

1 **Coordinated provisioning in a dual foraging pelagic seabird**

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5 In long-lived species, care-giving parents are expected to balance their own condition
6 with that of their offspring. Many species of seabirds display a unique behavioural
7 adaptation for managing these conflicting demands known as dual foraging, in which
8 long trips, largely for self-maintenance, are alternated with short trips, which are
9 primarily for offspring care. While dual foraging is a widely studied behaviour, it entails
10 a complication that is seldom discussed: if parents independently employ a dual
11 foraging strategy, chicks might be abandoned for extended periods when the long trips
12 of both partners coincide. Whether partners coordinate their dual foraging strategies,
13 however, is largely unknown. To investigate this possibility, we used radio frequency
14 identification readers coupled with passive integrated transponder tags to record
15 extended sequences of foraging trips for breeding Manx shearwaters *Puffinus puffinus*.
16 Our results show a pattern of foraging trips that indicates a high level of coordination
17 between parents, which facilitates consistent provisioning. Additionally, we show that
18 the propensity for pairs to coordinate declines across the chick rearing period. Given
19 the potential costs of not coordinating, we expect this behaviour to be widely spread
20 among dual foraging species.

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22 **Keywords:** Coordinated provisioning, dual foraging, parental investment, Manx
23 shearwater, *Puffinus puffinus*

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32 To maximize life-time fitness, iteroparous animals are expected to balance investment
33 in the current reproductive period against future breeding opportunities (Williams,
34 1966). For long-lived species, this trade-off suggests that parents are unlikely to invest
35 unduly in offspring at the expense of their own condition (Curio, 1988). Consequently,
36 individuals should prioritize self-provisioning and only provide parental care when
37 energetically capable (Sæther et al., 1993).

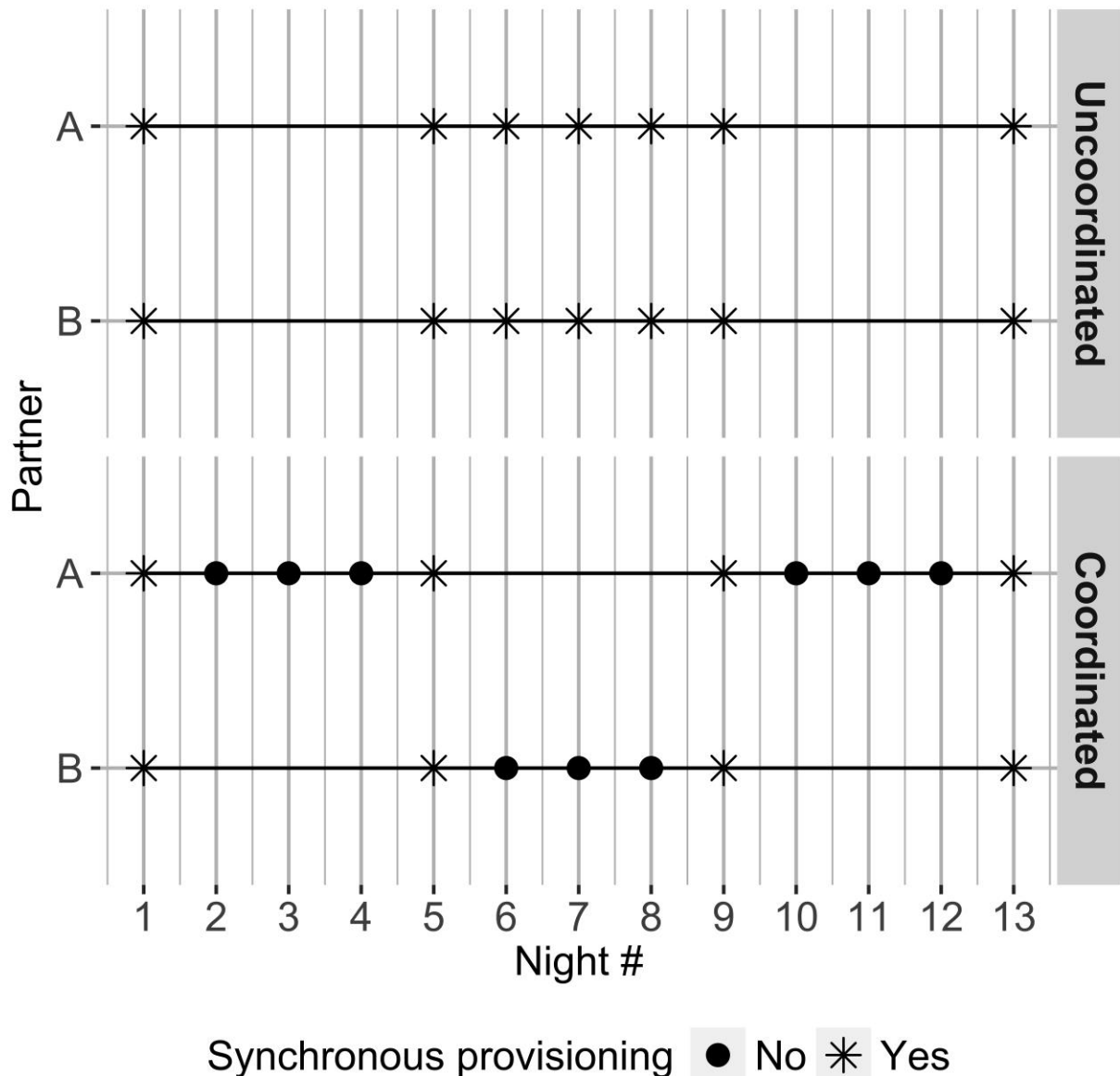
38 During chick care, many seabird species display a unique behavioural
39 adaptation to reconcile these conflicting energetic demands known as “dual foraging”
40 wherein long trips are interspersed with one or more short trips (Chaurand &
41 Weimerskirch, 1994). During long trips, parents avoid the high travel costs of repeated
42 commuting and may travel further to utilize more productive foraging grounds, but at
43 the cost of reduced provisioning of the offspring. During short trips, however, the
44 average daily provisioning load to the chick is larger (reviewed in Baduini & Hyrenbach,
45 2003). This strategy is likely an adaptation to the lengthy period of parental care
46 undertaken by many seabird species, especially those with pelagic foraging habits, and
47 the constraints of central place foraging. Numerous studies have documented dual
48 foraging across a variety of taxa, including Procellariiformes (Weimerskirch et al., 1997;
49 Granadeiro et al., 1998; Weimerskirch & Cherel, 1998), Sphenisciformes (Saraux et al.,
50 2011) and Alcids (Welcker et al., 2009). While there is some suggestion that dual
51 foraging might be more prevalent in offshore foraging species, this is not uniquely so
52 as inshore foraging species have also been observed to display dual foraging, e.g. little
53 penguins (*Eudyptula minor*) (Saraux et al., 2011).

54 While dual foraging is a widely studied behaviour, it entails a complication that is
55 seldom discussed. Namely, if parents independently employ a dual foraging strategy,
56 chicks might be abandoned for extended periods when long trips coincide. As
57 prolonged bouts of starvation are likely to increase mortality, especially in young
58 chicks, there should be selection for within-pair coordination in species with variable
59 foraging trip lengths. While there is some evidence that the timing of “long trips” is not
60 independent between partners in some species (Booth et al., 2000; Congdon et al.,
61 2005), the degree of such coordination and the mechanisms underlying it are poorly
62 understood.

63 The Manx shearwater *Puffinus puffinus* is a monomorphic, burrow-nesting
64 seabird that is known to display dual foraging (Shoji et al., 2015; Fayet et al., 2015) and
65 exhibits only minor sex-specific differences in foraging duration and meal size (Gray &
66 Hamer, 2001; Guilford et al., 2008). The similarity in parental effort between sexes
67 makes it likely that partners can compensate for each other. Moreover, like most
68 Procellariiformes, Manx shearwaters have protracted incubation and chick-rearing
69 periods, together lasting approximately 120 days (Brooke, 1990; Harris, 1966), which
70 makes the breeding period energetically demanding, and the potential need for
71 coordinated provisioning particularly acute. Given these features, the Manx shearwater
72 is a plausible candidate in which to observe coordination of dual foraging routines
73 between partners.

74 We used an automated nest monitoring system to examine the possibility of
75 coordinated provisioning by monitoring foraging trip durations in Manx shearwater pairs
76 during their chick-rearing period. These data allowed us to examine how individual
77 foraging behaviour was adjusted in response to the partner. If pairs coordinate dual
78 foraging routines in order to provision offspring consistently, we expected that while
79 one pair member (partner A) was undertaking a long trip, the partner (partner B) would
80 make repeated short trips. Upon returning from a long trip, partner A would initiate a
81 series of short trips and partner B would switch to a long trip (shown pictorially in
82 Figure 1). While several mechanisms might allow for individuals to coordinate such
83 behaviour, we hypothesized that reuniting at the burrow might trigger a switch between
84 foraging strategies. Smaller chicks lack the reserves to withstand prolonged periods of
85 fasting, which makes regular provisioning during the first few weeks post-hatching
86 especially critical for chick survival (Phillips & Hamer, 1999). Thus, we also predicted
87 that coordination might be most advantageous during this earlier period and would
88 decline as chick mass increased.

89



90

91 **Figure 1** Illustration of expected nest attendance patterns if partners have
 92 uncoordinated or coordinated dual foraging routines. In the former case, both partners'
 93 foraging strategies are completely in phase. This maximizes the interval between
 94 feedings for the chick. In the case of coordinated dual foraging routines, each strategy
 95 is out of phase, which results in consistent provisioning. On night 1, partner B initiates
 96 a long trip and partner A initiates a sequence of short trips. When partner B next
 97 returns on night 5, partner A initiates a long trip and partner B switches to a series of
 98 short trips. This minimizes the interval between feedings. Under this scenario, pair

99 members switch foraging strategies after synchronously returning to the colony with
100 their partner.

101 **Materials and Methods**

102 *Ethical Note*

103 All work adheres to the ASAB/ABS Guidelines for the Use of Animals in
104 Research, and was conducted after approval by the Countryside Council for Wales, the
105 Skomer and Skokholm Islands Advisory Committee, the British Trust for Ornithology
106 (BTO permit C/5311) and the University of Oxford Local Ethical Review Process
107 (Zoo/LERC/190505). This study was part of the long-term monitoring program carried
108 out by Oxford University since 2006 (see Dean et al. 2012 and Shoji et al. 2015 for
109 details). The combined weight of bio-logging tags was no more than 2.2 g, roughly
110 0.5% of 450 g mean body mass, which is well below the recommended limit of 3% for
111 flying birds (Phillips et al., 2003). Though handling and bio-logging tags may negatively
112 affect birds, we observed that fledging success was not significantly lower between
113 pairs monitored with RFID readers (0.84, n = 39) and other pairs (0.61, n = 38) within
114 our study colony (2-sample binomial test: $X^2_{1} = 3.9424$, p-value = 0.977). Furthermore,
115 in a detailed analysis of the impacts of our research on Manx shearwaters at our study
116 site, we found that for a sample of 1,321 breeding attempts between 2009 and 2014
117 which led to an egg being laid, fledging success was 0.695 in our experimental nests
118 versus 0.587 in control nests. This suggests that for a large sample our work has no
119 detectable adverse effects on breeding success.

120 *Study Site and Birds*

121 Fieldwork was conducted on Skomer Island (54.44°N, 05.17°W), Wales, UK
122 during the 2011 breeding period (March - August). Burrow nests were visited daily to
123 determine hatching dates and to establish breeding pairs. When possible, adult
124 females were sexed by cloacal inspection just after laying (Gray & Hamer, 2001).
125 Chicks were weighed every one to three days using a Pesola spring scale. The chick-
126 rearing period was considered to end once the chick had fledged (approximately 70
127 days after hatch) (Brooke, 1990).

128 To study foraging coordination between chick-rearing shearwater pairs, we used
129 radio-frequency identification (RFID) readers coupled with passive integrated
130 transponder (PIT) tags (see Naumowicz et al. (2010) for technical details of the sensor
131 network). Our RFID readers broadly consisted of a loop antenna, the computer and a
132 12V battery power supply. The antenna was placed around the opening of the burrow.
133 When a PIT tag passes within approximately 5 cm of the antenna, the tag is energized
134 and transmits a unique identification number, which the RFID reader stores, along with
135 the time of the detection.

136 We deployed RFID readers on 39 burrows nests in March at the start of the
137 breeding season. Both pair members in each burrow were fitted with a PIT tag that was
138 programmed with a unique identification number. PIT tags were shrink-wrapped to a
139 cable tie, which was loosely affixed to the tarsus above the metal BTO identification
140 ring. PIT tags including housing material weighed approximately 0.3 g. Five birds with
141 PIT tags, each from a different pair, were also equipped with British Antarctic Survey
142 geolocator-immersion loggers (models: Mk13, 14, 15, 18L, and 19), which weighed 1.5
143 - 1.9 g. Loggers were mounted to a Darvic plastic leg ring using two cable ties. All birds
144 were taken from study burrows through an access hatch by hand and weighed at
145 device deployment. Total handling time during the attachment procedure did not
146 exceed ten minutes.

147 *Data Analysis*

148 All data processing steps and statistical analyses were conducted in R 3.2.3 (R
149 Core Team, 2015). Means are presented throughout as ± 1 standard errors. We used
150 RFID readers to record foraging trip patterns within pairs. RFID readers record the PIT
151 tag number and detection time, but not the direction of movement through the burrow.
152 When a bird was detected by the reader, the direction of movement (entry to, or exit
153 from the nest) was inferred as follows: during chick rearing (July to September),
154 breeding shearwaters only visit the burrow for chick provisioning and do so exclusively
155 at night. After feeding, chick rearing shearwaters immediately return to sea. This
156 makes it likely that the first detection after sunset is an arrival at the burrow and the last
157 detection before sunrise is a departure from the burrow. Based on this classification
158 scheme, the time between each departure and arrival was considered the duration of

159 the foraging trip. Similarly, during the interval between each arrival and departure the
160 bird was assumed to be in the burrow. To validate these assumptions, saltwater
161 immersion records from geolocator loggers from a subset of PIT tagged birds were
162 interrogated. During any interval between RFID detections in which saltwater
163 immersion was recorded, the bird was taken to be at sea and similarly, in any detection
164 interval without saltwater immersion, the bird was taken to be at the nest. We used this
165 method rather than manually checking the burrows to reduce potential impacts of
166 visiting nests repeatedly. Our RFID readers also generated a log of the battery voltage.
167 Below 10 volts, the RFID readers would not reliably detect PIT tags. Therefore,
168 foraging trips during which the RFID reader fell below 10 volts for more than one hour
169 were discarded in order to avoid potentially combining multiple trips.

170 Of the 39 RFID readers initially deployed, 24 operated continuously throughout
171 the chick rearing period - the other 15 readers experienced prolonged periods of
172 battery failure. Our foraging trip classification procedure identified 972 foraging trips.
173 After discarding trips with more than one hour of lost battery power, 824 complete
174 foraging trips remained for the 24 pairs. All five geolocators were successfully
175 retrieved. Due to logger failure, however, saltwater immersion data could only be
176 downloaded from four devices. The four individuals with functioning immersion loggers
177 made a total of 37 foraging trips. All of these ostensible trips included periods of
178 saltwater immersion and similarly, none of the intervening ostensible burrow visits
179 contained periods of saltwater immersion, suggesting that our foraging classification
180 scheme was valid.

181 For our analysis of foraging coordination we removed pairs with fewer than five
182 synchronously initiated trips to promote a balanced comparison across pairs. Pairs
183 primarily had insufficient recorded synchronous trips due to a shortened monitoring
184 period. After this step, 17 pairs remained. These made 637 complete foraging trips.
185 Coordination was analysed by examining whether individuals altered trip duration
186 following synchronous visits to the burrow or to the colony. To examine this, we
187 calculated the absolute value of the difference in duration between consecutive trips.
188 Large differences in foraging duration between consecutive trips would indicate a shift
189 in foraging behavior, whereas small differences would indicate consistent foraging

190 behavior. We then compared this difference between nights when only one pair
191 member returned to the burrow and when both pair members returned to the burrow.
192 On nights when both pair members returned to the burrow, we considered two
193 scenarios: partners' visits to the burrow either overlapped (synchronous visit to the
194 burrow) or did not overlap (synchronous at the colony). Additionally, we evaluated the
195 influence of sex. The relationship between synchronicity and sex (as independent
196 variables) and the difference in duration between consecutive foraging trips (as the
197 dependent variable) was investigated through linear mixed models with a maximum-
198 likelihood fitting method using the lme4 package in R (Bates et al., 2014). Each model
199 included individual nested within burrow as a random effect and an autoregressive
200 within-group correlation structure representing the dependence between consecutive
201 trip duration. The normality and homoscedasticity of predictor variables was verified by
202 visual inspection. Models were ranked and selected based on AIC and Δ AIC relative to
203 the model with the lowest AIC value (Burnham & Anderson, 2002).

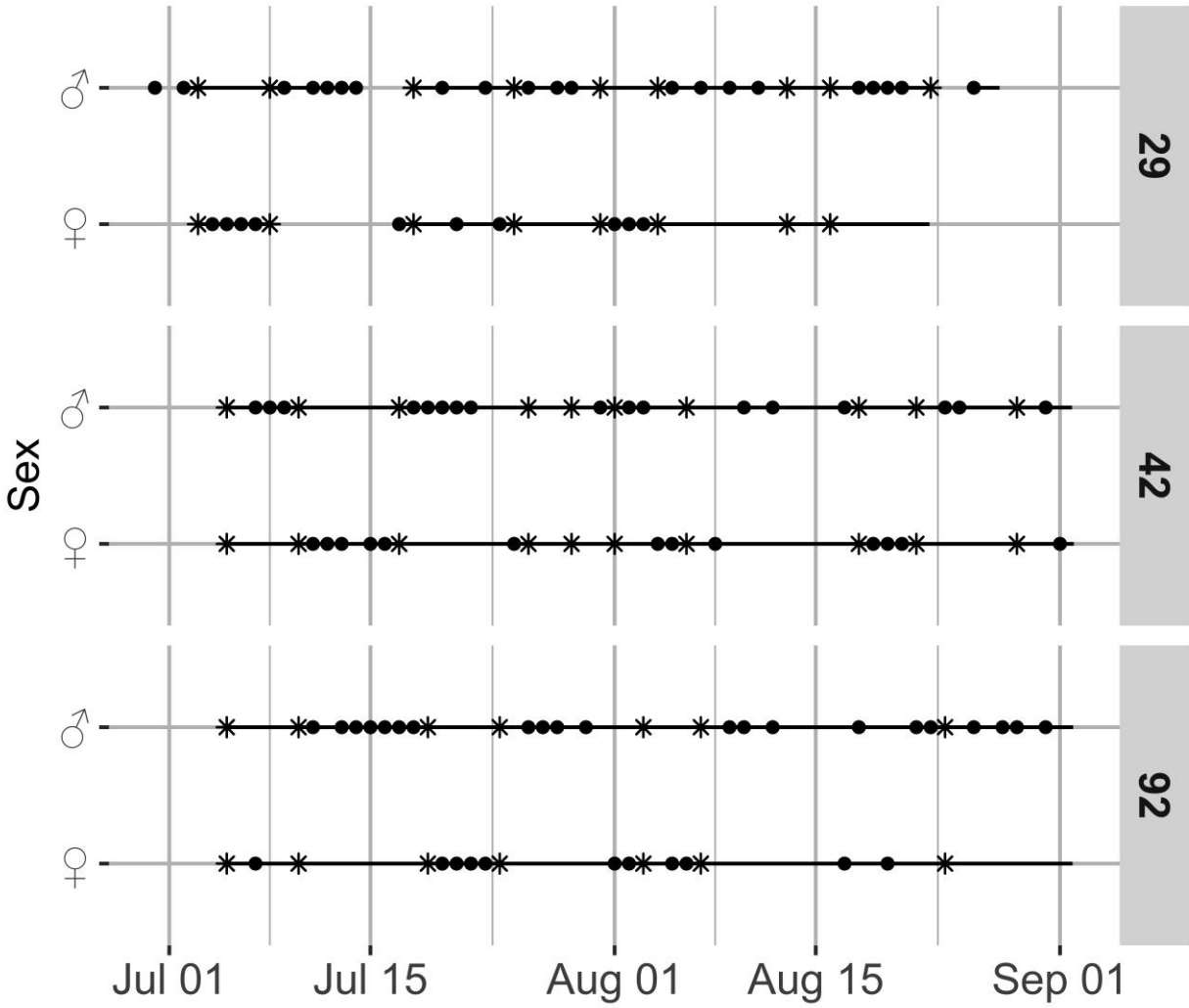
204 If foraging is coordinated in order to minimize the interval between chick
205 feedings, then partners should adjust foraging trip duration in opposite directions after
206 reuniting at the burrow. For example, if one pair member switches from a short trip to a
207 long trip, then the other partner should switch in the opposite direction from a long trip
208 to a short trip. By switching foraging duration in the same direction, pairs might either
209 increase or decrease provisioning rates, but would necessarily deviate from the pattern
210 seen in the "Coordinated" panel of Figure 1. We examined how frequently pairs
211 switched foraging strategies in opposite directions after synchronous returns relative to
212 cases where pairs increased or decreased foraging duration in the same direction (i.e.
213 both pairs shifted from a short trip to a long trip or vice versa as is shown in the
214 "Uncoordinated" panel of Figure 1). In some cases, individuals did not alter foraging
215 duration by a day or more between consecutive trips. These cases were not included
216 as our study focuses on the mechanism underpinning switches in foraging strategy
217 between partners, and so cases where birds did not switch strategy were not of
218 interest. We used generalized linear mixed effect models with a binomial error
219 distribution and a logit link function to evaluate the probability of parents switching
220 foraging duration in opposite directions or the same direction as a function of 1) chick

221 age and 2) the log of chick mass. Burrow was included as a random effect and the
222 same model selection procedure as before was applied.

223

224 **Results**

225 Visual inspection of the histogram of trip duration suggested a roughly tri-modal
226 distribution with the majority of trips lasting one day (Figure S1). A second, less
227 frequent mode is observed for trips lasting 3-4 days and a third mode with low
228 frequency appears for trips lasting 13 days. The mean trip duration was 50 hours
229 (range of 12 to 309 hours). The difference in mean trip duration for each member of the
230 pair was not significantly different from zero, suggesting that trip duration was similar
231 between sexes ($t_{16} = -0.276$, $P = 0.786$). Of the 637 retained chick-rearing trips used
232 to analyse coordinated provisioning, 223 trips were initiated following synchronous
233 visits at the colony (but not at the burrow), and 195 trips were synchronous at the
234 burrow (Figure S2). On synchronous returns to the burrow, males and females were
235 equally likely to arrive at the burrow first. The amount of time that individuals remained
236 in the burrow was highly variable, ranging from 10 minutes to six hours. Trip duration
237 between consecutive trips shifted most strongly after synchronous returns to the colony
238 and were not equal between sexes (Model 5, Table 1). Following synchronous visits to
239 the colony, trip duration shifted by a mean of 30 (± 4) hours more than on nights when
240 a trip was initiated in isolation (Figure 3A). Additionally, this shift was not equal
241 between sexes. On average, males adjusted foraging duration between trips by 13 (\pm
242 6) hours less than females (Figure 3B). This difference between sexes was observed
243 regardless of whether the trip was initiated synchronously with the partner or in
244 isolation.



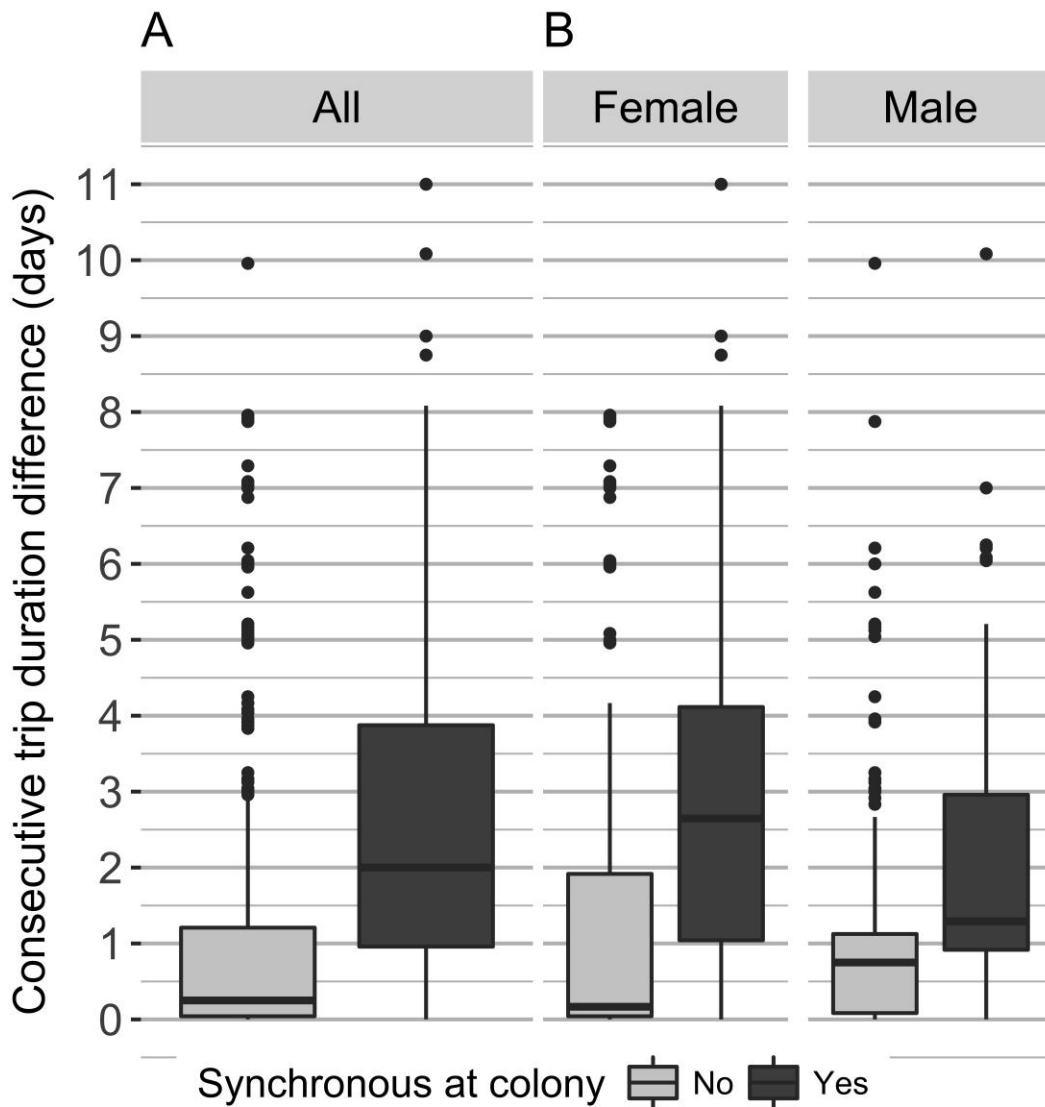
Synchronous at colony • No * Yes

245

246

Figure 2 Three exemplar detection time lines of pairs showing coordinated provisioning (all pairs are shown in Supplementary Figure 2). Individuals (IDs shown at the left) are grouped by pair (nest IDs shown in the grey squares at the right). All detections at the colony during chick rearing, save the last, are plotted. Asterisks represent nights when both partners were detected at the colony, while circles represent nights when only one partner was detected. Black lines connecting detections denote foraging trips with less than one hour of lost battery functioning.

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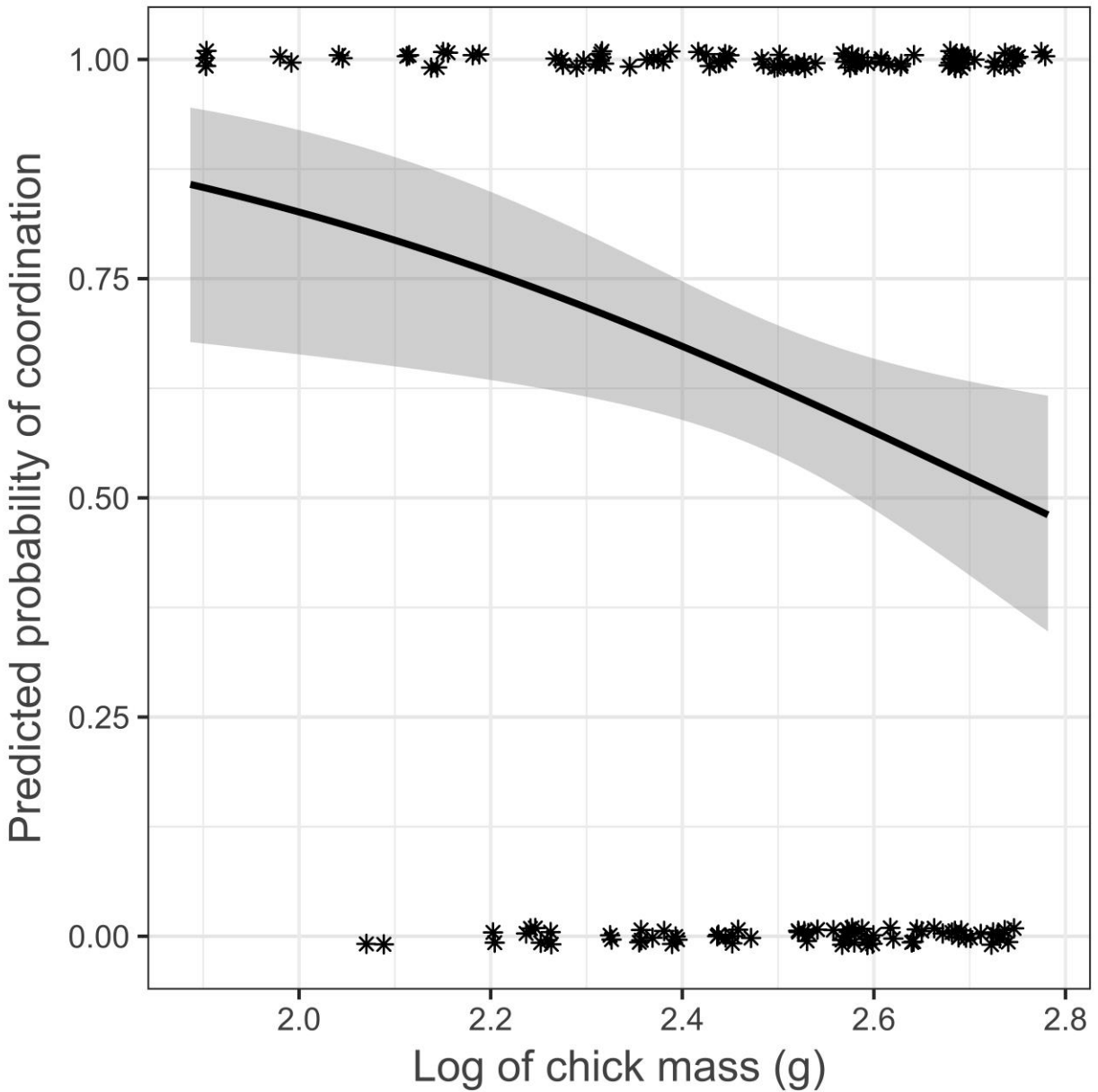


253

254 **Figure 3** Duration difference (in days) between consecutive foraging trips that were
 255 synchronously or asynchronously initiated for all pairs combined (A) and for each sex
 256 (B). Trips that were begun on nights when the partner had not returned to the colony
 257 were more similar to the previous trip than on nights when the partner also returned to
 258 the colony.

259

260 We further examined the probability that pairs switched foraging duration in
261 opposite directions following synchronously initiated trips as a function of chick mass
262 and age. We found that the probability of pairs switching foraging duration in opposite
263 directions was most strongly associated with chick mass (Model 3, Table 2). For newly
264 hatched chicks, the likelihood of pairs switching foraging strategies in opposite
265 directions after synchronously returning to the colony was nearly 0.86, but declined to
266 0.48 as chicks approached fledging mass (Figure 4).



268 **Figure 4** The probability of pairs coordinating as a function of the log of chick mass
269 (grey area reflects the 95% CI). When chick mass was low, pairs were most likely to
270 switch foraging strategies in opposite directions following synchronous returns to the
271 colony. As chick mass increased, pairs were less likely to coordinate, which resulted in
272 less regular provisioning.

273

274 **Discussion**

275 Life history theory predicts that to maximize long term reproductive success
276 iteroparous animals should balance investment in current offspring with their own
277 condition. Seabird species from several orders are known to alternate between short
278 trips for the purpose of chick provisioning and long trips for self-care. Without
279 coordination between partners, however, this variable foraging strategy would be likely
280 to result in periods of chick starvation when long trips coincide. Protracted bouts of
281 chick neglect are uncommon (Shoji et al., 2015), but it is unclear how this is achieved.
282 Using an automated burrow monitoring system validated using a sample of birds with
283 saltwater immersion loggers, we recorded provisioning trips across the chick rearing
284 period. Using this sequential record of foraging trips for each pair, we show that Manx
285 shearwaters displaying a variable foraging strategy, wherein individuals alternate
286 between long trips and short trips, do indeed coordinate foraging patterns with their
287 partner.

288 Following synchronous returns to the colony, partners tended to shift foraging
289 strategies; either switching from a short trip to a long trip or vice versa. On nights when
290 partners both returned to the colony, the duration of the subsequent foraging trip was
291 shortened or extended by an average of 30 hours more than if the trip was begun
292 following a visit to the colony alone. This shift amounts to a roughly 50% increase over
293 the mean trip duration or the difference between a “short” and a “long” trip. From the
294 other perspective, on nights when individuals returned alone, the duration of the
295 subsequent foraging trip was largely unaltered, indicating that the same foraging
296 strategy was employed.

297 Several mechanisms might plausibly enable partners to coordinate foraging
298 patterns such as endogenous rhythms, e.g. hormonal cycles that govern foraging
299 behaviour (Ricklefs et al. 1985; Weimerskirch, 1998); contact at the burrow, colony or
300 at-sea (Congdon et al., 2005); or indirect cues through chick begging calls or odour
301 (Gray & Hamer, 2001; Riou & Hamer, 2010). We found synchronous colony visits to be
302 a better predictor of foraging shifts than synchronous burrow visits. This suggests that
303 physically reuniting at the burrow is unnecessary for coordinating foraging movements.
304 It is possible that pairs recognize their partner's vocalizations at the colony or meet
305 while rafting offshore prior to coming to land (Brooke, 1990; Booth et al., 2000). While
306 colonially breeding seabirds are known for their ability to locate their partner among
307 numerous conspecifics (reviewed in Falls, 1982), neither of these mechanisms appears
308 likely in this case. Upon returning to the colony, chick-rearing Manx shearwaters
309 quickly go to their burrow and immediately return to sea after provisioning the chick,
310 leaving little time to encounter their partner. It is also unlikely that partners would be
311 able to reunite while rafting offshore as these congregations only form in the last few
312 hours of daylight (Brooke, 1990) and typically consist of thousands of individuals. While
313 our data cannot exclude these mechanisms, some indirect signal mediated through
314 either chick begging or burrow odour would be more feasible as it would not rely on
315 chance contact with the partner. Chick begging intensity may contain information about
316 body condition in shearwaters (Quillfeldt et al., 2004; Granadeiro et al., 2000; Quillfeldt
317 & Masello, 2004) that could act as a signal to the second parent returning to the nest.
318 As this information would only be available to the second partner to return, however,
319 one would expect to see a more pronounced shift in foraging duration for the second
320 partner than the first. While we did not have sufficient data to explore this possibility
321 adequately, this did seem to be the case. Future research will be required to address
322 the specific mechanism that allows partners to coordinate parental duties as we
323 observed.

324 Though overall foraging duration and the number of foraging trips was similar
325 between sexes, on average females altered the duration of consecutive foraging trips
326 by 13 hours more than males. This finding is consistent with other studies of Manx
327 shearwater provisioning effort (Dean, 2012; Shoji et al., 2015) that found no sex-

328 specific differences in foraging duration. Female Manx shearwaters, however, are
329 known to be more sensitive to chick begging and adjust provisioning effort accordingly
330 (Quillfeldt et al., 2004; Hamer et al., 2006). Conversely, males generally provision at
331 consistent levels irrespective of begging intensity. This difference would account for our
332 finding that females adjusted foraging duration between consecutive trips more than
333 males.

334 Cooperation should be favoured when offspring survival is heavily dependent on
335 contributions from both parents (Clutton-Brock, 1991). We observed that coordination
336 was highest when chick mass was low. During early chick rearing, individuals were
337 most likely to adjust foraging duration in opposite directions, which resulted in
338 consistent provisioning. While the probability of coordination was inversely related to
339 both chick age and mass, we found that the latter was a better predictor. We did not
340 observe any seasonal changes in foraging duration, which could similarly give rise to
341 this pattern. For young procellariiform seabird chicks without accumulated lipid
342 reserves, there is an elevated risk of mortality (Boersma et al. 1979; Catry et al., 2006).
343 As such, for a lean, vulnerable chick, coordination is likely to be especially valuable,
344 which is consistent with our findings (Figure 4). This means that breeding pairs can
345 potentially better accommodate environmental changes which may lead to a chick
346 losing body condition despite having grown in terms of developmental stage.

347 Reproductive success is positively correlated with pair experience in many avian
348 taxa (Van De Pol et al., 2006; Naves et al., 2007; Sanchez-Macouzet et al., 2014). A
349 variety of mechanisms may account for this relationship such as increased
350 coordination and improved foraging efficiency (reviewed in Ens et al., 1996; see Fayet
351 et al., 2015 for this species). In seabirds, considerable research has focused on
352 mechanisms specifically related to increased coordination that may be advantageous,
353 such as synchronous arrival at the breeding colony (Mills, 1973) and incubation
354 changeovers (Davis, 1988). Our work suggests that coordination in foraging routines
355 may be an important, but overlooked, mechanism underlying reproductive success.
356 Although we were not able here to measure directly the effect of parental coordination
357 on reproductive success, it is known that consistent feedings, especially early during
358 chick rearing, can reduce chick mortality (Boersma et al. 1979; Catry et al., 2006) and

359 optimize chick growth (Schaffner 1990). An alternative explanation is that caregiving
360 parents may directly benefit by coordinating, for instance by determining which partner
361 is in greater need of a long, self-maintenance foraging trip, which could allow pairs to
362 optimise their relationship accordingly. Given the potential costs of not coordinating
363 and the possible benefits of coordinating, we expect that this behaviour is likely to be
364 observed in a wide range of other taxa that engage in a dual foraging strategy. There
365 are considerable prospects for future research that explores how both intrinsic factors
366 such as pair experience or individual quality and extrinsic factors such as resource
367 availability influence the degree of coordination.

368

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512 **Tables**

513 **Table 1** Parameter estimates and standard errors (shown in parenthesis) for five
 514 alternative linear mixed *effect* models describing the *difference* in trip duration (in
 515 hours) of consecutive trips. Apart from the four predictor variables (in *different*
 516 combinations), each model contains individual, nested within burrow, as a random
 517 *effect*. Models are ordered by Δ AIC. Full model descriptions are given in the Methods.

Model / Parameter	5	4	3	2	1
Intercept	40.51 (4.80) ^{***}	33.69 (3.58) ^{***}	42.23 (4.95) ^{***}	35.25 (3.67) ^{***}	44.16 (3.41) ^{***}
Synchronous at colony (Yes)	29.59 (4.23) ^{***}	29.92 (4.22) ^{***}			
Sex (M)	-12.65 (6.05) [*]		-12.99 (6.36) [*]		
Synchronous at burrow (Yes)			29.17 (4.40) ^{***}	29.58 (4.40) ^{***}	
AIC	6359.34	6361.36	6364.21	6366.06	6407.67
ΔAIC	0.00	2.02	4.87	6.72	48.33

518 *** p < 0.001, ** p < 0.01, * p < 0.05

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521 **Table 2** Parameter estimates and standard errors (shown in parenthesis) for three
522 alternative generalized linear mixed effect models (using a binomial error distribution
523 and a logit link function), describing the probability of switching trip duration following
524 synchronous returns to the colony. The natural logarithm of chick mass and chick age
525 were used as predictor variables (the variables were not combined as they are highly
526 correlated), in addition to a random effect of burrow. Models are ordered by Δ AIC.
527 Full model descriptions are given in the Methods.

Model / Parameter	3	1	2
Intercept	5.80 (2.35) *	0.52 (0.35)	0.78 (0.52)
Log(Mass)	-2.11 (0.93)*		
Age			-0.01 (0.01)
AIC	213.84	222.7	223.82
ΔAIC	0.00	8.43	9.98

528 *** p < 0.001, ** p < 0.01, * p < 0.05

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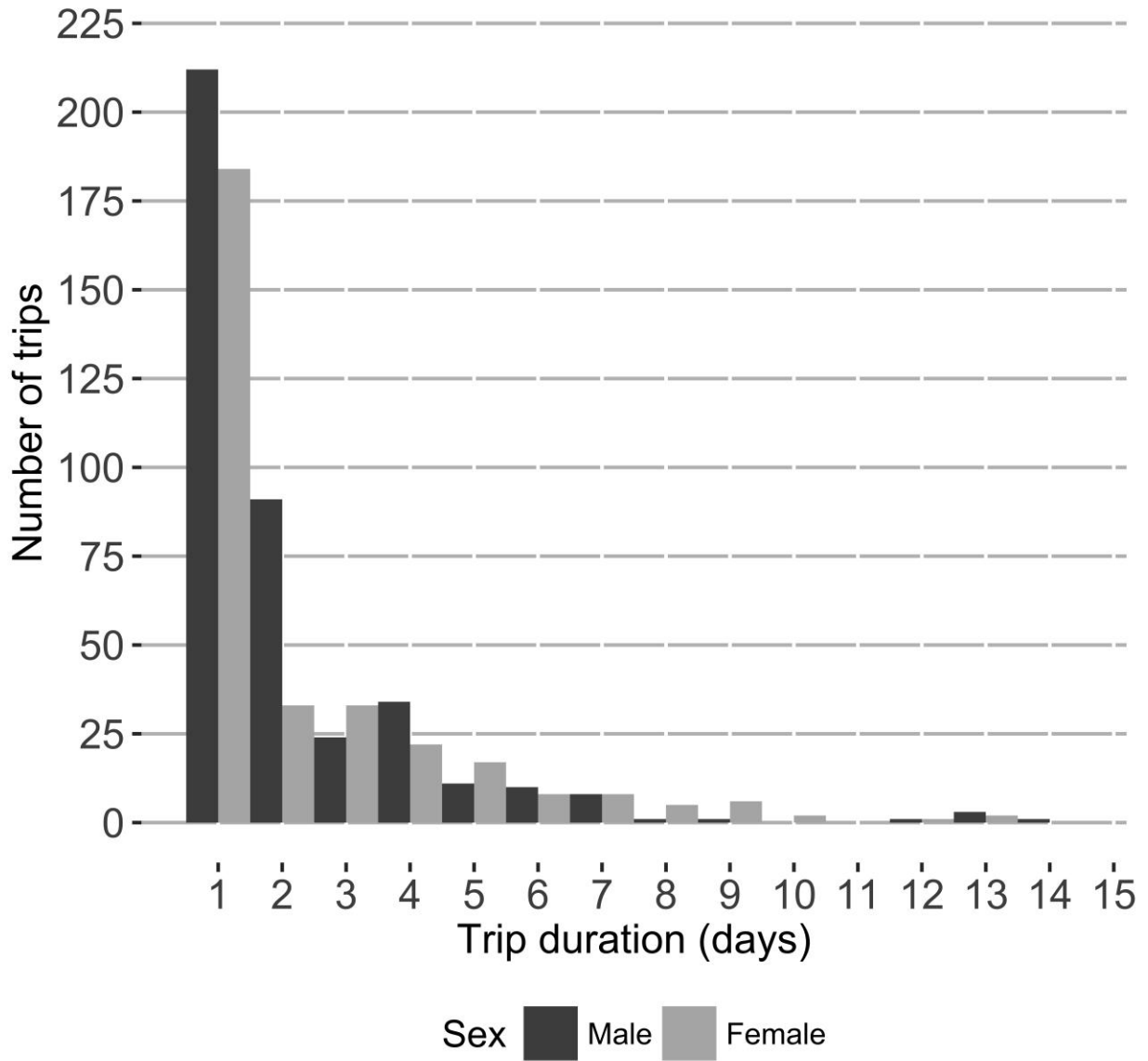
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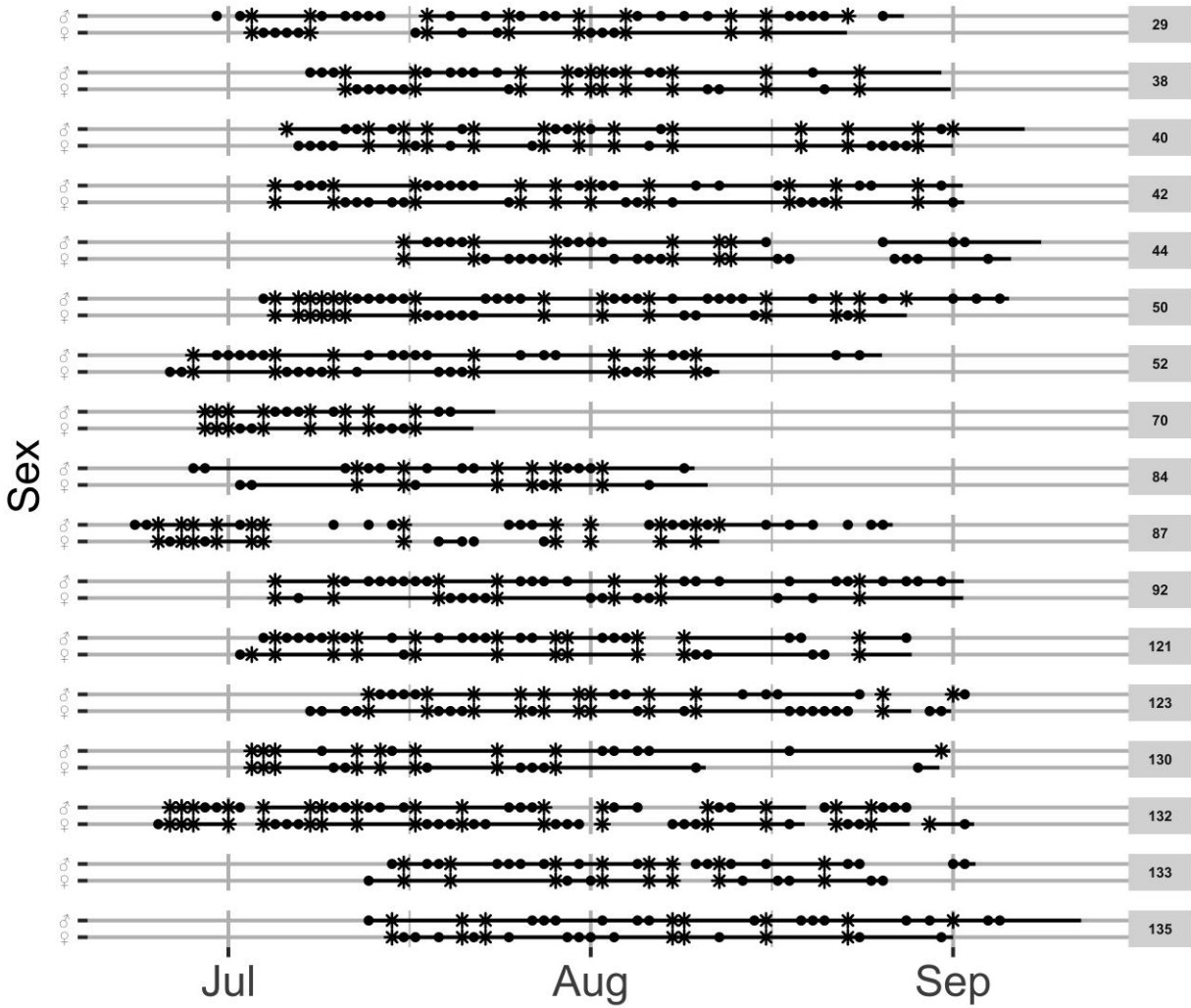
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Supplemental figures



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Supplemental figure 1 Frequency distribution of trip duration in days for each sex. Only trips that were made by known-sex birds are shown (n = 718).



Synchronous at colony • No * Yes

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543 **Supplemental figure 2** Detection time lines for all analyzed pairs, i.e. those with more
 544 than 5 synchronous trips. All detections, save the last, are plotted. Asterisks represent
 545 nights when both partners were detected at the colony, while circles represent nights
 546 when only one partner was detected. Black lines connecting detections denote foraging
 547 trips with less than one hour of lost battery functioning.