Habitat use and site fidelity of Irrawaddy dolphins (Orcaella brevirostris) in the coastal waters of Bago-Pulupandan, Negros Occidental, Philippines

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Abstract. The Irrawaddy dolphins in Guimaras Strait compose the second population to be reported in the Philippines. Their very small population size, isolation, and high vulnerability to human-induced threats in the coastal areas have earned them a local conservation status of critically endangered. Appropriate conservation and management of this species will need a better understanding of their relationship with their known habitat and interactions with human activities. Regular boat-based surveys were conducted in a defined study area in the coastal waters of Bago and Pulupandan, Negros Occidental, Philippines, to document behaviour and gather photo ID data from 2010 to 2016. Behaviour and habitat use were quantified using area use and activity indices, while site fidelity was analysed using photo catalogues. Of the nineteen catalogued individuals, at least eight dolphins were present throughout the study, indicating high site fidelity. The dolphins used a relatively small nearshore area spanning a commercial port and northward towards the mouth of Bago River. The Minimum Convex Polygon area is estimated at 12.68 km² and is one of the smallest core areas known to have been recorded for this species. The dolphins showed a preference for areas with a steep increase in water depth and were often observed foraging, highlighting the importance of these areas as feeding grounds. Several threats to the dolphins were identified, most of which are related to human activities. Identifying the behavioural aspects of the Irrawaddy dolphins’ local ecology helps put the scope and limitations of managing their population into perspective and provides the critical information needed to delineate special management or conservation areas in their habitat.

Keywords. Irrawaddy dolphin, habitat use, behaviour, site fidelity, Guimaras Strait

INTRODUCTION

The habitat ranges of animals are often dictated by the heterogeneity of resources. Animals may move in different patches within their habitat or allot more energy to migrate to different habitats either spontaneously or seasonally to fulfill their physiological needs (Stern, 2002). Preference to stay in a particular area for long periods can indicate reliability to food resources, availability of mates, and protection from predators (Karczmarski et al., 2000; Parra et al., 2006). However, wildlife habitats are becoming more threatened as human populations increase and exploit more natural resources. Human expansion into natural habitats increases the survival pressure on animals, especially those with limited home range and high site fidelity. For marine ecosystems, rapid development in coastal areas is identified as one of the biggest drivers of extirpation of large, slow-producing marine vertebrates such as dugongs (Dugong dugon), whale sharks (Rhincodon typus), crocodiles, and coastal cetaceans (Smith & Jefferson, 2002; Parra et al., 2006).

The Irrawaddy dolphin (Orcaella brevirostris) is an endangered cetacean species found in small patchy populations in coastal, estuarine, and riverine habitats (Baird & Moussounphom, 1997; Stacey & Arnold, 1999; Smith & Jefferson, 2002; Kreb, 2004; Baird & Beasley, 2005; Peter, 2012). Throughout their distribution in the tropical and subtropical Indo-west Pacific, Irrawaddy dolphin populations have declined in the past century due to habitat destruction, pollution, disease, hunting, and by-catch (Smith & Jefferson, 2002; Whitty, 2015; Minton et al., 2017). Most of their regional populations, including those in the Philippines, have been declared as critically endangered (Dolar et al., 2012; Minton et al., 2017; Dolar et al., 2018).

Irrawaddy dolphins in the Philippines are distributed into three geographically distinct populations: within the inner Malampaya Sound (Dolar et al., 2002; Smith et al., 2004;
Aquino et al., 2006; Matillano, 2007; Whitty, 2016), in the coastal waters of Quezon Province in western Palawan (Matillano, pers. comm.), and the Iloilo and Guimaras Straits in the Visayan Region (de la Paz, 2012; Dolar et al., 2012; Casipe et al., 2017). Their habitat preferences are often small, restricted areas utilised by human communities (e.g., artisanal fisheries, navigational lanes, etc.), making them vulnerable to net entanglement, boat strikes, and pollution (Gonzales & Matillano, 2008; Dolar et al., 2011; Whitty, 2016). All populations have been reported to be very small, with each comprising no more than 100 individuals (Dolar et al., in prep; Whitty, 2016).

In Guimaras Strait, regular sightings of Irrawaddy dolphins occur in the inshore waters of Bago and Pulupandan, Negros Occidental (de la Paz, 2012; Dolar, 2012; Dolar et al., 2018), where daily human activities like gill and tidal net fishing, and ferry boat travel are also occurring (de la Paz, 2012; Dolar, 2012; Casipe et al., 2017). Population size estimates using mark-recapture analysis were 18–23 dolphins (95% C.I.) in 2014 (Silliman University, 2014), which declined to 9–19 individuals in 2016 (Dolar et al., unpublished data). The population trend is predicted to decrease further as mortalities have been reported at least once a year (Silliman University, 2014). The causes of these mortalities have not yet been properly assessed. While conservation programmes have recently been initiated, proper conservation and management can only be effective if there is a thorough understanding of the species’ behaviour and autecology. This paper aimed to describe the habitat use and site fidelity (through individual sighting rates) of Irrawaddy dolphins in Guimaras Strait using data collected during boat-based dolphin monitoring surveys conducted from 2010 to 2016.

**MATERIAL AND METHODS**

**Study Site.** The coastal waters of Bago City and the Municipality of Pulupandan were chosen as the focus site of regular dolphin monitoring due to the reliability of Irrawaddy dolphin sightings there. The coast is on the southeastern border of the Guimaras Strait, a narrow channel between the islands of Negros, Guimaras, and Panay in the central Philippines (Fig. 1). The study area covered approximately 16 km² of inshore waters from Barangay Sampinit in Bago City to Barangay Palaka Sur in Pulupandan. The boundaries of the study site were based on the farthest areas where dolphin sightings usually ceased (Fig. 2). The area is estuarine, receiving freshwater, silt, and mineral input from Bago River and several smaller creeks. Average salinity during the survey period was 33.14 ppt while average sea surface temperature was 30°C. The water was always silty, with turbidity averaging at 30.18 NTU (Silliman University, 2014). The habitat is characterised as mostly soft-bottom,
with muddy and sandy shores and patchy mangroves fringing some parts of the coastline. It is strongly influenced by the movement of tides, which move in a northerly direction during flooding and southerly direction during ebb tide (Formilleza et al., 2014; Silliman University, 2014). Most of the area is also relatively shallow, with an average depth of 5 m and a range of 0.5–11 m. Deeper areas were located near the port in Barangays Zone 6 and Canjusa of Pulupandan where there were regular dredging operations. Docking of cargo ships and ferry boats, gillnet fishing, crab pots, and handline fishing are some of the activities observed within the study site. Permanent tidal nets used to harvest seasonal *Acetes* spp. are stationed along the study area and are considered a major source of livelihood in Pulupandan (Casipe et al., 2017).

**Sampling Method.** Boat-based surveys of dolphins were conducted using a 6-m wooden artisanal fishing boat during periods when the study site was protected from monsoon winds (i.e., from April to September 2010, May to November 2011, April to August 2014, April to September 2015, and April to August 2016). Surveys were conducted from 0630 to 1130 hours during favourable sea conditions (Beaufort Sea State ≤3). These were limited in the morning as winds often picked up by midday, increasing the Beaufort Sea States >3. Surveys conducted in the afternoon also yielded very poor sightings. Surveys were launched from Paco Beach, Pulupandan and followed a predetermined route parallel to the coastline going northeast towards Sampinit, Bago City with average speeds of 8–12 kph. Observers scanned the left, right, and anterior sides of the boat both with and without binoculars. The time spent searching for dolphins is termed as “search effort time” and any sighting during this time was considered “on-effort sighting”. Once dolphins were spotted, search effort was interrupted and the dolphins were approached slowly, with the least disturbance as possible. Time and location of the sighting were recorded using handheld Garmin GPS 120H, while the estimated dolphin group size and group activity were noted every 5–10 min. Photographs of dolphins’ dorsal fins were taken using Canon DSLR 550 and 700D cameras with 75–300 mm lenses. An effort was made to ensure that all dolphins in the group were photographed. The time spent observing the dolphins that were within ~50 m radius from the research boat was considered as “interaction time”. During this time, the boat engine was turned off to allow less noise and movement as possible. When dolphins moved away from the observable area, a 2-min buffer time was allotted before the boat engine was turned on again and the dolphins were followed at minimum speed and at least 10 m distance. When dolphins disappeared, this was declared as “dolphins lost”, and the general survey would resume. A Minimum Convex Polygon (MCP) was calculated to delineate the extent of the core area used by the dolphins by plotting GPS coordinates of all sightings into a map of the survey site using QGIS 2.18.
Photographs taken during the survey were used to identify individual dolphins. All photographs were sorted as either ‘usable’ or ‘unusable’ for photo identification. ‘Usable’ photographs included images of the dolphins’ dorsal fin, fluke, or flippers that would qualify for photo-ID; these were then further sorted as ‘poor’, ‘good’, or ‘excellent’ based on the quality and the distinctness of the image. Photographs were classified as poor if the dolphin was either too small in proportion to the frame, blurred, or is not positioned perpendicular to the photographer, therefore not showing the lateral side of its dorsal fin. ‘Good’ photographs consisted of dorsal fins and flukes laterally positioned in the frame and were large enough to show distinguishing marks, while ‘excellent’ photographs further allowed better distinguishability of each dolphin based on clear marks and other diagnostic features. For analysis of dolphin sight fidelity, only ‘excellent’ photos were used.

Individual dolphins were identified from the photographs by using recognisable marks and nicks on the leading and trailing edges of their dorsal fins. In addition, unusual dorsal fin shapes and markings on the dorsal part of the body were considered. Successive shots of diving dolphins also allowed the identification of unique scars and nicks found in flukes, which were then paired up with the corresponding dorsal fin (Cockcroft & Karczmarski, 1998; Parra & Corkeron, 2001). Dolphins with unique, distinguishing marks on their dorsal fins were included in a catalogue database and given individual identification numbers. Identified dolphins that were re-sighted during the succeeding surveys were recorded and compared each month and year. Over the 25 survey months, the number of identifiable dolphins added into the catalogue was noted using a Discovery curve, which was expected to plateau when no more new individuals were added throughout the surveys.

Group behaviour, defined as the dominant behaviour of the group at any time, was categorised as either foraging, socialising, resting, or traveling, following the descriptions of Karczmarski et al. (2000). Other behavioural events such as water spitting, flippering, and spyhopping were also noted. Due to the low population size, any number of Irrawaddy dolphins observed during the survey was assumed and treated as one ‘social group’, although different authors have used varying operational definitions of a group (Karczmarski et al., 2000; Gowans et al., 2007).

**Data Analysis**

**Area use and Activity index.** To measure the extent of the dolphins’ habitat (area) use, the Bago-Pulupandan coastal area was divided into 16 polygonal sectors, each approximately 1 km in width, and 2 km in length measuring seaward from the coastline (Fig. 2). However, the irregular contour of the coastline made it impossible to measure all sectors with the same area, therefore some sectors were more extensive than others. Sighting coordinates were plotted into the map using QGIS 2.18 software and this was used to determine which specific sectors were most and least used by the dolphins by measuring the time spent in each area/sector. Area use (AU) was computed as:

\[ AU = \frac{D}{T} \]
Table 1. Sectors and corresponding geographical locations shown in the nMDS.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Corresponding geographical locations</th>
</tr>
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<tbody>
<tr>
<td>1, 2, 3, 4, 5</td>
<td>South of port</td>
</tr>
<tr>
<td>6</td>
<td>Port area</td>
</tr>
<tr>
<td>7, 8, 9, 10, 11</td>
<td>North of port</td>
</tr>
<tr>
<td>12</td>
<td>Bago river mouth</td>
</tr>
<tr>
<td>13, 14, 15, 16</td>
<td>East of river</td>
</tr>
</tbody>
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Where D is the time spent by dolphins in a particular sector, and T is the total observation time on any one day (Karczmarski et al., 2000). A mean Coefficient of Area Use was calculated for each of the 16 sectors.

Moreover, the Activity Index (AI) was used to quantify the activity of the dolphins in the study site. It ranges from 0.0 to 1.0 and represents the time the animals were engaged in a particular activity (behaviour) within a sector, as a proportion of the total time spent by dolphins in this sector during any one day (Karczmarski et al., 2000):

\[
AI = \frac{B}{S}
\]

Where B is the time that the dolphins were engaged in a particular activity within a particular sector, and S is the time spent by dolphins in any one sector. The Activity Index, and subsequently mean AI, was calculated separately for each of the four categories of behaviour. Analysis for area use and activity index included pooled behavioural data from 2011, 2014, 2015, and 2016.

**Site fidelity.** Site fidelity is a measure of the relative length of time in which individual dolphins were found in the entire study area. It was calculated as: (1) the monthly sighting rate, or the number of months an individual dolphin was sighted as a proportion of the number of months in which surveys were conducted; and (2) the yearly sighting rate, or the number of calendar years an individual dolphin was sighted as a proportion to the number of total calendar years surveyed (Parra et al., 2006). For yearly analysis, data from identified dolphins included in the 2012–2014 catalogue (Silliman University, 2014) were compared to dolphins sighted in 2010, 2011, 2015, and 2016.

**Statistical analysis.** Multivariate analysis of AI per behaviour and sectors per monthly sampling was performed in PRIMER version 6.1 (Clarke & Warwick, 2001) to investigate potential relationships between time spent per behaviour and geographic location. A similarity matrix based on Euclidean distance was made using the activity indices per monthly sampling. A non-metric Multidimensional Scaling (nMDS) was then generated from the matrix to visualise relatedness or clustering of sectors in terms of time spent by the dolphins for each activity. Only AI data from sampling months with at least 4 sampling days were used, while months with no sightings were excluded from the analysis. For a more relevant interpretation of results, the nMDS plot was visualised by substituting sectors with geographical locations within the study site (Table 1). Area use was also tested for correlation with average depth of each sector using Pearson product moment.

**RESULTS**

A total of 128 survey days (spanning 25 months) were completed during 2010, 2011, 2014, 2015, and 2016 combined, resulting in 237 interaction hours. Dolphin interaction was highest between 0700 and 1000 h and usually decreased thereafter. Interactions usually lasted until midday when the dolphins tended to spread out and became difficult to follow. Despite active efforts to follow them or resume search efforts, dolphins were more difficult to relocate around this time.

Nineteen recognisable dolphins were used to construct the Discovery curve over 25-survey months. Eight (42%) dolphins were identified and included in the catalogue in the first two months of 2010. Seventeen dolphins were identified until the 18th month, and two more individuals were added after that (Fig. 3).

**Area Use.** Sightings of dolphins occurred within the same areas in the 7 years of study, indicating a critical diurnal habitat in coastal areas near Barangay Sampinit in Bago City down to Barangay Zone 1A in Pulupandan. The dolphins were frequently sighted very close to the coastline and seldom seen farther than 2 km from shore (Fig. 4A). The Minimum Convex Polygon (MCP) or the area that contained all sightings, was calculated to be 12.68 km² (Fig. 4B).

Area use was not evenly distributed throughout the study area. There was a clear preference for areas north of the port (Sectors 6 and 7) to areas outside the mouth of Bago River (Figs. 4, 5; nMDS stress = 0.17). The dolphins were only sighted within 12 out of 16 sectors and were never sighted south of Sector 3 and north of Sector 13.

Dolphin sightings were associated with areas adjacent to drop-off zones or steep slopes with an average depth of 10 m (Sectors 6–9) (Fig. 4A). The time spent by the dolphins in each sector was positively correlated to the average depth of each sector (r = 0.525, P = 0.037) (Fig. 6).

**Activity Index.** Compared to other activities, the dolphins spent most of their time foraging. This was followed by socialising, traveling, and then resting. Fish surfacing out of the water after being chased by dolphins, or sometimes being deliberately thrown out the water by the dolphins themselves, were also observed during their foraging activities. Other foraging-associated behavioural events such as water-spitting and flippering were also often observed.

Foraging was predominantly done north of the port area (Fig. 5) with the greatest time spent feeding in Sector 7 (Fig. 7). In this area, a steep slope leads to a deep underwater canal that reaches up to 11 m deep. This slope can possibly cause
Fig. 4. A, sightings of Irrawaddy dolphins (in yellow dots) relative to sectors; B, minimum convex polygon (MCP) of all sightings in Bago-Pulupandan coastal waters.
Fig. 5. Non-metric Multidimensional Scaling of activity index in relation to geographic location. Straight lines indicate the degree of influence of each behaviour based on the distribution of clustered eigenvalues.

Fig. 6. Strong positive correlation between time spent in each sector with average depth.
upwelling of deep water currents to the surface, bringing nutrients and organisms to the surface.

There did not appear to be an area preference for socialising behaviour (Fig. 7), although it appears that areas with the highest activity index for socialising are similar to where foraging was also high. Different forms of social behaviour between two or more individuals were also observed, usually between calves and adults. Socialising included various vigorous activities like leaping out of the water and prolonged body-to-body contact between two or more dolphins. Dolphins were occasionally seen rolling on each other at the surface as well, suggesting possible mating behaviour.

Similarly, no preference was evident for areas used for traveling and resting (Fig. 7). Traveling was usually observed when dolphins moved from one feeding area to another, or when they moved toward the edges of the identified study area and slowly scattered and disappeared. Resting was the least observed activity for Irrawaddy dolphins. For most pelagic cetaceans, resting usually involves floating on the surface like a log for several minutes, hence the term “logging”. However, logging was never observed in Irrawaddy dolphins during the day, and it could be possible that they log mostly at night or do not log at all. In this study, resting was only described when the dolphins were milling, or surfaced sluggishly, with no particular activity or swimming direction.

**Site Fidelity.** Over seven years, only 19 individuals had dorsal fin marks remarkable enough to qualify them to be included in the catalogue (Fig. 3). This is not interpreted as the total number of dolphins in the population, even though the most recent population estimate resulted to only 9–19 individuals in 2016 (Dolar et al., unpublished data), since 28.2% of the dorsal fin data used during the study comprised of unidentifiable dorsal fins.

Eight of the nineteen (42%) identified dolphins were sighted in more than half of the total survey months. Most of these belonged to the first group of dolphins to make it to the catalogue identified in 2010. Three individuals were only sighted once in 25 months (Fig. 8).

The dolphin identified as N-14 was associated as the calf of N-06 in 2013 and both dolphins were constantly seen together. By 2014, N-14 had a lower sighting rate than in 2013 and was no longer sighted swimming close to N-06. N-14 had grown in size and its dorsal fin was harder to identify.

**DISCUSSION**

The consistent sightings of Irrawaddy dolphins in Bago-Pulupandan since 2010, or even further before as claimed by fishermen, is strong evidence that this estuary and its surrounding coastal waters are a critical part of the dolphins’ home range. However, the total core area of 12.68 km² occupied by the dolphins during the surveys represents one of the smallest core ranges of Irrawaddy dolphins. In the Mekong River (Cambodia/Laos Border-Vietnam Delta), Beasley (2007) reported an average of 11.9 and 40.2
km$^2$ during dry and wet seasons respectively, while Kreb (2004) reported an average of 10 km distance home range for Irrawaddy dolphins in the Mahakam River, Indonesia. In Kuching Bay, Malaysia, they were known to occupy 246.42 km$^2$ and 37.22 km$^2$ representative and core areas, respectively (Peter et al., 2016), while in Chilika Lagoon, India, they were reported to occupy 280 km$^2$ and 61 km$^2$ representative and core areas, respectively (Sutaria, 2009; Sutaria & Marsh, 2011). In Malampaya Sound, Philippines, where the dolphins are known to be confined to the inner part of the Sound, Whitty (2016) recorded a total of 93.1 km$^2$ of area occupancy. Guimaras Strait, the larger body of water where the Bago-Pulupandan coastal waters are a part of, is an open habitat and loosely connected to Iloilo Strait where they have been previously sighted (Dolar, 2009). However, surveys in 2010–2011 and 2012–2013 did not record any sightings in Iloilo Strait (Dolar et al., unpublished data), making the Irrawaddy dolphins’ maximum representative range difficult to delineate.

Irrawaddy dolphins have also consistently been observed (diurnal) feeding in the Bago-Pulupandan area, similar to other coastal species (Karczmarski & Cockroft, 1999; Karczmarski et al., 2000; Shane, 2004). The high incidence of diurnal foraging in areas between Pulupandan port in Barangay Zone 6 and Barangay Sampinit, including the mouth of the Bago River, shows that these areas are important feeding grounds. The habitat in Bago-Pulupandan is characteristic of most coastal habitats preferred by Irrawaddy feeding, which are usually shallow and highly turbid (Arnold, 2002; Dolar et al., 2002; Parra et al., 2002; Stacey & Hvenegaard, 2002; Kreb, 2004; Smith et al., 2004; Tun, 2004; Reeves et al., 2008; Peter, 2012; Peter et al., 2016). The soft-bottom habitat is likely to be enriched by nutrients brought by river input and upwelling from deeper water.

Prey in the area ranges from a variety of fishes and soft-bottom invertebrates (Silliman University, 2014). Gut analyses from a stranded dolphin carcass (Dolphin N-05 in 2013) by Divinigracia et al. (unpublished data) and Postrado et al. (2019) have revealed demersal fish species, including ponyfishes (*Eublekeeria splendens*) and conger eels (*Conger japonicus*), as part of their diet. Feeding on demersal species also confirms the observed mud plumes in the water when the dolphins are feeding and may play a significant part in the recycling of nutrients to the water column. Pony fishes are also known to prey on small crustaceans and shrimp (Kimura et al., 2005), which are some of the species (*Acetes* spp.) targeted by tidal net fisheries in Pulupandan. Foraging behaviour by Irrawaddy dolphins was nearshore, often in the vicinity of tidal nets commonly found in Barangay Zone 6 and Canjusa (Sector 7). Of the eight tidal nets scattered along the study area, Casipe et al. (2017) reported that the tidal net with the highest productivity (in catch per unit effort) was also located in Sector 7. The proximity of this area to steep drop-offs and the constant influence of tidal movement and monsoonal shifts in wind and water current may result in higher productivity, thus attracting a denser assemblage of prey (Silliman University, 2014).

While there is no evidence that the dolphins feed directly from the nets, depredation can cause by-catch from net
entanglement. These tidal nets are recommended to be closely monitored in case of any accidental entanglement during soaking time. Fisherfolk and *Bantay Dagat* (local sea patrols) should be trained to respond and be able to rescue dolphins when cases arise. The dolphins’ strong association with tidal nets also suggests similar associations with other fishing gear in the area (Casipe et al., 2017), particularly different kinds of submerged gill nets and crab traps. Gill nets have larger mesh sizes and higher possibilities of entangling dolphins than tidal nets. One mortality caused by gillnets was reported in May 2017 in Cavan, Pulupandan. Similarly, crab traps are usually connected by lines that have previously entangled dolphins in Malampaya Sound and Mahakam River (Kreb, 2004; Gonzales & Matillano, 2008). The use of many gillnets and crab traps in the area should be studied further, and it is recommended that they are not left unattended—especially overnight.

No apparent area preference was observed for socialising and rest behaviours. Such behavioural states were often random and occurred in between foraging states. The presence of calves and the regular observations of social behaviour between individual dolphins support the importance of Bago-Pulupandan as a safe nursery ground to raise their young. The observation of flippering behaviour, when dolphins swim on their sides, exposing one flipper and one fluke, has also been suggested to be a form of mating or courtship behaviour (Sutaria, 2009).

Strong site fidelity was exhibited by at least eight dolphins, indicated by the frequent re-sightings of identified individuals during the sampling occasions. Site fidelity is usually an indicator of reliable prey availability, protection from predators, availability of mates, and familiarity with the area (Gowans et al., 2007). Identifying the sex of each individual is still challenging, given their elusive behaviour. Dolphins spotted with calves are most likely to be nursing mothers or females exhibiting ‘allo-mothering’ (Mann, 2019). The observation of flippering and mating behaviour may indicate that both sexes of Irrawaddy dolphins can use the area. In contrast, a large proportion of identified dolphins were sighted for less than half of the time, suggesting a more extensive distribution for these individuals (Parra et al., 2006). Furthermore, decreased sightings towards midday indicate movement to other locations outside the study area and this should further be investigated.

Regular Irrawaddy dolphin occurrence in Bago-Pulupandan and a declining population trend suggest that the dolphins in this area may consist of a relict population whose fidelity to the area is threatened by the vulnerability of their habitat and availability of prey (Dolar et al., 2018). Although more research is needed to determine their maximum home range and whether there are other extant populations nearby, it is clear that the existing population is small, probably one of the smallest populations of Irrawaddy dolphins ever reported (Minton et al., 2017; Dolar et al., 2018). During the period of the recent estimate, only nine dolphins were identifiable. It is not clear whether the other identified dolphins died or migrated outside of the study site. To note, at least two identified dolphins (N-05 and N-15) were found dead in 2013 and 2019, respectively. Five other strandings were reported during the seven-year study; most were calves and were not part of the catalogue. This alarming number of calf strandings, however, may indicate very low survival rates for calves of this population. Their survival is largely dependent on the quality of their habitat, which is slowly being degraded by several factors directly related to coastal development and overlap with human fishing and navigational grounds. There is a looming threat of bridge construction in Pulupandan to connect the Islands of Negros and Guimaras (CCCC Highway Consultants, 2020; Parrocha, 2019), which could add further disturbance to the dolphin’s core area through noise pollution caused by pile driving and heavier boat traffic during construction. The long term effects of this bridge on the current flow of Guimaras Strait and its biodiversity will need to be further studied. Pollution also poses a threat to the dolphins and wastewater discharged by at least two industrial factories in Bago and Pulupandan may affect water quality for both the Irrawaddy dolphins and their prey. Domestic pollution from nearby coastal villages, as well as pesticides from agricultural runoff, can also affect estuarine health (Smith & Jefferson, 2002). Floating garbage in the Bago and Pulupandan area can potentially be ingested by dolphins and other marine wildlife. These risk factors are predicted to further contribute to the Irrawaddy dolphins’ vulnerability to local extinction in Guimaras Strait if not properly addressed.

The establishment of sound habitat management measures to regulate fishing gear and boat traffic, and mitigate habitat destruction, are highly recommended (Kreb et al., 2010). Mangroves and the soft-bottom habitats should be protected to increase the productivity of fish prey, and the effects of river runoff should be monitored. Lastly, the management plan should include continuous monitoring of the dolphins’ population trends, behaviour, and interaction with fisheries as this information is vital for fine-tuning management plans for their conservation.

DEDICATION

The authors would like to dedicate this paper to Ma. Victoria Matillano, who has dedicated her life’s work to the conservation of Irrawaddy dolphins in the Philippines, and who has been a shining beacon for conservation work in the island of Palawan. May her dedication, hard work, and passion for the protection of our marine ecosystems be a reminder for us to continue our science and community works with as much rigor and enthusiasm as she did.

ACKNOWLEDGEMENTS

This research was made possible through funding from Ocean Park Conservation Foundation Hong Kong (OPCFHK), the National Geographic Conservation Trust (NGCT), Muhammad Bin Zayed Conservation Foundation (MBZ), and Deutsche Gesellschaft fur Internationale Zusammenarbeit
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