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# Nocturnal colony attendance by Common Guillemots

# *Uria aalge* at colony in Shetland during the pre-

# breeding season

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7 Natalie C. Sinclair*[1][◊], Mike P. Harris[2], Ruedi G. Nager[1], Chris D. B. Leakey[3] And

8 Alexandra M. C. Robbins[4]

9 *Correspondence author. Email: Natalie.sinclair3@googlemail.com

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11 *[1]Institute of Biodiversity, Animal Health and Comparative Medicine, College of*

12 *Medical, Veterinary and Life Sciences, University of Glasgow, G12 8QQ, Glasgow, UK;*

13 *[2]Centre for Ecology & Hydrology, Bush Estate, Penicuik, Midlothian EH26 0QB, UK;*

14 *[3]Scottish Natural Heritage, Battleby House, Redgorton, Perth, PH1 3EW, UK;*

15 *[4]Scottish Natural Heritage, Great Glen House, Leachkin Road, Inverness, IV3 8NW,*

16 *UK.*

17 [◊]Current address: Scottish Oceans Institute, School of Biology, University of St
18 Andrews, KY16 8LB, UK
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**Abstract**

Time-lapse photography was used to describe daily and seasonal trends in attendance by

Common Guillemot *Uria aalge* at a colony in Shetland prior to the breeding season,

including detection of nocturnal presence. A camera took a photo every 30 minutes from 30

January until 21 April 2015.  A total of 3,435 photos were analysed, of which 3,232 photos

allowed birds to either be accurately counted (2,552) or estimated (680) within a

representative plot. High quality moonlit shots showed that large numbers of Common

Guillemots were present ashore at Sumburgh throughout the night, while manipulated non-

moonlight night photos revealed attendance at the colony, even when counting was not

possible. Clear cycles of attendance at the colony were apparent with day-time peaks of 90 –

120 birds occurring on average every 7 days over the study period. Pre-breeding attendance

is described, as is the nocturnal presence of Common Guillemots in the three months prior

to breeding.

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**Introduction**

Monitoring during the non-breeding season is difficult for many seabirds since individuals

often spread out widely (e.g. Frederiksen *et al*. 2012) and into areas where they are not

easily observed. Paucity of data leads to a lack of conservation management outside of the

breeding season, even though the non-breeding period is an important time for survival and

acquisition of body reserves for breeding (Calvert *et al.* 2009). Telemetry has facilitated

efforts to better understand the non-breeding season of migratory seabirds; however, it is

difficult to apply this method to large numbers of individuals within a population as tags are

frequently lost (Fort *et al.* 2013). Although the timing of breeding for most seabirds is

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50    documented in detail, little is known about the proportion of the year species spend visiting

51    breeding colonies.

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53    The Common Guillemot (*Uria aalge*; hereafter Guillemot) is an abundant colonial-breeding

54    seabird in the northern North Atlantic and North Pacific. In the northern parts of its range,

55    the species is strictly seasonal in its attendance at the breeding colonies. At the end of the

56    breeding season adults disperse away from the colonies and undertake their main moult of

57    the year during which they are flightless, and return to the colonies 4-6 weeks prior to the

58    first eggs being laid (Gaston & Jones 1998). However, at the south-easternmost colonies in

59    both the North Pacific (e.g. Farallon Islands, California) and North Atlantic (e.g. Britain),

60    Guillemots visit breeding sites during the late autumn and the winter (Boekelheide *et al.*

61    1990; Greenwood 1972, Taylor & Reid 1981). In extreme cases, birds can be seen ashore

62    during the day at the breeding ledges for 10 months of the year (Harris *et al.* 2006).

63

64    In Britain autumn and winter attendance during the day has been well documented at the

65    Isle of May (Firth of Forth), St Abb's Head (Berwickshire), Fowlsheugh (Kincardineshire), and

66    Iresgoe and An Dun (Moray Firth) (Harris 1984; Mudge *et al.* 1987). Although attendance

67    varies both between and within years, there a clear pattern of daily attendance. Harris

68    (1984) monitored the time Guillemots spent at Fowlsheugh, where the first eggs are

69    typically laid in late April and the last chicks fledge in early August, from October 1981 to

70    March 1982 and found that birds arrived at the colony just before dawn and typically left

71    well before dusk.  In contrast, Mudge *et al.* (1987) following attendance at colonies in the

72    Moray Firth between September and April 1983-85 reported less frequent attendance.

73    Again, birds were usually present at dawn, although during February and March, birds

74    sometimes came ashore later in the day, and remained on land for less than a few hours,

75    but occasionally were present until dark. These studies suggested that Guillemots are not

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76 present at the colonies overnight. However, the above studies used outdated Kodak

77 'Analyst' time-lapse film cameras and slow Kodachrome 40 film, so would not have been

78 able to detect birds present overnight.

79

80 In early 2015, we monitored the attendance of Guillemots at a colony in Shetland for the

81 three months prior to the breeding season using a more sensitive time-lapse camera setup

82 than had been available for earlier studies. Here, we present evidence to show, for the first

83 time, that Guillemots are often present at the breeding site throughout the night prior to

84 the breeding season and that likelihood of attendance at the colony increased with

85 approaching breeding season.

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88 **Methods**

89 The study colony is located on a large sea stack in Smithfield Geo, Sumburgh Head (59°51'N,

90 1°16'W) at the southern tip of mainland Shetland, Scotland, where c. 2,000 individual

91 Guillemots are present during the breeding season (M. Heubeck pers. comm.) (Figure 1a).

92 This large sea stack was chosen as it is thought to be representative of whole colony

93 attendance and provided accessible location to install and update the camera equipment. A

94 Canon 550D with 18-megapixel photo quality and a 70–300 mm lens was fitted with a Godox

95 timing system and installed in a waterproof case; technical details of the system can be

96 found in Sinclair (2017). The camera was focused on the colony 160 m away (Figure 1b) and

97 took pictures every 30 minutes, regardless of the light conditions, from 30 January to 21

98 April 2015 except for 14–17 March when battery failure occurred. The first Guillemot egg

99 anywhere at Sumburgh in 2015 was seen on 5 May (M. Heubeck pers. comm.).

100

101 A plot outline encompassing a group of c. 200 Guillemots was overlain on each photo and

102 the enclosed area was divided into four approximately equal quarters (Figure 2). The plot

103 outline was chosen to follow the natural contours of the sea stack to allow accurate and

104 easy application to new batch photos of which focal lens length and precise orientation may

105 change between camera equipment updates. Each count was categorized as day or night

106 according to the sunrise and sunset timings recorded on Nautical Twilight (data derived from

107 www.timeanddate.com). In photographs taken in daylight hours individual Guillemots were

108 counted using the novel method of Adobe Photoshop Count Tool (Version CC 15.0), in which

109 the counter manually added a marker to each individual Guillemot (Sinclair 2017). Initially,

110 on photographs taken in full daylight birds were counted in each of the four quarters but,

111 because there was a highly significant correlation between the four counts (pairwise

112 correlation between counts in the four quarters: $r > 0.9$, p < 0.001, $n = 82$ including only

113 images when Guillemots were present at the colony), later counts were restricted to the

114 top-right quarter as this quarter had the highest correlation coefficient with the total count

115 ($r = 0.942$, $P < 0.001$, $n = 82$). Measuring a subset of each image reduced the time needed to

116 count each picture from 7 minutes to 3 minutes. The maximum day count was taken as a

117 measure of attendance during that date.

118

119 Dark photos (those photos not taken in full day light) were brightened to 100% in Adobe

120 Photoshop (Figure 3), to increase the proportion of photographs where the number of

121 Guillemots could at least be estimated. Even after lightening, Night photographs were of

122 lower quality so that birds could not be counted as accurately as in day photographs.

123 Therefore, each Night photograph was categorized as no birds visible, very low attendance

124 (at least 1 bird unambiguously present), low attendance (at least 5 birds confidently

125 counted) or high attendance (at least 50 birds confidently counted). These estimates of the

126    minimum number of birds from dark night photos was used for the calculations but are

127    likely an underestimate.

128

129    We recorded the number of days no Guillemots were present at the colony between two

130    periods of attendance and correlated (non-parametric Spearman rank correlation) with the

131    start date of the period of absence (date where 1 January = 1) in order to investigate

132    seasonal changes in the duration of periods of absence.

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135    **Results**

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137    Of the 3,435 photographs, 3,232 (94.1%) photos allowed confirmation of whether birds

138    were present or not, and either produced accurate count data (2,552, 74.3%) or allowed

139    systematic estimation of number present (680, 19.8%). From February to April, Guillemots

140    attended the colony for 38 (48.7%) of the 78 days in which the camera functioned (Table 1,

141    Figure 4, Appendix). Guillemots were present at night during all periods when birds attended

142    the colony on more than one day but numbers were lower at night as indicated by the

143    minimum estimates derived from lower quality night photographs. It was not possible to

144    determine whether individual birds came and went from the colony during the night.

145

146    Clear cycles of attendance at the colony were apparent, these are defined as at least one

147    day when Guillemots were present at the colony followed by two or more days when they

148    were absent from the colony. During the observation period there was a total of 11 cycles

149    each with a peak count of 90–120 birds (except cycle 8) (Figure 4). Nine cycles followed the

150    same trend in attendance (excluding cycle 5 which was subject to a data gap after day 1 and

151    cycle 8, where relatively few birds were present on only one day. The average pattern of

152    these cycles is shown in Figures 5 and details of each cycle in Figure 6. In each cycle,

153    Guillemots were present during the day for between 3 to 5 days (mean ± SD = 3.78 ± 0.67, n

154    = 9).  On the first day Guillemots were present after an absence, the birds typically arrived

155    early in the day (mean ± SD = 57.6 ± 28.1, n = 11) but many departed again after a few hours.

156    Excluding cycle 8, Guillemots returned the next day in higher numbers (mean ± SD = 95.0 ±

157    11.3, n = 10) after which birds were present continuously for 2 to 4 days (mean ± SD = 3.33 ±

158    0.87, n = 9) (excluding cycle 5 due to data gap after day 2).

159

160    On the final day of attendance fewer birds (mean ± SD = 68.2 ± 27.8, n = 9) were present and

161    all left before dark and then no birds were seen for two or more days.  Absences became

162    shorter as the breeding season approached ($r_s$ = -0.82, p = 0.004). When birds remained

163    overnight, numbers increased around first light, which was clear to the observer when

164    accounting for both counting method and quality between day and night photographs (day:

165    mean ± SD = 100.1 ± 10.4, n = 9; night: 70.4% with at least 50 birds present) (Figure 5).

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168    **Discussion**

169    Guillemots regularly attended this colony from at least early February until the first egg was

170    laid in early May. Attendance was cyclic with peaks in numbers occurring on average every 7

171    days. Such cycling has been reported elsewhere, although the periodicity varies greatly

172    (Harris & Wanless 1984; Mudge *et al.* 1987). High quality night shots when the moon was

173    near full and much of the sky was clear showed that large numbers of Guillemots were

174    present ashore at Sumburgh throughout the night. Although the photographs from non-

175    moonlit nights were of too low in quality to count accurately, they confirmed that

176    Guillemots regularly attended this colony overnight but in lesser numbers than during the

177    day.  This appears to be the first documented evidence of overnight attendance at a colony

178    site during the non-breeding season by Guillemots. The finding that birds are present

179    overnight is in contrast to other accounts of Guillemot behaviour, which found that

180    Guillemots typically vacate the colony at night (Harris 1984; Harris & Wanless 1989, 1990).

181    Indeed, visits to colonies on the Isle of May prior to dawn over 50 mornings in October,

182    March and April in the 1980s confirmed that birds had not been present overnight (Harris,

183    unpublished data). It is not clear whether overnight attendance at Sumburgh was specific to

184    this colony in this year, had been overlooked in earlier studies or the colony attendance

185    behaviour of Guillemots has changed since the 1980s.

186

187    Since the birds we followed were not individually identifiable we could not determine

188    whether the birds present were breeders or non-breeders or how long an individual spent at

189    the colony during any day or cycle of attendance. However, studies of marked birds on the

190    Isle of May in autumn and early winter have shown that the majority of Guillemots at the

191    colony outside the breeding season are mature adults returning to their breeding sites

192    (Harris & Wanless 1989, 1990). These authors concluded that colony visiting could be

193    explained by (a) competition for the best sites to use the following season, or (b) birds

194    returning to maintain pair bonds and found no evidence that immatures visited the colony

195    during the winter.

196

197    Estimates of numbers of Guillemots attending overnight were predominantly categorized as

198    'minimum count 50' (70.4% of Nights in all recorded cycles). In contrast the mean daytime

199    count was 100.1 ± 10.4 which was higher than most of the estimates during the night, and

200    hence it is likely that fewer birds attended the colony site at night than at day. Day counts

201    increased around first light as had been recorded by earlier studies (Harris 1984; Mudge *et*

202    *al.* 1987), which raises the question as to what makes some individuals remain overnight

203    while others may leave. Results from the deployment of archival tags in Newfoundland have

204   shown Guillemots, usually considered to be a visual predator, forage at night during both

205   moonlit and starlit periods (Regular *et al.* 2011). These authors found that some individuals

206   dived only when there was moonlight whereas others dived regardless of the state of the

207   moon so perhaps Guillemots present overnight at Sumburgh were those that cannot, or do

208   not need to, forage nocturnally; for instance breeding Brünnich's Guillemot males tend to

209   forage more at night than females (Elliot *et al*. 2010; Young *et al*. 2015). Why Guillemots

210   show these regular patterns of presence and absence at the colony site and why the

211   numbers differ between day and night remain unclear but factors other than stochastic

212   environmental factors are required to explain the observed regular pattern of attendance at

213   the colony.

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302   FIGURES

303   **Figure 1a.** Map of North of Scotland showing position of Sumburgh Head on most Southern

304   tip of Shetland. Created using Google Earth and Paint X Lite.

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**Figure 1b**. Sumburgh Head showing the relative positions of the stack at Smithfield Geo and

the position of the camera c.160 m away near the visitor centre at the lighthouse. Created

using Google Earth and Paint X Lite.

**Figure 2.** A plot outline encompassing a group of c.200 Guillemots *Uria aalge* was overlain

on each photo and the enclosed area was divided into four approximately equal quarters.

Ultimately, counts presented were obtained from the upper right quarter only.

**Figure 3a**. Non-manipulated night photograph of the counting plot at Sumburgh Head during

clear moonlit night taken at 00:50 GMT, 4 March 2015. Common Guillemots *Uria aalge* are

clearly visible before manipulation.

**Figure 3b.** Manipulated photograph of the counting plot at Sumburgh Head during non-

moonlit night taken at 00:50 GMT, 11 April 2015.  Photograph is brightened to 100% using

Photoshop CC. Common Guillemots (*Uria aalge*) are clearly visible.

**Figure 4**. Pre-laying attendance of Common Guillemots *Uria aalge* at Sumburgh Head from

30 January (day 30) to 21 April (day 111) 2015. Points are daily maximum counts per day

period (red line) and night period (blue line) Due to camera failure, data are lacking for days

73-76.

**Figure 5**. Mean number (mean ± SE) of Common Guillemots per two-hour period over ten

cycles of attendance at counting plot at Sumburgh Head. Day values are mean maximum

counts and night values are mean minimum estimates within each two-hour period. The

330    different colours shows the average onset of day (yellow) and night periods (blue) over

331    study period.

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333    **Figure 6.** Number of Common Guillemots *Uria aalge* per two-hour period (e.g. 00:00 –

334    02:00, 02:00 – 04:00 and so on) for each cycle of attendance at stack plot at Sumburgh. Day

335    values are maximum counts within each two-hour period and NIGHT values are maximum

336    estimates within each two-hour period. Cycles 1 to 10 of monitoring period in run up to

337    laying.  The different colours shows the average onset of day (lighter colour) and night

338    periods (darker colour) over study period as determined by nautical twilight. Missing values

339    due to camera failure or fog are omitted.

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| Cycle | Days in | Nights in | Days out | First night attendance |
|-------|---------|-----------|----------|------------------------|
| 1 | 4 | 2 | 4 | No attendance |
| 2 | 3 | 1 | 6 | No attendance |
| 3 | 3 | 2 | 7 | Low numbers |
| 4 | 4 | 3 | 6 | High numbers |
| 5 | 2* | 1* | ? | No attendance |
| 6 | 4 | 3 | 2 | Low numbers |
| 7 | 4 | 3 | 3 | High numbers |

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|---|---|---|---|---|
| 8 | 1 | 0 | 2 | No attendance |
| 9 | 4 | 3 | 2 | High numbers |
| 10 | 3 | 1 | 2 | No attendance |
| 11 | 5 | 3 | 3+ | No attendance |

**Table 1**. Cycle characteristics of Common Guillemots *Uria aalge* over the study period. The cycles are shown in Figure 4 and detailed in the Appendix.

'No attendance': Colony deserted few hours after arrival, hence no overnight attendance.

'Low numbers': Attendance consistent over cycle but on first night numbers attending the colony drops to low numbers. Subsequent nights of cycle have high attendance.

'High numbers': Colony attended consistently from first day of attendance to last day of attendance in high numbers including overnight.

*Data gap during cycle.

APPENDIX
382
383    Day and night data for all dates monitored during pre-laying period when any birds were
384    present.

385    Period: Day or night classified according to nautical dawn and dusk
386    Presence: Guillemots present within study plot at any time within daily period
387    Minimum attendance estimated from low quality night photographs (Low attendance = >5;
388    High attendance = >50).
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| CYCLE | DATE | PERIOD | ATTENDANCE | DETAILS |
|---|---|---|---|---|
| **1** | 03/02 | DAY | 67 | Arrived early morning - left after 2hr |
| | 04/02 | DAY | 102 | Arrived during day |
| | | NIGHT | >50 | Present overnight |
| | 05/02 | DAY | 104 | Present |
| | | NIGHT | >50 | Present overnight |
| | 06/02 | DAY | 94 | Left during day |
| **2** | 11/02 | DAY | 20 | Arrived early morning - let after 1hr |
| | 12/02 | DAY | 92 | Arrived during day |
| | | NIGHT | >50 | Present overnight |
| | 13/02 | DAY | 89 | Left during day |
| **3** | 20/02 | DAY | 60 | Arrived during day |
| | | NIGHT | >5 | Present overnight |
| | 21/02 | DAY | 88 | Attendance |
| | | NIGHT | >50 | Present overnight |
| | 22/02 | DAY | 86 | Left during day |
| **4** | 02/03 | DAY | 76 | Arrived early morning |
| | | NIGHT | >50 | Present overnight |
| | 03/03 | DAY | 105 | Attendance |
| | | NIGHT | >50 | Present overnight |
| | 04/03 | DAY | 112 | Attendance |
| | | NIGHT | >50 | Present overnight |
| | 05/03 | DAY | 48 | Left early morning |
| **5** | 12/03 | DAY | 52 | Arrive early morning – leave after 1hr |
| | 13/03 | DAY | 78 | Arrived early morning |
| | | NIGHT | NA | Present until 22.20hr (no data after) |
| **6** | 18/03 | DAY | 20 | Arrived during day |
| | | NIGHT | >1 | Present overnight in low numbers 2- 3 individuals |
| | 19/03 | DAY | 80 | Attendance |
| | | NIGHT | >50 | Present overnight |
| | 20/03 | DAY | 91 | Attendance |

| | | | | |
|---|---|---|---|---|
| | | NIGHT | >50 | Present overnight |
| | 21/03 | DAY | 15 | Left at 10:19hr |
| **7** | 24/03 | DAY | 66 | Arrived during day |
| | | NIGHT | >50 | Present overnight |
| | 25/03 | DAY | 100 | Attendance |
| | | NIGHT | >50 | Present overnight |
| | 26/03 | DAY | 93 | Attendance |
| | | NIGHT | >50 | Present overnight |
| | 27/03 | DAY | 53 | Left during day |
| **8** | 31/03 | DAY | 47 | Arrived early morning, left couple hours later |
| **9** | 03/04 | DAY | 111 | Arrived during day |
| | | NIGHT | >50 | Present overnight |
| | 04/04 | DAY | 115 | Attendance |
| | | NIGHT | >50 | Present overnight |
| | 05/04 | DAY | 102 | Attendance |
| | | NIGHT | >50 | >50 present overnight |
| | 06/04 | DAY | 50 | Left at 07:48hr |
| **10** | 09/04 | DAY | 22 | Arrived early in morning and and left couple hours later |
| | 10/04 | DAY | 97 | Arrived during day |
| | | NIGHT | >50 | Present overnight |
| | 11/04 | DAY | 85 | Left during day - late afternoon |
| **11** | 14/04 | DAY | 12 | Arrived early in morning and and left couple hours later |
| | 15/04 | DAY | 93 | Arrived during day |
| | | NIGHT | >50 | Present overnight |
| | 16/04 | DAY | 109 | Attendance |
| | | NIGHT | >50 | Present overnight |
| | 17/04 | DAY | 118 | Attendance |
| | | NIGHT | >50 | Present overnight |
| | 18/04 | DAY | 94 | Left late evening |

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**Figure 1a: Map of North of Scotland showing position of Sumburgh Head on most Southern tip of Shetland. Created using Google Earth and Paint X Lite**



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**Figure 1b: Sumburgh Head showing the relative positions of the stack at Smithfield Geo and the position of the camera 160 m away near the visitor centre at the lighthouse. Created using Google Earth and Paint X Lite.**

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397   **Figure 2.** A plot outline encompassing a group of c.200 Guillemots was overlain on each

398   photograph. The enclosed area was divided into four approximately equal quarters. Counts

399   presented in this paper come from the upper right portion.

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403    **Figure 3a**: Non-manipulated night photograph of stack plot at Sumburgh during clear

404    moonlit night taken at 00:50 GMT, 4 March 2015. Common Guillemots *Uria aalge* are clearly

405    visible before manipulation.

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408    **Figure 3b**: Manipulated photograph of stack plot at Sumburgh during non-moonlit night

409    taken at 00:50 GMT, 11 April 2015.  Photograph is brightened to 100%. Common Guillemots

410    *Uria aalge* are clearly visible.



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**Figure 4**. Pre-laying attendance of Common Guillemots *Uria aalge* at Sumburgh Head from

30 January (day = 30) to 21 April (day = 111) 2015 showing 11 cycles. Points are daily

maximum counts per day period (red line) and minimum number categories per (as defined

in methods) night period (blue line). Due to camera failure, data are lacking for days 73-76.
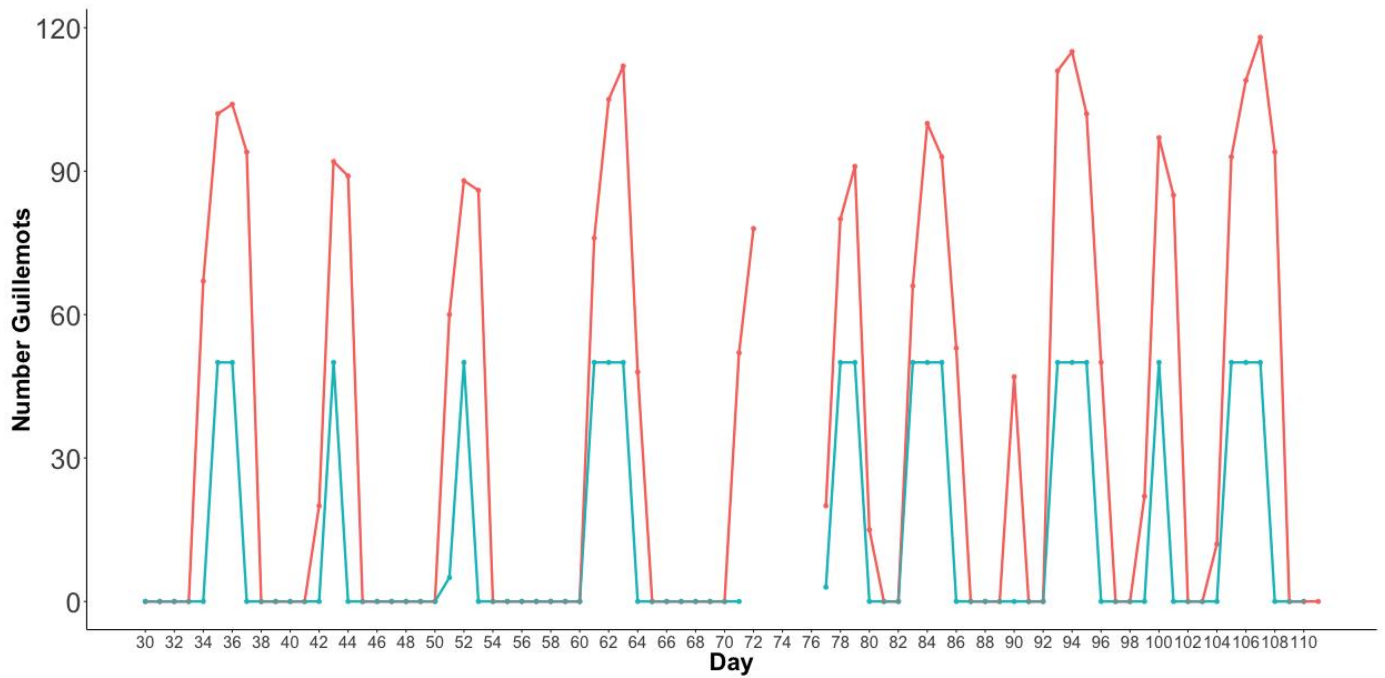


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**Figure 5**. Mean number (mean ± SE) of Common guillemots per two-hour period over ten
cycles of attendance at breeding colony at Sumburgh during the non-breeding period. Day
values are mean maximum counts and night values are mean minimum estimates (as
categorized in methods) within each two-hour period. Background colour shows average
onset of day (yellow) and night (blue) periods over study period.
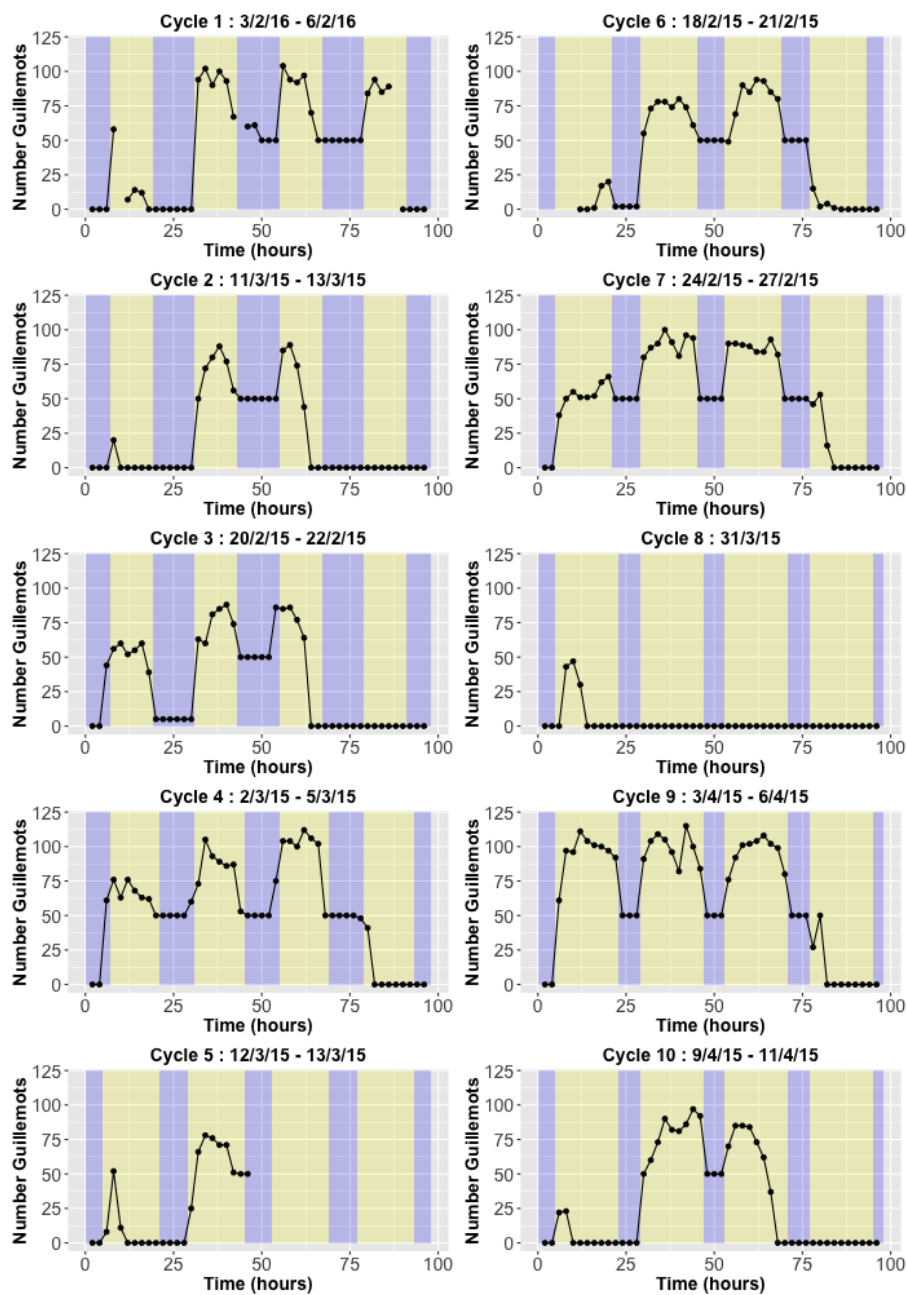
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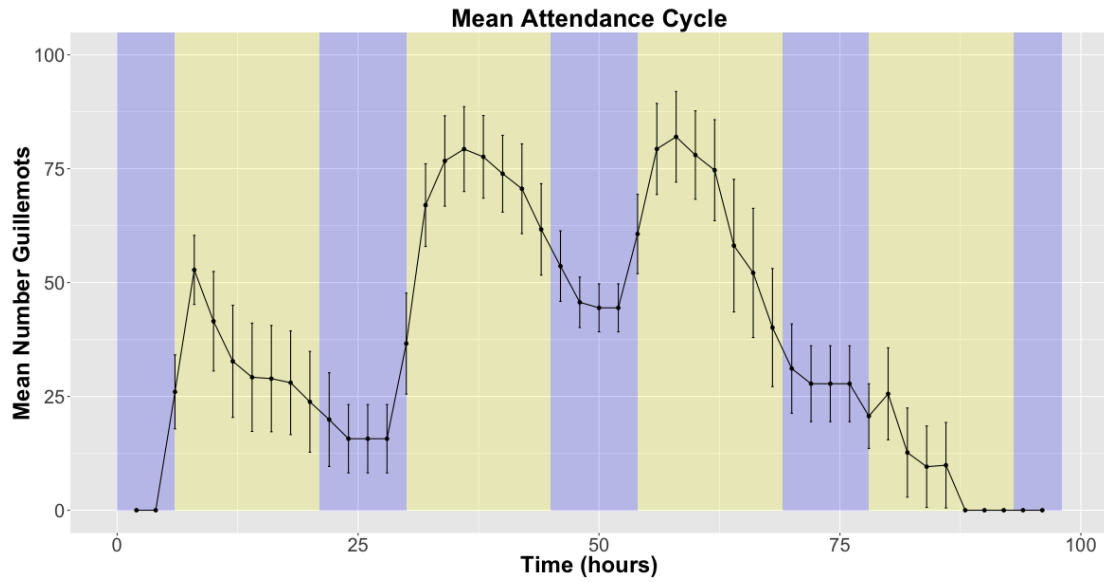


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Figure 6. Number of Common Guillemots *Uria aalge* per two-hour period (e.g. 00:00 – 02:00, 02:00 – 04:00 and so on) for each cycle of attendance at colony at Sumburgh during non-breeding period. Day values are maximum counts within each two-hour period and night values are minimum estimates within each two-hour period as defined in method. Cycles 1 to 10 of monitoring period in the run up to breeding season. Background colour shows day (yellow) or night (blue) period as determined by nautical twilight. Missing values due to camera failure or fog are omitted.

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