UNIVERSITY of Cumbria

1 **Short Note**

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

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13 In Cambodia, information on the distribution of Irrawaddy dolphins *Orcaella brevirostris* and

14 dugongs *Dugong dugon* is limited (Beasley & Davidson, 2007; Hines et al., 2015a). Irrawaddy

15 dolphin presence is confirmed in the coastal waters of Thailand's Trat Province, Cambodia's Koh

16 Kong and Sihanoukville provinces and Vietnam's Kien Giang Province (Figure 1) (Beasley &

17 Davidson, 2007; Ponnampalam, 2013; Smith et al., 2014; Vu et al., 2015; Hines et al., 2015b;

18 Smith et al., 2016). Unconfirmed fisher reports identify the presence of small and sporadic

19 dugong populations at both the Thai-Cambodian and Vietnamese-Cambodian border regions

20 (Perrin et al., 1995, 1996; Nelson, 1999; Beasley & Davison, 2007; Hines et al., 2008). The

21 coastal distribution of both species exposes them to anthropogenic threats, specifically habitat

22 degradation, and fisheries bycatch (Reeves et al. 2003; Hines et al., 2008; Smith et al. 2008;

23 Jaaman et al. 2009; Marsh et al. 2011; Peter et al., 2016a; Peter et al. 2016b; Pilcher et al. 2017).

24 Dugongs are also affected by targeted hunts (Hines et al., 2008; Marsh et al. 2011; Robards &

25 Reeves 2011). Irrawaddy dolphin and dugong populations are declining across Southeast Asia

26 (IWC, 1994; Robards & Reeves 2011), with conservation statuses reflecting these declines.

27   Irrawaddy dolphins were reclassified from 'vulnerable' to 'endangered' by the IUCN in

28   November 2017 (Minton et al., 2017), with dugongs classified as 'vulnerable' since 2015 (Marsh

29   & Sobtzick, 2015). According to Cambodian Fisheries Law *Sub-decree no. 123* (2009), both

30   species are considered as endangered fisheries resources and are therefore protected by law (*Law*

31   *on Fisheries*, 2007). In September 2017, The Cambodian Marine Mammal Conservation Project

32   (CMMCP) was established to fill marine mammal knowledge gaps in Cambodian waters and

33   highlight the need for marine mammal conservation strategies in the region. As an initiative of

34   CMMCP, the current study aims to provide initial sighting and occurrence records of Irrawaddy

35   dolphins and dugongs in Cambodia's Kep and Kampot region. Additionally, we have initiated a

36   photo-identification catalog for the region's Irrawaddy dolphins, which is part of on-going

37   survey work in the region.

38

39   Methodology

40   The Kep and Kampot coastline spans from Sihanoukville Province, Cambodia, to Kien

41   Giang Province, Vietnam, on the eastern coast of the Gulf of Thailand (Figure 1). Coastal waters

42   range between depths of 2 and 12m, with the exception of a deeper channel off the western

43   Kampot coast reaching 25m. Kep supports 13 offshore islands, collectively known as the Kep

44   Archipelago (Figure 1), home to fringing coral reef, seagrass meadows, and commercially

45   valuable fish and crustacean species (Cockerell et al., 2016).

46   (insert Figure 1 here)

47   Between October 2017 and May 2018, CMMCP conducted 14 boat-based cetacean

48   surveys in Kep's coastal waters (Table 1). Surveys lasted for a minimum of three hours, during

49   sea state conditions ≤ Beaufort 3. Surveys were conducted on a 20m long by 4.5m wide

50   converted pair trawling boat with a 200HP inboard engine and a viewing platform 3.8m above

51   sea level. The vessel travelled at an average speed of 4 knots around the Kep Archipelago,

52   following a repeated circular route that gave visual coverage of all islands and regions in the Kep

53   Archipelago with known marine mammal occurrence (Figure 2). 100% of the survey route was

54   covered at least once on each survey day, with routes were recorded using a Garmin 64s GPS.

55   Each survey employed four cetacean observers, two scanning the sea surface with Bushnell 8 x

56   42 binoculars and two with the naked eye. When a group or an individual was sighted, time,

57   species, group size and the number of sub-adults were recorded. Sub-adults were distinguished

58   based on their size. GPS coordinates of dolphin sightings were calculated using boat GPS

59   coordinates, the distance of the group or individual from the boat and the angle of the group or

60   individual from north. Resultant sighting locations were transformed into line data *Esri*®

61   *ArcGIS*^TM (ESRI, 2014) and used to create kernel density maps, weighted by the number of

62   animals per group.   Mask extraction and percent volume contour, where 50% contours were

63   selected as the core zones, were then used to produce raster maps. 50% contours were selected,

64   as in Bertrand et al. (1996) and Gubbins (2002), as most animals do not use their full home

65   range, but focus their activities in certain areas (Dixon & Chapman, 1980; Samuel et al., 1985;

66   Hauser et al., 2007). Finally, buffers of 1 km radius were created around the core zones. Due to

67   the level of sample effort to date, we did not adjust densities for bias due to survey effort (e.g.,

68   McBride et al. 2018). However, this approach will be employed in future surveys.

69   (insert Figure 2 and Table 1)

70   Over a total of 14 survey days (40 hours 12 minutes), Irrawaddy dolphins were sighted on

71   8 days (18 groups). No other cetacean species were encountered during the surveys. Core

72   dolphin habitat was found south of Koh Tonsay, south-east of Koh Tbal and west of Koh Poh

73   (Figure 1; Figure 3). It also should be noted that project scientists remained in the study area,

74   residing on Koh Ach Seh island (Figure 1), over the entire survey period. Over this time, Illegal,

75   Unreported, and Unregistered (IUU) fishing activities, specifically bottom and electric trawling,

76   were observed and logged in the study region at least once per day.

77   (insert Figure 3 here)

78   For all marine mammals sighted between 4 January and 15 May 2018 photographs of

79   dorsal fins and/or tail flukes were captured with a Canon Rebel T6i Digital SLR and EF 75-

80   300mm f/4-5.6 III lens. The photographer avoided bias towards more distinctive individuals by

81   trying to capture images of both sides of each individual in the group. Photograph resolution was

82   used to sort photographs in 'good' and 'poor' quality folders, with only 'good' quality

83   photographs used for post-analysis to identify individuals. Photographs were also assessed for

84   the number of distinctive characteristics shown (e.g., nicks, notches, unusual fin shapes, fin

85   scars, body scars, body deformities). If a 'poor' quality image showed two or more distinctive

86   characteristics, it was also included in the analysis. Images of calves and unmarked individuals

87   were discarded to avoid misidentification. *Discovery software* (Gailey & Karczmarski, 2012)

88   was then used to catalogue individuals.

89   15 individual Irrawaddy dolphins were identified through photo-identification techniques,

90   as reported in CMMCP's 2018 technical report (Tubbs, 2018). One identified individual

91   possessed deep scars characteristic of entanglement in fishing gear (Figure 4).

92   (insert Figure 4 here)

93   On 20 February 2018, a C-POD - Continuous POrpoise Detector - (Chelonia Ltd. 2014a)

94   was deployed in the Kep Archipelago (10° 21' 29"N, 104° 19' 16"E), suspended 0.5m above the

95   seabed, at a water depth of 2m. C-PODs are fully automated static data loggers, logging peak

96   frequency, duration, intensity and bandwidth for sounds between 20 and 160kHz. *CPOD*

97   software (Chelonia Ltd. 2014b) was used to identify click trains using the KERNO classifier

98   algorithm (Chelonia Ltd. 2014b). Click trains were sorted into 'high', 'moderate', low' or

99   'doubtful' quality groups.   Based on parameters including frequency and click interval,

100 'moderate' and 'high' click trains were further sorted into species classification groups.

101   The C-POD recorded data for 62 days, with post analysis revealing 60 click trains

102 characterised as belonging to cetaceans. The *CPOD* software's KERNO classifier (Chelonia Ltd.

103 2014b) does not allow for species-specific identification to be made; however, as Irrawaddy

104 dolphins were the only species sighted through observational surveys, it is likely that acoustic

105 data belongs to this species.

106   Between September 2017 and May 2018, CMMCP ran a marine mammal stranding and

107 bycatch network in the Kep and Kampot region. The network is comprised of local fishers and

108 fisheries officers, who report events to project scientists. Over this period, four Irrawaddy

109 dolphin carcasses were stranded in Kep Province and one dugong caught via bycatch in Kampot

110 Province (Table 2), as reported in CMMCP's 2018 technical report (Tubbs, 2018). No necropsies

111 were conducted, hence causes of death for strandings could not be determined. The figures

112 reported here are likely underestimates of true stranding and bycatch figures, due to lack of

113 rigour of data compilation by fishers or fisheries authorities and/or lack of basic information

114 about species occurrence or identification (Reeves et al., 2005).

115   (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

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138   **Acknowledgements**

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145   **Literature Cited**

146   Beasley, I. & Davidson, P. (2007). Conservation status of marine mammals in Cambodian
147   waters, including seven new cetacean records of occurrence. *Aquatic Mammals, 33*(3),
148   368-379.

149   Bertrand, M., DeNicola, A., Beissinger, S. & Swihart, R. (1996). Effects of parturition on home
150   ranges and social affiliations of female white-tailed deer. *The Journal of Wildlife*
151   *Management*, 60(4), 899.

152   Chelonia Ltd. (2014a). *C-POD specification*. Available at:
153   https://chelonia.co.uk/cpodspecification.htm [accessed 21 January 2019].
154
155   Chelonia Ltd. (2014b). *CPOD.exe: a guide for users*. Available at:
156   https://chelonia.co.uk/downloads/CPOD.pdf CMS Technical Series No. 32 [accessed 2
157   February 2018].
158
159   Cockerell, B., Haïssoune, A. & Ferber, P. (2016). *Koh Seh marine environmental assessment*.
160   Unpublished report for the Cambodian Ministry of Agriculture, Forestry and Fisheries.
161
162   Dixon, K. & Chapman, J. (1980). Harmonic mean measure of animal activity areas. *Ecology*,
163   61(5), 1040-1044.
164
165   ESRI. (2014). *ArcGIS Desktop: Release 10.3*. Redland, CA: Environmental Systems Research
166   Institute.

167   Gailey G. & Karczmarski L. (2012). *Discovery: Photo-identification data-management system*
168   *for individually recognizable animals*. Available at:
169   https://biosch.hku.hk/ecology/staffhp/1k/Discovery [accessed 8 May 2018].

170   Gubbins, C. (2002). Use of home ranges by resident bottlenose dolphins (*Tursiops truncatus*) in
171   a South Carolina estuary. *Journal of Mammalogy*, 83(1), 178-187.

172 Hauser, D., Logsdon, M., Holmes, E., Van Blaricom, G. & Osborne, R. (2007). Summer
173   distribution patterns of southern resident killer whales *Orcinus orca*: core areas and
174   spatial segregation of social   groups. *Marine Ecology Progress Series*, 351, 301-310.

175 Hines, E., Adulyanukosol, K., Somany, P., Ath, L., Cox, N., Boonyanate, P. & Hoa, N. (2008).
176   Conservation needs of the dugong *Dugong dugon* in Cambodia and Phu Quoc Island,
177   Vietnam. *Oryx*, *42*(1).

178 Hines, E., Ponnampalam, L., Jamal Hisne, F., Tara S., Jackson-Ricketts, J., Kuit, S. &
179   Acebes, J. (2015a). *Report of the Third Southeast Asian Marine Mammal Symposium*
180   *(SEAMAM III)* UNEP / CMS Secretariat, Bonn, Germany.

181 Hines, E., Strindberg, S., Junchumpoo, C., Ponnampalam, L., Ilangakoon, A., Jackson-Ricketts,
182   J. & Monanunsap, S. (2015b). Line transect estimates of Irrawaddy dolphin abundance
183   along the eastern Gulf Coast of Thailand. *Frontiers in Marine Science*, 2.

184   IWC (1994) *Report of the workshop on mortality of cetaceans in passive fishing nets and traps.*
185   Report of the International Whaling Commission (Special Issue) 1*, 1-71.
186
187 Jaaman, S., Lah-Anyi, Y. & Pierce, G. (2009). The magnitude and sustainability of marine
188   mammal by catch in fisheries in East Malaysia. *Journal of the Marine Biological*
189   *Association of the United Kingdom, 89*, 907-920.

190 *Law on Fisheries* (2007) Cambodia. Available at:
191   http://extwprlegs1.fao.org/docs/pdf/cam82001.pdf. [accessed 18 January 2019].

192 Marsh, H. & Sobtzick, S. (2015). *Dugong dugon. The IUCN Red List of Threatened Species*
193   *2015*.   Available at: http://dx.doi.org/10.2305/IUCN.UK.2015-
194   4.RLTS.T6909A43792211.en.[accessed 3 June 2018].

195 Marsh, H., O'Shea, T. & Reynolds III, J. (2011). *The ecology and conservation of Sirenia:*
196   *dugongs and manatees*. Cambridge, England: Cambridge University Press.

197 Minton, G., Smith, B., Braulik, G., Kreb, D., Sutaria, D. & Reeves, R. (2017). *Orcaella*
198   *brevirostris*. In *The IUCN Red List of Threatened Species 2017*. Available at:
199   http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T15419A50367860.en. [accessed 3
200   June 2018].

201 Nelson, V. (1999). *The coastal zone of Cambodia – Current status and threats: Volumes I and II.*
202   Unpublished report for the Ministry of Environment and DANIDA.

203 Perrin, W., Leatherwood, S., & Dolar, M. (1995). *The status of marine mammal research in*
204   *Southeast Asia* (UNEP/SEA95/BP6, IBI Reports No. 5), 16.

205   Perrin, W., Dolar, M., & Alava, M. (1996). *Report of the workshop on the biology and*
206   *conservation of small cetaceans and dugongs of Southeast Asia.* Dumaguete: United
207   Nations Environment Programme.
208
209   Peter, C., Poh, A., Ngeian, J., Tuen, A. & Minton, G. (2016a). Identifying habitat characteristics
210   and critical areas for Irrawaddy Dolphin, *Orcaella brevirostris*: Implications for
211   Conservation. In I. Das & A. Tuen (Eds), *Naturalists, Explorers and Field Scientists in*
212   *South-East Asia and Australasia* (pp. 225-238). Springer.

213   Peter, C., Ngeian, J., Minton, G., Zulkifli Poh, A., Grinang, J. & Tuen, A. (2016b). *Artisanal*
214   *fisheries and cetaceans in Kuching Bay, Sarawak, East Malaysia: Threats and potential*
215   *mitigation.* Report presented to the meeting of the Scientific Committee of the
216   International Whaling Commission   SC/66b/SM09.

217   Pilcher, N., Adulyanukosol, K., Das, H., Davis, P., Hines, E., Kwan, D., Marsh, H.,
218   Ponnampalam, L. &   Reynolds, J. (2017). A low-cost solution for documenting
219   distribution and abundance of endangered marine fauna and impacts from fisheries.
220   *PLOS ONE*, *12*(12).

221   Ponnampalam, L., Hines, E., Monanunsap, S., Ilangakoon, A., Junchompoo, C., Adulyanukosol,
222   K., &   Morse, L. (2013). Short note: behavioral observations of coastal Irrawaddy
223   Dolphins *(Orcaella brevirostris*) in Trat Province, Eastern Gulf of Thailand. *Aquatic*
224   *Mammals*, *39*(4), 401-408.

225   Reeves, R., Smith, B., Crespo, E. & Notarbartolo di Sciara, G. (2003). Dolphins, whales and
226   porpoises: 2002-2010 Conservation Action Plan for the World's Cetaceans. *IUCN*,
227   Gland, Switzerland & Cambridge, UK.

228   Reeves, R., Berggren. P., Crespo, E., Gales, N., Northridge, S., di Sciara G., Perrin, W., Read.
229   A., Rogan, E., Smith, B., & Van Waerebeek, K. (2005). Global priorities for reduction of
230   cetacean bycatch. *WWF.* Available at:
231   https://www.researchgate.net/profile/Koen_Van_Waerebeek/publication/228345242_Glo
232   bal_priorities_for_Reduction_of_Cetacean_Bycatch/links/0fcfd5057ee79c5e7b000000.p
233   df [accessed 5 July 2018]

234   Robards, M. & Reeves R. (2011). The global extent and character of marine mammal
235   consumption   by humans: 1970–2009. *Biological Conservation*,*144*, 2770–2786.

236   Samuel, M., Pierce, D. & Garton, E. (1985). Identifying areas of concentrated use within the
237   home range. *The Journal of Animal Ecology*, 54(3), 711.

238   Smith, B., Kong, S., & Saroeun, L. (2014). Conservation status and the use of Irrawaddy
239   dolphins as a flagship species for climate adaptation in the Peam Krasop Wildlife
240   Sanctuary, Cambodia. *IUCN Asia,* Bangkok, Thailand. Available at:

241   http://cmsdata.iucn.org/downloads/bcr_dolphin_survey_report_final.pdf [accessed 23
242   January 2019].

243 Smith, B., Ahmed, B., Mowgli, R. & Strindberg, S. (2008). Species occurrence and distributional
244   ecology of nearshore cetaceans in the Bay of Bengal, Bangladesh, with abundance
245   estimates for Irrawaddy dolphins *Orcaella brevirostris* and finless porpoises
246   N*eophocaena phocaenoides*. *Journal of Cetacean Research and Management*, *10*, 45-58.

247 Smith, B., Sonim, V., Boonchai, R., Joehl Cadena, A. & Manopawitr, P. (2016). *Final Report on*
248   *Dolphin Conservation along the Coastline of the Thai and Cambodian Border.* Available
249   at:https://www.iucn.org/sites/dev/files/content/documents/2016/final20report20iucn20ca
250   mbodia20thailand20dolphin20project_final2028229.pdf [accessed 3 July 2018].

251 *Sub-decree no. 123 Determination of a taxon of fishery and endangered fishery* product (2009).
252   Cambodia. Available at: https://www.ajne.org/sites/default/files/resource/laws/7217/sub-
253   decree-123- endangered-fisheries-products-2009.pdf [accessed 18 January 2019].
254
255   Tubbs, S. (2018). *The Cambodian Marine Mammal Conservation Project*. Technical report for
256   the Cambodian Ministry of Agriculture, Forestry and Fisheries.

257 Vu, L., Tho, T., Ny, T., Tham, N., Duy, L., Hung, N. & Duc, H., (2015). *Conservation of*
258   *cetacean in Kien Giang Biosphere Reserve, Vietnam.* Proceedings at the 21st Biennial
259   Conference of the Society for Marine Mammalogy, San Francisco, CA.

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262 **Figures**

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

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

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

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

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273 **Tables**

274 **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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