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## Distribution and abundance of common bottlenose dolphin ( *Tursiops truncatus* ) over the French Mediterranean continental shelf

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**1 Distribution and abundance of common bottlenose dolphin (*Tursiops truncatus*) over the**

**2 French Mediterranean continental shelf**

3

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## 22 **Abstract**

23 The common bottlenose dolphin (*Tursiops truncatus*) subpopulation in the Mediterranean is  
24 listed as vulnerable by the International Union for Conservation of Nature. This species is  
25 strictly protected in France and the designation of Special Areas of Conservation (SAC) is  
26 required under the EU Habitats Directive (92/43/EEC). However, little information is  
27 available about the structure and dynamics of bottlenose dolphins in French Mediterranean  
28 waters. We collected photo-identification data over the whole French Mediterranean  
29 continental shelf year round between 2013 and 2015. We sighted 151 groups of bottlenose  
30 dolphins allowing the individual photo-identification of 766 animals. The encounter rate  
31 distribution showed the presence of bottlenose dolphins over the whole continental shelf year  
32 round. We estimated for the first time, using capture-recapture methods, the size of this  
33 bottlenose dolphin population at 2,350 individuals (95% credible interval 1,827-3,135). Our  
34 results were used in support of the designation of a new dedicated SAC in the Gulf of Lion  
35 and provide a baseline for the bottlenose dolphin monitoring in the French Mediterranean  
36 waters in the context of the Marine Strategy Framework Directive.

37

## 38 **KEYWORDS**

39 Abundance, bottlenose dolphin, capture-recapture, distribution, French Mediterranean Sea,  
40 photo-identification, *Tursiops truncatus*

## 41 **Introduction**

42 The common bottlenose dolphin (*Tursiops truncatus*, Montagu, 1821; hereafter bottlenose  
43 dolphin) is considered as a regular species in the Mediterranean Sea (Reeves & Notarbartolo  
44 di Sciara, 2006). It has been observed along most of the Mediterranean coast (Bearzi, Fortuna  
45 & Reeves, 2009), most often over the continental shelf (Gannier, 2005; Gnone *et al.*, 2011;  
46 Notarbartolo Di Sciara *et al.*, 1993), even though groups have also been observed offshore  
47 (Laran *et al.*, 2016). Both resident populations and transient individuals have been reported  
48 (Gnone *et al.*, 2011). The Mediterranean bottlenose dolphin subpopulation is genetically  
49 differentiated from populations inhabiting the contiguous eastern North Atlantic and the Black  
50 Sea and is structured into a Western and an Eastern population, corresponding to habitat  
51 boundaries (Natoli, Birkun, Aguilar, Lopez & Hoelzel, 2005).

52 The Mediterranean bottlenose dolphin subpopulation is considered as vulnerable on the IUCN  
53 (International Union for Conservation of Nature) Red List. It is listed in Annex II of the  
54 Washington Convention on International Trade in Endangered Species, in Appendix II of the  
55 Bern Convention for the Conservation of European Wildlife and Natural Habitats, in  
56 Appendix II of the Protocol to the Barcelona Convention on Specially Protected Areas of  
57 Mediterranean Importance (SPAMI), and is one of only two species of cetaceans listed in  
58 Appendix II of the European Habitats Directive (92/43/CEE). It is also strictly protected in  
59 France by the decree of July 1, 2011 prohibiting, among other things, the destruction,  
60 capture, and intentional disturbance of marine mammals. In addition, the bottlenose dolphin is  
61 the subject of a specific action plan under development by the Agreement on the Conservation  
62 of Cetaceans of the Black Sea, Mediterranean Sea, and contiguous Atlantic Area  
63 (ACCOBAMS).

64 In this context the population's conservation status, including population trends, needs to be  
65 assessed. Population indicators (e.g., distribution, abundance) should be regularly evaluated

66 and compared with reference values through standardized long-term monitoring (Cairns,  
67 McCormick & Niederlehner, 1993; Dale & Beyeler, 2001).

68 In France, the monitoring program set up for the implementation of the European Marine  
69 Strategy Framework Directive (2008/56/EC; MSFD) recommends specific monitoring of  
70 resident coastal populations of marine mammal species using photo-identification, including  
71 bottlenose dolphins. Bottlenose dolphins can be identified individually from their natural  
72 markings, and the resulting longitudinal sighting histories of individuals can be analyzed with  
73 capture-recapture (CR) models (Hammond, 2009; Hammond, Mizroch & Donovan, 1990;  
74 Rosel *et al.*, 2011) to estimate population abundance and survival. Photo-identification data  
75 have been used widely to monitor populations of bottlenose dolphins (e.g. Defran & Weller,  
76 1999; Gnone *et al.*, 2011; Karczmarski & Cockcroft, 2014; Louis *et al.*, 2015; Shane, Wells,  
77 Würsig & Odell, 1986).

78 In French Mediterranean waters, several studies on bottlenose dolphins have been conducted  
79 since the 1990s, and many of them were based on photo-identification (Bompar, Dhermain &  
80 Ripoll, 1994; Dhermain, Ripoll, Bompar, David & Di Meglio, 1999; Labach, Dhermain &  
81 Dupraz, 2015; Labach, Dhermain, Dupraz & Colombey, 2011; Ripoll *et al.*, 2001). The  
82 knowledge of the population structure, ecology, and dynamics remains poor and unequal, in  
83 part because these studies were limited to small areas over short periods.

84 In this study, we conducted the first large-scale bottlenose dolphin photo-identification survey  
85 in French Mediterranean waters. Standardized photo-identification data were collected  
86 throughout the French Mediterranean continental shelf year round over two years through a  
87 standard protocol by a network of organizations. The objectives of our study were to evaluate  
88 the distribution of bottlenose dolphins and to provide the first population abundance estimate  
89 over the French continental shelf.

90

## 91 **Methods**

92

### 93 *Study area*

94 The French Mediterranean waters contain high diversity and a richness of habitats and seabed.

95 The Gulf of Lion, from the Spanish border to Marseille, is a vast continental shelf limited to

96 the north by a sandy and lagoon coastline and to the south by a broad slope cut by numerous

97 canyons. The Corso-Liguro-Provençal basin (Riviera and west coast of Corsica) presents a

98 rocky coastline prolonged by a narrow continental shelf quickly giving way to an abrupt

99 slope, cut by deep canyons. To the east of Corsica, the reliefs are shallower with a wider

100 continental shelf. The Corso-Liguro-Provençal basin and the Gulf of Lion are highly

101 productive areas, attracting a high diversity of species (D'ortenzio & Ribera Dalcaï, 2009).

102 The study area covers the continental shelf of the French Mediterranean waters between the

103 coast and the 500 m isobath, bounded by the Spanish border to the west, the Italian border to

104 the east, and includes the whole Corsican coastline (Fig. 1). The overall study area covers

105 24,481 km<sup>2</sup> and was divided into three regions based on geographic and topographic

106 characteristics: Gulf of Lion (14,731 km<sup>2</sup>), Riviera (2,866 km<sup>2</sup>), and Corsica (6,884 km<sup>2</sup>). To

107 ensure homogeneous sampling over the whole study area, each region was divided into

108 subregions of similar area, covering on average 2,500 (+/- 500) km<sup>2</sup> (4 in Gulf of Lion, 2 in

109 Riviera and 3 in Corsica) and assigned to 5 local organizations associated with marine

110 mammal monitoring (BREACH, CARI, EcoOcéan Institut, GECEM, and Parc naturel

111 régional de Corse) according to their location and usual study areas, with each organization

112 covering one or two subregions.

113

### 114 *Data collection*

115 The objective of the survey was to conduct four days of boat-based survey effort per season  
116 within each subregion. We defined the survey effort as the length (in km) of track actively  
117 traveled, prospecting the area with naked eyes by three observers. Surveys were conducted  
118 only in favorable weather conditions (Beaufort scale 0-3 and good visibility). Seasons were  
119 defined as spring (March 22-June 21), summer (June 22-September 21), autumn (September  
120 22-December 21), and winter (December 22-March 21). This survey design was conducted  
121 twice between 2013 and 2015 using small sailing and motor boats. Routes were planned on a  
122 variable basis, according to weather conditions, to optimize the study area sampling coverage.  
123 All partners applied a standard common protocol using a digital application for the data  
124 collection specifically designed with Cybertracker (<https://www.cybertracker.org/>),  
125 systematically recording survey tracks with a GPS receiver. When we encountered a group of  
126 bottlenose dolphins, we recorded the position of first contact, group size, and composition  
127 along with the group's main activity. We defined a group as all dolphins seen with naked eye  
128 during the sighting. The estimated group size is the estimated number of individuals observed  
129 or photo-identified when the latter figure is greater than the estimated one.  
130 Whenever possible, we took photographs with a digital reflex camera of both sides of the  
131 dorsal fins of all individuals of the group, regardless of their markings.

132

### 133 *Photo-identification*

134 We identified individuals using natural marks: scars, nicks, and scratches on their dorsal fins  
135 (Würsig & Jefferson, 1990; Würsig & Würsig, 1977). The best photographs of each side of  
136 each individual at every encounter were selected and scored according to their quality (Q1 for  
137 good, Q2 for medium, and Q3 for bad) and the distinctiveness of animals (D1 for well-  
138 marked, D2 for moderately marked and D3 for poorly marked) (Berrow, O'Brien, Groth,  
139 Foley & Voigt, 2012; Ingram, 2000) to generate catalogs of identified dolphins. Catalog and

140 associated data were incorporated into a common database which was uploaded onto the  
141 international web database INTERCET (<http://www.intercet.it/>). Each partner compared its  
142 own catalog with all the others compiled within the project, and a global matching was  
143 conducted by one additional scientist, ensuring that matching was conducted by at least three  
144 people, minimizing bias due to false positive and negative matching. The matching process  
145 led to three regional catalogs and one global one. A matrix of sighting histories was  
146 associated with each catalog gathering all the sighting data and information of all the dolphins  
147 identified. For the analyses, we used only medium and good quality photographs (quality  
148 scores = 1 or 2) of moderately and well-marked individuals (distinctiveness score = 1 or 2).  
149 The proportion of moderately and well-marked individuals was evaluated as the number of  
150 individuals identified during the project, considering each side (right or left side) separately,  
151 that scored D1 or D2 (removing all pictures scored D3) among individuals identified by at  
152 least one photograph scored Q1 or Q2 (removing all pictures scored Q3) (see also the  
153 Abundance estimation section).

154

#### 155 *Distribution*

156 We calculated the encounter rate (ER) as the number of sightings per km of effort traveled in  
157 each region and within each 5'x5' cell of the Marsden grid WGS 84. All maps and spatial  
158 analyses were done in R 3.5.0 (R Core Team, 2018).

159

#### 160 *Abundance estimation*

161 To estimate the abundance of bottlenose dolphins occurring within the study area, we fitted  
162 CR models to the photo-identification data (Hammond *et al.*, 1990). We defined a capture  
163 when an individual was identified using photo-identification, and a recapture as the resighting  
164 of an individual already identified during the project. Because some individuals were sighted



165 both in Gulf of Lion and in the Riviera during the study period, we performed three separate  
166 analyses, corresponding to the sightings made in the Gulf of Lion, in the Riviera, and along  
167 the continental coast (Gulf of Lion plus Riviera). We did not pursue CR analyses with the  
168 Corsican sightings because of insufficient recaptures (Table1).

169 We used Bayesian closed population models (McClintock, 2015) to estimate abundance while  
170 accounting for a capture probability less than one. We considered the eight seasons as our  
171 capture occasions. The main assumptions underlying closed population CR models are 1) the  
172 population is demographically closed (i.e., natality and mortality events do not occur) during  
173 the study period; 2) all individuals are correctly identified at each capture occasion and 3) the  
174 marks are considered permanent.

175 To fit CR models, we used the package multimark (McClintock 2015) in R (R CoreTeam,  
176 2018), which implements Markov Chain Monte Carlo (MCMC) simulations. We performed  
177 an analysis for each data set, that is the Gulf of Lion, the Riviera, and the continental coast  
178 (Gulf of Lion plus Riviera). For each analysis, we fitted eight models, including a model with  
179 constant detection probability (M0), a model with time variation in the detection probability  
180 (Mt), a model with heterogeneity in the detection probability (Mh) under the form of an  
181 individual random effect, a model with behavioral response in the detection probability (Mb),  
182 and combinations of these effects (Mbt, Mht, Mbh, Mbht). To determine the model best  
183 supported by the data, we calculated posterior model probabilities (Barker & Link 2013).

184 More precisely, we relied on an extension of the standard Bayes theorem where the posterior  
185 distribution of all parameters is now defined over both the parameter and model space. In  
186 addition to posterior summaries for parameters (abundance and detection probabilities), we  
187 also obtained the posterior probability for each model obtained as the proportion of the time  
188 the MCMC simulations spend in each model. Because we used only moderately- and well-  
189 marked individuals (assumed to be adults) in the CR analyses, the abundance, including

190 poorly marked individuals (juveniles and neonates), was obtained by correcting the CR  
191 abundance by the proportion of moderately and well-marked individuals (Williams, Dawson a  
192 Slooten, 1993) estimated as :  
193  $\Delta = n_{QD12}/n_{Q12}$  where  $\Delta$  is the proportion of moderately and well-marked individuals,  
194  $n_{Q12}$  is the number of individuals identified after removing bad quality photos (Q3) and  
195  $n_{QD12}$  is the number of individuals identified after removing bad quality photos (Q3) and  
196 poorly marked individuals (D3) evaluated on the global data set (all captures included) for  
197 each data set. We estimated this proportion for left- and right-side photographs then  
198 calculated the average of these two proportions for each data set. The standard error was  
199 obtained with the formula  $\hat{p} (1 - \hat{p}) / n$  for a proportion estimate  $\hat{p}$  where  $n$  is the sample size.  
200 In practice, the Bayesian approach using MCMC made it easy to propagate the uncertainty in  
201 the proportion of moderately and well-marked individuals. We divided each MCMC value  
202 drawn in the posterior distribution of abundance by a random draw from a normal distribution  
203 with mean  $\Delta$  and standard deviation the standard error, therefore providing the posterior  
204 distribution of the corrected CR abundance. We reported posterior means and 95% credible  
205 intervals for abundance and detection probabilities.

206

## 207 **Results**

### 208 *Survey effort*

209 We traveled 21,464 km in survey effort. The distribution of the effort between the 3 regions  
210 was heterogeneous with a high coverage of Riviera but low coverage of Corsica and the  
211 offshore areas of Gulf of Lion. Summer was the best prospected season, autumn and winter  
212 being less prospected in the three regions (Fig. 2).

213

### 214 *Distribution*

215 We sighted bottlenose dolphins across the study area in all seasons (Fig. 3). Global ER was  
216 higher in Corsica (0.012) than in Gulf of Lion (0.007) and in Riviera (0.003) (Table 2). In  
217 Riviera, ER appeared higher in spring (Fig. 3), while in Gulf of Lion and Corsica, ER  
218 appeared higher in summer (Fig. 3).

219

#### 220 *Sightings and photo-identification*

221 We sighted 151 groups of bottlenose dolphins during the project. Group size was highly  
222 variable in the three regions, mean group size was similar in Riviera (15.7 SD 10.3) and Gulf  
223 of Lion (16.6 SD 13.2) and lower in Corsica (5.3 SD 4.5) (Table 2).

224 After photos scoring and sorting, 766 different moderately and well-marked dolphins were  
225 identified on the basis of good and medium quality photos (Table 2), of which 30% were  
226 observed more than once during the project. The percentage of individuals recaptured was  
227 higher in Gulf of Lion (29%) than in Riviera (19%) and in Corsica (18%). Six individuals  
228 were sighted in both the Gulf of Lion and Riviera, while no recaptures were made between  
229 continental and Corsican coast.

230

#### 231 *Abundance estimates*

232 We excluded 15% of the 1,705 photographs from the analyses because of their low quality  
233 (Q3). The proportion of moderately- and well-marked individuals was 0.73 in Riviera (SE =  
234 0.02), 0.84 (SE = 0.01) in Gulf of Lion and 0.86 (SE = 0.01) in the whole continental coast  
235 (Riviera and Gulf of Lion). Many dolphins (68% in continental coast) were seen only once.

236 The maximum number of captures was 6 for two dolphins (Table 1).

237 The model best supported by the Gulf of Lion and whole continental coast data included  
238 heterogeneity and temporal variation in the detection probability (posterior probability = 0.70  
239 and 0.78 respectively), while the model best supported by the Riviera data was the one

240 considering heterogeneity, a behavioral response and temporal variation in the detection  
241 probability (posterior probability = 1). Detection probabilities varied between 0.02 (0.01-0.03)  
242 and 0.16 (0.11-0.22) for Gulf of Lion, between 0.07 (0.01-0.19) and 0.44 (0.19-0.68) for  
243 Riviera, and between 0.02 (0.02-0.03) and 0.15 (0.11-0.19) for the whole continental coast.  
244 Abundance (corrected by the proportion of moderately- and well-marked individuals) of  
245 population was estimated at 223 (152-385) individuals in Riviera, 2,231 (1,590-3,175) in Gulf  
246 of Lion and 2,350 (1,827-3,135) along the whole continental coast.

247

## 248 **Discussion**

249 Our study provides the first large-scale dedicated photo-identification survey for the  
250 bottlenose dolphin in the French Mediterranean waters. We demonstrate the power of a  
251 collaborative and coordinated survey to study a mobile species at population's scale. Our  
252 results show that the whole continental shelf is frequented by bottlenose dolphins, including  
253 the entire Gulf of Lion, all year round and provides the first abundance estimate of bottlenose  
254 dolphins frequenting the French continental shelf of Riviera and Gulf of Lion.  
255 The effort of 21,464 km covered 87% of the study area. We found heterogeneity in this effort,  
256 mainly between Corsica and the continental coast, which we explain by a later start of the  
257 survey in Corsica and difficult survey conditions during the study. The results obtained in  
258 Gulf of Lion and Riviera show that the survey effort is sufficient to provide consistent  
259 estimates of abundance and distribution.

260 The global encounter rate (0.007) was higher than the encounter rates obtained with the  
261 program "Surveillance Aérienne de la Mégafaune Marine" (SAMM) (0.0041 in winter and  
262 0.0028 in summer) (Laran *et al.*, 2016). This difference could be explained by the fact that  
263 this comprehensive aerial survey of marine megafauna conducted by the French Biodiversity  
264 Agency in 2011 and 2012 over the whole French Exclusive Economic Zone (EEZ),

265 encompasses continental shelf, slope, and oceanic waters (Laran *et al.*, 2016). Another likely  
266 reason might be that aerial surveys consistently have lower encounter rates than boat-based  
267 surveys because of the order of magnitude difference in survey speed. The ER in Riviera  
268 (0.003) and in Corsica (0.012) were also higher than the maximum ER obtained by Gnone *et*  
269 *al.* (2011) between 1994 and 2007 in Provence (ER = 0.0006) and in Corsica (ER = 0.0086),  
270 which suggest an increase in dolphin abundance in these two regions.

271 The distribution of ER showed that bottlenose dolphins were present over the entire French  
272 Mediterranean continental shelf all year round. The higher ER in summer in the Gulf of Lion  
273 and Corsica was consistent with the results of the SAMM survey, which despite showing  
274 higher ER in winter than summer in the global EEZ, also showed contrasting seasonal  
275 distributions, with encounters concentrating in coastal areas of the Gulf of Lion and Corsica in  
276 the summer (Laran *et al.*, 2016). These results suggest a seasonal migration of bottlenose  
277 dolphins between offshore waters in winter to coastal waters in summer, especially in Gulf of  
278 Lion and Corsica. The sighting of dolphins both in Riviera and Gulf of Lion also points  
279 towards some eastward and westward movements. No movement between the continental  
280 areas and Corsica was observed during the project. In previous studies (Gnone *et al.*, 2011), 5  
281 individuals were identified both in Corsica and the continental coast, highlighting that some  
282 dolphins perform long distance travels. The high percentage of dolphins captured only once  
283 (70%) during the project can be explained by the short period and the large study area of the  
284 project decreasing the recapture probability. It may also highlight that an important proportion  
285 of bottlenose dolphins sighted over the French Mediterranean continental shelf are transient  
286 animals coming from remote areas, as suggested by the seasonal differences in the ER and the  
287 movements identified, whereas other animals are resident, as suggested by sightings of some  
288 individuals all year round for more than 20 years (authors unpublished data). Pursuing photo-  
289 identification at this scale over the long term will allow further exploration of and

290 characterizing residency patterns. In their study, Gnone *et al.* (2011) identified two  
291 subpopulations inside the Pelagos Sanctuary coinciding with the national boundaries between  
292 French and Italian territories. The identification of distinct units and the characterization of  
293 connections between them along the French continental coast is the object of ongoing work  
294 using population genetic and social structure analyses based on photo-identification and  
295 biopsy data collected during the present study. Sharing photo-identification catalogs and  
296 associated metadata through the INTERCET platform will make possible the characterization  
297 of bottlenose dolphin movements and social structure at wider Mediterranean scale. The  
298 higher percentage of poorly marked individuals in Riviera (27%) suggests a higher percentage  
299 of immature dolphins in this region than in Gulf of Lion (16%).

300 The robust estimation of abundance relies on the validation of CR model assumptions. The  
301 two-year sampling period and the fact that newborns were observed in the study area suggest  
302 that assumption 1 of the capture-recapture model is likely to have been violated. We expect  
303 little underestimation bias in the abundance estimates because of birth occurring during the  
304 study, as we considered adults only, and they have high survival probability. Mortality  
305 occurring during the study could also lead to abundance overestimation, nevertheless we  
306 expect little bias considering the relative short period for this long-lived species and the high  
307 survival probability. Assumptions 2 and 3 are ensured by the fact that only moderately and  
308 well-marked individuals with medium and good-quality photographs were included in the  
309 analysis. Also, if the marks evolve, the short sampling period would allow recognition of the  
310 animals.

311 The population abundance along the continental coast was higher than the estimates of the  
312 only previous census dedicated to bottlenose dolphins in the same area, which estimated  
313 based on observed count (not corrected by imperfect detection) the number of bottlenose  
314 dolphins between 200 and 209 in the Gulf of Lion and 16 in Provence (Ripoll *et al.*, 2001).

315 These figures are not inconsistent with our abundance estimates which accounted for  
316 imperfect detection by correcting the observed counts by the estimated detection probability.  
317 Our abundance estimates are coherent with the results obtained from the program SAMM  
318 with the distance sampling methodology, which estimated the absolute abundance of  
319 bottlenose dolphins in the Gulf of Lion at 63 (95% CI 17-241) in winter and at 1,331 (95% CI  
320 466-3,805) in summer and over the continental slope inside the French EEZ waters and  
321 including some Italian and Spanish waters at the eastern and western borders at 1,795 (95%  
322 CI 769-4,190) in winter and 10 (95% CI 3-30) in summer (Laran *et al.*, 2016).  
323 Further efforts should be implemented to complete the survey planned for this study in  
324 Corsica in order to provide consistent estimates for this region also.

325

### 326 *Implications for conservation*

327 Our study provides an operational framework as well as a baseline for the implementation of a  
328 long-term large-scale monitoring of bottlenose dolphin population in the French  
329 Mediterranean waters. We therefore recommend pursuing the monitoring initiated in this  
330 study for the long-term, taking into consideration the evaluation of the efficacy of the survey  
331 design, on which we're currently working, to allow the identification of trends in the  
332 population as required for the surveillance program of the MSFD.

333 We shared the data on the international webGIS platform INTERCET  
334 (<http://www.intercet.it/>), which will allow enlarging the study of this species beyond French  
335 boundaries to the basin and Mediterranean scale.

336 The results of our study, together with those from the SAMM survey (Laran *et al.*, 2016), led  
337 to an update of the Mediterranean bottlenose conservation status in the national IUCN Red  
338 List, which was changed from “vulnerable” in 2009 to “near threatened” in 2017 because of  
339 the improved knowledge. They also contributed to the update of the Mediterranean  
340 subpopulation status initiated in 2020. Our demonstration of the presence of bottlenose

341 dolphins in the entire Gulf of Lion led France to submit the designation of a dedicated  
342 offshore SAC encompassing the whole Gulf of Lion continental shelf beyond the territorial  
343 waters and to the recognition of this area as an important marine mammal area (IMMA) for  
344 bottlenose dolphins (<https://www.marinemammalhabitat.org/imma-eatlas/>). Our results will  
345 also contribute to updating the ACCOBAMS bottlenose dolphin conservation plan.

346

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352 Parc naturel régional de Corse, as well as all the people who participated to the survey. We  
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354 INTERCET platform.



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463 **Tables**

464

465 **Table 1.** Distribution of individuals per number of captures.

	1	2	3	4	5	6	Total
Corsica	78	16	0	1	0	0	95
Riviera	79	9	5	3	1	0	97
Gulf of Lion	411	100	51	15	1	2	580
Continental coast	458	123	61	21	6	2	671

466

467 Number of moderately- and well-marked individuals identified (on the basis of good and  
 468 medium quality photos) 1, 2, 3, etc. times in each data set.

469 Continental coast refers to Riviera plus Gulf of Lion

470

471 **Table 2:** Sightings and photo-identification of bottlenose dolphins

	Sightings	Encounter rate	Mean Group size (SD)	Identified individuals	Recaptured individuals
Corsica	41	0.012	5.3 (4.5)	95	17 (18%)
Riviera	18	0.003	15.7 (10.3)	97	18 (19%)
Gulf of Lion	92	0.007	16.6 (13.2)	580	169 (29%)
Global	151	0.007	13.6 (12.5)	766	230 (30%)

472

473 Number of sightings, encounter rates, mean group size and standard deviation (SD), number  
 474 of moderately- and well-marked individuals identified on the basis of good and medium  
 475 quality photos, and number of recaptured individuals (sighted more than once) in each region.

476

477 **Figure legends**

478

479 **Figure 1:** Study area (in light blue) encompassing the French Mediterranean continental shelf  
480 in north-western Mediterranean Sea. The Pelagos sanctuary boundaries appear in dark blue.  
481 The bathymetry is also displayed on the map.

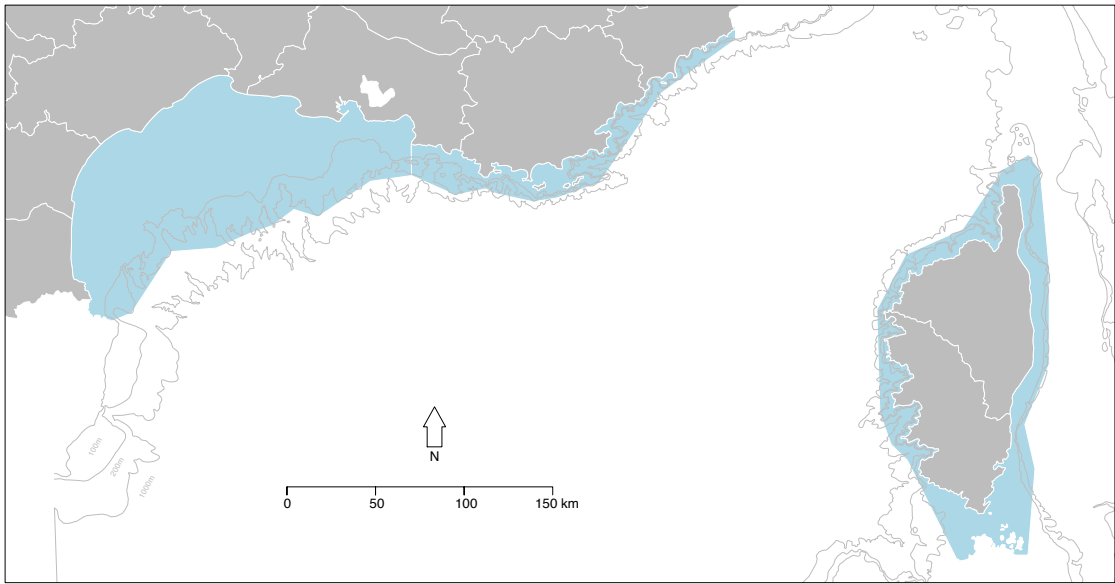
482

483 **Figure 2:** Seasonal distribution of survey effort (number of kilometers actively traveled per  
484 5'x5' cell) between 2013 and 2015 over the French Mediterranean continental shelf.

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486 **Figure 3:** Seasonal distribution of bottlenose dolphins over French Mediterranean waters  
487 between 2013 and 2015. Encounter rates (number of sightings/km) per 5'x5' cell.

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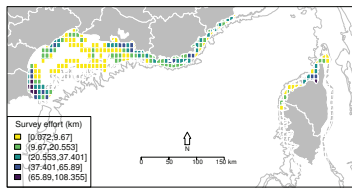


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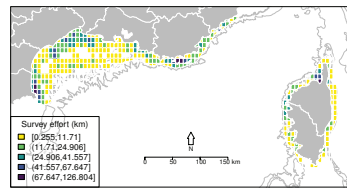
490 Fig. 1

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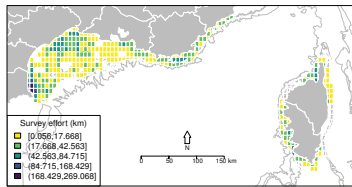




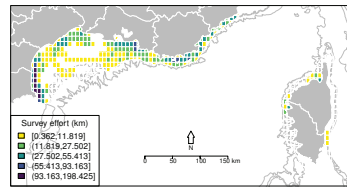
(a) Autumn



(b) Spring



(c) Summer

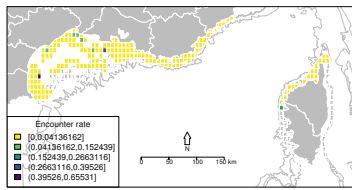


(d) Winter

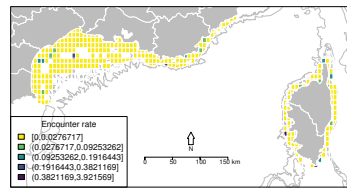
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493 Fig. 2

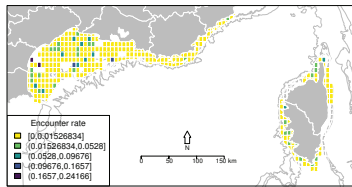
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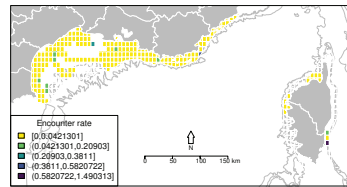
(a) Autumn



(b) Spring



(c) Summer



(d) Winter

495

496 Fig. 3