Occurrence of Marine Fauna in Offshore Northwest Myanmar

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EXECUTIVE SUMMARY

A number of marine seismic surveys were conducted in the offshore waters of northwest Myanmar by oil and gas operators between 2015 and 2017. Marine megafauna sightings and fishing activity data were collected during these seismic surveys by Marine Fauna Observers (MFOs) consistent with international best practice guidelines. Oil and gas operators recognised the value of these data in adding to the environmental knowledge and understanding of the offshore environment of Myanmar. This report is the result of an initiative amongst operators to collate the marine megafauna and fishing activity sightings data collected between 2015 and 2017. The purpose of the project is to contribute biodiversity knowledge in an area where limited information currently exists.

MFOs recorded sightings of marine megafauna during ten marine seismic surveys conducted by seven different oil and gas operators. Sightings of fishing activity were recorded during three of these surveys. Surveys were conducted between 18th March 2015 and 24th February 2017 and occurred in every month except August and September, due to rough sea conditions during this period associated with the south-west monsoon (wet season). The total survey area covered by the marine seismic surveys was estimated to be approximately 77,642 km. The marine seismic surveys generally targeted deep offshore areas in water depths up to 2,800 m.

The ten MFO datasets were collated to create a single MFO dataset. Data processing considered data at the species-level where sample size permitted, i.e. where over 20 sightings existed. Species with adequate sample sizes were Bryde's whale (*Balaenoptera edeni*), spinner dolphin (*Stenella longirostris*), Risso's dolphin (*Grampus griseus*) and olive ridley turtle (*Lepidochelys olivacea*). Other species were less frequently sighted and thus were combined to create 'taxonomic groups', which also included unidentified animals. The resulting groups considered in this report are as follows:

- Baleen whales – Bryde's;
- Baleen whales – other;
- Oceanic dolphins – spinner;
- Oceanic dolphins – Risso's:
- Oceanic dolphins - other;
- Toothed whales;
- Unidentified cetaceans;
- Marine turtles – olive ridley; and
- Marine turtles - other.

Although cetaceans and turtles were the primary fauna of interest, some 'other wildlife' records were part of the marine seismic surveys sightings data, such as sea snakes, fish and birds. These are presented in the report as a general, qualitative description.

The various marine seismic surveys had different durations and acquisition areas, resulting in spatial and temporal variations in survey effort. Therefore, some areas received considerably more hours of observation than others. To assist interpretation of the collated datasets, sighting rates for each species, taxonomic group or fishing activity were calculated per 1,000 hours of survey effort using the number of overall sightings. This method accounted for uneven spatial and temporal coverage between surveys. Sighting rates were reported for the overall study area.

The final megafauna dataset represented 8,591 hours of survey effort, during which 808 marine megafauna sightings were documented. Of these, 580 were sightings of cetaceans (whales and dolphins) comprising 29,421 individuals, and 228 were sightings of marine turtles comprising 267 individuals. Across the total survey area, approximately 68 cetacean sightings and 26 marine turtle sightings occurred per 1,000 hours of survey effort.

A total of 15 cetacean and five marine turtle species were encountered. Of these, four cetacean species and all five marine turtle species had a previously confirmed occurrence in Myanmar waters. Another eight cetacean species were previously listed as having a 'probable' or 'possible' occurrence in Myanmar and are now confirmed by this project. The remaining three cetacean species are understood to have been documented for the first time in Myanmar waters through this project. These species were: humpback whale (*Megaptera novaeangliae*), Omura's whale (*Balaenoptera omurai*), and sei whale (*Balaenoptera borealis*).

Seven of the marine megafauna species encountered are listed as 'threatened' by the International Union for the Conservation of Nature (IUCN). These species are: sei whale, sperm whale (*Physeter macrocephalus*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), and olive ridley turtle (*Lepidochelys olivacea*).

The most frequently encountered species in terms of number of sightings were spinner dolphin, Bryde's whale, and olive ridley turtle. The most numerous species in terms of total number of individuals observed was the spinner dolphin. Oceanic dolphins accounted for 72% of sightings and 95% of individuals (combining the spinner dolphin, Risso's dolphin and other oceanic dolphin groups). However, the high detectability of dolphins, particularly spinner dolphins (due to their large group sizes and acrobatic behaviours), must be considered alongside such results.

The sightings data reflect areas being targeted for marine seismic survey acquisition where sightings effort took place, rather than a true representation of the distribution of fauna as would be collected on dedicated megafauna surveys from marine or aerial platforms. Furthermore, the sightings reflect the locations of mobile individuals at a single point in time and are only indicative of the geospatial distribution of species and numbers that may be present in the region. Given the variation in spatial and temporal survey effort between individual surveys it is not possible to draw any conclusions on distribution patterns. However, analysis of the data provided some indicative temporal patterns that may be worth further investigation through future data collection:

- Sightings of spinner dolphins and other oceanic dolphins were consistently high across most months of the year surveyed, other than June and July (note that no surveys were undertaken during August and September). During June and July there were no sightings of spinner dolphins and low sightings of other oceanic dolphins during June only.
- Sightings of baleen whales were highest between April and June but number of sightings varied considerably between years, particularly for Bryde's whales.
- Turtle sightings were highest in the months January to July, with no turtles recorded in October and a low number of sightings in November and December. The data suggest lower numbers of marine turtles in the offshore waters of the total survey area early in the nesting season (which extends from September to March), with an increase coinciding with the peak of the nesting season (January and February). These higher numbers continued beyond the end of the nesting season through to June and July (no surveys occurred in August or September).

The fishing activity dataset represented 2,206.5 hours of survey effort, during which 234 sightings of fishing activity were documented. This equated to approximately 103 fishing activity sightings per 1,000 hours of survey effort. Of these sightings, 213 involved fishing vessels, the majority of which were deep-sea gill-netters. Fishing vessels appeared to be largely concentrated on the continental shelf within approximately 50 km of the coast. The remaining 21 sightings were of abandoned fishing gear.

Based on the outcomes of this report it is recommended that the data-sharing initiative between operators is continued with datasets from future marine seismic surveys added to the collated database to continue improving the understanding of species occurrence and contribute further biodiversity knowledge in offshore waters of northwest Myanmar.

1. INTRODUCTION

1.1 Background

The offshore waters of northwest Myanmar are under title for oil and gas exploration and production and are allocated into a number of blocks managed by the Myanmar Government (Figure 1.1). Between 2015 and 2017, oil and gas operators (defined as 'operators' for the purpose of this report) undertook a number of marine seismic surveys which included some of these blocks. Seismic surveys are a key technique used to explore and map offshore oil and gas. They use sound waves to produce detailed images of the rock formations underlying the seabed, to determine the location and size of potential oil and gas reservoirs. Marine seismic surveys typically encompass large areas of offshore waters that are surveyed over several weeks to months. The area represented by the marine seismic survey activities included in this study that were conducted in the period 2015-2017 is shown in Figure 1.2.

Marine megafauna sightings and fishing activity data were collected during the seismic surveys by Marine Fauna Observers (MFOs) (see Section 2.1 below). The term 'marine megafauna' includes mammals, reptiles (turtles and sea snakes), sharks and seabirds. Oil and gas operators recognised the value of these data in adding to the environmental knowledge and understanding of the offshore environment of Myanmar. This report is the result of an initiative amongst operators to collate the marine megafauna and fishing activity sightings data collected during the 2015-2017 seismic surveys in the offshore waters of northwest Myanmar. The purpose of this project is to contribute biodiversity knowledge in an area where limited information currently exists.

1.2 Objectives

The objectives of this project and the report are to:

- Contribute to the knowledge of marine megafauna biodiversity in offshore waters of northwest Myanmar;
- Provide a publicly available source of information to support Myanmar Government and Non-Governmental Organisations (NGOs) understanding of offshore marine megafauna presence; and,
- Contribute to operator understanding of the existing environment in offshore waters of northwest Myanmar for the purposes of environmental impact assessment for offshore oil and gas activities.

Figure 1.1: Title Blocks for Oil and Gas Exploration and Production in Offshore Waters of Northwest Myanmar Included in this Project

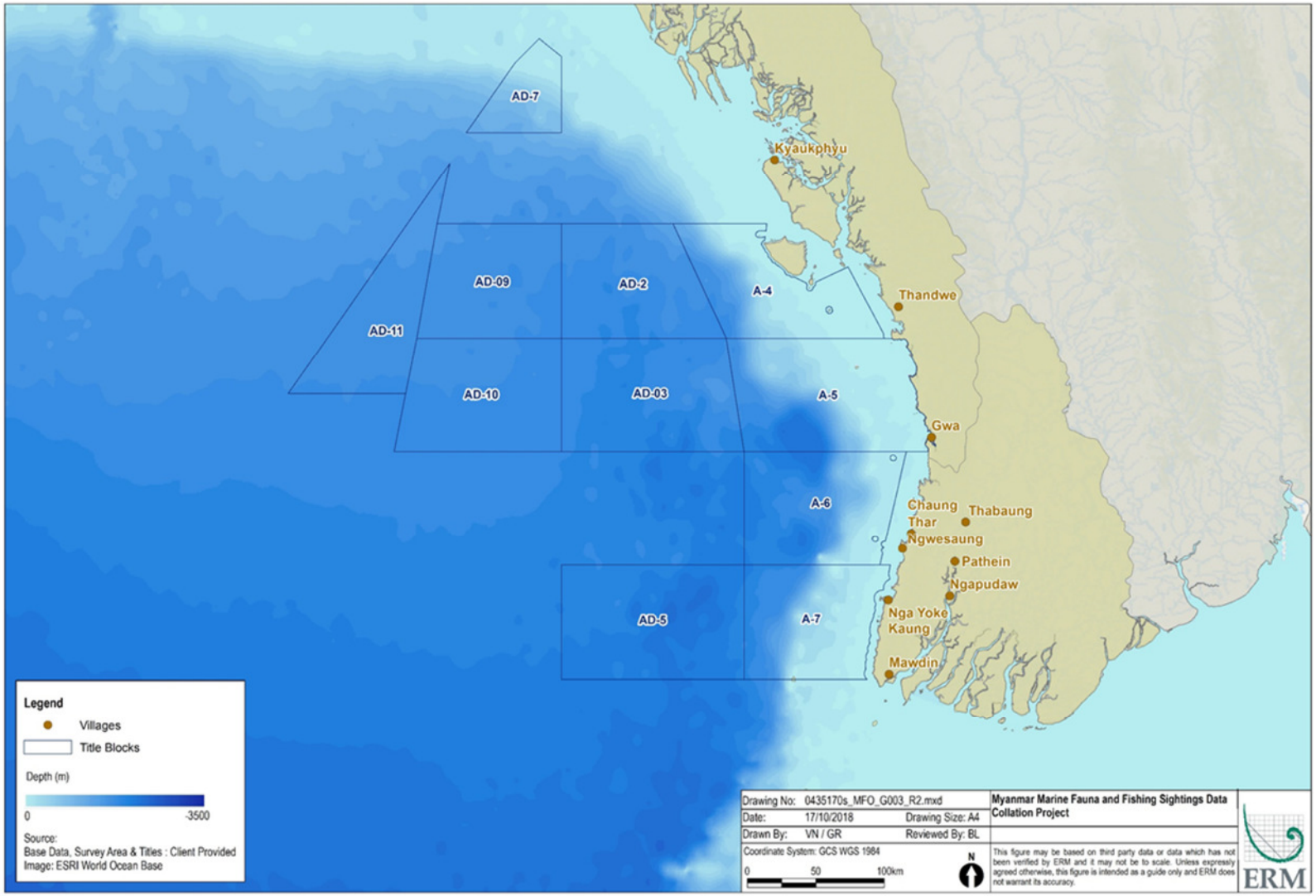
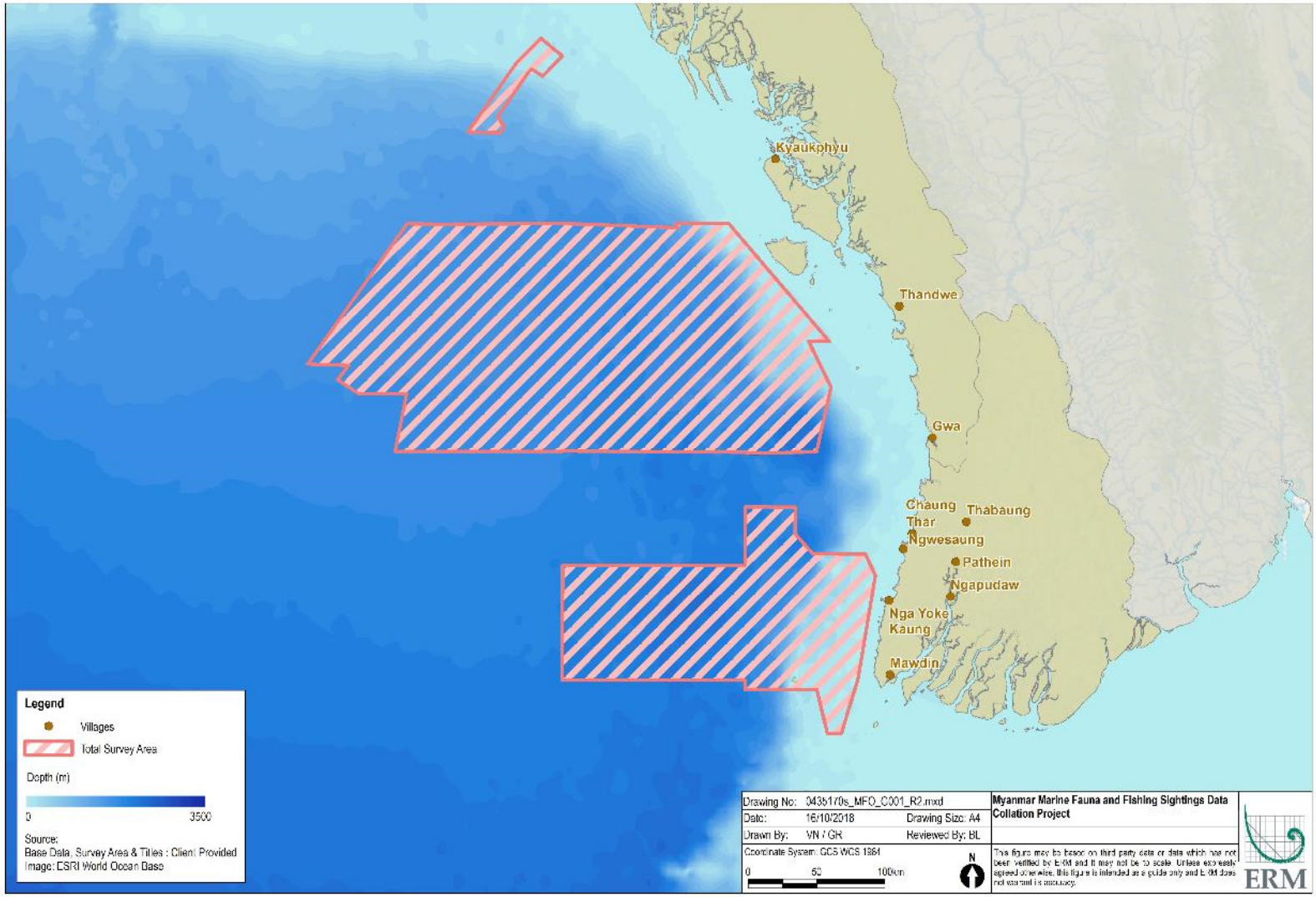


Figure 1.2: Total Survey Area Representative of the Ten Marine Seismic Survey Areas Conducted by Seven Operators between 2015 and 2017



2. METHODS

This section outlines the methods for collection of marine megafauna and fishing activities sightings data during the 2015-2017 marine seismic surveys; collation of the data into a single consolidated dataset and processing of the data to generate the results presented in Section 3 of this report. A discussion of the constraints and limitations for interpretation of the data is also provided.

2.1 Data Collection

International best practice guidelines for minimising acoustic disturbance to marine wildlife recommend the use of Marine Fauna Observers (MFOs), who monitor for the presence of marine megafauna during marine seismic surveys.

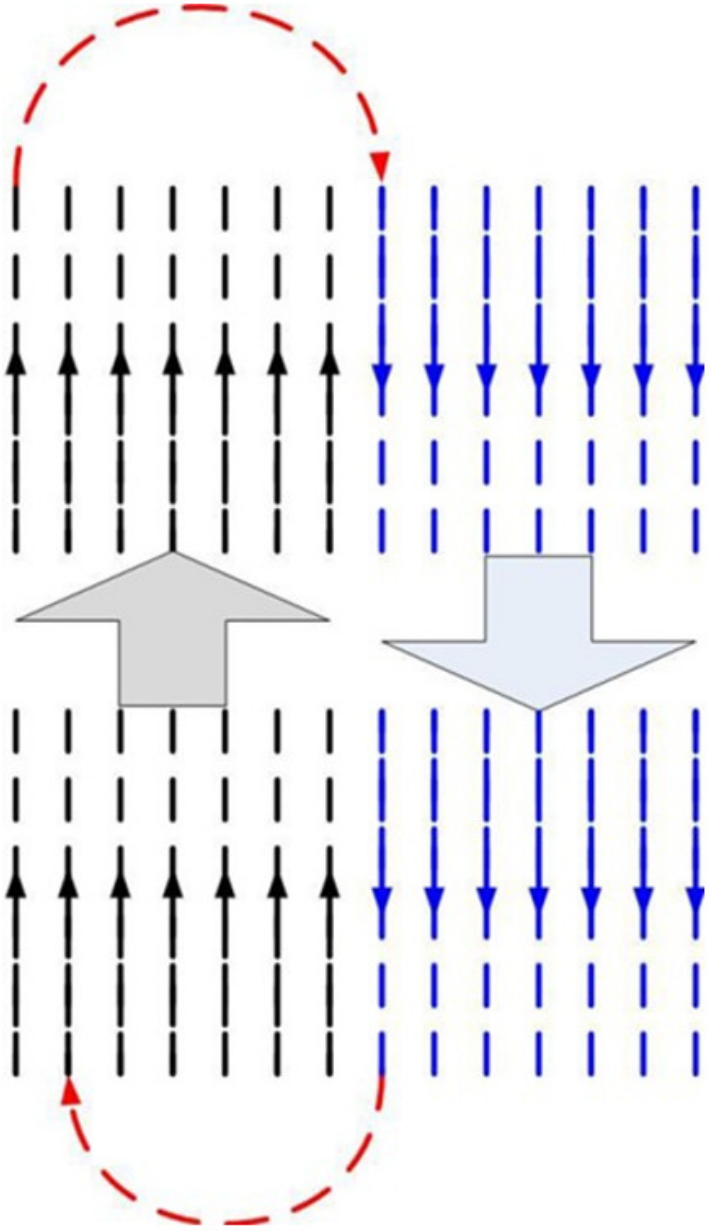
For each of the 2015-2017 seismic surveys included in this study, observations were carried out by an MFO positioned on the bridge or the bridge wings of the survey vessel. Observations were conducted during daylight hours and followed UK Joint Nature Conservation Committee (JNCC) guidelines (JNCC, 2010; refer to Box 1 below). Data were generally recorded on standard pro-forma JNCC recording forms.

The total survey area, representing a collation of the approximate marine seismic acquisition areas for each of the seismic surveys included in the project is shown in Figure 1.2. The MFO sightings data includes a number of records located outside the total survey area. These records resulted from periods when vessels were in transit or manoeuvring outside the survey area boundaries.

The primary wildlife of interest for the MFOs were marine mammals and turtles. Sightings were identified to species level where possible or species group (e.g. unidentifiable dolphin). Some ‘other wildlife’ records were also part of the sightings datasets, such as sea snakes, fish and birds. For some surveys MFOs also recorded fishing vessel activity or any discarded fishing gear.

It is important to note that the marine seismic surveys of this project were not dedicated marine fauna surveys but adhered to operational procedures as required for surveys of this nature. The sightings datasets do, however, provide the opportunity to make a contribution to the marine biodiversity knowledge of offshore waters where data are typically lacking. The MFO sightings data were recorded from a moving vessel that acquired seismic data along a pre-defined line configuration known as a ‘race track’ pattern (Figure 2.1). As a result, the sightings data reflect areas being targeted for marine seismic survey acquisition where sightings effort took place, rather than a true representation of the distribution of fauna as would be collected on dedicated megafauna surveys from marine or aerial platforms. Furthermore, the sightings reflect the locations of mobile individuals at a single point in time and are only indicative of the geospatial distribution of species and numbers that may be present in the region.

Figure 2.1: Schematic View of an Indicative 'Race Track' Pattern typically undertaken when conducting Marine Seismic Surveys



Box 1 Marine Fauna Observers (MFOs)

MFOs are typically qualified marine megafauna experts employed by specialist contract agencies who provide personnel for marine seismic surveys.

MFO protocols typically follow guidelines developed by the UK Joint Nature Conservation Committee (JNCC). The JNCC was the first regulatory body in the world to issue guidelines for minimising impacts of noise from seismic surveys on marine mammals. These guidelines became statutory in the UK and have since been adopted, in whole or in part, by several other management agencies around the world, as well as being voluntarily adopted by industry in some areas without regulatory requirements or local guidelines.

The JNCC guidelines provide information relevant to the reporting of marine wildlife sightings during seismic surveys. For example, the guidelines advise on appropriate methodology for fauna observation and recommend that these data are recorded on standard pro-forma JNCC recording forms (JNCC, 2010).

This detailed data collection provides an opportunity to further the knowledge of biodiversity for targeted survey areas. For example, data collected from seismic survey vessels has previously been used to report cetacean species ranges, spatial and temporal patterns in occurrence, species diversity, and cetacean density (Parente et al., 2007; de Boer, 2010; Weir, 2011; Baines and Reichelt, 2014; Stone, 2015). The presence of MFOs on marine seismic surveys therefore provides a platform of opportunity to document the occurrence of marine fauna and human activity in areas surveyed.

2.2 Data Collation

Ten sightings datasets from seven different oil and gas operators were collated for this report. The surveys occurred between 18th March 2015 and 24th February 2017. Surveys occurred during all months, except August and September (Table 3.1).

Data were collated to create a single consolidated sightings dataset using a standardised set of column headers based on the JNCC recording forms (JNCC, 2010). Any sightings recorded outside the offshore waters of northwest Myanmar, for example while a vessel was in transit from its port of origin to the survey area, were removed from the dataset. Data were quality controlled to ensure the consistent use of species names and check whether species identity correctly corresponded with the description provided by MFOs. Group sizes were also assessed for plausibility. These checks were applied consistently across all data and any errors were corrected, where possible. Otherwise, it was assumed that all data provided were accurate.

2.3 Data Processing

The collated dataset provides the number of sightings of marine megafauna and fishing activity during the 2015-2017 seismic surveys and the number of individuals per sighting.

Processing of the marine megafauna data for marine mammals and turtles broadly followed the methodology applied in Stone (2015). Data were considered at the species-level where sample size permitted, i.e. where over 20 sightings existed. Species with adequate sample sizes were Bryde's whale (*Balaenoptera edeni*), spinner dolphin (*Stenella longirostris*), Risso's dolphin (*Grampus griseus*) and olive ridley turtle (*Lepidochelys olivacea*). Other species were less frequently sighted and were therefore combined to create 'taxonomic groups' (see Table 2.1), which also included unidentified animals. The resulting groups considered in this report are as follows:

- Baleen whales – Bryde's;

- Baleen whales – other;
- Oceanic dolphins – spinner;
- Oceanic dolphins – Risso's;
- Oceanic dolphins - other;
- Toothed whales;
- Unidentified cetaceans
- Marine turtles – olive ridley; and
- Marine turtles - other.

Approximately 25 sightings could not be identified to a taxonomic level beyond 'cetacean' (whales and dolphins); these were combined to form an 'unidentified cetaceans' group. Sightings of mixed species were also classified in this group for the purpose of analysis. Example images of marine mammal and turtle groups are provided in Figure 2.2.

The ten MFO sightings datasets were standardised to account for survey effort given the different durations and size of areas surveyed. Survey effort was considered in terms of hours spent 'on effort' by MFOs, i.e. when observers were actively searching for marine fauna. Survey effort was not equal across all of the seismic surveys. This resulted in temporal and spatial variation in effort between surveys, with some areas and months of the year receiving considerably more hours of observation than others. To assist interpretation of the collated datasets, sighting rates for each species, taxonomic group or fishing activity were calculated per 1,000 hours of survey effort using the number of overall sightings. This method accounted for uneven spatial and temporal coverage between surveys. Sighting rates are reported for the total survey area. Furthermore, given the distribution of survey effort between years, all years were combined for subsequent data analysis.

Although cetaceans and turtles were the primary fauna of interest, some 'other wildlife' records were part of the marine seismic surveys sightings data, such as sea snakes, fish and birds. These are presented as a general, qualitative description as sightings records usually did not include locational information and were generally ad hoc additional information recorded by individual MFOs.

Table 2.1: Allocation of Species to Taxonomic Groups

Baleen whales		Oceanic dolphins			Toothed whales	Unidentified cetaceans	Marine turtles	
Bryde's	other	spinner	Risso's	other			olive ridley	other
Bryde's whale	Humpback whale	Spinner dolphin	Risso's dolphin	Common bottlenose dolphin	False killer whale	Unidentified cetacean	Olive ridley	Green turtle
	Omura's whale			Indo-Pacific bottlenose dolphin	Melon-headed whale	Unidentified large whale		Hawksbill turtle
	Sei whale			Long-beaked common dolphin	Short-finned pilot whale	Unidentified small whale		Leatherback turtle
	Unidentified baleen whale			Pan-tropical spotted dolphin	Sperm whale	Unidentified whale		Loggerhead turtle

Baleen whales		Oceanic dolphins			Toothed whales	Unidentified cetaceans	Marine turtles	
Bryde's	other	spinner	Risso's	other			olive ridley	other
				Striped dolphin	Unidentified beaked whale	Mixed cetaceans		Unidentified turtle
				Unidentified dolphin	Unidentified small blackfish			
					Unidentified toothed whale			

2.4 Data Constraints

As outlined above, the MFO sightings data collected during the 2015-2017 seismic surveys in the offshore waters of northwest Myanmar provides an opportunity to contribute biodiversity knowledge on marine megafauna. While the visual observation data provides valuable information on the occurrence of species, interpretation of the data must be carried out with consideration of the nature and constraints of the datasets, including the following:

- The spatial coverage of the marine seismic surveys was extensive; however, the MFO data collection purpose was primarily to mitigate and manage interactions of the seismic survey activities and megafauna as part of good international practice and therefore, the sightings recorded reflect the timing, location and duration of each of the surveys.
- Certain information (e.g. distribution and abundance of individuals) is subject to limitations arising from the potential behavioural responses of animals to the survey vessels and seismic sound source.
- Survey effort was variable across the total survey area, with some survey areas and months of the year receiving considerably more hours of observation than others.
- Sighting conditions (i.e. range of visibility for sightings) varies with weather conditions and sea state and are therefore not consistent across a survey or between different surveys. Additionally, the height of the observation point above sea level will have a significant influence on the range at which animals can be detected and is likely to have varied between surveys.
- Species-specific characteristics can also affect the ease with which some species are sighted. Some small to mid-sized cetaceans, such as beaked whales, are difficult to spot even in ideal conditions due to their cryptic nature and long dive times. In comparison, other species can be very 'surface active' and relatively easy to spot; spinner dolphins are acrobatic and form large groups that, in some cases, can include several hundred animals. Consequently, the chances of spotting this species are high, even in rough swell and wave conditions.
- Sightings locations used in this report represent the position of the vessel at the time the sighting was made, rather than the position of the sighting itself. Depending on sightings conditions, the actual location of animals or groups of animals may have been up to several kilometres from the geographic position recorded for the sighting.
- The majority of survey effort was in water depths greater than 1,000 m. Species sightings are therefore more representative of the deep oceanic waters of offshore northwest Myanmar rather than shallower areas on the continental shelf.

Reporting and interpretation of the sightings data presented in Section 3 takes into account the constraints and limitations outlined above, and includes an evaluation of species diversity observed and an analysis of sightings based on sighting rates that have been normalised for survey effort.

Figure 2.2 Example images of species groups: (a) Baleen whales (e.g. Bryde's whale), (b) Toothed whales (e.g. pilot whale), (c) Oceanic dolphins (e.g. spinner dolphin), and (d) Marine turtles (e.g. olive ridley turtle)

(a)

(b)

(c)

(d)

Source of images: Woodside

3. RESULTS

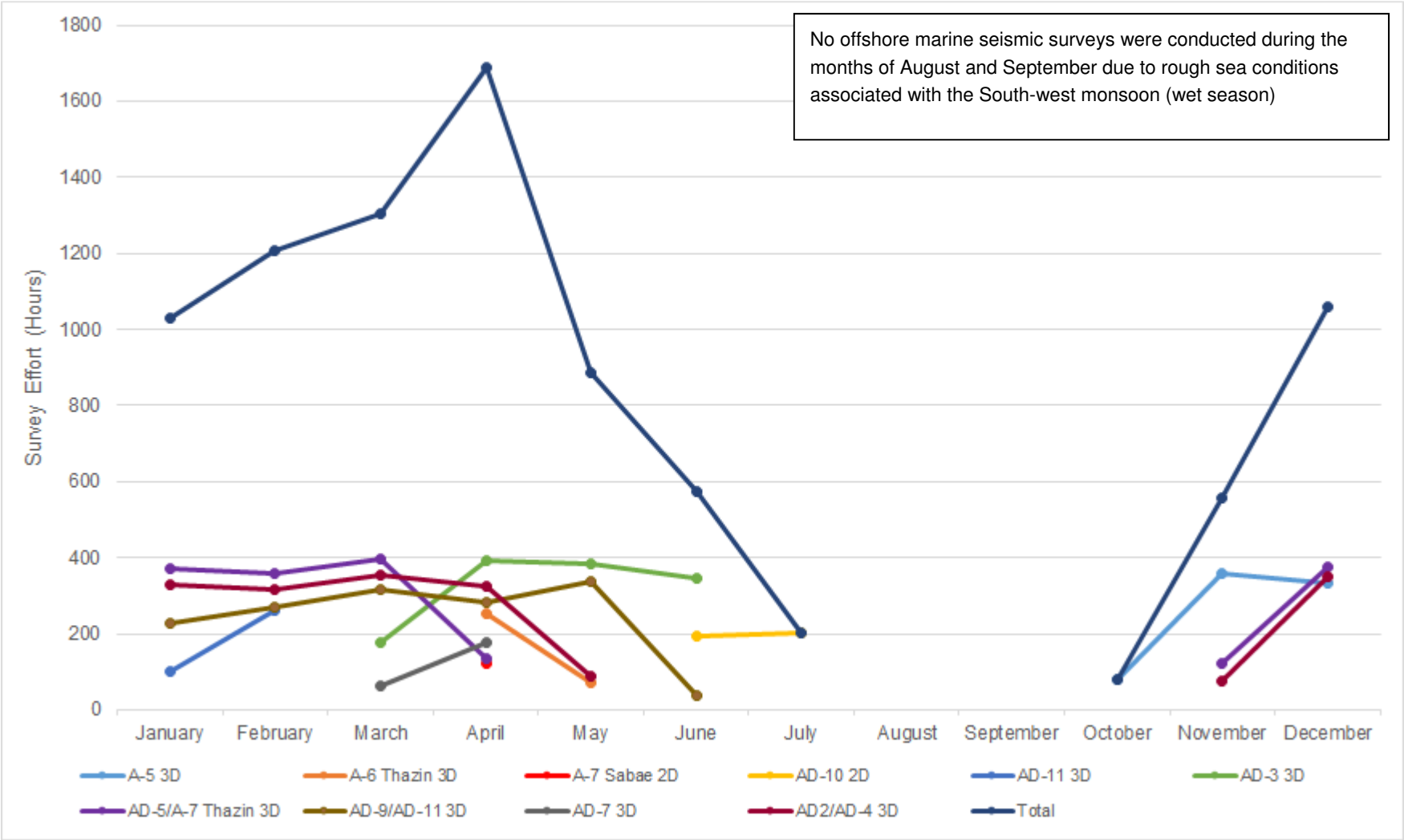
3.1 Summary of Survey Effort

Ten sightings datasets from seven oil and gas operators were collated (Table 3.1). The total survey area covered by the marine seismic surveys was estimated to be approximately 77,642 km^2 (Figure 1.2. The seismic surveys generally targeted deep offshore areas in water depths up to a maximum of 2,800 m. Surveys occurred between 18th March 2015 and 24th February 2017 in all months of the year except August and September (due to rough sea conditions during this period associated with the south-west monsoon (wet season)). Surveys lasted an average of 79 days (minimum 13, maximum 176 days) (Table 3.1). Consequently, some survey areas within the total survey area and months received greater survey effort than others, which provides important context for interpretation of the sightings data. Seasonal variation in survey effort by month is illustrated in Figure 3.1 (data for all years combined). The total observation effort across the entire period of the seismic surveys was 8,591 hours.

Table 3.1 Summary of Marine Seismic Surveys (MSS)

Survey Name	Operator	Survey dates	Total survey hours	Approximate Survey area (km^2)
A-5 3D MSS	Chevron (Unocal Myanmar Offshore Co Ltd)	19/10/2015 – 03/01/2016	771	4,948
A-6 Thazin 3D MSS	Woodside Energy (Myanmar) Pte Ltd; MPRL E&P Pte Ltd	11/04/2016 – 06/05/2016	326	1,710
A-7 Sabae 2D MSS	Woodside Energy (Myanmar) Pte Ltd	11/04/2016 – 24/04/2016	123	9,797
AD-2/ A-4 3D MSS	BG Asia Pacific Pte Ltd	21/11/2015 – 11/05/2016	1,838	12,059
AD-3 3D MSS	Ophir Energy Plc	18/03/2015 – 29/06/2015	1,302	10,009
AD-5/ A-7 Thazin 3D MSS	Woodside Energy (Myanmar) Pte Ltd	21/11/2015 – 11/04/2016	1,758	15,004
AD-7 3D MSS	Daewoo International Corporation	24/03/2016 – 20/04/2016	240	1,135
AD-11/AD-9 3D MSS	Shell Myanmar Energy (Pte) Ltd	07/01/2016 – 05/06/2016	1,475	12,778
AD-10 2D MSS	Statoil Myanmar Pte Ltd	12/06/2016 – 24/07/2016	395	9,004
AD-11 3D MSS	Shell Myanmar Energy (Pte) Ltd	22/01/2017 – 24/02/2017	363	1,198
Total			**8,591**	**77,642**

Figure 3.1: Seasonal Variation in Survey Effort by Month (Data for all Years Combined)



3.2 Occurrence of Marine Fauna

Overall, 808 marine megafauna sightings were recorded across the total survey area. These included 580 marine mammal sightings and 228 marine turtle sightings. Other wildlife sightings (sea snakes, fish and birds) are qualitatively described in Section 3.2.3.

3.2.1 Marine Mammals

3.2.1.1 Species Diversity

The 580 marine mammal sightings recorded across the total survey area totalled 29,421 individuals. All sightings were of cetacean species, therefore the term 'cetaceans' is used hereafter. Fifty-two percent of the sightings (n = 303) were identified to the species level. A total of 15 different cetacean species were identified, of which 12 were previously considered as having a 'confirmed', 'probable' or 'possible' occurrence in Myanmar (Table 3.2). The remaining three species were not previously known to occur in Myanmar, namely humpback whale, Omura's whale and sei whale.

The species recorded were compared with the species included in Holmes et al. (2014), which lists the occurrence of cetaceans in Myanmar as confirmed, probable or possible (see Table 3.2). Four of the 15 cetacean species reported in the MFO records between 2015 and 2017 had a previously confirmed occurrence in Myanmar:

- Bryde's whale (*Balaenoptera edeni*);
- Indo-Pacific bottlenose dolphin (*Tursiops aduncus*);
- Pantropical spotted dolphin (*Stenella attenuata*); and
- Spinner dolphin (*Stenella longirostris*)[1].

Another eight species were listed as having a 'probable' or 'possible' occurrence in Myanmar and are now confirmed by the MFO sightings records from this project:

- Common bottlenose dolphin (*Tursiops truncatus*);
- False killer whale (*Pseudorca crassidens*); and
- Long-beaked common dolphin (*Delphinus capensis*)[2].
- Melon-headed whale (*Peponocephala electra*);

[1] During data processing, it was noted that dwarf spinner dolphins (*Stenella longirostris roseiventris*) were observed during only one survey, whilst spinner dolphins (*Stenella longirostris*) were observed during eight surveys. Due to the difficulties in differentiating these animals, sightings were grouped as 'spinner dolphins' and not considered at the sub-species level. No other sub-species were reported.

[2] The sighting of two long-beaked common dolphins was originally reported as two short-beaked common dolphins (*Delphinus delphis*). However, this was considered to be erroneous. Both species share similar physical characteristics, with the main difference involving beak length, as well as subtle variations in colouration and body size. Their distribution is the main differentiating factor, as short-beaked common dolphins occur primarily in the Atlantic and Pacific Oceans (Perrin, 2002). Whilst short-beaked common dolphins may occur in parts of the Indian Ocean, this is generally around south-east Africa and southern Australia (Jefferson and Van Waerebeek, 2002). In contrast, the long-beaked common dolphin is found throughout the Indo-Pacific from the Red Sea to western Taiwan and Indonesia (Jefferson and Van Waerebeek, 2002). Consequently, this sighting was most likely of long-beaked common dolphins. This sighting is thus referred to as long-beaked common dolphins throughout this report.

- Risso's dolphin (*Grampus griseus*);
- Short-finned pilot whale (*Globicephala macrorhynchus*);
- Sperm whale (*Physeter macrocephalus*); and
- Striped dolphin (*Stenella coeruleoalba*).

As described above, the remaining three species recorded in the present project were not listed in Holmes et al. (2014) and are understood to be new to Myanmar cetacean records:

- Humpback whale (*Megaptera novaeangliae*);
- Omura's whale (*Balaenoptera omurai*); and
- Sei whale (*Balaenoptera borealis*).

These three new species records for Myanmar waters were further assessed in terms of their likelihood and reliability. No previous reports of humpback whales in the Bay of Bengal have been identified. Despite individuals from the Arabian Sea humpback whale population being sighted in Sri Lanka and the Maldives (Minton et al. 2015; Ilangakoon 2006; Ilangakoon 2012), no humpback whales have been reported along the east coast of India (Sutaria et al. 2017). However, it is noted that Myanmar is listed as a 'country of occurrence' in the IUCN Red List assessment for humpback whales (Reilly et al. 2008). In the current project, two humpback whale sightings comprising 16 individuals were reported. Both sightings were made by the same MFO, who has over 12 years of experience in marine mammal observation and a PhD in humpback whale ecology. Therefore, these sightings are considered highly reliable. No humpback whales have ever been recorded crossing the Equator; therefore, these individuals are likely to have originated from the nearest Northern Hemisphere population located in the Arabian Sea, which is genetically distinct from that of the southern Indian Ocean (Reilly et al. 2008). This population is understood to be resident in the Arabian Sea year-round rather than migratory (Reilly et al. 2008).

There is some possibility of misidentification regarding Omura's and sei whales. Both bear similarity to the Bryde's whale, which occurs in large numbers throughout the Bay of Bengal. Only one sighting of Omura's whales and two sightings of sei whales were recorded during the current project. Both the Omura's whale sighting and one of the sei whale sightings were made by the same MFO during the same survey. The sightings both occurred within 150 m of the survey vessel, thus allowing a relatively close inspection of the animals for identification. As numerous Bryde's whale sightings were also reported for this survey, the MFO presumably had confidence in differentiating between these species. The main physical characteristics used to differentiate between Bryde's, Omura's and sei whales include differences in colouration, the presence/absence of rostral and lateral ridges, and dorsal fin shape (Cerchio et al. 2015; de Vos 2017; WDC 2018). Given the similarity between species, it is also possible that some animals identified as Bryde's whales in this project could have been Omura's or sei whales.

Overall, given the favourable sighting conditions and considerable experience of the MFOs involved, it was concluded that these three new species records had a high probability of being accurate and correct.

Of the 15 cetacean species identified, two are listed as 'threatened' by the International Union for Conservation of Nature (IUCN) (Table 3.2). These species are:

- Sei whale (Endangered); and
- Sperm whale (Vulnerable).

Table 3.2: Records of Cetacean Species in Myanmar Waters

Common name	Scientific name	IUCN conservation status	Reported in Holmes et al. (2014)	Recorded in current Project
Baleen whales				
Blue whale	*Balaenoptera musculus*	Endangered	Confirmed	No
Bryde's whale	*Balaenoptera edeni*	Data Deficient	Confirmed	Yes
Minke whale	*Balaenoptera acutorostrata*	Least Concern	Probable	No
Fin whale	*Balaenoptera physalus*	Endangered	Possible	No
Humpback whale	*Megaptera novaeangliae*	Least Concern	No Records	Yes
Omura's whale	*Balaenoptera omurai*	Data Deficient	No Records	Yes
Sei whale	*Balaenoptera borealis*	Endangered	No Records	Yes
Toothed whales (including dolphins and porpoises)				
Indo-Pacific bottlenose dolphin	*Tursiops aduncus*	Data Deficient	Confirmed	Yes
Indo-Pacific finless porpoise	*Neophocaena phocaenoides*	Vulnerable	Confirmed	No
Indo-Pacific humpback dolphin	*Sousa chinensis*	Vulnerable	Confirmed	No
Irrawaddy dolphin	*Orcaella brevirostris*	Endangered	Confirmed	No
Longman's beaked whale	*Indopacetus pacificus*	Data Deficient	Confirmed	No
Pantropical spotted dolphin	*Stenella attenuata*	Least Concern	Confirmed	Yes
Spinner dolphin	*Stenella longirostris*	Data Deficient	Confirmed	Yes
Strap-toothed whale	*Mesoplodon layardii*	Data Deficient	Confirmed, anomaly	No
Blainville's beaked whale	*Mesoplodon densirostris*	Data Deficient	Probable	No
Dwarf sperm whale	*Kogia sima*	Data Deficient	Probable	No

Common name	Scientific name	IUCN conservation status	Reported in Holmes et al. (2014)	Recorded in current Project
False killer whale	*Pseudorca crassidens*	Data Deficient	Probable	Yes
Fraser's dolphin	*Lagenodelphis hosei*	Least Concern	Probable	No
Killer whale	*Orcinus orca*	Data Deficient	Probable	No
Long-beaked common dolphin	*Delphinus capensis*	Data Deficient	Probable	Yes
Melon-headed whale	*Peponocephala electra*	Least Concern	Probable	Yes
Pygmy killer whale	*Feresa attenuata*	Data Deficient	Probable	No
Pygmy sperm whale	*Kogia breviceps*	Data Deficient	Probable	No
Risso's dolphin	*Grampus griseus*	Least Concern	Probable	Yes
Rough-toothed dolphin	*Steno bredanensis*	Least Concern	Probable	No
Short-finned pilot whale	*Globicephala macrorhynchus*	Data Deficient	Probable	Yes
Sperm whale	*Physeter macrocephalus*	Vulnerable	Probable	Yes
Striped dolphin	*Stenella coeruleoalba*	Least Concern	Probable	Yes
Common bottlenose dolphin	*Tursiops truncatus*	Least Concern	Possible	Yes

3.2.1.2 Species Occurrence

Distribution of cetacean sightings are illustrated in Figure 3.2, including a broad indication of group sizes observed. However, it is noted that this figure does not take into account spatial and temporal variation in survey effort between individual seismic surveys. It is therefore not possible to determine any patterns of distribution, other than demonstrating that cetacean sightings were frequent and occurred across the total survey area for the period of marine seismic surveys between 2015 and 2017.

The most frequently encountered species by number of sightings was the spinner dolphin (n = 168), followed by Bryde's whales (n = 62) and Risso's dolphin (n = 28) (Table 3.3). The remaining 12 species were each sighted on fewer than ten occasions. The most numerous species by number of individuals sighted was also the spinner dolphin (n = 15,687), followed by pantropical spotted dolphin (n = 598), Risso's dolphin (n = 592), short-finned pilot whale (n = 180) and false killer whale (n = 123) Table 3.3). These species are known to typically occur in large groups, with some species also showing the tendency for multiple groups to join and create 'super-pods'. For all other species, fewer than 100 individuals were observed in total per species.

Seven mixed-species associations were observed (Table 3.3). The species most commonly occurring in association were spinner and pantropical spotted dolphins (n = 5 sightings). The remaining two mixed-species associations involved short-finned pilot whales with common bottlenose dolphins and unidentified dolphins.

As outlined in Section 2.3, sightings were grouped by species or broader taxonomic group (depending on number of sightings) for further analysis (refer to Table 2.1). The number of sightings for each of the taxonomic groups is presented in Table 3.4.

The cetacean sightings were standardised by calculating sightings per 1,000 hours of survey effort as described in Section 2.3. The 580 total sightings of cetaceans equated to approximately 68 cetacean sightings per 1,000 hours survey effort across the total survey area (Table 3.4).

Oceanic Dolphins

Seventy-two percent of the total sightings for the collated dataset were oceanic dolphins (combining the spinner dolphin, Risso's dolphin and other oceanic dolphin groups) (Figure 3.3). Furthermore, when considering the number of individuals sighted, 95% were dolphins (Table 3.4). Group size per sighting ranged from one to 2000 individuals (Table 3.3), with a large number of sightings involving group sizes of more than 50 individuals (Figure 3.2).

The overall sighting rate of spinner dolphins was approximately 20 sightings per 1,000 hours survey effort (Table 3.4). The overall sighting rate of other oceanic dolphins was similar, with approximately 26 sightings per 1,000 hours survey effort. This represents the highest overall sighting rate of all cetacean species and taxonomic groups considered. The sighting rate of Risso's dolphins was lower with 3 sightings per 1,000 hours survey effort. Spinner dolphins and other oceanic dolphins had a very broad spatial distribution encompassing the full depth range of the surveys.

A comparison of sighting rate by month for all years combined (2015, 2016 and 2017) showed that sightings of spinner dolphins and other oceanic dolphins were consistently high across most months of the year surveyed, other than June and July (note that no surveys were undertaken during August and September) (Figure 3.4). During June and July there were no sightings of spinner or Risso's dolphins and low sightings of other oceanic dolphins during June only (1.7 sightings per 1,000 hours survey effort) despite approximately 780 hours of combined effort over these two months across three different survey areas.

Baleen Whales

Baleen whales made up 17% of total sightings for the collated dataset (combining the Bryde's whale and other baleen whale groups) (Figure 3.3). However, baleen whales made up only 0.5% of individuals sighted (Table 3.4). Group sizes ranged from one to five individuals for Bryde's whales, and one to ten individuals for other baleen whales (Table 3.3).

The overall sighting rate was approximately seven sightings per 1,000 hours survey effort for Bryde's whales and four sightings per 1,000 hours survey effort for other baleen whales (Table 3.4). Baleen whales were sighted throughout the total survey area in depths encompassing the full depth range of the surveys.

Bryde's whales were sighted in six of the ten months of the year surveyed. The sighting rate was highest in the months of April and May (21 and 18 sightings per 1,000 hours survey effort respectively) (Figure 3.4). Lower sighting rates were recorded in other months with no sightings in July, October or December (no survey effort in August or September).

It is notable that of the 62 sightings of Bryde's whales, 53 were recorded during surveys in 2015, with the remaining 9 sightings recorded during surveys conducted in 2016. This is despite a lower overall survey effort in 2015 (approximately 3,000 hours compared to approximately 5,230 in 2016). Survey effort during the peak sighting rate months of April and May was also lower in 2015 compared to 2016 (approximately 780 hours in 2015 compared to 1,790 hours in 2016). While this may reflect spatial variation in survey effort between years to some extent, it also suggests some temporal variation in distribution and numbers of Bryde's whales in the region, which may relate to upwellings and opportunistic feeding events that could occur anywhere along the continental shelf edge.

Other baleen whales were sighted in eight of the ten months surveyed, with a relatively low sighting rate ranging from zero in July and October to 12 individuals per 1,000 hours survey effort in June (Figure 3.4). The two sightings of humpback whales were recorded in April and the sightings of Omura's and sei whales were recorded in January/February.

Toothed Whales

The proportion of toothed whale sightings for the collated dataset was 4%, making up 1.2% of individuals. Group sizes ranged from one to 100 individuals. The overall sighting rate of toothed whales was approximately three sightings per 1,000 hours survey effort (Table 3.4). This represents the lowest overall sighting rate of all cetacean species and taxonomic groups considered. Toothed whales were sighted across the total survey area. Toothed whales were sighted in seven of the ten months surveyed (Figure 3.4). There were no individuals sighted in July or October and only low sightings were recorded in December (0.9 sightings per 1,000 hours; no surveys were undertaken during August and September).

Unidentified Cetaceans

Unidentified cetaceans made up 7% of total sightings for the collated dataset. The ability to identify cetaceans to species-level may be associated with weather conditions, with factors such as sea state and visibility affecting sighting conditions. The overall sighting rate of unidentified cetaceans was four sightings per 1,000 hours survey effort (Table 3.4). Unidentified cetaceans were recorded across the total survey area. Unidentified cetaceans were sighted in seven of the 10 months surveyed (Figure 3.4).

Figure 3.2: Map of Cetacean Sightings Across the Total Survey Area

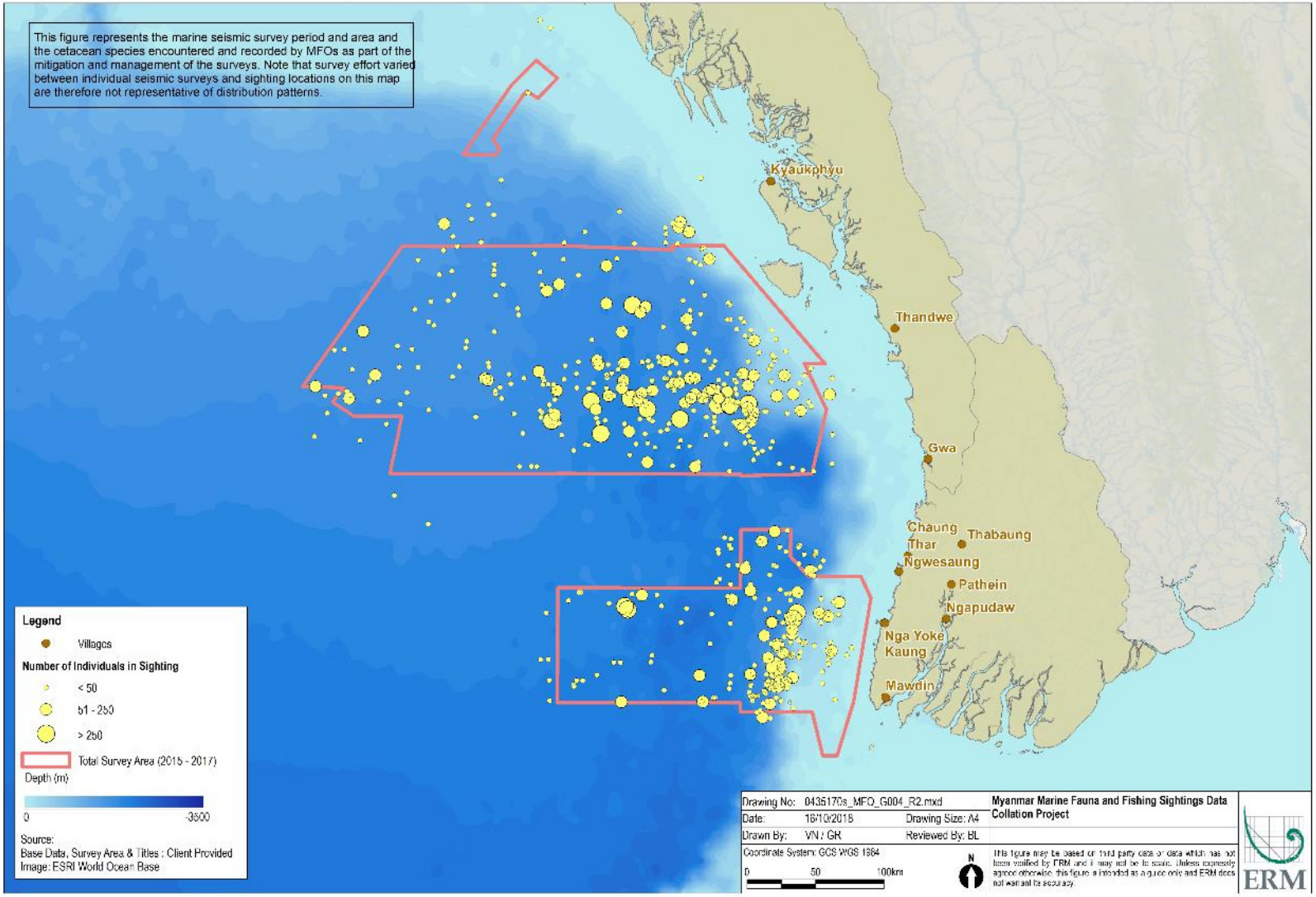


Table 3.3: Overview of Cetacean Sightings

Common name	Number of sightings	Number of individuals	Average/ median group size	Minimum-maximum group size
Single-species sightings of baleen whales				
Bryde's whale	62	88	1.4/1	1-5
Humpback whale	2	16	8/8	6-10
Omura's whale	1	1	N/A	N/A
Sei whale	2	2	1/1	1
Subtotal	**67**	**106**		
Single-species sightings of oceanic dolphins				
Common bottlenose dolphin	3	27	9/6	3-18
Indo-Pacific bottlenose dolphin	3	85	28.3/40	5-40
Long-beaked common dolphin	1	2	2/2	2
Pantropical spotted dolphin	8	598	74.8/20	3-450
Risso's dolphin	28	592	21.1/10	1-100
Spinner dolphin	168	15,687	93.4/40.5	1-2000
Striped dolphin	4	58	14.5/13.5	1-30
Subtotal	**215**	**17049**		
Single-species sightings of toothed whales				
False killer whale	5	123	24.6/12	2-30
Melon-headed whale	1	4	4/4	4-4
Short-finned pilot whale	6	180	30/16.5	1-100
Sperm whale	7	10	1.4/1	1-3
Subtotal	**19**	**712**		
Mixed-species sightings				
Short-finned pilot whale and common bottlenose dolphin	1	60	N/A	N/A

Common name	Number of sightings	Number of individuals	Average/ median group size	Minimum-maximum group size
Short-finned pilot whale and unidentified dolphin	1	20	N/A	N/A
Spinner and pantropical spotted dolphin	5	730	146/150	30-300
Subtotal	**7**	**810**		
Unidentified cetacean species				
Unidentified baleen whale	32	36	1.1/1	1-3
Unidentified beaked whale	4	5	1.3/1	1-2
Unidentified cetacean	7	23	3.3/1	1-10
Unidentified dolphin	202	11022	54.8/20	1-1500
Unidentified large whale	15	18	1.2/1	1-2
Unidentified small whale	1	1	N/A	N/A
Unidentified small blackfish	1	20	N/A	N/A
Unidentified toothed whale	2	4	2/2	2
Unidentified whale	8	9	1.1/1	1-2
Subtotal	**21**	**2430**		
Total	**580**	**29,421**		

Table 3.4: Sighting Rates of Cetaceans per 1,000 hours Survey Effort across the Total Survey Area

Species or grouping	Number of sightings	Sighting rate per 1,000 hours effort
Baleen whales - Bryde's	62	7
Baleen whales - other	37	4
Oceanic dolphins - spinner	168	20
Oceanic dolphins – Risso's	28	3
Oceanic dolphins - other	221	26
Toothed whales	26	3
Unidentified cetaceans	38	4
Overall	**580**	**68**

Figure 3.3: Proportion of Sightings of Cetacean Groups for the Combined Survey Data

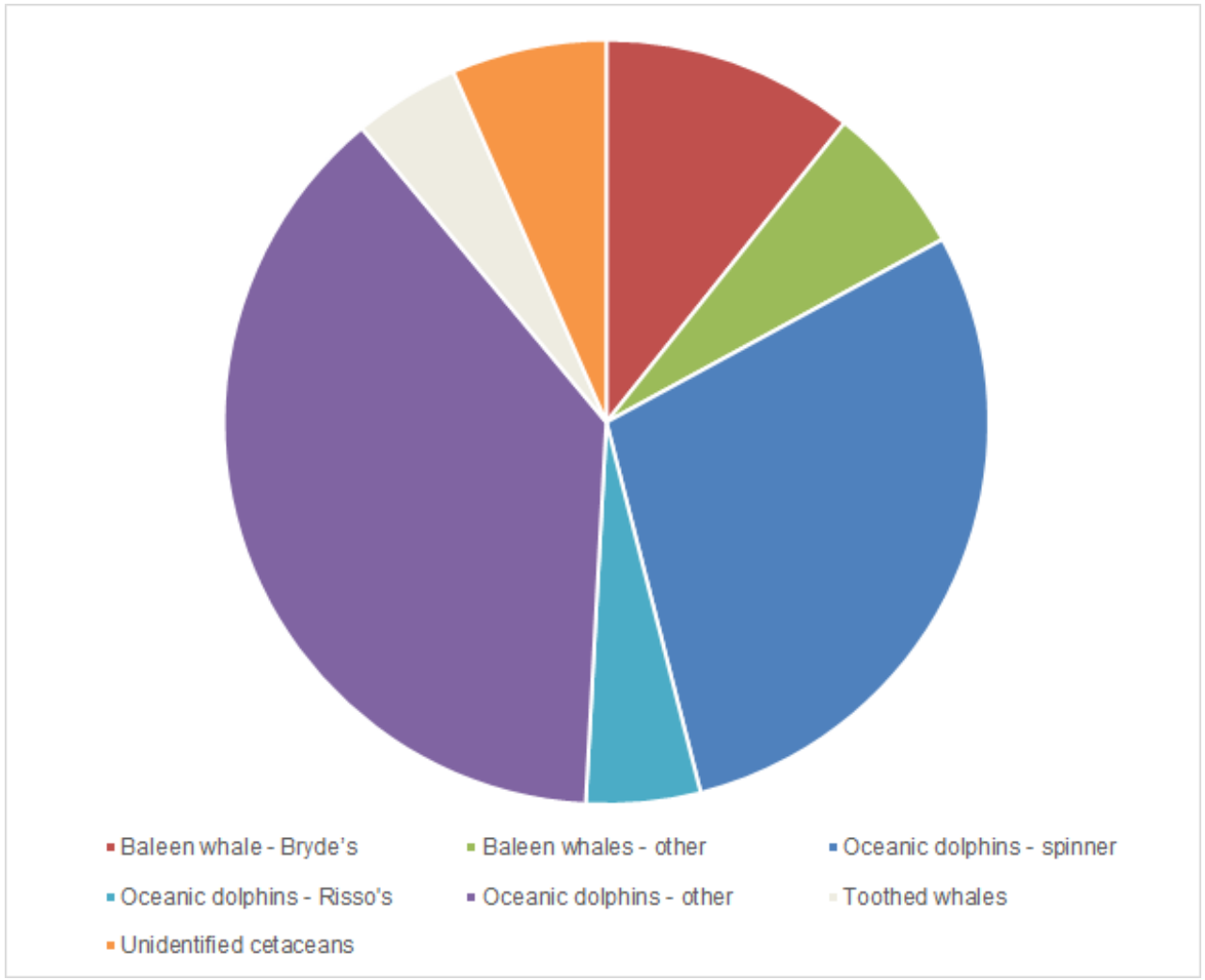
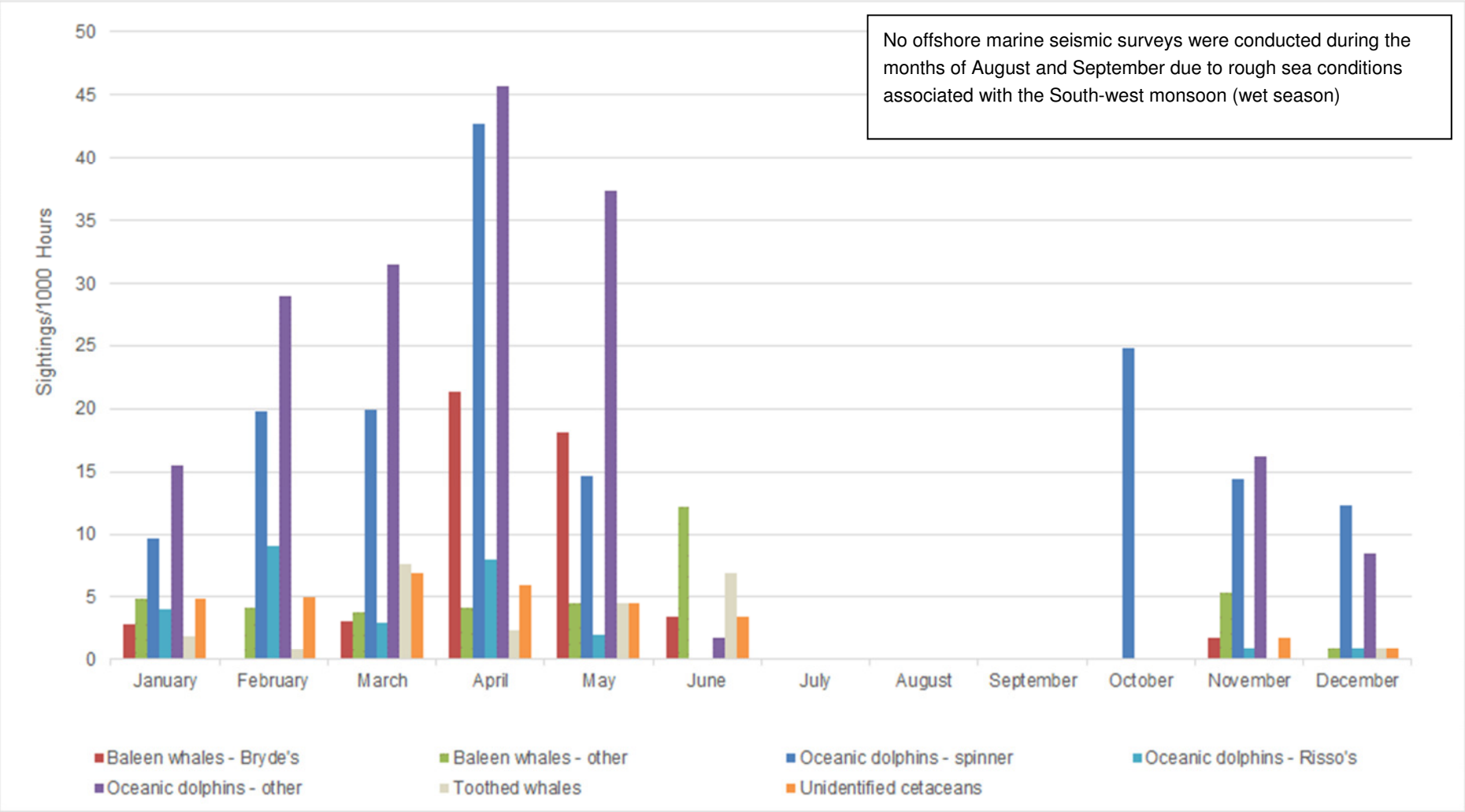


Figure 3.4: Total Sightings per 1,000 hours for Cetacean Groups Across the Total Survey Area by Month (Data for All Years Combined)



3.2.2 Marine Turtles

3.2.2.1 Species Diversity

A total of five marine turtle species were identified, all of which had previously been confirmed as occurring in Myanmar waters (Table 3.5). These species are:

- Green turtle (*Chelonia mydas*);
- Hawksbill turtle (*Eretmochelys imbricata*);
- Leatherback turtle (*Dermochelys coriacea*);
- Loggerhead turtle (*Caretta caretta*); and
- Olive ridley turtle (*Lepidochelys olivacea*).

All five of these marine turtle species are listed as 'threatened' by the IUCN (Table 3.5). The hawksbill turtle is Critically Endangered, the green turtle is Endangered, and the leatherback turtle, loggerhead turtle and olive ridley turtle are Vulnerable.

3.2.2.2 Species Occurrence

Sightings of marine turtles were recorded across the total survey area (Figure 3.5). A total of 228 sightings of marine turtles were recorded, comprising 267 individuals (Table 3.6).

The most frequently sighted species was the olive ridley turtle (n = 78; Table 3.6). The remaining four species were each sighted on six or fewer occasions. The most numerous species by number of individuals sighted was also the olive ridley turtle (n = 82; Table 3.6). The majority of turtle sightings were of solitary individuals. However, 16 sightings involved multiple individuals, ranging from pairs to an aggregation of 17 marine turtles (Table 3.6). These marine turtle groups included two pairs of olive ridley turtles, a pair of loggerhead turtles, and a trio of olive ridley turtles. None of the other marine turtle groups could be identified to species level. No mixed-species groups were observed.

Sighting rates were considered for olive ridley turtles, with remaining marine turtle sightings combined to form an 'other turtle' taxonomic group. The number of sightings for each group is presented in Table 3.7 and Figure 3.6. The marine turtle sightings were standardised by calculating sightings per 1,000 hours of survey effort as described in Section 2.3. The 228 total sightings of turtles equated to approximately 26 marine turtle sightings per 1,000 hours of survey effort across the total survey area (Table 3.7).

The overall sighting rate was approximately nine sightings per 1,000 hours survey effort for olive ridley turtles, and 17 sightings per 1,000 hours survey effort for 'other turtles' (Table 3.7). Turtles had a relatively broad spatial distribution, in water depths encompassing the full depth range of the surveys.

A comparison of sighting rate by month for all years combined showed that turtle sightings were highest in the months January to July, with no turtles recorded in October and a low number of sightings in November and December (no surveys occurred in August or September) (Figure 3.6). Nesting season in the region has been reported to occur September to March, with a peak in January and February (Thorbjarnarson et al., 2000). The data suggest lower numbers of marine turtles in the offshore waters of the total survey area early in the nesting season, with an increase coinciding with the peak of the nesting season. These higher numbers appear to continue beyond the end of the nesting season. However, it is noted that survey effort varied spatially across the total survey area and any patterns in spatial distribution (which are not accounted for) could contribute to the difference in sighting rates between months.

The ability to spot marine turtles is strongly associated with weather conditions, with factors such as sea state and visibility affecting sighting success. Windier weather during the south-west monsoon (wet season - May to September) is likely associated with less favourable sighting conditions compared to the north-east monsoon (dry season – November to March). It is therefore notable that sightings per 1,000 hours survey effort for marine turtles remained relatively high between May and July, with the highest sighting rate recorded in July.

Table 3.5: Records of Marine Turtle Species in Myanmar Waters

Common name	Scientific name	IUCN conservation status	Reported in Holmes et al. (2014)	Recorded in current Project
Green turtle	*Chelonia mydas*	Endangered	Confirmed	Yes
Hawksbill turtle	*Eretmochelys imbricata*	Critically Endangered	Confirmed (but rare)	Yes
Leatherback turtle	*Dermochelys coriacea*	Vulnerable	Confirmed (but rare)	Yes
Loggerhead turtle	*Caretta caretta*	Vulnerable	Confirmed	Yes
Olive ridley turtle	*Lepidochelys olivacea*	Vulnerable	Confirmed	Yes

Figure 3.5 Map of Turtle Sightings Across the Total Survey Area

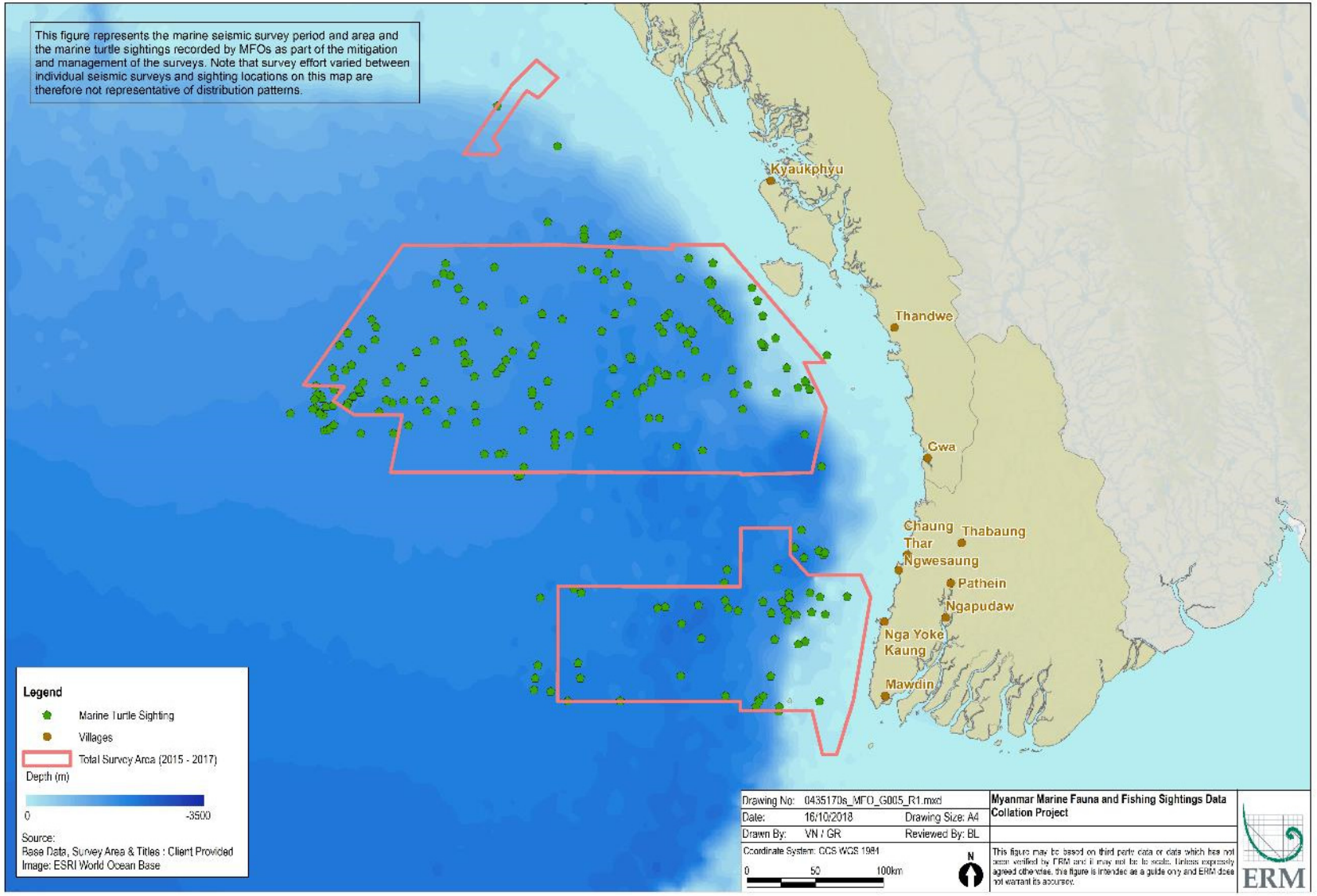


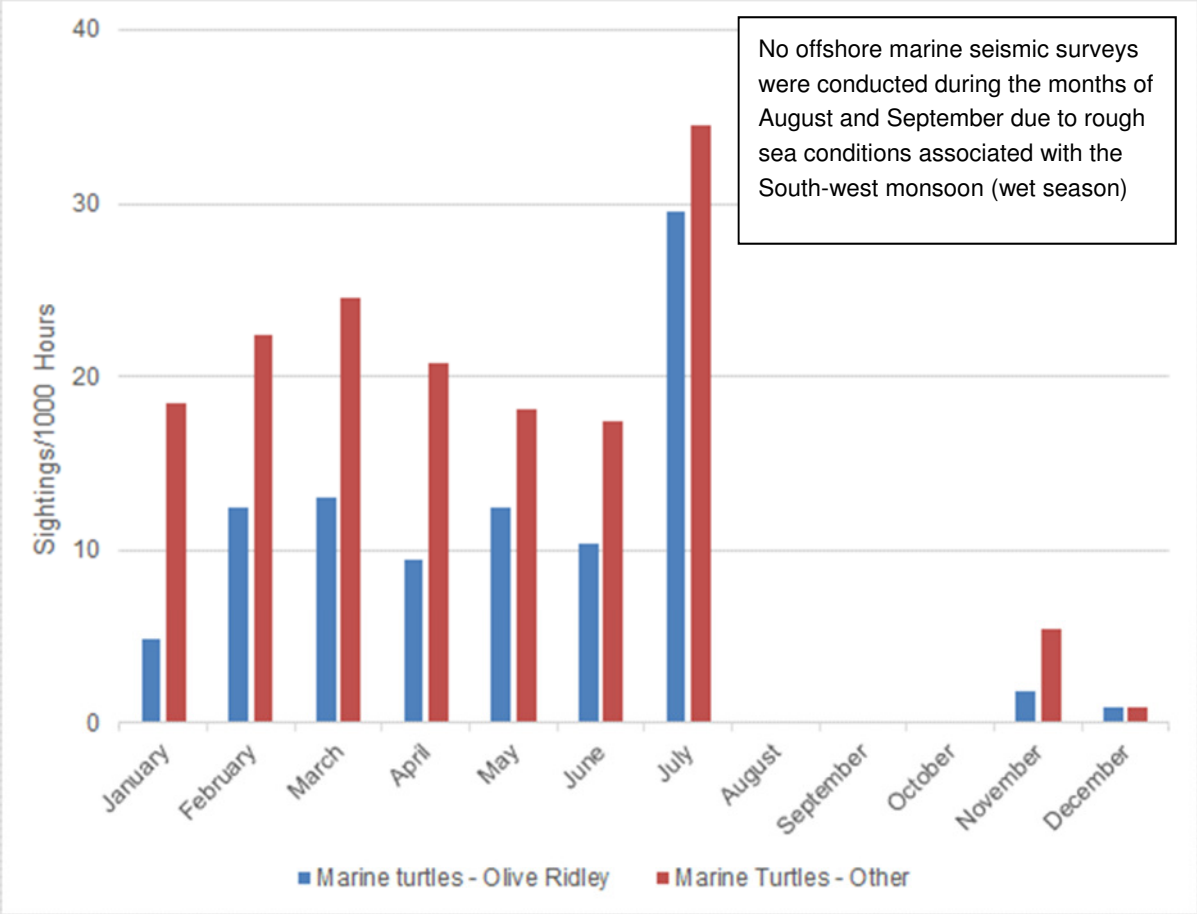
Table 3.6: Overview of Marine Turtle Sightings

Common name	Number of sightings	Number of individuals	Average/Median group size	Minimum-maximum group size
Green turtle	3	3	1/1	1
Hawksbill turtle	2	2	1/1	1
Leatherback turtle	2	2	1/1	1
Loggerhead turtle	6	7	1.2/1	1-2
Olive ridley turtle	78	82	1.1/1	1-3
Unidentified turtle	134	171	1.3/1	1-17
Total	**225**	**267**		

Table 3.7: Sighting Rates of Marine Turtles per 1,000 hours Survey Effort Across the Total Survey Area

Species or grouping	Number of sightings	Sighting rate per 1,000 hours effort
Marine turtles - Olive ridley	78	9
Marine turtles - other	150	17
Overall	**225**	**26**

Figure 3.6: Total Sightings per 1,000 hours of Marine Turtles Across the Total Survey Area by Month (Data for All Years Combined)



3.2.3 Other Wildlife Sightings

A number of other fauna species were also reported; however, these sightings were infrequent and generally not accompanied with geographic coordinates. These are summarised in Table 3.8. In particular, it is worth noting that there were three whale shark (*Rhincodon typus*) sightings, all of which were of single juveniles (approximately 4 m in length).

Table 3.8: Summary of Other Wildlife Sightings

Common name	Scientific name
Fish	
Abe's flying fish	*Cheilopogan abei*
Brown tripletails	*Lobotes surinamensis*
Dorado	*Caryphaena huppurus*
Starry triggerfish	*Abalistes stellaris*
Two-winged flying fish	*Exocoetus volitans*
Whale shark	*Rhincodon typus*
Yellow-finned tuna	*Thunnus albacares*
Unidentified fish	N/A
Unidentified sharks	N/A
Unidentified swordfishes	N/A
Reptiles	
Yellow-bellied sea snake	*Pelamis platura*
Unidentified sea snake	N/A
Birds	
Cattle egret	*Bubulcus ibis*
Germain's swiftlet	*Aerodramus germani*
Scops owl	*Otus lettia*
Watercock	*Gallicrex cinerea*
Unidentified shearwaters	N/A
Unidentified swallows	N/A
Unidentified terns	N/A

3.3 Occurrence of Fishing Activity

Fishing activity data were available for three seismic surveys (in the A-6 Thazin, A-7 Sabae and AD-5/A-7 Thazin survey areas). Fishing activity information is therefore available for seven months of the year (January to May and November/December) and over the years 2015 and 2016.

There were 234 sightings of fishing activity (Table 3.9), which equated to 103 sightings per 1,000 hours of survey effort. Of these sightings, 213 involved fishing vessels, the majority of which were deep-sea gill-netters (Figure 3.7 and Figure 3.8). Fishing activity was largely concentrated on the continental shelf within approximately 50 km of the coast. This is consistent with a recent study by the Wildlife Conservation Society – Myanmar, which reported that offshore fisheries (which have fishing grounds that overlap with the marine seismic survey areas) generally operate in water depths ranging from 50 to 100 m based on interviews with 36 offshore fishers (WCS - Myanmar 2018).

The WCS - Myanmar study also reported that fishing activity is highest in the dry season months of October through April and stops during the closed season months (June to August) during the wet season (WCS - Myanmar 2018). Of the months where fishing activity was recorded in the MFO datasets for this project, the highest sighting rates occurred between December and February in the dry season (Figure 3.9). However, it is noted that surveys that recorded fishing activity were not undertaken between June and October, and that survey effort varied spatially.

The remaining 21 sightings were of abandoned fishing gear. From the brief descriptions of fishing gear provided, most occurrences recorded involved drifting nets or ropes that became caught on part of the survey vessel or the towed seismic equipment.

Table 3.9: Sighting Rates of Fishing Activity per 1,000 hours Survey Effort across the Total Survey Area

Fishing activity	Number of sightings	Sighting rate per 1,000 hours effort
Fishing vessel	213	97
Fishing gear	21	6
Overall	**234**	**103**

Figure 3.7: Examples of Fishing Vessel Types

Source of images: Shell

Figure 3.8: Fishing Vessels by Type

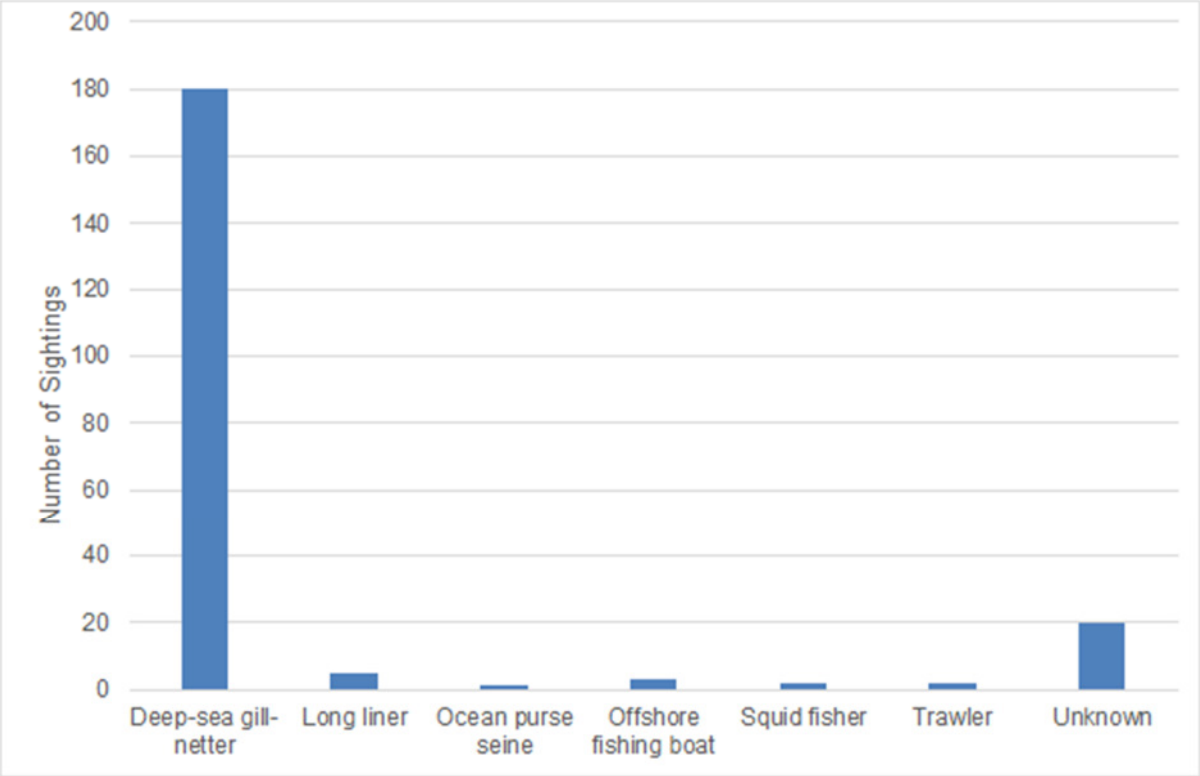
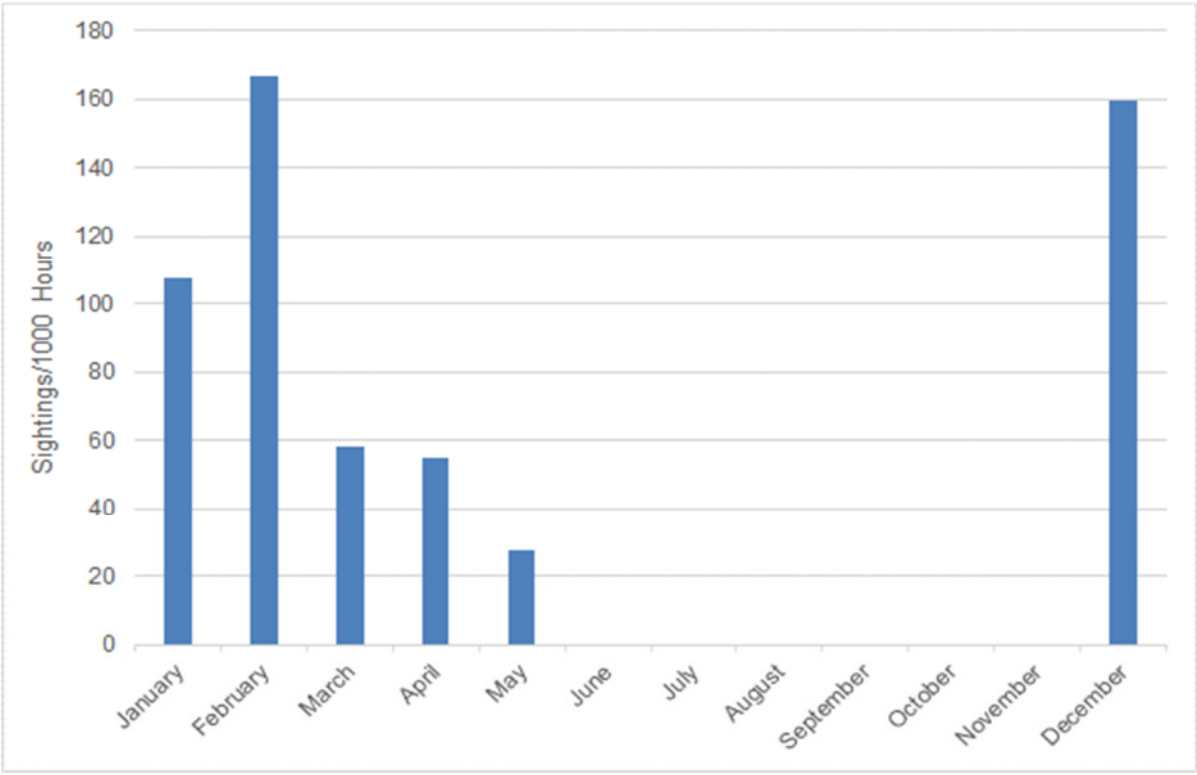


Figure 3.9: Total Sightings per 1,000 hours of Fishing Vessels by Month (Data for All Years Combined)



4. SUMMARY AND CONCLUSIONS

This report represents a large-scale description of marine megafauna occurrence in the offshore waters of northwest Myanmar recorded between 2015 and 2017, compiled through an initiative amongst seven oil and gas operators. The findings contribute biodiversity knowledge in an area where limited information currently exists, and can be used to support environmental impact assessments for future offshore oil and gas activities. Key findings are summarised below:

- Overall, 808 marine megafauna sightings were recorded across the total survey area and were widely distributed. This included 580 marine mammal sightings and 228 marine turtle sightings.
- The results from the project provide confirmation of the occurrence of 15 cetacean species and five marine turtle species. Four of the 15 cetacean species and all five turtle species had a previously confirmed occurrence in Myanmar. Another eight cetacean species were previously listed as having a 'probable' or 'possible' occurrence in Myanmar and are now confirmed by this project.
- There were records of three additional cetacean species that are understood to have been documented for the first time in Myanmar waters through this project: humpback whale, Omura's whale, and sei whale. These records were evaluated in terms of their plausibility and reliability, and were found to have a high likelihood of accuracy. The sightings confirm Myanmar as a 'country of occurrence' for humpback whales as cited in the IUCN Red List assessment (Reilly et al. 2008).
- Of all the species observed, spinner dolphins, Bryde's whales, and olive ridley turtles were the most frequently encountered and spinner dolphins most numerous. Oceanic dolphins accounted for 72% of sightings and 95% of individuals (combining the spinner dolphin, Risso's dolphin and other oceanic dolphin groups). However, the high detectability of dolphins, particularly spinner dolphins (due to their large group sizes and acrobatic behaviours), must be considered alongside such results.
- The majority of survey effort was in water depths greater than 1,000 m. Species sightings are therefore more representative of the deep oceanic waters of offshore northwest Myanmar rather than shallower areas on the continental shelf.
- The sightings represent the location of mobile individuals at a single point in time and are only indicative of the distribution of species and numbers that may be present in the region. Given the variation in spatial and temporal survey effort between individual surveys, it is not possible to draw any conclusions on distribution patterns. However, analysis of the data provided some indicative temporal patterns that may be worth further investigation with future MFO datasets or targeted marine fauna surveys:
  - Sightings of spinner dolphins and other oceanic dolphins were consistently high across most months of the year surveyed, other than June and July (note that no surveys were undertaken during August and September). During June and July there were no sightings of spinner dolphins and low sightings of other oceanic dolphins during June only.
  - Sightings of baleen whales were highest between April and June but number of sightings varied considerably between years, particularly for Bryde's whales.
  - Turtle sightings were highest in the months January to July, with no turtles recorded in October and a low number of sightings in November and December. The data suggest lower numbers of marine turtles in the offshore waters of the total survey area early in the nesting season (September to March), with an increase coinciding with the peak of the nesting season (January and February). These higher numbers continued beyond the end of the nesting season through to June and July (no surveys occurred in August or September).

- Fishing activity data had limited survey effort, but appeared to be largely concentrated on the continental shelf within approximately 50 km of the coast. Most of the fishing activity observed involved deep-sea gill-netters.

Based on the outcomes of this report, the following recommendations are made in relation to further work:

- This collation of MFO sightings data provides valuable information on the presence of a number of cetacean and marine turtle species in the deep, offshore waters of northwest Myanmar. It is recommended that oil and gas operators continue to work together in the collection and analysis of MFO data, which will further improve understanding of species occurrence and contribute additional biodiversity knowledge.
- It is recommended that all oil and gas operators in the region adopt the JNCC guidelines and reporting forms for the collection and recording of visual observations of marine megafauna using MFOs, and that the collated database is maintained with operators continuing to add future marine seismic surveys datasets. These data would then have the potential to determine the focus for future research initiatives, such as investigation of spatial and temporal trends in marine megafauna occurrence, including further exploration of preliminary findings in this report relating to the timing of marine fauna sightings across the year.

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