

Movement and ecology of bottlenose dolphins
(*Tursiops truncatus*) along the North-East coast
of the UK.



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A dissertation submitted in partial fulfilment of the requirements for the degree of Master of
Science (MSc) in Marine Biology.

By Katie Hackett
(BSc Zoology, University College Dublin)

School of Ocean Sciences
Bangor University
Gwynedd, UK
www.bangor.ac.uk

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This work has not previously been accepted in substance of any degree and not being concurrently submitted in candidature for any degree.

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Date: 12th September 2022

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1 **Movement and ecology of bottlenose dolphins (*Tursiops truncatus*) along the North East**
2 **coast of the UK.**

3 Author: Katie Hackett

4 Address: Bangor University, Bangor, Gwynedd, LL57 2DG.

5 E-mail address: kth21gxc@bangor.ac.uk

6 **Abstract**

7 Bottlenose dolphin movement along northeastern UK coasts is understudied, and
8 monitoring programmes are showing an increase in numbers of these animals outside
9 their designated marine protected areas (MPAs). Sightings of bottlenose dolphins have
10 increased greatly along the northeastern coast of England since 2014, averaging from
11 17 a year in 2014 to 507 in the first half of 2022 alone.

12 Photo identification of dorsal fins revealed that 38 dolphins previously identified by
13 Aberdeen University within the Moray Firth SAC have been seen at least once along
14 the northeastern English coast. Thirty-one individuals have been seen on more than
15 one occasion, and 14 dolphins only seen in the study area within the last four years.
16 This suggests that some members of this population are relocating from Scottish
17 waters into waters off the coast of eastern England. Further research is required before
18 these animals can be considered anything more than a transient population, and to
19 fully understand the movement and ecology of these animals along this coast.
20 However, robust protection should be put in place for these animals while these
21 studies are being carried out.

22 **KEYWORDS:** bottlenose dolphin, ecology, photo ID *Tursiops*

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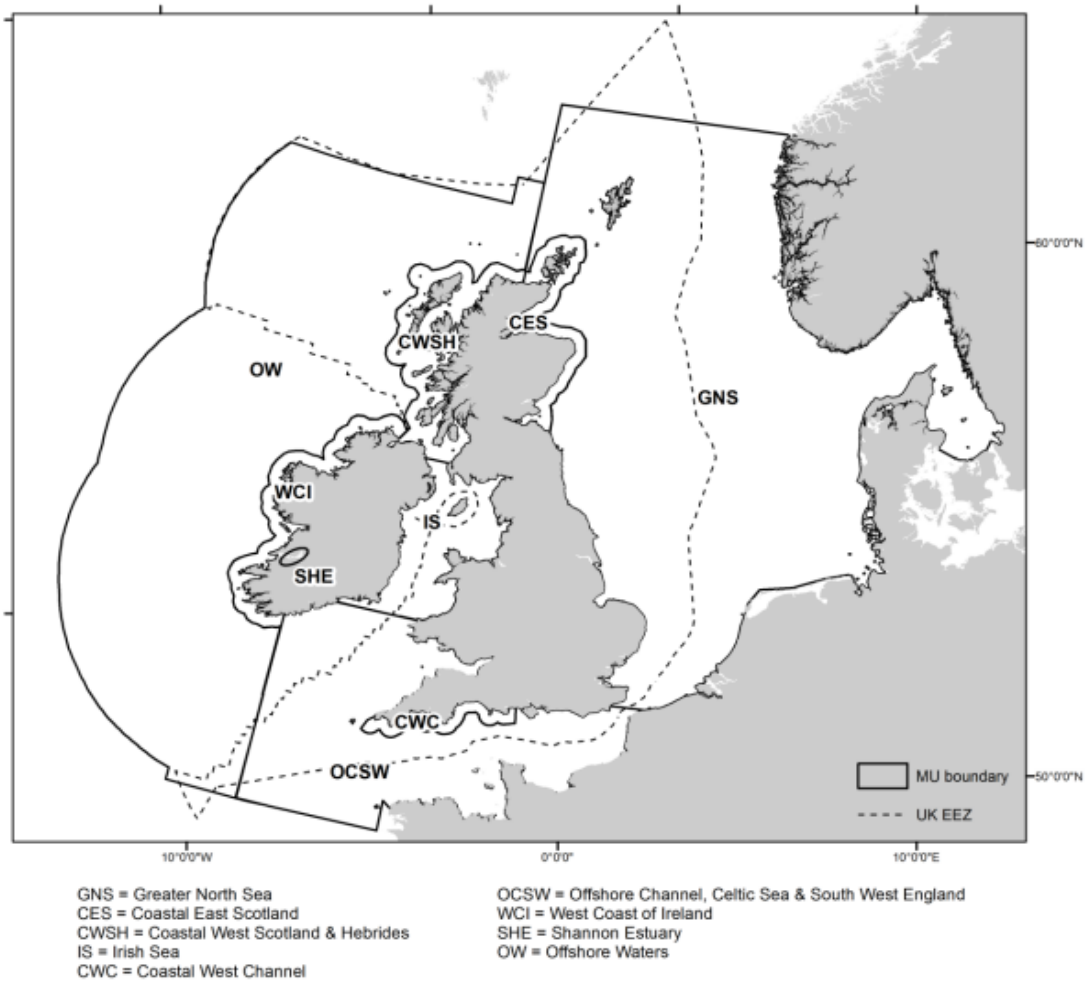
48 1. Introduction

49 Bottlenose dolphins (*Tursiops truncatus*) are one of the most well-known and
50 therefore best studied cetaceans to call the coasts of the UK home. This species lives
51 throughout UK waters, and is split into two distinctive communities: coastal, and
52 offshore. Both ecotypes exhibit different ecological and behavioural adaptations
53 depending on their respective habitats, despite the lack of obvious physical boundaries
54 (Oudejans, et al., 2015). Within these communities, however, individuals often exhibit
55 great ecological plasticity, overlapping ranges and travel long distances, thus ensuring
56 gene flow over large areas (Qu  rouil, et al., 2007; Tezanos-Pinto, et al., 2008). This
57 level of mobility has raised serious questions for their conservation: how do you
58 manage a species with such a large range that can cross county, even international,
59 borders?

60 The distribution of these charismatic cetaceans around the UK is best studied at large
61 spatial scales, to fully understand the range that they cover. Divisions between
62 populations have been difficult to define, with dolphins undertaking long distance
63 movements outside their home range (O'Brien, et al., 2009). Using photographic
64 identification, seven dolphins that were first spotted on the southern shore of the
65 Moray Firth in 2001 were later seen off the west coast of Scotland in 2002 and 2007,
66 and then around the coasts of the Republic of Ireland in 2010 (Robinson, et al., 2012).

67 More recently, nine Bottlenose dolphins known to inhabit waters near the Moray Firth
68 were spotted at Marsdiep, the Netherlands (Hoekendijk et al., 2021).

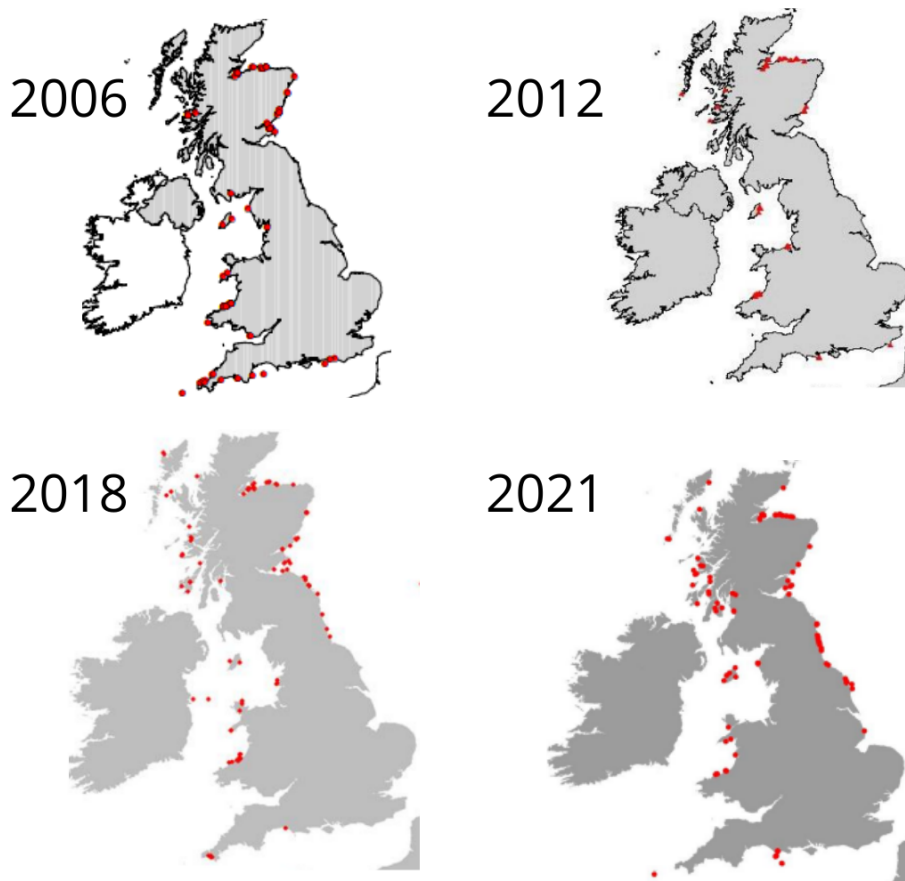
69 Seven management units (MUs) are recognised currently in the UK, with their
70 geographic boundaries shown in figure 1. Within these MUs, two main, semi-resident
71 populations exist, one on the west coast of Wales, particularly in Cardigan Bay
72 (Baines and Evans, 2012; Lohrengel et al., 2017), and the other in Eastern Scotland,
73 particularly between the Moray Firth and St Andrew’s Bay (Thompson et al. 2004;
74 Cheney et al. 2012).



76 Figure 1: Bottlenose dolphin Management Units (MU). Image Contains JNCC © copyright
77 and database right 2015. Boundaries defined through discussions of the Inter-Agency Marine
78 Mammal Working Group (IAMMWG).

79 The stock structure off the coast of Scotland is becoming better understood (Cheney,
80 et al.,2014), and regular monitoring since the 1990s led to the designation of the
81 Moray Firth Special Area of Conservation (SAC) for Bottlenose dolphins in 2005
82 under the European Habitats Directive (Council Directive 1992/43/EEC). However, in
83 recent years, an increasing number of bottlenose dolphins have been spotted further
84 south within the coastal regions of Eastern England (Aynsley, 2017), roughly 300
85 miles outside of what would be considered their ‘normal’ home range (Cheney et al.
86 2018).

87 Bottlenose dolphins are not new to this area, with sightings of solitary individuals
88 going back at least to 1987 (Bloom, 1991). However, the sightings data detailed in the
89 Sea Watch Foundation's National Whale and Dolphin Watch reports have revealed an
90 influx of animals in the last decade (figure 2).



91

92 Figure 2: Bottlenose dolphin sightings on the coasts of the UK and Ireland (red) from the Sea
93 Watch Foundation's 2006, 2012, 2018, and 2021 National Whale and Dolphin Watch reports
94 (Sea Watch Foundation., 2022).

95 The presence of these animals south of the Scottish border is historically understudied,
96 and whether or not this is the establishment of a new population or just a range
97 expansion of the Scottish population is an ongoing debate. When it comes to
98 management, these dolphins are often overlooked as there is very little data in the
99 literature about the species' use of this area. What is clear, though, is that these
100 animals are becoming frequent sights around Northumbria and more southern shores,
101 and we must reassess our management of this species in order to continue to protect
102 this beloved animal.

103 The current strategy for protecting marine ecosystems are Marine Protected Areas
104 (MPAs). These sites are areas of the sea that have been reserved by law with the
105 intention of protecting part or all of their environment, including flora, fauna, and
106 habitats (Kelleher and Kenchington, 1992; Agardy, 1994). There are currently
107 hundreds of MPAs around the UK coast, but only three aimed at the protection of
108 bottlenose dolphins, two in Cardigan Bay, and one in the Moray Firth. The aim of
109 these protected areas is to help in the conservation of animals based on their risk
110 status, vulnerability to change, and location. However, this ideology has limitations
111 when it comes to looking at the protection of highly motile predators (Nykänen, et al.,
112 2018; Nykänen, et al., 2019), especially considering their lifespan, and the proportion
113 of time they actually spend in protected areas (Cheney et al., 2014).

114 That is not to say that policy makers do not already try to work around the problems
115 caused by the large ranges that marine animals often inhabit. These discrete spatial
116 designations often are drawn up focusing on common breeding or nursery grounds of
117 marine cetaceans (Rodgers and Smith, 1995; Garla, et al., 2005; Lindsay et al., 2016).
118 Through the continued surveying and studying of these ‘problematic’ groups, our
119 understanding of ecological management will continue to grow to better aid in the
120 conservation of all marine species.

121 The best method of surveying and identifying individual bottlenose dolphins is
122 through photographic identification (photo ID). This non-invasive method involves
123 identifying individual animals by unique body markings. Bottlenose dolphins often
124 experience intraspecific aggression (Parsons, et al., 2003), and so are often left with
125 notable scarring on their skin (Marley, et al., 2013), particularly their dorsal fins

126 (Oudejans, et al., 2015). Fin markings do tend to change over time; markings and cuts
127 may get larger, fade and heal, or be replaced entirely by a larger injury. It is
128 recommended that photo-identification surveys and analysis be carried out at least
129 every two years to enable the continuous tracking of individual animals (Pleslić, et al.,
130 2018). This simple method is a highly useful tool in marine biology (Stevick et al.
131 2001) and retains its use as a reliable means of identifying individuals on a large scale
132 (Berrow, et al., 2021).

133 The aims of this project are to investigate the movement patterns of these bottlenose
134 dolphins around the East coast of the UK. This will help determine whether there are
135 two separate, isolated populations of dolphins along this coast or if this is merely a
136 range expansion of Scottish dolphins into English seas. Individual dolphins will be
137 identified using Photo ID of their dorsal fins and tracked based on where each photo
138 was taken using GIS systems. Sightings data, with information on location and group
139 size, will then be used to identify any patterns of these movements between seasons
140 and over the years.

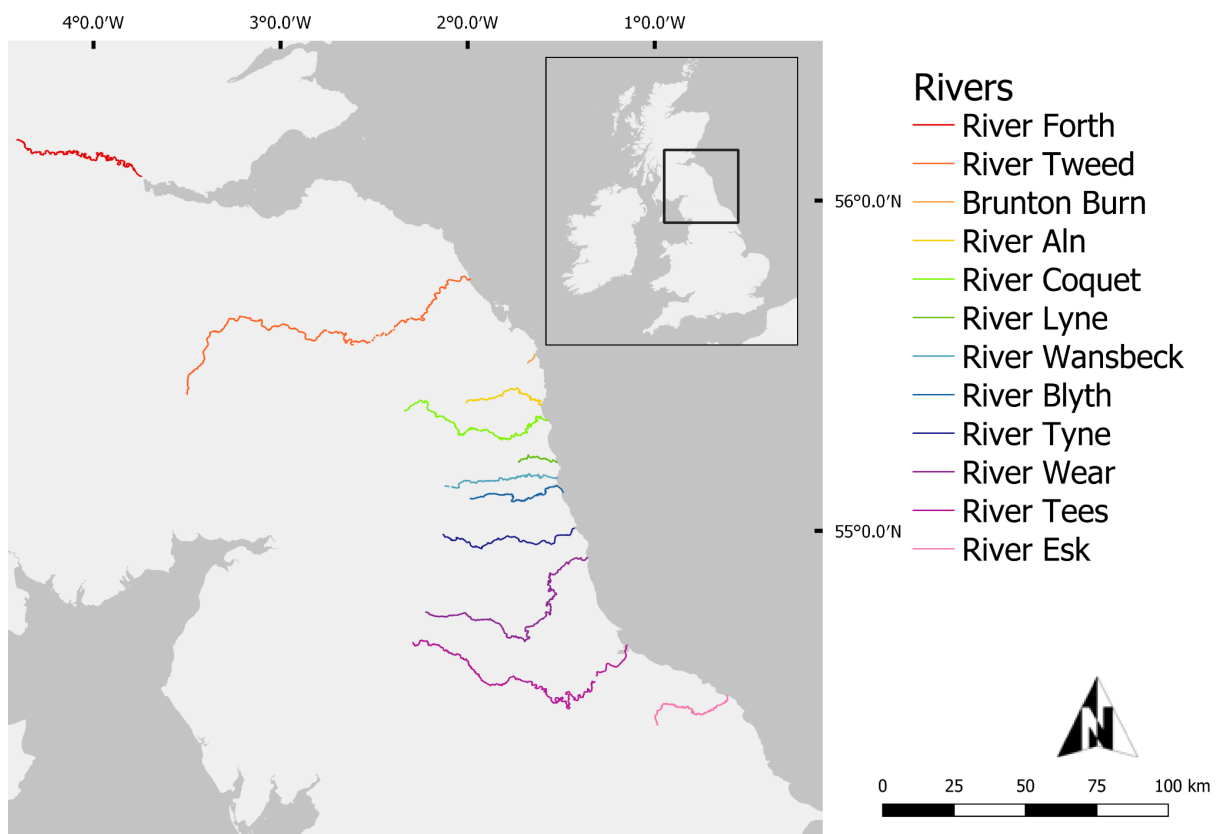
141 The Moray Firth MPA plays a key role in the conservation effort for this species
142 (Arso Civil et al, 2019), but considerations need to be made for when the animals
143 move outside this safe space. Any management policies made must be centred around
144 the welfare of the animals and quality of the habitat they are aimed at protecting
145 (Gerber, et al., 2005), but consistent and regular monitoring of these species is the key
146 to ensuring these areas have the effect originally intended (Hooker and Gerber, 2004).
147 The implications that these changes in movement patterns have on the conservation of

148 this species within current MPA boundaries are unknown, but this project aims to
149 begin to shed some light on the best way to move forward.

150 2. Methods

151 2.1 Study site

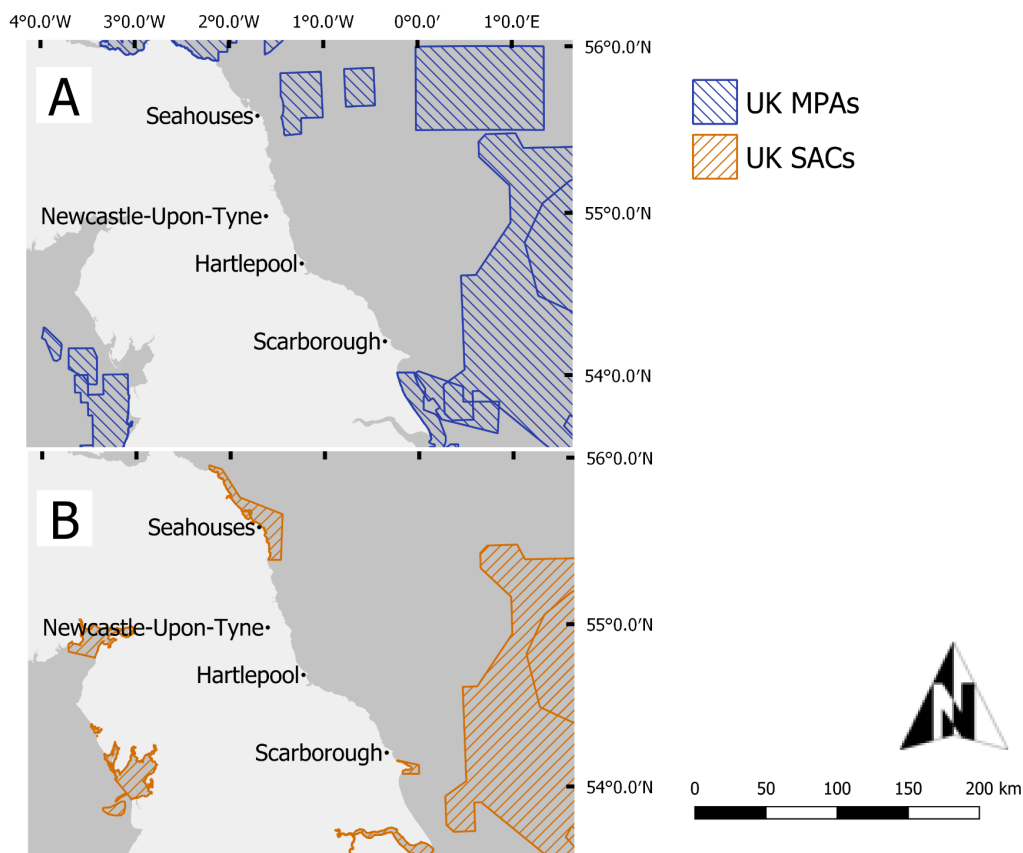
152 All data were collected within a 200km stretch of coast off the Northeast of England,
153 from The Firth of Forth, Scotland, to Withernsea, Hull (Latitude 56.06N to 53.73N;
154 Longitude: -2.67W to 0.04W) (figure 3). Located in the North Sea, this stretch of
155 coast is influenced by a southward current from Scottish coastal waters (Howarth,
156 2001).



157

158 Figure 3: Map of the study Site with major rivers.

159 There exists only three MPAs established primarily for the protection of bottlenose
 160 dolphins in the UK: the Moray Firth SAC, the Cardigan Bay and Pen Llyn a'r Sarnau
 161 SACs. There are several other Special Areas of Conservation (SACs) that may by
 162 chance protect dolphins, but in eastern Britain there is a 170km stretch of coastline
 163 that is completely unprotected (figure 4).



164

165 Figure 4: Map of the study Site with Marine Protected areas (MPAs) and Special Areas of
 166 Conservation (SACs).

167 2.2 Photo Identification and tracking of individual animals

168 Images for photo ID were sourced from various researchers and groups on social
 169 media in early June (sources detailed in table 7 in appendix). Field work was carried

170 out over a week-long period (June 24th to June 31st) in the vicinity of Newcastle-
171 upon-Tyne in June. This had two main objectives: to liaise with locals familiar with
172 these animals, and take more images for photo ID. This was done with two 4-hour
173 boat surveys upon the *JFK TWO* catamaran, based in Tynemouth, and eight land
174 surveys, four in the mornings (9am to 12pm), and four in the evenings (5pm to 8pm).
175 Land surveys were carried out in King Edwards Bay and on the North Tyne Pier as
176 these areas were identified as common dolphin sighting areas.

177 The social media site Facebook was used to find images that could lead to a positive
178 ID match. Images were only processed from Facebook groups if the location and date
179 on which the photo was taken was included.

180 All images were sorted by photographer, year, and date. Images from both land- and
181 boat-based surveys were used in this study. Images of dorsal fins where the animal is
182 directly perpendicular to the camera were selected from each source collection. Only
183 images with a clear, focused, and unobscured shot of the dorsal fin were used. All
184 usable images were viewed in Adobe Photoshop, being lightened or the contrast
185 edited, if necessary, to see identifiable markings.

186 Usable images were then sorted by the largest or most obvious marking on the dorsal
187 fin: nicks, white patches, scrapes, missing tops of fins, or none. Images in the first
188 three categories were then sorted by the location of the marking on the fin: top,
189 middle, or bottom of the fin, or if they had multiple markings.

190 Aberdeen University maintains a bottlenose dolphin Photo ID catalogue of 326
191 identifiable individuals from around the Moray Firth. A catalogue of dorsal fins

192 photographed within the study area was created using the images detailed above, then
193 cross-referenced with and matched to those in the University of Aberdeen dolphin
194 catalogue. Extra care was taken when matching dolphins using older images as
195 identifiable markings can change and fade over time (Pleslić, et al., 2018). Jo
196 Richardson, a regular dolphin watcher who is very familiar with these animals, was
197 consulted on any uncertainties surrounding the matches.

198 These sightings of individual dolphins were paired with the locations of each survey
199 to begin the tracking process. The Aberdeen University catalogue details the annual
200 sightings of each dolphin. These data were compared with the annual sightings data of
201 each dolphin seen in the study area of this project to understand their residency
202 patterns and movement.

203 2.3 Analysis of sightings data

204 Sightings data were obtained from multiple sources to map the changing movement
205 patterns of these animals (sources detailed in table 8 in appendix). The most detailed
206 source of citizen reported data was the NECP Facebook page, where daily discussions
207 are posted and members of the group can share details of sightings all along the
208 Northeast coast of England.

209 From 2014 to 2019, posts were few across all networks. In 2020, sightings increased,
210 and many people began posting daily about sightings. Due to the high volume of posts
211 and comments on each post, and the time constraints of this project, posts from only
212 2-3 days each week could be included. However, these days were chosen randomly
213 with a random number generator so as not to over report on days that people usually

214 have more time to dolphin watch, such as Saturday or Sunday. This ensured a
215 minimum of 10 days a month were included.

216 Only reports where the species was confirmed were included. Great care was taken to
217 ensure no pod or individual was reported twice in one day by noting the direction each
218 pod was heading and the distance/time between sightings. Any reports that did not
219 include group size were included, but the number of dolphins was denoted as 1. This
220 is to ensure that all sightings were included, even if information on group size was not
221 available.

222 Amongst the data taken from each post was date, time of day, location, direction if the
223 group was travelling, species, group size (minimum estimate), number of calves,
224 behaviours, and identity of the individual if they could be identified.

225 2.3.1 Statistical Analysis

226 Dolphin group size, number of sub adults, and the number of dolphins seen feeding
227 around the northeastern English coast were compared across years and seasons to
228 investigate if these have changed since 2014 and if there was a pattern that emerged.
229 None of these data was normally distributed, so non-parametric Kruskal-Wallis rank
230 sum tests were run to assess these changes (Kruskal and Wallis, 1952). Post-hoc
231 testing was carried out to identify where the differences were in the data by means of
232 the Dunn test (Dunn, 1964).

233 2.3.2 Visual Analysis

234 The locations of each sighting by year and season were mapped, as well as sightings
235 of calves and animals feeding, using the free and open-source mapping software QGIS
236 (QGIS.org, 2022). Data were compiled into three groupings of three years, 2014-16,
237 2017-19, and 2020-22, to identify any major changes in movement patterns and to see
238 to what degree these animals have shifted their range.

239 Heat maps of dolphin sightings per year and season were created with these data.

240 Common hot spots were noted, and behavioural data were used to identify common
241 feeding and foraging grounds.

242 3. Results

243 3.1 Individual dolphin analysis

244 Of the 8,000 images sourced for this study, roughly 18% were usable, i.e. clear, in-
245 focus dorsal fins that could be used for photo ID. A total of 38 individuals were
246 identified from 584 individual sightings along the Northumbrian coast collected
247 between 2014 and 2022 using photo ID techniques, matching them to the Aberdeen
248 University Bottlenose Dolphin Catalogue (University of Aberdeen, 2022).

249

250 Seven Individuals were only recorded once. Of the 31 animals recorded more than
251 once, the dolphin coded ABD#116, Runny Paint, was seen the most, with 97 re-
252 sightings. Four other dolphins were identified more than 30 times over the study
253 period: ABD#1150 was seen 40 times, ABD#1048 was seen 37 times, ABD#882 was

254 seen 36 times, and ABD#009 was seen 34 times. A full breakdown of recordings is
255 available in Appendix tables 9 and 10.

256 A ‘floppy fin calf’, or a calf with spinal deformities, was seen 23 times by NECP
257 members between 2020 and 2022, but there are two calves that meet this description
258 in the Aberdeen catalogue, ABD#1232, and ABD#1269, so sightings of this individual
259 were omitted from these data.

260 Of the 38 individuals, all except one (ABD#42, Hubbs) have also been recorded in the
261 Moray Firth SAC since 2014, and 23 of them since 2018. These other 14 dolphins all
262 have been seen exclusively off the Northeastern English coast since 2018.

263 Of the other 24 identified dolphins, eight have been seen travelling between the Moray
264 Firth SAC and the Northeastern coast of England on an annual basis, being seen at
265 least once in both locations in the same year. Of the five individuals most commonly
266 seen off the English coast, only ABD#009, ABD#116, and ABD#1048 have been seen
267 travelling back to the Moray Firth since 2018.

268 3.2 Sightings data

269 A total of 1,221 individual sightings of bottlenose dolphins were reported to the
270 aforementioned social media groups over the last nine years. The average monthly
271 sighting from before June 2020 was 1.4/month, but, since then, the average has
272 increased to 42.7/month. Tables 1 and 2 show the distribution of those sightings by
273 year and by season, and these data are visualised in figures 5 and 7. Seasons are
274 grouped based on the Celtic calendar where Spring begins on February 1st, Summer

275 begins on May 1st, Autumn begins on August 1st, and Winter begins on November

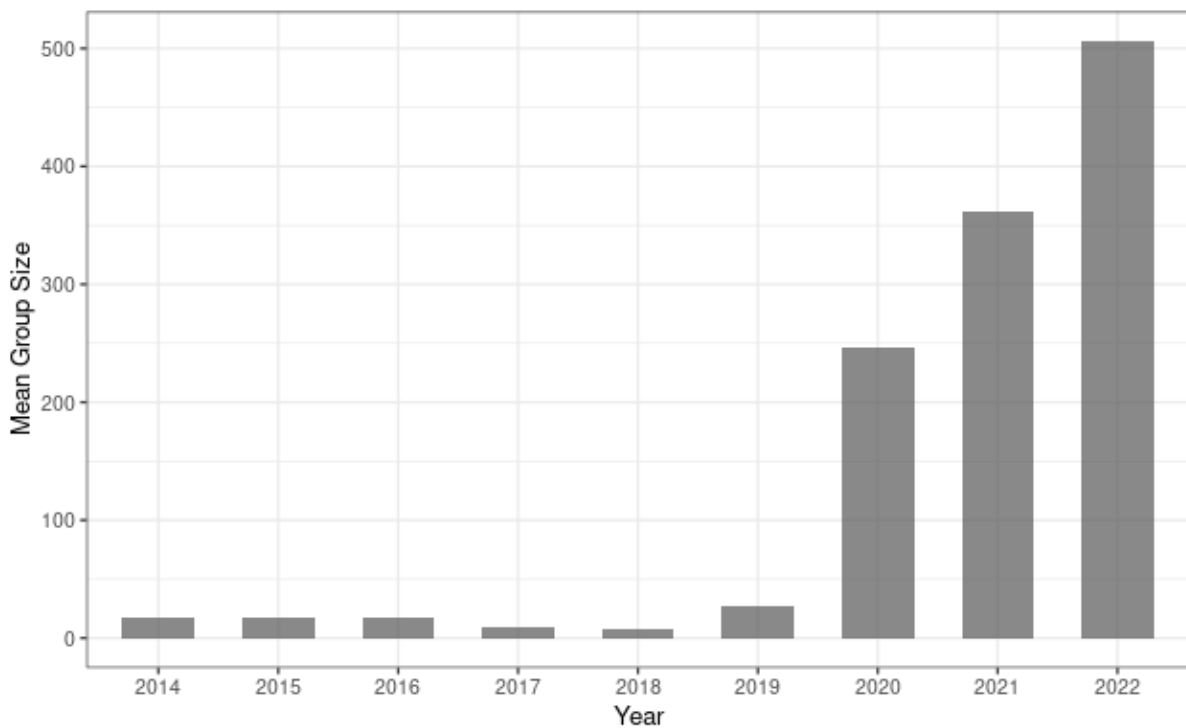
276 1st

277 Table 1: Sightings of Bottlenose Dolphins per year from 2014 to 2022.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Sightings	17	18	17	11	8	25	249	369	507

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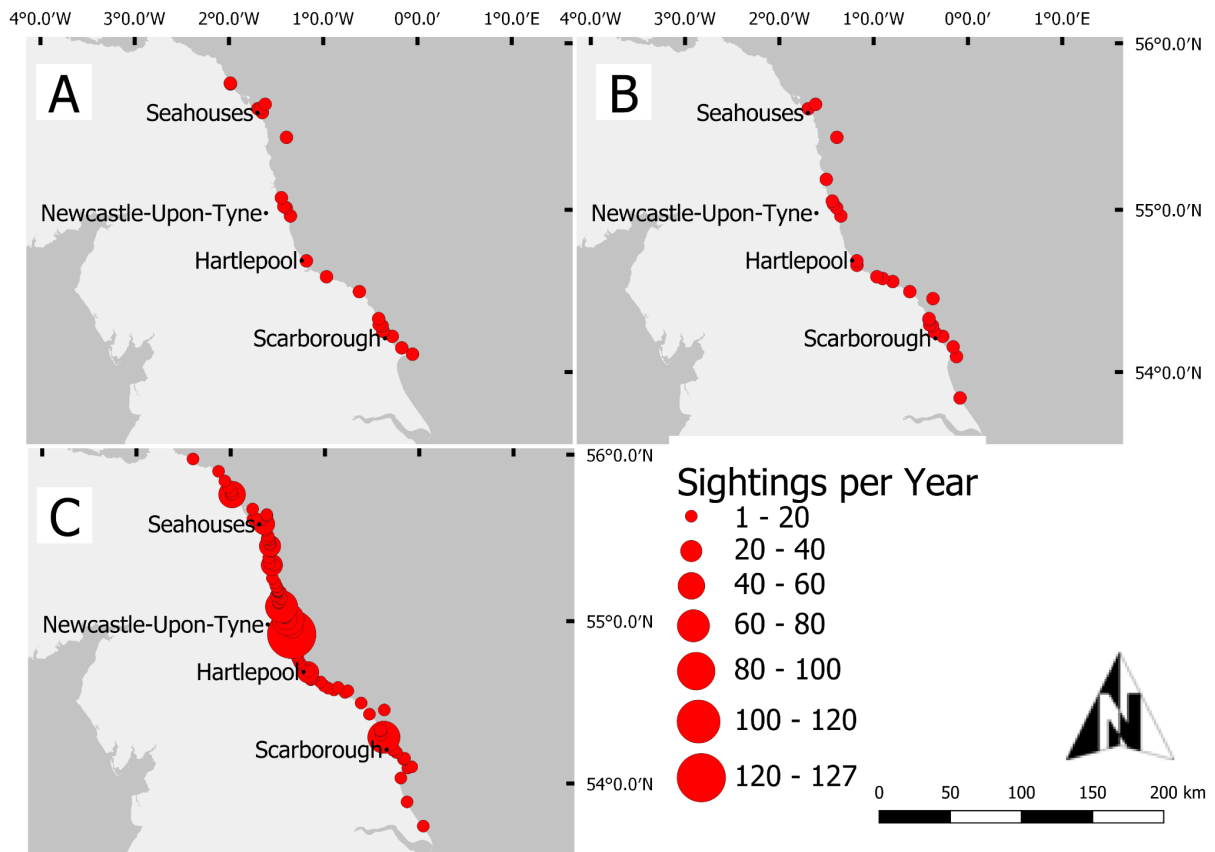
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281 Figure 5: Sightings of bottlenose dolphins per year from 2014 to 2022.

282 The mouth of the Tyne River had a high number of sightings, with 127 sightings being

283 reported in the river alone from 2020-2022 (figure 6). Other locations with numerous

284 sightings were Scarborough, Hartlepool, Seahouses, and Berwick-upon-Tweed.



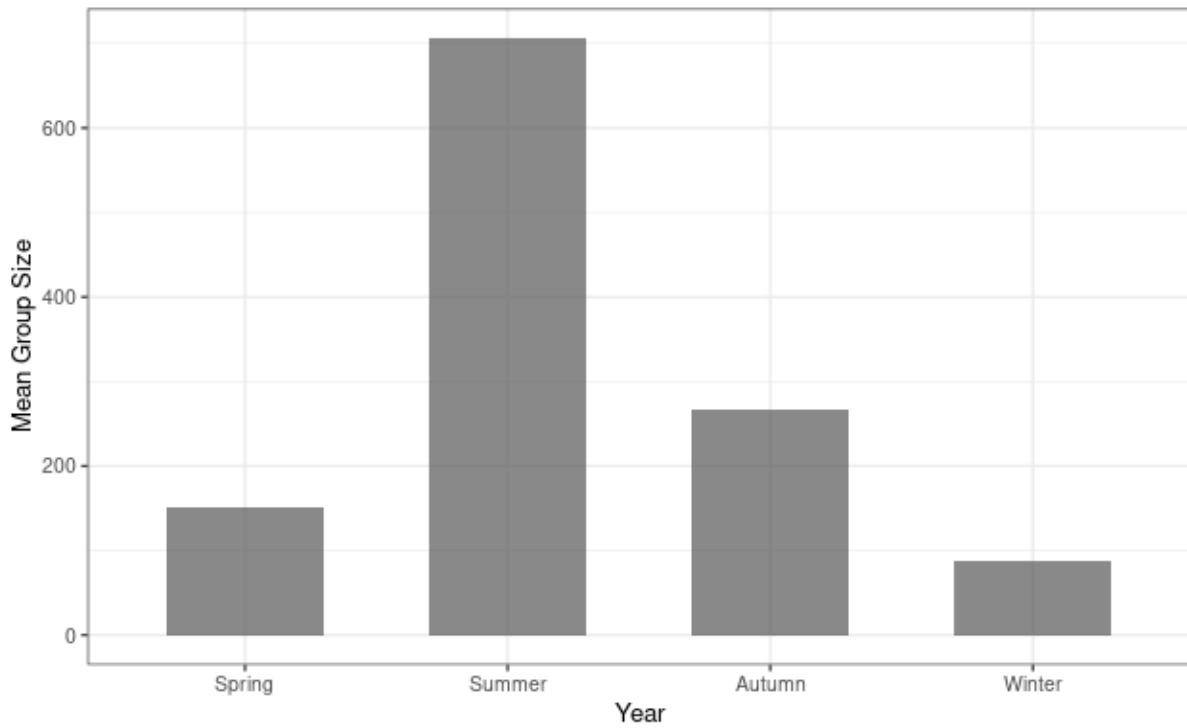
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286 Figure 6: Sightings of bottlenose dolphins per year from A) 2014-16, B) 2017-19, and C)
 287 2020-22. Point size relates to the number of sightings at each location per year.

288 Table 2: Sightings of Bottlenose Dolphins per season from 2014 to 2022.

Season	Spring	Summer	Autumn	Winter
Sightings	151	713	262	95

289

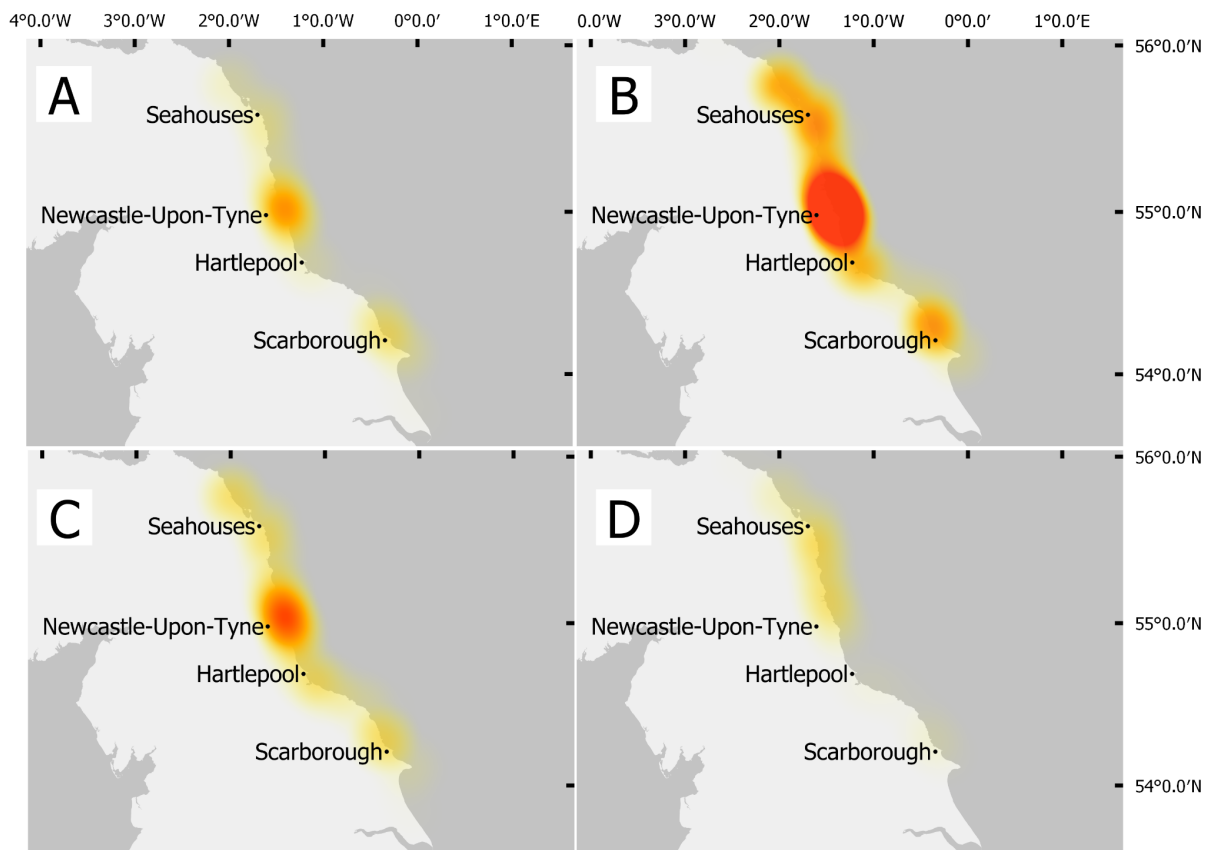


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291 Figure 7: Sightings of bottlenose dolphins per season from 2014 to 2022.

292 Sightings during spring, summer, and autumn were common around the Tyne and

293 Scarborough, but sightings in the winter were concentrated further north (figure 8).

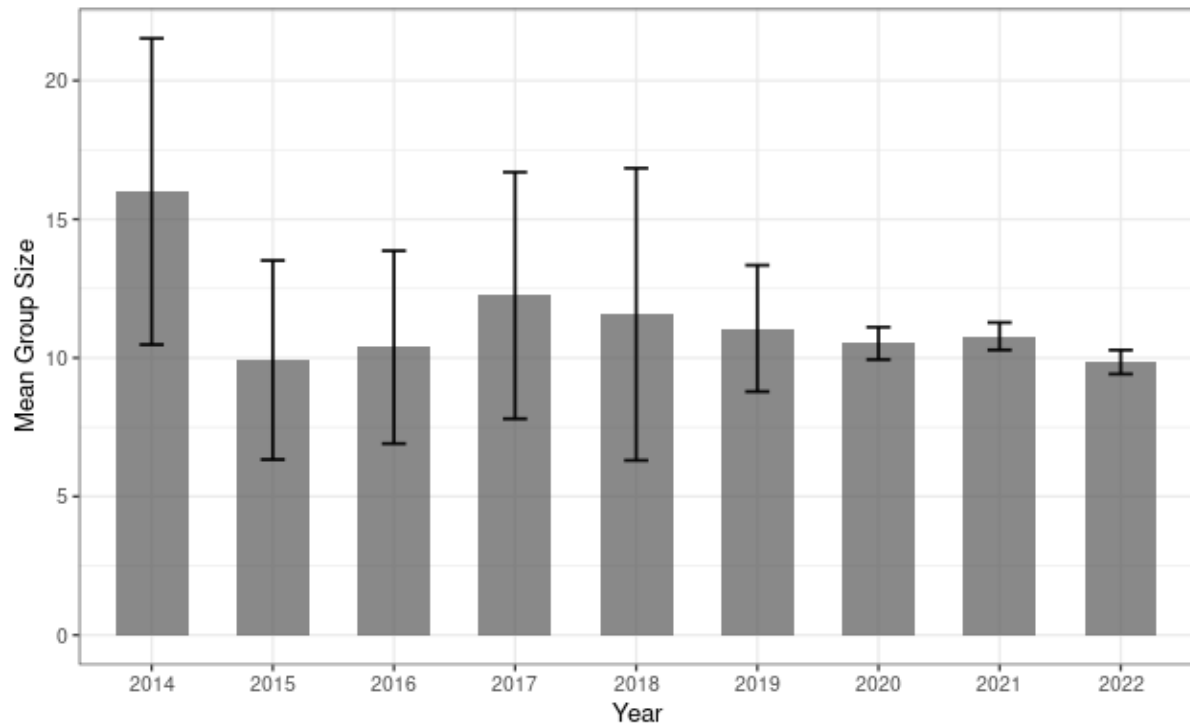


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295 Figure 8: Sightings hotspots during A) Spring, B) summer, C) Autumn D) Winter from 2014
 296 to 2022. Heatmap weighted by number of sightings per year in each location.

297 3.3 Group Size data

298 Mean group size between 2014 and 2022 was 10.37 individuals per sighting (figure
 299 9). There was low variation over the years, and non-parametric testing showed no
 300 significant differences between years ($\chi^2 = 10.517$, $df = 8$, $P = 0.2306$).

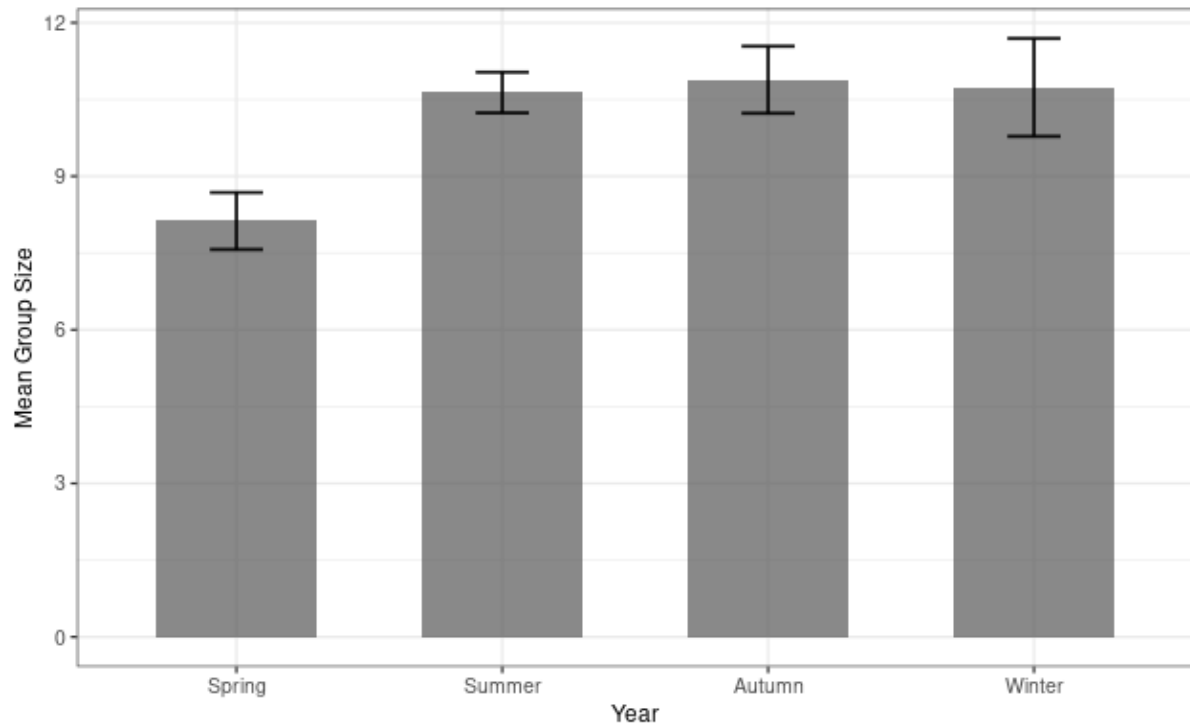


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302 Figure 9: Bottlenose Dolphin mean group sizes (\pm SE) per year from 2014 to 2022.

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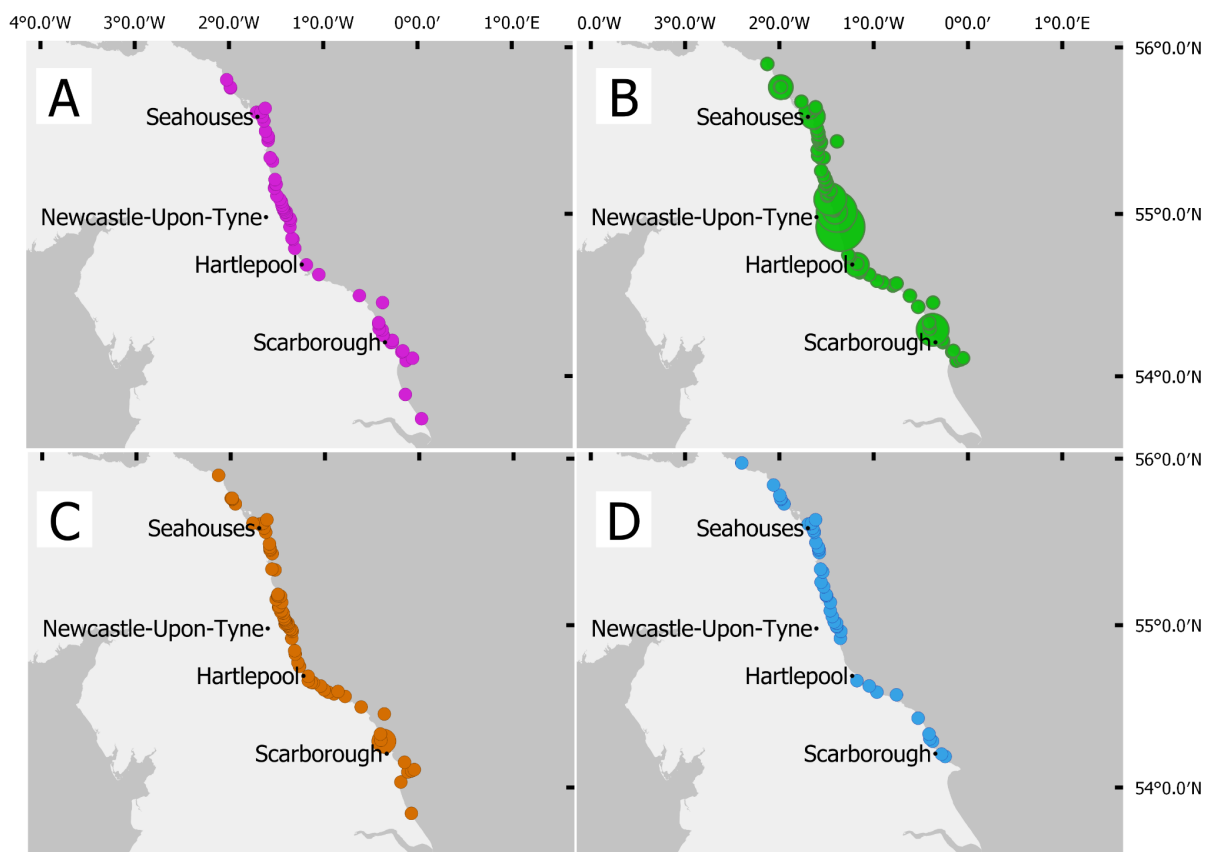
304 Group size did vary slightly across seasons, and non-parametric testing showed there
305 were significant differences between years (chi-squared = 8.3748, df = 3, P = 0.03887)
306 (fig 10). Further multiple-comparison post hoc testing showed that only group size in
307 spring was significantly different to all other seasons, with group sizes being smaller
308 in Spring.



309

310 Figure 10: Bottlenose Dolphin mean group sizes (\pm SE) per season from 2014 to 2022.

311 The locations of each dolphin sighting based on group size is shown in figure 11.



312

313 Figure 11: Group size data during A) Spring, B) summer, C) Autumn D) Winter from 2014 to
 314 2022. Point size relates to the number of sightings at each location per year.

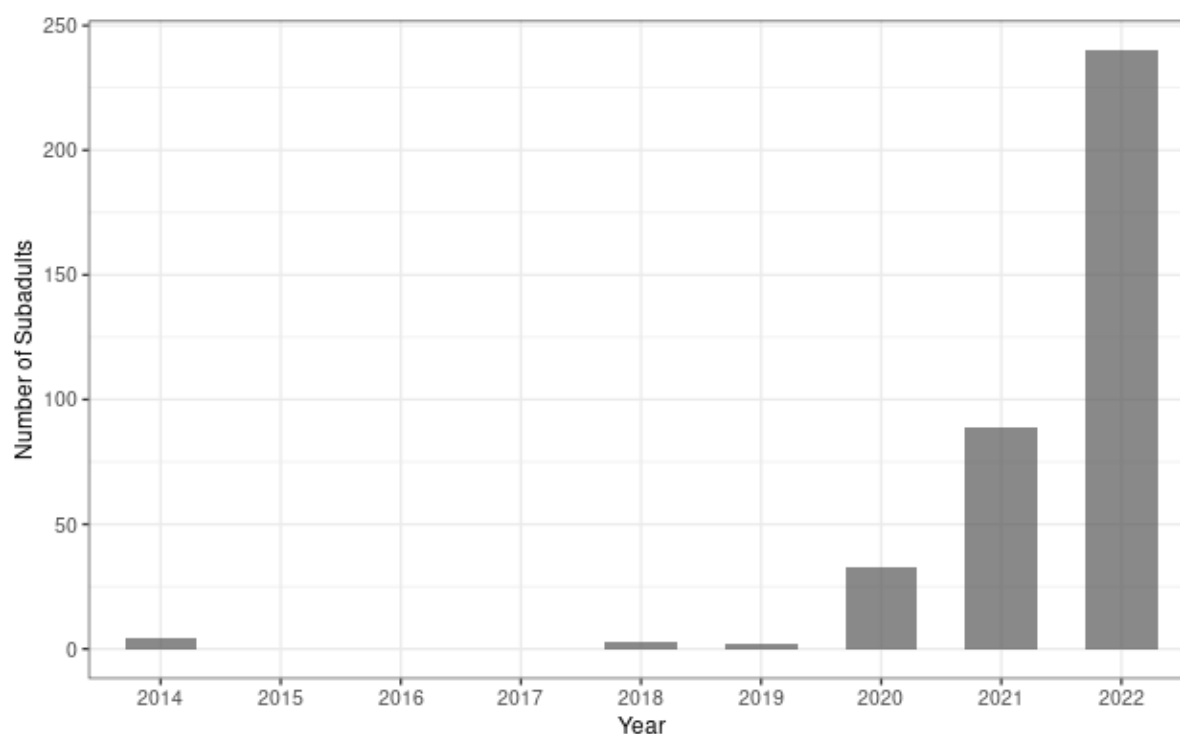
315 3.4 Presence of Calves and Juveniles

316 A total of 371 subadults were reported over 150 sightings from the citizen science
 317 sources. The number of subadults increased from 2020 to 2022 (table 3, fig 12) (chi-
 318 squared = 19.021, $df = 5$, $p\text{-value} = 0.001905$). Further multiple-comparison post hoc
 319 testing showed that the number of subadults significantly increased in 2022 compared
 320 to other years.

321 Table 3: Number of Bottlenose Dolphin subadults seen in Northumbria per year from 2014 to
322 2022.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Subadults	4	0	0	0	3	2	33	89	240

323



324

325 Figure 12: Number of Bottlenose Dolphin subadults seen in Northumbria per year from 2014
326 to 2022.

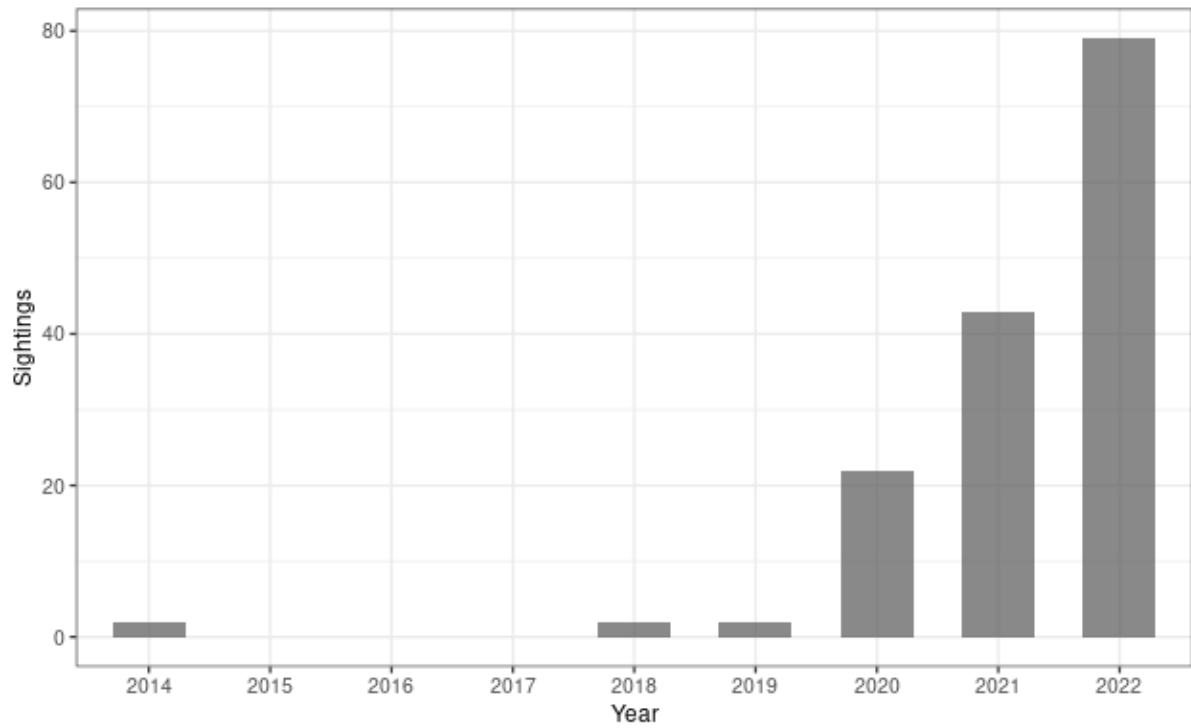
327 The number of sightings that included calves are detailed in table 4 and figure 13.

328 Figure 14 shows the locations of each of these sightings.

329 Table 4: Sightings that include at least 1 subadult per year from 2014 to 2022.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Sightings	2	0	0	0	2	2	22	43	79

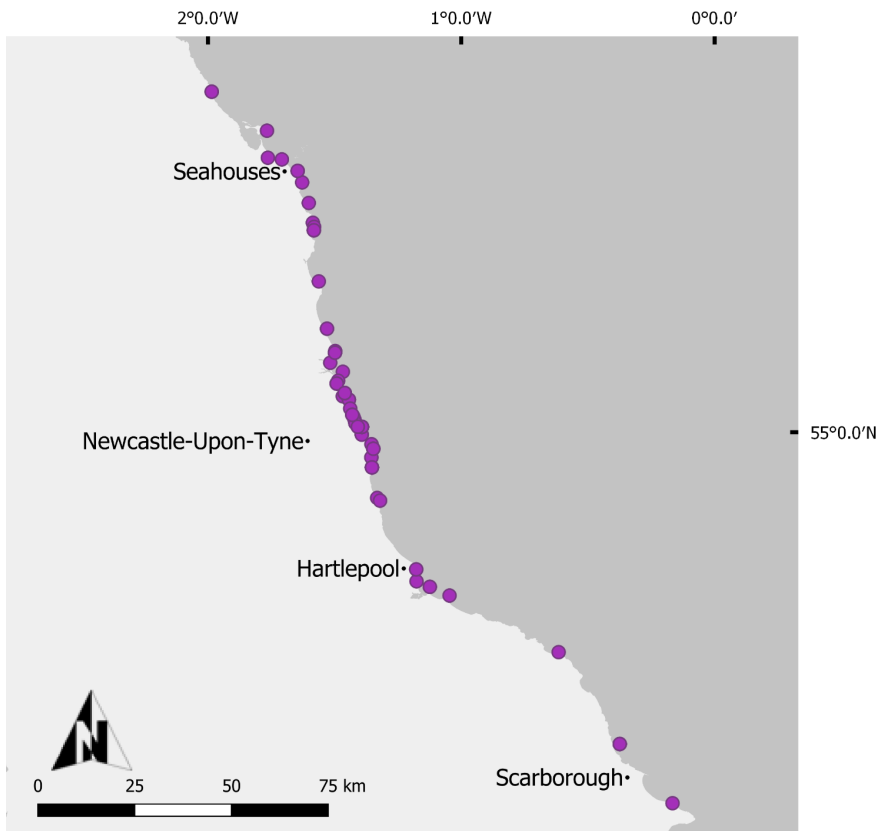
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331

332 Figure 13: Number of Bottlenose Dolphin subadults seen in Northumbria per year from 2014
 333 to 2022.

334



335

336 Figure 14: Locations of sightings with calves from 2014 to 2022.

337 3.5. Feeding Hotspots

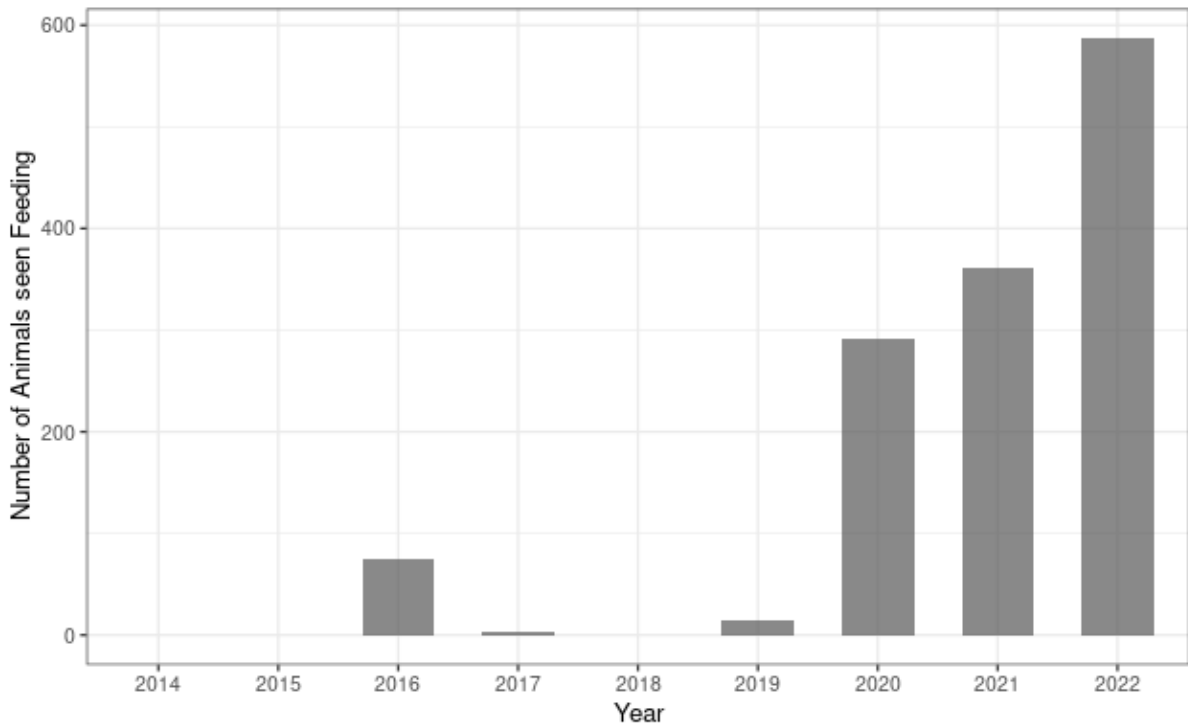
338 There were 142 instances of bottlenoses feeding along the Northumbrian coast from
 339 2014 to 2022. The number of dolphins seen feeding along the Northumbrian coast
 340 appeared to increase from 2020 to 2022 (table 5, figure 15), but non-parametric testing
 341 showed this increase was not statistically significant across any years (chi-squared =
 342 6.9635, df = 5, p-value = 0.2234).

343 Table 5: Number of Bottlenose Dolphins seen feeding in Northumbria per year from 2014 to
 344 2022.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total									
Feeding	17	18	17	11	8	25	249	369	589

345

346



347

348 Figure 15: Number of Bottlenose Dolphin seen feeding in Northumbria per year from 2014 to
349 2022.

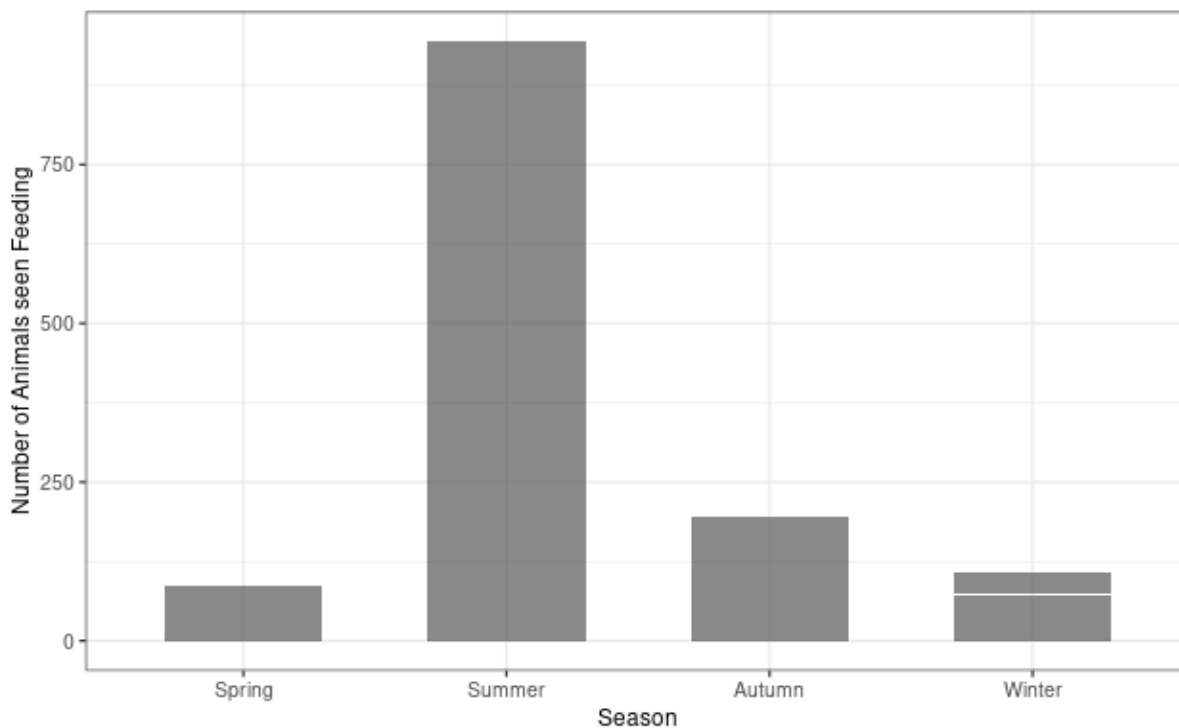
350 Similarly, when looking at feeding per season, the differences in the number of
351 animals feeding between each season did not appear to be significant at first
352 investigation (chi-squared = 2.978, df = 3, p-value = 0.395) but multiple-comparison
353 post hoc testing showed significantly more animals were seen feeding during summer
354 than the other seasons (table 6, figure 16)

355 Table 6 Number of Bottlenose Dolphin seen feeding in Northumbria per season from 2014 to
356 2022.

Season	Spring	Summer	Autumn	Winter
Total feeding	151	713	262	95

357

358

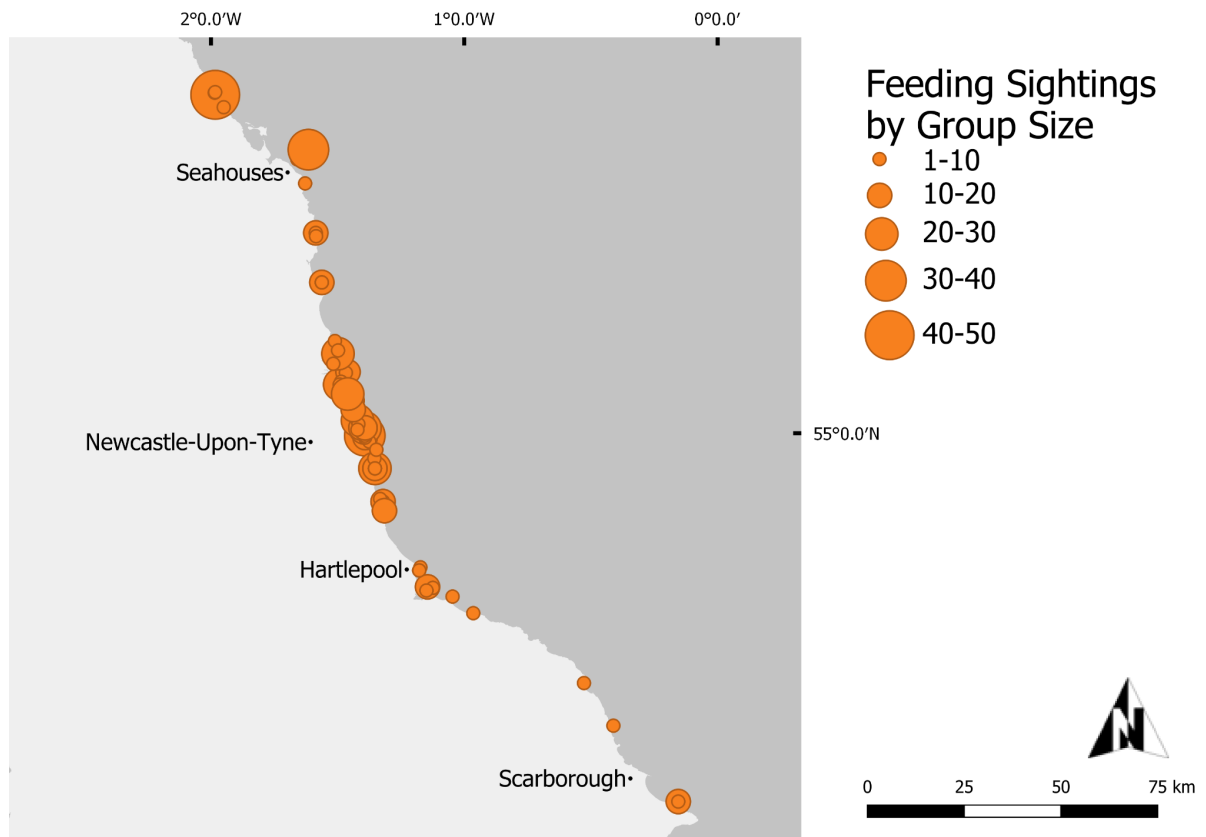


359

360 Figure 16: Number of Bottlenose Dolphins seen feeding in Northumbria per season from
361 2014 to 2022.

362 Sightings of animals feeding and foraging are visualised in figure 17. Mouths of the
363 Rivers Tyne, Tweed, Wansbeck, Wear, Blyth, and Coquet were all identified to be
364 important foraging / feeding grounds (figure 18).

365



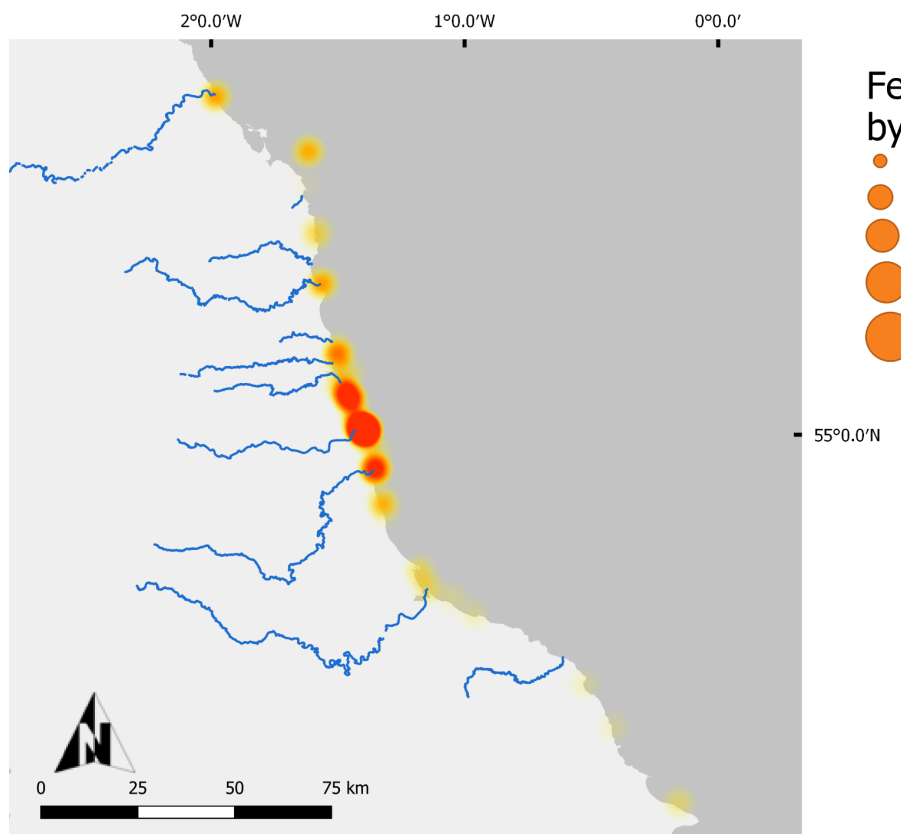
366

367 Figure 17: Number of bottlenose dolphins seen feeding from 2014 to 2022. Point size relates
368 to the number of sightings at each location per year.

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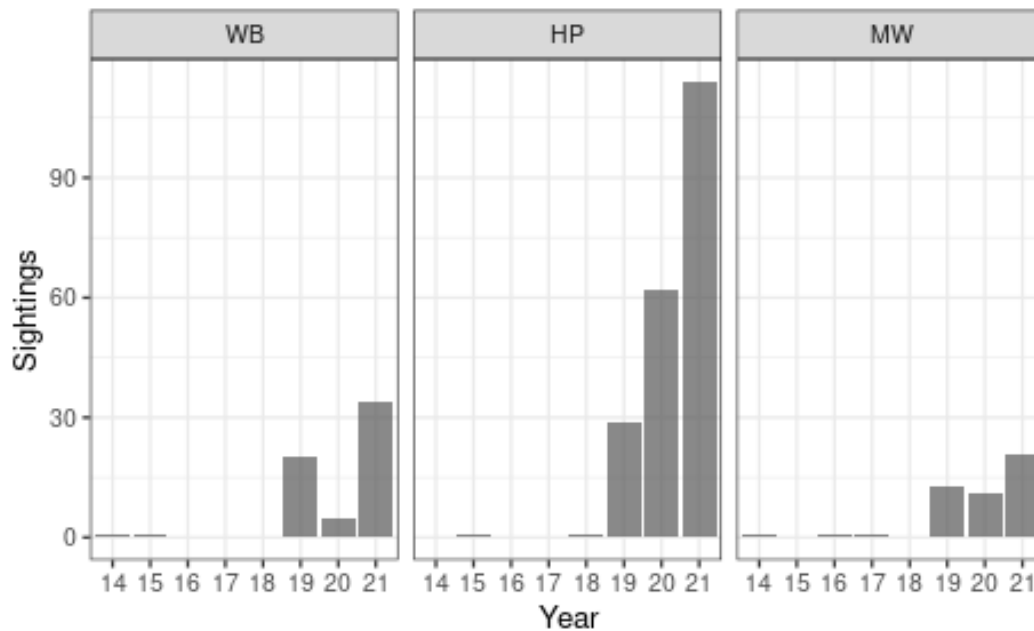
372

373 Figure 18: Feeding hotspots from 2014 to 2022 with major rivers.

374 3.6 Other species

375 Besides bottlenose dolphins, the North-East Coast of England is home to a number of
 376 other cetacean and pinniped species. From 2014-2022, eight other species were seen at
 377 least once in this area: common dolphin (*Delphinus delphis*), harbour porpoise
 378 (*Phocoena phocoena*), humpback whale (*Megaptera novaeangliae*), minke whale
 379 (*Balaenoptera acutorostrata*), northern bottlenose whale (*Hyperoodon ampullatus*),
 380 Orca (*Orcinus orca*), Risso's dolphin (*Grampus griseus*), and white-beaked dolphins
 381 (*Lagenorhynchus albirostris*). Data from 323 non-bottlenose dolphin sightings were
 382 reported over the nine years.

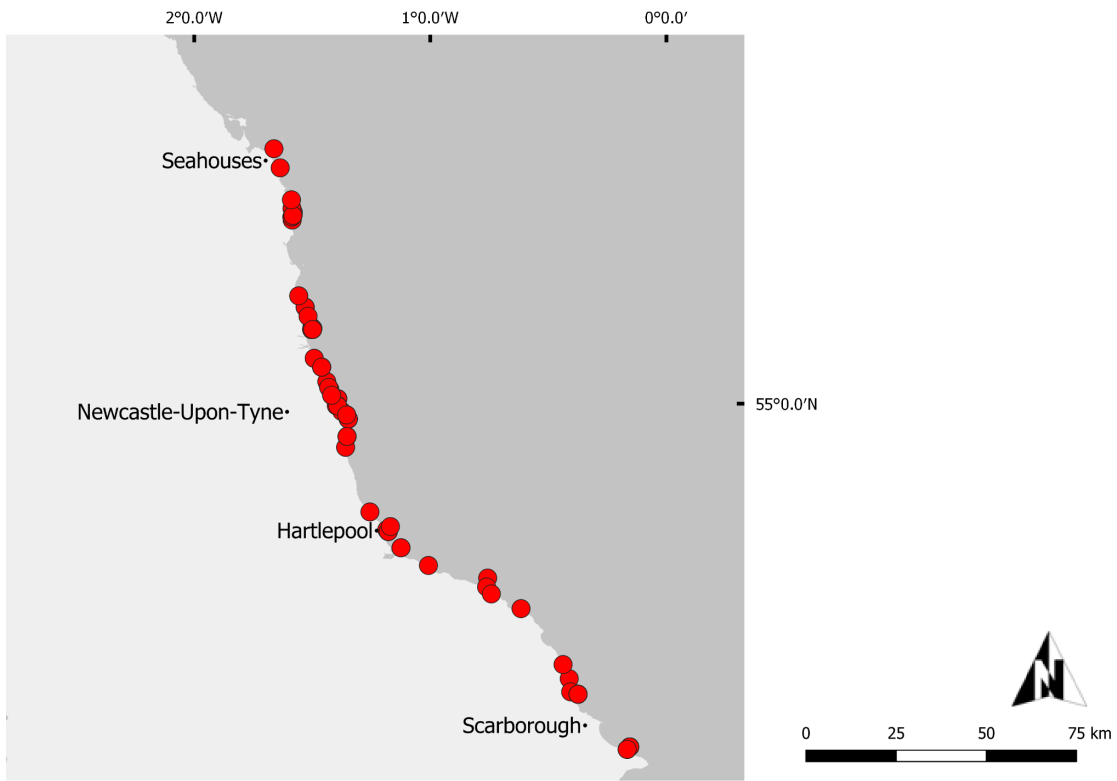
383 Harbour porpoises were the most commonly reported species (207 sightings) followed
384 by white-beaked dolphins (62 sightings), and minke whales (49 sightings) (figure 19).



385

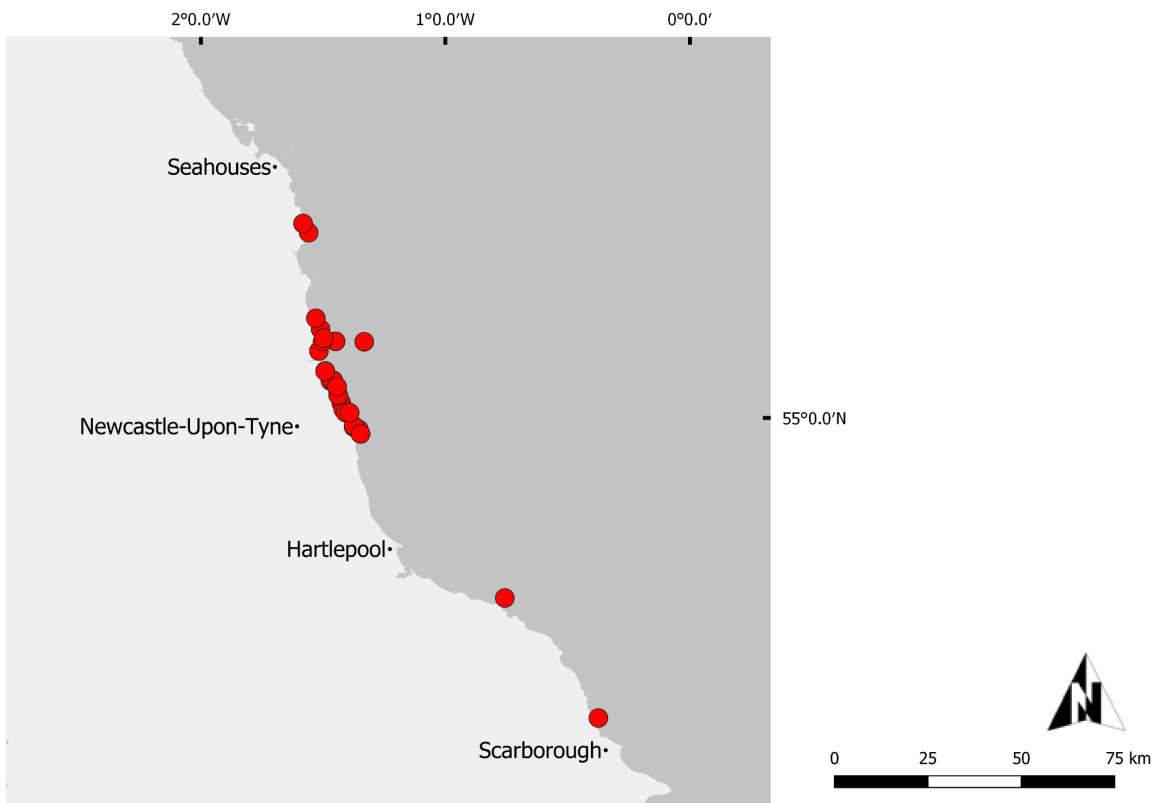
386 Figure 19: Sightings of non-bottlenose species per year from 2014 to 2022 from citizen
387 science sources. WB= White-beaked Dolphin, HP= Harbour Porpoise, MW= Minke Whale.

388 Figures 20 - 22 show the locations of each of these sightings from 2014 to 2019, and
389 figure 23 shows the locations of the other non-bottlenose species sightings



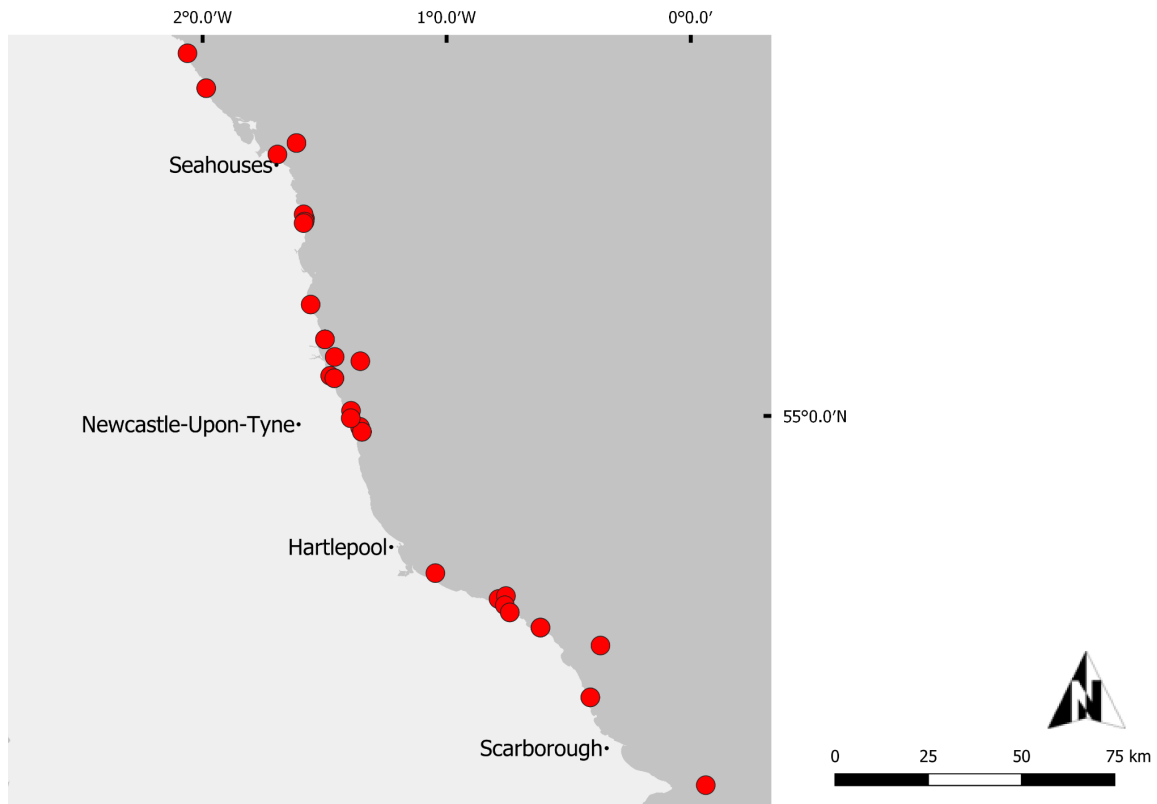
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391 Figure 20: Sightings of harbour porpoise (*Phocoena phocoena*) from 2014 to 2022.



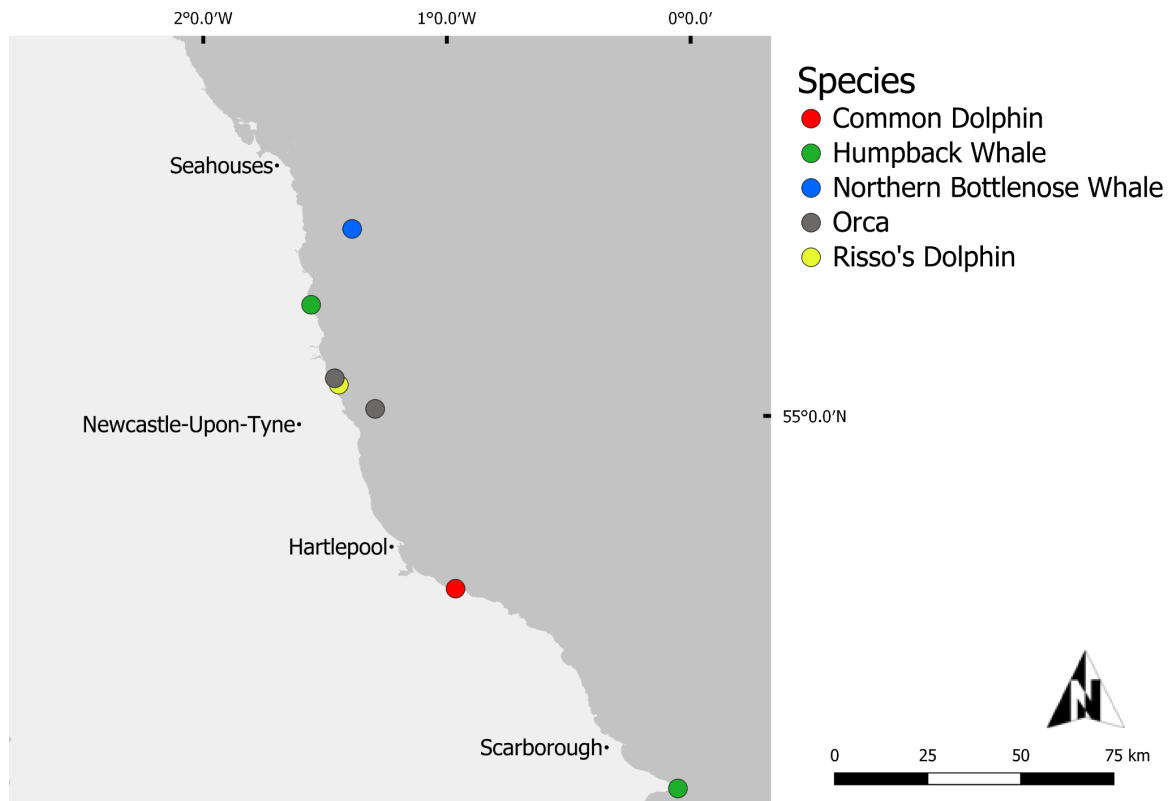
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393 Figure 21: Sightings of white-beaked dolphins (*Lagenorhynchus albirostris*) from 2014 to
394 2022



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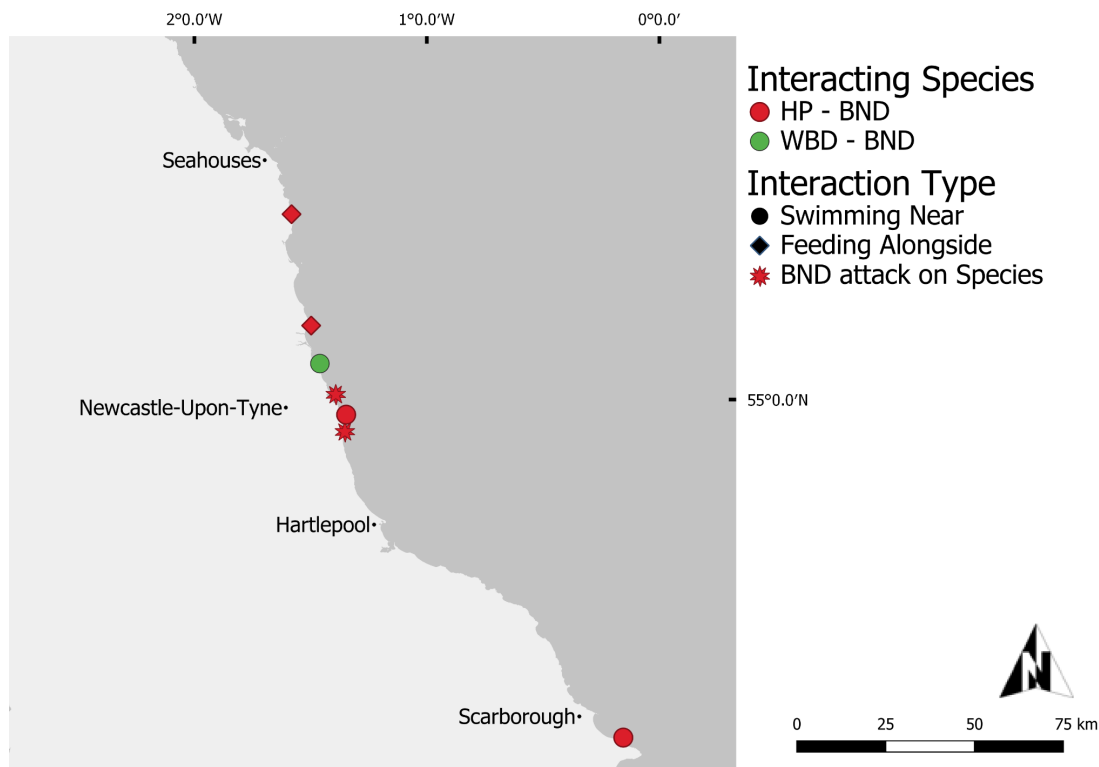
396 Figure 22: Sightings of minke whales (*Balaenoptera acutorostrata*) from 2014 to 2022



397

398 Figure 23: Sightings of common dolphins (red), humpback whales (green) northern
 399 bottlenose whales(blue), Orca (grey), and Risso's dolphins (yellow) from 2014 to 2022

400 Interactions between bottlenose dolphins and these other species were not common,
 401 but several were reported. Peaceful co-swimming was reported three times, instances
 402 of two species feeding alongside each other were reported twice, and there were two
 403 separate instances of bottlenose dolphin attacks on harbour porpoises (figure 24).



404

405 Figure 24: Locations of inter-species interactions categorised by species and interaction type.

406 3.7 Human interactions with bottlenose dolphins

407 Occasionally, a member of one of the social media groups would note a
 408 human/bottlenose dolphin interaction. Rib/small boats were reported chasing dolphins
 409 three times, kayakers were noted to approach dolphins six times, and on 22/08/20, a
 410 jetski collided with a dolphin at South Gare, North Yorkshire.

411 4. Discussion

412 This is the first multi-year study undertaken on the bottlenose dolphins found off the
 413 northeastern coast of England. This study shows that sightings of bottlenose dolphins

414 are increasing every year, and that dolphins that previously were considered residents
415 all year round in the Moray Firth SAC are now travelling south more frequently.

416 Short-range movements of bottlenose dolphins are not uncommon, and studies have
417 shown that seasonal transience occurs in populations all around the world (Toth, et al.,
418 2010; Durden, 2011), but the data presented in this study show that this is not a
419 seasonal migration since dolphins are seen year-round in this area.

420 The purpose of this study was to understand the long-term movements of these
421 animals along the Northumbrian coast, and to determine if this group of dolphins now
422 being seen more frequently in the area could be considered a new population, or just
423 evidence of a range expansion of the semi-resident dolphins already inhabiting eastern
424 Scottish waters.

425 Annual sightings have steadily increased since 2019. Average group size has remained
426 constant over the nine years, with the average being 10.37 individuals per sighting.

427 The rates at which dolphins are being seen are 3 to 7 times higher during summer than
428 other seasons, although group size have remained constant over this time period too.

429 This is the first study of its kind on these animals off the northeastern English coast,
430 so there is no baseline for these results to be compared to. However, it is clear that the
431 number of animals being seen off the east coast of England is increasing every year,
432 especially in summer months. This could be evidence of a new population taking up
433 residency in this area, or just proof of a range expansion of the Moray Firth dolphins.

434 Definitions of a population differ for the purposes of assessment and management.

435 The International Union for Conservation of Nature (IUCN) defines a population as a

436 “set of individuals from the same wild species that share the same habitat” (IUCN
437 Standards and Petitions Committee. 2022.). The United States Marine Mammal
438 Protection Act builds on this by including that a population can only be defined when
439 the animals interbreed when mature (MMPA, 2022).

440 Despite the varying definitions, the data from this study indicate that these animals
441 found off the northeast coast of England are not a separate, isolated population from
442 those in the Moray Firth SAC. Of the 38 individuals identified over the nine years of
443 this study, only 14 dolphins appear to be no longer travelling north. Of the other 23
444 dolphins - not including ABD#42, Hubbs - seen over the nine years, eight were
445 identified as travelling between the Moray Firth SAC and the Northumbrian coast
446 within the same year, whilst the other 15 travelled between the two regularly. If this
447 were to be a new population separate from that within the Moray Firth, it would be
448 expected that fewer dolphins were making this trip, thus isolating both groups.

449 Instead, with the evidence that at least 14 dolphins have only being seen south of the
450 border since 2018, there is an argument to be made that there exists a larger eastern
451 UK population whose range extends from Northeastern Scotland to at least Hull,
452 England, with two semi-resident subpopulations, one existing in the Moray Firth SAC,
453 the other off the Northumbrian coast, and a transient population of at least 23 dolphins
454 travelling between the two.

455 Dinis et al. (2021), in their study, categorised individual dolphins by their residency
456 pattern following the mapping of their movements. This protocol could be adapted to
457 this population to better understand their movements and help with conservation and

458 management. A ‘resident’ dolphin would be one which is seen once every few years
459 in the study area but is known to be either exclusively or most commonly residing
460 around the east coast of Scotland. Any individual seen regularly in both ranges would
461 be a ‘transient’ dolphin. Building on this method, any dolphin which was previously
462 consistently seen in Scottish waters but has been spotted more regularly in English
463 waters could be considered a ‘possible migrant’.

464 Other studies on the bottlenose dolphin population in Wales suggest seasonal
465 migration by a number of individual dolphins between two subpopulations located in
466 the Cardigan Bay SAC and the Pen Llyn SAC (Feingold and Evans, 2014, Lohrengel,
467 et al., 2017). Studies monitoring these dolphins and their movements date back to
468 1999, and have aided in the conservation effort of these animals.

469 4.1 Possible causes for this movement

470 Bottlenose dolphins around the UK feed primarily on demersal fish species, as well as
471 some cephalopods (Spitz, et al., 2006). While the majority of their diet consists of cod,
472 saithe, and whiting, they do also eat salmon and haddock when the opportunity arises
473 (Santos, et al., 2001).

474 A 2004 study shows that bottlenose dolphins in the Moray Firth lived in smaller group
475 sizes and occurred less frequently where there was fewer salmon available (Lusseau et
476 al., 2004), a result that can also be seen in this study. Salmon stocks have increased in
477 rivers along the East coast of England thanks to both water quality improvements and
478 salmon stocking programmes in rivers such as the River Tyne (Mawle and Milner,

479 2003; Milner, et al., 2008). This increase in food abundance could be a driving factor
480 in the increase in dolphins seen in the area.

481 Another possible reason for these movements is climate change. An increase of fish in
482 one area may cause an influx of dolphins, but changes to fish abundance may push
483 animals away. As climate change affects sea temperature and sea currents, the
484 abundance of the bottlenose dolphin's staple diet may change too. An increase in
485 temperature is hypothesised to affect spawning times, growth, and migration of North
486 Sea mackerel (Jansen and Gislason, 2011), and the recruitment of North Sea cod,
487 whiting, and saithe (Dippner, 1997). Quantifying the effects these fish stock changes
488 have on bottlenose dolphins were beyond the scope of this study, but these hypotheses
489 could help in beginning to understand the cause of the influx of dolphins into this area
490 in the last half decade.

491

492 4.3 Limitations

493 One limitation of this study is the lack of analysis of photo ID data from the Moray
494 Firth. 14 dolphins have been identified as no longer travelling north into the SAC.
495 These 14 could be considered possible migrants, but data from designated photo ID
496 studies in Scotland from 2021 and 2022 will be needed to begin investigating whether
497 these animals can be considered a new population. For now, it is more appropriate to
498 say that the increase in dolphin sightings southwards represent a range expansion of
499 the Moray Firth dolphins, with a subpopulation potentially staying south all year
500 round.

501 This study relies mostly on opportunistic sightings. While the Sea Watch Foundation
502 did provide a number of dolphin sightings, the majority of the data for this project
503 came from citizen scientist reporting. Care was taken to exclude the same group of
504 dolphins twice in one day by estimating distance between sightings and the time it
505 would take for a pod to travel that distance. However, some errors may still remain.
506 Group sizes may also be inaccurately or under-reported. Whereas the minimum best
507 estimate from each report was used, there is potential for it to lead to underreporting
508 of group size.

509 While sightings did become more numerous over the years, a measure of effort by
510 citizen scientists is not accounted for. Recent years have seen an increase in dolphin
511 watchers on shore in these areas, and as such, this could be a cause for increase in
512 sightings. A similar trend might be a cause for the increased sightings over the
513 summer months. However, as the goal was to determine whether there were distinct
514 populations, the benefits of including these sightings was deemed more important.

515 The Coronavirus pandemic affected all networks during March-June 2020 and
516 January-April 2021. Stay-at-home regulations all around the UK meant less citizen
517 scientists on the shore and may have led to fewer sightings per month. However, these
518 various lockdowns also led to people exploring their local areas and reconnecting with
519 nature (with ref), and this may have also caused increases in sightings in some areas.
520 This may have affected data around these periods, but there was nothing that could
521 have been done to prevent this.

522 Seasonality and weather will also have a huge part to play in both photo ID data and
523 sightings data. Boats are less likely to go out on stormy seas affected by winter
524 weather to carry out photo ID studies, and citizen scientists are less numerous on the
525 shore when the weather is bad. Increased waves and sea spray can also result in less
526 usable photographs ID. Regardless of any of these factors, it is clear that bottlenose
527 dolphins are being spotted more frequently on the North-East coast of England,
528 especially in the summer months.

529 There are a number of dolphins along this coast whose physical characteristics lend
530 themselves to being more identifiable than others. For example, ABD#1219 is missing
531 part of its beak, so any time that animal surfaces headfirst, dolphin watchers know
532 who it is. Similarly, ABD#116, Runny Paint, has white markings outlining her
533 pectoral, dorsal, and caudal fins, making her very easy to spot within a crowd. This
534 means that dolphins like these will certainly be overreported compared to other, less
535 identifiable individuals. This unfortunately cannot be avoided, but by training citizen
536 scientists in photo ID or having a select number of people familiar with these animals
537 in these social media groups could aid in less well-marked dolphins being seen along
538 the coast, aiding in defining the movement patterns seen within this community.
539 However, with the constraints of this project, this was not feasible at this time.

540 4.4 Recommendations

541 The importance of establishing long-term home ranges for individual dolphins and
542 understanding the movements of these animals has been emphasised in the literature
543 (Feingold and Evans, 2014, Cheney, et al., 2018). This study reveals an indisputable

544 increase in dolphins in the last three years along the North-East of England. There is
545 an argument to be made that these animals are no longer visiting this area
546 occasionally; there have been at least two sightings a month since June 2020, with an
547 average of 42.7 sightings a month since this date. While more research will be needed
548 to identify if those animals being seen year-round are all the same individuals or if
549 different individuals travel between Scotland and England at different times of the
550 year, it is becoming increasingly obvious that these animals are here to stay in English
551 waters.

552 Violent and often lethal interactions between bottlenose dolphins and other marine
553 mammal species like harbour porpoises are not uncommon (Haelters and Everaarts,
554 2011), and are in fact one of the leading causes of death in harbour porpoises in UK
555 waters (Ross and Wilson, 1996; Patterson et al., 1998). This increase in bottlenose
556 dolphins may impact on other species known to inhabit the area, but further dedicated
557 work and monitoring of these species will be needed to determine any effects, adverse
558 or otherwise, that these animals have on other marine mammal species.

559 Specific regulations regarding these animals will be needed. As the frequency of visits
560 from these dolphins increases, so will tourist activity. Bottlenose dolphins are a well-
561 loved species, and whale watching tourism is a rapidly growing sector that is
562 estimated to be worth over 2 billion US dollars (O'Connor, et al., 2009). There are
563 already a number of tour companies that offer marine mammal and bird watching trips
564 up and down the Northumbrian coast, and while UK cetacean codes of conduct do
565 recommend a 200m no-approach zone and a 10-knot speed limit within 1km of an
566 animal (The Green Blue, 2010), it is not always the case that people abide by these

567 rules (section 3.7). Boat traffic has been shown to suppress site use by this species
568 (Pierpoint et al., 2009), but abiding by these rules has been shown to reduce the effects
569 that tourism and boat traffic have on cetaceans (Pérez-Jorge et al., 2016), and so more
570 awareness of these rules in this area is needed.

571 There are a number of initiatives along the Northeastern coast of England to bring
572 awareness to locals and tourists concerning safe cetacean interactions, but there is a
573 need for clear laws dedicated to protecting cetaceans in this area of the UK. As seen in
574 figure 4, there is a 170km stretch of coast not covered by any Special Areas of
575 Conservation. In order to accurately assess the needs for further protection for
576 bottlenose dolphins along the northeastern coast of England, these animals must be
577 further monitored, and studies quantifying the anthropogenic impacts on these animals
578 are needed. Redefining this population as one large eastern UK population with two
579 semi-resident subpopulations, one in the Moray Firth SAC, the other off the
580 Northumbrian coast, with a number of dolphins travelling between the two may lead
581 to more accurate assessments of the population and aid in better conservation of these
582 animals.

583 5. Conclusions

584 There has been a steady increase in the number of dolphins seen off the northeastern
585 shores of England since 2019, but little is understood of this population or its ecology.
586 Many of the animals seen on this coast originate from the Moray Firth SAC, and so
587 this is most likely the result of a range expansion happening over a few years.
588 However, there does appear to be at least 14 dolphins who reside here all year round,

589 and so it would be most appropriate, in terms of conservation and management, to
590 conclude that there exists a larger northeastern UK population of bottlenose dolphins
591 that can be divided up into two semi-resident subpopulations with a number of
592 dolphins travelling between the two.

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787 7. Appendix

788 Table 7: Sources of images used for Photo ID

Name of photographer	Name of photographer
Martin Kitching	Jo Richardson
Kim Willis	K. Henry
Jackie Hedley	Heather Robinson
I. Rackham	C. Bielby
M. Newman	Stuart
Michael Matthews	Vivienne Mannifield

John Clavering	Gillian Findlay
Linda Johnson	Helen Cowan
Walter McGregor	Trevor Maddison

789

790 Table 8: Sources of sightings data

Facebook group name	URL
North East Cetacean Project	https://www.facebook.com/groups/NorthEastCetaceanProject
Scarborough Porpoise	https://www.facebook.com/ScarboroughPorpoise
Dolphin Spotting NE	https://www.facebook.com/groups/289573879072026
Teeside Coastal Wildlife	https://www.facebook.com/groups/643506296144648
Billy Shiel Farne Islands Boats	https://www.facebook.com/farneislands
Berwick Dolphin Watch	https://www.facebook.com/groups/BDW18
St.Mary's Lighthouse and Visitor Centre	https://www.facebook.com/stmaryslighthouse

791

792 Table 9: Details of identified dolphins seen per year along A) the northeastern England coast
793 and B. in and around the Moray Firth SAC from 2014-2022.

ID	A.									B.						
	22	21	20	19	18	17	16	15	14	20	19	18	17	16	15	14
1		X								X	X	X	X	X	X	X
009	X	X		X							X	X			X	X
20							X						X	X		X
42			X			X										
116	X	X	X		X	X		X				X		X	X	X

	A.									B.						
ID	22	21	20	19	18	17	16	15	14	20	19	18	17	16	15	14
227				X		X	X						X	X		X
344	X					X							X	X	X	X
773	X	X									X	X	X	X	X	X
769	X	X		X							X	X	X	X	X	
882	X	X	X	X									X		X	X
886	X	X	X								X	X	X	X	X	
964	X	X	X								X	X	X	X	X	X
965	X	X									X		X	X	X	X
1002	X	X	X	X							X		X	X	X	X
1026	X										X			X	X	
1029	X	X	X								X	X	X	X	X	X
1043	X	X	X								X	X	X	X	X	X
1047	X	X	X										X	X	X	X
1048	X	X	X	X							X		X		X	X
1049	X										X	X	X		X	X
1050	X	X	X	X									X		X	X
1051	X	X		X									X	X	X	X
1058	X	X										X			X	X
1098		X									X	X	X		X	X

	A.									B.						
ID	22	21	20	19	18	17	16	15	14	20	19	18	17	16	15	14
1102	X	X	X								X	X	X	X	X	X
1116	X	X	X										X	X		
1130				X								X	X	X	X	X
1136	X	X	X											X		
1140	X	X	X										X		X	X
1150	X	X	X								X			X		X
1156	X	X	X												X	X
1176	X	X											X	X		X
1197	X	X									X	X	X	X	X	
1203	X	X									X	X	X	X	X	
1217	X	X									X		X	X	X	X
1219	X	X												X	X	X
1264			X								X	X	X	X	X	X
1269	X											X	X	X	X	X

794

795 Table 10: Details of identified dolphins seen per season along the Northeastern England
796 coast.

797

ID Number	Spring	Summer	Autumn	Winter
001			X	
009	X	X	X	X

ID Number	Spring	Summer	Autumn	Winter
20		X		
42		X	X	
116	X	X	X	X
227		X		
344	X	X		
773	X	X	X	
769	X	X	X	X
882	X	X	X	X
886	X	X	X	X
964	X	X	X	X
965		X		X
1002		X	X	X
1026		X		
1029	X	X	X	X
1043		X	X	X
1047	X	X	X	X
1048	X	X	X	X
1049		X		
1050	X	X	X	X
1051	X	X	X	
1058	X	X	X	
1098			X	X
1102	X	X	X	X
1116		X	X	X
1130		X		
1136		X	X	X
1140	X	X	X	X
1150	X	X	X	X
1156		X	X	X
1176	X	X	X	X
1197	X	X	X	

ID Number	Spring	Summer	Autumn	Winter
1203		X		X
1217		X	X	X
1219	X	X		X
1264			X	
1269	X			