

MYANMAR OCEAN PROJECT



Abandoned, Lost or otherwise
Discarded Fishing Gear (ALDFG)
in Myanmar's Myeik Archipelago

Myanmar Ocean Project is a marine conservation organization with the mission to restore and protect the health of Myanmar's ocean. Founded in 2018, the non-profit organization is the first to plan and execute strategic survey and cleanup expeditions to understand and assess the problem of abandoned, lost or otherwise discarded fishing gear (ALDFG) in Myanmar.

For more information see: www.myanmarocean.org

The project, Developing Collaborative Solutions to the Problem of Ghost Fishing Gear in Myanmar, and this report would not have been possible without the generous financial support of National Geographic Society and World Animal Protection.

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PROJECT PARTNERS & SUPPORTERS



TABLE OF CONTENTS

05	Foreward	23	Pots
06	Acronyms used	24	Longlines
07	Acknowledgements	25	Floats and attachments
08	Key findings	26	Undefined multiple type of nets
09	Executive summary	28	Langann findings
10	Introduction	32	Lampi findings
11	Background	35	Thayawthadangyi findings
13	Results summary	37	High Rock findings
14	Locations of sites surveyed	39	List of marine species encountered entangled
15	Categories of sites surveyed	40	Synthesis
17	Description and characteristics of observed ALDFG	42	Knowledge gaps in understanding the ALDFG problem
18	Gillnets	44	Recommendations
21	Cages	47	Conclusion

FOREWORD

The ocean is one of our planet's most valuable resources. Yet, under multiple threats from climate change to unsustainable fishing, its health is deteriorating rapidly.

Abandoned, lost, or otherwise discarded fishing gear (ALDFG, or “ghost gear”) is one of the primary driving forces behind degrading marine ecosystems worldwide. Recent studies suggest that fishing gear accounts for at least 46 percent of the debris found in the North Pacific Gyre when measured by weight, and between 5 - 30 percent of some harvestable fish populations are killed by ghost gear every year.

While global demand for seafood continues to rise, ALDFG affects marine environments around the globe and depletes global fish stocks, leaving fishers with empty nets and pockets. In Myanmar, where about 40 percent of the population relies on the ocean to feed their families and make a living, protecting marine resources is critical to safeguard the future of millions of people.

Myanmar Ocean Project is undertaking fundamental work to understand the state of Myanmar's underwater world, put the issue of ALDFG on the public, industry and government agendas, and work collaboratively with fishing communities to conserve local biodiversity.

This report is the first quantitative and qualitative analysis of ALDFG in Myanmar. It sheds light on the scale of the ALDFG issue in Myanmar's pristine Myeik Archipelago, investigates potential causes/drivers of ALDFG, and recommends measures to prevent, mitigate and remediate the issue.

The Global Ghost Gear Initiative is proud to support the Myanmar Ocean Project and their work to help preserve local marine life and, by extension, peoples' health and livelihoods. Human actions are disturbing the delicate balance of marine ecosystems around the globe. It's time to reverse this trend to ensure a more verdant and prosperous future in Myanmar and everywhere.



Joel Baziuk
Deputy Director, Global Ghost Gear Initiative
National Geographic Explorer

ACRONYMS USED



ALDFG.....Abandoned, Lost or otherwise Discarded Fishing Gear
(also ghost gear or ghost nets)

DoF.....Department of Fisheries

GGGI.....Global Ghost Gear Initiative

LMMA.....Locally Managed Marine Areas

MoHT.....Ministry of Hotel and Tourism

MOP.....Myanmar Ocean Project

MPA.....Marine Protected Areas

ACKNOWLEDGEMENTS

This first-ever survey of abandoned, lost or otherwise discarded fishing gear (ALDFG) in the Myeik Archipelago in Myanmar would not have been possible without the continuous support of the Global Ghost Gear Initiative (GGGI), the National Geographic Society and the Ocean Conservancy.

Myanmar Ocean Project (MOP) would like to thank the Department of Fisheries (DoF), Fauna and Flora International-Myanmar (FFI), Istituto Oikos and the Ministry of Hotel and Tourism (MoHT). Their assistance in providing Myanmar Ocean Project's team with the necessary permits and support staff to conduct survey and retrieval work in these remote locations in the Myeik Archipelago have been invaluable.

MOP also extends its appreciation to the Kaung Pyae boat captain and crew for their enthusiasm and dedication to ensure the success of our expeditions and the safety of the dive team.

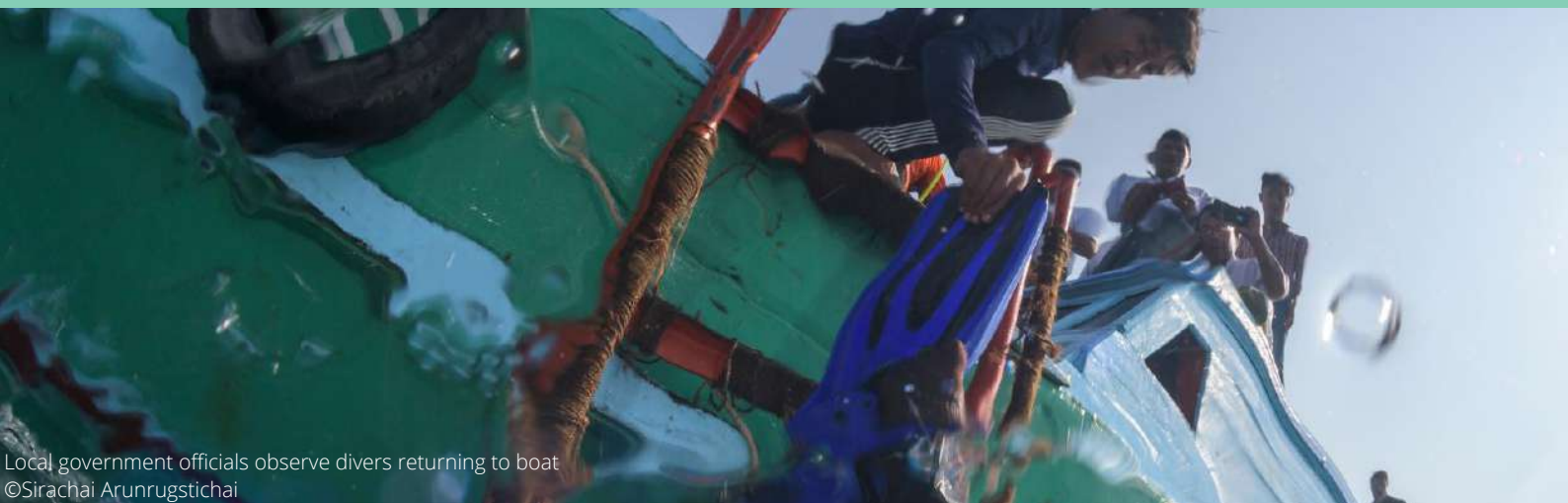
A special thank you to everyone on MOP's dive team: Benjamin Bull, Sophie Gotthardt, Mirja Neumann, Sol Milne, Nicolina Alring, Joy Rojanavongse, Kaleb Matlack, Pyae Phyo Hein, Gloria Castellano Gonzalez and Sirachai Arunrugstichai who worked tirelessly in supporting our efforts to collect the insights and data that have informed this report.

Finally, a big thank you to Tara Sayuri Whitty for her valuable edits of this report and MOP's board members, Ma Kyi Kyi Sein Thet and Ma May Su Aung, for the continuous support of all the logistical needs.



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KEY FINDINGS



- Abandoned, lost, or otherwise discarded fishing gear (ALDFG) was found to be highly prevalent across the Myeik Archipelago. 95 percent of the 87 marine sites surveyed were affected by discarded fishing gear with 31 percent of sites identified as ALDFG hotspots.
- Gillnets were the most commonly found type of discarded fishing gear. This type of net was also observed causing the majority of marine entanglements.
- ALDFG pollution visibly affects marine biodiversity in surveyed areas. Marine entanglement affected both target and non-target species, including critically endangered species like the Hawksbill turtle and animals vital for marine ecosystem health such as sharks, rays and turtles.
- Fishing gear conflict and fishing gear disposal were identified as the most common causes for ALDFG.
- ALDFG removal operations are very resource-intensive. A skilled team of divers took 43 diving days to remove 1,821.7kg of fishing nets from marine habitats across the Myeik Archipelago. While ALDFG recovery is much needed, efforts must be geared towards prevention and reduction to stop the problem of ALDFG at its source.
- The majority of fishing communities are aware of the prevalence of discarded fishing gear in Myanmar's waters but there is an urgent need to raise awareness about the negative impacts on marine ecosystem health and the potential consequences for local livelihoods.
- Strategic placement of collection points for end-of-life gear, effective marine zoning mechanisms and additional Marine Protected Areas around biodiversity hotspots could help to reduce the amount of ALDFG in Myanmar.

EXECUTIVE SUMMARY



Abandoned, lost, or otherwise discarded fishing gear (ALDFG) is a serious threat to marine ecosystems, damaging sensitive habitats and entangling animals of commercial and conservation concern. In Myanmar, fishing activities overlap with valuable but little-studied ecosystems; unfortunately, documentation of these activities and their direct and indirect impact is limited. Given the importance of healthy, biodiverse fisheries for the livelihoods of local fishing communities, food security, and potential marine ecotourism activities, Myanmar Ocean Project started to investigate the ALDFG issue in Myanmar's waters. We focused on the Myeik Archipelago in Tanintharyi Region, home to many well-known dive sites, coastal communities, a Marine Park and Locally Managed Marine Areas (LMMAs).

Over the course of our expeditions to four main survey areas, we conducted surveys at over 80 sites and interviewed a number of local stakeholders to gain a better understanding of both the problem of ALDFG and its potential solutions in Myanmar. We documented ALDFG presence at most sites, finding relatively elevated levels in the Langann LMMA area. Gillnets were the most prevalent, and evidently the most harmful; even during our relatively brief time at each site, we observed entanglements of charismatic and commercially important species by ghost gear. Most ALDFG resulted from deliberate discarding to save both space on the boat and fuel before returning to port, and from conflict with other gear types.

In total, our team retrieved 1,821kgs of ALDFG. We observed quick replacement of ALDFG in some of our previously cleaned sites, indicating that the rate of ALDFG accumulation can be rapid. This problem threatens the blossoming marine tourism industry, destroys coral reefs, and likely has negative impacts for local fisheries. Possible solutions include ALDFG-specific actions, such as exploring collection points in villages that are linked to the recycling market chain, as well as actions that would improve general marine resource management in the region.

©Sol Milne

INTRODUCTION



Surface support member retrieves ghost nets
©Sirachai Arunrugstichai

Each year, Ocean Conservancy's International Coastal Cleanup documents the most persistent and proliferating forms of ocean trash on beaches and waterways around the world. In evaluating the most common kinds of trash in the ocean, abandoned, lost, or otherwise discarded fishing gear (ALDFG) poses the greatest overall threat to all types of marine wildlife. It is estimated that at least 640,000 metric tons of fishing gear is lost or abandoned in our ocean each year. This ghost gear hurts millions of marine animals, destroys underwater habitats and catches countless fish of economic value every year. Once adrift in the ocean, ghost gear can last for hundreds of years, contributing substantially to the ocean's plastic problem.

In Myanmar, discarded commercial and artisanal fishing gear is emerging as a critical threat to coastal areas, where it impacts both ecologically and economically valuable marine resources.

Fishing is an important livelihood in Myanmar, with an estimated 43% of the population dependent to some degree on fishing or aquaculture, according to a 2014 Oxfam report, including many residents relying on subsistence fishing for food. Yet the fish catch has been declining for years, due to factors including overfishing and environmental degradation.

Lost gear threatens the integral functions of marine ecosystems and poses a very real threat to Myanmar's budding ocean-based tourism industry. It continues to catch harvestable species, thereby impacting artisanal fishers; it drowns marine mammals including endangered species like dugongs, turtles, and birds, and kills sharks, rays, and fish. Furthermore, lost fishing gear smothers seafloor and reef habitats, killing coral and altering local biodiversity.

BACKGROUND

Background on the survey methodology.

At present, quantitative data about the ghost gear problem in Myanmar does not exist. This project represents the first efforts to assess this problem in the country, which is home to important marine habitats, charismatic animals, and fisheries that could be negatively impacted by ghost gears. We worked in the Myeik Archipelago, Tanintharyi Region, where marine biodiversity has not yet been extensively studied but clearly is important for local communities, the fishing industry, and the future of eco-tourism in the region.

The aim of this report is to communicate our efforts to collect and analyze data on the quantity, type and location of ghost fishing gear and to produce evidence in the forms of images and maps on the impact ALDFG has on the local marine environment and community.

This assessment of the magnitude and characteristics of the ALDFG problem in the region will hopefully assist us in developing collaborative solutions with the stakeholders involved.

The following specific steps were undertaken to achieve this first goal of characterizing ALDFG in the Myeik Archipelago:

1a. Gathering information about ghost gear: Our team gathered anecdotal information about ghost gear from local fishermen, divers and other ocean users in and on the water to establish potential causes and hotspots for gear loss and discarding.

1b. Conducting systematic underwater surveys for ghost gear: Next, we performed dives to determine exact locations where ghost gear accumulates and assess the scope of the pollution and the types of gear. The underwater surveys allowed us to obtain hard evidence of the magnitude and types of ghost gear, including data, images and maps.

1c. Performing gear recovery operations: Our trained team of divers employed cutting instruments and float bags to safely remove and lift retrieved gear to the ocean surface. They were dried prior to packing them into bags, then each bag was weighed to measure the amount removed from each expedition location.



Crab entangled in ghost nets near Langann
©Sirachai Arunrugstichai

The second goal of the project was to engage with coastal communities and local fishermen to raise awareness of ALDFG, to understand its different causes and to develop collaborative solutions to prevent the occurrence of ghost gear in the future. The following measures were initiated:

2a. Conducting interviews with fishermen to understand different drivers of ALDFG and to develop collaborative solutions: At formal and informal meetings with local fishermen, we showed them intelligence collected during our survey operations, including photographs, videos and maps of gear and explained how lost gear has the potential to affect their livelihoods. We cultivated a two-way dialogue to understand the unique challenges, identify the main drivers of ALDFG in the area and develop locally appropriate solutions to prevent gear loss.

2b. Engaging with local communities and youth: Throughout our expeditions, we engaged with the local island communities to raise awareness of ALDFG in their area. We achieved this by sharing our experiences through photos and videos with them, by allowing community members, including Moken children, to observe our survey and clean-up dives and empowering them to be part of the solution by assisting us in the retrieval efforts both at low tide clean-ups and by helping our surface support teams.



Children from Langann assist with surface ghost net removal efforts
©Sirachai Arunrugstichai

RESULTS SUMMARY

Throughout 2019, six expeditions, over 43 diving days, were conducted. 87 sites were surveyed and 1,821.7kg of ghost fishing nets were recovered.

Expedition area	Weight of ALDFG recovered (kg)	Number of expedition days	Number of sites	Number of survey and retrieval dives
Langann	1091.3	18	36	55
Lampi	279	15	29	45
Thayawthadangyi	103.4	6	18	21
High Rock	348	4	4	14
Total	1821.7	43	87	135

Table 1. Expedition data for the four survey areas

We found ALDFG to be prevalent across the Myeik Archipelago. 95 percent of sites surveyed had some form of ghost gear present, and 31 percent of sites surveyed can be classified as hotspots. We define ghost gear hotspots as marine environments where regular intentional discarding of old nets by resting boats were recorded or where we encountered multiple layers of lost nets covering reefs, ghost fishing and posing a threat to a variety of marine life.

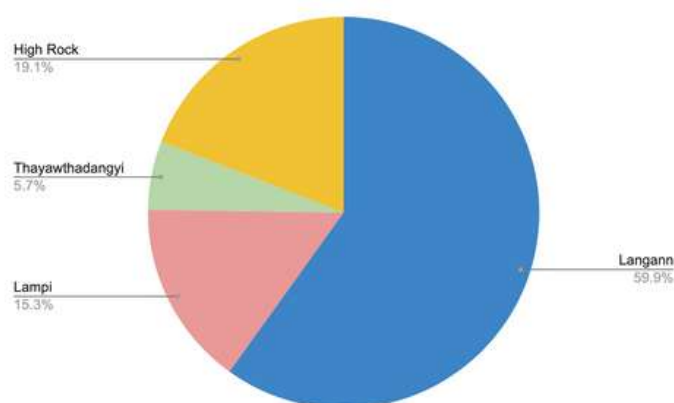


Figure 1. Percentage of weight of ALDFG retrieved from the four expedition areas

	total sites	ALDFG present	% of ALDFG presence	ALDFG hotspots	% of ALDFG hotspots	area km ²
Langann	36	36	100.00%	23	63.89%	32.1
Lampi	29	26	89.66%	2	6.90%	38.26
Thayawthadangyi	18	18	100.00%	0	0.00%	16.34
High Rock	4	3	75.00%	2	50.00%	3.04
Total sites	87	83	95.40%	27	31.03%	89.74

Table 2. ALDFG data from the four expedition areas

LOCATIONS OF SITES SURVEYED

We focused on the Myeik Archipelago due to its sensitive but important and biodiverse coral reef habitats which overlap with diverse types of fishing activities, and also because it is the primary area for developing marine tourism in the country.

The survey sites across the Myeik Archipelago were selected with a focus on three different types of areas:

1. **Dive sites:** previously frequented by divers but now abandoned due to extreme ghost net pollution. We revisited High Rock, a dive site no longer frequented by dive liveboards and two other dive sites in the area in March 2019.

2. **Marine Protected Area:** Two expeditions were conducted to Lampi National Marine Park and its surrounding areas. Lampi is the country's only marine national park, and was established in 1996. We conducted surveys in and around the park in March and December 2019.

There are five villages with Bamar, Karen and Moken people living in Lampi Marine National Park. It has among the most developed infrastructure among the island communities surveyed, with a school, a medical clinic, and a cell phone tower. There is a ranger station manned by five team members of the Forestry Department based on Bo Cho Island in Lampi.

3. **Locally Managed Marine Areas (LMMA):** Two expeditions to Langann LMMA and one expedition to Thayawthadangyi LMMA were conducted. These Locally Managed Marine Areas were established in 2017 through a participatory process with local communities. Top priorities included protecting their resources against encroachment by industrial fisheries. We surveyed across Langann LMMA over two expeditions in February and November 2019 and surveyed sites around Thayawthadangyi LMMA in October 2019.

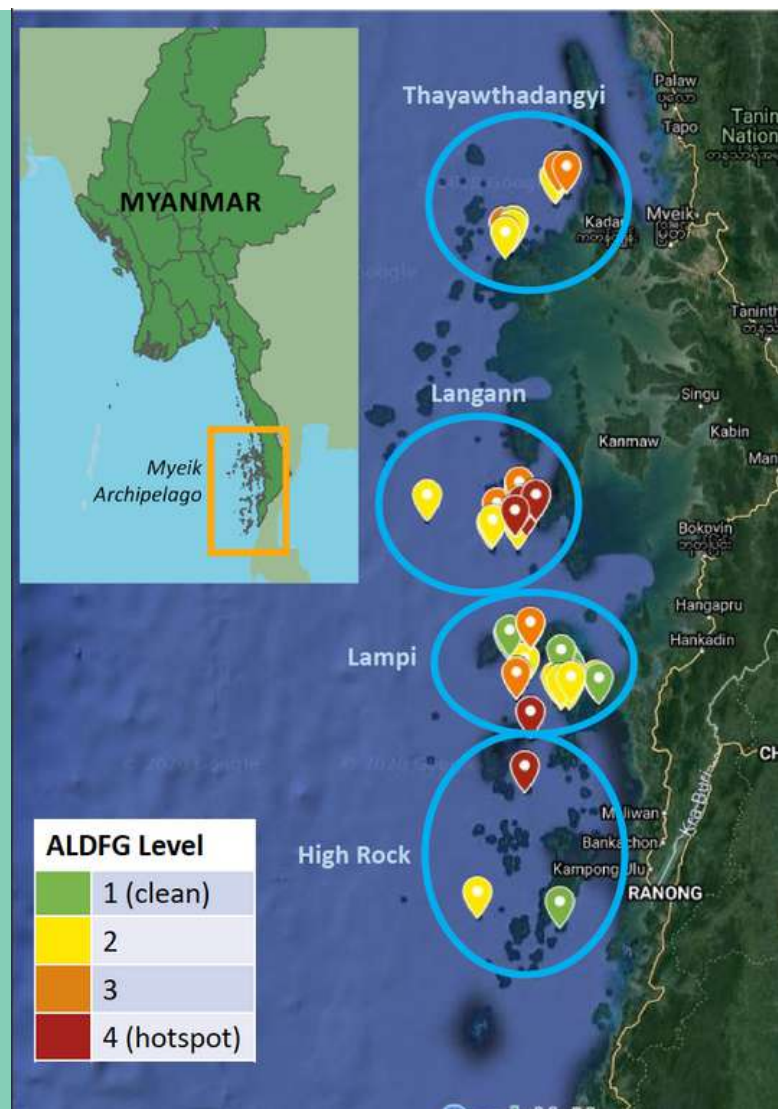


Figure 2. Map of the four expedition areas

Surveyed sites are marked on the map in colors based on their level of ALDFG pollution: Green pins for Level 1/ Clean, Yellow pins for Level 2, Orange pins for Level 3 and Red pins for Level 4/Hotspot as explained in the following section.

CATEGORIES OF SITES SURVEYED

We sorted all surveyed sites into four categories to demonstrate the amount of ALDFG pollution observed.

- Level 1 - Little or no evidence of ghost gear
- Level 2 - Old remnants of possible snagging or discarding incidents. Unlikely to cause marine entanglements. Small coverage/bundle.
- Level 3 - Old evidence of single or multiple snagging or discarding incidents with or without active ghost fishing. Large coverage.
- Level 4 (hotspot) - Recent evidence of multiple snagging or discarding incidents. Large coverage, and multiple layers. Evidence of marine entanglements.

Figure 3. Different levels of ALDFG pollution. Pictures below are examples of the amount of ghostgear observed or recovered. Photo credit: Thanda Ko Gyi (1&3) and Sirachai Arunrugstichai (2&4)



LEVEL 1/ CLEAN



LEVEL 2



LEVEL 3



LEVEL 4/ HOTSPOT

Level of ALDFG pollutants at expeditions

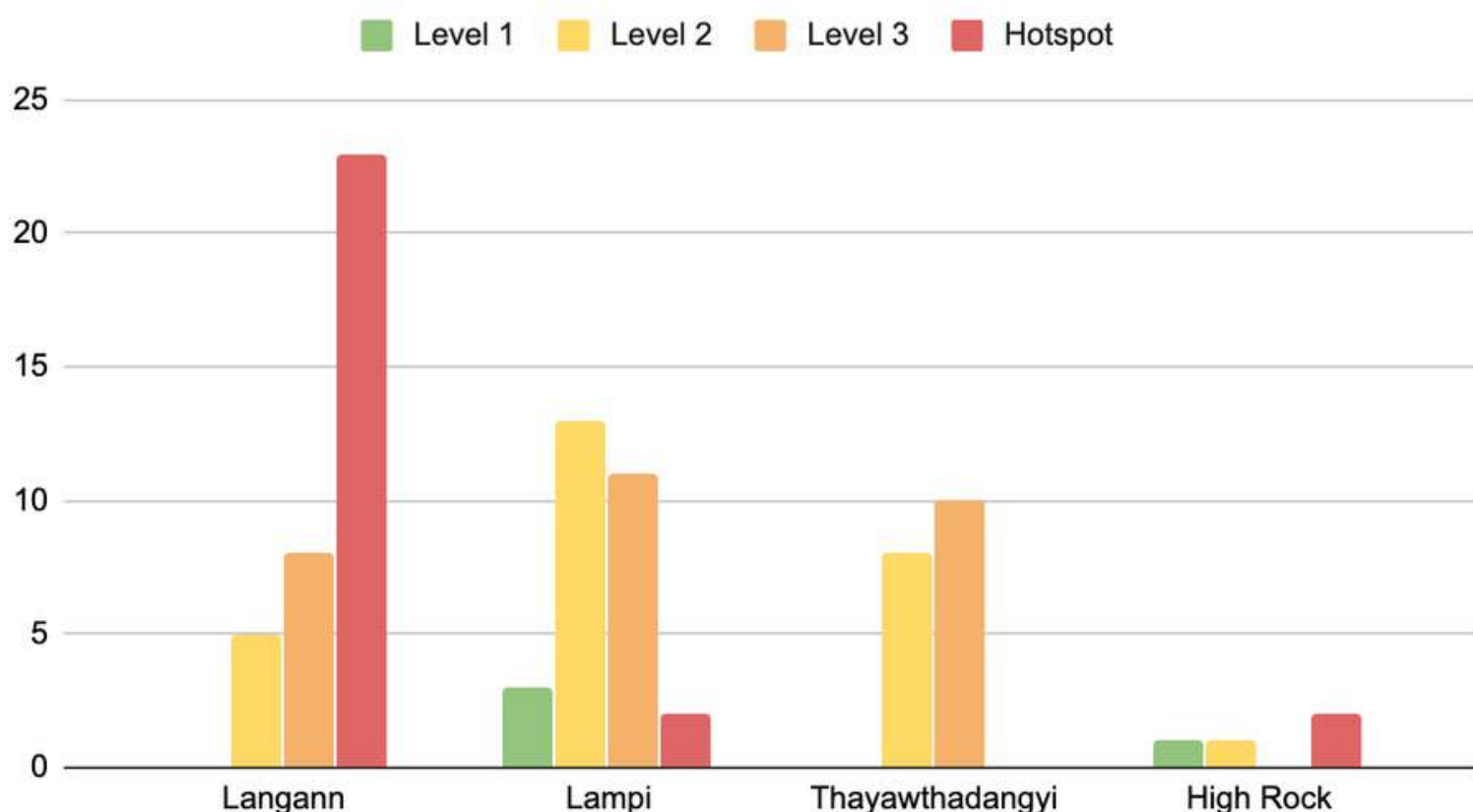


Table 3. Number of sites at each expedition area according to their ALDFG pollution level

COMPARING LMMA'S, MARINE PARK AND DIVE SITES

Our survey sites in the Langann expeditions included those within designated LMMAs as well as outside of LMMA boundaries. The majority of the sites (64%) surveyed during Langann expeditions were identified as hotspots alarmingly polluted with ALDFG, posing immense threats to marine life, coral reefs and the livelihood of the communities. While no hotspots were identified during the Thayawthadangyi LMMA expedition, every site surveyed had various types of ghost gear. There were no sites considered Level 1 (clean) within either the Langann and Thayawthadangyi LMMA survey areas.

In comparison, the Lampi Marine Park survey area revealed less-polluted sites (more Level 1 and Level 2 sites in the park). Most of the Level 3 and Level 4 sites identified were outside the designated marine park zone.

The High Rock expedition displayed how quickly underwater pinnacles in areas with high fishing boat traffic can become a Level 4/hotspot within two fishing seasons. The High Rock dive site was surveyed in April 2016 and again on our expedition in March 2019. Between these dates spanning just under three years, multiple layers of varying ghost nets accumulated, killing coral and marine life, turning a formerly vibrant dive site into a place fully covered in ghostnets.

DESCRIPTION & CHARACTERISTICS OF OBSERVED ALDFG

Based on direct observation as well as stakeholder interviews, we gathered the following observations on ALDFG in the Myeik Archipelago across our expeditions:



Divers prepare ghost net removal near Langan
©Sirachai Arunrugstichai

GILLNETS

HOW THEY ARE USED:

Monofilament nylon net comes in packages from Thailand in different mesh sizes. Before the nets can be used, they need to be prepared.

Different pieces are stitched together to a desired length, which can be up to 2 miles in length when deployed. On the top row, a rope with attached floats is used to suspend the net vertically in the water column. On the bottom row a stronger strip of net is installed with lead weights (see Figure 4).

These nets are either left in the water with marker floats or one end is attached to the boat, allowing the net and the boat to drift with the current.

Gillnets are most commonly used by artisanal fisheries in Myanmar. Small boats with a crew of three to five people fish close to the villages and perform all the labour manually. Larger boats with a crew of five to nine people who use a mechanical pull to assist with deploying and retrieving nets stay out longer during the fishing season and venture further out towards rougher seas.



Fishermen fix their gillnet at Sitat Galet
©Sirachai Arunrugstichai

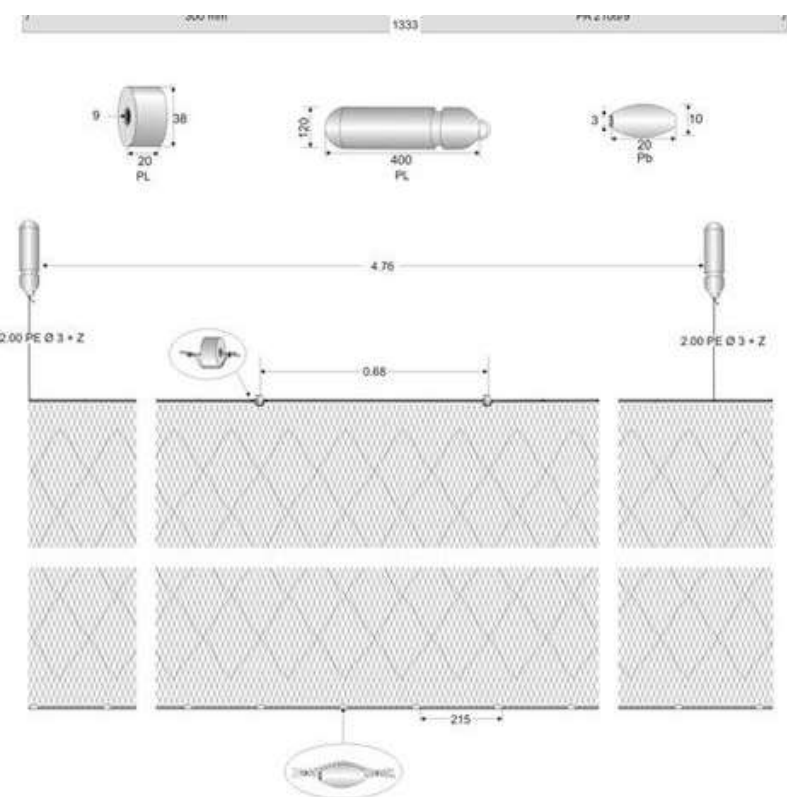


Figure 4. An illustration showing how gillnets are prepared with weights and floats. Figure from Siriraksophon et al. online (http://map.seafdec.org/Monograph/Monograph_myanmar/credit.php)

HOW THEY ARE FOUND:

Both lost and discarded gillnets are very commonly found in sites surveyed across the archipelago. They also cause the most marine entanglements. Larger mesh size nets (6 inches in diameter) designed to trap mobulas were observed causing greater harm to larger marine life - from cuttlefish to turtles to rays.

Fishermen tend to fix their nets constantly, reusing what they can. However, due to the very low price when reselling used gillnets, most fishermen do not make the effort to make room on the boat to store unusable pieces of nets to bring back to the mainland for proper disposal.



A new pack of gillnet on a boat in Lampi
©Thanda Ko Gyi



Dead fish entangled in multiple layers of ghost nets near Langann
©Sirachai Arunrugstichai



MOP team member removing marine life from retrieved ghost net
©Sirachai Arunrugstichai



Old gillnets packed and stored at a warehouse in Dawei
©Thanda Ko Gyi

GEAR LIFE CYCLE INFORMATION:

During our expeditions, we were able to sell newer recovered gillnets to the junk shops in Myeik for a small amount of money.

Price and recyclability depend on how long the nets have been in the water. If the recovered nets are in a state that can still be cleaned, they are washed and stored until they can be transported to a facility in Yangon to be melted down for packaging plastic. Any newer pieces of nets that are larger in size are sold back to smaller local fishers who will reuse them.

Recovered gillnets that have been in the ocean for more than a year with algae growth on them (the colour of the nets have turned red as seen in the picture on the top left) cannot be washed or recycled and they are taken to the landfills in Myeik, Aung Bar or Kawthaung.



Retrieved gillnets being sorted at the end of the expedition at a junk shop in Myeik
©Thanda Ko Gyi

CAGES

HOW THEY ARE USED:

Cages (around 3x2x2m) are made out of bamboo frames with metal mesh held together by metal wires. They are usually made on boats on site and dropped into the water around 30m, where lots of schooling fish aggregate. Target catch is mostly groupers and snappers.



Fishing boat making and dropping cages near Black Rock
©Thanda Ko Gyi



Fish caught in abandoned cage
©Thanda Ko Gyi

GEAR LIFE CYCLE INFORMATION:

As of today, we do not have information on how these cages are abandoned - whether they are lost or deliberately discarded - or potential incentives for fishermen to retrieve old cages.

HOW THEY ARE FOUND:

These types of cages are present at most of the known dive sites in Myanmar that are regularly visited by recreational divers, although we only visited a few such sites during the expeditions. They are usually found on sea-floors at deeper dive sites ranging from 20-30 meters in depth.

Divers encountering these cages usually undo the wires to open the cage and release the marine life. A variety of marine animals have been observed trapped or dead, including giant trevallies and a hawksbill turtle.

The cages appear to be marked with a rope and a float but most of the cages encountered sitting on the seafloor no longer have the rope or the floatation marker has been detached.

Removal of these cages has not been attempted due to their size and weight. Undoing the wires at the cage doors to keep them open seem to be sufficient to prevent further unnecessary harm to marine life. Some of the older cages have been observed collapsed and flat on the seafloor after a little over a year.



Cage found at Western Rocky sitting on coral
©Sirachai Arunrugstichai



Old pots left on empty beach near Kawthaung
©Thanda Ko Gyi



Broken pots washed up on empty beach at Myin Kwah Beach, near Dawei
©Thanda Ko Gyi

POTS

HOW THEY ARE USED:

These small cages (0.5x0.5x07.5m) have frames made of bamboo or trees found in mangroves with pieces of nets on the sides. Large repurposed plastic bottles or styrofoam serve as floats.

Pots are used by small boats to catch squid or crabs. They are usually maintained and set up on empty beaches or in villages with leaves/vegetation attached to them to act as an aggregating device.

HOW THEY ARE FOUND:

Large numbers of broken pots were commonly found washed up on beaches. On a few occasions during our Thayawthadangyi and Lampi expeditions, we encountered them smashed up and stranded in shallow water on the reef while diving.

GEAR LIFE CYCLE INFORMATION:

Since used plastic bottles, mangrove trees and bamboo as well as small pieces of nets are readily available, there seems to be very little value in maintaining or repairing pots.

LONGLINES



A longline with steel hooks still attached, removed from the reef at Black Rock
©Thanda Ko Gyi

HOW THEY ARE USED:

Longlines comprise a monofilament line with steel hooks and usually a float. At this point, it is unclear how this tool is used in Myanmar as we did not observe it above water being used by fishers. The thickness of longlines differ and they will have steel hooks attached often with wires.

HOW THEY ARE FOUND:

Longlines are mostly found entangled on reefs, uprooting soft coral and gorgonian fans. They are regularly found at dive sites and can cause harm to divers. They can be difficult to remove since the line is usually very long and the hooks can be wedged in coral and rocks.

GEAR LIFE CYCLE INFORMATION:

Not a lot of information has been collected about the possible drivers for longlines. In the future, it would be helpful to find out about the cost of the gear and possible incentives for maintaining and/or retrieving old gear.



Old float markers on an empty beach near Kawthaung
©Thanda Ko Gyi



A dead grouper entangled in gillnets with lead weights still attached
©Thanda Ko Gyi

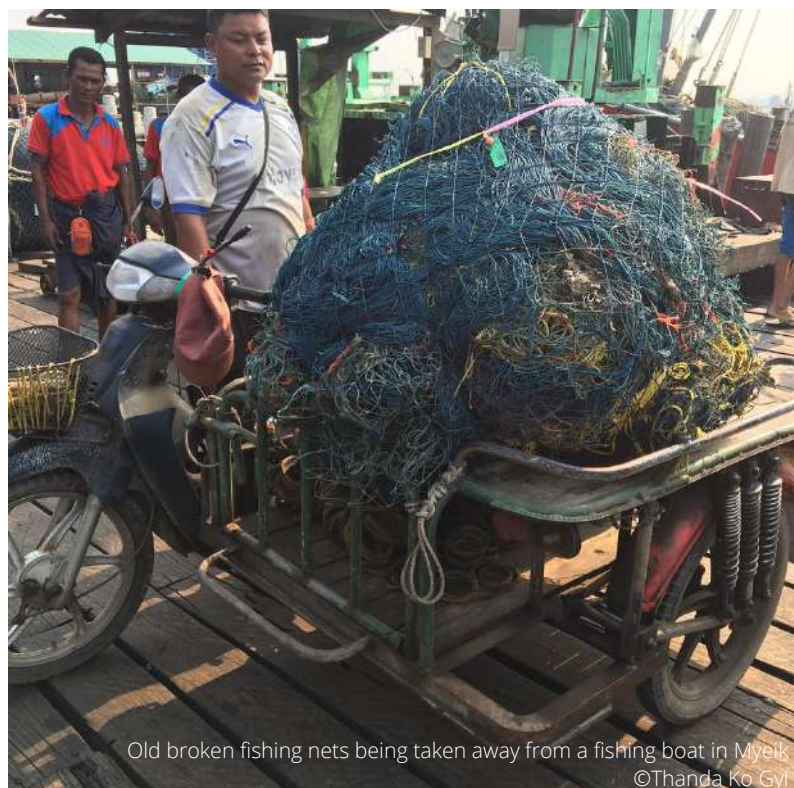
FLOATS AND ATTACHMENTS

HOW THEY ARE USED:

Both plastic floats that are normally used with fishing gear and makeshift floats, made from old plastic water bottles or pieces of styrofoam were frequently encountered. The former tends to be attached to gillnets, the latter usually marks smaller fishing gear, such as pots or longlines.

HOW THEY ARE FOUND:

Gillnets found at hotspots tend to have lead weights (see picture above on the right) and/or small plastic floats still attached, indicating that the net was lost and not intentionally discarded. The lead weights are quite expensive and villagers will remove them from the retrieved nets during our expeditions.



UNDEFINED MULTIPLE TYPE OF NETS

HOW THEY ARE USED:

Nets in this category stem from different types of fisheries including broken pieces of rope from cages and pots, different types of purse seine nets and other types of nets from small fisheries.

HOW THEY ARE FOUND:

Most of what is found in this range tends to be different types of purse seine nets that have been deployed too close to the reef, causing them to entangle. The rest tends to be a combination of ropes and small bundles of entangled old nets.

GEAR LIFE CYCLE INFORMATION:

The junk shops in Myeik sort the nets and ropes and purchase the following: ropes that can be reused, stronger nets that can be sold to small poultry farms to use as fences and pieces of nets that can be reused to patch up older nets. Other pieces are sent to the landfill. Nets with a mixture of cotton in the twine are always thrown away because they cannot be reused.

FINDINGS BY EXPEDITION AREA



Diver removes entangled fish from ghost nets near Langann
©Sirachai Arunrugstichai

LANGANN FINDINGS

The two villages in Langann have a combined population of less than 500 people across 92 households. The villages are populated by both Moken and Bamar people. The Moken are all fishers while the Bamar population works in additional trades, such as wholesale buying of seafood from artisanal fishers working in the region and selling supplies like water and rice to fishermen. As a result, the island is a busy area with a steady stream of boats in the bay and fishermen frequenting the village shops.

Solid Waste Management Context:

Both of the villages on Langann island have no waste management system in place. Rubbish is either burnt under or near homes or collected to be dumped further out at sea (“to avoid the rubbish coming back to the village’s beaches”). The amount of plastic waste on the beaches in front of both villages grew noticeably worse between our two visits which were eight months apart, with more boats using the once quieter Moken beach.

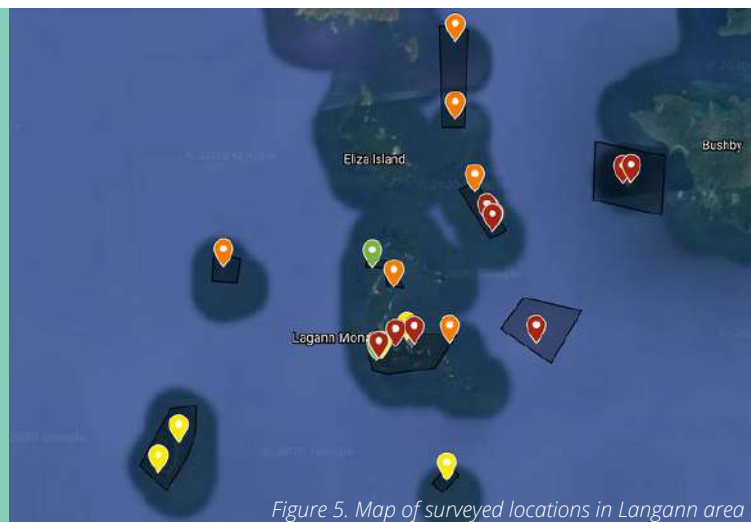


Figure 5. Map of surveyed locations in Langann area



Empty beach next to Langann village ©Thanda Ko Gyi



Langann village jetty ©Thanda Ko Gyi



Healthy reef near Langann
©Sirachai Arunrugstichai

SURVEY FINDINGS

An estimated 50 fishing boats use the bay throughout the day. The majority of them are small-scale fishers using gillnets and squid boats.

Surveys at the bays in front of the villages revealed a diversity of coral but also showed that both areas are used as a dumping site by resting fishermen while they take shelter and resupply.

The areas outside of Langann LMMA are abundant with marine life and are often targeted by shark and ray fisheries. It is an area that is used by small and medium-sized fisheries.

There are regulations in place, such as keeping a certain distance from the islands when fishing and restricted areas for baby trawlers. However, enforcement of these regulations by authorities was not observed.

The isolation of the region and the lack of phone connectivity hinder the efforts of locals to raise concerns about illegal fishing activities and enforcing LMMA zoning.



Eagle ray entangled in ghost nets near Langann
©Sirachai Arunrugstichai



Diver rescues juvenile turtle entangled in ghost nets near Langann
©Sirachai Arunrugstichai



Purse seine boats working through the night near Langann village
©Thanda Ko Gyi

Initial interviews conducted with gillnet fishermen in Langann suggest the following causes for ALDFG:

DISCARDING

Every fisherman interviewed admitted to discarding unusable nets into the water while the boat was taking shelter (in and outside the village bay). The fishermen were asked if they would come into the village or the jetty area to dispose of their nets at a collection point if there was an option, but most of them were not interested in the idea of putting aside time and effort to drop off old nets.

LOSS DUE TO WEATHER

Gear loss due to weather conditions was not very commonly reported in the interviews. The only incident shared during the interviews was loss of nets due to accidental snagging on a pinnacle while fishing too close to it during rough seas. The particular fisherman being interviewed has been working in the area for over 15 years and knows the reefs in the area well. He explained that he took the risk of losing his gear by getting too close to the pinnacle due to “lack of fish in the other areas” and possibly too much competition with other boats.

LOSS DUE TO GEAR CONFLICT

All of the interviewees highlighted gear conflict as the main reason for losing their gear. The areas around Langann are busy with boat traffic throughout day and night, with different kinds of fishing boats conducting a wide array of activities including fishing, taking shelter, getting supplies and transferring catch to mother-boats, particularly for purse seine boats and trawlers. The likelihood of gear conflict between illegal baby trawlers and gillnet fishing boats is high as evident in the number of ALDFG hotspots identified around Langann LMMA.

Langann Gear Type

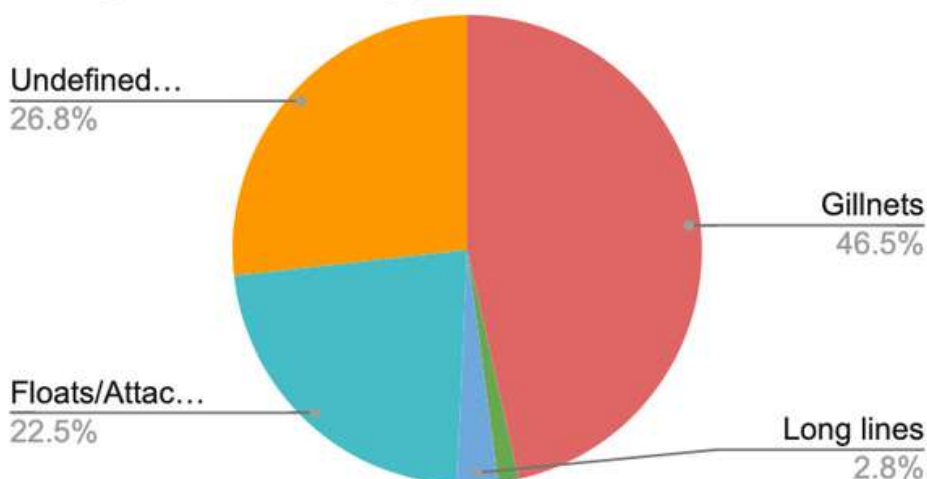


Figure 6. Percentage of different types of ALDFG found in Langann area

In total during the two expeditions, 36 sites were surveyed over 18 days and 55 dives. A combined weight of 1,091 kg of ghost nets were removed over the course of the two expeditions.

The majority of ALDFG retrieved from inside the LMMA (where nets are being discarded) and outside the LMMA (where nets are being lost) were gillnet. Compared to the other expedition areas, marine entanglements were observed most frequently in Langann. It was concluded that the majority of large pieces of gillnets found underwater with lead weights still attached were lost unintentionally.

In spite of the damages and excessive unregulated fishing activities in Langann, the health and biodiversity of coral reefs is still very impressive and marine life abundant.



Children from Langann assisting with ghost net removal
©Sirachai Arunrugstichai

LAMPI FINDINGS

The Moken around Lampi National Marine Park fish for squid, while a lot of the Karen and Bamar use pots and small gillnets or compressor dive for lobsters and reef fish. There are also a lot of Bamar traders working with the fishermen in the area.

Although there was ALDFG present in sites across Lampi MPA, no problem areas were identified within the park. The most Level 1/clean sites with healthy hard coral and an abundance of marine life were encountered during the Lampi expeditions compared to other expedition areas. ALDFG retrieved within the park mostly consisted of old, bundled remains. This finding suggests that there are less fishing activities conducted near-shore in Lampi waters. Occasionally, illegal baby trawlers operating near the park were observed but since there is access to communication, these incidents are recorded and reported.

The presence of multiple resort islands close to Lampi also means there is a higher likelihood of illegal fishing being observed and more incentives to regulate the area. The identified hotspots are located outside of the marine park with frequent snagging incidents.

Figure 7. Map of surveyed locations in Lampi area



Healthy reef at Lampi
©Sirachai Arunrugstichai



Fisherman at Sitat Galet being interviewed
©Sirachai Arunrugstichai



Sitat Galet Village ©Sol Milne

Initial interviews were conducted at Sitat Galet, a village at the northern end of the park that is frequented by many different kinds of fishing boats taking shelter from the open sea. Most of the interviewees were gillnet users.

DISCARDING

Though no retrieval dives were conducted at this site, interviews and footage from a Remotely Operated Vehicle (ROV) confirm that fishermen discard gillnets around Sitat Galet village. The resting fishing boats are concentrated in a small area around the village and seem to have a good working relationship with the mechanic at Sitat Galet. Given the large number of boats frequenting the bay (up to 80 on busy days), these findings suggest setting up a collection point for nets at this village may be feasible.

No one interviewed at Sitat Galet has lost gear due to weather conditions.

LOSS DUE TO GEAR CONFLICT

All the boat captains interviewed in this location have lost their nets due to gear conflict. At the time of the interview (December 2019), one of the boat captains admitted to having experienced three separate incidents during the current season, averaging an incident every five weeks. Because of the high frequency of these incidents, the boat captain explained how they have learned to adapt their fishing behaviour. For example, stitching older nets at the ends where they tend to lose the net from or having someone looking out for trawlers and other boat traffic after net deployment, instead of resting and sleeping. This is so that they can either radio the trawler or have the time to change their own path.

Lampi Gear Type

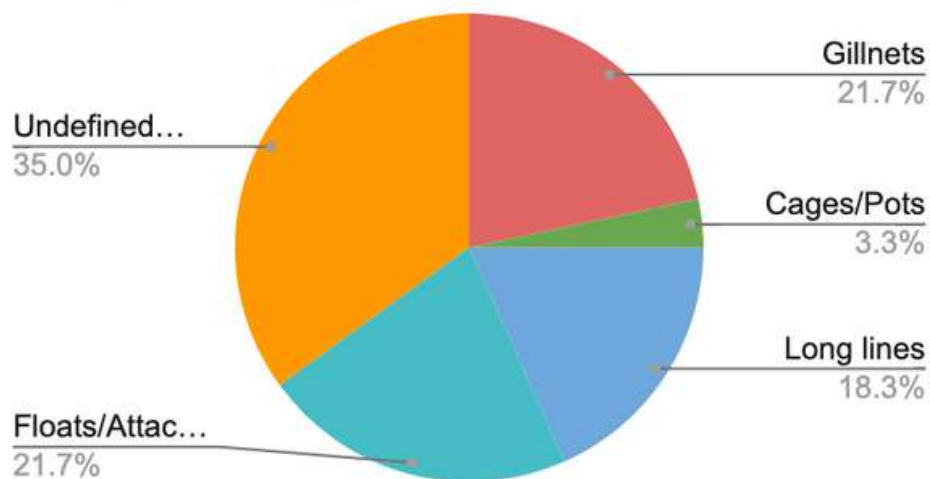


Figure 8. Percentage of different types of ALDFG found in Lampi area

In total during the two expeditions, 29 sites were surveyed over 13 days and 45 dives.

A combined weight of 279 kg of ghost nets were removed over the course of the two expeditions.



Diver detangles old bundle of fishing net from coral.
©Sirachai Arunrugstichai

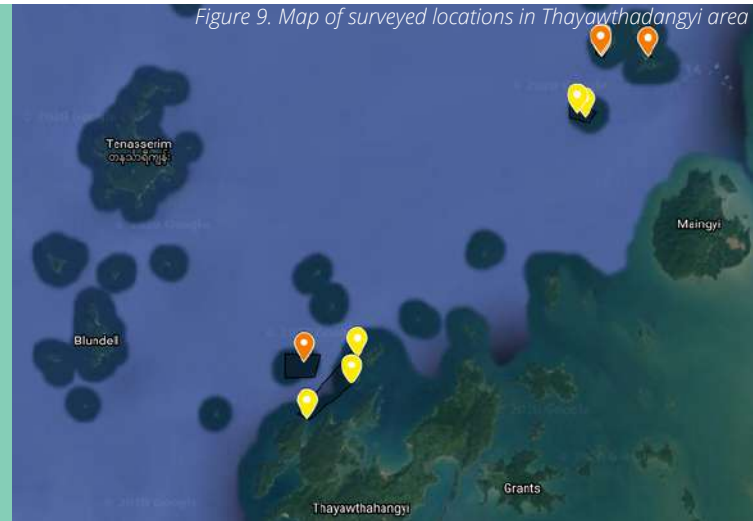
THAYAWTHADANGYI FINDINGS

Thayawthadangyi LMMA has three main villages: Don Pale, LingLong and Palarwah. LingLong village has farms, schools and churches. Palarwah is the smallest out of the three villages with a mostly Moken population. Don Pale was not visited but has the largest population out of the three with infrastructure in place.

More exploration around these islands is required. The diverse types of ALDFG retrieved from this region suggests there are various types of small-scale fisheries around the villages surveyed. A significant amount of rope was retrieved compared to other locations.

There were no obvious problem areas or hotspots. This was the only expedition where we encountered and retrieved ghost gear bundled with other types of plastic debris floating on the surface. This may be due to the timing of our expedition to this area after the end of monsoon. A lot of the observed damage caused to the marine environment in the LMMA zone stemmed from a large number of landslides causing mud and trees to cover and kill corals.

Figure 9. Map of surveyed locations in Thayawthadangyi area



Thayawthadangyi Gear Type

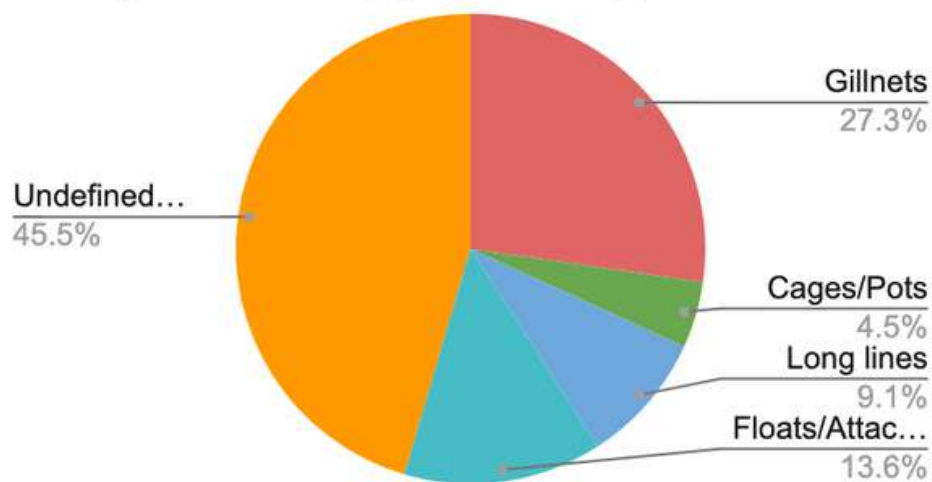


Figure 10. Percentage of different types of ALDFG found in Thayawthadangyi area

Over the six days of our expedition, 21 dives were conducted at 18 sites inside and around the designated LMMA and 103 kg of ALDFG removed.

No interviews were conducted with fishermen on this expedition.



Wrasse in ghostnet near Thayawthadangyi ©Thanda Ko Gyi

HIGH ROCK FINDINGS

Due to its proximity to Kawthaung (the border port next to Thailand) and its diverse marine life, High Rock used to be a very popular dive site with liveaboards visiting Myanmar. It is a small rocky outcrop with submerged pinnacles next to it. The surrounding sandy sea floor reaches 30 meters in depth.

One big piece of gillnet and some longlines with hooks were recorded when it was visited in April 2016. The net was an unattractive sight for the visitors and the rampant long lines with their steel hooks and fish lures were causing harm to the divers.

The liveaboards stopped visiting this site at the end of the 2016/2017 season due to the drastic accumulation of ghostnets.

When we surveyed the site in March 2019, it was covered in multiple layers of different kinds of nets both on the pinnacles and on the seafloor. The amount of nets accumulated in a little over two years was astounding.

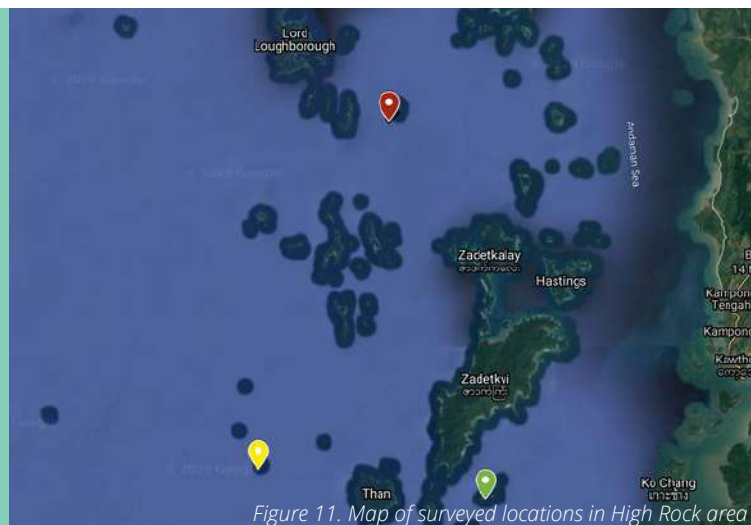
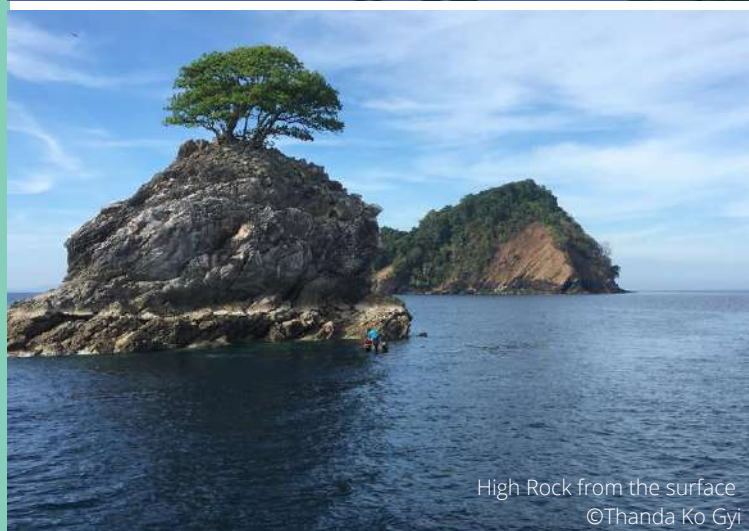


Figure 11. Map of surveyed locations in High Rock area



High Rock from the surface
©Thanda Ko Gyi



High Rock below the surface
©Thanda Ko Gyi

High Rock Gear Type

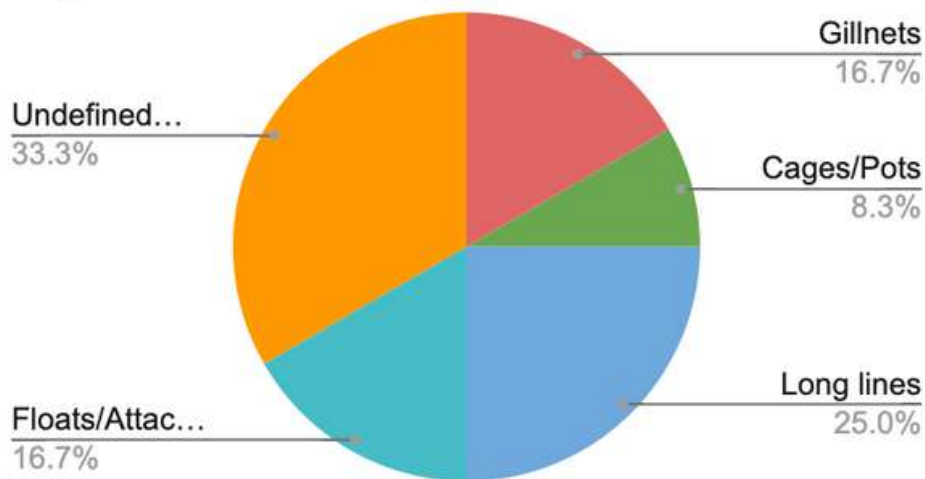
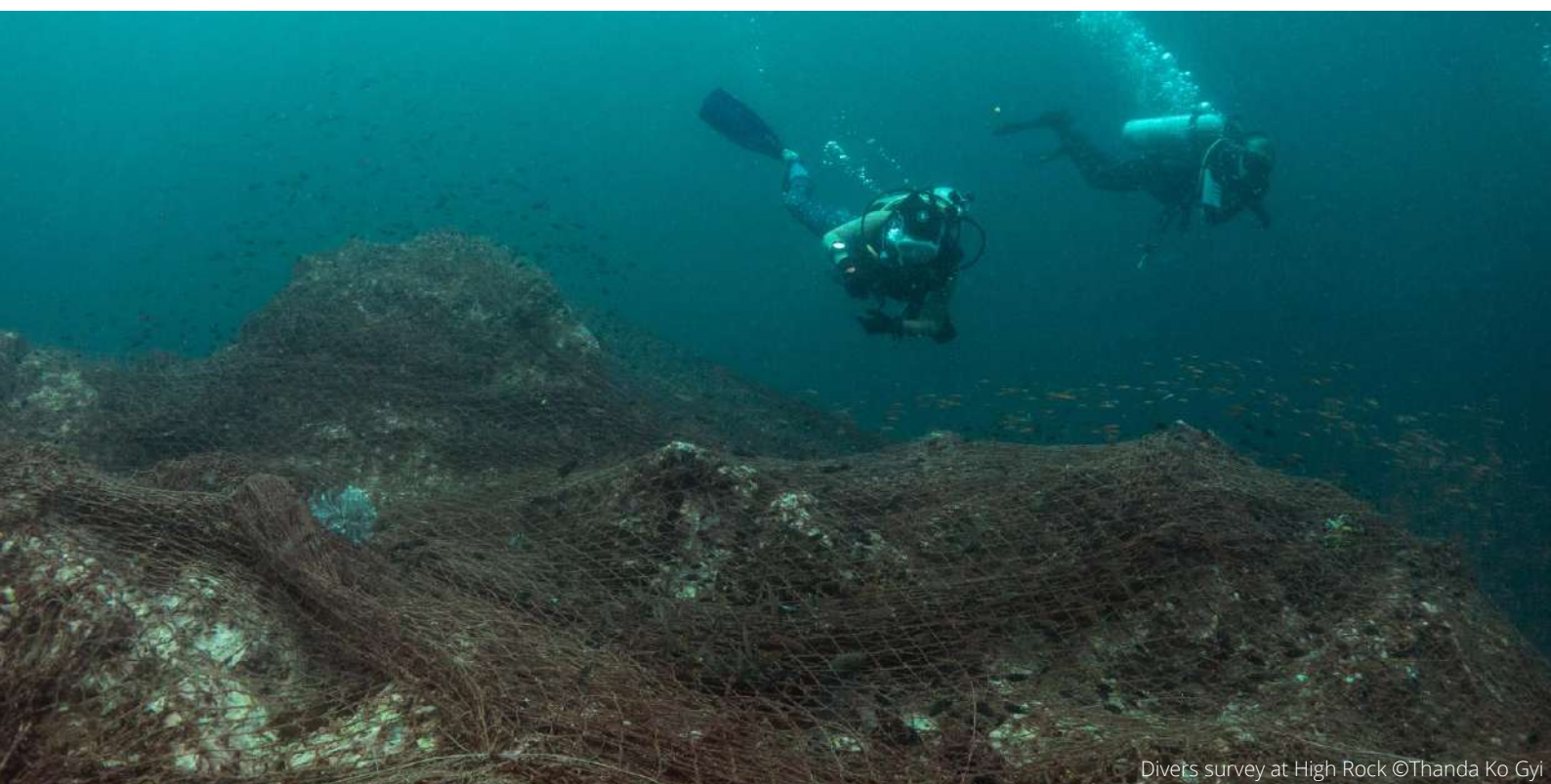


Figure 12. Percentage of different types of ALDFG found in High Rock area

In total 12 survey and removal dives were conducted at High Rock with additional surveys at two other dive sites over four days. Gear removal was conducted only at High Rock resulting in 348 kg of ALDFG retrieved.

No interviews were conducted due to lack of access to resting boats. It is very likely the causes for the ghost gear accumulation are both from fishing too close to the pinnacle and loss due to gear conflict nearby before the nets drifted to this pinnacle in the current.



Divers survey at High Rock ©Thanda Ko Gyi

LIST OF MARINE SPECIES ENCOUNTERED ENTANGLED

Even though our surveys represent only a snapshot in time of these sites, we unfortunately still witnessed several species caught in ALDFGs, including species of conservation concern:

Common name	Scientific name
Hawksbill turtle	<i>Eretmochelys imbricata</i>
Blue-ringed angelfish	<i>Pomacanthus annularis</i>
Whitespotted rabbitfish	<i>Siganus canaliculatus</i>
Java rabbitfish	<i>Siganus javus</i>
Bigeye snapper	<i>Lutjanus lutjanus</i>
Brown-striped red snapper	<i>Lutjanus vitta</i>
Yellowtail false fusilier	<i>Paracaesio xanthura</i>
Herring scad	<i>Alepes vari</i>
Giant trevally	<i>Caranx ignobilis</i>
Bigeye trevally	<i>Caranx sexfasciatus</i>
Talang queenfish	<i>Scomberoides commersonianus</i>
Pickhandle barracuda	<i>Sphyræna jello</i>
Yellow-back fusilier	<i>Caesio xanthonota</i>
Bluespotted grouper	<i>Cephalopholis argus</i>
Chocolate grouper	<i>Cephalopholis boenak</i>
Bluelined grouper	<i>Cephalopholis formosa</i>
Coral hind	<i>Cephalopholis miniata</i>
Honeycomb rock cod	<i>Epinephelus merra</i>
Thicklip wrasse	<i>Hemigymnus melapterus</i>
Blotcheye soldierfish	<i>Myripristis berndti</i>
Reef lizardfish	<i>Synodus variegatus</i>
Tasseled scorpionfish	<i>Scorpaenopsis oxycephala</i>
Titan trigger fish	<i>Balistoides viridescens</i>
Black-blotched porcupinefish	<i>Diodon liturosus</i>
Bamboo shark	<i>Chiloscyllium punctatum</i>
Whale shark	<i>Rhincodon typus</i>
Ocellated eagle ray	<i>Aetobatus ocellatus</i>
Oceanic manta ray	<i>Mobula birostris</i>
Painted spiny lobster	<i>Panulirus versicolor</i>
Cuttlefish	<i>Sepia spp.</i>

Table 4. List of species observed entangled in ALDFG in Myanmar

SYNTHESIS

Drivers of ALDFG and possible solutions to explore

Based on our initial interviews with fishermen, we found that most fishers and community members are aware of the problem and they are welcoming of and open to suggestions to work together to remedy it. Information from the interviews across all sites suggests the main behaviours leading to ALDFG in the survey areas were discarding of gear and loss due to gear conflicts.

To address the disposal of fishing gear, alternatives must be developed with incentives for behaviour change. Reasons for discarding gear includes limited storage space on boats for old nets. Because this is a deliberate action, fishers can provide information on discard locations, allowing for targeted clean-up operations. However, since such operations are costly and fouled nets have lower potential for sale in the recycling chain, it would be better to prevent disposal in the first place.

Possible solutions include end-of-life gear collection points at villages. This would require the following;

1. A good relationship between the village and the fishing boats.
2. Incentives to return the nets, at a village instead of in the water. For example, sheltered areas around Langann village where boats rest are spread out and fishermen not visiting the village don't see a reason for visiting the village just to drop off the nets. In contrast, the resting area around Sitat Galet village is smaller and more concentrated. Thus, there is more interaction with the village, making it easier to incentivise visits to the village for drop-offs.
3. Storage areas in villages for broken nets that have been collected.

End-of-life gear could also be collected by wholesale or market boats. This idea was very well received by the fishermen when it was discussed as a possible solution. While a collection point at Sitat Galet village might work, for Langann village, wholesale boats present a better alternative as fishermen seem to have a better relationship and more interaction with these boats. The opportunity of working with wholesale boats interacting with resting boats while selling rice, water, or nets should be explored to use them to collect and transport end-of-life gear.

In terms of loss from gear conflict, small-scale fishers usually try to retrieve the nets to prevent economic losses. Fishermen seem to lose a lot of money on nets as gear conflict events seem to occur regularly. However, sites where lost gear accumulates might be difficult to identify and access. Limiting their financial loss might be one avenue for encouraging use of gear loss reporting methods by local fishermen if there are retrieval teams or ways to retrieve the lost gear.

This should be addressed at fishing gear workshops both run by companies that own trawlers and at workshops run by regional DoF offices for small-scale fishermen. There should be increased awareness of the consequences of such incidents at all the different fisheries and support and collaboration from stakeholders to avoid such incidents where enforcement of zoning is not possible. There should be support and procedures on how to proceed once these incidents occur.

Most importantly, a lot of these incidents can be avoided by enforcing clear regulation.

Rather than introducing blanket bans, more detailed research into how different fishing activities could be zoned would be beneficial around the Myeik Archipelago. One of the fishermen interviewed mentioned Thailand as an example of proper separation of zones for different types of fisheries, as well as enforcement, thus avoiding gear loss from conflict.

The results are apparent when you compare Langann and Lampi for ALDFG from gear conflicts. Even with minimal enforcement, illegal fishing behaviour is deterred around Lampi through local activists bringing attention to these activities. The obvious disregard of regulations by all types of fisheries and isolation of the area around Langann showed a very different state of the ocean.

It should also be noted that areas around Langann are not just isolated due to location, lack of communication and enforcing bodies, but also a lack of marine tourism activities.



Fisherman being interviewed near Sitat Galet
©Sirachai Arunrugstichai

KNOWLEDGE GAPS IN UNDERSTANDING THE ALDFG PROBLEM



Survey dive near Langann
©Sirachai Arunrugstichai

Our expeditions thus far have yielded important baseline information on the ALDFG problem in one of Myanmar's pristine marine regions. Continued work on this problem could help to clearly identify and understand drivers of ALDFG, impacts of ALDFG as well as possible intervention points for reducing ALDFG.

Critical knowledge gaps include:

Management

- Study of existing regulations and legislation bodies for fisheries to understand what laws can be created and/or applied to reduce ALDFG.
- Better understanding and management of effective zoning needs for different types of fishing boats and methods.
- Understanding introduction workshops fishermen receive from the DoF or internally by their own companies when they start working to assess how ALDFG issues are being addressed by the different stakeholders.

Ecosystems and impacts

- Research is needed to identify more areas of biodiversity importance. There seems to be a significant knowledge gap leading to ineffective zoning. Where are the pupping grounds for hammerhead sharks? Where are the mantas courting and cleaning? Where are the mobulas feeding? Have all the turtle nesting beaches been identified and protected?
- Perceived impacts on fisheries from ghost fishing
- Estimated loss of potential tourism dollars due to ALDFG fouling of dive sites

Drivers

- A comprehensive understanding of fishing boats' movements and crew behaviours and motives in locations surrounding identified hotspots.
- Better understanding of the community's attitude to waste in general, focusing on island coastal communities and fishing crew.

Keeping old gear out of the ocean

- Detailed research on local informal net recycling and repairing at processing jetties and junk yards, including price structure and acceptable material types.
- How can the existing informal recycling at junkyards be scaled up or supported or replicated?
- Fisheries specific plan of action. What roles can the big companies with lots of boats play as opposed to small scale fisheries in reducing ALDFG and collection?

Further documentation of ALDFG extent, magnitude, and characteristics

- Similar surveys in other coastal regions in Myanmar to compare ALDFG problems across different regions and how they might be addressed.
- Additional interviews and surveys to understand ALDFG from fisheries not using gillnets. Our findings and understanding so far has been around gillnet fisheries. It should still be explored to determine if the reduced sightings of ALDFG from other fisheries is from the lack of it or the location of our surveys.
- During our expeditions, we only came across one floating bundle of ALDFG. Interviews and discussions with fishermen should also include sightings of floating ghost gear to understand how they behave. This knowledge should also assist with surveys of ALDFG washing up on coastal areas for a more holistic understanding of the ghost gear problem in Myanmar oceans.

RECOMMENDATIONS

Reduction/Prevention

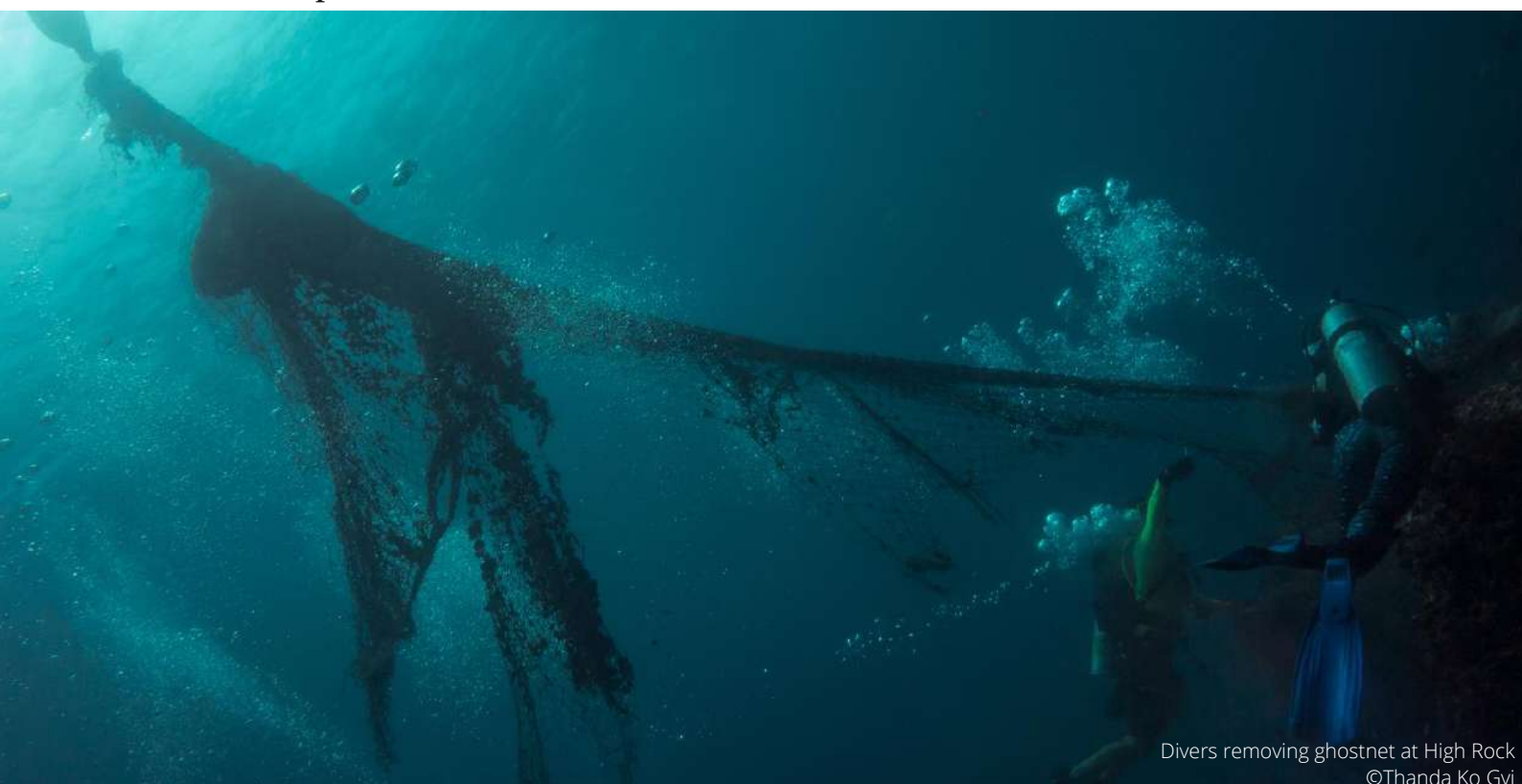
- Better management and implementation of zoning of the archipelago for use by different stakeholders.
- Implementation of a system across the archipelago where illegal fishing activities by all kinds of fisheries can be reported and/or recorded, along with publicised clear follow-up enforcement action and consequences.
- Awareness workshops about the causes and effects of ALDFG to be part of existing workshops conducted by DoF and/or fisheries associations, with an emphasis on loss of income from marine biodiversity degradation.
- Waste separation awareness workshops for fisheries. There seems to be some regulation around “no littering” in the ocean since all the large fishing boats visited had said sign attached to the boat by DoF. They are also required to present a bag or two full of rubbish when being inspected upon returning to land. However it is doubtful the crew can bring back all their rubbish after being out at sea for many weeks, even when proper inspection is conducted. Fishing boats, whether small or large, are packed with fishermen with very little space left for anything else. Some boats house up to around 70 crew members and stay out at sea for a few weeks at a time. All of their food waste, along with nets, have been observed being discarded into the ocean. It would make more sense for them to understand that there are biodegradable rubbish, like food scraps, and non-biodegradables that do not belong in the ocean, such as bottles, plastic packaging, ropes and nets. The rubbish bag they should be showing at inspection (however unrealistic) should be all non-biodegradable materials. This waste separation awareness workshop should be conducted not just with the fishermen but also with the island and coastal communities that are interacting everyday with the fisheries.
- Public awareness! Myanmar needs a lot of catching up on awareness and education around marine conservation. People need to learn not only about ALDFG but that it is possible to overexploit the ocean (e.g. not all marine animals have the same conservation status, and there is real risk that some might disappear in the next decade). This need for awareness should apply to not just the general public but also at governmental institutions.

Recycling/Mitigation

- For hotspots caused by discarding near villages: To identify suitable villages to install strategic collection points. A collection point should be trialled where there is support available at the village in terms of staff or volunteers and space. Depending on how successful the incentives are for the returns and the amount of nets that can be collected, an assessment can be made to determine whether recycling on the mainland is financially feasible or if the village is best suited with an incinerator frame similar to the ones being trialled in other remote villages with sensitive biodiversity.
- For hotspots caused by discarding when resting in sheltered areas: Some areas where boats rest are spread out or away from villages. A trial to collaborate with wholesale/market boats to collect old nets might be feasible. While the large fleets of trawlers and purse seine boats use their own (in-house) resupply boats, the smaller fishing boats seem to use different available market boats that sell supplies or buy fish from the boats. Opportunities should be assessed to collect and transport end-of-life nets, back to the mainland or to the nearby village with a collection point on the market boats. The larger boats with their own processing factories already do this to a certain degree in their warehouses, where they repair nets. In this case, efforts should also be emphasised to take into account broken pieces of strings and small pieces of nets being discarded, as they are very commonly found on clean beach surveys.
- Gear loss reporting system or GGGI Ghost Gear Reporter app in Myanmar (or similar) should be tested when loss occurs from gear conflicts with other boats. This would assist in narrowing down surveying for retrieval efforts. Since hotspots resulting from gear conflicts are seen to cause the most damage to marine life and coral reef with large coverage of ghost nets, identifying them is crucial. This needs to be implemented with support from DoF and relevant fisheries associations when conducting workshops in areas where there is phone reception. Identifying hotspots early would also mean, the nets that are retrieved can still be cleaned and reused/recycled while avoiding the unnecessary death of marine life.

Removal/Cure

- Gear loss reporting systems could be trialled across both the fisheries and tourism sectors, with dive shops on resort islands in the region and all liveaboards and sailing boats operating in Myanmar. Divers regularly encounter ghost gear but often on a scheduled trip, limited time does not allow for removal efforts. This would allow collaborative efforts for retrieval dives to be organised. Dive boats and shops are often identifying new dive sites, and they are often the first to encounter ghost gear in different places. This would also be a great incentive to report and remove ghost gear from potential dive sites that would otherwise have been skipped and ignored.
- Concentrated efforts to remove ghost gear from hotspots that have already been identified are crucial to create awareness and to prevent further marine life entanglements. Priorities should be given to areas where marine megafauna have been sighted or known to frequent.
- Identification of hotspots from gear loss and discarding in other coastal areas in Myanmar. The rate at which the ALDFG situation worsened is alarming and should be addressed as a matter of urgency.
- Where assistance and collaboration with dive boats and resorts are not available, collaborations across government departments (DoF/MoHT) to allow for quick access/permits to areas for ALDFG survey and retrieval efforts would be helpful.



Divers removing ghostnet at High Rock
©Thanda Ko Gyi

CONCLUSIONS



Melanistic *Mobula birostris* entangled in fishing gear at Black Rock.
© Anna Flam, Marine Megafauna Foundation

This first effort to understand ALDFG in Myanmar's waters has demonstrated that this problem poses a threat to local biodiversity, thus potentially impacting the important sectors of fisheries and tourism. It is clear that further solutions-driven investigations must continue to better understand and reduce the threats that ALDFG poses to our valuable marine ecosystems in and beyond Tanintharyi.

As learned from the High Rock sites, ALDFG is damaging Myanmar's blossoming marine tourism sector. It is extremely concerning that the thriving marine life that made the place a tourist attraction, is now threatened by ghost nets. Myanmar needs to consider the likelihood of similar submerged pinnacles teeming with diverse marine life with significant tourism potential facing a similar fate across the coast.

Further, Myanmar's local small-scale fishers are impacted through conflict with larger, often illegal fishing operations. Proper zoning, improved regulations, and effective enforcement will not only help reduce levels of ALDFG from gear loss but also are necessary to improve the general health and management of our waters.