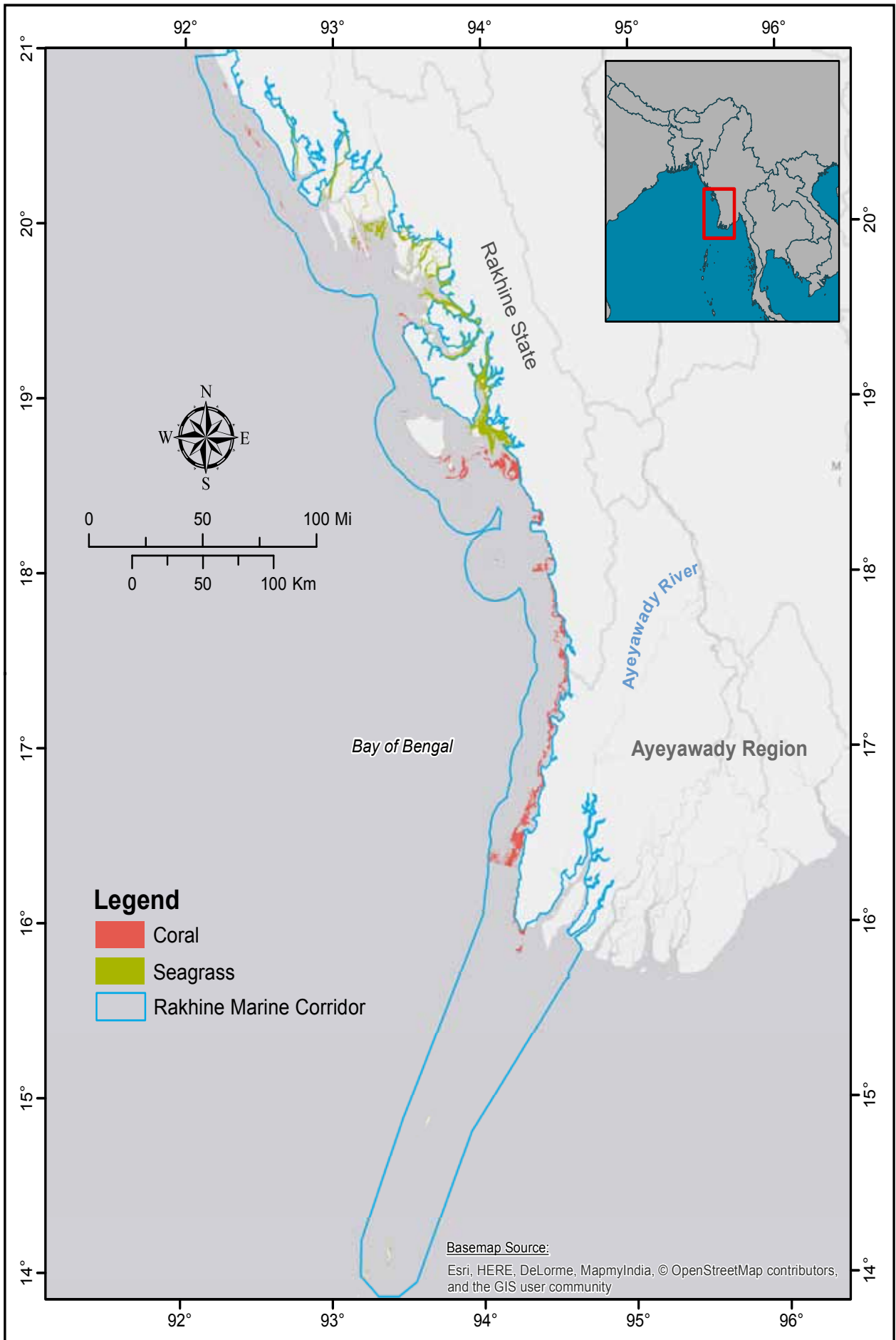


Figure 8. Distribution of coral reef and seagrass habitats within the Rakhine Marine Corridor.

Tourism

Currently marine tourism in the Rakhine Coast is divided into two regional pockets. In the Ayeyawady Region, Chaung Tha and Ngwesaung are the main seaside destinations near to Yangon (Figure 2). Tourism there is dominated by domestic tourists. Souvenir shops packed with t-shirts and crafts made from shell products line the town's streets, seafood is sold in almost every restaurant and beaches have been developed to support strips of hotels.

In Thandwe Township with Ngapali Beach (Figure 2), hotels similarly line the strips of beaches. As of 2013, there were approximately 17 hotels with two under construction. This translates to approximately 750 rooms and capacity for 1500 tourists. This area is targeted more toward foreign tourists but affluent Myanmar tourists also visit this popular destination. On average, most international tourists will only stay for two to three days. This is typically near the end of a busy vacation visiting Myanmar's crowded cultural destinations. Most foreign tourists visit this area to relax before returning home.

The boom in tourism and the growth of various economic opportunities has resulted in an influx of people from other regions to Thandwe. Over 30 years, two small schools, one with only 15 students, swelled into three with the largest serving over 600 students today (Stakeholder interviews).

Only a small subset of tourists at these destinations explore the marine environment. Local tour guides have developed flexible business models where they'll take tourists on full day or half-day boat trips that involve a combination of fishing, snorkeling and beach visits, depending on the tourists' interests.

Tourist fishing trips target mainly Mackerel, Barracuda and Yellowfin tuna. There was a sharp increase in the number of tour boats in 2010 as local operators reacted to the growing opportunity (Stakeholder interviews).

A SCUBA diving shop is now open in Thandwe but does not yet have much dive business. The Rakhine Coast is not an international dive destination, unlike nearby Thailand. Because of health and safety issues relating to breathing compressed air under water, most SCUBA divers will not dive for a full day before a flight. Therefore tourists who are visiting the area for only two days may only dive on the first day, which can be difficult to arrange. The business has identified some offshore dive locations that may support pelagic species of interest to divers and, in time, reports from their explorations will improve the understanding of marine life in the area. Research by visiting scientists will be enabled by the new access to SCUBA facilities.

At local restaurants, foreign tourists tend to favour prawns, squids and finfishes and many of these are harvested from other regions of Myanmar. The many small restaurants support a range in number of employees. Small restaurants typically employ two or more employees who, in turn, typically support three or four family members on their wages (Stakeholder interviews).

Tourists from different countries and of different ages tend to purchase different types of shell products. Single shells are popular with older foreign tourists. Chinese tourists purchase large shells and Europeans purchase those as well as polished shells and bracelets. Myanmar tourists purchase everything that they sell including decorations made out



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Women and men in Thandwe District of the Rakhine Coast clean shells and make various crafts from them. These are sold locally as well as sent to business partners to sell at other tourist sites in the country.

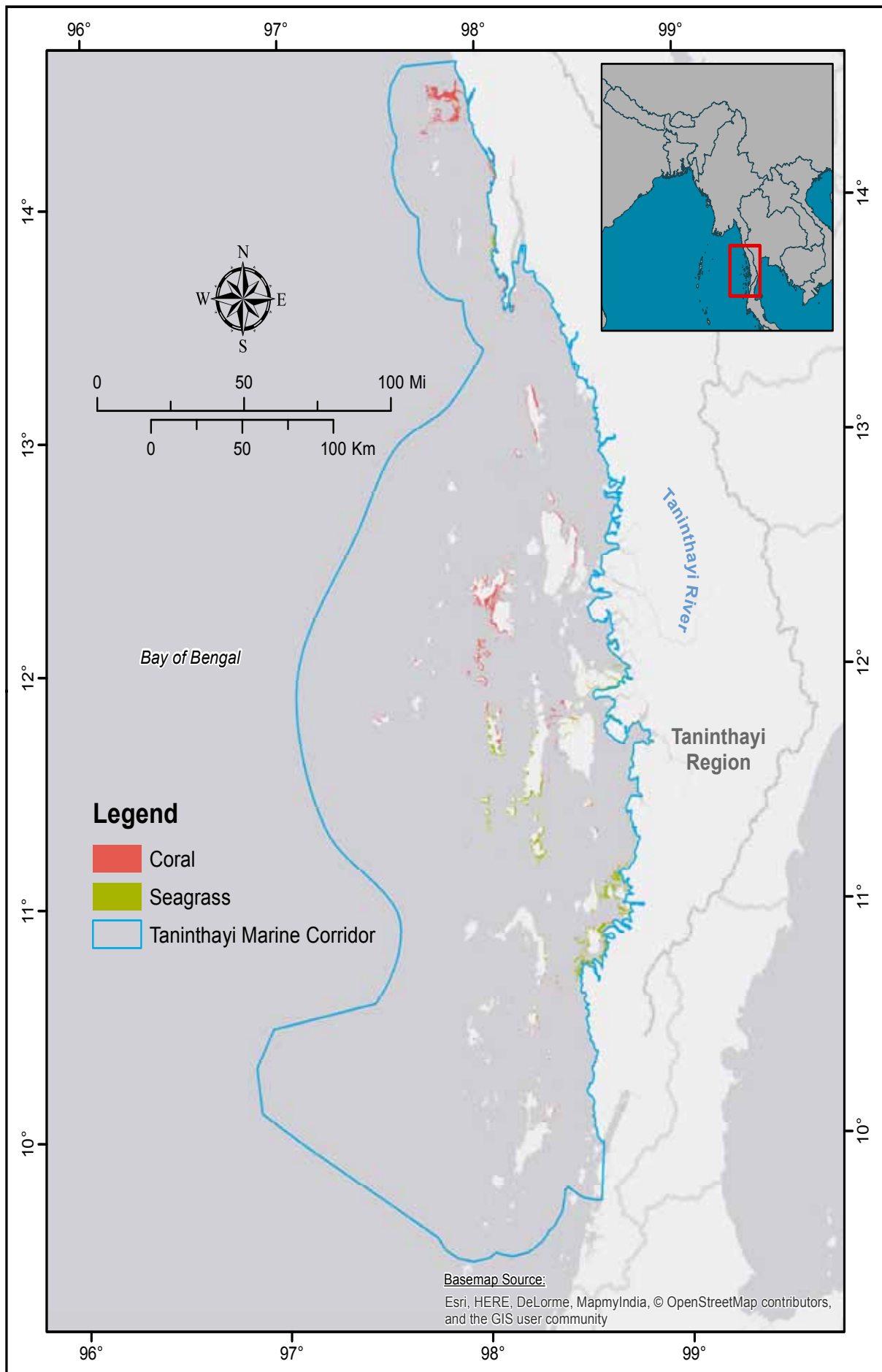


Figure 9. Distribution of coral reef and seagrass habitats within the Taninthayi Marine Corridor.

of many shells glued together. Some of the shells that are sold in the area are processed elsewhere and are sent back to the area for sale. For example, Trocha shells are polished in Yangon (Stakeholder interviews).

Many of the hotels are at or near to boat landing sites and the height of fishing activities and tourism coincide over the dry season period. Many tourists enjoy watching the activity of fishers in the early morning and mid-afternoon. Fish drying areas are often close to areas where tourists relax and the smell from the fish can be an annoyance for some tourists. In some stretches of beach, fish processing takes place about a five-minute walk from populated hotel beaches. Many of these processing areas are extremely unhygienic, sometimes with feces and rotting fish nearby. Surprisingly, the small number of tourists and hotel managers we spoke with did not express any concerns about this nor about issues around waste management.

TANINTHAYI MARINE CORRIDOR

Description

The Taninthayi Marine Corridor extends along virtually the entire length of Taninthayi Region in southern Myanmar and encompasses the Moscos Islands in the northern part of the Region, the numerous islands of the Myeik Archipelago and the offshore islands of the Burma Banks, totaling 1195 islands. The corridor covers an area of 65,780 km² (Figure 3). Note that this corridor is different from what is often referred to as the Taninthayi Coast. The Taninthayi Marine Corridor does not include the coastline of Mon State, further to the north. The Lampi Marine National Park and the Moscos Island Wildlife Sanctuary are within this corridor.

Key Biodiversity Areas

There are six KBA's encompassed within the Taninthayi Marine Corridor. Moscos Wildlife Sanctuary in the northern end is a Notified Protected Area that is mainly focused on terrestrial conservation but the islands also support marine life that includes priority species as outlined by the MBCIV, namely Indo-Pacific finless porpoises, Hawksbill, Leatherback, Green and Olive ridley marine turtles and mangroves (Wildlife Conservation Society, 2013). Lampi Marine National Park, within the Myeik Archipelago, focuses on both terrestrial and marine life and is home to dugongs, mangroves and

Hawksbill, Leatherback and Green marine turtles. A Shark Protected Area encompasses Lampi Island and another similar, larger Shark Protected Area is further north (Figure 6). It is not yet known what of the key species these two reserves include in their areas but likely they are likely home to marine mammals, sharks and giant clams on the nearshore reefs. Other KBAs identified through the MBCIV stakeholder process include the entire Myeik Archipelago and the Burma Banks, which are not yet under governmental protection.

Stakeholders

Stakeholders that are relevant to marine conservation activities in this corridor include most of the national level government bodies reviewed in the Stakeholder section of this report. Stakeholders of particular relevance to this area are the Taninthayi's Regional Government bodies; the Marine Science Department of Myeik University; the businesses and people benefitting from the soon-to-be growing tourism sector; fishers, processors and exporters who rely on the areas rich marine resources; Thai fishers; SCUBA diving operators and tourists who enter from Thailand; the Moken peoples; and other local communities.

Fisheries

The major fish landing sites in the Taninthayi Marine Corridor are in Myeik and Kawthoung (Figure 5). Squid fishing and trawlers are the dominant offshore fishers and nearshore fishers are able to catch and harvest a wide range of species that rely on the rich mangrove, seagrass and reef resources of the area.

Habitats

Our classification and mapping of coral, seagrass, and mud flat habitats in the Taninthayi Marine Corridor was accomplished using a Classification Tree Analysis with Landsat's visible and infrared bands (1-5) along with distinct training sites for both habitat classes in each study area.

Within the 65,780 km² area of the Taninthayi Marine Corridor, 362 km² were classified as supporting coral habitat (Figure 9). This coverage is approximately 100 km² more than the coral coverage we initially calculated from the coarser Millennium Coral Reef Assessment data set (2010) from UNEP-WCMC.

The reefs of the Taninthayi Marine Corridor are closer to the Coral Triangle, noted for high reef biodiversity and, unsurprisingly, these reefs are more diverse and richer than those of the Rakhine Marine Corridor. Major coral formations are found around some of the smaller islands, such as the Gregory Group of islands off the eastern side of Lampi Island. The region supports a range of coral formation types including fringing reefs; submerged pinnacles and seamounts; sheer and sloping walls; and boulder-strewn sand bottoms.

Also within the corridor, we classified 363 km² as seagrass habitat (Figure 9) and 238 km² as mud flats (not shown).

The 2011 Global Distribution of Mangroves USGS (Giri *et al.*, 2011a) data suggests that the Taninthayi Marine Corridor supports 2413.8 km² of mangroves (Figure 9). This is equivalent to 249,906 ha which is on the same order of magnitude but still much greater than the estimate of 195,103 ha made by Maung Maung Kyaw (2012). Based on assessments of mangrove encroachment by Maung Maung Kyaw (2012), the entire Taninthayi Coast had lost approximately 2.5% of its original mangrove habitat to encroachment by 2010. The main threat to Taninthayi's mangroves has been extraction for charcoal. The FD has intensified the protection through punishing illegal loggers and charcoal traders and it recently destroyed 204 charcoal furnaces (Kyaw Tint *et al.*, 2012a). These actions, along with current efforts by Myeik University to promote the importance of mangroves in the area, have ensured this ecosystem is not severely threatened compared to mangroves



Squids being dried in the sun.

of other areas of the country. Small but pristine stands of mangroves are also found within the Lampi Marine National Park. Note that we did not conduct a new Classification Tree Analysis on mangrove habitats for this review.

Research Efforts

Our general understanding of the marine systems within the Taninthayi Marine Corridor is strongest around Myeik Township and the two townships to the south as reflected by studies by thesis students. Of the theses we collected that had an explicit geographic focus, 37 (13.9%) were in Myeik Township. And just to the south, Kyunsu and Bokpyin Townships both supported six (2.3%). This is unsurprising since these three townships are close to Myeik University and include the northern and central islands of the diverse Myeik Archipelago. Kawthoung Township, the furthest south in the country, has been the focus of only one geographically-explicit marine thesis. Launglon Township was the focal site of six (2.3%), all but one of these by students of the University of Yangon. Among the non-thesis reviews, articles and reports there have been a number that review systems or species of the Myeik Archipelago across multiple townships and many reports focused on Lampi Island of Bokpyin Township (Figure 3).

Tourism

Tourism in the Taninthayi Marine Corridor is dominated by dive tourism. These tourists' primary interests revolve around the marine realm and, as such, they have a strong knowledge of and concern relating to marine life and conservation. Marine related tourism is going to be expanding in the area in the near future with the development of resorts on islands in the Myeik Archipelago and a growing influx of tourists entering the region from Thai-operated dive businesses. Tourism will provide economic opportunities for some people in the region and increase some stresses. Nature-based tourists tend to appreciate pristine environments, yet the activities and businesses that support them while they're visiting will generate increased waste and the industry will create new challenges relating to land development and sewage management. Careful and thoughtful regulations of this industry in its infancy could lead to a model of sustainable tourism in the area.

THREATS AND ISSUES

Various meetings and a workshop conducted in Myeik as part of this review revealed the main priorities for marine research and conservation activities from the perspective of the staff of Myanmar's government bodies and academics. Attendees of the 7 June 2013 workshop are listed in Appendix 20. The primary threats, issues and recommendations with respect to the sustainability of marine resources that they identified in workshop discussions are listed in Appendix 19 and are incorporated here and in the recommendations section that follows.

Overfishing

Overfishing in Myanmar's waters is widely believed to be leading to stock decline for various target species. Workshop attendees listed a number of issues within the country that contribute to overfishing. Illegal, Unregulated and Unreported (IUU) fishing is widespread in Myanmar. It is almost impossible to effectively manage for sustainable use of marine resources if laws are not adhered to and managing bodies do not know the full extent of extraction.

Destructive fishing

Fishers are using inappropriate technologies in certain areas and this can lead to destructive fishing. For example, trawlers are ignoring laws forbidding targeting inshore waters and they destroy delicate and important nearshore habitats such as reefs and seagrasses. They also tend not to use appropriate technology. TEDs on trawling equipment can allow marine turtles to escape, but anecdotal evidence suggests that most trawl fishers have not yet incorporated them into their nets.

Undisciplined Tourism

Despite the MoHT's efforts to develop and disseminate guidelines for coastal tourism development, there have been few strong regulations governing sustainable growth of the sector along coastal areas. Poorly planned tourism developments can lead to destruction of near-shore habitats

through construction, dredging, sedimentation and pollution; social issues through livelihood displacement and inequitable distribution of resources; and overfishing.

Well-planned tourism growth that considers the various social, economic and environmental impacts and incorporates thoughtful planning, outreach and mitigation efforts could have net positive benefits on long-term human and environmental health. With the anticipated growth of tourism, MoHT is considering environmental sustainability and marine issues can be incorporated into planning. The MoHT's recent development of policies relating to responsible tourism and community involvement in tourism reflect a commitment to consider these issues within the sector's development.

Watershed Degradation

Watersheds can be degraded through poorly regulated and planned coastal and riverside activities. Agricultural runoff and sedimentation can choke and poison marine habitats, plants and animals. Myanmar's scientists and government staff have cited this as a major threat that needs attention and legislation.

Extractive Industries

In addition to the direct harvest of marine life through fisheries, other extractive industries may negatively affect the marine environment.

Altogether there are 101 blocks set aside for oil and gas exploration in Myanmar including 48 offshore blocks. As of January 2012, there were 12 foreign oil companies working in 27 offshore blocks: 10 off the Rakhine Coast, 12 near the Gulf of Mottama and 5 off the Taninthayi Coast (Kyaw Tint *et al.*, 2012b) (Figure 2). Offshore oil and gas extraction carries a series of potential threats and spills can be catastrophic to marine life. The primary environmental risk stems from the possibility of oil spills from oil tankers or pipelines transporting oil and from leaks and accidents during the drilling process.

Oil spills can affect a range of marine life in the short and long term. Through coating hair and feathers, oil destroys the insulating abilities of mammals' fur and the water-repelling quality of bird's feathers. These animals can also be poisoned through ingesting oil. Oil in the water column can also be consumed by shellfish and finfish. It has been found that finfishes exposed to oil may experience reduced growth, enlarged livers, changes in heart and respiration rates, fin erosion and reproduction impairment (National Oceanic and Atmospheric Administration, Web page). Oil on the water's surface limits light penetration below, affecting marine plants and phytoplankton. Oil can wash ashore and impact coastal communities through killing algae, other plants and a wide range of animals. Certain compounds from oil, namely the cyclic hydrocarbons such as benzene, toluene and xylene, are soluble in water and can reach marine life that didn't have direct contact with the oil. A well-studied spill in Panama documented the widespread and devastating impact of the spill on mangroves, seagrasses, algae, invertebrates and coral reefs (Jackson *et al.*, 1989).

Water is often used in the oil extraction process offshore and, in offshore operations, it is released directly into the sea. This "produced water" contains varying amounts of oil and other compounds and is another source of oil pollution in addition to those from leaks and accidents.

Industrial and infrastructure development relating to the growth of extractive industries also threaten coastal areas. Currently, three major coastal centres are being considered for large-scale industrial development: Dawei in the Taninthayi, Thilawa Port near

Yangon, and Kyaukphyu in the Rakhine. Kyaukphyu could be the most impactful since plans include huge infrastructure supporting offshore oil drilling, pipelines, oil refineries, and a deep-sea port.

Myanmar has a long history of mining gemstones and gold and large mineral potential still exists. The Ministry of Mines is working to attract foreign investors and boost production to fulfill domestic needs and export potential. Poor industry standards and operations could result in discharge of noxious elements into fresh water and marine systems including mine tailings or poisonous chemicals such as arsenic and cyanide that are used by some extraction procedures. Offshore mining for minerals is a burgeoning industry that may also be considered in Myanmar. It is currently being developed in Papua New Guinea and its range of impacts is still unknown.

Another extractive industry of concern is sand mining. Currently sand is being mined from river bottoms and the sandy sea floor within the Myeik Archipelago for export to Singapore for use in construction and land-reclamation. It is unclear the extent of impact these operations may have on deep water and nearshore ecosystems. Other countries in the region, including Indonesia and Malaysia, have enacted bans on the industry because of environmental concerns.

Research Gaps

Research is a critical component to improving the understanding of the current state of Myanmar's marine resources, identifying the primary



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Big boats trawling in inshore areas often can damage shallow marine habitats such as seagrass beds.

threats to the sustainability of those resources and creating realistic plans for effective conservation and management. Stakeholders highlighted that there is insufficient funding and field and laboratory equipment available to support excellent research. Currently there is weak in-country capacity to conduct research. Poor communication channels and difficult logistical planning can be time consuming. Policy makers do not have sufficient data from which to develop action plans.

Inadequate Policies and Laws

The various laws regulating fisheries make concerted efforts to protect various marine systems and species. However, without adequate compliance and enforcement, many of these laws are ineffectual. There is a lack of funding for law enforcement and few incentives for compliance.

There is a lack of clarity on some laws and legal structures. It is not clear to many stakeholders as to who, between national and State/Regional governments, has authority over fishing concessions. There is confusion among government officials as to how to interpret the delineation of inshore and offshore zones. It is not clearly stated in the fisheries laws whether the coastline from which the inshore fishing zone is defined includes the coasts of islands or only the main land.

Related to this, some of the country's States and Regions lack a clear set of policies on resource management and development plans.

Climate Change

Climate change is expected to exacerbate existing threats to Myanmar's biodiversity both directly through habitat loss and reduced resilience of ecosystems and indirectly through impacting people and their dependence on natural resources. Rao *et al.* (2013) provide a summary of anticipated impacts and vulnerability ratings for ecosystems from extreme weather events throughout Myanmar.

In terms of marine coastal systems, communities living on the shore and on islands are particularly vulnerable to climate change. Sea level rise, salt-water inundation and increasing frequency and strength of storms can lead to failed crops and human displacement. Meanwhile, increasing water temperature and ocean acidification will affect nearshore reef ecosystems in both predictable and unpredictable ways, negatively impacting the food security of

coastal peoples. Increased water temperatures paired with sea level rise will accelerate coastal erosion and impact estuarine communities, mangroves and reefs and displace coastal communities. Cyclone Nargis of 2008, the worst natural disaster in the country's recorded history, killed over 146,000 people and affected over 7 million people, many through damaging the coastal ecosystems on which they rely. Habitat destruction, namely the clearance of mangroves for rice paddies and charcoal production, exacerbated the destructive impacts of the cyclone. In the area of the Ayeyawady Delta that was worst hit, little primary growth mangroves were found within 30 km of the coast (Fritz *et al.*, 2011).

The Myanmar Action Plan for Disaster Risk Reduction (MAPDRR) of 2012 explicitly discusses the unique vulnerabilities of coastal communities and has given high priority to the production of cyclone and storm surge vulnerability maps for coastal areas. This effort is to be led by the Department of Meteorology and Hydrology, the Settlement and Land Records Department and Local Governments; to be contributed to by the Irrigation Department and the Department of Health; and to be partnered by the Myanmar Information Management Unit, the Myanmar Engineering Society, the Myanmar Geosciences Society, UN Agencies and International NGOs.

Community Issues

Many coastal communities of Myanmar are poor and sometimes isolated, affecting their interaction with natural resources. People who have low education levels and possibly little contact with outsiders may have low levels of awareness. Without access to alternative livelihoods, they may rely solely on fishing and gleaning for subsistence and entry into the cash economy. These factors and immediate needs can influence their ability to consider the long-term sustainability of resources on which they depend. Furthermore, poor communities are less resilient to the impacts of climate change due to limited resources for adaptation.

Weak Collaborations

Workshop participants highlighted that collaboration and coordination among people working toward the continued health of marine resources is often weak. There are no formalized mechanisms or incentives that encourage collaboration and communication between the various stakeholders.





RECOMMENDATIONS

NATIONAL MARINE SPATIAL PLAN

Myanmar's marine resources are being accessed and impacted by a wide range of stakeholders with growing influences. Tourism is increasing and large-scale tourism developments are anticipated in the Taninthayi area. In March 2014, the government of Myanmar awarded 20 new offshore oil and gas blocks to foreign firms for exploration and development, doubling the area of offshore habitat given up to oil and gas production. Foreign fishing vessels in Myanmar may decline due to the 2014 parliamentary ban of foreign fishing boats. And, since the 2013 lifting of economic sanctions, already poorly-understood fishery export markets entered a period of flux and new markets for nearshore marine resources may emerge, which will influence fishers' livelihoods.

A national-level spatial planning exercise will allow for a clearer understanding of the influences and interactions of these and other marine-related activities across Myanmar's EEZ. A national level management plan can be developed based on a strong understanding of the distribution of the range of marine influences in Myanmar's waters. Therefore, we recommend the following:

- Develop a national marine spatial plan for conservation and development, including marine protected areas, community-based coastal management areas, industrial development areas, allotments for tourism development, and fishery zones.

This effort would require the following components:

- Data collection from academic partners, government bodies, and NGOs to build a national marine spatial plan.
- Gap assessment of additional data needs across the entirety of Myanmar's EEZ.
- Data overlay and analysis using marine spatial planning tools to provide a foundation for an interactive process that considers the range of competing priorities and allows for the involvement of a range of users.
- Stakeholder review/consultation process.
- Draft marine spatial management strategy that will include a proposal for the expansion of habitat and biodiversity protection for both fisheries production and precautionary preservation through a representative network of marine protected areas.

Such an exercise would have a range of outcomes:

- Inform tradeoff decision-making processes concerning development and conservation allowing

for improved government planning for sustainable use and conservation of Myanmar's marine environment.

- Increase multi-sector collaboration for sustainable and equitable use and conservation of Myanmar's marine environment.
- Improve the sustainability of artisanal and commercial fisheries.
- Develop policies and interventions to increase protections for specific threatened marine species.

SUSTAINABLE FISHERIES CONSERVATION STRATEGY

Fisheries provide the dominant livelihoods in many of Myanmar's coastal regions, the extent and sustainability of which is unknown. In March 2014 a Norwegian government-funded survey of pelagic and demersal fish stocks across the entirety of Myanmar's Exclusive Economic Zone revealed that pelagic fish stocks currently stand at 10% of their 1979 biomass, with similar estimates for coastal fisheries. Endangered sharks and rays are also increasingly being landed for sale to foreign markets. According to the FAO, Myanmar's fisheries sector provides close to 1 million jobs for coastal fishers directly and nearly 3 million jobs indirectly. A sustainable fisheries conservation strategy would aim to reverse the current trajectory of marine resource decline in the country. We recommend the following:

- Develop a sustainable fisheries conservation strategy, to link the lessons of a growing range of ground-level field projects to national level top down support for fisheries research and reform. The plan would engage with commercial and artisanal fisheries as well as seek species protections for marine taxa such as sharks and rays.

This strategy would need to include both ends of the fisheries spectrum, from industrialized offshore fleets to bottom up community-based coastal fisheries management, ubiquitous in much of the developing world. The holistic strategy should include the following three components:

- Offshore fishery assessment and conservation strategy. Potential solutions for industrial fleets may include top-down controls such as Vessel Monitoring Systems, increased fishery observer programs, stock modeling, or even quota or spatially-based property rights.
- Inshore fishery assessment and conservation strategy. A critical component to successful small-scale fisheries management will be the

introduction of a legal framework that allows for co-management by coastal fishers and their communities.

- Species protection strategy. This could focus on some of the species groups, outlined below.

A sustainable fisheries strategy would have numerous impacts, including the following:

- Improve the sustainability of artisanal and commercial fisheries.
- Positively impact local livelihoods in the coastal regions.
- Allow for coordinated action on a national level for particularly vulnerable animals such as sharks and rays.

COMMUNITY-BASED COASTAL MANAGEMENT

Community-based coastal management involving clear, integrated management plans can be used to conserve a range of coastal habitats and the species and people that rely on them.

Before additional coastal conservation activities are started, it would be useful to understand what has worked and what has not in the current system and to establish what actions are needed to clarify and achieve realistic goals. This analysis could then be placed in the wider context of lessons learned to date involving community-based natural resource management in Myanmar and the potential application of such to coastal conservation. The analysis could include the following:

- Conduct a lessons-learned analysis of Lampi Marine National Park, identifying legal structures, history of the process, current protective measures, threats and challenges, to assess the functioning of the park.
- Conduct a similar analysis of other nearshore conservation areas including Meinmahla Kyun, Thamihla Kyun and Moscos Island Wildlife Sanctuaries, as well as the conservation areas for lobsters and clams in Thanbyuzayat and Pulaw Townships respectively.
- Analyse community natural resources management approaches used to date in fisheries and forestry by DoF, FD and NGOs, and their potential application in coastal ecosystems.
- Conduct an assessment of co-managed fisheries such as that in Bogale Township, where village fisheries sectors were allowed to manage some aspects of local fisheries. Analyses should, in particular, consider the legal structure of co-management.

Community-Based Natural Resource Management (CBNRM) and co-management approaches could be used to establish a community-based coastal conservation initiative. This is in line with the suggested action of the National Biodiversity Strategy and Action Plan (2011) to “develop participatory approaches for community based fishery resource conservation and management” as one of its stated objectives within its “Five-year Action Plan Toward Sustainable Management of Coastal, Marine and Island Ecosystems”. On-the-ground conservation efforts could tie into larger efforts being conducted at national and even regional levels such as in a multi-scale project addressing the conservation of a target species and testing co-management approaches. Such efforts would involve working with a subset of vulnerable island communities and could involve a series of activities:

- Conduct a Village Consultation Process (VCP) in communities to identify natural resource use, priority species and habitats and threats.
- Use participatory mapping to assess resource use.
- Develop a local biological monitoring approach, modeled after similar monitoring approaches used elsewhere (such as in Locally Managed Marine Areas in the Pacific).
- Conduct socio-economic monitoring to understand the current state of reliance on marine resources and to measure changes over time.
- Evaluate susceptibility to the effects of climate change.
- Assess the roles of community organisations to understand how they shape and impact decision making.
- Test community co-management approaches through developing Community Management Plans. These may incorporate protection measures (such as quotas, size restrictions or gear restrictions), remediation measures (such as replanting mangroves), or spatial management (such as no-take areas).

A suggested geographic focus for this work would be in a subset of islands of the Myeik Archipelago. There are a number of reasons for this focus:

- Trends in tourism suggest that this area will likely experience greater near-term changes in pressures on the resources and a shifting composition of stakeholders. It is likely that increased tourism in the region will lead to more opportunities for livelihood diversifications but, if poorly planned, also resource depletion. This will be a critical time to work with communities to understand and benefit from these changes.

- The Taninthayi Coast supports the more diverse and rich marine communities in the country. These communities are under-studied and, while there are indications the area is already suffering from over-exploitation, there is no understanding on the degree to which these systems are already being degraded.
- Through working with a small subset of island communities, managers would learn the nature of the issues facing these communities and effective ways to engage with them. In time, community engagement projects could take lessons learned and expand to other communities in the region, thus creating a network of areas and increasing the impact of the efforts.

MARINE MEGAFUNA PROTECTED AREAS

A number of Myanmar's priority species are threatened by the use of nets and longlines. These include sharks, rays, five species of marine turtles, cetaceans and dugongs. We propose the creation of a coordinated, multi-taxa initiative to create zones that aim to benefit multiple species through gear restrictions by location and or season. Such an initiative would involve the following:

- Evaluate and improve the implementation of the existing Shark PAs (see below), which would be a critical first step. Lessons learned can inform the creation of future marine PAs
- Conduct a spatial risk analysis based on deployment points of fishing gears, species distributions, and seasonality and habitat models.
- Use these maps and analyses to identify
 - Key areas of overlap between species of conservation concern with areas heavily used by fisheries. These are areas where the probability of entanglement with fishing nets would be high.
 - Areas of high fishing use but lower levels of species occurrence. These are areas where fishing with standard fishing gears could be continued.
- Consult with stakeholders to choose a subset of areas for protection through gear restrictions.
- Integrate megafauna-friendly actions with other conservation efforts such as the DoF's National Plan of Action (NPOA) for sharks and research activities relating to marine turtles.

LEGAL REFORM AND IMPLEMENTATION

Myanmar's coastal communities are not legally empowered to contribute to decision-making relating to the management of the marine resources they rely on. Current legal structures and enforcement capabilities are not sufficient to support the enforcement of fisheries regulations and compliance to laws is low. Stakeholders emphasized the need to improve enforcement and compliance through clarifying and reforming laws and enforcement. Recommendations relating to legal reform and implementation include:

- Based on assessments of natural resource management approaches and in consultation with the DoF and other stakeholders, suggested provisions for fisheries co-management should be developed. This would allow for improved community participation in fisheries management, which could lead to better compliance and more effective management.
- Relevant laws could be updated through reviewing the policy and existing laws with research and public participation.

Mechanisms to clarify and communicate relevant laws and notifications across stakeholders are needed, such as the definition of coast within the "Myanma Marine Fisheries Law".

In cases where compliance is low and resources are insufficient for adequate enforcement, consideration should also be made for other ways to improve compliance. For example, where laws are in line with local beliefs and attitudes, it may be possible to improve compliance through education and outreach. A no-fishing zone was established by monks of the Namada Pagoda and Monastery along a section of the Ma Yu River and, although not legally recognized, it is well respected by local fishermen.

ECOSYSTEM-SPECIFIC RECOMMENDATIONS

Coral Reefs

The coral reefs of the Myeik Archipelago are poorly studied due to the unique requirements for researching these distant and deep systems, namely high costs (for fuel and specialized equipment) and unique skills (such as SCUBA diving). However these systems are being exploited by SCUBA divers and fishers for recreation and extraction purposes. Long-term observations by recreational divers suggest that exploitation on remote reefs has increased



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dramatically in recent years. Recommendations are, therefore, broad and large in scale:

- Support local research and collaborations to develop local capacity to study and monitor coral reefs.
- Design a monitoring protocol appropriate to local capacity and resources that will be able to
 - Identify the ‘baseline’ state of reef systems and
 - Reveal predominant and site-specific threats.
- Work with local communities on management plans that incorporate mitigating threats to coral reefs along with other issues (climate change, overfishing, sustainability, livelihoods), ecosystems and organisms (target food fish, sharks, marine turtles).
- Blast fishing must be reduced immediately through awareness raising activities, legislation and enforcement.
- Tourist shops, curios sellers and tourists should be made aware that transporting coral products from Myanmar and into many other countries is illegal under CITES.

Seagrass

Trawlers operating in the inshore areas can destroy nearshore habitats such as seagrass beds. The current impact level from this fishing activity on Myanmar’s

seagrass beds is not known. Seagrasses in Myanmar are likely to face a range of new threats during the anticipated increase in development.

- Bans on “baby trawlers” in nearshore areas need to be enforced.
- The importance of seagrass beds needs to be emphasized at all national and regional meetings relating to coastal zone planning so that decision makers remain aware of the need to protect this habitat.
- Seagrasses need to be considered in future EIAs so as to minimize negative impacts on their health during inevitable coastal development projects.
- The MoHT needs to be aware of the importance of coastal habitats to marine life and the burgeoning coastal tourism sector that depends upon it. Tourism developments occurring in coastal areas should be legislated to minimize the removal of seagrasses (as well as mangrove and reefs) during their coastal development activities.
- University marine science departments should encourage further research on the distribution of seagrasses and the identification of particularly healthy stands or those important to science that might warrant targeted, spatial protection. These may include stands dominated by *Cymodocea serrulata* in the Rakhine Marine Corridor and *C. rotundata* in the Taninthayi Marine Corridor.

Mangroves

Due to the dramatic levels of threats and encroachment along with the wide recognition of the services that mangroves play in shoreline protection, particularly after Cyclone Nargis, mangrove systems have received substantial attention from government departments and NGOs. The FD has collaborated on projects using an Integrated Management Approach that combines environmental management with economic development. Unfortunately the scale of impact of this work pales when compared to the estimates of habitat already affected. This study therefore makes the following broad recommendations:

- The FD's Integrated Management Approach should be replicated and expanded.
- Where mangroves still form contiguous cover, there may be enough potential for natural regeneration and recovery, but this would require protection from further encroachment and fragmentation.
- In other areas, replanting methods would need to be used to encourage any recovery as part of a management plan. Reforestation could be done with local mangrove species such as *Avicennia officinalis* and *Sonneratia apetala*.
- Efforts to help communities manage firewood and timber extraction from mangroves at sustainable levels, especially in the Ayeyawady Delta region should be expanded.
- Conversion of mangrove to shrimp ponds and rice paddies in the same areas must be curtailed dramatically.
- A broad Mangrove Management Plan should be developed for the entire tracts of mangroves in the country. The soon-to-be created Mangrove Conservation Division under the FD will, ideally, evaluate the critical ecosystem services provided by the habitat in various areas and include zoning. The Division should:
 - Evaluate mangrove contribution to fisheries.
 - Identify potential acid-sulphate soil problems relating to shrimp ponds.
 - Assess economic and social values of the mangrove stands.
 - Assess likely role of mangroves in protection of human populations and agriculture from storm surges.
 - Evaluate the potential for aquasilviculture with shrimp farming to diversify income risk.
 - Study sediment dynamics to understand the role of mangroves in sediment entrapment

deposition and erosion to identify particular areas where mangroves are providing critical protection.

SPECIES-SPECIFIC RECOMMENDATIONS

Sharks and Rays

The creation of a national multi-stakeholder Shark and Ray Advisory Committee, involving the DoF, the Navy and conservation NGOs, could guide the Shark NPOA as well as any other conservation, management or legislative processes involving elasmobranchs. This committee could oversee necessary steps toward developing the NPOA, which would include the following:

- Review of the current laws relating to shark captures and legal structures for enforcing Shark PAs.
- Review of enforcement activities and protocols through interviews with those authorities involved.
- Assessments of the level of exploitation through market surveys similar to those conducted in 2004.
- Workshops with Navy and DoF personnel to assess the threats, challenges and possible solutions relating to management of Shark Protected Areas.
- Assessing the level of fisher displacement and/or socio-economic impacts and alternatives from the creation of the Shark Protected Areas.
- Visiting sites with Navy collaborators to assess operational threats to shark reserve effectiveness.
- Interviewing local communities to assess their perceptions and understandings of shark fishing pressure within the current protected areas and identification of culturally and economically viable livelihood alternatives.
- Identifying public perception of sharks and rays and using preliminary results to develop an outreach and awareness campaign for Myanmar.
- Providing recommendations to key enforcement agencies and personnel to improve law enforcement effectiveness.

Sharks are a priority species for dive tourists who are attracted to the relatively isolated waters of Myanmar. Efforts to halt the illegal harvest of sharks can be tied with initiatives to develop a sustainable tourism industry. Activities relating to shark conservation and tourism could include:

- Conducting consultative workshops and planning with the MoHT with respect to dive tourists.
- Assessing the impacts and distribution of benefits from tourism initiatives related to sharks.
- Developing educational and awareness campaigns on the importance of sharks that are tied to larger, income-generating initiatives such as tourism.
- Exploring novel income-generating approaches for conservation and awareness projects benefiting first and foremost communities utilizing resources in the shark reserves.

Additional understanding of shark and ray populations, distributions, seasonality, critical habitats and behaviour would inform and underpin management actions. Approaches similar to those used in other locations in the world could be replicated in Myanmar. WCS has initiated a research program in Belize that has been successful in standardizing baseline assessments for sharks that is now being extended to neighbouring countries. Research activities could involve:

- Collaborative research between the DoF and international NGOs or researchers with experience in shark research
- A bottom up approach that is standardized and scalable to other sites in Myanmar and ultimately the SE Asian region so that the status of sharks and rays in different sites and countries could be compared
- Peer to peer exchanges between countries that could be implemented for participants in the different sectors (fishing, tourism, enforcement, science) to promote an exchange of lessons learned and prepare for CITES enforcement requirements

Considering the uplisting to Appendix II of five of Myanmar's shark species and two of its ray species at CITES COP 16 in 2013, Myanmar needs to prepare for implementing controls needed for trade in sharks. Recommendations include:

- Conduct a review of the monitoring, documentation, and controls needed for trade in sharks and rays.
- Assess the current procedures and needed procedures for CITES processing in Myanmar, including permitting procedures, port procedures and licensing procedures.
- Identify training and materials needed to support implementation.

Marine Turtles

- Continue and strengthen the enforcement of protection laws (no mechanized near-shore fishing, no harvesting of eggs, release of turtles caught in fishing gear).
- Introduce a programme and legislation to further encourage the use of TEDs with trawling gear.
- Conduct a Myanmar-wide mapping exercise using consultations with local experts and field interviews to inform designation and management of Marine Megafauna Protected Area(s).
- Improve hatching techniques following the specific recommendations outlined by the IOSEA advisor.
- Extend “wildlife sanctuary” protection status to existing nesting beaches.

Crocodiles

- Conduct rapid surveys along Rakhine and Taninthayi's coastlines to check where crocodile populations remain.
- Establish a monitoring programme at Meinmahla Kyun Wildlife Sanctuary for the large, robust and possibly increasing crocodile population.

Cetaceans

- Assess near and inshore shore cetacean populations more rigorously with special emphasis on identifying preferred habitat for focal conservation attention.
- Incorporate cetaceans into initiatives to establish a network of conservation areas along the Taninthayi and Rakhine Coasts where gill netting would be eliminated or dramatically reduced. This could be independent or as part of a larger Marine Megafauna Protected Area, as proposed above. Priority areas already identified for cetacean protection include:
 - Rakhine:
 - Lower reaches of the Meybone River and adjacent coastal inlet to the south,
 - Ma Yu River, upstream of the one already established by the Namada Pagoda and Monastery
 - Taninthayi:
 - The Salon-Daung channel between the east side of Sakhan Thit Island and the

mainland

- The south of the Kau Yea Straights in the channel between Sit The Kyunn Gyi Island and the mainland.
- Investigate incidental and intentional catches and identify ways to reduce or eliminate them especially in inshore and nearshore waters inhabited by threatened species (e.g., Irrawaddy dolphins and Finless porpoises).
- Educate about and enforce laws that prohibit the intentional killing of cetaceans and the sale of products, including meat, oil and bones, from marine mammals.
- Assess the potential for integrating well-managed dolphin and whale watching tourism into marine mammal research and conservation efforts.
- Conduct an inventory of whale skeletons in the country including confirming and updating descriptions, identifications and location data.
- Incorporate messages on cetacean conservation and use them as flagship species for marine conservation in educational outreach and education initiatives.

Dugongs

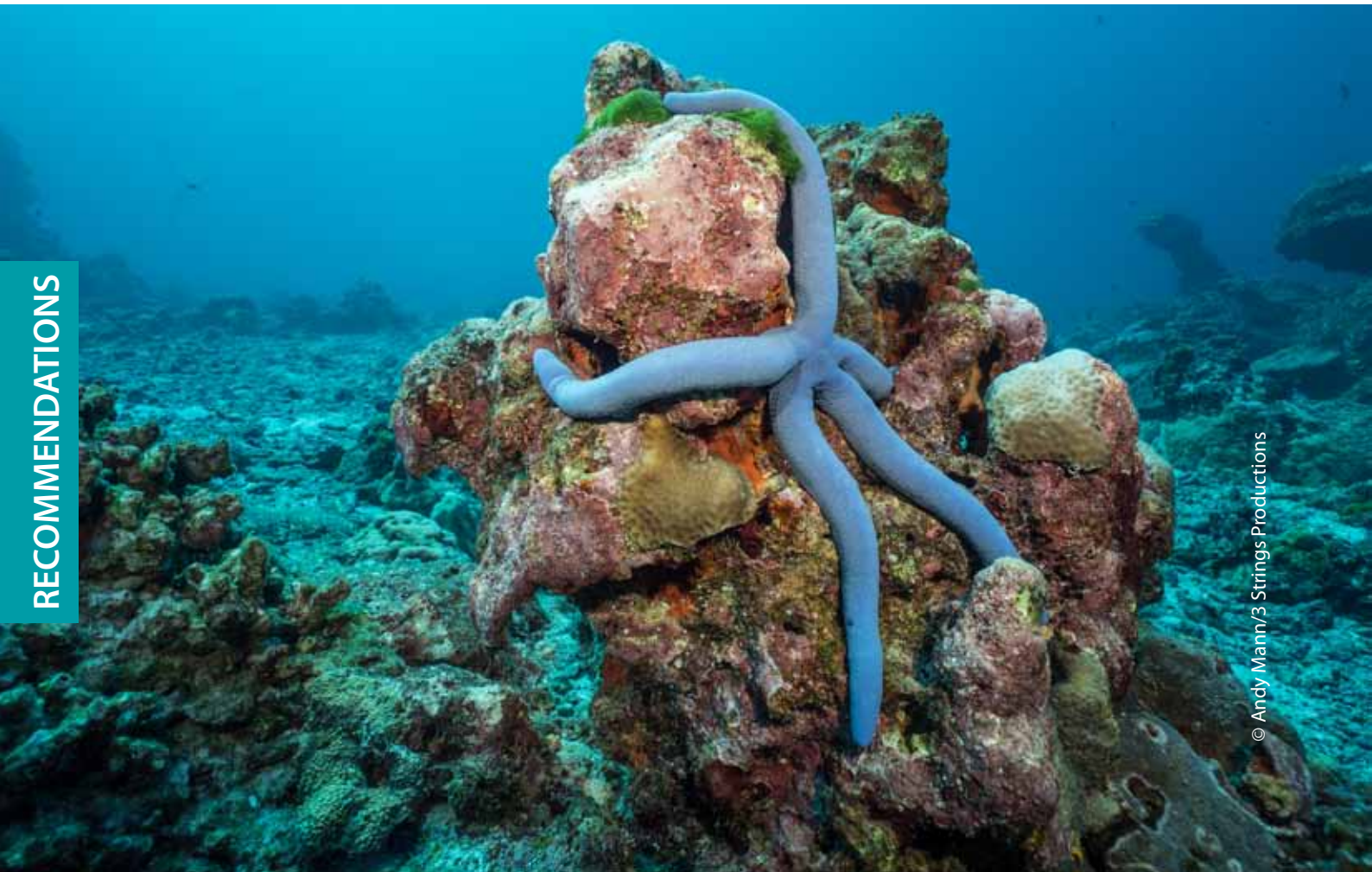
- Conduct a threat assessment of seagrass areas that have been identified as priority habitat for

dugongs and identify ways to protect these areas from loss and degradation.

- Initiate integrated management campaigns for conservation management in these areas that include:
 - Conducting aerial surveys of dugong populations and seagrass beds in areas identified as hotspots for dugongs particularly along the Rakhine Coast.
 - Assessing the feasibility of creating conservation areas in sea grass beds where gill nets and bottom trawling are prohibited. Note that this work could be done in conjunction with baseline research needed to establish Marine Megafauna Protected Area(s), as proposed above.
 - Building on awareness campaigns already conducted by the DoF and involve local NGOs, such as the Rakhine Coastal Region Conservation Association, to foster a sense of pride and stewardship over fragile dugong populations.

Squids

- Continue to monitor catches of squid at major landing sites.
- Work with international bodies to improve monitoring and studies with the aim of generat-



ing accurate stock assessments.

- Consider and review management and regulatory actions to assure sustainability of the fishery.

Prawns and Shrimps – Live Capture

Official data show wild caught marine shrimp capture increased more than three fold in the decade up to 2011 however other studies have found that landings peaked in 2001 in Myeik. Extreme levels of exploitation and decreased landings in some areas suggest that wild caught stocks may be falling below their carrying capacity.

- Stock analyses should be performed on the most up to date set of fisheries data to determine the status of wild prawn and shrimp stocks. DoF should use findings from this to make informed management decisions on potential restrictions.
- Legislation which forbids the use of trawl nets in inshore waters needs to be enforced to protect delicate and important nearshore habitats.

Prawns and Shrimps – Farming

Government officials from both FD and DoF are well-aware of the issues around prawn farming and mangrove deforestation in the country and, there is concern and institutional desire to see that protection measures to date continue to be strengthened. Various considerations should be made to effectively manage any expansion of this aquaculture practice in Myanmar:

- Efforts should be made to upgrade and rehabilitate low productivity coastal ponds and degraded mangrove systems through removing acid and toxic leachates or implementing aquasilviculture rather than cutting healthy mangroves.
- A national-level Mangrove Management Plan, described above, should include consideration of the impacts of prawn and shrimp farming.
- A comprehensive environmental management plan should be developed in coordination between the DoF and private sector shrimp industry in Myanmar and could create a voluntary Code of Conduct to guide development of the industry.

Spiny Lobsters

- The DoF should create notifications that dictate size limitations for capture and sale of species within the genus *Panulirus*. This should involve

consultation with exporters who also value larger lobsters and would be key in implementing the restriction.

- As there are five different species in the fishery, the life histories, in particular, the size at sexual maturity, of each species should be evaluated in order to decide if more than one size limitation would be needed and what the size(s) should be.
- Gravid (with eggs) lobsters should be restricted for sale (similar to Notification No. 3/95 that protects gravid prawns).
- The fishery's stocks would benefit from restricting gear use to selective methods (such as traps rather than gill nets) to help the stocks recover and to create a sustainable fishery.
- Awareness programmes may help fishers understand the importance of any introduced restrictions protecting juvenile and berried lobsters.

Crabs

- Additional research on mud crabs (*Scylla serrata*) is needed to determine the sustainability of present harvest and farming practices to generate advice on sustainable management.
- Research on Frog crabs (*Ranina ranina*) populations of the Taninthayi Region would benefit management decisions relating to this relatively new fishery.

Seaweeds

- Legislation of seaweed farming needs to be introduced before there is any further expansion of the industry. Legislation should include:
 - Regulations around species and nursery stock to prevent the import of potentially invasive species
 - Prohibitions on removing mangroves for seaweed culture
 - Limits on the area of seagrass beds to be directly impacted by any open-sea seaweed culture operation

Shellfish

The impact of shell collecting for the curious trade needs to be assessed including identifying source populations and assessing the sustainability and carrying capacity of the populations.

Sea and Coastal Birds

- Additional surveys of bird populations are needed at a range of Myanmar's coastal and marine habitats to improve our understanding of these poorly known species and their dynamic ecology. Habitats include pelagic waters, the Cocos Islands, mud flat areas used by wintering shorebirds, undisturbed mangroves tracts and offshore islands.
- Survey work should be used to inform Myanmar's government of areas of high conservation importance and identify management opportunities to conserve these areas. This could include the expansion of the National Protected Areas network as well as smaller community-managed conservation schemes for specific species or important nesting or wintering areas.
- With a projected dramatic increase in tourism, community-based enterprises could be linked with nature tourism.

RESEARCH

Myanmar's University Zoology and Marine Science departments are eager to improve the capacity of their institutions and students, expand their impact on the understanding of Myanmar's marine resources and increase collaboration with outside researchers. Recommendations relating to these needs, include:

- Establish a "Marine and Coastal Resources Research Centre" administered through the DoF and Mawlamyine University's Marine Science Department, in conjunction with Myeik University where it could be based, with the following functions and responsibilities:
 - To provide a formalized structure for collaboration and coordination between DoF and the Ministry of Education for research and conservation activities
 - To engage and coordinate marine scientists from across Myanmar's universities and the DoF
 - To provide a mechanism for foreign researchers to collaborate with students and academics
 - To provide a mechanism for NGOs conducting conservation research to access and support students interested in the marine conservation field
 - To provide training to students in essential field skills such as snorkeling and SCUBA

diving

- To facilitate information sharing through hosting workshops and serving as a repository for research reports, papers and materials relating to marine research and conservation
- Improve Local capacity in particular areas of research including skills needed for publishing in peer-reviewed journals through collaborative research.
- Address gaps in marine research as identified by Myanmar's academics, namely:
 - Identify indicator species for environmental and ecological studies.
 - Generate data needed for policy makers and action plans.
 - Develop long-term ecological studies on specific species.
 - Develop monitoring programmes of water quality.
- Students could further and better explore the taxonomy, population structures and dynamics of Myanmar's marine life through access to high tech facilities in international laboratories. For example, international universities can provide training and facilities for genetic analyses, GIS skills and computer modeling.

CLIMATE CHANGE

Community-based planning activities by NGOs and other organisations can help improve local adaptive capacity for the most vulnerable populations through a range of activities:

- Conduct awareness-raising activities for local communities around climate change.
- Incorporate planning for the impacts of climate change during co-management activities such as the creation of Community Management Plans.
- Expand and link conservation areas and the protected area network to help maintain a diverse set of intact marine habitats and viable populations of marine species.
- Support activities planned within the MAP-DRR.
- Contribute to advanced climate modeling studies to understand changes in climate on spatial and temporal scales to influence planning.

TOURISM

The state of the Taninthayi Coast's marine system has already started to decline in terms of its value for dive-based tourism. Through efforts to limit domestic waste, blast fishing and the abandonment of fishing gear, some aspects of Myanmar's special qualities for tourism (such as a sense of remoteness and isolation) might be maintained. Improvements in these areas will also help maintain healthy marine resources for the needs of other stakeholders beyond those benefitting directly from tourism.

- Tourism development plans should take into account the importance of healthy marine habitats, healthy fish and shark populations and a clean environment for marine-based tourism.
- University marine science departments, the DoF and NGOs focusing on environmental conservation could contribute to tourism development plans.
- MoHT directives for the private sector, which currently include guidelines for building and operations, should be improved to specifically include measures and restrictions intended to limit harmful impacts from marine tourism on the marine environment. These could include items such as regulations on how hotels are to process sewage and detailed limitations on the direct alteration of marine habitats during construction.
- Tourism initiatives from other countries should be looked to for models on best practices and innovative income generating approaches. For example, portions of income generated through tourist fees could be directed toward targeted marine conservation efforts.





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APPENDICES

APPENDIX 1. MANGROVES OF MYANMAR (NOT INCLUDING ASSOCIATES)

Scientific Name	Occurrence	IUCN	*Citation(s)	Coastal Region		
				Rakhine	Ayeya.	Tanin.
<i>Acanthus ilicifolius</i>	Confirmed	LC	4, 5, 6, 12, 14, 20	X	X	X
<i>Acanthus volubilis</i>	Confirmed	LC	4, 6, 12	X	X	X
<i>Acrostichum aureum</i>	Confirmed	LC	4, 5, 12, 14	X	X	X
<i>Aegialitis rotundifolia</i>	Confirmed	NT	1, 4, 5, 12, 13, 14	X	X	X
<i>Aegisceras corniculatum</i>	Confirmed	LC	1, 3, 4, 5, 12, 14	X	X	X
<i>Avicennia alba</i>	Confirmed	LC	1, 3, 4, 5, 12, 13, 14, 17	X	X	X
<i>Avicennia lanata</i>	Probable	VU	8			X
<i>Avicennia marina</i>	Confirmed	LC	1, 3, 4, 6, 12, 13, 14, 16, 17	X	X	X
<i>Avicennia officinalis</i>	Confirmed	LC	1, 3, 4, 5, 12, 13, 13, 14, 16, 17, 19, 20	X	X	X
<i>Brownlowia tersa</i>	Confirmed	NT	1, 3, 4, 14	X	X	X
<i>Bruguiera cylindrica</i>	Confirmed	LC	4, 5, 14, 21	X		X
<i>Bruguiera gymnorhiza</i>	Confirmed	LC	3, 4, 5, 12, 13, 14, 21	X	X	X
<i>Bruguiera parviflora</i>	Confirmed	LC	4, 5, 12, 14, 19	X	X	X
<i>Bruguiera sexangula</i>	Confirmed	LC	3, 4, 6, 12, 19, 20	X	X	X
<i>Ceriops decandra</i>	Confirmed	NT	3, 4, 5, 12, 13, 14, 20, 21	X	X	X
<i>Ceriops tagal</i>	Confirmed	LC	4, 5, 12, 14, 20, 21	X	X	X
<i>Derris indica</i>	Confirmed		4, 12	X	X	
<i>Derris scandens</i>	Confirmed	LC	4, 12, 14	X	X	X
<i>Derris trifoliata</i>	Confirmed		14			X
<i>Dolichandrone spathacea</i>	Confirmed	LC	14			X
<i>Excoecaria agallocha</i>	Confirmed	LC	1, 3, 4, 5, 12, 14, 19	X	X	X
<i>Heritiera fomes</i>	Confirmed	EN	3, 4, 12, 17	X	X	X
<i>Heritiera littoralis</i>	Confirmed	LC	1, 6, 13, 14			X
<i>Hibiscus tiliaceus</i>	Confirmed		3, 4, 12, 14, 20	X	X	X
<i>Kandelia candel</i>	Confirmed	LC	3, 4, 12	X	X	X
<i>Lumnitzera littorea</i>	Confirmed	LC	6, 14			X

<i>Lumnitzera racemosa</i>	Confirmed	LC	6			X
<i>Nypa fruticans</i>	Confirmed	LC	1, 3, 4, 10, 12, 18	X	X	X
<i>Pemphis acidula</i>	Confirmed	LC	12			X
<i>Phoenix paludosa</i>	Confirmed	NT	1, 3, 4, 10	X	X	X
<i>Rhizophora apiculata</i>	Confirmed	LC	3, 4, 6, 8, 10, 12, 13, 15, 17, 19	X	X	X
<i>Rhizophora mucronata</i>	Confirmed	LC	1, 4, 8, 10, 12	X	X	X
<i>Rhizophora stylosa</i>	Confirmed	LC	6			X
<i>Sesuvium portulacastrum</i>	Possible		1, 12Y			X
<i>Sonneratia alba</i>	Confirmed	LC	4, 13, 18	X		X
<i>Sonneratia apetala</i>	Confirmed	LC	3, 4, 10	X	X	X
<i>Sonneratia caseolaris</i>	Confirmed	LC	3, 4, 9, 10, 15, 16, 17, 18	X	X	X
<i>Sonneratia griffithii</i>	Confirmed	CE	1, 2, 3, 10, 12	X	X	X
<i>Xylocarpus granatum</i>	Confirmed	LC	1, 3, 4, 12	X	X	X
<i>Xylocarpus mekongensis</i> [recorded as <i>Xylocarpus gangeticus</i>]	Confirmed	LC	1, 10	X	X	
<i>Xylocarpus molluccensis</i>	Confirmed	LC	1, 4, 10, 18	X	X	X

*Citations			
1	Aye Aye Mon, 2012	12	Nay Win Oo, 2004
2	Cho Meol Aung, 2010	13	Nyo Nyo San, 2011
3	Forestry Department of Myanmar & Japan International Cooperation Agency, 2005	14	San Tha Tun et al., 2008
4	Hnin Khaing Aye, 2007	15	San Tha Tun, 2011
5	Kyaw Thura, 2011	16	Tay Zar Tun, 2010
6	Kyaw Thura, pers. comm.	17	Thet Su Mar, 2010
7	Khin Wai Hlaing, 2012	18	Thi Thi Htaik, 2009
8	Khit Latt Dwe, 2010	19	Toe Toe Aung et al., 2013
9	Kyaw Tint et al., 2012a	20	Wah Wah Khaing et al., 2013
10	Myint Sein & Bo Ni, 2009	21	Wint Yee Paing, 2010
11	Nant Nay Chit Latt, 2009		

APPENDIX 2. HERMATYPIC CORALS OF MYANMAR

Scientific Name	Occurrence	*Citation(s)	Coastal Region		
			Rakhine	Ayeya.	Tanin.
Family Acroporidae					
<i>Acropora abrotanoides</i> [also recorded as <i>A. irregularis</i>]	Confirmed	2, 6, 9			X
<i>Acropora aculeus</i>	Confirmed	2, 6, 9			X
<i>Acropora acuminata</i>	Confirmed	2, 5, 6, 9			X
<i>Acropora appressa</i>	Possible	5			X
<i>Acropora aspera</i>	Confirmed	1, 2, 3, 5, 6, 9	X		X
<i>Acropora austera</i>	Confirmed	2, 5, 6, 8, 9	X		X
<i>Acropora bifurcata</i>	Possible	5			X
<i>Acropora carduus</i>	Possible	6, 9			
<i>Acropora cerealis</i>	Confirmed	2, 5, 6, 9			X
<i>Acropora clathrata</i>	Probable	5, 6, 9			X
<i>Acropora cytherea</i> [also recorded as <i>A. efflorescens</i>]	Confirmed	2, 5, 6, 9			X
<i>Acropora dendrum</i>	Confirmed	2, 6, 8, 9	X		X
<i>Acropora digitifera</i>	Confirmed	1, 2, 5, 9	X		X
<i>Acropora divaricata</i> [also recorded as <i>A. stoddarti</i>]	Confirmed	2, 5, 6, 9			X
<i>Acropora donei</i>	Possible	6, 9			
<i>Acropora echinata</i>	Probable	5, 6, 9			X
<i>Acropora florida</i>	Confirmed	2, 6, 9			X
<i>Acropora gemmifera</i>	Confirmed	2, 5, 6, 9			X
<i>Acropora granulosa</i>	Probable	5			X
<i>Acropora grandis</i>	Possible	6, 9, 12			
<i>Acropora horrida</i>	Probable	5, 6, 9			X
<i>Acropora humilis</i> [also recorded as <i>A. ocellata</i>]	Confirmed	2, 4, 5, 6, 9			X
<i>Acropora hyacinthus</i>	Confirmed	2, 3, 5, 6, 9			X
<i>Acropora inermis</i>	Confirmed	5			X
<i>Acropora intermedia</i>	Probable	5			X
<i>Acropora kosurini</i>	Confirmed	5			X
<i>Acropora latistella</i>	Confirmed	2, 5, 6, 9			X
<i>Acropora listeri</i>	Confirmed	2, 6, 9			X
<i>Acropora longicyathus</i>	Possible	6, 9			
<i>Acropora loripes</i>	Confirmed	2, 5, 6, 9			X
<i>Acropora lutkeni</i>	Probable	5			X
<i>Acropora macrostoma</i>	Probable	5			X
<i>Acropora microphthalma</i> [also recorded as <i>A. inermis</i>]	Confirmed	2, 5, 6, 9			X
<i>Acropora millepora</i>	Confirmed	2, 6, 9			X
<i>Acropora monticulosa</i>	Possible	6, 9			
<i>Acropora multiacuta</i>	Confirmed	2, 6, 9			X

<i>Acropora muricata</i> [recorded as <i>A. formosa</i>]	Confirmed	2, 5, 6, 9		X
<i>Acropora nana</i>	Probable	5		X
<i>Acropora nasuta</i>	Confirmed	2, 5, 6, 9		X
<i>Acropora palmerae</i>	Confirmed	2, 6, 9		X
<i>Acropora pharaonis</i>	Possible	1, 4, 6		X
<i>Acropora pulchra</i>	Possible	6, 9		
<i>Acropora rambleri</i>	Possible	6, 9		
<i>Acropora retusa</i>	Possible	5		X
<i>Acropora robusta</i> [also recorded as <i>A. nobilis</i> and <i>A. pinguis</i>]	Confirmed	2, 3, 5, 6, 9		X
<i>Acropora roseni</i>	Possible	5		X
<i>Acropora rudis</i>	Confirmed	2, 5, 6, 9		X
<i>Acropora samoensis</i> [also recorded as <i>A. wallacea</i>]	Confirmed	2, 5, 6, 8, 9, 11	X	X
<i>Acropora schmitti</i> [taxonomy uncertain]	Confirmed	2, 9		X
<i>Acropora secale</i>	Confirmed	2, 3, 5, 6, 9		X
<i>Acropora selago</i>	Confirmed	2, 5, 6, 9		X
<i>Acropora spicifera</i>	Probable	5		X
<i>Acropora subglabra</i>	Possible	6, 9		
<i>Acropora subulata</i>	Confirmed	2, 5, 6, 9		X
<i>Acropora tenuis</i> [also recorded as <i>A. macrostoma</i>]	Confirmed	2, 5, 6, 9		X
<i>Acropora valenciennesi</i>	Confirmed	2, 3, 6, 9		X
<i>Acropora valida</i> [also recorded as <i>A. variabilis</i>]	Confirmed	2, 5, 6, 9		X
<i>Acropora vaughani</i>	Confirmed	2, 6, 9		X
<i>Acropora verweyi</i>	Confirmed	2, 6, 9		X
<i>Acropora yongei</i>	Probable	3, 6		X
<i>Astreopora expansa</i>	Probable	5, 6, 9		X
<i>Astreopora gracilis</i>	Probable	5		X
<i>Astreopora incrustans</i>	Possible	5		X
<i>Astreopora listeri</i>	Confirmed	2, 5, 6, 9		X
<i>Astreopora myriophthalma</i>	Confirmed	2, 5, 6, 9, 11		X
<i>Astreopora ocellata</i>	Probable	1, 4, 5, 6, 10	X	X
<i>Isopora brueggemanni</i> [recorded as <i>Acropora brueggemanni</i>]	Probable	1, 2, 4, 6	X	X
<i>Isopora cuneata</i> [recorded as <i>Acropora cuneata</i>]	Confirmed	2, 6, 9		X
<i>Isopora palifera</i> [recorded as <i>Acropora palifera</i>]	Confirmed	2, 5, 6, 9		X
<i>Montipora aequituberculata</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Montipora angulata</i>	Confirmed	2, 6, 9		X
<i>Montipora calcarea</i>	Possible	5		X
<i>Montipora confusa</i>	Probable	5		X
<i>Montipora cryptus</i>	Possible	5		X
<i>Montipora crassituberculata</i>	Confirmed	1, 2, 6, 9, 10	X	X

<i>Montipora danae</i> [recorded as <i>Porities convexa</i>]	Probable	1, 4, 6		X
<i>Montipora digitata</i>	Confirmed	2, 5, 6, 9		X
<i>Montipora efflorescens</i>	Confirmed	1, 2, 4, 5, 6, 9		X
<i>Montipora effusa</i>	Possible	5		X
<i>Montipora floweri</i>	Probable	5		X
<i>Montipora foliosa</i>	Confirmed	2, 6, 9		X
<i>Montipora foveolata</i>	Probable	5, 6, 9		X
<i>Montipora hispida</i>	Confirmed	1, 2, 5, 6, 9, 10		X
<i>Montipora informis</i>	Confirmed	1, 4, 5, 6, 9		X
<i>Montipora mollis</i>	Confirmed	2, 6, 9		X
<i>Montipora monasteriata</i>	Probable	5, 6, 9, 12		X
<i>Montipora nodosa</i>	Probable	5		X
<i>Montipora peltiformis</i>	Confirmed	2, 6, 9		X
<i>Montipora spongodes</i>	Confirmed	2, 5, 6, 9		X
<i>Montipora spumosa</i>	Confirmed	2, 6, 9		X
<i>Montipora stellata</i> [recorded as <i>M. solanderi</i> and <i>M. striata</i>]	Confirmed	1, 4, 6	X	X
<i>Montipora stilosa</i>	Possible	5		X
<i>Montipora tuberculosa</i>	Confirmed	2, 5, 6, 9		X
<i>Montipora turgescens</i>	Confirmed	2, 6, 9		X
<i>Montipora undata</i>	Confirmed	2, 5, 6, 9		X
<i>Montipora venosa</i>	Confirmed	2, 6, 9		X
<i>Montipora verrucosa</i>	Confirmed	2, 5, 6, 9		X
Family Agariciidae				
<i>Coeloseris mayeri</i>	Confirmed	1, 5, 6, 9, 10	X	X
<i>Gardineroseris planulata</i>	Confirmed	1, 2, 5, 6, 9, 10		X
<i>Leptoseris amitoriensis</i>	Possible	5		X
<i>Leptoseris explanata</i>	Possible	6, 9, 12		
<i>Leptoseris foliosa</i>	Probable	5, 6, 9		X
<i>Leptoseris gardineri</i>	Possible	6, 9		
<i>Leptoseris glabra</i>	Possible	5		X
<i>Leptoseris incrustans</i>	Probable	5		X
<i>Leptoseris hawaiiensis</i>	Possible	6, 9		
<i>Leptoseris mycetoseroides</i>	Confirmed	2, 5, 6, 9		X
<i>Leptoseris papyracea</i>	Possible	6, 9		
<i>Leptoseris scabra</i>	Probable	5, 6, 9		X
<i>Leptoseris solida</i>	Possible	5		X
<i>Pachyseris rugosa</i>	Confirmed	2, 5, 6, 9, 10		X
<i>Pachyseris speciosa</i>	Confirmed	1, 2, 5, 6, 9, 12	X	X
<i>Pavona cactus</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Pavona clavus</i>	Confirmed	2, 5, 6, 9		X
<i>Pavona decussata</i>	Confirmed	1, 2, 3, 5, 6, 9, 10		X
<i>Pavona duerdeni</i>	Confirmed	2, 5, 6, 9		X
<i>Pavona explanulata</i>	Confirmed	2, 5, 6, 9		X

<i>Pavona frondifera</i>	Probable	1, 2, 4, 6		X
<i>Pavona maldivensis</i>	Confirmed	1, 2, 5, 6, 9	X	X
<i>Pavona minuta</i>	Confirmed	2, 6, 9		X
<i>Pavona varians</i>	Confirmed	2, 5, 6, 9		X
<i>Pavona venosa</i>	Confirmed	1, 2, 5, 6, 9, 10		X
Family Astrocoeniidae				
<i>Madracis kirbyi</i>	Confirmed	1, 2, 5, 6, 9, 10	X	X
<i>Palauastrea ramosa</i>	Confirmed	1, 2, 6, 9, 10		X
<i>Stylocoeniella armata</i>	Probable	1, 4, 5, 6, 10		X
<i>Stylocoeniella guentheri</i>	Confirmed	2, 5, 6, 9		X
Family Coscinaraeidae				
<i>Anomastraea irregularis</i>	Unlikely	5		X
<i>Coscinaraea columna</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Coscinaraea crassa</i>	Possible	5		X
<i>Coscinaraea exesa</i>	Probable	5		X
<i>Coscinaraea monile</i>	Confirmed	1, 2, 5, 6, 9		X
<i>Coscinaraea wellsii</i>	Confirmed	5		X
Family Dendrophyllidae				
<i>Heteropsammia cochlea</i>	Confirmed	2, 6, 9		X
<i>Tubastraea micranthus</i> [recorded as <i>T. micrantha</i>]	Confirmed	5		X
<i>Turbinaria frondens</i>	Confirmed	1, 2, 5, 6, 9, 12	X	X
<i>Turbinaria irregularis</i>	Possible	5		X
<i>Turbinaria mesenterina</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Turbinaria peltata</i>	Confirmed	1, 2, 5, 6, 9		X
<i>Turbinaria reniformis</i>	Confirmed	2, 6, 9		X
<i>Turbinaria stellulata</i>	Confirmed	2, 5, 6, 9		X
Family Euphyllidae				
<i>Euphyllia ancora</i>	Probable	5, 6, 9, 12		X
<i>Euphyllia glabrescens</i>	Confirmed	2, 4, 5, 6, 9		X
<i>Physogyra lichtensteini</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Plerogyra sinuosa</i>	Confirmed	2, 4, 5, 6, 9, 12		X
Family Faviidae				
<i>Blastomussa loyae</i> [recorded as <i>Parasimplastrea sheppardi</i>]	Possible	5		X
<i>Blastomussa merleti</i>	Possible	5		X
<i>Caulastrea connata</i>	Unlikely	5		X
<i>Coelastrea aspera</i> [recorded as <i>Goniastrea aspera</i>]	Confirmed	2, 5, 6, 9		X
<i>Cyphastrea chalcidicum</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Cyphastrea microphthalma</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Cyphastrea serailia</i>	Confirmed	1, 2, 5, 6, 9		X
<i>Diploastrea heliophora</i>	Confirmed	2, 5, 9, 12		X
<i>Dipsastraea danai</i> [recorded as <i>Favia danae</i>]	Confirmed	5		X
<i>Dipsastraea favus</i> [recorded as <i>Favia favus</i>]	Confirmed	1, 2, 5, 6, 9, 11	X	X

<i>Dipsastraea helianthoides</i> [recorded as <i>Favia helianthoides</i>]	Confirmed	2, 5, 6, 9, 11		X
<i>Dipsastraea lacuna</i> [recorded as <i>Favia lacuna</i>]	Confirmed	2, 6, 9, 11		X
<i>Dipsastraea laxa</i> [recorded as <i>Favia laxa</i>]	Confirmed	1, 2, 6, 9, 11	X	X
<i>Dipsastraea lizardensis</i> [recorded as <i>Favia lizardensis</i>]	Confirmed	2, 5, 6, 9, 12		X
<i>Dipsastraea maritima</i> [recorded as <i>Favia maritima</i>]	Confirmed	2, 5, 6, 12		X
<i>Dipsastraea matthaii</i> [recorded as <i>Favia matthaii</i>]	Confirmed	2, 5, 9, 12		X
<i>Dipsastraea maxima</i> [recorded as <i>Favia maxima</i>]	Confirmed	2, 5, 6, 9, 12		X
<i>Dipsastraea pallida</i> [recorded as <i>Favia pallida</i>]	Confirmed	2, 5, 6, 9, 12		X
<i>Dipsastraea rosaria</i> [recorded as <i>Favia rosaria</i>]	Possible	5		X
<i>Dipsastraea rotumana</i> [recorded as <i>Favia rotumana</i>]	Confirmed	2, 5, 6, 9		X
<i>Dipsastraea rotundata</i> [recorded as <i>Favia rotundata</i>]	Confirmed	2, 6, 9		X
<i>Dipsastraea speciosa</i> [recorded as <i>Favia speciosa</i>]	Confirmed	1, 2, 4, 5, 6, 7, 9, 12	X	X
<i>Dipsastraea stelligera</i> [recorded as <i>Favia stelligera</i>]	Confirmed	2, 5, 6, 9, 10		X
<i>Dipsastraea truncata</i> [recorded as <i>Favia truncatus</i>]	Possible	5		X
<i>Dipsastraea veroni</i> [recorded as <i>Favia veroni</i>]	Probable	5		X
<i>Dipsastraea vietnamensis</i> [recorded as <i>Favia vietnamensis</i>]	Probable	5		X
<i>Dipsastrea amicornum</i> [recorded as <i>Barabattoia amicornum</i>]	Confirmed	2, 5, 6, 9		X
<i>Echinopora gemmacea</i>	Confirmed	1, 5, 6, 9	X	X
<i>Echinopora horrida</i>	Confirmed	2, 6, 9		X
<i>Echinopora lamellosa</i>	Confirmed	2, 5, 6, 7, 9, 10, 12		X
<i>Echinopora pacificus</i>	Probable	5		X
<i>Echinopora taylorae</i> [recorded as <i>Echinophyllia taylorae</i>]	Possible	5		X
<i>Favites abdita</i>	Confirmed	1, 2, 4, 5, 6, 9, 10, 12	X	X
<i>Favites acuticollis</i>	Probable	5		X
<i>Favites chinensis</i>	Probable	5		X
<i>Favites complanata</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Favites flexuosa</i>	Possible	6, 9		
<i>Favites halicora</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Favites melicerum</i> [recorded as <i>F. bestae</i>]	Confirmed	5		X
<i>Favites pentagona</i>	Confirmed	2, 5, 6, 9, 12		X

<i>Favites russelli</i>	Confirmed	2, 5, 6, 9		X
<i>Favites spinosa</i>	Possible	5		X
<i>Favites vasta</i>	Possible	5		X
<i>Goniastrea edwardsi</i>	Confirmed	2, 5, 6, 9		X
<i>Goniastrea minuta</i>	Probable	5		X
<i>Goniastrea palauensis</i>	Confirmed	2, 5, 6, 9		X
<i>Goniastrea pectinata</i>	Confirmed	1, 2, 4, 5, 6, 7, 9	X	X
<i>Goniastrea retiformis</i>	Confirmed	1, 2, 3, 4, 5, 6, 9, 12	X	X
<i>Leptastrea aequalis</i>	Confirmed	2, 5, 6, 9		X
<i>Leptastrea bewickensis</i>	Possible	2, 6, 9		X
<i>Leptoria irregularis</i>	Possible	5		X
<i>Leptastrea pruinosa</i>	Confirmed	2, 5, 6, 9		X
<i>Leptastrea purpurea</i>	Confirmed	2, 5, 6, 9		X
<i>Leptastrea transversa</i>	Confirmed	2, 5, 6, 9, 10		X
<i>Leptoria phrygia</i>	Confirmed	2, 5, 6, 9, 10		X
<i>Oulastrea crispata</i>	Confirmed	2, 6, 9, 10		X
<i>Oulophyllia bennettae</i>	Confirmed	2, 6, 9, 12		X
<i>Oulophyllia crispata</i>	Confirmed	2, 5, 6, 9		X
<i>Oulophyllia levis</i>	Possible	5		X
<i>Paragoniastrea australensis</i> [recorded as <i>Goniastrea australensis</i>]	Possible	5		X
<i>Paramonastrea salebrosa</i> [recorded as <i>Montastrea salebrosa</i>]	Possible	5		X
<i>Phymastrea annuligera</i> or <i>Astrea annuligera</i> [taxonomy disputed, recorded as <i>Montastrea annuligera</i>]	Probable	5		X
<i>Phymastrea curta</i> or <i>Astrea curta</i> [taxonomy disputed, recorded as <i>Montastrea curta</i>]	Confirmed	2, 5, 6, 9, 11		X
<i>Phymastrea magnistellata</i> or <i>Favites magnistellata</i> [taxonomy disputed, recorded as <i>Montastrea magnistellata</i>]	Confirmed	2, 5, 6, 9, 11		X
<i>Phymastrea valenciennesi</i> or <i>Favites valenciennesi</i> [taxonomy disputed, recorded as <i>Montastrea valenciennesi</i>]	Confirmed	2, 5, 6, 9, 10, 11		X
<i>Platygyra acuta</i>	Probable	5		X
<i>Platygyra carnosa</i> [recorded as <i>P. carnosus</i>]	Possible	5		X
<i>Platygyra daedalea</i>	Confirmed	2, 5, 6, 9		X
<i>Platygyra lamellina</i>	Confirmed	1, 2, 4, 5, 6, 7, 9	X	X
<i>Platygyra pini</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Platygyra ryukyuensis</i>	Probable	5		X
<i>Platygyra sinensis</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Platygyra verweyi</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Platygyra yaeyamaensis</i>	Unlikely	5		X
<i>Plesiastrea versipora</i>	Confirmed	2, 5, 6, 9		X

Family Fungiidae					
<i>Ctenactis crassa</i>	Confirmed	2, 6, 9			X
<i>Ctenactis echinata</i> [also recorded as <i>Fungia echinata</i>]	Confirmed	1, 2, 5, 6, 7, 9, 12	X		X
<i>Cycloseris costulata</i>	Probable	5, 6, 9			X
<i>Cycloseris cyclolites</i>	Possible	9, 12			
<i>Cycloseris distorta</i> [recorded as <i>Diaseris distorta</i>]	Possible	6, 9			
<i>Cycloseris explanulata</i> [recorded as <i>Psammocora explanulata</i>]	Probable	5			X
<i>Cycloseris fragilis</i> [recorded as <i>C. patelliformis</i> and <i>Diaseris fragilis</i>]	Confirmed	2, 5, 6, 9			X
<i>Cycloseris hexagonalis</i>	Possible	6, 9			
<i>Cycloseris mokai</i> [recorded as <i>Lithophyllon mokai</i>]	Confirmed	2, 6, 9			X
<i>Cycloseris somervillei</i>	Confirmed	2, 5, 6, 9, 12			X
<i>Cycloseris tenuis</i> [also recorded as <i>C. erosa</i>]	Probable	2, 5, 6, 9			X
<i>Cycloseris wellsii</i> [also recorded as <i>Coscina-raea wellsii</i>]	Possible	5, 6, 9, 12			X
<i>Danafungia horrida</i> [recorded as <i>Fungia danai</i> and <i>F. horrida</i>]	Confirmed	2, 5, 6, 9			X
<i>Danafungia scruposa</i> [recorded as <i>Fungia corona</i> and <i>F. scruposa</i>]	Confirmed	2, 5, 6, 9, 11			X
<i>Fungia fungites</i>	Confirmed	1, 2, 4, 5, 6, 9, 10	X		X
<i>Fungia moluccensis</i>	Confirmed	1, 2, 5, 6, 9, 10	X		X
<i>Halomitra pileus</i>	Possible	6, 9			
<i>Heliofungia actiniformis</i> [recorded as <i>Fungia actiniformis</i>]	Confirmed	1, 2, 4, 6, 9		X	X
<i>Herpolitha limax</i> [also synonym <i>H. weberi</i> recorded]	Confirmed	1, 2, 4, 5, 6, 9, 10, 12	X		X
<i>Lithophyllon concinna</i> [recorded as <i>Fungia concinna</i>]	Confirmed	2, 4, 5, 6, 9, 11			X
<i>Lithophyllon repanda</i> [recorded as <i>Fungia repanda</i>]	Confirmed	1, 2, 4, 5, 6, 7, 9	X		X
<i>Lithophyllon scabra</i> [recorded as <i>Fungia scabra</i>]	Confirmed	1, 2, 5, 6, 9, 10			X
<i>Lithophyllon undulatum</i> [also synonym <i>L. lobata</i> recorded]	Confirmed	2, 5, 6, 11, 12			X
<i>Lobactis scutaria</i> [recorded as <i>Fungia scutaria</i>]	Confirmed	2, 3, 6, 9			X
<i>Pleuractis granulosa</i> [recorded as <i>Fungia granulosa</i>]	Probable	5, 9			
<i>Pleuractis paumotensis</i> [recorded as <i>Fungia paumotensis</i>]	Confirmed	1, 2, 5, 6, 9, 10	X		X
<i>Pleuractis seychellensis</i> [recorded as <i>Fungia seychellensis</i>]	Possible	5			X
<i>Podabacia crustacea</i>	Probable	4, 5, 6, 9			X
<i>Podabacia lankaensis</i>	Possible	5			X

<i>Polyphyllia novaehiberniae</i>	Probable	5		X
<i>Polyphyllia talpina</i>	Confirmed	1, 2, 4, 5, 6, 9, 10	X	X
<i>Sandalolitha dentata</i>	Probable	5		X
<i>Sandalolitha robusta</i>	Confirmed	5, 6, 9, 10		X
Family Merulinidae				
<i>Hydnophora exesa</i>	Confirmed	1, 2, 4, 5, 6, 7, 9	X	X
<i>Hydnophora microconos</i>	Confirmed	2, 5, 6, 9		X
<i>Hydnophora rigida</i>	Confirmed	1, 2, 4, 5, 6, 7, 9, 10	X	X
<i>Merulina ampliata</i>	Confirmed	1, 2, 5, 6, 9, 10, 12		X
<i>Merulina scabricula</i>	Confirmed	1, 2, 6, 9, 12	X	X
<i>Scapophyllia cylindrica</i>	Confirmed	2, 5, 6, 9, 12		X
Family Mussidae				
<i>Acanthastrea brevis</i>	Possible	5		X
<i>Acanthastrea echinata</i>	Confirmed	1, 2, 5, 6, 9		X
<i>Acanthastrea hemprichi</i>	Possible	5		X
<i>Acanthastrea regularis</i>	Possible	5		X
<i>Acanthastrea rotundiflora</i>	Confirmed	5		X
<i>Acanthastrea subechinata</i>	Possible	5		X
<i>Cynarina lacrymalis</i>	Confirmed	2, 5, 6, 9		X
<i>Homophyllia australis</i> [recorded as <i>Scolymia australis</i>]	Unlikely	5		X
<i>Lobophyllia corymbosa</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Lobophyllia flabelliformis</i>	Probable	5		X
<i>Lobophyllia diminuta</i>	Confirmed	2, 5, 6, 9		X
<i>Lobophyllia hataii</i>	Confirmed	2, 5, 6, 9		X
<i>Lobophyllia hemprichii</i>	Confirmed	1, 2, 4, 5, 6, 9	X	X
<i>Lobophyllia pachysepta</i>	Probable	5		X
<i>Lobophyllia robusta</i>	Probable	5		X
<i>Micromussa amakusensis</i>	Possible	5		X
<i>Parascolymia rowleyensis</i> [recorded as <i>Australomussa rowleyensis</i>]	Confirmed	2, 5, 6, 9		X
<i>Symphyllia agaricia</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Symphyllia hassi</i>	Possible	2, 6, 9		X
<i>Symphyllia radians</i>	Confirmed	1, 2, 5, 6, 9, 12		X
<i>Symphyllia recta</i> [also recorded as <i>S. nobilis</i>]	Confirmed	1, 2, 5, 6, 7, 9, 12		X
<i>Symphyllia valenciennesi</i>	Confirmed	1, 2, 5, 6, 9, 10		X
Family Oculinidae				
<i>Galaxea astreata</i>	Confirmed	1, 2, 6, 9	X	X
<i>Galaxea fascicularis</i>	Confirmed	2, 5, 6, 9, 12		X
<i>Galaxea pauciradiata</i> [recorded as <i>G. paucisepta</i>]	Possible	5		X

Family Pectiniidae					
<i>Echinomorpha nishihirai</i>	Unlikely	5			X
<i>Echinophyllia aspera</i>	Confirmed	2, 5, 6, 7, 9	X		X
<i>Echinophyllia echinata</i>	Confirmed	1, 2, 5, 6, 9			X
<i>Echinophyllia echinoporoides</i>	Probable	5			X
<i>Echinophyllia patula</i>	Probable	5, 6, 9			
<i>Mycedium elephantotus</i>	Confirmed	1, 2, 5, 6, 9, 12			X
<i>Mycedium robokaki</i>	Possible	5			X
<i>Oxypora crassispinosa</i>	Probable	5, 6, 9			X
<i>Oxypora lacera</i>	Confirmed	1, 4, 5, 6, 9			X
<i>Pectinia africana</i>	Possible	5			X
<i>Pectinia alcicornis</i>	Confirmed	1, 2, 5, 6, 9			X
<i>Pectinia lactuca</i>	Confirmed	1, 2, 4, 5, 6, 7, 9, 10			X
<i>Pectinia paeonia</i>	Confirmed	2, 5, 6, 9, 12			X
<i>Pectinia teres</i>	Confirmed	2, 6, 9			X
Family Pocilloporidae					
<i>Pocillopora ankeli</i>	Confirmed	2, 6, 9			X
<i>Pocillopora damicornis</i>	Confirmed	1, 2, 4, 5, 6, 7, 9, 10, 12	X	X	X
<i>Pocillopora grandis</i> [recorded as <i>P. eydouxi</i>]	Confirmed	1, 5, 6, 9, 10, 12	X		X
<i>Pocillopora indiania</i>	Possible	5			X
<i>Pocillopora ligulata</i>	Possible	5			X
<i>Pocillopora meandrina</i>	Confirmed	1, 6, 9, 10			X
<i>Pocillopora verrucosa</i> [also recorded as <i>P. danaï</i>]	Confirmed	1, 2, 4, 5, 6, 9, 10	X		X
<i>Pocillopora woodjonesi</i>	Probable	5, 6, 9			X
<i>Pocillopora zelli</i>	Possible	5			X
<i>Seriatopora caliendrum</i>	Confirmed	2, 6, 9			X
<i>Seriatopora hystrix</i>	Confirmed	1, 2, 4, 6, 9, 10	X		X
<i>Seriatopora stellata</i>	Confirmed	2, 6, 9			X
<i>Stylophora pistillata</i>	Confirmed	1, 2, 6, 9, 10, 12			X
Family Poritidae					
<i>Alveopora allingi</i>	Confirmed	2, 6, 9			X
<i>Alveopora catalai</i>	Confirmed	2, 6, 9			X
<i>Alveopora excelsa</i>	Probable	1, 2, 4	X		X
<i>Alveopora spongiosa</i>	Confirmed	2, 6, 9			X
<i>Alveopora tizardi</i>	Probable	5			X
<i>Goniopora albiconus</i>	Possible	5			X
<i>Goniopora burgosi</i>	Confirmed	2, 6, 9			X
<i>Goniopora columna</i>	Confirmed	1, 2, 4, 5, 6, 9, 12	X		X
<i>Goniopora djiboutiensis</i>	Confirmed	2, 5, 6, 9, 12			X
<i>Goniopora fruticosa</i>	Confirmed	1, 4, 6, 9	X		X

<i>Goniopora lobata</i>	Confirmed	1, 2, 4, 5, 6, 9	X		X
<i>Goniopora pandoraensis</i>	Confirmed	2, 6, 9			X
<i>Goniopora pedunculata</i> [recorded as <i>G. minor</i>]	Confirmed	2, 5, 6, 9, 12			X
<i>Goniopora pendulus</i>	Possible	5			X
<i>Goniopora planulata</i>	Probable	5, 6, 9			
<i>Goniopora somaliensis</i>	Confirmed	2, 5, 6, 9, 12			X
<i>Goniopora stokesi</i>	Confirmed	2, 5, 6, 9			X
<i>Goniopora stutchburyi</i>	Confirmed	4, 5, 6, 9			X
<i>Goniopora tenella</i>	Possible	6, 9			
<i>Goniopora tenuidens</i>	Confirmed	2, 6, 9			X
<i>Porites annae</i>	Confirmed	2, 5, 6, 9			X
<i>Porites aranetai</i>	Confirmed	2, 6, 9			X
<i>Porites australiensis</i>	Probable	5, 6, 9			
<i>Porites cylindrica</i>	Confirmed	2, 5, 6, 9, 12			X
<i>Porites deformis</i>	Possible	5			X
<i>Porites evermanni</i>	Confirmed	2, 6, 9			X
<i>Porites horizontalata</i>	Possible	5			X
<i>Porites lichen</i>	Probable	5			X
<i>Porites lobata</i>	Confirmed	1, 2, 5, 6, 9, 12	X		X
<i>Porites lutea</i>	Confirmed	1, 2, 4, 5, 6, 9	X	X	X
<i>Porites monticulosa</i>	Probable	5			X
<i>Porites murrayensis</i>	Confirmed	2, 6, 9, 12			X
<i>Porites nigrescens</i>	Confirmed	1, 4, 5, 6, 9, 12			X
<i>Porites profundus</i>	Possible	5			X
<i>Porites rus</i> [also recorded as <i>P. convexa</i>]	Probable	1, 5, 6, 9			X
<i>Porites sillimaniani</i>	Possible	5			X
<i>Porites solida</i>	Confirmed	2, 3, 5, 6, 9			X
<i>Porites stephensoni</i>	Confirmed	2, 5, 6, 9, 12			X
Family Siderastreidae					
<i>Psammocora albopicta</i>	Possible	5			X
<i>Psammocora contigua</i> [also recorded as <i>P. obtusangula</i>]	Confirmed	1, 2, 4, 5, 6, 9	X		X
<i>Psammocora digitata</i>	Confirmed	1, 2, 5, 6, 9, 10			X
<i>Psammocora verrilli</i> [recorded as <i>P. nierstraszi</i>]	Possible	5			X
<i>Psammocora profundacella</i>	Probable	5, 6, 9			
<i>Pseudosiderastrea tayamai</i>	Confirmed	1, 2, 4, 5, 6, 9, 10	X		X
<i>Siderastrea savignyana</i>	Confirmed	2, 5, 6, 9			X
Family Trachyphyllidae					
<i>Trachyphyllia geoffroyi</i>	Confirmed	4, 5, 6, 9			X

*Citations					
1	Cherry Aung, 2009a	7	San San Win, 1993		
2	Cherry Aung, 2009b	8	Soe Tint Aung, 2010		

3	Mya Than Tun & Tint Tun, 2002	9	Veron, 2000
4	Myint Pe, 2003	10	War War Soe & Htay Aung, 2009
5	Obura et al., 2014	11	World Register of Marine Species, Web page
6	OBIS, Web page	12	This study

APPENDIX 3. SEAGRASSES OF MYANMAR

Scientific Name	Occurrence	IUCN	*Citation(s)
<i>Cymodocea rotundata</i>	Confirmed	LC	1, 2, 3, 4, 5, 6, 7, 8, 9
<i>Cymodocea serrulata</i>	Confirmed	LC	1, 4, 5, 6, 7, 8, 9, 10
<i>Enhalus acoroides</i>	Confirmed	LC	1, 3, 4, 5, 6, 7, 8
<i>Halodule pinifolia</i>	Confirmed	NT	1, 3, 4, 5, 6, 7, 8, 9, 10
<i>Halodule uninervis</i>	Confirmed	LC	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
<i>Halophila beccarii</i>	Confirmed	LC	1, 4, 5, 6, 7, 8
<i>Halophila decipiens</i>	Confirmed	VU	2, 4, 5, 6, 7, 8, 9, 10
<i>Halophila minor</i>	Possible	LC	1
<i>Halophila ovalis</i>	Confirmed	LC	1, 3, 4, 5, 6, 7, 8, 9, 10
<i>Syringodium isoetifolium</i>	Confirmed	LC	1, 2, 3, 5, 6, 8, 9
<i>Thalassia hemprichii</i>	Confirmed	NT	1, 3, 5, 6, 7, 9

*Citations			
1	Beffasti, 2010	6	Thaung Htut, 2011
2	Htet Lynn Aung, 2012	7	Tint Tun & Bendell, 2010
3	Novak <i>et al.</i> , 2009	8	Win Win Si, 2011
4	Soe Htun <i>et al.</i> , 2001	9	Soe Htun, 1998
5	Soe Htun <i>et al.</i> , 2009b	10	This study

APPENDIX 4. CETACEANS OF MYANMAR

Scientific Name	Common Name	IUCN	CITES	Occurrence	*Citation(s)
Suborder Mysticeti: Baleen whales					
<i>Balaenoptera edeni</i>	Bryde's whale	DD	I	Confirmed	1,7,8,9
<i>Balaenoptera musculus</i>	Blue whale	EN	I	Confirmed	8
<i>Balaenoptera acuto-rostrata</i>	Common minke whale	LC	I	Probable	4
<i>Balaenoptera physalus</i>	Fin whale	EN	I	Possible	6
Suborder Odontoceti: Toothed whales (including dolphins and porpoises)					
<i>Indopacetus pacificus</i>	Longman's beaked whale	DD	II	Confirmed	4
<i>Neophocaena phocaenoides</i>	Indo-Pacific finless porpoise	VU	I	Confirmed	7,9,10,11,12
<i>Orcaella brevirostris</i>	Irrawaddy dolphin	VU	I	Confirmed	7,8,9,10,11,12
<i>Sousa chinensis</i>	Indo-Pacific humpbacked dolphin	NT	I	Confirmed	7,8,9,10,11,12
<i>Stenella attenuata</i>	Pantropical spotted dolphin	LC	II	Confirmed	5,7,9,10
<i>Stenella longirostris</i>	Spinner dolphin	DD	II	Confirmed	7,8,9,10
<i>Tursiops aduncus</i>	Indo-Pacific bottlenose dolphin	DD	II	Confirmed	7,8,9,10,12
<i>Mesoplodon layardii</i>	Strap-toothed whale	DD	II	Confirmed, anomaly	2
<i>Mesoplodon densirostris</i>	Blainville's beaked whale	DD	II	Probable	3
<i>Delphinus capensis tropicalis</i>	Long-beaked common dolphin	LC	II	Probable	4
<i>Feresa attenuata</i>	Pygmy killer whale	DD	II	Probable	4
<i>Globicephala macrorhynchus</i>	Short-finned pilot whale	DD	II	Probable	4
<i>Grampus griseus</i>	Risso's dolphin	LC	II	Probable	4,5
<i>Kogia breviceps</i>	Pygmy sperm whale	DD	II	Probable	4
<i>Kogia sima</i>	Dwarf sperm whale	DD	II	Probable	4
<i>Lagenodelphis hosei</i>	Fraser's dolphin	LC	II	Probable	4
<i>Orcinus orca</i>	Killer whale	DD	II	Probable	4
<i>Peponocephala electra</i>	Melon-headed whale	LC	II	Probable	4
<i>Physeter macrocephalus</i>	Sperm whale	VU	I	Probable	4
<i>Pseudorca crassidens</i>	False killer whale	DD	II	Probable	4
<i>Stenella coeruleoalba</i>	Striped dolphin	LC	II	Probable	4
<i>Steno bredanensis</i>	Rough-toothed dolphin	LC	II	Probable	4
<i>Tursiops truncatus</i>	Common bottlenose dolphin	LC	II	Possible	4

*Citations			
1	Anderson, 1878	7	Nang Mya Han, 2008
2	Aung Myo Chit <i>et al.</i> , 2012	8	Smith <i>et al.</i> , 1997
3	IUCN	9	Smith, 2005
4	Jefferson <i>et al.</i> , 2008	10	Smith & Mya Than Tun, 2008
5	Leatherwood <i>et al.</i> , 1984	11	Smith & Aung Myo Chit, 2011
6	Mason, 1852	12	Tint Tun, 2006

APPENDIX 5. MARINE TURTLES OF MYANMAR

Scientific Name	Common Name	IUCN	CITES	Occurrence	Citation(s)
<i>Caretta caretta</i>	Loggerhead turtle	EN	I	Confirmed	10
<i>Chelonia mydas</i>	Green turtle	EN	I	Confirmed	1, 2, 4, 5, 7, 8, 10
<i>Lepidochelys olivacea</i>	Olive ridley turtle	VU	I	Confirmed	1, 3, 4, 5, 6, 10
<i>Dermochelys coriacea</i>	Leatherback turtle	CR	I	Confirmed but rare	10
<i>Eretmochelys imbricata</i>	Hawksbill turtle	CR	I	Confirmed but rare	1, 2, 9, 10

*Citations			
1	Kay Thi, 2009	6	Maung Maung Lwin, 2007
2	Kay Thi <i>et al.</i> , 2011	7	Maung Maung Lwin, 2009b
3	Ko Myint, 2005	8	Maung Maung Lwin, 2009a
4	Ko Myint, 2007	9	Soe Thant & Maung Maung Lwin, 2011
5	Ko Myint, 2009	10	Thorbjarnarson <i>et al.</i> , 2000b

APPENDIX 6. FINFISHES OF MYANMAR

Scientific Name	Common Name	Citations
Anchovy		
<i>Coilia dussumieri</i>	Goldspotted grenadier anchovy	Cho Cho Latt, 2010; Hla Hla Htay, 1994; Khine Khine Lin, 1983; Mie Mie Sein, 2006a; Ngu War Hlaing, 2010; Sein Moh Moh Khaing, 2011; Tint Swe, 2011; Tint Swe & Daw Tin Nu, 2012
<i>Coilia ramcarati</i>	Ramcarat grenadier anchovy	Cho Cho Latt, 2010
<i>Setipinna taty</i>	Scaly hairfin anchovy	Cho Cho Latt, 2010; Tint Swe, 2011; Tint Swe & Daw Tin Nu, 2012
<i>Setipinna tenuifilis</i>	Common hairfin anchovy	Cho Cho Latt, 2010
<i>Setipinna wheeleri</i>	Burma hairfin anchovy	Cho Cho Latt, 2010
<i>Stolephorus</i> sp.	Anchovy	Tint Swe & Daw Tin Nu, 2012
<i>Stolephorus indicus</i>	Indian anchovy	This study
Angelfish		
<i>Heniochus acuminatus</i>	Longfin bannerfish	This study
<i>Heniochus monoceros</i>	Masked bannerfish	This study
<i>Pomacanthus annularis</i>	Blue-ringed angelfish	This study
<i>Pomacanthus imperator</i>	Emperor angelfish	This study
Bahaba		
<i>Bahaba taipingensis</i>	Chinese bahaba	Hnin Ei Soe, 2012
Baramundi		
<i>Lates calcarifer</i>	Barramundi; Seabass	Aye Thida, 2003; Hla Hla Win, 2004; Ma Sein Mo Mo Hlaing, 2011; May Win Maw, 2005; Moe Thida Htway, 2003; Phyu Phyu Sin, 1983; Swe Swe Myint, 2003; Tin Tin Aye, 2004
Barb		
<i>Catlocarpio siamensis</i>	Giant barb	Phyu Phyu Sin, 1983
Barracuda		
<i>Sphyraena barracuda</i>	Great barracuda	Tint Swe & Daw Tin Nu, 2012; This study
<i>Sphyraena jello</i>	Pickhandle barracuda	Cho Cho Mar, 1988; Kyaw Kyaw Htay, 2010; Moe Sapai, 1998; This study
Bigeye		
<i>Heteropriacanthus cruentatus</i> [recorded as <i>Priacanthus boops</i>]	Glasseye	Tint Swe & Daw Tin Nu, 2012
<i>Priacanthus</i> spp.	Bigeye	Wai Zar Phyo, 2012; This study
Bonefish		
<i>Albula argentea</i> [recorded as <i>A. neoguinaica</i>]	Sharpjaw bonefish	Tint Swe <i>et al.</i> , 2011
Bream		
<i>Nemipterus</i> spp.	Bream	Cho Cho Mar, 1988; Maw Maw Than, 1991; May Thet Htar Aung, 1983; Mya Saw, 1975; Saw Nanda, 2000; Sein Moh Moh Khaing, 2011; Tin Oo, 1983; Wai Zar Phyo, 2012

<i>Nemipterus furcosus</i>	Fork-tailed threadfin bream	This study
<i>Nemipterus japonicus</i> [also recorded as <i>Synagris japonicus</i>]	Japanese threadfin bream	Cho Cho Mar, 1988; Maw Maw Than, 1991; May Thet Htar Aung, 1983; Mya Saw, 1975; Pauly & Aung, 1984; Saw Nanda, 2000; Sein Moh Moh Khaing, 2011; Tin Oo, 1983; Tint Swe & Daw Tin Nu, 2012; This study
<i>Nemipterus peronii</i> [recorded as <i>N. tolu</i>]	Notchedfin threadfin bream	Tint Swe & Daw Tin Nu, 2012
<i>Scolopsis bilineatus</i>	Bridled monocle bream	
<i>Scolopsis ciliatus</i>	Whitestreak monocle bream	This study
Butterflyfish		
<i>Chaetodon collare</i>	White collar butterflyfish	This study
<i>Chaetodon decussatus</i>	Indian vagabond butterflyfish	This study
<i>Chaetodon lunula</i>	Racoon butterflyfish	This study
<i>Chaetodon octofasciatus</i>	Eight-banded butterflyfish	This study
Cardinalfish		
<i>Apogon fleurieu</i>	Flower cardinalfish	This study
<i>Cheilodipterus quinquelineatus</i>	Fivelined cardinalfish	This study
<i>Ostorhinchus thermalis</i>	Half-barred cardinal	This study
Catfish		
<i>Arius</i> spp.	Catfish	Cho Cho Mar, 1988; Khin Khin San, 2010; Kyaw Kyaw Htay, 2010; May Win Maw, 2005; Min Thu Aung, 2006; Moe Sapai, 1998; Naung Naung Oo, 2012; Roberts, 2001; Thi Thi Mar, 1981
<i>Arius gagora</i>	Gagora catfish	Khin Khin San, 2010
<i>Arius maculatus</i>	Spotted catfish	Khin Khin San, 2010; Kyaw Kyaw Htay, 2010
<i>Clarias batrachus</i>	Philippine catfish	Thida Khin Khin Htun, 1998
<i>Mystus seenghala</i>	Giant river-catfish	Kyaw Phone Lynn, 1979; Phyu Phyu Sin, 1983
<i>Mystus vittatus</i>	Striped dwarf catfish	Kyaw Phone Lynn, 1979
<i>Nemapteryx nenga</i> [also recorded as <i>Arius nenga</i>]	Catfish	Khin Khin San, 2010
<i>Netuma thalassina</i> [also recorded as <i>Arius thalassinus</i>]	Giant catfish	Cho Cho Mar, 1988; Khin Khin San, 2010; Min Thu Aung, 2006; Tint Swe & Daw Tin Nu, 2012
<i>Ompok pabo</i>	Pabo catfish	Aye Aye Cho, 1987
<i>Osteogeneiosus militaris</i>	Soldier catfish	Khin Khin San, 2010; Moe Sapai, 1998; Tint Swe & Daw Tin Nu, 2012
<i>Pangasius pangasius</i>	Pangas catfish	Thida Khin Khin Htun, 1998
<i>Plicofollis dussumieri</i> [recorded as <i>Arius dussumieri</i>]	Blacktip sea catfish	Khin Khin San, 2010
<i>Plicofollis dussumieri</i>	Blacktip sea catfish	Khin Khin San, 2010
<i>Plotosus canius</i>	Gray eel catfish	Cho Cho Mar, 1988; Khin Khin San, 2010; Moe Sapai, 1998; Thida Khin Khin Htun, 1998

<i>Plotosus lineatus</i>	Striped eel catfish	Khin Khin San, 2010
<i>Sciades sona</i> [recorded as <i>Arius sona</i>]	Sona sea catfish	Moe Sapai, 1998
<i>Sciades sona</i>	Sona sea catfish	Moe Sapai, 1998
Chromodoris		
<i>Chromodoris geminus</i>	Twin chromodoris	This study
Clownfish		
<i>Amphipiron clarikii</i>	Clark's anenome fish	This study
Cobia		
<i>Rachycentron canadum</i>	Cobia	Min Thu Aung, 2006; Tint Swe & Daw Tin Nu, 2012; This study
Conger		
<i>Congresox talabon</i> [also recorded as <i>Muraenesox talabon</i>]	Yellow pike conger	Moe Sapai, 1998; Saw Nanda, 2000; Thida Khin Khin Htun, 1998; Tint Swe & Daw Tin Nu, 2012
Cornetfish		
<i>Fistularia</i> sp.	Cornetfish	Tint Swe & Daw Tin Nu, 2012
Corsula		
<i>Rhinomugil corsula</i>	Corsula	Khin Maung Cho, 2009; Kyaw Min Naing, 2010
Cowfish		
<i>Ostracion cornutus</i>	Longhorn cowfish	Khin Khin Nwe, 1990
Croaker		
<i>Chrysochir aureus</i>	Reeve's croaker	Aung Aung Aye, 2010; Hnin Ei Soe, 2012; Khine Khine Lin, 1983; Mie Mie Sein, 2006a; Saw Nanda, 2000; Tin Oo, 1983; Tint Swe, 2011; Tint Swe & Daw Tin Nu, 2012
<i>Dendrophysa russlii</i>	Goatee croaker	Aung Aung Aye, 2010
<i>Johinius coitor</i>	Coitor croaker	Aung Aung Aye, 2010
<i>Johnieops sina</i>	Sin croaker	Hnin Ei Soe, 2012
<i>Johnius belangerii</i>	Belanger's croaker	Aung Aung Aye, 2010; Khine Khine Lin, 1983; Mie Mie Sein, 2006a; Seim Moh Moh Hlaing, 2012
<i>Johnius carutta</i>	Karut croaker	Nu Nu Aye, 1984
<i>Johnius elongatus</i>	Spindle croaker	Aung Aung Aye, 2010
<i>Johnius borneensis</i> [recorded as <i>J. vogleri</i>]	Sharpnose hammer croaker	Min Thu Aung, 2006
<i>Nibea soldado</i>	Soldier croaker	Hnin Ei Soe, 2012
<i>Otolithes</i> spp.	Croaker	Aung Aung Aye, 2010; Hnin Ei Soe, 2012; Maw Maw Than, 1991; Thu Ya Kyi Zin, 2011; Wai Zar Phyo, 2012
<i>Otolithes ruber</i>	Tigertooth croaker	Aung Aung Aye, 2010; Hnin Ei Soe, 2012; Maw Maw Than, 1991; Tint Swe & Daw Tin Nu, 2012; This study
<i>Otolithoides biauritus</i>	Bronze croaker	Aung Aung Aye, 2010; Hnin Ei Soe, 2012
<i>Otolithoides pama</i>	Pama croaker	Hnin Ei Soe, 2012; Sein Moh Moh Khaing, 2011; Tint Swe & Daw Tin Nu, 2012
<i>Panna microdon</i>	Panna croaker	Hnin Ei Soe, 2012

<i>Pennahia</i> spp.	Croaker	Hnin Ei Soe, 2012; Maw Maw Than, 1991; Thet Thet Myaing, 2006; Tin Oo, 1983; Wai Zar Phy, 2012
<i>Pennahia macrocephalus</i>	Big-head pennah croaker	Maw Maw Than, 1991
<i>Pennahia anea</i> [recorded as <i>P. macrophthalmus</i>]	Bigeye croaker	Hnin Ei Soe, 2012; Thet Thet Myaing, 2006; Tin Oo, 1983
<i>Protonibea diacanthus</i>	Blackspotted croaker	Hnin Ei Soe, 2012; Khine Khine Lin, 1983; Maw Maw Than, 1991; Mie Mie Sein, 2006a
<i>Pterolithus maculatus</i>	Blotched tiger-toothed croaker	Hnin Ei Soe, 2012
<i>Sciaena</i> spp.	Croaker	Phyu Phyu Sin, 1983; Thi Thi Mar, 1981
<i>Johnius coitor</i> [recorded as <i>Sciaena coitor</i>]	Coitor croaker	Phyu Phyu Sin, 1983
Damsel fish		
<i>Abudefduf bengalensis</i>	Bengal sergeant	This study
<i>Abudefduf vaigiensis</i>	Indo-Pacific sergeant	This study
<i>Pomacentrus moluccensis</i>	Lemon damsel	This study
<i>Pomacentrus proteus</i>	Columbo damsel	This study
<i>Pomacentrus similis</i>	Similar damsel	This study
<i>Stegastes obreptus</i>	Western gregory	This study
<i>Chrysiptera rollandi</i>	Rolland's demoiselle	This study
Dart		
<i>Trachinotus botla</i>	Largespotted dart	Kyaw Kyaw Htay, 2010
Emperor		
<i>Lethrinus lentjan</i>	Pink ear emperor	May Win Maw, 2005; This study
<i>Lethrinus ornatus</i>	Ornate emperor	This study
Featherback		
<i>Notopterus notopterus</i>	Bronze featherback	Thida Khin Khin Htun, 1998
Flathead		
<i>Platycephalus indicus</i>	Bartail flathead	Tint Swe, 1987; Tint Swe & Daw Tin Nu, 2012
Flounder		
<i>Pseudorhombus arsius</i>	Largetooth flounder	Aye Aye Maw, 1994
<i>Pseudorhombus elevatus</i>	Deep flounder	Tint Swe & Daw Tin Nu, 2012
<i>Pseudorhombus javanicus</i>	Javan flounder	Soe Thant, 1979
Flyingfish		
<i>Exocoetus</i> sp.	Flyingfish	This study
Fusilier		
<i>Caesio caerulea</i>	Scissortail fusilier	This study
<i>Caesio xanthonota</i>	Yellowback fusilier	This study
Garfish		
<i>Xenentodon cancila</i>	Freshwater garfish	Thida Khin Khin Htun, 1998
Goatfish		
<i>Parupeneus barberinus</i>	Dash-dot goatfish	This study
<i>Parupeneus cyclostomus</i>	Gold-saddle goatfish	Sein Thiri Htwe, 2012
<i>Parupeneus heptacanthus</i>	Cinnabar goatfish	Sein Thiri Htwe, 2012; Tint Swe & Daw Tin Nu, 2012

<i>Parupeneus indicus</i>	Indian goatfish	Sein Thiri Htwe, 2012
<i>Parupeneus macronemus</i>	Long-barbel goatfish	Sein Thiri Htwe, 2012
<i>Upeneus</i> sp.	Goatfish	Tint Swe & Daw Tin Nu, 2012
<i>Upeneus taeniopterus</i>	Finstripe goatfish	This study
<i>Upeneus australiae</i>	Australian goatfish	Sein Thiri Htwe, 2012
<i>Upeneus moluccensis</i>	Goldband goatfish	Sein Thiri Htwe, 2012; This study
<i>Upeneus sulphureus</i>	Sulphur goatfish	Khine Khine Lin, 1983; Mie Mie Sein, 2006a; Sein Thiri Htwe, 2012; Tin Oo, 1983
<i>Upeneus sulphureus</i> [recorded as <i>Eupeneus sulphureus</i>]	Sulphur goatfish	Khine Khine Lin, 1983
<i>Upeneus sundaicus</i>	Ochre-banded goatfish	Sein Thiri Htwe, 2012
<i>Upeneus tragula</i>	Freckled goatfish	Sein Thiri Htwe, 2012; This study
Goby		
<i>Apocryptes bato</i> [recorded as <i>A. batoides</i>]	Goby	
<i>Apocryptes serperaster</i>	Goby	Thu Thu Minn, 2012
<i>Boleophthalmus boddarti</i> [recorded as <i>B. boddaerti</i>]	Boddart's goggle-eyed goby	Thu Thu Minn, 2012
<i>Glossogobius sparsipapillus</i>	Linecheek tank goby	Thu Thu Minn, 2012
<i>Glossogobius giuris</i>	Tank goby	Thida Aung, 2006; Thu Thu Minn, 2012
<i>Gobius</i> spp.	Goby	Thi Thi Mar, 1981; Thida Aung, 2006; Thu Thu Minn, 2012; This study
<i>Odontamblyopus rubicundus</i>	Goby	Thu Thu Minn, 2012
<i>Pseudapocryptes elongatus</i> [recorded as <i>P. lanceolatus</i>]	Goby	Thu Thu Minn, 2012
<i>Taenioides buchanani</i>	Burmese eel goby	Thu Thu Minn, 2012
<i>Taenioides gracilis</i>	Slender eel goby	Thu Thu Minn, 2012
<i>Trypauchen vagina</i>	Goby	Thu Thu Minn, 2012
Grouper		
<i>Anyperodon leucogrammicus</i>	Slender grouper	Tin Win, 2002
<i>Cephalopholis argus</i>	Peacock hind	Tin Win, 2002; This study
<i>Cephalopholis boenak</i>	Chocolate hind	Tin Win, 2002; This study
<i>Cephalopholis fomosa</i>	Bluelined grouper	This study
<i>Cephalopholis polyspila</i>		This study
<i>Cromileptes altivelis</i>	Humpback grouper	Tin Win, 2002
<i>Epinephelus analogus</i>	Spotted grouper	Tin Win, 2002
<i>Epinephelus bleekeri</i>	Duskytail grouper	May Win Maw, 2005; Tin Win, 2002; This study
<i>Epinephelus coioides</i>	Orange-spotted grouper	Min Thu Aung, 2006; Tin Win, 2002
<i>Epinephelus fasciatus</i>	Blacktip grouper	Tin Win, 2002
<i>Epinephelus fuscoguttatus</i>	Brown-marbled grouper	Tin Win, 2002
<i>Epinephelus labriformis</i>	Starry grouper	Tin Win, 2002
<i>Epinephelus maculatus</i>	Highfin grouper	Tin Win, 2002
<i>Epinephelus malabaricus</i>	Malabar grouper	Tin Win, 2002
<i>Epinephelus megachir</i>	Longfin grouper	Tin Win, 2002
<i>Epinephelus merra</i>	Honeycomb grouper	Nu Nu Aye, 1984; Tin Win, 2002

<i>Epinephelus sexfasciatus</i>	Sixbar grouper	Food and Agriculture Organization of the United Nations, 2003
<i>Epinephelus tauvina</i>	Greasy grouper	Hla Hla Win, 2004; Tin Win, 2002
<i>Epinephelus undulosus</i>	Wavy-lined grouper	Tin Win, 2002
<i>Plectropomus areolatus</i>	Squairetail coralgroup- per	Tin Win, 2002
<i>Plectropomus maculatus</i>	Spotted coralgroup- per	Tin Win, 2002
<i>Plectropomus pessuliferus</i>	Roving coralgroup- per	Toe Nanda Tin, 2009
Grunt		
<i>Pomadasys argenteus</i> [record- ed as <i>P. hasta</i>]	Silver grunt	Druzhinin & Phone Hlaing, 1972; Maw Maw Than, 1991; May Thet Htar Aung, 1983; Saw Nanda, 2000; Tin Oo, 1983; Tint Swe, 1987; Tint Swe & Daw Tin Nu, 2012
<i>Pomadasys maculatus</i>	Saddle grunt	Maw Maw Than, 1991
<i>Rhonciscus</i> spp.		Tint Swe <i>et al.</i> , 2011
Hairtail		
<i>Eupleurogoammus muticus</i>	Smallhead hairtail	Nu Nu Aye, 1984
<i>Lepturacanthus savala</i>	Savalai hairtail	Druzhinin & Phone Hlaing, 1972; Maw Maw Than, 1991; May Win Maw, 2005; Myint Myint Kyi, 1994
<i>Trichiurus lepturus</i>	Largehead hairtail	Thet Thet Myaing, 2006; Tint Swe & Daw Tin Nu, 2012; This study
<i>Trichiurus savala</i> [renamed <i>Lepturacanthus savala</i>]	Savalai hairtail	Druzhinin & Phone Hlaing, 1972; Myint Myint Kyi, 1994
Halfbeak		
<i>Hemirhamphus far</i>	Black-barred halfbeak	Tint Swe, 1987
Halibut		
<i>Psettodes erumei</i>	Indian halibut	Soe Thant, 1979; Tint Swe & Daw Tin Nu, 2012
Hump head		
<i>Kurtus indicus</i>	Indian hump head	Soe Thant, 1979 Tint Swe & Daw Tin Nu, 2012
Ilisha		
<i>Ilisha elongata</i>	Elongate ilisha	Cho Cho Mar, 1988; Maw Maw Than, 1991; Min Thu Aung, 2006
<i>Ilisha filigera</i>		Druzhinin & Phone Hlaing, 1972
<i>Ilisha megaloptera</i>	Bigeye ilisha	Tint Swe & Daw Tin Nu, 2012
<i>Ilisha novacula</i> [recorded as <i>I. sladeni</i>]	Burmese River ilisha	Tin Oo, 1983
Labeo		
<i>Labeo rohita</i>	Rohu	Moe Thida Htway, 2003
Lizardfish		
<i>Harpadon nehereus</i>	Bombay-duck lizard- fish	Khin Thida Oo, 1994; Ngu War Hlaing, 2010; Thida Khin Khin Htun, 1998; Thu Ya Kyi Zin, 2011; Tint Swe, 2011; Tint Tun <i>et al.</i> , 1991; Zaw Lunn, 1988
<i>Harpadon nehereus</i> [recorded as <i>H. nehereus</i>]	Bombay-duck lizard- fish	Khin Thida Oo, 1994; Thida Khin Khin Htun, 1998; Thu Ya Kyi Zin, 2011; Tint Swe, 2011; Tint Swe & Daw Tin Nu, 2012; Zaw Lunn, 1988

<i>Saurida</i> spp.	Lizardfish	Khine Khine Lin, 1983; Maw Maw Than, 1991; Mie Mie Sein, 2006a; Min Thu Aung, 2006; Thapanand-Chaidee <i>et al.</i> , 2010; Thi Thi Mar, 1981; Tin Oo, 1983
<i>Saurida elongata</i>	Slender lizardfish	Tint Swe & Daw Tin Nu, 2012; This study
<i>Saurida tumbil</i>	Greater lizardfish	Khine Khine Lin, 1983; Maw Maw Than, 1991; Mie Mie Sein, 2006a; Min Thu Aung, 2006; Tin Oo, 1983
<i>Saurida undosquamis</i>	Brushtooth lizardfish	Thapanand-Chaidee <i>et al.</i> , 2010
<i>Synodus variegatus</i>	Reef lizardfish	This study
Lionfish		
<i>Pterois antennata</i>	Spotfin lionfish	This study
Mackerel		
<i>Rastrelliger brachysoma</i>	Short mackerel	Hnin Zar Htwe, 2012; Honey Shwe, 2012; Min Thu Aung, 2006; Pauly & Aung, 1984; Thet Thet Myaing, 2006; This study
<i>Rastrelliger faughni</i>	Island mackerel	Hnin Zar Htwe, 2012; Honey Shwe, 2012
<i>Rastrelliger kanagurta</i>	Indian mackerel	Cho Cho Mar, 1988; Hnin Zar Htwe, 2012; Honey Shwe, 2012; May Soe Oo, 1994; Min Thu Aung, 2006; Saw Nanda, 2000; Thet Swe, 1987; Tint Swe & Daw Tin Nu, 2012; This study
<i>Rastrelliger</i> spp.	Mackerel	Cho Cho Mar, 1988; Hnin Zar Htwe, 2012; Honey Shwe, 2012; May Soe Oo, 1994; Min Thu Aung, 2006; Moe Sapai, 1998; Saw Nanda, 2000; Thet Swe, 1987; Thet Thet Myaing, 2006
<i>Scomberomorus commerson</i>	Narrow-barred Spanish mackerel	Hnin Zar Htwe, 2012; Tint Swe & Daw Tin Nu, 2012; This study
<i>Scomberomorus guttatus</i>	Indo-Pacific king mackerel	Cho Cho Mar, 1988; Hnin Zar Htwe, 2012; May Win Maw, 2005; Min Thu Aung, 2006; Saw Nanda, 2000; Sein Moh Moh Khaing, 2011; Thida Khin Khin Htun, 1998; Tint Swe & Daw Tin Nu, 2012; Zin Zin Zaw, 2010; This study
Marlin		
<i>Kajikia audax</i>	Striped marlin	Kyaw Tint <i>et al.</i> , 2012b
Moony		
<i>Psettus falciformis</i>	Full moony	Nu Nu Aye, 1984
Moorish Idol		
<i>Zanclus cornutus</i>	Moorish idol	This study
Moray eel		
<i>Gymnothorax fimbriatus</i>	Fimbriated moray	This study
Mudskipper		
<i>Periophthalmodon schlosseri</i>	Giant mudskipper	Thu Thu Minn, 2012
<i>Periophthalmus barbarus</i> [recorded as <i>Periophthalmus barbarus</i>]	Atlantic mudskipper	Thu Thu Minn, 2012
Mullet		
<i>Paramugil parmatus</i> [recorded as <i>Liza [liza] parmata</i>]	Broad-mouthed mullet	Khin Maung Cho, 2009

<i>Chelon subviridis</i> [recorded as <i>Liza [liza] subviridis</i>]	Greenback mullet	Khin Maung Cho, 2009
<i>Chelon planiceps</i> [recorded as <i>Liza [liza] tade</i>]	Tade gray mullet	Khin Maung Cho, 2009; Tint Swe, 1987
<i>Liza parsia</i>	Goldspot mullet	Kyaw Min Naing, 2010
<i>Ellochelon vaigiensis</i> [recorded as <i>Liza vaigiensis</i>]	Squaretail mullet	Kyaw Min Naing, 2010
<i>Mugil</i> spp.		Khaing Khaing Kyi, 2010; Kyaw Min Naing, 2010
<i>Mugil cephalus</i>	Flathead grey mullet	Kyaw Min Naing, 2010
<i>Valamugil speigleri</i> [recorded as <i>Mugil specigleri</i>]	Speigler's mullet	Phyu Phyu Sin, 1983
<i>Sicamugil hamiltoni</i>	Burmese mullet	Khin Maung Cho, 2009
<i>Valamugil</i> spp.	Mullet	Kyaw Min Naing, 2010; Tint Swe, 1987
<i>Moolgarda cunnesius</i> [recorded as <i>Valamugil cunnesius</i>]	Longarm mullet	Kyaw Min Naing, 2010
Needlefish		
<i>Belone strongylurus</i>	Spottail needlefish	Than Than Naing, 2000
<i>Tylosurus</i> sp.	Needlefish	This study
Orbfish		
<i>Ephippus orbis</i>	Orbfish	Khine Khine Lin, 1983; Tint Swe & Daw Tin Nu, 2012
Parrotfish		
<i>Scarus viridifucatus</i>	Greenlip parrotfish	This study
Perch		
<i>Anabas testudineus</i>	Climbing perch	Mya Saw, 1975
<i>Ambassis interrupta</i> [recorded as <i>Ambassis interruptus</i>]	Long-spined glass perchlet	Tint Swe <i>et al.</i> , 2011
<i>Ambassis vachellii</i>	Vachelli's glass perchlet	Tint Swe <i>et al.</i> , 2011
Pomfret		
<i>Pampus argenteus</i> [also recorded as <i>Pomadasys hasta</i>]	Silver grunt	Cho Cho Lwin, 1997; Kyaw Kyaw Htay, 2010; May Khin Htun, 2005; May Win Maw, 2005; Min Thu Aung, 2006; Ngu War Hlaing, 2010; Saw Nanda, 2000; Tint Swe & Daw Tin Nu, 2012; Zaw Zaw Aung, 2012
<i>Pampus chinensis</i>	Chinese silver pomfret	Min Thu Aung, 2006; Nu Nu Aye, 1984; Ohm Mar Myin, 1989
<i>Pampus chinensis</i> [recorded as <i>P. sinensis</i>]	Chinese pomfret	Ohm Mar Myin, 1989
<i>Parastomateus niger</i> [also recorded as <i>Formio niger</i>]	Black pomfret	May Khin Htun, 2005; May Thet Htar Aung, 1983; Tint Swe & Daw Tin Nu, 2012
<i>Parastomateus niger</i> [recorded as <i>Stromateus niger</i>]	Black pomfret	May Thet Htar Aung, 1983
Ponyfish		
<i>Gazza minuta</i>	Toothpony	Thet Lyar Win, 2012; This study
<i>Leiognathus bindus</i>	Orangefin ponyfish	Thet Lyar Win, 2012; This study
<i>Leiognathus equulus</i>	Common ponyfish	May Win Maw, 2005; Thet Lyar Win, 2012; Tint Swe, 1987; This study

<i>Leiognathus fasciatus</i>	Striped ponyfish	Thet Lyar Win, 2012
<i>Leiognathus splendens</i>	Splendid ponyfish	Thet Lyar Win, 2012; This study
<i>Nuclequula blochii</i> [recorded as <i>Leiognathus pan</i>]	Twoblotch ponyfish	Thet Lyar Win, 2012
<i>Nuclequula gerreoides</i>	Decorated ponyfish	Thet Lyar Win, 2012
<i>Nuclequula gerreoides</i> [recorded as <i>Leiognathus decorus</i>]	Decorated ponyfish	Thet Lyar Win, 2012
<i>Secutor</i> sp.	Ponyfish	This study
<i>Secutor hanedai</i>	Haneda's ponyfish	Thet Lyar Win, 2012
<i>Secutor insidiator</i> [also recorded as <i>Equals insidiatrix</i>]	Pugnose ponyfish	May Thet Htar Aung, 1983; Thet Lyar Win, 2012
<i>Secutor ruconius</i>	Deep pugnose ponyfish	Nu Nu Aye, 1984; Thet Lyar Win, 2012
Porcupinefish		
<i>Diodon hystrix</i>	Spot-fin porcupinefish	Win Win Mar, 1991; This study
Pufferfish		
<i>Arothron</i> sp.	Pufferfish	This study
<i>Arothron meleagris</i>	Guineafowl pufferfish	This study
<i>Arothron nigropunctatus</i>	Blackspotted pufferfish	This study
<i>Takifugu oblongus</i> [recorded as <i>Sphoeroides oblongus</i> and <i>Tetraodon oblongus</i>]	Lattice blaasop	Nang Mya Han, 1985; Tint Swe & Daw Tin Nu, 2012
<i>Tetraodon</i> spp.	Pufferfish	Tint Swe, 1987; This study
<i>Tetraodon fluviatilis</i>	Green pufferfish; Estuarine blowfish	Cho Cho Myint, 1997
Queenfish		
<i>Scomberoides commersonianus</i>	Talang queenfish	Nu Nu Aye, 1984; Tint Swe & Daw Tin Nu, 2012; This study
<i>Scomberoides lysan</i>	Doublespotted queenfish	This study
Raconda		
<i>Raconda russeliana</i>	Raconda	Tint Swe & Daw Tin Nu, 2012
Rainbow Runner		
<i>Elagatis bipinnulata</i>	Rainbow runner	Tint Swe & Daw Tin Nu, 2012
Remora		
<i>Remora</i> sp.	Remora/suckerfish	This study
<i>Remora remora</i>	Remora	Tint Swe & Daw Tin Nu, 2012
Ricefish		
<i>Oryzias</i> sp.		Cho Cho Myint, 1997; Tint Swe <i>et al.</i> , 2011
<i>Oryzias javanicus</i>	Javanese ricefish	Cho Cho Myint, 1997
Sailfish		
<i>Istiophorus platypterus</i>	Indo-Pacific Sailfish	Kyaw Tint <i>et al.</i> , 2012b
Sardine and Sardinella		
<i>Dussumieria acuta</i>	Rainbow sardine	Khaing Myat Myat Htwe, 2012; Tint Swe & Daw Tin Nu, 2012; This study

<i>Escuolosa thoracata</i>	White sardine	Khaing Myat Myat Htwe, 2012
<i>Sardinella albella</i>	White sardinella	Khaing Myat Myat Htwe, 2012
<i>Sardinella fimbriata</i>	Fringescale sardinella	Nwe Nwe Win, 1986
<i>Sardinella gibbosa</i>	Goldstripe sardinella	Tint Swe & Daw Tin Nu, 2012; This study
<i>Sardinella longiceps</i>	Indian oil sardine	Khaing Myat Myat Htwe, 2012
Scad		
<i>Alepes djedaba</i>	Shrimp scad	Tint Swe & Daw Tin Nu, 2012; This study
<i>Caranx affinis</i>	Yellowtail scad	Moh Moh Win, 1988
<i>Megalaspis cordyla</i>	Torpedo scad	Ei Ei Khin, 1994; Min Thu Aung, 2006; Nu Nu Aye, 1984; Tint Swe & Daw Tin Nu, 2012; This study
<i>Selaroides</i> sp.	Scad	This study
<i>Selaroides leptolepis</i>	Yellowstripe scad	Tint Swe & Daw Tin Nu, 2012
<i>Scatophagus argus</i>	Spotted scat	Nu Nu Aye, 1984; Nyo Nyo Than, 1987; Tint Swe, 1987
Scorpionfish		
<i>Scorpaenopsis oxycephala</i>	Tasseled scorpionfish	This study
Seerfish		
<i>Scomberomorus koreanus</i>	Korean seerfish	Hnin Zar Htwe, 2012
Shad		
<i>Anodontostoma chacunda</i>	Chacunda gizzard shad	Khaing Myat Myat Htwe, 2012; This study
<i>Anodontostoma thailandiae</i>	Thai gizzard shad	Khaing Myat Myat Htwe, 2012
<i>Gonialosa manmina</i>	Ganges river gizzard shad	Khaing Myat Myat Htwe, 2012
<i>Gudusia variegata</i>	Burmese river shad	Khaing Myat Myat Htwe, 2012
<i>Pellona</i> sp.	Pellona/Ilisha	This study
<i>Tenualosa ilisha</i> [recorded as <i>Hilsa ilisha</i>]	Hilsa shad	Cho Cho Mar, 1988; Kyu Kyu Than, 1978; Moe Sapai, 1998; Saw Nanda, 2000; This study
<i>Tenualosa</i> spp.	Shad	Cho Cho Mar, 1988; Hlaing Hlaing Oo, 2012; Kalayar Win Maung, 2007; Khaing Myat Myat Htwe, 2012; Kyu Kyu Than, 1978; Lei Lei Khine, 2007; Moe Sapai, 1998; Saw Nanda, 2000
<i>Tenualosa ilisha</i> [also recorded as <i>Hilsa toli</i>]	Hilsa shad	Cho Cho Mar, 1988; Hlaing Hlaing Oo, 2012; Kalayar Win Maung, 2007; Khaing Myat Myat Htwe, 2012; Kyu Kyu Than, 1978; Lei Lei Khine, 2007; Moe Sapai, 1998; Saw Nanda, 2000; Tint Swe & Daw Tin Nu, 2012
<i>Tenualosa toli</i>	Toli shad	Hlaing Hlaing Oo, 2012; Kalayar Win Maung, 2007; Khaing Myat Myat Htwe, 2012
Sicklefish		
<i>Drepane punctata</i>	Spotted sicklefish	May Win Maw, 2005; Tint Swe & Daw Tin Nu, 2012
Sillago		
<i>Sillago domina</i>	Flathead sillago or Gangetic whiting	Cho Cho Mar, 1988; Malar Tun, 1997; Moe Sapai, 1998; Thida Khin Khin Htun, 1998
<i>Sillago sihama</i>	Silver sillago	May Thet Htar Aung, 1983; May Win Maw, 2005; Tint Swe & Daw Tin Nu, 2012; This study

Silverside		
<i>Atherinomorus endrachtensis</i>	Eendracht land silver-side	Tint Swe <i>et al.</i> , 2011
<i>Atherinomorus ogilbyi</i>	Ogilby's hardyhead	Tint Swe <i>et al.</i> , 2011
Whipfin		
<i>Gerres erythrourus</i> [recorded as <i>G. abbreviatus</i>]	Deep-bodied mojarra	Tint Swe & Daw Tin Nu, 2012
<i>Gerres filamentosus</i>	Whipfin silver-biddy	Tin Oo, 1983; Tint Swe, 1987; Tint Swe & Daw Tin Nu, 2012
<i>Gerres oyena</i>	Common silver-biddy	This study
Snakefish		
<i>Channa</i> spp.	Snakehead	Thi Thi Mar, 1981; Thida Khin Khin Htun, 1998
<i>Channa striatus</i>	Striped snakehead	Thida Khin Khin Htun, 1998
Snapper		
<i>Lutjanus</i> spp.	Snapper	Chaw Su Lwin, 2012; Druzhinin & Phone Hlaing, 1972; May Thet Htar Aung, 1983; May Win Maw, 2005; Tin Oo, 1983
<i>Lutjanus quinquelinearis</i>	Five-lined snapper	Phyu Phyu Win, 1992
<i>Lutjanus bohar</i>	Two-spot red snapper	Chaw Su Lwin, 2012
<i>Lutjanus decussatus</i>	Checkered snapper	Chaw Su Lwin, 2012; This study
<i>Lutjanus ehrenbergii</i>	Blackspot snapper	Chaw Su Lwin, 2012
<i>Lutjanus erythropterus</i>	Crimson snapper	May Thet Htar Aung, 1983
<i>Lutjanus fulviflamma</i>	Dory snapper	Chaw Su Lwin, 2012
<i>Lutjanus johnii</i>	John's snapper	Chaw Su Lwin, 2012; May Win Maw, 2005
<i>Lutjanus kasmira</i>	Common bluestripe snapper	Chaw Su Lwin, 2012
<i>Lutjanus lutjanus</i> [recorded as <i>L. lineolatus</i>]	Bigeye snapper	Chaw Su Lwin, 2012
<i>Lutjanus lunulatus</i>	Lunartail snapper	Chaw Su Lwin, 2012
<i>Lutjanus lutjanus</i>	Bigeye snapper	Chaw Su Lwin, 2012; This study
<i>Lutjanus madras</i>	Indian snapper	This study
<i>Lutjanus malabaricus</i>	Malabar blood snapper	Chaw Su Lwin, 2012; May Win Maw, 2005; Tint Swe & Daw Tin Nu, 2012
<i>Lutjanus quinquelineatus</i>	Five-lined snapper	This study
<i>Lutjanus rufolineatus</i>	Yellow-lined snapper	This study. Confirmation needed.
<i>Lutjanus russelli</i>	Russell's snapper	Chaw Su Lwin, 2012; May Win Maw, 2005; This study
<i>Lutjanus sanguineus</i>	Humphead snapper	Tin Oo, 1983
<i>Lutjanus sebae</i>	Emperor red snapper	Chaw Su Lwin, 2012; Tint Swe & Daw Tin Nu, 2012
<i>Lutjanus timoriensis</i>	Timor snapper	This study
<i>Lutjanus vitta</i>	Brownstripe red snapper	Chaw Su Lwin, 2012; This study
Soapfish		
<i>Diploprion bifasciatum</i>	Doublebanded soapfish	This study
Solderfish		

<i>Myripristis hexagona</i>	Double-tooth soldier-fish	This study
Sole		
<i>Brachirus pan</i> [recorded as <i>Synaptura pan</i>]	Pan sole	Soe Thant, 1979
<i>Zebrias zebra</i> [recorded as <i>Synaptura zebra</i>]	Zebra sole	Soe Thant, 1979
Spinefoot		
<i>Siganus fuscescens</i>	Mottled spinefoot	This study
<i>Siganus javus</i>	Streaked spinefoot	Nu Nu Aye, 1984; Tint Swe & Daw Tin Nu, 2012
<i>Siganus puelloides</i>	Blackeye rabbitfish	This study
Spineless eel		
<i>Chaudhuria caudata</i>	Burmese spineless eel	Htwe Htwe Khine, 1999
Spiny eel		
<i>Macrognaathus aculeatus</i>	Lesser spiny eel	Htwe Htwe Khine, 1999
<i>Mastacembelus alboguttatus</i>	Spiny eel	Htwe Htwe Khine, 1999
<i>Mastacembelus armatus</i>	Zig-zag eel	Htwe Htwe Khine, 1999
<i>Mastacembelus caudocellatus</i>	Spiny eel	Htwe Htwe Khine, 1999
<i>Mastacembelus oatesii</i>	Spiny eel	Htwe Htwe Khine, 1999
<i>Mastacembelus unicolor</i>	Spiny eel	Htwe Htwe Khine, 1999
<i>Mastacembelus zebrinus</i>	Zebra spiny eel	Htwe Htwe Khine, 1999
Sprat		
<i>Corica soborna</i>	Ganges river sprat	Khaing Myat Myat Htwe, 2012
Surgeonfish		
<i>Acanthurus</i> sp.	Surgeonfish	This study
Sweetlips		
<i>Plectorhinchus</i> sp.	Sweetlips	This study
<i>Plectorhinchus vittatus</i>	Oriental sweetlips	This study
Swordfish		
<i>Xiphias gladius</i>	Swordfish	Kyaw Tint <i>et al.</i> , 2012b
Tarpon		
<i>Megalops cyprinoides</i>	Indo-Pacific tarpon	This study
Terapon		
<i>Therapon</i> spp. [also called <i>Terapon</i>]	Terapon	Khine Khine Lin, 1983; Mie Mie Sein, 2006a; Ohn Mar Han, 1996; Tint Swe, 1987
<i>Therapon jarbua</i>	Jarbua terapon	Ohn Mar Han, 1996; Tint Swe, 1987; Tint Swe & Daw Tin Nu, 2012; This study
<i>Therapon theraps</i>	Largescaled terapon	Khine Khine Lin, 1983; Mie Mie Sein, 2006a; This study
Threadfin		
<i>Alectis ciliaris</i>	African pompano	Tint Swe & Daw Tin Nu, 2012
<i>Alectis indicus</i>	Indian threadfin	Nu Nu Aye, 1984; Thint Thint Aung, 1994; Tint Swe & Daw Tin Nu, 2012
<i>Eleutheronema tetradactylum</i>	Fourfinger threadfin	Min Thu Aung, 2006; Tint Swe & Daw Tin Nu, 2012

<i>Leptomelanosoma indicum</i>	Indian threadfin	Khin Nwe Mu, 1980; Khine Khine Lin, 1983; May Khin Htun, 2005; May Win Maw, 2005; Mie Mie Sein, 2006a; Min Thu Aung, 2006; Saw Nanda, 2000; Sein Moh Moh Khaing, 2011; Tin Oo, 1983
<i>Polydactylus indicus</i> [recorded as <i>Leptomelanosoma indicum</i>]	Indian threadfin	May Win Maw, 2005
<i>Polynemus</i> spp.	Threadfin	Khin Swe Thoung, 1977; Khine Khine Lin, 1983; May Khin Htun, 2005; Mie Mie Sein, 2006a; Min Thu Aung, 2006; Ngu War Hlaing, 2010; Phyu Phyu Sin, 1983; Saw Nanda, 2000; Sein Moh Moh Khaing, 2011; Soe Moe Htun, 2010; Thi Thi Mar, 1981; Thida Aung, 2006; Thu Ya Kyi Zin, 2011; Tin Oo, 1983
<i>Leptomelanosoma indicum</i> [recorded as <i>Polynemus indicus</i>]	Indian threadfin	Khine Khine Lin, 1983; May Khin Htun, 2005; Mie Mie Sein, 2006a; Min Thu Aung, 2006; Pauly & Aung, 1984; Saw Nanda, 2000; Sein Moh Moh Khaing, 2011; Tin Oo, 1983
<i>Polynemus paradiseus</i>	Paradise threadfin	Khin Swe Thoung, 1977; Ngu War Hlaing, 2010; Phyu Phyu Sin, 1983; Soe Moe Htun, 2010; Thida Aung, 2006; Thu Ya Kyi Zin, 2011; Tint Swe & Daw Tin Nu, 2012
Thryssa		
<i>Thryssa hamiltonii</i>	Hamilton's thryssa	Tint Swe, 1987; Tint Swe & Daw Tin Nu, 2012
<i>Thryssa setirostris</i>	Longjaw thryssa	Tint Swe & Daw Tin Nu, 2012
Toadfish		
<i>Batrachus</i> spp.	Toadfish	Thi Thi Mar, 1981; Thida Khin Khin Htun, 1998
Tonguesole		
<i>Cynoglossus arel</i>	Largescale tonguesole	Sabai Soe, 2012
<i>Cynoglossus bilineatus</i>	Fourlined tonguesole	Sabai Soe, 2012; Soe Thant, 1979
<i>Cynoglossus cynoglossus</i>	Bengal tonguesole	Sabai Soe, 2012; Tint Swe & Daw Tin Nu, 2012
<i>Cynoglossus lingua</i>	Long tonguesole	Sabai Soe, 2012; Soe Thant, 1979
<i>Cynoglossus oligolepis</i>	Tonguesole	Soe Thant, 1979
<i>Cynoglossus bilineatus</i> [re-recorded as <i>C. quinquelineatus</i>]	Fourlined tonguesole	Soe Thant, 1979
Trevally		
<i>Atropus atropus</i>	Cleftbelly trevally	Tint Swe & Daw Tin Nu, 2012; This study
<i>Carangoides chrysophrys</i>	Longnose trevally	Nu Nu Aye, 1984; Tint Swe & Daw Tin Nu, 2012
<i>Carangoides ferdau</i>	Blue trevally	Tint Swe & Daw Tin Nu, 2012; This study
<i>Carangoides malabaricus</i>	Malabar trevally	May Win Maw, 2005; Tint Swe & Daw Tin Nu, 2012
<i>Caranx sexfasciatus</i>	Bigeye trevally	Moe Sapai, 1998; Thida Khin Khin Htun, 1998; This study
<i>Gnathanodon speciosus</i>	Golden trevally	Nu Nu Aye, 1984; Tint Swe & Daw Tin Nu, 2012
<i>Lactarius lactarius</i>	False trevally	May Win Maw, 2005; Tint Swe & Daw Tin Nu, 2012; This study
Tripodfish		
<i>Triacanthus</i> sp	Tripodfish	Tint Swe & Daw Tin Nu, 2012
Triggerfish		

<i>Abalistes</i> sp.	Triggerfish	Tint Swe & Daw Tin Nu, 2012
<i>Sufflamen chrysopterus</i>	Flagtail triggerfish	Min Thu Aung, 2006
Tripletail		
<i>Lobotes surinamensis</i>	Tripletail	Min Thu Aung, 2006
Tuna		
<i>Auxis thazard thazard</i> [recorded as <i>A. thazard</i>]	Frigate tuna	Hnin Zar Htwe, 2012
<i>Euthynnus affinis</i>	Kawakawa	Hnin Zar Htwe, 2012; Kyaw Kyaw Htay, 2010; This study
<i>Thunnus albacares</i>	Yellowfin tuna	Kyaw Tint <i>et al.</i> , 2012b
<i>Thunnus tonggol</i>	Longtail tuna	Hnin Zar Htwe, 2012; Thet Thet Myaing, 2006
Wallago		
<i>Wallago attu</i>	Wallago	Thida Khin Khin Htun, 1998
Wolf-herring		
<i>Chirocentrus dorab</i>	Blackfin wolf-herring	Sanda Soe Tin, 1992; Saw Nanda, 2000; Tint Swe & Daw Tin Nu, 2012; This study
<i>Chirocentrus nudus</i>	Whitefin wolf-herring	Ngu War Hlaing, 2010
Wrasse		
<i>Cheilinus chlorourus</i>	Floral wrasse	This study
<i>Cheilinus fasciatus</i>	Redbreasted wrasse	This study
<i>Cirrhilabrus cyanopleura</i>	Bluesided wrasse	This study
<i>Haliophanes hortulanus</i>	Checkerboard wrasse	This study
<i>Halichoeres melanurus</i>	Pinstriped wrasse	This study
<i>Labroides dimidatus</i>	Cleaner wrasse	This study
<i>Leptojulius cyanopleura</i>	Shoulder-spot wrasse	This study
<i>Thalassoma lunare</i>	Crescent wrasse	This study

APPENDIX 7. SHARKS AND RAYS OF MYANMAR

Scientific Name	Common Name	CITES	IUCN	Occurrence	Citations)
Sharks					
<i>Atelomycterus marmoratus</i>	Marble cat shark		NT	Probable	2
<i>Carcharhinus albimarginatus</i>	Silvertip shark		NT	Possible?	5, 6
<i>Carcharhinus amblyrhynchoides</i>	Graceful shark		NT	Confirmed	3, 5
<i>Carcharhinus amboinensis</i>	Pigeye shark		DD	Confirmed	5
<i>Carcharhinus borneensis</i>	Borneo shark		EN	Confirmed	5, 6
<i>Carcharhinus brevipinna</i>	Spinner shark		NT	Confirmed	3, 5, 6
<i>Carcharhinus dussumieri</i>	Whitecheek shark		NT	Confirmed	2, 5, 6
<i>Carcharhinus falciformis</i>	Silky shark		NT	Confirmed	3, 5, 6
<i>Carcharhinus galapagensis</i>	Galapagos shark		NT	Unlikely	5
<i>Carcharhinus leucas</i>	Bull shark		NT	Confirmed	3, 5, 6, 7
<i>Carcharhinus limbatus</i>	Blacktip shark		NT	Confirmed	2, 5, 6
<i>Carcharhinus longimanus</i>	Oceanic whitetip shark	II - Sept 14, 2014	VU	Probable	2
<i>Carcharhinus melanopterus</i>	Blacktip reef shark		NT	Confirmed	3, 5, 6
<i>Carcharhinus plumbeus</i>	Sandbar shark		VU	Confirmed	5, 6
<i>Carcharhinus sealei</i>	Blackspot shark		NT	Possible	2
<i>Carcharhinus sorrah</i>	Spottail shark		NT	Confirmed	3, 5, 6
<i>Chaenogaleus macrostoma</i>	Hooktooth shark		VU	Probable	5, 6
<i>Chiloscyllium griseum</i>	Grey bamboo shark		NT	Confirmed	5, 6
<i>Chiloscyllium punctatum</i>	Brownbanded bamboo shark		NT	Confirmed	3, 5, 6
<i>Chioscyllium griseum</i>	Ray bamboo shark		NT	Confirmed	2, 5
<i>Eusphyra blochii</i> [recorded as <i>Sphyrna blochii</i>]	Winghead shark		NT	Probable	2, 5

<i>Galeocerdo cuvier</i>	Tiger shark		NT	Confirmed	3, 5, 6
<i>Glyphis gangeticus</i>	Ganges shark		CR	Confirmed	5, 6
<i>Hemigaleus microstoma</i>	Sickelfin weasel shark		VU	Possible	5
<i>Hemipristis elongata</i>	Snaggletooth shark		VU	Confirmed	5
<i>Hemipristis elongatus</i>	Snaggletooth shark		VU	Confirmed	3
<i>Loxodon macrorhinus</i>	Sliteye shark		LC	Confirmed	3, 5, 6
<i>Rhincodon typus</i>	Whale shark	II	VU	Probable	2
<i>Rhizoprionodon acutus</i> [recorded as <i>Scoliodon walbeehmi</i>]	Milk shark		LC	Probable	2, 5, 6
<i>Rhizoprionodon oligolinx</i>	Grey sharpnose shark		LC	Confirmed	3, 6
<i>Scoliodon laticaudus</i>	Spadenose shark		NT	Confirmed	3, 5, 6, 7
<i>Sphyrna lewini</i>	Scalloped hammerhead	II - Sept 14, 2014	EN	Confirmed	3, 5, 6, 7
<i>Sphyrna mokarran</i>	Great hammerhead shark	II - Sept 14, 2014	EN	Probable	2, 5, 6
<i>Sphyrna zygaena</i>	Smooth hammerhead shark	II - Sept 14, 2014	VU	Confirmed	4
<i>Stegostoma fasciatum</i>	Leopard shark		VU	Confirmed	5, 6
Rays					
<i>Aetobatis narinari</i>	Spotted eagle ray		NT	Probable	2, 5
<i>Aetomylaeus nichofii</i>	Banded eagle ray		VU	Probable	2, 5
<i>Aetomylaeus vespertilio</i>	Ornate eagle ray		EN	Possible	5
<i>Anoxypristis cuspidata</i>	Narrow sawfish	I	EN	Probable	1, 2
<i>Dasyatis fluviarum</i>	Estuary stingray		VU	Unlikely	5
<i>Dasyatis sinensis</i>	Chinese stingray		DD	Unlikely	5
<i>Dasyatis zugei</i>	Pale-edged stingray		NT	Possible	5
<i>Dasyatis zugei</i> [recorded as <i>Amphotistius zugei</i>]	Pale-edged stingray		NT	Possible	2

<i>Gymnura poecilura</i>	Longtail butterfly ray		NT	Probable	5
<i>Gymnura zonura</i> [recorded as <i>Aetomylaeus zonura</i>]	Zonetail butterfly ray		VU	Probable	5
<i>Himantura fai</i>	Pink whipray		LC	Confirmed	5
<i>Himantura gerardi</i>	Whitespotted whipray		VU	Confirmed	5
<i>Himantura imbricata</i>	Scaly whipray		DD	Probable	5
<i>Himantura jenkinsii</i>	Jenkins whipray		LC	Confirmed	5
<i>Himantura toshi</i>	Brown whipray		LC	Unlikely	5
<i>Himantura uarnacoides</i>	Bleeker's whipray		VU	Probable	2
<i>Himantura uarnak</i>	Reticulate whipray		VU	Probable	2, 5
<i>Himantura undulata</i>	Bleeker's variegated whipray		VU	Confirmed	5
<i>Himantura walga</i>	Dwarf whipray		NT	Possible	5
<i>Manta alfredi</i>	Reef manta ray	II - Sept 14, 2014	VU	Possible	2
<i>Manta birostris</i>	Giant manta ray	II - Sept 14, 2014	VU	Probable	2
<i>Mobula</i> sp.	Devil ray			Probable	5
<i>Narcine timplei</i>	Electric ray		DD	Probable	2
<i>Neotrygon annotata</i> [recorded as <i>Dasyatis annotata</i>]	Brown stingray		NT	Possible?	5
<i>Neotrygon kuhlii</i> [also recorded as <i>Dasyatis kuhlii</i>]	Blue-spotted stingray		DD	Confirmed	2, 5
<i>Pastinachus sephen</i>	Cowtail stingray		DD	Unlikely	2, 5, 7
<i>Pristis clavata</i>	Dwarf sawfish	I	EN	Possible	1
<i>Pristis pristis</i>	Largetooth sawfish	I	CR	Probable	1
<i>Pristis zijsron</i>	Green sawfish	I	CR	Probable	1
<i>Rhinoptera javanica</i>	Javanese cow-nose ray		VU	Probable	2, 5
<i>Rhynchobatus djiddensis</i>	White-spotted guitarfish		VU	Unlikely	5
<i>Urogymnus asperrimus</i>	Porcupine ray		VU	Confirmed	7

*Citations	
1	Harrison & Dulvy, 2014
2	IUCN, Web page
3	Khaing Khaing Thein, 2008
4	Kyi Win, 1978
5	Maung Hla & Thein Thein Kyi, 2012
6	National Biodiversity Strategy and Action Plan, 2011
7	San San Khine, 2010

APPENDIX 8. SEA AND COASTAL BIRDS OF MYANMAR

Scientific Name	Common Name	IUCN	Coastal Region		
			Cocos	Rakhine	Tanin.
Family Megapodiidae: Scrubfowl					
<i>Megapodius nicobariensis</i>	Nicobar scrubfowl	VU	X		
Family Hydrobatidae, Subfamily Oceanitinae: Oceanites storm-petrels					
<i>Oceanites oceanicus</i>	Wilson's storm-petrel	n/a			X
Family Ardeidae, Subfamily Ardeinae: Herons & egrets					
<i>Ardea sumatrana</i>	Great-billed heron	n/a			X
<i>Egretta sacra</i>	Pacific reef egret	n/a		X	X
Family Phaethontidae: Tropicbirds					
<i>Phaethon aethereus</i>	Red-billed tropicbird	n/a			X
<i>Phaethon lepturus</i>	White-tailed tropicbird	n/a			X
Family Fregatidae: Frigatebirds					
<i>Fregata minor</i>	Great frigatebird	n/a			X
Family Sulidae: Boobies					
<i>Sula leucogaster</i>	Brown booby	n/a			X
<i>Sula sula</i>	Red-footed booby	n/a			X
Family Heliornithidae: Finfoots					
<i>Heliopais personata</i>	Masked finfoot	EN			X
Family Burhinidae: Thick-knees					
<i>Esacus neglectus</i>	Beach Thick-knee	NT			X
Family Pluvialidae: Pluvialis plovers					
<i>Pluvialis fulva</i>	Pacific golden plover	n/a			X
<i>Pluvialis squatarola</i>	Grey plover	n/a			X
Family Recurvirostridae: Stilts & avocets					
<i>Himantopus himantopus</i>	Black-winged stilt	n/a		X	X
Family Haematopodidae: Oystercatchers					
<i>Haematopus ostralegus</i>	Eurasian oystercatcher	n/a		X	
Family Dromadidae: Crab-plover					
<i>Dromas ardeola</i>	Crab-plover	n/a			X
Family Charadriidae: Charadrius plovers & allies					
<i>Charadrius alexandrinus</i>	Kentish plover	n/a		X	X
<i>Charadrius dubius</i>	Little ringed plover	n/a			X
<i>Charadrius hiaticula</i>	Common ringed plover	n/a		X	
<i>Charadrius leschenaultii</i>	Greater sand-plover	n/a		X	X
<i>Charadrius mongolus</i>	Lesser sand-plover	n/a		X	X
<i>Charadrius peronii</i>	Malaysian plover	n/a			X
Family Scolopacidae, Subfamily Tringinae: Godwits, dowitchers, curlews, sandpipers & allies					
<i>Actitis hypoleucos</i>	Common sandpiper	n/a		X	X
<i>Limnodromus semipalmatus</i>	Asian dowitcher	NT			X
<i>Limosa lapponica</i>	Bar-tailed godwit	n/a		X	
<i>Limosa limosa</i>	Black-tailed godwit	NT		X	X

<i>Numenius arquata</i>	Eurasian curlew	NT	X	X
<i>Numenius menutus</i>	Little curlew	n/a		X
<i>Numenius phaeopus</i>	Whimbrel	n/a	X	X
<i>Tringa erythropus</i>	Spotted redshank	n/a	X	X
<i>Tringa glareola</i>	Wood sandpiper	n/a	X	X
<i>Tringa guttifer</i>	Nordmann's greenshank	EN		X
<i>Tringa nebularia</i>	Common greenshank	n/a	X	X
<i>Tringa ochropus</i>	Green sandpiper	n/a	X	X
<i>Tringa stagnatilis</i>	Marsh sandpiper	n/a	X	X
<i>Tringa totanus</i>	Common redshank	n/a	X	X
<i>Xenus cinereus</i>	Terek sandpiper	n/a	X	X
SCOLOPACIDAE: CALIDRIDINAE: Calidris sandpipers & allies				
<i>Calidris alba</i>	Sanderling	n/a		
<i>Calidris canutas</i>	Red knot	n/a	X	X
<i>Calidris ferruginea</i>	Curlew sandpiper	n/a	X	X
<i>Calidris minuta</i>	Little stint	n/a	X	X
<i>Calidris pygmeus</i>	Spoon-billed sandpiper	CR	X	
<i>Calidris ruficollis</i>	Red-necked stint	n/a	X	X
<i>Calidris subminuta</i>	Long-toed stint	n/a	X	X
<i>Calidris temminckii</i>	Temminck's stint	n/a	X	X
<i>Calidris tenuirostris</i>	Great knot	VU	X	X
<i>Limicola falcinellus</i>	Broad-billed sandpiper	n/a	X	X
<i>Philomachus pugnax</i>	Ruff	n/a	X	X
Family Scolopacidae, Subfamily Subfamily Calidridinae: Calidris sandpipers & allies				
<i>Arenaria interpres</i>	Ruddy turnstone	n/a	X	X
Family Stercorariidae: Jaegers & allies				
<i>Stercorarius pomarinus</i>	Pomarine jaeger	n/a		X
Family Rhynchopidae: Skimmers				
<i>Rynchops albicollis</i>	Indian skimmer	VU	X	
Family Sternidae: Noddies & terns				
<i>Anous stolidus</i>	Brown noddy	n/a		X
<i>Chlidonias hybridus</i>	Whiskered tern	n/a	X	X
<i>Chlidonias leucopterus</i>	White-winged tern	n/a		X
<i>Gelocbelidon nilotica</i>	Gull-billed tern	n/a	X	X
<i>Hydroprogne caspia</i>	Caspian tern	n/a		
<i>Onychoprion fuscata</i>	Sooty tern	n/a		X
<i>Sterna acuticauda</i>	Black-bellied tern	EN	X	X
<i>Sterna aurantia</i>	River tern	NT	X	X
<i>Sterna dougallii</i>	Roseate tern	n/a		X
<i>Sterna hirundo</i>	Common tern	n/a		X
<i>Sterna sumatrana</i>	Black-naped tern	n/a		X
<i>Sternula albifrons</i>	Little tern	n/a	X	X
<i>Thalasseus bengalensis</i>	Lesser crested tern	n/a	X	X
<i>Thalasseus bergii</i>	Great crested tern	n/a	X	X

Family Laridae: Gulls & allies				
<i>Chricocephalus brunnicephalus</i>	Brown-headed gull	n/a	X	
<i>Chricocephalus ridibundus</i>	Black-headed gull	n/a	X	X
<i>Larus ichthyaetus</i>	Pallas's gull	n/a	X	X
Family Columbidae, Subfamily Columbinae: Typical pigeons & doves				
<i>Caloenas nicobarica</i>	Nicobar pigeon	NT		X
<i>Columba punicea</i>	Pale-capped pigeon	VU	X	X
Family Columbinae, Subfamily Treroninae: Green-pigeons, fruit-doves, imperial-pigeons & allies				
<i>Ducula bicolor</i>	Pied Imperial-pigeon	n/a	X	X
<i>Treron capellei</i>	Large green-pigeon	VU		X
<i>Treron chloropterus</i>	Andaman green-pigeon	n/a	X	
<i>Treron fulvicollis</i>	Cinnamon-headed green-pigeon	NT		X
Family Cuculidae, Subfamily Centropodinae: Coucals				
<i>Centropus andamanensis</i>	Andaman coucal	n/a	X	
Family Apodida, Subfamily Apodinae: Typical swifts				
<i>Aerodramus fuciphaga</i>	Edible-nest swiftlet	n/a		X
<i>Aerodramus germani</i>	Germain swiftlet	n/a		X
<i>Aerodramus maxima</i>	Black-nest swiftlet	n/a		X
Family Alcedinidae: River kingfishers				
<i>Pelargopsis amauroptera</i>	Brown-winged kingfisher	NT	X	X
Family Halcyonidae, Tree kingfishers				
<i>Halcyon coromanda</i>	Ruddy kingfisher	n/a		X
<i>Todiramphus chloris</i>	Collared kingfisher	n/a	X	X
Family Bucerotidae: Hornbills				
<i>Aceros subruficollis</i>	Plain-pouched hornbill	VU		X
Family Pittidae: Pittas				
<i>Pitta megarhyncha</i>	Mangrove pitta	NT	X	X
Family Acanthizidae: Gerygones & allies				
<i>Gerygone sulphurea</i>	Golden-bellied gerygone	n/a		X
Family Pachycephalidae: Whistlers & allies				
<i>Pachycephala cinerea</i>	Mangrove whistler	n/a	X	X
Family Dicruridae: Drongos				
<i>Dicrurus andamanensis</i>	Andaman drongo	NT	X	

(Robson, 2008)

APPENDIX 9. PRAWNS AND SHRIMPS OF MYANMAR

Scientific Name	Common Name	IUCN	Occurrence	*Citation(s)	Marine	Brackish	Fresh
Marine Shrimps/Prawns							
Family Alpheidae							
<i>Alpheus euphrosyne</i>	Snapping shrimp	n/a	Probable	26	X		
Family Atyidae							
<i>Atyopsis</i> spp.		(LC)	Probable	25	X	X	
Family Hippolytidae							
<i>Exhippolysmata ensirostris ensirostris</i> [recorded as <i>Hippolysmata ensirostris</i>]	Hunter shrimp	n/a	Confirmed	25	X		
Family Pandalidae							
<i>Heterocarpus woodmasoni</i>	Indian nylon shrimp	n/a	Possible	20	X		
<i>Plesionika martia</i>	Golden shrimp	n/a	Possible	20	X		
<i>Plesionika spinipes</i> [recorded as <i>Parapandalus spinipes</i>]	Oriental narwal shrimp	n/a	Possible	20	X		
Family Palaemonidae							
<i>Exopalaemon styliferus</i> [also recorded as <i>Leander styliferus</i>]	Roshma prawn	n/a	Confirmed	11, 22, 25, 28	X	X	
<i>Palaemon semmelinkii</i>		n/a	Confirmed	25	X		
<i>Palaemon serrifer</i>	Barred estuarine shrimp	n/a	Probable	25	X		
Family Penaeidae							
<i>Alcockpenaeopsis hungerfordii</i> [recorded as <i>Parapenaeopsis hungerfordi</i>]		n/a	Confirmed	5, 19, 28	X		
<i>Ganjampenaeopsis uncta</i> [recorded as <i>Parapenaeopsis probata</i>]		n/a	Possible	19, 28	X		
<i>Kishinouyepenaeopsis maxillipedo</i> [recorded as <i>Parapenaeopsis maxillipedo</i>]	Torpedo shrimp	n/a	Confirmed	5, 25, 27, 28			
<i>Megokris pescadoreensis</i> [recorded as <i>Trachypeneus pescadoreensis</i>]	Big head king prawn	n/a	Possible	19, 28	X		
<i>Metapenaeopsis andamanensis</i>		n/a	Probable	20	X		
<i>Metapenaeopsis barbata</i>	Sand prawn/ Whiskered velvet prawn	n/a	Possible	19	X		
<i>Metapenaeopsis palmensis</i> [recorded as <i>M. barbeensis</i>]		n/a	Confirmed	5, 19, 28	X		

<i>Metapenaeopsis stridulans</i>	Fiddler shrimp	n/a	Confirmed	5, 19	X	
<i>Metapenaeus affinis</i>	Pink/Jinga prawn	n/a	Confirmed	5, 19	X	
<i>Metapenaeus brevicornis</i>	Yellow shrimp	n/a	Confirmed	5, 11, 13, 27	X	
<i>Metapenaeus dobsoni</i>	Kadal shrimp	n/a	Probable	19	X	
<i>Metapenaeus ensis</i>	Greasyback shrimp	n/a	Confirmed	5, 19	X	
<i>Metapenaeus lysianassa</i>	Small white/Bird prawn	n/a	Confirmed	5, 11, 12, 16	X	
<i>Metapenaeus monoceros</i>	Speckled prawn	n/a	Confirmed	11, 12, 13	X	
<i>Metapenaeus tenuipes</i>		n/a	Confirmed	5, 19	X	
<i>Nematopalaemon tenuipes</i> [recorded as <i>Palaemon tenuipes</i>]	Spider prawn	n/a	Confirmed	5, 11, 25, 28	X	
<i>Parapenaeopsis cornuta</i>	Coral shrimp	n/a	Confirmed	5, 19	X	
<i>Parapenaeopsis hardwickii</i>	Spear shrimp	n/a	Confirmed	5, 6, 11	X	
<i>Parapenaeopsis sculptilis</i>	Coral prawn	n/a	Confirmed	5, 25, 27	X	
<i>Parapenaeopsis stylifera</i>	Kiddi shrimp	n/a	Possible	11	X	
<i>Parapenaeopsis tenella</i>		n/a	Confirmed	5, 19	X	
<i>Parapenaeus fissurus</i>		n/a	Probable	19	X	
<i>Parapenaeus longipes</i>	Flamingo shrimp	n/a	Probable	19	X	
<i>Penaeus canaliculatus</i>	Witch prawn	n/a	Possible	19	X	
<i>Penaeus indicus</i>	Indian white prawn	n/a	Confirmed	3, 5, 11, 12	X	X
<i>Penaeus japonicus</i>	Kuruma shrimp	n/a	Confirmed	3, 5		
<i>Penaeus latisulcatus</i>	Western king prawn	n/a	Confirmed	5, 19	X	
<i>Penaeus merguensis</i>	Banana prawn	n/a	Confirmed	5, 13, 21		X
<i>Penaeus monodon</i>	Giant tiger prawn	n/a	Confirmed	2, 4, 5, 7, 8, 9, 11, 12, 13, 14, 17, 18, 21, 23, 24	X	X
<i>Penaeus penicillatus</i>	Redtail shrimp	n/a	Probable	19	X	
<i>Penaeus semisulcatus</i>	Green tiger prawn	n/a	Confirmed	3, 5	X	
<i>Trachysalambria aspera</i>		n/a	Confirmed	5, 19	X	

<i>Trachysalambria curvirostris</i> [FAO recorded as <i>Trachypenaeus curvirostris</i>]	Southern rough shrimp	n/a	Probable	3, 28	X	
<i>Trachysalambria fulva</i>	Big head king prawn	n/a	Possible	19	X	
Family Sergestidae						
<i>Acetes indicus</i>		n/a	Confirmed	5, 25	X	X
<i>Acetes japonicus</i> [recorded as <i>A. cochinensis</i>]	Akiami paste shrimp	n/a	Probable	3, 28	X	
Family Solenoceridae						
<i>Solenocera crassicornis</i> [recorded as <i>S. indica</i> and <i>S. subnuda</i>]		n/a	Confirmed	5, 19, 28	X	
<i>Solenocera</i> spp.		n/a	Probable	11	X	
<i>Solenocera alticarinata</i>		n/a	Possible	19	X	
<i>Solenocera melantho</i>		n/a	Possible	19	X	
Family Squillidae						
<i>Harpisquilla raphidea</i>	Mantis shrimp	n/a	Confirmed	10, 15		X
<i>Miyakella nepa</i> [recorded as <i>M. nepa</i>]	Mantis shrimp	n/a	Probable	15, 28	X	
Freshwater Shrimps/Prawns						
<i>Macrobrachium rosenbergii</i>	Giant river prawn	LC	Confirmed	1, 5, 11, 12, 21, 25		X
<i>Macrobrachium villosimanus</i>	Dimua river prawn	LC	Confirmed	11, 25		X
<i>Macrobrachium idea</i>		LC	Probable	11		X
<i>Macrobrachium malcolmsonii malcolmsonii</i>	Monsoon river prawn	LC	Probable	11, 12		X
<i>Macrobrachium scabriculum</i>	Goda river prawn	LC	Probable			X
<i>Macrobrachium mirabile</i>	Shortleg river prawn	n/a	Possible	11		X
<i>Macrobrachium rude</i>	Hairy river prawn	LC	Possible	11		X
<i>Caridina</i> spp.	Cardinal shrimp	LC to EN	Probable	25		X

*Citations			
1	Ahmed <i>et al.</i> , 2013	15	Myo Nandar Myint, 2012
2	Aung Myo Htay, 2005	16	Nant Nay Chit Latt, 2009
3	Food and Agriculture Organization, Web page-b	17	Nwe Nwe Ni, 1998
4	Hlaing Hlaing Oo, 2005	18	Moe Swe, 2012
5	Htay Aung, 2004	19	OBIS, <i>Web page</i>
6	Htay Htay Win, 1977	20	Pont Pont Phyu, 1992
7	Htoo Thant, 1987	21	San San Yi, 1997
8	Khin Htwe Yi, 2000	22	Sein Moh Moh Khaing, 2011
9	Khin Khin Htay, 1998	23	Swe Swe Myint, 2007
10	Khin Myint Zin, 1984	24	Than Htaike, 1999
11	Khin Nwe Mu, 1980	25	Than Than Soe, 2012
12	Khin Wai Hlaing, 2012	26	Thanda Win, 2011
13	Kyi Kyi Myint, 1982	27	Thiri Tun, 2010
14	Myo Min Hlaing, 1999	28	World Register of Marine Species, <i>Web page</i>

APPENDIX 10. LOBSTERS OF MYANMAR

Scientific Name	Common Name	IUCN	Occurrence	*Citation(s)	Coastal Region	
					Rakhine	Tanin.
Spiny Lobsters						
<i>Panulirus homarus</i>	Scalloped spiny lobster	LC	Confirmed	1, 3, 5		X
<i>Panulirus longipes</i>	Longlegged spiny lobster	LC	Confirmed	1	X	X
<i>Panulirus ornatus</i>	Ornate spiny lobster	LC	Confirmed	1, 4	X	X
<i>Panulirus polyphagus</i>	Mud spiny lobster	LC	Confirmed	1	X	X
<i>Panulirus versicolor</i>	Common rock lobster	LC	Confirmed	1	X	X
<i>Thenus orientalis</i>	Flathead lobster	LC	Confirmed	1, 2		X
Lobsters (Other)						
<i>Gibbularctus gibberosus</i>		LC	Probable	2		
<i>Metanephrops andamanicus</i>	Andaman lobster	LC	Probable	2, 4		
<i>Nephropsis carpenteri</i>	Ridge-back lobsterette	LC	Probable	2, 4		
<i>Nephropsis ensirostris</i>	Gladiator lobsterette	LC	Probable	2, 4		
<i>Nephropsis stewarti</i>	Indian Ocean lobsterette	LC	Probable	2		
<i>Pentacheles gibbus</i>		LC	Probable	2, 4		
<i>Petrarctus veliger</i>	Slipper lobster	LC	Probable	2, 4		
<i>Biarctus sordidus</i>	Pygmy slipper lobster	LC	Possible	2		
<i>Stereomastis cerata</i>		LC	Possible	2		

*Citations	
1	Htay Aung, 2004
2	IUCN
3	Kumar <i>et al.</i> , 2010
4	OBIS, <i>Web page</i>
5	Win Win Si, 2011

APPENDIX 11. CRABS OF MYANMAR

Scientific Name	Common Name	Occurrence	*Citation(s)	Marine	Brackish	Mangroves	Beaches
<i>Ashtoret lunaris</i> [recorded as <i>Matuta lunaris</i>]		Possible	5, 12, 19	X			
<i>Calappa japonica</i>		Confirmed	5	X			
<i>Calappa lophos</i>		Confirmed	5	X			
<i>Carcinoscorpius rotundicauda</i> [also recorded as <i>Tachypleus rotundicauda</i>]	Mangrove horseshoe crab	Probable	6, 17, 19	X			
<i>Charybdis annulata</i>		Confirmed	5	X			
<i>Charybdis callianassa</i>		Confirmed	5	X			
<i>Charybdis feriata</i>	Coral crab	Confirmed	4, 5, 11	X			
<i>Charybdis hellerii</i> [recorded as <i>C. merguensis</i>]	Mangrove crab	Confirmed	5, 19	X			
<i>Clistocoeloma</i> spp.	Mangrove crab	Confirmed	5	X			
<i>Dardanus lagopodes</i> [recorded as <i>Pagurus euopsis</i>]	Hermit crab	Probable	10, 12, 19	X			
<i>Doclea rissoni</i> [recorded as <i>D. andersoni</i>]		Confirmed	5, 19	X			
<i>Dorippoides facchino</i> [recorded as <i>Dorippe astuta</i>]	Anenome-carrying crab	Confirmed	5, 19	X			
<i>Dotilla myctiroides</i>	Soldier crab	Confirmed	5				X
<i>Episesarma versicolor</i>		Possible	7	X	X	X	
<i>Etisus laevimanus</i>		Confirmed	5	X			
<i>Gelasimus tetragonon</i>		Confirmed	5				X
<i>Grapsus albolineatus</i> [recorded as <i>G. strigosus</i>]		Possible	5, 12, 19	X			
<i>Lauridromia dehaani</i> [recorded as <i>Dromia dehaani</i>]	Sponge crab	Possible	5, 19	X			
<i>Leptodius exaratus</i>		Confirmed	5				
<i>Macrophthalmus depressus</i>		Confirmed	5				X
<i>Matuta planipes</i>		Confirmed	5	X			
<i>Metaplax dentipes</i>		Possible	7	X			
<i>Metaplax elegans</i>		Confirmed	1	X			
<i>Metopograpsus messor</i>	Alamihi	Probable	7		X	X	
<i>Neosarmatium meinerti</i> [recorded as <i>Sesarma meinerti</i>]			1, 19			X	
<i>Ocypode stimpsoni</i>	Ghost crab	Unlikely	5, 12	X			X
<i>Perisesarma bidens</i> [recorded as <i>Sesarma bidens</i>]		Confirmed	4	X		X	
<i>Pilumnus vespertilio</i>		Probable	5	X			
<i>Portunus pelagicus</i>	Blue swimming crab	Confirmed	2, 4, 5	X	X		

<i>Portunus sanguinolentus</i>	Repspot swimming crab	Confirmed	4, 5, 11	X	
<i>Portunus trituberculatus</i>	Gazami crab	Probable	2	X	
<i>Pseudosesarma edwardsii</i>		Confirmed	16	X	X
<i>Ranina ranina</i>	Frog crab	Confirmed	4, 11	X	
<i>Scopimera globosa</i>	Mangrove crab	Possible	5		X
<i>Scylla olivacea</i>	Orange mud crab	Probable	13, 18	X	X
<i>Scylla serrata</i>	Giant mud crab	Confirmed	3, 5, 7, 8, 9, 14, 15	X	X X
<i>Thalamita prymna</i>		Confirmed	5	X	
<i>Uca (Austruca) annulipes</i> [recorded as <i>Gelasimus annulipes</i>]		Confirmed	5, 19		X
<i>Uca (Austruca) lactea</i> [recorded as <i>Gelasimus lactea</i>]	Fiddler crab	Probable	7, 19	X	
<i>Uca (Gelasimus) vocans</i> [recorded as <i>G. marionis</i> and <i>G. marionis nitidus</i>]	Fiddler crab	Probable	7, 12, 19	X	
<i>Uca</i> spp.	Fiddler crab	Confirmed	3	X	
<i>Varuna litterata</i>	Hairy crab	Possible	5, 16	X	X

*Citations			
1	Duncan <i>et al.</i> , 1889a	11	OBIS, <i>Web page</i>
2	Food and Agriculture Organization, <i>Web page-b</i>	12	San San Yi, 1997
3	Hla Hla Win, 2009	13	San Tha Tun, 2011
4	Htay Aung, 2004	14	Saw Htoo Baw, 1978
5	Isituto Oikos, 2011	15	Thanda Win, 2011
6	Khin Soe Nwe, 1979	16	Thet Su Mar, 2010
7	Khin Wai Hlaing, 2012	17	Thi Thi Mar, 2009
8	Kyi Kyi Maw, 2007	18	Thinzar Lwin Lwin, 2011
9	Ma Kyin Nwe, 1981	19	World Register of Marine Species, <i>Web page</i>
10	Mg Mg Gyi, 1993		

APPENDIX 12. CEPHALOPODS OF MYANMAR

Scientific Name	Common Name	IUCN	Occurrence	*Citation(s)
Order Teuthida: Squids				
<i>Ancistrocheirus lesueurii</i>	Sharpear enope squid	n/a	Probable	2
<i>Brachioteuthis picta</i>	Ornate arm squid	n/a	Probable	2
<i>Brachioteuthis riisei</i>	Common arm squid	n/a	Probable	2
<i>Chiroteuthis veranyi</i>	Long-armed squid	n/a	Probable	2
<i>Chtenopteryx sicula</i>	Toothed-fin squid	n/a	Probable	2
<i>Euprymna berryi</i>	Hummingbird bobtail squid	DD	Possible	2, 8
<i>Euprymna hillebergi</i>	Bobtail squid	DD	Probable	3, 5
<i>Euprymna morsei</i>	Mimika bobtail squid	DD	Possible	2
<i>Inioteuthis maculosa</i>	Bobtail squid	LC	Probable	3
<i>Nototodarus hawaiiensis</i>	Hawaiian flying squid	n/a	Probable	2
<i>Octopoteuthis sicula</i>	Ruppell's octopus squid	n/a	Probable	2
<i>Onychoteuthis banksi</i>	Common clubhook squid	n/a	Probable	2
<i>Ornithoteuthis volatilis</i>	Shiny bird squid	n/a	Probable	2
<i>Pterygioteuthis giardi</i>	Roundear enope squid	n/a	Probable	2
<i>Pyroteuthis margaritifera</i>	Jewel enope squid	n/a	Probable	2
<i>Sepiadarium kochi</i>	Koch's bottletail squid	n/a	Probable	2, 3
<i>Sepioteuthis lessoniana</i>	Bigfin reef squid	n/a	Probable	2
<i>Taningia danae</i>	Dana octopus squid	n/a	Probable	2
<i>Thysanoteuthis rhombus</i>	Diamondback squid	n/a	Probable	2
<i>Uroteuthis chinensis</i> [recorded as <i>Loligo chinensis</i>]	Mitre squid	n/a	Probable	2, 10
<i>Uroteuthis duvaucelii</i> [recorded as <i>Loligo duvauceli</i>]	Indian squid	n/a	Confirmed	2, 4, 8, 10
<i>Uroteuthis edulis</i> [recorded as <i>Loligo edulis</i>]	Swordtip squid	n/a	Probable	2, 10
<i>Uroteuthis singhalensis</i> [recorded as <i>Loligo singhalensis</i>]	Long barrel squid	n/a	Confirmed	2, 8, 10
Order Sepiida: Cuttlefish				
<i>Sepia aculeata</i>	Needle cuttlefish	DD	Confirmed	2, 4, 8
<i>Sepia brevimana</i>	Shortclub cuttlefish	DD	Probable	2, 3, 8
<i>Sepia esculenta</i>	Golden cuttlefish	DD	Unlikely	2, 9
<i>Sepia kobiensis</i>	Kobi cuttlefish	DD	Probable	2, 3
<i>Sepia latimanus</i>	Broadclub cuttlefish	DD	Probable	2, 3
<i>Sepia lycidas</i>	Kisslip cuttlefish	DD	Probable	2, 3
<i>Sepia pharaonis</i>	Pharaoh cuttlefish	DD	Confirmed	2, 4, 7, 8, 11
<i>Sepia recurvirostra</i>	Curvespine cuttlefish	DD	Probable	2, 3
<i>Sepia savignyi</i>	Broadback cuttlefish	DD	Unlikely	2, 4
<i>Sepia stellifera</i>	Starry cuttlefish	DD	Probable	2, 3
<i>Sepiella inermis</i>	Spineless cuttlefish	DD	Confirmed	2, 8
Order Octopoda: Octopuses				

<i>Amphioctopus aegina</i> [recorded as <i>Octopus aegina</i>]	Sandbird octopus	n/a	Probable	2, 5, 10
<i>Amphioctopus neglectus</i>	Octopus neglectus	n/a	Probable	2, 6
<i>Octopus globosus</i>	Globe octopus	n/a	Confirmed	4
<i>Octopus rugosus</i>	Common octopus	n/a	Probable	5
<i>Octopus vulgaris</i>	Common octopus	n/a	Confirmed	2
Order Nautilida: Nautiluses				
<i>Nautilus pompilius</i>	Nautilus	n/a	Possible	1

*Citations			
1	De Angelis, 2012	7	Su Su Khin, 1992
2	Food and Agriculture Organization, Web page-b	8	Thin Thin Maw, 2009
3	IUCN, Web page	9	Wai Wai Kan Oo, 1982
4	Jar San, 2011	10	World Register of Marine Species, Web page
5	OBIS, Web page	11	This study
6	Sreeja <i>et al.</i> , 2012		

APPENDIX 13. BIVALVES OF MYANMAR

Scientific Name	Common Name	IUCN	CITES	Occurrence	*Citation(s)	Habitat
Mussels						
<i>Neosolen aquaedul-cioris</i>		LC	n/a	Probable	7	Marine and freshwater
<i>Perna viridis</i> [also recorded as <i>Mytilus viridis</i>]	Green mussel	n/a	n/a	Confirmed	2, 8, 28	Marine
<i>Polymesoda bengalensis</i>	Bengali geloina	LC	n/a	Probable	7	Brackish water
<i>Scaphula deltae</i>		LC	n/a	Probable	7	Marine and freshwater
Oysters						
<i>Crassostrea belcheri</i>	Lugubrious cupped oyster	n/a	n/a	Confirmed	3, 4, 5, 12, 13, 20	Marine
<i>Crassostrea rhizophorae</i>	Mangrove oyster	n/a	n/a	Confirmed	13	Marine
<i>Pinctada imbricata fucata</i>	Akoya pearl oyster	n/a	n/a	Confirmed	22, 23, 24, 25, 26	Marine
<i>Pinctada margaritifera</i>	Black-lip oyster	n/a	n/a	Confirmed	21, 26	Marine
<i>Pinctada maxima</i>	White-lip oyster	n/a	n/a	Confirmed	9, 10, 14, 17, 26, 27	Marine
<i>Pteria penguin</i>	Winged pearl oyster	n/a	n/a	Confirmed	11	Marine
<i>Saccostrea cucullata</i>	Hooded oyster	n/a	n/a	Confirmed	3, 4, 6, 13, 15, 20	Marine
Clams						
<i>Acila divaricata</i>		n/a	n/a	Confirmed	19	Marine
<i>Geloina expansa</i> [recorded as <i>Polymesoda expansa</i>]	Marsh clam	LC	n/a	Confirmed	18, 28	Mangroves
<i>Hippopus hippopus</i>	Bear paw clam	LC	II	Probable	1, 7	Marine
<i>Sunetta meroe</i>		n/a	n/a	Confirmed	16	Marine
<i>Sunetta subquadrata</i>		n/a	n/a	Confirmed	16	Marine
<i>Tridacna gigas</i>	Giant clam	VU	II	Probable	1, 7	Marine
<i>Tridacna maxima</i>	Small giant clam	LC	II	Confirmed	16	Marine
<i>Tridacna squamosa</i>	Fluted giant clam	LC	II	Confirmed	16	Marine

APPENDIX 14. MARINE GASTROPODS OF MYANMAR

Scientific Name	Common Name	Occurrence	*Citation(s)
Snails			
<i>Anachis</i> spp.		Confirmed	3
<i>Architectonica maxima</i>	Giant sundial	Confirmed	2
<i>Atys</i> spp.	Bubble snails	Confirmed	3
<i>Babylonia</i> spp.	Babylonia snails	Confirmed	3
<i>Babylonia areolata</i>	Maculated ivory whelk	Confirmed	2
<i>Bulla</i> spp.	Bubble snails	Confirmed	4
<i>Canarium urceus</i> [re-recorded as <i>Strombus urceus</i>]	Little pitcher conch	Probable	2
<i>Cassidula</i> spp.		Confirmed	4
<i>Cassis cornuta</i>	Horned helmet	Confirmed	2
<i>Cellana rota</i>	Rayed limpet	Confirmed	2
<i>Cerithidea cingulata</i>	Girdled horn shell	Confirmed	2
<i>Cerithidea fluviatilis</i>		Confirmed	5, 6
<i>Chicoreus brunneus</i>	Adusta murex	Confirmed	5
<i>Chicoreus ramosus</i>	Ramose murex	Confirmed	2, 7
<i>Chicoreus torrefactus</i>	Firebrand murex	Confirmed	2
<i>Chromodoris geminus</i>	Twin chromodoris	Confirmed	7
<i>Conomurex luhuanus</i> [recorded as <i>Strombus luhuanus</i>]	Strawberry conch	Possible	2
<i>Conus</i> spp.	Cone shells	Confirmed	4
<i>Conus litteratus</i>	Lettered cone	Confirmed	2
<i>Conus suratensis</i>	Suratan cone	Confirmed	2
<i>Cryptospira ventricosa</i> [recorded as <i>Marginella ventricosa</i>]		Probable	2
<i>Cymatium</i> spp.	Triton shell	Confirmed	2
<i>Cypraea eglantina</i>	Eglamtine cowrie	Confirmed	2
<i>Cypraea mauritiana</i>	Humpback cowrie	Confirmed	2
<i>Cypraea talpa</i>	Mole cowrie	Confirmed	2
<i>Cypraea tigris</i>	Tiger cowrie	Confirmed	2
<i>Cypraea vitellus</i>	Pacific deer cowrie	Confirmed	2
<i>Dolomena variabilis</i> [recorded as <i>Strombus variabilis</i>]	Variable conch	Confirmed	2
<i>Drupa</i> spp.	Rock snails	Confirmed	4
<i>Elaeocyma</i> spp.		Confirmed	4
<i>Ellobium</i> spp.		Confirmed	4
<i>Ellobium aurismidae</i>	Midas's ear shell	Confirmed	2
<i>Engina</i> spp.		Confirmed	4
<i>Ficus subintermedia</i>	Underlined fig shell	Confirmed	2
<i>Fusinus colus</i>	Distaff spindle	Confirmed	2

<i>Harpago chiragra</i> [also recorded as <i>Lambis chiraga chiraga</i>]	Chiagra spider conch	Confirmed	2, 5
<i>Hypselodoris maculosa</i>	Spotted hypselodoris	Confirmed	7
<i>Laevistrombus canarium</i> [recorded as <i>Strombus canarium</i>]	Dog conch	Confirmed	2
<i>Lambis lambis</i>	Spider conch	Confirmed	2, 3
<i>Lora</i> spp.		Confirmed	4
<i>Magilus</i> spp.	Murex snails	Confirmed	4
<i>Mancinella</i> spp.	Rock snails	Confirmed	4
<i>Melo</i> spp.	Volutes	Confirmed	4
<i>Melo melo</i>	Indian volute	Confirmed	2
<i>Mitra</i> spp.	Miter shells	Confirmed	4
<i>Morula</i> spp.	Rock snails	Confirmed	4
<i>Murex</i> spp.	Rock snails	Confirmed	4
<i>Murex ternispina</i>	Black spined murex	Confirmed	2
<i>Myurella</i> spp.	Auger snails	Confirmed	4
<i>Myurella kilburni</i> [recorded as <i>Terebra areolata</i>]	Fly spotted auger	Confirmed	2
<i>Nassarius</i> spp.	Nassa mud snails	Confirmed	4
<i>Nassarius dorsatus</i>	Channeled nassa	Probable	2
<i>Natica lineata</i>	Lined moon snail	Probable	2
<i>Natica vitellus</i>	Calf moon snail	Probable	2
<i>Nerita albicilla</i>	Oxpalate nerite	Confirmed	2
<i>Nerita chamaeleon</i>	Chamelon nerite	Confirmed	2
<i>Nerita costata</i>	Costate nerite	Confirmed	2
<i>Nerita polita</i>	Polished nerite	Confirmed	2
Nudibranchs			
<i>Oliva miniacea</i>	Redmouth olive	Confirmed	
<i>Oliva</i> spp.	Olive shells	Confirmed	4
<i>Phos</i> spp.		Confirmed	4
<i>Phyllidia varicosa</i>	Swollen phyllidia	Confirmed	7
<i>Phyllidiella pustulosa</i>	Pimpled phyllidiella	Confirmed	7
<i>Pleuroploca</i> spp.	Tulip shells	Confirmed	4
<i>Pleuroplaea trapezium</i>	Rapizium horse		2
<i>Polinices mammilla</i>	Pear shaped moon snail		2
<i>Pugilina cochlidium</i>	Spiral melongena		2
<i>Pugilina</i> spp.	Crown conchs	Confirmed	4
<i>Purpura</i> spp.	Rock snails	Confirmed	4
<i>Pythia</i> spp.		Confirmed	4
<i>Rapana</i> spp	Rock snails	Confirmed	4
<i>Rhinoclavis vertagus</i>	Common vertagus		2
<i>Risbecia pulchella</i>	Beautiful risbecia	Confirmed	7
<i>Tectus niloticus</i> [recorded as <i>Trochus niloticus</i> and <i>T. maximus</i>]	Trochus shell	Confirmed	1, 2

<i>Tectus pyramis</i>	Pyramid top	Confirmed	2
<i>Terebra</i> spp.	Auger snails	Confirmed	4
<i>Thais</i> spp.	Rock shells	Confirmed	4
<i>Thais alouina</i>	Alou rock shell		2
<i>Tonna dolium</i>	Spotted tun		2
<i>Tonna olearium</i>	Oily tun		2
<i>Turbo argyrostomus</i>	Silvermouth turban		2
<i>Turbo marmoratus</i>	Green turban		2
<i>Turricula</i> spp.		Confirmed	4
<i>Turris</i> spp.	Turrids	Confirmed	4
<i>Turritella duplicate</i>	Duplicate turret		2
<i>Turritella terebra</i>	Screw turret		2
<i>Xenophora solaris</i>	Sunburst carrier	Possible	2
<i>Zierliana</i> spp.		Confirmed	4

*Citations	
1	Hla Hla Aye, 1996
2	Isituto Oikos, 2011
3	Mya Mya Htwe, 1995
4	Naung Naung Oo, 2012
5	Soe Soe Aye, 2009
6	Thanda Win, 2011
7	This study

APPENDIX 15. SEA CUCUMBERS OF MYANMAR

Scientific Name	Common Name	IUCN	Occurrence	*Citation(s)	**Commercial Value
<i>Acaudina molpadioides</i>		n/a	Confirmed	3	High
<i>Actinopyga echinites</i>	Deep water redfish	VU	Confirmed	3	High
<i>Actinopyga lecanora</i>	Stonefish	DD	Confirmed	3, 4, 5, 6	High
<i>Actinopyga mauritiana</i>	Surf redfish	VU	Confirmed	3	Low
<i>Actinopyga miliaris</i>	Blackfish	VU	Confirmed	4, 6	Not evaluated
<i>Bohadschia argus</i>	Leopardfish	LC	Confirmed	1, 3, 4, 6	Low
<i>Bohadschia atra</i>	Tigerfish	DD	Possible	3	Low
<i>Bohadschia marmorata</i>	Chalky cucumber	DD	Confirmed	3	Low
<i>Bohadschia vitiensis</i>	Brown sandfish	DD	Confirmed	3, 6	Medium
<i>Holothuria (Halodeima) atra</i>	Lollyfish	LC	Confirmed	1, 3, 4, 5, 6	Low
<i>Holothuria (Halodeima) edulis</i>	Pinkfish	LC	Confirmed	3, 5	Low
<i>Holothuria (Lessonothuria) pardalis</i>	Dragonfish	LC	Confirmed	2, 3, 5, 6	Low
<i>Holothuria (Lessonothuria) pardalis</i>		LC	Confirmed	3	Low
<i>Holothuria (Mertensiothuria) hilla</i>		LC	Confirmed	3, 5	Low
<i>Holothuria (Mertensiothuria) leucospilota</i> [also recorded as <i>H. vagabunda</i>]	White thread fish	LC	Confirmed	1, 3, 6, 7	Low
<i>Holothuria (Metriatyla) lessoni</i>	Golden sandfish	EN	Confirmed	3	High
<i>Holothuria (Metriatyla) scabra</i>	Sandfish	EN	Confirmed	2, 4, 8	High
<i>Holothuria (Microthele) fuscogilva</i>	White teatfish	VU	Confirmed	5, 6, 8	Low
<i>Holothuria (Microthele) nobilis</i>	Black teatfish	EN	Possible	5	Not evaluated
<i>Holothuria (Selenkothuria) erinaceus</i> [recorded as <i>H. andersoni</i>]		n/a	Confirmed	1, 7	Not evaluated
<i>Holothuria (Selenkothuria) moebii</i>		LC	Confirmed	2	Not evaluated
<i>Holothuria (Stauropora) fuscocinerea</i>		LC	Confirmed	2, 4	Low
<i>Holothuria (Theelothuria) spinifera</i>		DD	Confirmed	4	High
<i>Holothuria (Thymiosycia) impatiens</i>	Bottleneck sea cucumber	DD	Confirmed	2, 4	Low
<i>Opheodesoma</i> spp.		n/a	Possible	2	Not evaluated
<i>Pearsonothuria graeffei</i>	Blackspotted sea cucumber	LC	Confirmed	2, 4, 8	Low

<i>Polycheira rufescens</i> [recorded as <i>Chiridota rufescens</i>]		n/a	Confirmed	1, 7	Not evaluated
<i>Protankyra</i> spp.		n/a	Possible	2	Not evaluated
<i>Stichopus chloronotus</i>	Greenfish	LC	Confirmed	2, 4, 5, 6, 8	High
<i>Stichopus herrmanni</i>	Curryfish	VU	Confirmed	2, 4, 8	High
<i>Stichopus horrens</i> [recorded as <i>Stichopus variegatus</i>]	Selenka's sea cucumber	DD	Confirmed	2, 4, 5, 6, 7	High
<i>Stichopus naso</i>		LC	Confirmed	2, 4	Low
<i>Stichopus ocellatus</i>	Eye-spotted sea cucumber	DD	Possible	8	Not evaluated
<i>Stichopus vastus</i>	Curryfish	LC	Confirmed	2, 4, 8	Low
<i>Stolus buccalis</i> [recorded as <i>Thyone sacellus</i>]		n/a	Confirmed	1, 7	Not evaluated
<i>Synaptula</i> sp.	Whitefish	n/a	Confirmed	1, 2, 4	Low
<i>Thelenota ananas</i>	Prickly redfish	EN	Confirmed	4, 5, 6	Medium
<i>Thelenota anax</i>	Amberfish	DD	Confirmed	5	Not evaluated
**(Nang Mya Han, 2012)					

*Citations	
1	Duncan <i>et al.</i> , 1889a
2	Isituto Oikos, 2011
3	Khin Htwe Yee, 2007
4	Nang Mya Han, 2012
5	National Biodiversity Strategy and Action Plan, 2011
6	Yee Yee Htwe, 2009
7	World Register of Marine Species, Web page
8	This study

APPENDIX 16. ECHINODERMS OF MYANMAR (EXCEPT SEA CUCUMBERS)

Scientific Name	Common Name	Occurrence	*Citation(s)
Class Asteroidea: Sea stars			
<i>Acanthaster planci</i>	Crown-of-thorns starfish	Confirmed	4
<i>Anthenea pentagonula</i> [recorded as <i>Goniodiscus articulatus</i>]		Probable	1, 3
<i>Aquilonastra cepheus</i> [recorded as <i>Asterina cepheus</i>]		Probable	1, 3
<i>Archaster typicus</i>		Confirmed	1
<i>Astropecten andersoni</i>		Possible	1
<i>Astropecten euryacanthus</i>		Confirmed	2
<i>Astropecten hemprichi</i>		Confirmed	1
<i>Astropecten monacanthus</i> [recorded as <i>A. notograptus</i>]		Confirmed	1, 3
<i>Culcita novaeguineae</i>	Cushion star	Confirmed	3
<i>Fromia monilis</i>	Peppermint sea star	Confirmed	3
<i>Linckia guildingi</i>	Guilding's sea star	Confirmed	3
<i>Linckia laevigata</i>	Blue sea star	Confirmed	3
<i>Luidia hardwicki</i> [recorded as <i>L. forcifer</i>]		Possible	1, 3
<i>Luidia maculata</i>		Confirmed	1
<i>Nepanthia belcheri</i> [recorded as <i>N. suffarcinata</i>]		Probable	1, 3
<i>Pentaceraster gracilis</i>		Probable	2
Class Echinoidea: Sea urchins and sand dollars			
<i>Arachnoides placenta</i>		Confirmed	2
<i>Diadema savignyi</i>		Confirmed	2
<i>Diadema setosum</i>	Black longspine sea urchin	Confirmed	4
<i>Jacksonaster depressum</i> [recorded as <i>Laganum depressum</i>]		Confirmed	1, 3
<i>Salmaciella dussumieri</i>		Confirmed	1
<i>Salmacis bicolor</i>		Confirmed	1
<i>Salmacis sphaeroides</i> [recorded as <i>S. sulcata</i>]		Possible	1, 3
<i>Stomopneustes variolaris</i>		Confirmed	2
<i>Temnopleurus toreumaticus</i>		Confirmed	1

*Citations	
1	Duncan <i>et al.</i> , 1889b
2	Yee Yee Htwe, 2009
3	World Register of Marine Species, Web page
4	This study

APPENDIX 17. SEaweEDS OF MYANMAR

Scientific Name	Citations
Green Algae	
<i>Acetabularia caliculus</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Anadyomene stellata</i>	Isituto Oikos, 2011
<i>Avrainvillea</i> spp.	Mya Kyawt Wai <i>et al.</i> , 2009b; Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Avrainvillea erecta</i>	Isituto Oikos, 2011; Mya Kyawt Wai <i>et al.</i> , 2009b
<i>Avrainvillea lacerata</i>	Mya Kyawt Wai <i>et al.</i> , 2009b; Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Boergesenia forbesii</i>	Isituto Oikos, 2011
<i>Boodlea composita</i>	Isituto Oikos, 2011
<i>Caulerpa fergusonii</i>	Mya Kyawt Wai <i>et al.</i> , 2009a
<i>Caulerpa lentillifera</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Caulerpa microphysa</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Caulerpa racemosa</i>	Isituto Oikos, 2011; Moe Lwin Lwin, 2012; Mya Kyawt Wai <i>et al.</i> , 2009a and this study
<i>Caulerpa serrulata</i>	Isituto Oikos, 2011; Moe Lwin Lwin, 2012; Mya Kyawt Wai <i>et al.</i> , 2009a; This study
<i>Caulerpa sertularioides</i>	Isituto Oikos, 2011; Moe Lwin Lwin, 2012
<i>Caulerpa taxifolia</i>	Isituto Oikos, 2011
<i>Caulerpa verticillata</i>	Isituto Oikos, 2011
<i>Chaetomorpha</i> spp.	Hla Tint <i>et al.</i> , 1984; Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Chaetomorpha aerea</i>	Sein Moh Moh Khaing, 2012
<i>Chaetomorpha antennina</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Chaetomorpha gracilis</i>	Isituto Oikos, 2011; Sein Moh Moh Khaing, 2012
<i>Chaetomorpha linum</i>	Sein Moh Moh Khaing, 2012
<i>Cladophora prolifera</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Cladophora rupestris</i>	Sein Moh Moh Khaing, 2012
<i>Cladophora saracenia</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Cladophora vagabunda</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Cladophoropsis membranacea</i>	Chaw Thiri Pyay Phyto Aye, 2012; Sein Moh Moh Khaing, 2012
<i>Codium</i> spp.	Mya Kyawt Wai <i>et al.</i> , 2009c
<i>Codium adhaerens</i>	Mya Kyawt Wai <i>et al.</i> , 2009c
<i>Codium arabicum</i>	Isituto Oikos, 2011
<i>Codium edule</i>	Isituto Oikos, 2011; Mya Kyawt Wai <i>et al.</i> , 2009c
<i>Codium fragile</i>	Mya Kyawt Wai <i>et al.</i> , 2009c
<i>Dictyosphaeria cavernosa</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Dunaliella salina</i>	Tint Tun & Thi Thi Lay, 1989
<i>Halimeda discoidea</i>	Isituto Oikos, 2011; Moe Lwin Lwin, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Halimeda macroloba</i>	Isituto Oikos, 2011
<i>Halimeda opuntia</i>	Isituto Oikos, 2011; Moe Lwin Lwin, 2012
<i>Hydroclathrus clathratus</i>	Mya Kyawt Wai <i>et al.</i> , 2009a

<i>Neomeris annulata</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Rhizoclonium grande</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Rhizoclonium riparium</i>	Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Trichosolen gracilis</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Trichosolen mucronatus</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Ulva clathrata</i>	Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Ulva compressa</i>	Moe Lwin Lwin, 2012; Sein Moh Moh Khaing, 2012; Thandar, 2012
<i>Ulva flexuosa</i>	Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Ulva intestinalis</i>	Isituto Oikos, 2011; Moe Lwin Lwin, 2012; Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Ulva lactuca</i>	Sein Moh Moh Khaing, 2012
<i>Ulva linza</i>	Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009c
<i>Ulva reticulata</i>	Isituto Oikos, 2011
<i>Ulva</i> spp.	Chaw Thiri Pyay Phyoo Aye, 2012; Isituto Oikos, 2011; Moe Lwin Lwin, 2012; Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009c; Thandar, 2012
<i>Valonia</i> spp.	Chaw Thiri Pyay Phyoo Aye, 2012; Hla Tint <i>et al.</i> , 1984; Mya Kyawt Wai <i>et al.</i> , 2009a
<i>Valonia aegagropila</i>	Mya Kyawt Wai <i>et al.</i> , 2009a
<i>Valonia utricularis</i>	Chaw Thiri Pyay Phyoo Aye, 2012
Brown Algae	
<i>Canistrocarpus cervicornis</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009e
<i>Chnoospora minima</i> [recorded as <i>C. fastigiata</i>]	Soe Htun <i>et al.</i> , 2009a; World Register of Marine Species, Web page
<i>Colpomenia</i> spp.	Chaw Thiri Pyay Phyoo Aye, 2012; Khin Khin Gyi, 2010; Myint Myint Cho, 2011; Sein Moh Moh Khaing, 2012; Thin Shwe Yee Win, 2010
<i>Colpomenia sinuosa</i>	Chaw Thiri Pyay Phyoo Aye, 2012; Khin Khin Gyi, 2010; Sein Moh Moh Khaing, 2012; Thin Shwe Yee Win, 2010
<i>Dictyopteris woodwardia</i>	Soe Pa Pa Kyaw <i>et al.</i> , 2009f
<i>Dictyota adnata</i>	Ma Lei Lei Win, 1990; Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw, 2008; Soe Pa Pa Kyaw <i>et al.</i> , 2009a, b
<i>Dictyota bartayresiana</i>	Isituto Oikos, 2011; Soe Htun <i>et al.</i> , 2009a; Soe Pa Pa Kyaw, 2008
<i>Dictyota cervicornis</i>	Soe Pa Pa Kyaw, 2008; Soe Pa Pa Kyaw <i>et al.</i> , 2009e
<i>Dictyota cervicornis</i> [recorded as <i>D. indica</i>]	Soe Pa Pa Kyaw & Soe Htun, 2008; World Register of Marine Species, Web page
<i>Dictyota dichotoma</i>	Myint Myint Cho, 2011; Soe Htun <i>et al.</i> , 2009a; Soe Pa Pa Kyaw, 2008
<i>Dictyota divaricata</i>	Isituto Oikos, 2011; Soe Pa Pa Kyaw, 2008
<i>Dictyota hauckiana</i> [also recorded as <i>D. atomaria</i>]	Soe Htun <i>et al.</i> , 2009a; Soe Pa Pa Kyaw, 2008; Soe Pa Pa Kyaw & Soe Htun, 2009; World Register of Marine Species, Web page
<i>Dictyota</i> spp.	Ma Lei Lei Win, 1990; Mya Kyawt Wai, 2008; Mya Kyawt Wai & Soe Htun, 2008, 2009; Myint Myint Cho, 2011; Sein Moh Moh Khaing, 2012; Soe Htun <i>et al.</i> , 2009a; Soe Pa Pa Kyaw, 2008; Soe Pa Pa Kyaw <i>et al.</i> , 2009a, b; Soe Pa Pa Kyaw <i>et al.</i> , 2009e, f, g; Soe Pa Pa Kyaw & Soe Htun, 2008, 2009
<i>Feldmannia mitchelliae</i> [recorded as <i>Hinckesia mitchelliae</i>]	Soe Htun <i>et al.</i> , 2009a; World Register of Marine Species, Web page
<i>Lobophora variegata</i>	Isituto Oikos, 2011; Soe Htun <i>et al.</i> , 2009a
<i>Neoralfsia expansa</i>	Soe Htun <i>et al.</i> , 2009a

<i>Padina</i> spp.	Chaw Thiri Pyay Phyto Aye, 2012; Isituto Oikos, 2011; Mya Kyawt Wai, 2008; Mya Kyawt Wai & Soe Htun, 2008, 2009; Myint Myint Cho, 1980, 2011; Soe Htun <i>et al.</i> , 2009a
<i>Padina antillarum</i>	Mya Kyawt Wai, 2008; Mya Kyawt Wai & Soe Htun, 2009; Soe Htun <i>et al.</i> , 2009a
<i>Padina australis</i>	Isituto Oikos, 2011; Mya Kyawt Wai, 2008
<i>Padina boryana</i>	Chaw Thiri Pyay Phyto Aye, 2012; Mya Kyawt Wai & Soe Htun, 2008
<i>Padina japonica</i>	Mya Kyawt Wai, 2008
<i>Padina minor</i>	Isituto Oikos, 2011; Mya Kyawt Wai, 2008; Soe Htun <i>et al.</i> , 2009a
<i>Sargassum</i> spp.	Myint Myint Cho, 1980, 2011; Soe Htun <i>et al.</i> , 2009a; Soe Tun, 1984
<i>Sargassum aquifolium</i> [recorded as <i>S. crassifolium</i>]	Myint Myint Cho, 1980; World Register of Marine Species, Web page
<i>Sargassum ilicifolium</i> [recorded as <i>S. cristaefolium</i>]	Myint Myint Cho, 2011; World Register of Marine Species, Web page
<i>Sargassum polycystum</i>	Isituto Oikos, 2011; Myint Myint Cho, 1980; Soe Htun <i>et al.</i> , 2009a
<i>Sargassum stolonifolium</i>	Isituto Oikos, 2011; Soe Htun <i>et al.</i> , 2009a
<i>Sargassum swartzii</i>	Myint Myint Cho, 2011
<i>Stoechospermum polypodoides</i> [also recorded as <i>S. marginatum</i>]	Myint Myint Cho, 1980; Soe Pa Pa Kyaw <i>et al.</i> , 2009g; World Register of Marine Species, Web page
<i>Turbinaria ornata</i>	Isituto Oikos, 2011; Mya Kyawt Wai <i>et al.</i> , 2009a; Myint Myint Cho, 1980
Red Algae	
<i>Acanthophora spicifera</i>	Chaw Thiri Pyay Phyto Aye, 2012; Hla Tint <i>et al.</i> , 1984; Isituto Oikos, 2011; Myint Myint Cho & Thida Nyunt, 2009; Sein Moh Moh Khaing, 2012; Su Su Htwe, 2010; War War Shwe, 2010
<i>Acrochaetium robustum</i>	Soe Htun <i>et al.</i> , 2009d
<i>Actinotrichia fragilis</i>	Isituto Oikos, 2011
<i>Amphiroa foliacea</i>	Soe Htun <i>et al.</i> , 2009d
<i>Amphiroa fragilissima</i>	Isituto Oikos, 2011
<i>Antithamnion antillarum</i>	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Bangia atropurpurea</i> [recorded as <i>Bangiadulcis atropurpurea</i>]	Soe Htun <i>et al.</i> , 2009d; World Register of Marine Species, Web page
<i>Bostrychia calliptera</i> [recorded as <i>B. pinnata</i>]	Sein Moh Moh Khaing, 2012; World Register of Marine Species, Web page
<i>Bostrychia radicans</i>	Sein Moh Moh Khaing, 2012
<i>Bostrychia tenella</i> [also recorded as <i>B. binderi</i>]	Isituto Oikos, 2011; Sein Moh Moh Khaing, 2012; Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g; World Register of Marine Species, Web page
<i>Botryocladia botryoides</i>	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Caloglossa</i> spp.	Cho Cho Latt, 2011; Sein Moh Moh Khaing, 2012; Thandar Soe, 2012
<i>Caloglossa adhaerens</i>	Cho Cho Latt, 2011; Mya Kyawt Wai <i>et al.</i> , 2009c; Sein Moh Moh Khaing, 2012
<i>Caloglossa beccarii</i>	Cho Cho Latt, 2011; Sein Moh Moh Khaing, 2012
<i>Caloglossa continua</i>	Cho Cho Latt, 2011; Sein Moh Moh Khaing, 2012
<i>Caloglossa leprieurii</i>	Cho Cho Latt, 2011; Sein Moh Moh Khaing, 2012
<i>Caloglossa stipitata</i>	Cho Cho Latt, 2011; Sein Moh Moh Khaing, 2012
<i>Caloglossa vieillardii</i>	Sein Moh Moh Khaing, 2012

<i>Catenella</i> spp.	Aung Myint, 1980; Ma Myint Than, 1982; Myint Myint Cho & Thida Nyunt, 2009; Sein Moh Moh Khaing, 2012; Soe Htun <i>et al.</i> , 1984; Thandar, 2012; Thandar Soe, 2012; Wint Thuzar Nwe, 2010
<i>Catenella impudica</i>	Ma Myint Than, 1982; Sein Moh Moh Khaing, 2012
<i>Catenella nipae</i>	Aung Myint, 1980; Isituto Oikos, 2011; Ma Myint Than, 1982; Myint Myint Cho & Thida Nyunt, 2009; Sein Moh Moh Khaing, 2012; Soe Htun <i>et al.</i> , 1984; Thandar, 2012; Wint Thuzar Nwe, 2010
<i>Centroceras clavulatum</i>	Isituto Oikos, 2011
<i>Ceratodictyon repens</i> [recorded as <i>Gelidiopsis repens</i>]	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g; World Register of Marine Species, Web page
<i>Champia parvula</i>	Soe Htun <i>et al.</i> , 2009g
<i>Chroodactylon ornatum</i> [recorded as <i>Asterocytis ornata</i>]	Isituto Oikos, 2011; Soe Htun <i>et al.</i> , 2009d; World Register of Marine Species, Web page
<i>Crouania attenuata</i>	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Dasya flagellifera</i> [recorded as <i>D. flagelliformis</i>]	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Dichotomaria marginata</i>	Isituto Oikos, 2011
<i>Dichotomaria obtusata</i>	Isituto Oikos, 2011
<i>Dichotomaria spathulata</i> [recorded as <i>Galaxaura arborea</i>]	Su Su Htwe, 2010; World Register of Marine Species, Web page
<i>Endosiphonia horrida</i> [recorded as <i>Endosiphonia clavigera</i>]	Isituto Oikos, 2011; World Register of Marine Species, Web page
<i>Erythrocladia irregularis</i>	Soe Htun <i>et al.</i> , 2009d
<i>Erythrotrichia carnea</i>	Soe Htun <i>et al.</i> , 2009d
<i>Galaxaura filamentosa</i>	Isituto Oikos, 2011; Su Su Htwe, 2010
<i>Galaxaura rugosa</i>	Isituto Oikos, 2011
<i>Ganonema farinosum</i> [recorded as <i>Liagora farinosa</i>]	World Register of Marine Species, Web page; Yin Yin Htay, 2008
<i>Gelidiella acerosa</i>	Isituto Oikos, 2011; Su Su Htwe, 2010
<i>Gelidium arenarium</i>	Isituto Oikos, 2011; Phu Pwint Zin, 2012; Sein Moh Moh Khaing, 2012
<i>Gelidium crinale</i> var. <i>perpusillum</i>	Phu Pwint Zin, 2012; Sein Moh Moh Khaing, 2012
<i>Gelidium pusillum</i>	Soe Htun <i>et al.</i> , 2009d
<i>Gracilaria canaliculata</i>	Isituto Oikos, 2011; Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009d; Su Su Htwe, 2010
<i>Gracilaria canaliculata</i> [recorded as <i>Gracilaria crassa</i>]	Chaw Thiri Pyay Phyo Aye, 2012; Hla Tint <i>et al.</i> , 1984; Naw Le Le Hnin, 1980; Soe Pa Pa Kyaw <i>et al.</i> , 2009d; Toe Toe Aung, 1987
<i>Gracilaria edulis</i>	Hla Tint <i>et al.</i> , 1984; Mu Mu Aye, 1982; Naw Le Le Hnin, 1980; Soe Pa Pa Kyaw <i>et al.</i> , 2009d
<i>Gracilaria millardetii</i>	Soe Htun <i>et al.</i> , 2009e
<i>Gracilariopsis longissima</i> [recorded as <i>Gracilaria verrucosa</i>]	Mu Mu Aye, 1982; Sein Moh Moh Khaing, 2012; Soe Pa Pa Kyaw <i>et al.</i> , 2009d; World Register of Marine Species, Web page

<i>Grateloupia filicina</i>	Isituto Oikos, 2011; Soe Htun <i>et al.</i> , 2009d
<i>Halymenia durvillaea</i>	Mya Kyawt Wai <i>et al.</i> , 2009a; Su Su Htwe, 2010
<i>Halymenia durvillei</i>	Mya Kyawt Wai <i>et al.</i> , 2009a
<i>Herposiphonia secunda</i>	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Heterosiphonia muelleri</i> [recorded as <i>H. struthio-</i> <i>penna</i>]	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Hydrolithon farinosum</i> [reportded as <i>Fosliella</i> <i>farinosa</i>]	Soe Htun <i>et al.</i> , 2009d; World Register of Marine Species, Web page
<i>Hydrolithon reinboldii</i>	Soe Htun <i>et al.</i> , 2009d
<i>Hydropuntia edulis</i>	Mya Kyawt Wai <i>et al.</i> , 2009a; Soe Pa Pa Kyaw <i>et al.</i> , 2009d; Thandar, 2012
<i>Hydropuntia edulis</i> [recorded as <i>Gracilaria</i> <i>foliifera</i>]	Naw Le Le Hnin, 1980; Toe Toe Aung, 1987; World Register of Marine Species, Web page
<i>Hydropuntia eucheu-</i> <i>matoides</i> [recorded as <i>Gracilaria eucheumatoi-</i> <i>des</i>]	Isituto Oikos, 2011; World Register of Marine Species, Web page
<i>Hypnea boergesenii</i>	Mya Kyawt Wai <i>et al.</i> , 2009a; Naw Le Le Hnin, 1980; Su Su Htwe, 2010
<i>Hypnea japonica</i>	Mya Kyawt Wai <i>et al.</i> , 2009a
<i>Hypnea musciformis</i> <i>var. hippuroides</i> [also recorded as <i>Hypnea hip-</i> <i>purioides</i>]	Isituto Oikos, 2011; Mya Kyawt Wai <i>et al.</i> , 2009a; Naw Le Le Hnin, 1980; World Register of Marine Species, Web page
<i>Hypnea pannosa</i>	Isituto Oikos, 2011; Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Hypnea saidana</i>	Isituto Oikos, 2011
<i>Hypnea spinella</i>	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Hypnea</i> spp.	Mya Kyawt Wai <i>et al.</i> , 2009a; Myint Myint Cho & Thida Nyunt, 2009; Naw Le Le Hnin, 1980; Soe Htun <i>et al.</i> , 2009e; Su Su Htwe, 2010; Thandar, 2012
<i>Izziella orientalis</i> [also recorded as <i>Liagora</i> <i>orientalis</i>]	World Register of Marine Species, Web page; Yin Yin Htay, 2008; Yin Yin Htay & Soe Htun, 2009
<i>Jania</i> spp.	Hla Tint <i>et al.</i> , 1984; Isituto Oikos, 2011
<i>Kappaphycus alvarezii</i>	Htay Aung, 2009; Lay Min Naing, 2012; Myint Myint Cho & Thida Nyunt, 2009
<i>Laurencia</i> spp.	Chaw Thiri Pyay Phyo Aye, 2012; San Tha Tun, 1990; Sein Moh Moh Khaing, 2012; Su Su Htwe, 2010
<i>Laurencia intricata</i>	Sein Moh Moh Khaing, 2012
<i>Liagora</i> spp.	Yin Yin Htay, 2008; Yin Yin Htay & Soe Htun, 2009, 2010
<i>Liagora boergesenii</i>	Yin Yin Htay, 2008; Yin Yin Htay & Soe Htun, 2010
<i>Liagora ceranoides</i>	Yin Yin Htay & Soe Htun, 2010
<i>Lithophyllum okamurae</i>	Soe Htun <i>et al.</i> , 2009d
<i>Lophocladia lallemandii</i>	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Martensia fragilis</i>	Isituto Oikos, 2011
<i>Mesophyllum erubescens</i> [also recorded as <i>Litho-</i> <i>thamnion erubescens</i>]	Soe Htun <i>et al.</i> , 2009d; World Register of Marine Species, Web page

<i>Metagoniolithon stelliferum</i> [recorded as <i>M. stelligerum</i>]	Soe Htun <i>et al.</i> , 2009d; World Register of Marine Species, Web page
<i>Monostroma nitidum</i> [recorded as <i>Porphyra crispata</i>]	Soe Htun & Ko Zaw Zaw Pe, 1987; World Register of Marine Species, Web page
<i>Palisada intermedia</i> [recorded as <i>Chondrophyucus intermedius</i>]	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g; World Register of Marine Species, Web page
<i>Palisada perforata</i> [recorded as <i>Chondrophyucus papillosa</i>]	Mya Kyawt Wai <i>et al.</i> , 2009a; World Register of Marine Species, Web page
<i>Peyssonnelia rubra</i>	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Phyllophora</i> spp.	Isituto Oikos, 2011
<i>Plocamium cartilagineum</i>	Isituto Oikos, 2011
<i>Polysiphonia</i> spp.	Aung Myint, 1980; Isituto Oikos, 2011; Jar San, 2012; Mu Mu Aye, 1982; Sein Moh Moh Khaing, 2012; Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Polysiphonia subtilissima</i>	Isituto Oikos, 2011; Jar San, 2012; Sein Moh Moh Khaing, 2012; Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g
<i>Porphyra</i> spp.	Soe Htun & Ko Zaw Zaw Pe, 1987; Soe Htun <i>et al.</i> , 2009d
<i>Portieria hornemannii</i>	Isituto Oikos, 2011
<i>Ptilota gunneri</i> [recorded as <i>P. plumosa</i>]	Soe Htun <i>et al.</i> , 2009e; Soe Htun <i>et al.</i> , 2009g; World Register of Marine Species, Web page
<i>Pyropia suborbiculata</i> [recorded as <i>Porphyra suborbiculata</i>]	Soe Htun <i>et al.</i> , 2009d; World Register of Marine Species, Web page
<i>Rhodomenia</i> spp.	Isituto Oikos, 2011
<i>Scinaia furcellata</i>	Mya Kyawt Wai <i>et al.</i> , 2009a
<i>Stylonema cornu-cervi</i>	Soe Htun <i>et al.</i> , 2009d
<i>Titanophora</i> spp.	Mya Kyawt Wai <i>et al.</i> , 2009d
<i>Titanophora pikeana</i>	Mya Kyawt Wai <i>et al.</i> , 2009d
<i>Tolypocladia calodictyon</i>	Isituto Oikos, 2011
<i>Tolypocladia glomerulata</i>	Isituto Oikos, 2011
<i>Vanvoorstia spectabilis</i>	Isituto Oikos, 2011
<i>Yamadaella caenomyce</i> [recorded as <i>Liagora caeomyce</i>]	World Register of Marine Species, Web page; Yin Yin Htay, 2008
<i>Wrangelia hainanensis</i>	Isituto Oikos, 2011

APPENDIX 18. DIVE TOURISM SURVEY FINDINGS

Summary

- Many dive tourists entering Myanmar from Thailand are European. It is likely that there will be a growth in Asian and North American tourists in the near future.
- Tourists come to Myanmar to dive because they value the isolation (compared with other locations such as Thailand). They expect to see sharks, rays, big fish, healthy reefs and beautiful landscapes in Myanmar.
- Most of the divers surveyed were experienced divers with 77% at an advanced dive certification level or higher with 69% having already completed more than 101 dives. Their underwater observation skills were likely quite high.
- At dive sites, tourists most highly value seeing big fish, many fish and diverse systems.
- Of Marine animals, they most highly value seeing fish, especially sharks, pelagic fish and reef fish. This is in line with what they were expecting to see in Myanmar. This suggests that tourists likely specifically planned to visit Myanmar because their expectations matched with what they would value experiencing in the country.

In early 2013, sightings of sharks, rays and Marine turtles were rare. These findings are based on observations by 50 divers who conducted a total of 674 dives combined, which is roughly equivalent to 561.7 hours of in-water observations.

- Dive guides who had worked in Myanmar before (n = 11) and returning divers (n = 17) made similar observations on how things were changing in Myanmar:
 - o Populations of sharks, large fish and marine turtles are decreasing
 - o Increased observations of fishing gear at sites and rubbish
 - o Algae on the reefs is increasing
- Most tourists also noticed a number of negative human impacts: trash, blast fishing and abandoned fishing gear. They also noted other dive boats.
- Despite not seeing the sharks they were expecting and hoping to see, most tourists would still recommend Myanmar as a dive location. This is mainly to do with the underwater beauty, still healthy corals and a sense of isolation in a remote area.
- Demand for diving in Myanmar continues to grow; dive operators in Thailand are planning on expanding the number of trips to Myanmar for the 2013/2014 season. This will likely mean that their clients will see many other divers and dive boats in Myanmar and this will affect their clients' sense of isolation. Thai-based dive operators may want to consider more coordination with planning dive schedules to limit overlap and keep their clients satisfied.
- The state of Myanmar's marine resources has already started to decline in terms of their value for dive-based tourism. Efforts to protect and conserve sharks and populations of large fish will be critical for the development of a healthy dive-based tourism industry in Myanmar. And through efforts to limit trash, blast fishing and the abandonment of fishing gear, some aspects of Myanmar's special qualities for tourism (a sense of remoteness and isolation) might be maintained. Improvements in these areas will also help maintain healthy marine resources for the needs of other stakeholders beyond simply tourism.
- Tourism development plans should be made in conjunction with clear marine conservation and management goals in order to maintain health of the ecosystems while providing tourists with the experiences they value.

- Portions of the income currently generated through fees paid by tourists entering Myanmar to dive could be directed toward some targeted marine conservation efforts.

Nationalities

Most of the respondents who were interviewed were either French (23%) or German (21%). This is, in part, because most of the interviews (85%) were guests of the Smiling Seahorse and Aladdin Dive Safari companies which are owned and operated by French and German/Dutch nationals, respectively. These owners are best able to attract customers who use their same language or are of the same culture. A-One Divers, which is Thai-owned, accounted for only 15% of the respondents who were from a wide range of countries. Europeans were, by far, the dominant tourists representing a total of 77% of the tourists interviewed. North Americans accounted for 15% and Asians 8%.

Gender

The sex ratio within both the tourists and dive guides surveyed over this research were almost identical with males dominating at 73 and 71%, respectively. This is higher but still comparable to the general SCUBA diving population; across 2007 to 2012, the proportion of men earning their Diving Certification through PADI ranged from 66.0 to 67.1% (PADI, 2013).

Age

Tourists included a full range of ages with most (69%) being between 31 and 50 years old. Dive Guides tended to be slightly younger with the majority being between 31 and 40 years old.

Experience

The majority of tourists surveyed have an Advanced dive certification level or higher (77%) and have already completed more than 101 dives (69%). This illustrates that most of those surveyed were experienced divers who likely are aware and observant of marine life plus have experienced a range of dive conditions. Seventeen of the 52 surveyed (33%) had dived in Myanmar before up to four separate trips so their perceptions are of particular interest.

Unsurprisingly, all the dive guides have reached high dive certification levels since this is a requirement for their positions plus they have logged a great number of dives. This level of experience likely reflects an even greater level of observational skills of underwater conditions.

Most of the dive guides the dive guides worked in Thailand before starting to work in Myanmar. Fourteen (82%) had dived in Myanmar over previous seasons with two having worked seven dive seasons in the country and as far back as 2005.

Expectations

Before entering Myanmar, tourists were asked the open-ended question of what they were expecting to see while diving there. Fifty people responded, many with multiple answers. The majority (62%) of people were expecting to see sharks. Other high expectations were to see healthy corals and rays.

What do tourists most value at a dive site?

Tourists were asked to choose and rank the top three things they value at a dive site from a list. They had the option to add additional items but no one surveyed choice to do so. Overwhelmingly tourists said they valued

dive sites that had many fish. They next valued pelagic fish at the sites. Highly diverse sites with healthy corals are also important. They also value a variety of sites, a clean environment and good visibility. Dive guides were asked what they thought tourists most value. They correctly identified that tourists value many fish, pelagic fish and high diversity in the same order, which suggests that the tourists surveyed during this survey period are similar to those that the dive guides have guided in the past. However, overall the guides undervalued the importance of a clean environment and site variety to the tourists they guide.

What animals do tourists most value?

Tourists were also asked to choose and rank the top five organisms they value at a dive site from a list. The top four are presented here. Overwhelmingly tourists valued sharks with 87% of respondents valuing them the most. Pelagic fish were identified by 75% as the second most valued organism to see on a dive. Dive guides also expected this valuation — 100% thought sharks were the most valued and 88% identified pelagic fish as the second most valued. Tourists also valued reef fish, octopuses, rays and marine turtles highly.

What animals did divers see on their trips to Myeik Archipelago in 2013?

The 52 divers surveyed conducted a total of 701 dives over their combined trips ($n = 52$, mean = 13.5 dives/trip, $SD = 1.4$). However, two of the 52 tourist divers did not respond to questions on observed species. The remaining 50 divers who did respond conducted a total of 674 dives combined. With each dive conservatively estimated at 50 minutes long, this is equivalent to 561.7 hours of in-water observations.

Of the species of interest to divers, they all saw nudibranchs, moray eels and shrimps at some point on their dive trip. Many also reported seeing Lobsters (98%), Rays (74%) and Octopuses (46%). Many made additional comments that they saw Scorpionfish, a category that wasn't included in the original list of expected, valued target animals. We did not ask specifically about sightings of the large priority animal groupings of reef fish and pelagic fish in this question since those categories are very broad and every diver would undoubtedly see them on these trips.

Sharks

Considering that sharks were identified as an animal of primary interest to 87% of all the divers, we can be confident that they made special efforts to look out for them. However, only 16 divers (32%) saw sharks over these dives and reported seeing a total of 24 sharks. This is equivalent to seeing one shark every 28 dives or one shark every 23.4 hours that a diver is in the water ("diver-hours"). Most of the sharks seen were Nurse sharks (*Nebrius ferrugineus*, the Tawny nurse shark) (54%) and the next most common were White-tipped reef sharks (*Triaenodon obesus*) (29%).

Rays

Thirty-seven divers (74%) saw rays over these dives and reported seeing a combined total of 113 rays. This is equivalent to seeing one ray every 6 dives or one shark every 5.0 diver-hours. Many divers reported the species they saw but were not clear on the number of each. Species included the Blue-spotted Stingray (*Neotrygon kuhlii*) and Eagle rays (*Aetobatus ocellatus*). Three divers also reported seeing "Black-spotted stingrays", however there is no clear, common understanding of what species this common name refers to.

Marine turtles

Marine turtles were reported seen by 42% of 50 tourist divers over 674 dives. Two were Hawksbills (*Eretmochelys imbricata*) and 19 were Green sea turtles (*Chelonia mydas*). Twenty-one sightings by these 50 divers are equivalent to one sighting every 31 dives or 25.5 diver-hours.

Octopuses

Octopuses were reported seen by 46% of 50 tourist divers over 674 dives. This is equivalent to one animal every 13.5 dives or 11.2 diver-hours. None of the tourists identified octopuses to species.

Human Impacts

Tourists were asked what of a variety impacts they noticed during their dive trip in Myanmar. Most of the 51 people, unsurprisingly, saw fishing boats at an average of 6.9 boats over the 3-4 day trip. Of concern, though, is that 90% heard or noticed evidence of blast fishing. The tourists reported hearing the blasts underwater and would feel nervous and insecure. Also, 55% provided the additional comment that they saw abandoned fishing nets and gear. This broken and lost gear may continue to ensnare and kill fish and is often called “ghost nets” or “ghost traps”.

A majority (69%) noticed coral bleaching. Of the 35 persons that reported on coral colony bleaching numbers, it was reported that they saw, on average, 4.5 bleached colonies each over 13 to 14 dives. That rate is not alarming but additional monitoring should be considered.

Many also noticed human trash (94%) and saw other dive boats (94%) during their trip, which are both things that can impact tourist satisfaction.

Changes over time

Of the 17 dive guides who were surveyed, six did not note any changes on Myanmar reefs; three of these guides were working their first season in Myanmar so could not comment on changes.

Of the 11 guides who noted changes, they all noted that there have been decreases in sharks and large reef fish plus an increase the fishing gear and rubbish at the dive sites. Most (8 to 10) also indicated fewer marine turtles, more algae on the reef (an indicator of poor reef health) and an increase in fishing activities. Fortunately most have not observed elevated levels of coral bleaching or the presence of Crown-of-Thorns starfish (which is an invasive species that consumes coral).

At the end of the dive trip, the 17 tourists who had dived in Myanmar in previous years were asked in an open-ended question what changes they had noticed at the sites since their previous dive trips to Myanmar. Respondents were allowed to provide more than one answer. The tourists noted that there were less fish in general (41%) and less big fish such as sharks (41%) and less rays (12%) compared to previous years. There were single comments on less guitarfish and less turtles. Since divers in Myanmar most highly value seeing sharks and pelagic fish, it is not surprising that the return divers’ comments focused on those groups. No comments were given by 29%.

What has changed since you last dived in Myanmar?	#	Percentage
Less fish	7	41%
Less big fish/ Less sharks	7	41%
Less Rays	2	12%
Less guitar fish	1	6%
No turtles	1	6%
No comment given	5	29%

Would you recommend diving in Myanmar?

Of the 50 tourists who responded to the question of whether they would recommend diving in Myanmar, interviewed, 48 (96%) said they would and two (4%) said no or maybe. When asked why, many said they valued the underwater beauty and topography (65%) and the coral communities (31%). They also mentioned the landscape, that there were few other dive boats and they enjoyed their experience with the dive operator. 10% mentioned that they were concerned about the lack of fish and it impacts whether they will return.

Why would you recommend diving in Myanmar?	#	Percentage
Underwater beauty/ Underwater topography	31	65%
Nice corals	15	31%
Nice Landscape (Above water, underwater, or both)	10	21%
Few other dive boats	10	21%
Enjoyable experiences with tourist operation	5	10%
Nice diving, general	3	6%
Variety of sites	1	2%
... but not many fish left	5	10%

Dive Pressure

The dive season in this region typically runs from the beginning of November to the end of April. Over the 2012/2013 dive season, a maximum of 646 diving tourists entered Myanmar from Ranong. During other trips, the companies focused on dive sites in Thailand. Dive shop owners are reporting a rising demand from their clients for more trips to Myanmar. They are planning on increasing their trips to the country for the 2013/2014 dive season.

APPENDIX 19. STAKEHOLDER MEETING — THREATS, ISSUES, AND OPPORTUNITIES

The primary threats, issues and recommendations identified in a stakeholder meeting on 7 June, 2013.

THREATS

1. Overfishing
 - a. Illegal, Unregulated and Unreported Fishing (IUU)
 - b. Over fishing capacity
 - c. Destructive fishing
 - d. Malpractice in technology
 - e. Over investment in the fisheries sector
2. Undisciplined Tourism
3. Watershed degradation
 - a. Sedimentation
 - b. Agro toxin
 - c. Land based pollution
 - d. Waste discharge
 - e. Boat based rubbish, jetsam
4. Extraction
 - a. Sand mining
 - b. Offshore mining
5. Climate Change
 - a. Sea Level Rise
 - b. Unreliable weather
 - c. Addiction to fossil fuels
6. Environmental chain reactions

ISSUES

1. Research
 - a. Capacity
 - i. Lack of funding
 - ii. Insufficient and inadequate essential field and laboratory equipment
 - iii. Long and time consuming communication channels and logistics
 - iv. Low capacity for research, conservation and local participation
 - b. Fields of study
 - i. Insufficient and/or lack of data and information for policy makers and action plans
 - ii. Need to identify indicator species for environmental and ecological studies
 - iii. More long-term ecological studies on specific species
 - iv. Need more ecological studies
 - v. Develop monitoring programme of water quality (physiochemical parameters)
2. Policies and Laws
 - a. Enforcement and compliance
 - i. Weak in legal supports and lack of funding for enforcement
 - ii. ... leading to weak enforcement and lack of compliance with laws and regula-

- tions
- iii. Relevant laws need updating
- b. Clarification
 - i. Authority over fishing concession between the Union Government and State/Regional governments is not yet clear
 - ii. Unclear policy of resource management and development plan of Taninthayi regional government
 - iii. Need clear and thorough comprehension of relevant laws and notifications
- 3. Community
 - a. Poverty
 - b. Low awareness
 - c. Lack of alternative livelihoods
- 4. General
 - a. Weak collaboration and coordination among stakeholders

RECOMMENDATIONS

1. Overfishing
 - a. Over investment in the fisheries sector can be reduced and controlled by establishment of fishery economy structure, development of zoning and sector planning and formulation and creation of alternative investment opportunities
2. Tourism
 - a. By issuing rules and regulations, formulation and implementation of pilot project, establishment of model and demonstration site(s) to show economic development and environmental sustainability will control undisciplined tourism
3. Watershed Degradation
 - a. Develop proper waterways and watershed management by identification and control of effluent from rivers and silting from soil erosion
 - b. Identify sources and control the use of agro toxin in order to mitigate the adverse effect of land based pollution to coastal and marine environment
 - c. Identification and control of waste at the source can reduce the waste discharge from both land and boat
4. Research
 - a. Investment in research must be encouraged
 - b. Local universities and departments at three coasts should take responsibility to conduct broader and intensive research work at their respective coasts
 - c. Establish a network among researchers, universities and government agencies to raise awareness
 - d. Establish a "Marine and Coastal Resources Research Centre" with biologists and scientists from universities in order to conduct both short term and long term research activities
 - e. Upgrade human resource at universities in collaboration and cooperation with international organisations, research centres and overseas universities
 - f. Divide big projects and financial support into several phases or in order to speed up and shorten communication channels and to be able to undertake research at lower levels
5. Legal
 - a. Practice bonus and penalty system for Illegal, Unreported and Unregulated (IUU) fishing
 - b. Establish a Monitoring, Control and Surveillance (MCS) system for fisheries enforcement
 - c. Enhance law enforcement through cooperation of multi stake holders
 - d. Update relevant laws by reviewing the policy and existing laws first based on research, public participation and other prevailing factors to maintain sustainability

6. Communities
 - a. In combination with pride campaign and celebrity campaign, launch training and education programmes for awareness and sustainable use of marine living resources
 - b. Develop alternative sources of income
7. Collaborations
 - a. Promote coordination and cooperation among researchers, relevant/in line departments, agencies and stakeholders by holding occasional meetings as needed
 - b. Collaborate with international fishery organisations for both national and regional
8. General
 - a. Environmental Impact Assessments (EIA), Social Impact Assessments (SIA) and Health Impact Assessments (HIA) should be compulsory for all development projects
 - b. Rational exploitation of resources with international practices, structure and methodologies should reduce malpractice in technology
9. Climate Change
 - a. Develop translatable and quick early warning system for climate change and natural disasters
 - b. Prepare a disaster risk map to inform vulnerable areas and to develop appropriate action plans
 - c. Promote alternative sources of energy to reduce environmental degradation
 - d. Encourage wind turbine and tide turbine installations

APPENDIX 20. STAKEHOLDER MEETING — ATTENDEES

No.	Name	Designation and Organization	Opening Ceremony	Whole Workshop
Taninthayi Regional Government				
1	U Tin Soe	Minister, Forestry and Mining, Taninthayi Regional Government, Dawei	X	
WCS				
2	U Than Myint	Country Director, WCS Myanmar Program, Yangon	X	X
3	U Saw Htun	Deputy Country Director, WCS Myanmar Program, Yangon	X	X
4	U Kyaw Thinn Latt	Landscape Coordinator, WCS Myanmar Program, Yangon	X	X
5	Mr. Robert Tizard	Technical Advisor, WCS Myanmar Program, Yangon	X	X
6	Ms. Katherine Holmes	Associate Conservation Scientist, Global Marine Conservation Program, WCS Global Program, USA	X	X
MSAM				
7	U Tint Tun	Marine Science Association, Myanmar, Yangon	X	X
8	U Tint Wai	Marine Science Association, Myanmar	X	X
9	U Myo Than Naing	Marine Science Association, Myanmar	X	X
Technical				
10	U Hla Win	Deputy Director General (Retired), Department of Fisheries, Yangon	X	X
11	Dr. Swe Thwin	Professor (Retired), Yangon	X	X
Department of Fisheries, Nay Pyi Taw				
12	U Mya Than Tun	Deputy Director, Environment and Endangered Aquatic Animals Conservation Unit, DoF, Nay Pyi Taw	X	X
Department of Fisheries, Taninthayi Region				
13	U San Maung Oo	Township Fishery Officer, Department of Fisheries, Thayetchaung Township	X	X
14	U Soe Thant	Township Fishery Officer, Department of Fisheries, Launglon Township	X	X
15	U Soe Tun Naung Oo	Township Fishery Officer, Department of Fisheries, Myeik Township	X	X
16	U Thein Naing	Township Fishery Officer, Department of Fisheries, Kyunsu Township	X	X
17	U Tun Than	Township Fishery Officer, Department of Fisheries, Palaw Township	X	X
18	U Tin Maung Maung	Township Fishery Officer, Department of Fisheries, Bokebyin Township	X	X
Relevant Departments, Myeik District and Township				
19	U Min Naing	District Officer, Planning Department, Myeik District	X	X

20	U Kyaw Thu	District Officer, Irrigation Department, Myeik District	X	X
21	U Kyaw Oo	Township Officer, Water Resource Department, Myeik Township	X	X
22	U Htay Win	Township Officer, Agricultural Department, Myeik Township		
General Administration, Myeik District and Township				
23	U Lwin Ko Oo	Administrator, General Administration Department, Myeik District	X	X
24	U Thein Win	Administrator, General Administration Department, Myeik Township	X	X
Navy, Taninthayi Coast				
25	Major Htet Htet Tun	Representative, Navy, Kyunsu Township	X	X
26	Captain Win Than	Representative, Navy, Kyunsu Township	X	X
Forest Departments, Taninthayi Region				
27	U Tint Swe	Director, Forest Department, Taninthayi Region	X	X
28	U Tin Maung Lwin	Assistant Director, Forest Department, Myeik District	X	X
29	U Hla Thaug	Staff Officer, Forest Department, Myeik Township	X	X
30	U Win Tun Oo	Staff Officer, Forest Department, Kyunsu Township	X	X
Universities				
31	Dr. Thet Tun Aung	Rector, Myeik University	X	X
32	Dr. Than Tun Oo	Pro-rector, Myeik University	X	X
33	Dr. Nang Mya Han	Professor, Head of Department, Marine Science Department, Myeik University	X	X
34	Dr. Khin Khin Than	Professor, Head of Department, Chemistry Department, Myeik University	X	X
35	Dr. Naw Lar Pwe Phaw	Professor, Head of Department, Zoology Department, Myeik University	X	X
36	Dr. Sanda Hlaing	Professor, Head of Department, Botany Department, Myeik University	X	X
37	Dr. Than Htut Lwin	Professor, Head of Department, Geology Department, Myeik University	X	X
38	Dr. Nant Mu Aye	Professor, Head of Department, Geography Department, Myeik University	X	X
39	Dr. Khin Than Kywe	Professor, Head of Department, Zoology Department, Dawei University	X	X
40	Dr. Khin Maung Cho	Professor, Head of Department, Marine Science Department, Patheingyi University	X	X
41	Dr. Tint Swe	Professor, Marine Science Department, Mawlamyine University	X	X
42	Dr. San Thar Tun	Professor, Marine Science Department, Myeik University	X	X
43	Dr. Lay Wah	Professor, Botany Department, Dawei University	X	X





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