

Cetaceans of the Northern Bismarck Sea, Papua New Guinea¹

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Abstract: There is little known about cetaceans in the waters of Papua New Guinea (PNG). Here we present findings from the first two sets of cetacean sighting and acoustic surveys conducted within the Admiralty Island group in the northern Bismarck Sea. More than 1,000 cetaceans were sighted during our boat-based surveys—the most common being spinner dolphins (*Stenella longirostris*), followed by pantropical spotted dolphins (*Stenella attenuata*), short-finned pilot whales (*Globicephala macrorhynchus*), and sperm whales (*Physeter macrocephalus*). The relative group size of spinner dolphins was different between years with group sizes in 2010 being significantly lower (median = 15, range = 2–50) than those recorded in 2013 (median = 50, range = 5–100). The presence of large aggregations of spinner dolphins (including calves) as well as sightings of Vulnerable sperm whales suggest the northern Bismarck Sea as an area of conservation importance for cetaceans. Our surveys also provide useful baseline data for a variety of marine protected area planning processes and management initiatives that are ongoing in PNG.

Keywords: Cetacean diversity, Coral Triangle Initiative, marine protected areas, sperm whale

THE WATERS OF PAPUA NEW GUINEA (PNG) lie within the marine biodiversity hotspot of the Coral Triangle (Veron et al. 2009). Diversity and abundance of PNG marine species, most notably shallow water species such as reef fish, are likely supported by the relatively healthy coral reef systems, wetlands and mangroves, seamounts, and deep ocean basins present within the PNG Economic Exclusive Zone (EEZ) (Asian Development Bank 2015). Furthermore, the geographic location of PNG within the equatorial tropics and influence of productive

oceanographic currents and regimes all combine to provide a conducive environment for marine ecosystems and communities to thrive.

For some taxa, such as cetaceans there is less certainty concerning both species' diversity and distribution within PNG waters (Reeves et al. 1999). Miller (2009) reviewed information on cetaceans in PNG waters from various sources including pilot surveys conducted in Kimbe Bay, West Britain (Munday 1994, Visser 2003), "Discovery" tagging efforts from whaling activities (Ohsumi 1978), various anecdotal reports (for e.g., Dawbin 1972, Miyazaki and Wada 1978, Stacey and Arnold 1999, Jefferson and Karczmarski 2001), and historical sperm whale (*Physeter macrocephalus*) whaling take records (Townsend 1935). However, since Miller's review there has been a number of additions to the cetacean literature for PNG. Firstly, the work by Beasley et al. (2016) confirms the presence of Australian humpback dolphin (*Sousa sabulensis*) as well as the presence of snubfin dolphin (*Orcaella heinsohni*) in the Kikori delta region (Beasley et al.

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2005, Beasley and Rei 2011). Records of these two species likely replace previous reports of Indo-Pacific humpback dolphin (*Sousa chinensis*) and irrawaddy dolphin (*Orcaella brevirostris*), respectively, as both *S. sabulensis* and *O. heinsobni* descriptions and distributional records occurred after the reports for the given related species. Secondly, a global study on synthetic contaminants in the world's oceans, the Voyage of the Odyssey, included samples taken from sperm whales in PNG waters (for example, Wise et al. 2009, Savery et al. 2014a) (see discussion for more details). Although primarily focused on sperm whales, the unpublished Odyssey trip report also confirmed sightings of sei whale (*Balaenoptera borealis*), Risso's dolphin (*Grampus griseus*), false killer whale (*Pseudorca crassidens*), and Fraser's dolphin (*Lagenodelphis hosei*) in PNG waters (Ocean Alliance 2001). A post-graduate thesis conducted at the University of PNG provided a review of cetacean strandings, museum and anecdotal records from PNG and included two historical records (i.e., a lower jaw and skull) of ginkgo-toothed beaked

whales (*Mesoplodon ginkgodens*) recovered from a local market (Mavea 2017). Another unique species record was the detection of blue whale (*Balaenoptera musculus*) calls from broader acoustic monitoring efforts that were conducted in the Solomon Sea in eastern PNG waters (Frank and Ferris 2011). Finally, a recent review of bycatch and interactions in the longline and purse seine fisheries notes bycatch and/or interactions with sei whales, Bryde's whales (*Balaenoptera edeni*), short-finned pilot whales (*Globicephala macrorhynchus*), melon-headed whales (*Peponocephala electra*), false killer whales, and bottlenose dolphins (*Tursiops* sp.) within the PNG EEZ (Williams et al. 2020). These assorted reviews provide well-documented records for 15 cetacean species (or species groups) in PNG waters (Table 1). Additional cetacean records with either less complete, relatively dated or unverified records include pygmy killer whale (*Feresa attenuata*) (Munday 1994), humpback whale (*Megaptera novaeangliae*) (Munday 1994), Blainville's beaked whale (*Mesoplodon densirostris*) (Visser 2003),

TABLE 1

Overview of Reliable Records of Cetaceans within the Papua New Guinea Economic Exclusive Zone

Common Name	Scientific Name	Key References
Sei whale	<i>Balaenoptera borealis</i>	Ocean Alliance 2001, Williams et al. 2020
Blue whale	<i>Balaenoptera musculus</i>	Frank and Ferris 2011
Bryde's-like whale	<i>Balaenoptera edeni</i>	Ohsumi 1978, Williams et al. 2020
Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	Munday 1994, this study, Williams et al. 2020
Risso's dolphin	<i>Grampus griseus</i>	Ocean Alliance 2001, Visser 2003
Fraser's dolphin	<i>Lagenodelphis hosei</i>	Miyazaki and Wada 1978, Ocean Alliance 2001
Snubfin dolphin	<i>Orcaella heinsobni</i>	Beasley et al. 2005, Beasley and Rei 2011
Orca	<i>Orcinus orca</i>	Munday 1994, Visser and Bonaccorso 2003
Melon-headed whale	<i>Peponocephala electra</i>	Munday 1994, Reeves et al. 1999, Williams et al. 2020
False killer whale	<i>Pseudorca crassidens</i>	Munday 1994, Ocean Alliance 2001, Williams et al. 2020
Australian humpback dolphin	<i>Sousa sabulensis</i>	Beasley et al. 2016
Pantropical spotted dolphin	<i>Stenella attenuata</i>	Visser 2003, this study
Spinner dolphin	<i>Stenella longirostris</i>	Munday 1994, Ocean Alliance 2001, Visser 2003
Bottlenose dolphin	<i>Tursiops</i> sp.	Munday 1994, Visser 2003, Williams et al. 2020
Sperm whale	<i>Physeter macrocephalus</i>	Lever 1964, Dawbin 1972, Munday 1994

Records for bottlenose dolphins have been collectively listed as *Tursiops* sp. while Bryde's whales have been listed more generally as Bryde's-like whales. Additional records for seven unconfirmed, anecdotal or dated records are discussed in the text.

Cuvier's beaked whale (*Ziphius cavirostris*) (Visser 2003), rough-toothed dolphin (*Steno bredanensis*) (Visser 2003), diminutive sperm whale (*Kogia* sp.) (Visser 2003), and ginkgo-toothed beaked whale (Mavea 2017).

Mechanisms for cetacean management in PNG exist through a number of fora and conventions. On a national level, the National Biodiversity and Strategic Action Plan (NBSAP) serves as the broader environmental overview and biodiversity framework for PNG under the Convention of Biological Diversity (CBD). As a Secretariat of the Pacific Regional Environment Programme (SPREP) member country, PNG has been engaged in regional marine species' action plans (e.g., SPREP 2007, 2013) as well as numerous inter-related environmental remits of this inter-governmental agency. The Convention of Migratory Species Memorandum of Understanding for the Conservation of Cetaceans in the Pacific Islands Region (CMS Pacific Cetaceans MoU) to which the PNG government was one of the initial signatories (Miller and Prideaux 2013) works from a global perspective to support these regional SPREP plans. All of the above initiatives are funnelled within the PNG government's engagement with the Coral Triangle Initiative (CTI), an inter-governmental agreement focusing on coral reefs, fisheries and food security for the six member states (i.e., PNG, Solomon Islands, Timor Leste, the Philippines, Malaysia, and Indonesia) (CTI-CFF 2009, 2013). Each CTI member country, including PNG, has developed a National Plan of Action (NPOA) focused on the marine environment which integrates and prioritizes the CTI objectives at the national level (PNG Government 2018). Although protection of marine biodiversity is inherently woven into all of the CTI objectives, the Threatened Species objective of the PNG NPOA is most relevant for cetaceans.

This present paper reports the results of two sets of cetacean sighting and acoustic surveys conducted within the Admiralty Island group in the northern Bismarck Sea, PNG, in 2010 and 2013. These field surveys—as well as anecdotal information that was collected from community members—repre-

sents the first cetacean surveys and research data to be collected in this relatively remote, equatorial region of PNG. The study site in which the surveys were conducted is of significance as it is one of the priority seascapes noted within the regional management plan outlined through the CTI (CTI-CFF 2013). Further reasons for choosing this site were related to anecdotal cetacean sightings by community members and active agreement and interest from the local community.

Study Area

The Admiralty Island group in the Bismarck Sea, PNG, covers approx. 2,100 km² and contains 18 islands ranging from relatively small and uninhabited atolls to higher islands (i.e., Manus Island with elevations > 700 m). Shallow waters directly surround the islands (<10 m); however, there are also deeper canyons (>1,000 m) present within the area (NOAA 2020). This equatorial and tropical location is subject to elevated sea surface temperatures year-round (average 29–31 °C) (BOM 2021) with average rainfall exceeding 3,000 mm with seasonal rises from June to August (Hamilton et al. 2009). Surveys were conducted between the southern border of Manus Island (2° 51' 37.28" S, 146° 58' 17.33" E) to waters that were approximately equivalent to the northern latitude of M'buke Island (2° 23' 16.4" S, 146° 49' 48.9" E) (Figure 1). The average north-south distance between these two locations was 14 km, whereas the east-west extent was approximately 40 km.

MATERIALS AND METHODS

North-south transects from the southern side of Manus Island to the latitude of M'buke Island were conducted from a traditional PNG canoe (12 m length × 4 m wide with a flat, raised platform approximately 2.5 m above sea level—equipped with both sail and 40 hp engine) for two weeks in November of both 2010 and 2013. Ten transects were designated in a relatively even east-west array across the study area. Transects were chosen randomly on each survey day with one–three

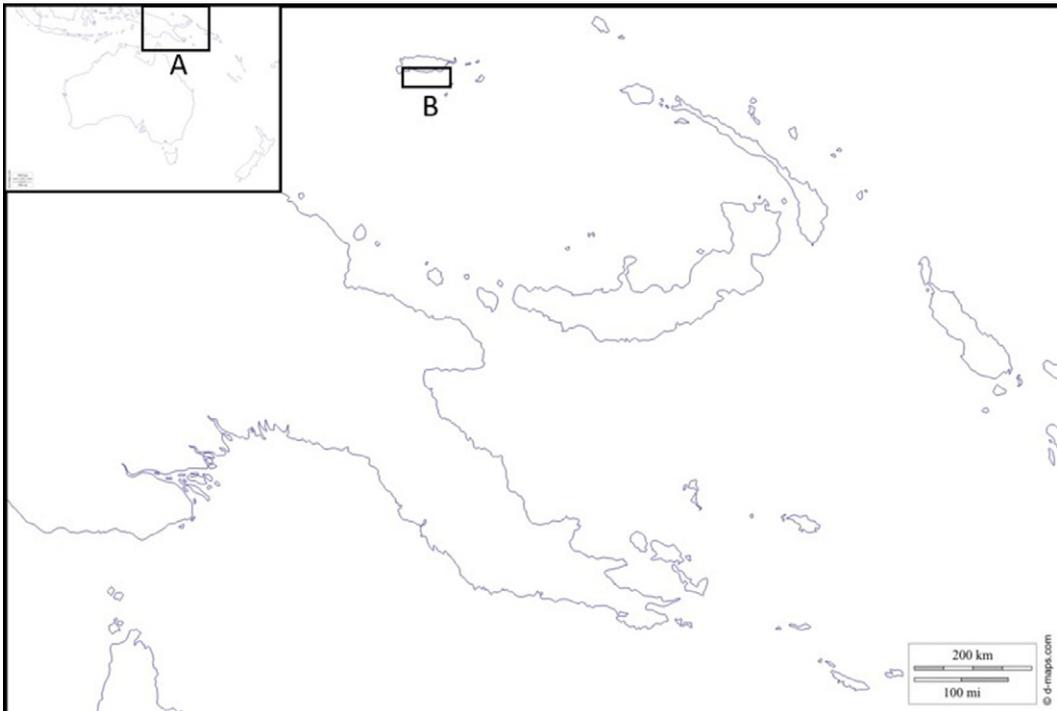


FIGURE 1. Study site location in the waters of Papua New Guinea (*A*) in the northern Bismarck Sea between Manus and M'buke Islands (*B*).

transects covered during each survey day as weather conditions permitted (Beaufort Sea State (BSS) equal to or less than 3). During each survey year all ten transects were covered in random order. Once this had been completed we started the process again and continued as time permitted. A minimum of three observers (i.e., left, right and central) were on watch during transects, using a combination of naked eye and binoculars (7×50 magnification) to search for cetaceans. Following each initial sighting the canoe would go off effort (i.e., move away from the transect line) to collect photo-identification images and to gather more detailed observations such as the presence of calves, general behavior, and confirmation of species for the whole pod. When conditions permitted, acoustic recordings using a High Tech HTI-96-MIN hydrophone with a 30 m cable attached to an M-Audio Micro track II digital recorder were also taken. In addition, acoustic listening stations (of 10-minute duration)

were taken every 2 hours throughout the survey period.

To explore whether spinner dolphin use of the study area was consistent between the two survey periods a number of statistical tests were conducted. Spinner dolphin group size was compared for significant differences between years. Wilcoxon's test for comparing two groups was used as the data set was not normal and Bartlett's test indicated that variances between years were nonhomogeneous. Differences in the distribution of relative group size of spinner dolphins encountered between years was tested using a chi-square test of independence. For this assessment, relative group sizes were designated as: small (less than 15), medium (16–49) and large (more than 50 individuals). Time of day (summarized by hour) and year were also investigated for independence using the chi-square goodness-of-fit approach. Where appropriate, standardized residuals of the chi-square values were examined to identify

which combination of factors were either lower or higher than expected for each of these statistical tests. All statistical analyses were undertaken using R statistical software (R Core Team 2017).

RESULTS

More than 500 km² coastal waters within the Admiralty Island group, PNG, were surveyed for cetaceans during the 2010 and 2013 survey periods. Ninety-two hours and 25 minutes were spent on effort along the 10 distinct north-south transects in 2010 ($n = 11$, i.e., one repeat) and 2013 ($n = 20$, i.e., all transects repeated) respectively. Sea state remained relatively conducive to sightings at all times during the survey periods ($BSS \leq 3$) with relatively calm and sunny conditions present during all 16 survey days. A total of 39 independent sightings of cetaceans were

observed during the field surveys (Figure 2, Table 2). Of the 18 sightings during 2010, a majority were of spinner dolphin pods. A minimum estimate of the number of individuals sighted in 2010 was 275 animals—ranging in group size from 2 to 50 individuals with an average group size (± 1 SD) of 17.2 ± 14.1 individuals. All groups were initially detected visually with the exception of the sperm whale which was first detected acoustically during a regular listening station period. This sperm whale individual was subsequently confirmed visually. In addition to the sightings of sperm whale and spinner dolphins—a small group (6 individuals) of short-finned pilot whales was also observed. During the 2013 surveys, 21 cetacean sightings were documented. Again, a majority (66%) of all sightings were of spinner dolphins. In addition, two mixed groups of spinner dolphins and pantropical spotted

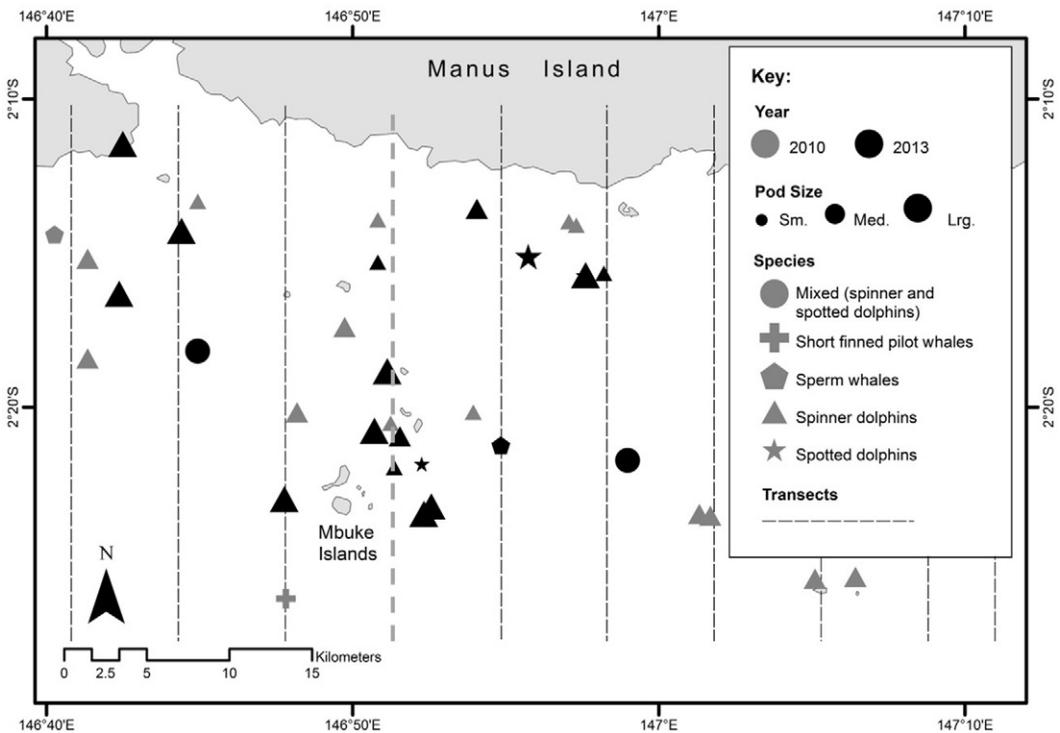


FIGURE 2. Sighting patterns of whales and dolphins along surveyed transects in 2010 and 2013. Approximate pod size is scaled as Sm. (Small: less than 15 individuals), Med. (Medium: between 16 and 49 individuals), and Lrg. (Large: more than 50 individuals).

TABLE 2
 Cetacean Species Sighted on M'buke Field Surveys
 During 2010 and 2013 Research Trips

Species or Species' Groups	Year	Number of Sightings	Minimum Number of Individuals Sighted
Spinner dolphin (<i>Stenella longirostris</i>)	2010	16	275
	2013	14	750
Pantropical spotted dolphin (<i>Stenella attenuata</i>)	2010	–	–
	2013	3	70
Mixed group of spinner and pantropical spotted dolphins	2010	–	–
	2013	2	40
Sperm whale (<i>Physeter macrocephalus</i>)	2010	1	1
	2013	2	9
Short-finned pilot whale (<i>Globicephala macrorhynchus</i>)	2010	1	7
	2013	–	–

The number of sightings as well as minimum number of individuals for each species within each year is also presented.

dolphins of minimum size 15 and 25 (respectively) were observed. Three additional groups containing only pantropical spotted dolphins of minimum sizes 8, 10 and 50 were also observed. Two groups of slow-moving and deep-diving sperm whales were also present during the 2013 surveys. Two different sightings of single, relatively small, unidentified balaenopterid (rorqual) (*Balaenoptera* sp.) were also sighted. Given the location of our surveys these individuals are most likely Omura's whales (*Balaenoptera omurai*), Eden's whales (*Balaenoptera edeni edeni*), or dwarf minke whales (*Balaenoptera acutorostrata* unnamed subspecies). However, due to the relative distance of the individuals from the boat and no collection of images, these identifications remain unconfirmed. In total there were more than 850 cetaceans encountered during the second year of Admiralty Island surveys. In both years, calves were noted in both spinner dolphin and pantropical spotted dolphin groups.

The sizes of spinner dolphin groups sighting during our surveys were significantly

different between years ($W = 45$, $p = 0.005$). Group sizes in 2010 were significantly lower (median = 15, range = 2–50) than those recorded in 2013 (median = 50, range = 5–100). The distribution of group sizes (see Methods and Materials) of spinner dolphins was also significantly different between years ($\chi^2 = 6.316$, $df = 2$, $p = 0.043$). Inspection of the standardized chi-squared statistic residuals revealed higher than expected occurrences of large groups during 2013. The distribution of group sizes was not different in relation to time of day ($\chi^2 = 2.682$, $df = 6$, $p = 0.848$). Furthermore, the time of day at which sightings were recorded did not differ between years ($\chi^2 = 0.277$, $df = 3$, $p = 0.964$).

DISCUSSION

Our northern Bismarck Sea surveys represent the first published records of whales and dolphins in this relatively remote and pristine region of PNG. Sightings of large aggregations of spinner dolphins, including calves, suggest that the northern Bismarck Sea provides critical habitat for this species. Our sightings of sperm whales in this region is also important given the Vulnerable conservation status of this species and the relatively high pollutant loads of lead in this species sampled in PNG waters (see discussion below). These findings also provide useful baseline data for a variety of marine protected area planning processes and management initiatives that are ongoing in PNG.

Spinner dolphins are the most commonly reported species across the tropical and subtropical Pacific Islands (Miller 2009, Lammers 2019). More detailed studies in numerous locations across the region suggest that these populations are primarily resident with restrictions to individual island (Oremus et al. 2007) and coral reef systems in some cases (Cribb et al. 2012). The spinner dolphin pods observed in our study occurred in relatively large groups (aggregations) with behavior that varied between moderate resting and relatively active social interactions and displays (such as leaping and spinning). We observed significant differences in the median group size for spinner dolphins in the two

survey years, i.e., 15 versus 50 for 2010 and 2013 respectively. These discrepancies were found despite consistency in temporal (i.e., time of year and time of day), spatial, environmental (i.e., BSS and general weather conditions), research team members, and research platform between the two survey periods. Furthermore, we implemented randomization in transect coverage and a temporal and spatial lag in effort to limit the possibility of double-counting. We sighted spinner dolphins in both somewhat shallow waters proximal to the numerous islands, as well in relatively deep waters close to submarine canyons. On numerous occasions when group size was greater than 50 individuals, we observed a tight grouping of 10–15 calves congregated in the centre of the given group. Complementary biodiversity surveys conducted by our research team reported numerous sightings of bull sharks (*Carcharhinus leucas*), so it is possible that social behavior of spinner dolphins in this area may in part be the need for protection. Further studies on

group fidelity and habitat use would provide additional insights into the ecology of spinner dolphins in our study area.

The spinner dolphins sighted in our study are most likely Gray's spinner dolphin (*Stenella longirostris longirostris*) (Figure 3) as evidenced by the slender beak, triangular and falcate dorsal fin, and colour pattern on the body along with the observations of typical spinning behaviour (Perrin 2009). However, our PNG study site is proximal to the distribution of the dwarf spinner dolphin of central Southeast Asia (*Stenella longirostris roseiventris*) which is described as including the “shallow inner waters of Southeast Asia, including the Gulf of Thailand, Timor and Arafura Seas, and similar waters of Indonesia, Malaysia, and northern Australia” (Perrin et al. 1999). The nature of our survey did not allow morphometric measurements or comparisons to be made; however, the personal observations of the authors were that at least some of the individuals observed in our surveys were somewhat smaller in length that

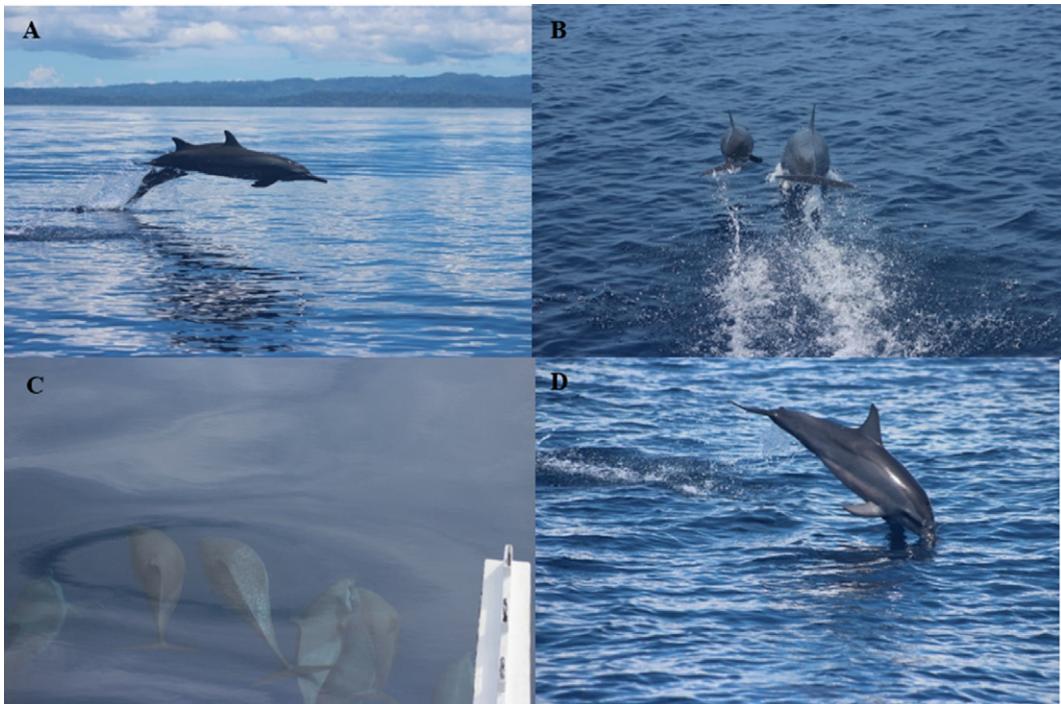


FIGURE 3. Images from the field surveys of (A) spinner dolphin adults, (B) a mother and calf pair, (C) a mixed pod of spinner dolphins and pantropical spotted dolphins, and (D) a smaller spinner dolphin individual with pink colouration present on the belly. All images copyright C. Miller.

S. l. longirostris seen elsewhere in the Pacific Islands (e.g., in Fijian waters). Documentation of the pink belly in some individuals (Figure 3) is similar to those of *S. l. roseiventris* individuals in the Philippines (Perrin et al. 2007). However, the lack of morphometrics or genetic data in this current study as well as uncertainty as to whether subadults may have been under observation mean that we are unable to confirm with certainty that any spinner dolphin subspecies other than *S. l. longirostris* were present.

The presence of sperm whales in the northern Bismarck Sea was also important, yet not surprising given historical whaling records (Townsend 1935). Townsend's (1935) charts reported 308 takes within the PNG EEZ between 1761 and 1920. These records suggest that there were numerous geographic regions within the PNG EEZ that included (at least historically) suitable habitat for sperm whales. Jaquet and Whitehead (1996) looked for environmental correlates of sperm whales in waters to the east of PNG and found secondary productivity and topography were linked to sperm whale density when considered at relatively large spatial scales. The Voyage of the Odyssey trip reported more than 350 individuals during a 6-month period, primarily in the Bismarck Sea. Although this total may include individuals that were seen on numerous occasions, the relatively confined geographic location suggests that suitable environmental conditions were available and that this is an area in which sperm whales were aggregating during the reported period.

Of the sperm whales sighted during the Voyage of the Odyssey trip, twenty-three biopsy samples were collected and a variety of heavy metals were sampled including silver, arsenic, barium, chromium and gold (Savery et al. 2013, Savery et al. 2014a, Wise et al. 2009, Wise et al. 2011). Levels of lead were relatively high in PNG sperm whales with one of the females being the highest recorded globally (Savery et al. 2014b). The migratory nature of sperm whales along with the lack of individual identification of animals from this study places some uncertainty as to whether the biopsied sperm whales accumulated these levels of lead within the PNG EEZ. Sperm

whales have been documented in nearby EEZs including the Solomon Islands (Kahn 2006) and Indonesia (Mustika et al. 2009). It is unknown whether these populations intermingle with those in PNG waters. The results of these pollutant studies along with the conservation status of this species suggest the necessity for further research and appropriate environmental impact assessment studies on sperm whales in PNG.

Anecdotal conversations with M'buke Island community members provided support for the relatively consistent and regular presence of the four species visually sighted during our surveys. All discussions confirmed having recently seen spinner dolphins, with a number of references to individuals of smaller size (presumed to be calves). The blunt head of both the short-finned pilot whale and the sperm whale were noted, as was the shape of the dorsal fin of the former species (described as "fat," "squashed," and "pressed down" by various villagers). The approximate length of individuals seen for both of these species (most often expressed in comparison to the length of their boat) was also recalled. Finally, a number of community members described accurately the shape of the tail as well as some details of the diving behaviour of what may have been sperm whales. In addition, we heard multiple, independent descriptions of orca (*Orcinus orca*) being present within the study area on a seasonal basis. The timing of sightings was referenced in a few cases to the latter part of the year (i.e., September and October), but not specifically recalled by all community members. Orca has been documented in other parts of PNG, most notably the Kimbe Bay area which also lies within the Bismarck Sea to the south-east of M'buke Island (Visser 2003, Visser and Bonaccorso 2003). Habitat suitability modelling provides support for both these reported and tentative sightings of orca within the Bismarck Sea basin (Kaschner et al. 2016).

The importance of the Bismarck Sea for cetaceans has recently been recognised through the activities of the Marine Mammal Protected Areas Task Force which was created by the International Committee on Marine Mammal Protected Areas, the IUCN, and

members of the IUCN Species Survival Commission. A workshop focused on the Pacific Islands held in 2017 engaged regional experts to identify Important Marine Mammal Areas (IMMAs), defined broadly as “discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation” (IUCN MMPATF 2017). The Bismarck Sea region of 22,533 km² was proposed as an IMMA based on the documentation of both reproduction and feeding of orca in Kimbe Bay, presence of sperm whales (as a species of conservation concern on the IUCN Red List), as well as the number of cetacean species with confirmed (albeit anecdotal) records in this area.

CONCLUSIONS

Increasing the baseline knowledge of the diversity, critical habitat, and behaviour of cetaceans in the Bismarck Sea has multiple applications, including biodiversity modelling, conservation management, and threat abatement. Our research surveys suggest the importance of this area for spinner dolphins, along with pantropical spotted dolphins and sperm whales. It is likely that additional effort may reveal a much richer diversity of cetacean species’ using this area. Integration of cetaceans within the many useful marine management frameworks in PNG is recommended. For example, we suggest that our findings could (i) be used within the monitoring and reporting requirements of the CTI Threatened Species plan, (ii) provide baseline data for the PNG NBSAP, and (iii) aid in future discussions of the relative ecological and biological importance of the northern Bismarck Sea. We hope that that our records of sperm whale presence in this region might provide a platform for further research efforts on this species within PNG waters.

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