Short Note

Sighting and Stranding Reports of Irrawaddy dolphins (*Orcaella brevirostris)* and Dugongs (*Dugong dugon)* in Kep and Kampot, Cambodia

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In Cambodia, information on the distribution of Irrawaddy dolphins *Orcaella brevirostris* and dugongs *Dugong dugon* is limited (Beasley & Davidson, 2007; Hines et al., 2015a). Irrawaddy dolphin presence is confirmed in the coastal waters of Thailand's Trat Province, Cambodia's Koh Kong and Sihanoukville provinces and Vietnam's Kien Giang Province (Figure 1) (Beasley & Davidson, 2007; Ponnampalam, 2013; Smith et al., 2014; Vu et al., 2015; Hines et al., 2015b; Smith et al., 2016). Unconfirmed fisher reports identify the presence of small and sporadic dugong populations at both the Thai-Cambodian and Vietnamese-Cambodian border regions (Perrin et al., 1995, 1996; Nelson, 1999; Beasley & Davison, 2007; Hines et al., 2008). The coastal distribution of both species exposes them to anthropogenic threats, specifically habitat degradation, and fisheries bycatch (Reeves et al. 2003; Hines et al., 2008; Smith et al. 2008; Jaaman et al. 2009; Marsh et al. 2011; Peter et al., 2016a; Peter et al. 2016b; Pilcher et al. 2017). Dugongs are also affected by targeted hunts (Hines et al., 2008; Marsh et al. 2011; Robards & Reeves 2011). Irrawaddy dolphin and dugong populations are declining across Southeast Asia (IWC, 1994; Robards & Reeves 2011), with conservation statuses reflecting these declines.

Irrawaddy dolphins were reclassified from ‘vulnerable’ to ‘endangered’ by the IUCN in November 2017 (Minton et al., 2017), with dugongs classified as 'vulnerable' since 2015 (Marsh & Sobtzick, 2015). According to Cambodian Fisheries Law *Sub-decree no. 123* (2009), both species are considered as endangered fisheries resources and are therefore protected by law (*Law on Fisheries*, 2007). In September 2017, The Cambodian Marine Mammal Conservation Project (CMMCP) was established to fill marine mammal knowledge gaps in Cambodian waters and highlight the need for marine mammal conservation strategies in the region. As an initiative of CMMCP, the current study aims to provide initial sighting and occurrence records of Irrawaddy dolphins and dugongs in Cambodia’s Kep and Kampot region. Additionally, we have initiated a photo-identification catalog for the region’s Irrawaddy dolphins, which is part of on-going survey work in the region.

Methodology

The Kep and Kampot coastline spans from Sihanoukville Province, Cambodia, to Kien Giang Province, Vietnam, on the eastern coast of the Gulf of Thailand (Figure 1). Coastal waters range between depths of 2 and 12m, with the exception of a deeper channel off the western Kampot coast reaching 25m. Kep supports 13 offshore islands, collectively known as the Kep Archipelago (Figure 1), home to fringing coral reef, seagrass meadows, and commercially valuable fish and crustacean species (Cockerell et al., 2016).

(insert Figure 1 here)

Between October 2017 and May 2018, CMMCP conducted 14 boat-based cetacean surveys in Kep’s coastal waters (Table 1). Surveys lasted for a minimum of three hours, during sea state conditions ≤ Beaufort 3. Surveys were conducted on a 20m long by 4.5m wide

converted pair trawling boat with a 200HP inboard engine and a viewing platform 3.8m above sea level. The vessel travelled at an average speed of 4 knots around the Kep Archipelago, following a repeated circular route that gave visual coverage of all islands and regions in the Kep Archipelago with known marine mammal occurrence (Figure 2). 100% of the survey route was covered at least once on each survey day, with routes were recorded using a Garmin 64s GPS. Each survey employed four cetacean observers, two scanning the sea surface with Bushnell 8 x 42 binoculars and two with the naked eye. When a group or an individual was sighted, time, species, group size and the number of sub-adults were recorded. Sub-adults were distinguished based on their size. GPS coordinates of dolphin sightings were calculated using boat GPS coordinates, the distance of the group or individual from the boat and the angle of the group or individual from north. Resultant sighting locations were transformed into line data *Esri® ArcGIS™* (ESRI, 2014) and used to create kernel density maps, weighted by the number of animals per group. Mask extraction and percent volume contour, where 50% contours were selected as the core zones, were then used to produce raster maps. 50% contours were selected, as in Bertrand et al. (1996) and Gubbins (2002), as most animals do not use their full home range, but focus their activities in certain areas (Dixon & Chapman, 1980; Samuel et al., 1985; Hauser et al., 2007). Finally, buffers of 1 km radius were created around the core zones. Due to the level of sample effort to date, we did not adjust densities for bias due to survey effort (e.g., McBride et al. 2018). However, this approach will be employed in future surveys.

(insert Figure 2 and Table 1)

Over a total of 14 survey days (40 hours 12 minutes), Irrawaddy dolphins were sighted on 8 days (18 groups). No other cetacean species were encountered during the surveys. Core dolphin habitat was found south of Koh Tonsay, south-east of Koh Tbal and west of Koh Poh

(Figure 1; Figure 3). It also should be noted that project scientists remained in the study area, residing on Koh Ach Seh island (Figure 1), over the entire survey period. Over this time, Illegal, Unreported, and Unregistered (IUU) fishing activities, specifically bottom and electric trawling, were observed and logged in the study region at least once per day.

(insert Figure 3 here)

For all marine mammals sighted between 4 January and 15 May 2018 photographs of dorsal fins and/or tail flukes were captured with a Canon Rebel T6i Digital SLR and EF 75-300mm f/4-5.6 III lens. The photographer avoided bias towards more distinctive individuals by trying to capture images of both sides of each individual in the group. Photograph resolution was used to sort photographs in 'good' and 'poor' quality folders, with only 'good' quality photographs used for post-analysis to identify individuals. Photographs were also assessed for the number of distinctive characteristics shown (e.g., nicks, notches, unusual fin shapes, fin scars, body scars, body deformities). If a 'poor' quality image showed two or more distinctive characteristics, it was also included in the analysis. Images of calves and unmarked individuals were discarded to avoid misidentification. *Discovery software* (Gailey & Karczmarski, 2012) was then used to catalogue individuals.

15 individual Irrawaddy dolphins were identified through photo-identification techniques, as reported in CMMCP's 2018 technical report (Tubbs, 2018). One identified individual possessed deep scars characteristic of entanglement in fishing gear (Figure 4).

(insert Figure 4 here)

On 20 February 2018, a C-POD - Continuous POrpoise Detector - (Chelonia Ltd. 2014a) was deployed in the Kep Archipelago (10° 21' 29"N, 104° 19' 16"E), suspended 0.5m above the

seabed, at a water depth of 2m. C-PODs are fully automated static data loggers, logging peak frequency, duration, intensity and bandwidth for sounds between 20 and 160kHz. *CPOD* software (Chelonia Ltd. 2014b) was used to identify click trains using the KERNO classifier algorithm (Chelonia Ltd. 2014b). Click trains were sorted into 'high', 'moderate', low' or 'doubtful' quality groups. Based on parameters including frequency and click interval, 'moderate' and 'high' click trains were further sorted into species classification groups.

The C-POD recorded data for 62 days, with post analysis revealing 60 click trains characterised as belonging to cetaceans. The *CPOD* software's KERNO classifier (Chelonia Ltd. 2014b) does not allow for species-specific identification to be made; however, as Irrawaddy dolphins were the only species sighted through observational surveys, it is likely that acoustic data belongs to this species.

Between September 2017 and May 2018, CMMCP ran a marine mammal stranding and bycatch network in the Kep and Kampot region. The network is comprised of local fishers and fisheries officers, who report events to project scientists. Over this period, four Irrawaddy dolphin carcasses were stranded in Kep Province and one dugong caught via bycatch in Kampot Province (Table 2), as reported in CMMCP's 2018 technical report (Tubbs, 2018). No necropsies were conducted, hence causes of death for strandings could not be determined. The figures reported here are likely underestimates of true stranding and bycatch figures, due to lack of rigour of data compilation by fishers or fisheries authorities and/or lack of basic information about species occurrence or identification (Reeves et al., 2005).

(insert Table 2 here)

116 Baseline knowledge on species presence is the essential first step in the creation of
117 conservation strategies. Here, we report the first observations of Irrawaddy dolphins in Kep and
118 report one incident of dugong bycatch in Kampot. Field observations of IUU fishing were noted
119 during the current study, with previous studies by Nelson (1999) and Beasley and Davidson
120 (2007) also reporting presence of IUU activities in the region. Past and present observations of
121 IUU fishing, combined with marine mammal entanglement, stranding and bycatch cases reported
122 during the current study, identify the urgency for regional conservation strategies. As a starting
123 point, we recommend that the Irrawaddy dolphin core and buffer zone habitat presented in
124 Figure 3 should be managed for the purposes of Irrawaddy dolphin conservation. This study
125 highlights the need for more research activities in the Kep and Kampot region, so data can be
126 used to design tailored conservation strategies for the populations. Conservation strategies for
127 both species will require ongoing, comprehensive data collection on their population, ecology
128 and area use. We, therefore, also recommend expanding survey efforts for Irrawaddy dolphins to
129 the Sihanoukville and Kien Giang Province borders, as well as dedicated dugong studies in Kep
130 province to fill these knowledge gaps.
131
132 Author contributions:
133 Study design and fieldwork: ST, GC
134 Data analysis: ST, AAB, GC
135 Writing the article: ST, AAB, AJ, GN
136
137
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Figures

Figure 1. The eastern coast of the Gulf of Thailand and the islands of Cambodia's Kep Archipelago. UPLOADED AS A SEPARATE DOCUMENT.

Figure 2. Boat survey tracklines and study area covered between October 2017 and May 2018. UPLOADED AS A SEPARATE DOCUMENT.

Figure 3. Boat route core zones, and Irrawaddy dolphin core and buffer zones, produced from tracklines and sightings between October 2017 and May 2018. UPLOADED AS A SEPARATE DOCUMENT.

Figure 4. Irrawaddy dolphin with scars characteristic of fishing gear entanglement, Kep Archipelago,15th May 2018 (Tubbs, 2018). UPLOADED AS A SEPARATE DOCUMENT.

Tables

Table 1. Dates of boat surveys undertaken. UPLOADED AS A SEPARATE DOCUMENT.

275 **Table 2.** Stranding and bycatch records from Kep and Kampot provinces, between September
276 2017 and May 2018. UPLOADED AS A SEPARATE DOCUMENT.

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