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Trial of the use of silicone cord leg-loop harnesses on Black-legged Kittiwake during the 2023 breeding season

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Birds Science People

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Trial of the use of silicone cord leg-loop harnesses on Black-legged Kittiwake during the 2023 breeding season

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Executive summary

Understanding the importance of different pressures that seabirds face over the annual cycle requires year-round data. One factor limiting our ability to collect this information is the lack of suitable methods to attach devices long-term to individuals, without causing adverse effects on individuals in terms of their welfare, behaviour and demographic rates.

The Black-legged Kittiwake *Rissa tridactyla* (hereafter Kittiwake) is one seabird species where year-round high-resolution data are required, especially in relation to informing decisions around the consent of offshore wind farm developments.

In 2021, a field trial was conducted at Whinnyfold, part of the Buchan Ness to Collieston Coast Special Protection Area (SPA), to assess the suitability of two harness designs (leg-loop and thoracic cross strap) using Teflon to attach devices long-term to six Kittiwakes. Due to adverse effects on the Kittiwakes associated with the Teflon harness material, a further trial was recommended using an alternative harness material, elastic silicone cord, with a leg-loop design.

Here we describe the outcome of this follow-up field trial during the 2023 breeding season to assess the feasibility of using silicone cord for the leg-loop harness attachment of devices to Kittiwakes on a sample size of six individuals.

We found that the tagged Kittiwakes pecked at the knot securing the device to the harness resulting in three devices being lost within five days of deployment. The remaining three birds were recaught and the knot was retied and secured with Tesa tape, but all three of the remaining devices stopped transmitting by the first week of September. Limited data on Kittiwake movement were therefore obtained from the deployed devices. However, one individual was tracked for a short period post-breeding where it headed north-west with the last fix recorded south of Greenland.

Around two weeks following deployment we started to observe extensive preening by the tagged Kittiwakes, but by then it was not possible to recatch the birds for a third time to check for abrasion. During the subsequent 2024 breeding season we resighted five of the six Kittiwakes that had been fitted with harnesses, which included the three secured with Tesa tape, and the individual that provided locational data for its autumn migration to Greenland. Two of the control individuals were also resighted in 2024.

In light of the issues experienced in 2023, we provide a further recommendation to redesign the housing of the tag to allow a four-point attachment with tubes so that a secure single knot can be tied and tucked away from where the bird can reach. This will move forward the testing of long-term attachment of devices using leg-loop harnesses and silicone cord on Kittiwakes in future.

1. Introduction

1.1. Background

Globally, seabirds are one of the most threatened groups of birds, with many populations facing severe declines (Dias et al. 2019), which is also reflected at the national scale in the UK (Burnell et al. 2023). Relying on both marine and terrestrial ecosystems, seabird species encounter multiple threats throughout their annual cycle (Dias et al. 2019). While there is widespread acknowledgement of the importance of understanding the pressures seabird populations face throughout the year, most research is still focused on the breeding season (Calvert et al. 2009, Strøm et al. 2021).

One limiting factor in identifying pressures outside the breeding season is the lack of available suitable methods to attach tracking devices to individuals to collect data during this period when species are no longer tied to colonies (Clewley et al. 2021a). Harnesses are one method that can be used for long-term attachment, and have been successfully used to collect data over multiple years in several waterbird and seabird species, including large gulls (e.g. Thaxter et al. 2014, Clewley et al. 2021b). However, current harness designs are not suitable for all species, notably those which seem to show a stronger preference for marine habitats (Thaxter et al. 2014, Mott et al. 2015, Langlois Lopez et al. 2023).

The Black-legged Kittiwake *Rissa tridactyla* (hereafter Kittiwake) is a Red-listed species of conservation concern in the UK (Stanbury et al. 2024), as well as being classified as Vulnerable on the IUCN Red List at the global and European scale (BirdLife International 2021a, b). Declines in Kittiwake breeding populations are largely linked to climate change and fisheries (Frederiksen et al. 2004, Carroll et al. 2017). Kittiwakes are also considered sensitive to impacts from offshore wind farms (OWFs), due to the risk of collision with turbines (Furness et al. 2013) and are therefore a key consenting risk for OWFs (Ruffino et al. 2020). How Kittiwakes interact with OWFs across the annual cycle, and how this influences collision risk, is a key evidence gap. Although high-resolution tracking data have been successfully collected from Kittiwakes this has been achieved with short-term attachment methods lasting a few days to several weeks over the breeding season (Daunt et al. 2002, Chivers et al. 2012, O'Hanlon et al. 2024). During the 2021 breeding season, a trial was undertaken by the British Trust for Ornithology (BTO) to assess the suitability of two harness designs (leg-loop and thoracic cross strap) to allow long-term attachment of biologging devices to Kittiwakes (Clewley et al. 2021b). However, after recapture of the tagged individuals 10 to 24 days after deployment, acute impacts were observed in all individuals from the Teflon material used to make the harnesses. Specifically signs of feather and skin abrasion was observed especially around the base of the wings in the individuals with the thoracic harness (Clewley et al. 2021b). The trial recommended that using alternative materials fitted as a leg-loop design may still be suitable for longer-term tracking of Kittiwakes (Clewley et al. 2021b). Elastic silicone cord was therefore recommended as an alternative to Teflon given this has been successfully used with no issues of abrasion on several species, including waders (Vandenabeele et al. 2013, Smith et al. 2017, Le Rest et al. 2019, Clewley et al. 2021b).

1.2. Aims

The overall aim of this project was to facilitate the collection of long-term tracking data of Kittiwakes during and outside the breeding season to improve our understanding of important areas to this species outside the breeding season and to investigate potential year-round interactions between individuals and OWFs, especially individuals from breeding populations within Special Protection Areas (SPAs). This study expands on the harness field trial of long-term attachment of devices on Kittiwakes undertaken in 2021 (Clewley et al. 2021b) which outlined recommendations, specifically on the material used to construct the leg-loop harness. Here we describe the outcome of the follow up field trial in 2023 to assess the feasibility of using silicone cord instead of Teflon for future long-term, non-permanent, attachment of devices to Kittiwakes.

2. METHODS

Tagging field work was conducted at Whinnyfold, (57°23′07″N, 001°52′11″W), part of the Buchan Ness to Collieston Coast SPA, on 24th June 2023, during the late incubation/early chick rearing period (Figure 1). A total of 12 breeding adult Kittiwakes was caught on the nest from a single cliff face using a noose-pole. Microwave Telemetry 5 g Solar PTT devices (dimensions: 2.46 x 1.52 x 0.81 cm with a 21.59 cm antenna protruding from the back edge of the device) were deployed onto six individuals, with an equal number of untagged controls. All tagged and control individuals were fitted with a unique metal and alpha-numeric colour ring, had biometrics taken (maximum wing chord, body mass, total head length, bill length to feather and bill depth at gonys) and were dye marked to improve detectability during monitoring (tagged — Picric Acid, control — Silver Nitrate). The total processing time between capture and release was 25–52 minutes including additional holding time for the plumage dye to dry, with the handling time to fit the harnesses being between nine and 13 minutes.

2.1. Device harness design and deployment

A 3 mm thick closed-cell foam pad was attached to the base of each Solar PTT device to elevate the device and improve its solar performance by reducing the likelihood of shading from the bird's feathers. A leg-loop harness design (Rappole & Tipton 1991, Sanzenbacher et al. 2000) was constructed using 2.0 mm silicone cord prior to the start of the field season. A single length of silicone cord was attached to the front of the device with a simple lark's foot knot, and then to each side of the harness by threading the silicone cord through the rear attachment points to create two loops. The device was positioned on the bird so that it sat on the lower back. To secure the harness, once on the bird a double reef knot was tied around the device's antenna (to prevent the harness material covering the solar panels; Figure A1). The harness straps were carefully bedded down within the feather tracts to ensure no feathers were caught in an unnatural position. Measurements in permanent marker were made along the harness straps before deployment to allow the size of the harness to be quickly assessed in the field, and to ensure symmetry of each strap before securing. We expected the devices to remain on the Kittiwakes for c. 1 year based on a similar attachment design used on Curlew *Numenius arquata* (range two to 23 months, F. Jiguet Pers. Comms.). The combined harness and device weight was c.6.5g, which represented 1.6 to 2.1% of the tagged Kittiwakes' body masses (Table 1). Once attached, the Solar PTT devices recorded data for a duty cycle of 10 hours on and 48 hours off, with locations collected using the Argos system. All trapping and ringing activities were carried out by licensed individuals holding valid BTO ringing permits and all devices and harnesses were fitted under endorsement from the Special Method Technical Panel (SMTP) of the BTO Ringing Committee.

2.2. Monitoring potential device effects

All nests where birds were caught from were numbered on a photograph of the sub-colony (Figure A1). On the date of capture (24 June), continuous monitoring of the tagged and control birds was carried out between 12:00 until 19:00 to record the time from the release of an individual to when it returned to its nest. We also carried out continuous monitoring on 25th June from 07:15 to 16:00. We recorded whether tagged, marked control, or unmarked individuals were present on the nest every 15 minutes to check for any immediate adverse effects of device deployment.

Between 25 June and 6 August we made 13 visits to the colony across daylight hours to record nest contents (number and the size of chicks: small, medium or large) and whether tagged, marked control or unmarked individuals were present on the nest from vantage points overlooking the colony to prevent disturbance. We monitored the productivity of tagged and control individuals to check for any adverse effects of tagging on breeding success. We recorded two measures relating to productivity: i) whether a nest failed or was successful and ii) the number of fledged young from each nest (based on the maximum count of young during the last three monitoring visits with large primary feather growth).

During the following 2024 breeding season we re-visited the colony on five occasions between 8 and 14 July to resight tagged and control individuals. All data processing and analyses were carried out in R version 4.3.2 (R Core Team 2023). We used Pearson's chi-squared tests to compare rate of nest failures between tagged or control marked individuals, and Kruskal-Wallis chi-squared tests to compare brood sizes, minimum fledging rates, nest attendance and return rates.

3. RESULTS

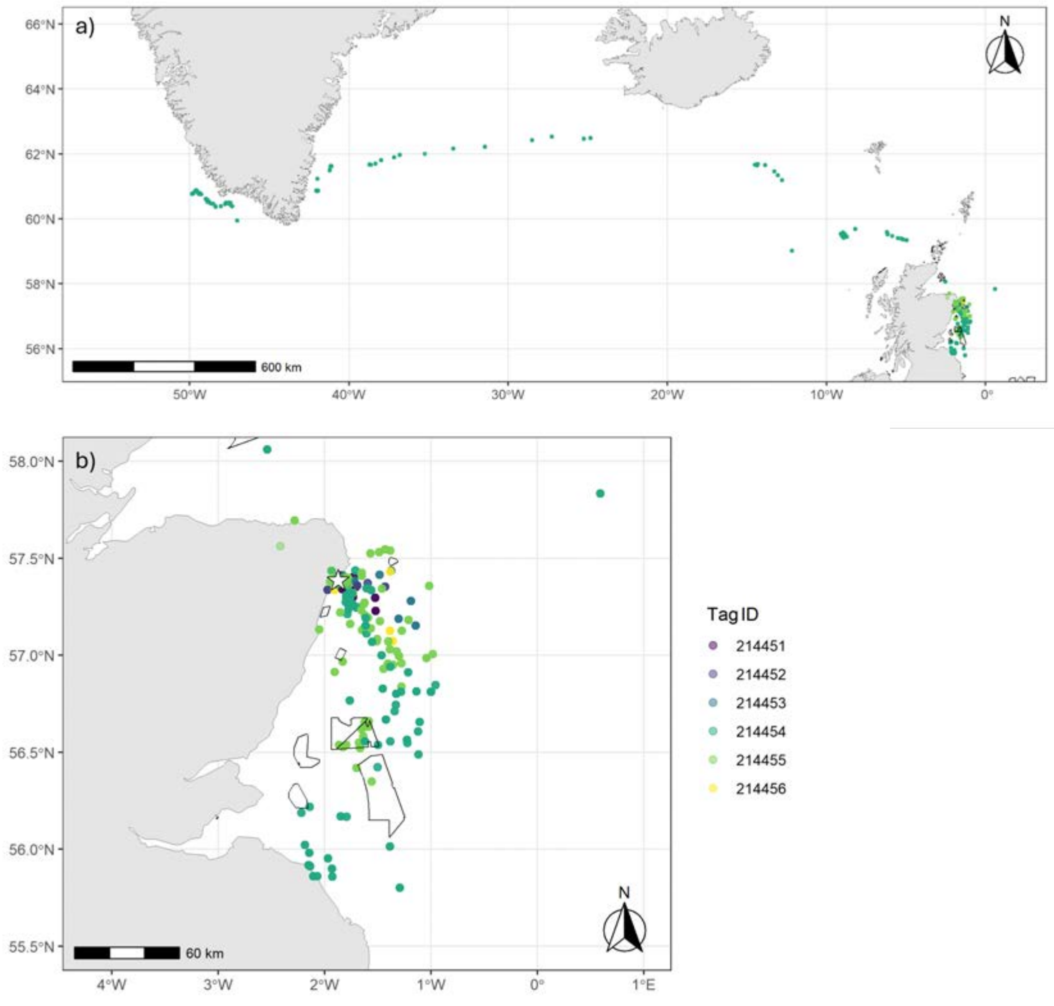
3.1. Observations post-deployment

During the continuous monitoring on 24 June, all tagged and control individuals were observed to return to the nest within two hours except for one tagged bird (214455) which was seen the following day (c.12:00). During this intense period of monitoring, all individuals were observed to be acting as expected at the nest. However, it became clear that some tagged individuals were pecking at and undoing the silicone knots — with ‘prongs’ of silicone observed sticking up above the tag (Figure A2). Therefore between 11:00 and 11:30 on 25 June, three tagged individuals (214452, 214454 and 214455) that were present in the colony at the time of the visit were recaught and inspected. No abrasions were observed from the silicone harness. However, the inspection did confirm that the back double reef knot had come undone. These knots were resecured on all three recaptured individuals and Tesa (4561, Tesa AG, Hamburg) tape wrapped around the knot and external antennae to secure the knot (Figure A3).

To check how applying the Tesa tape had worked, we revisited the colony on 29 June and recaptured tagged individual 214452 to inspect the tag (initial mass of this individual 345 g, recapture mass of 360 g). No abrasions were observed and the Tesa tape was still securing the back knot; therefore the individual was released. However, it should be noted that the Tesa tape did have signs of being pecked (Figure A4).

During less intensive monitoring of the tagged birds between 10 and 12 July, it was noticed that the preening by the remaining three tagged Kittiwakes was becoming more extensive — especially around the devices. We therefore decided to try and recatch the remaining three tagged individuals to inspect and remove the leg-loop harnesses. However, at this time the attendance rates of tagged and control birds at the colony reduced dramatically due to the presence of High Pathogenicity Avian Influenza (HPAI) in and around the colony; therefore, recatching the individuals was not possible.

Figure 1. Map of a) all data downloaded from the six Solar PTT devices deployed on Kittiwakes and b) zoomed in to the study area off Whinnyfold, part of the Buchan Ness to Collieston Coast (white star). Also shown are the proposed and operational offshore wind farms at the time of the study (black solid outline).



Data were downloaded from all six Kittiwakes with devices deployed (Figure 1, Table 1; see Figures A5 and A6 for individual maps). Devices from three individuals (214451, 214453 and 214456) stopped transmitting data within five days of being deployed (Table 1). All three individuals were observed in the colony on subsequent days, without their devices, therefore once data stopped transmitting these individuals were assumed to have lost their devices during this time. Although no data were received from individual 214452 after 4 July, this bird was observed alive in the colony on 10 July demonstrating that the cessation of data transmission was due to device issues rather than death (with the voltage of this tag dropping on the final day fixes were received suggesting a fault with the device, the solar panel being obscured by feathers or the device being lost). The devices on two individuals (214454 and 214455) provided data up to 31 July and 6 September respectively.

Table 1. Summary information on the data obtained from the six tagged Kittiwakes.

Tag ID	Nest ID	Device and harness as % of body mass at capture	Start Date	End Date	Number of fixes	Last date individual seen at colony during monitoring in 2023
214451	5	1.76	24/06/2023	29/06/2023	11	03/07/2023
214452	6	1.86	26/06/2023	04/07/2023	12	10/07/2023
214453	3	1.62	24/06/2023	26/06/2023	12	18/07/2023
214454	7	1.97	24/06/2023	31/07/2023	200	03/07/2023
214455	4	2.06	24/06/2023	06/09/2023	110	12/07/2023
214456	8	1.77	24/06/2023	28/06/2023	10	18/07/2023

From the tracking data, individual 214454 remained near the breeding colony until around 22 July (but was not observed on the monitoring visits after 3 July). It then rapidly headed north over mainland Scotland and continued north-west to the southern point of Greenland with the last fix recorded on 31 July (Figure A6). The termination of transmission was not preceded by declining voltage, temperature or activity level, suggesting either tag failure or loss. The nest of this individual appeared to fledge one chick (last seen on 27 July) which suggested that the other parent continued to come back to feed their young over those four to five days.

The tracking data from individual 214455 indicated this individual did not leave the breeding colony area before the last fix was received on 6 September. However, only 19 fixes were obtained between the 25 July and 6 September. Over this period the temperature and activity level measured by the tag was much lower, suggesting that it had become detached from the bird. The nest of this individual failed between 18 and 23 July.

3.2. Potential tag effects

We found no significant difference in the rate of nest failures between tagged or control marked individuals (Pearson's chi-squared test: χ^2 = 0.667, P = 0.414, Table 2), nor in the minimum number of fledglings (Kruskal-Wallis chi-squared test: χ^2 = 3.088, P = 0.378). Failure rates were high, and number of chicks fledged low, across both groups; this was attributed to HPAI. There was no significant difference in brood sizes of the two groups at the time when individuals were caught (Kruskal-Wallis chi-squared test: χ^2 = 0.544, P = 0.461).

There was no significant difference between attendance rates of the tagged and control birds during the first five monitoring watches (25 June and 7 July) before signs of HPAI increased in the colony (Kruskal-Wallis chi-squared test: χ^2 = 2.302, P = 0.129, Table 3). Attendance rates dropped for both groups during the subsequent monitoring visits after 7 July across all nests and for those with active nests (Table 3) — attributed to the presence of HPAI in the colony.

Table 2. Productivity of tagged Kittiwake (leg loop harness) compared to control individuals that were caught and ringed.

Group	Number	Failure rate (number in brackets)	Brood size (Mean ± SD)	Min. fledged (Mean ± SD)
Tagged	6	0.67 (4)	1.83 ± 0.41	0.67 ± 0.82
Control	6	0.50 (3)	1.50 ± 0.84	0.33 ± 0.52

Table 3. Attendance of tagged Kittiwake (leg loop harness) compared to control individuals that were caught and ringed. The attendance rate reflects the proportion of visits that individuals were present on the nest over three different time periods / situations.

Group	Number	Attendance rate First 5 visits (Mean ± SD)	Attendance rate All visits (Mean ± SD)	Attendance rate Active nests across all visits (Mean ± SD)
Tagged	6	0.70 ± 0.11	0.32 ± 0.10	0.35 ± 0.10
Control	6	0.50 ± 0.24	0.26 ± 0.16	0.33 ± 0.38

3.3. Resightings of tagged and control individuals during the 2024 breeding season

On the revisits to the colony during the 2024 breeding season we resighted five of the six Kittiwakes that had been deployed with harnesses in 2023 (Table 4). This included the three individuals that had the harness secured with Tesa tape (214452, 214454 and 214455). We also resighted two of the control individuals (Table 4). Individual 214454 was recaught on nest 7 (the same as in 2023) on 9 July 2024 for inspection (initial mass of this individual in 2023 – 325 g, recapture mass of 295 g). The tag and harness had been lost and there was no sign of any scarring or indication that long-lasting or severe abrasions had occurred (Figure A8). The tag and harness are assumed to have been lost when the transmission of data stopped on 31 July 2023.

There was no significant difference between return rates of the tagged and control birds during the 2024 breeding season (Kruskal-Wallis chi-squared test: $\chi^2 = 2.829$, $P = 0.093$), although statistical power was low.

Table 4. Details of tagged Kittiwake (leg loop harness) resighted during the 2024 breeding season. Individual 214456 was not resighted in 2024.

Tag ID	Nest ID in 2023	Nest ID in 2024	First date resighted in 2024	Nest contentson date resighted in 2024
214451	5	5	09/07/2024	1+ small chick
214452	6	6	08/07/2024	Empty
214453	3	3	08/07/2024	Empty
214454	7	7	08/07/2024	1+ small chick
214455	4	4	13/07/2024	2 small chicks
214456	8	–	–	–

4. DISCUSSION

During this second trial of the leg loop harness attachment method, we found issues with the updated design using silicone cord. Although we found no evidence of abrasions, the tagged Kittiwakes were able to peck at the double reef knot used to secure the harness to the back edge of the device. This resulted in this knot becoming loose within a few days of the devices being deployed. Wrapping Tesa tape around the double reef knot improved the situation, with one device remaining attached for c. five weeks (214454) and another for c.10 weeks (214455). However, these time frames were still shorter than we were expecting (c. 1 year).

The excessive preening that was observed two weeks following deployment is of concern, and unfortunately, we do know the exact cause for this preening as we were unable to recatch the tagged individuals at this point due to the presence of HPAI in the colony. Although we had not been recording information to quantity the extent of preening by tagged or control individuals, the preening observed for three tagged individuals was thought to be excessive (although it was not quantified per se). These were the same three individuals that had their harnesses re-secured with Tesa tape when recaptured post-deployment. We recommend that focal watches are incorporated into future trials of attaching harnesses on Kittiwakes, of tagged and control individuals, to monitor and quantify the extent of preening to better understand this potential impact. It is also important to note that an initial lack of preening following deployment does not mean that excessive preening will not commence at a later date.

The colony was revisited during the 2024 breeding season to search for returning tagged and control individuals. Given that the colony was badly hit by HPAI in July 2023 it was reassuring to resight five of the tagged individuals, including individual 214454 that had last been detected from the Argos data off Greenland, and two of the control individuals. There was no indication that deploying the device and leg loop harness negatively impacted the return rates of the Kittiwakes within this trial; with a higher number of tagged compared to control individuals resighted in 2024, although this was not statistically significant. It should also be noted that the 2024 breeding season was late with Kittiwakes being delayed in nesting and egg-laying by at least 1–2 weeks compared to the 2021 and 2023 breeding seasons. There were also indications of it being a poor breeding season with small clutch and brood sizes, as well as a number of empty nests, as observed with two of the resighted harness individuals (214452 and 214453), and high nest failures. Therefore, it is not possible to determine whether the tagged and control individuals that were not resighted skipped breeding in 2024 or succumbed to HPAI in 2023. The lower resighting rate of control individuals may be attributed to the three control Kittiwakes from nests 10, 11 and 12 (Figure 1a), that were not resighted in 2024, breeding in a dense part of the colony in 2023 that was suspected of being hit by HPAI. Effort will be made to resight these individuals in 2025 and 2026.

We recommend that further modifications are made to the current leg-loop harness design using silicone cord before future trials are undertaken. During the 2023 trial, we were restricted to modifications we could make to the harness design due to the location of the three attachment points on the Microwave Telemetry devices. At present bespoke attachments are not possible for these devices without adding additional weight. Ideally, devices using a four-point attachment with tubes are required so that a secure single knot can be tied and tucked away from where the bird can reach (as has been used on Curlew and Oystercatcher *Haematopus ostralegus*). Therefore, use of a bespoke device housing design should be explored with a closed loop design with the loops being able to accommodate 2 mm silicone cord, which would be tied in the centre gap (downward facing) of the loop.

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Appendix

Figure A1. Design of the leg-loop harness a) showing the three contact points on the device and b) the double reef knot around the antennae at the back edge of device.

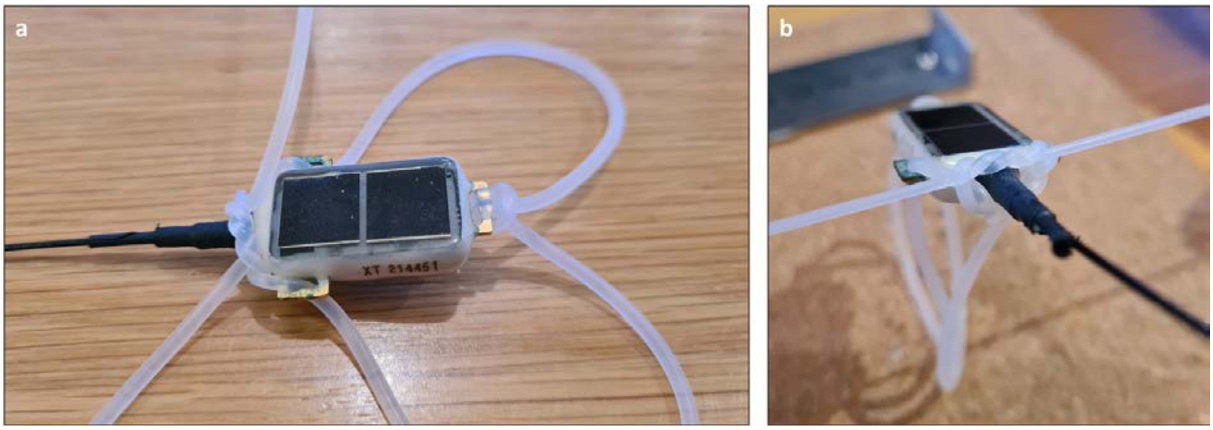

Figure A2. Location of the tagged (1, 4, 5, 6, 7, 8) and control (2, 3, 9, 10, 11, 12) Kittiwake nests within the sub-colony at Whinnyfold, UK.

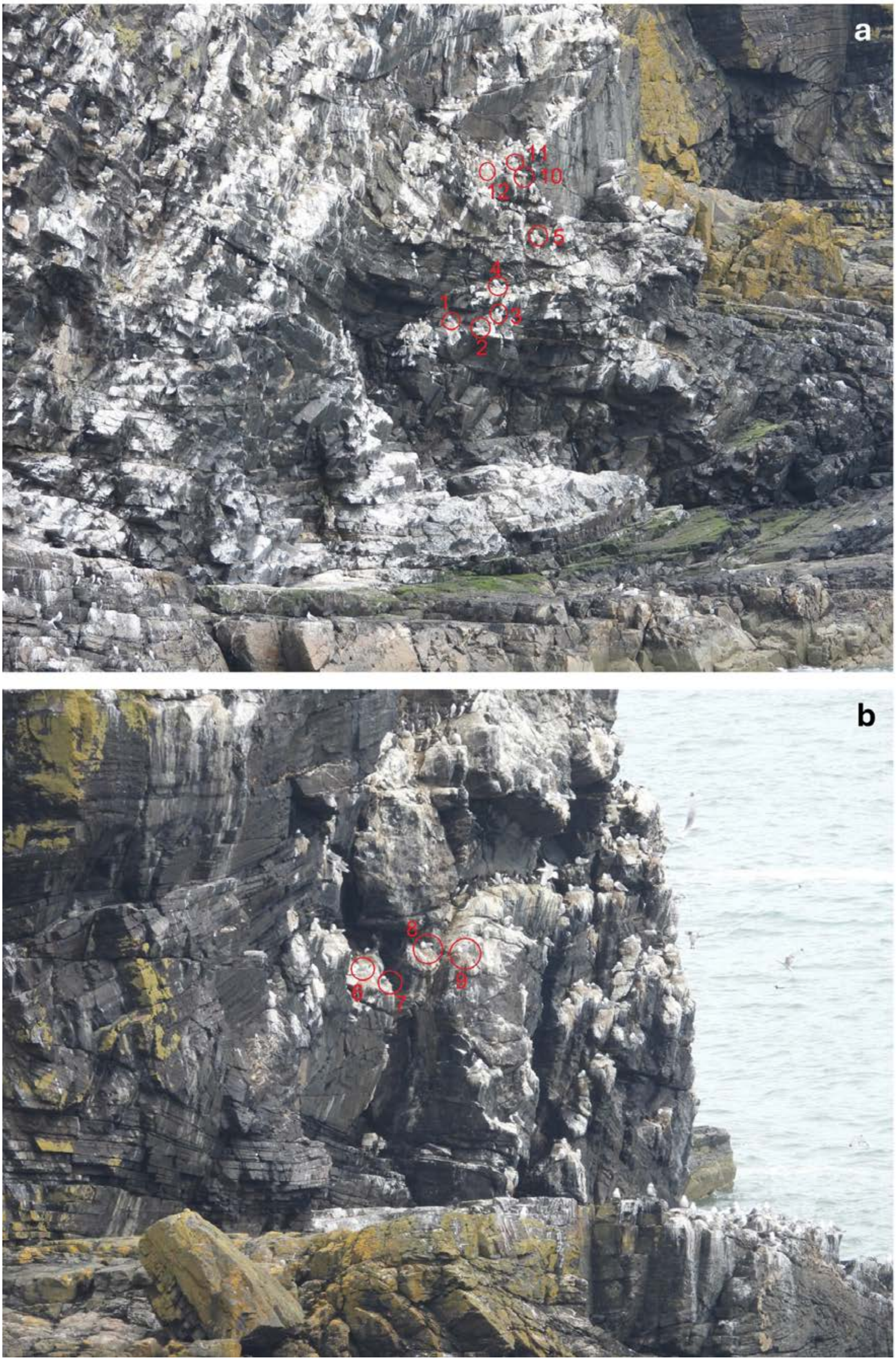

Figure A3. Photograph of tagged Kittiwake 214451 showing the prongs of silicone cord sticking up from the back of the device, indicating the double reef knot had come undone.

Figure A4. Photograph of a) the untied double reef knot on individual 214452 and b) the retied knot with Tesa tape wrapped around to secure the knot in place.

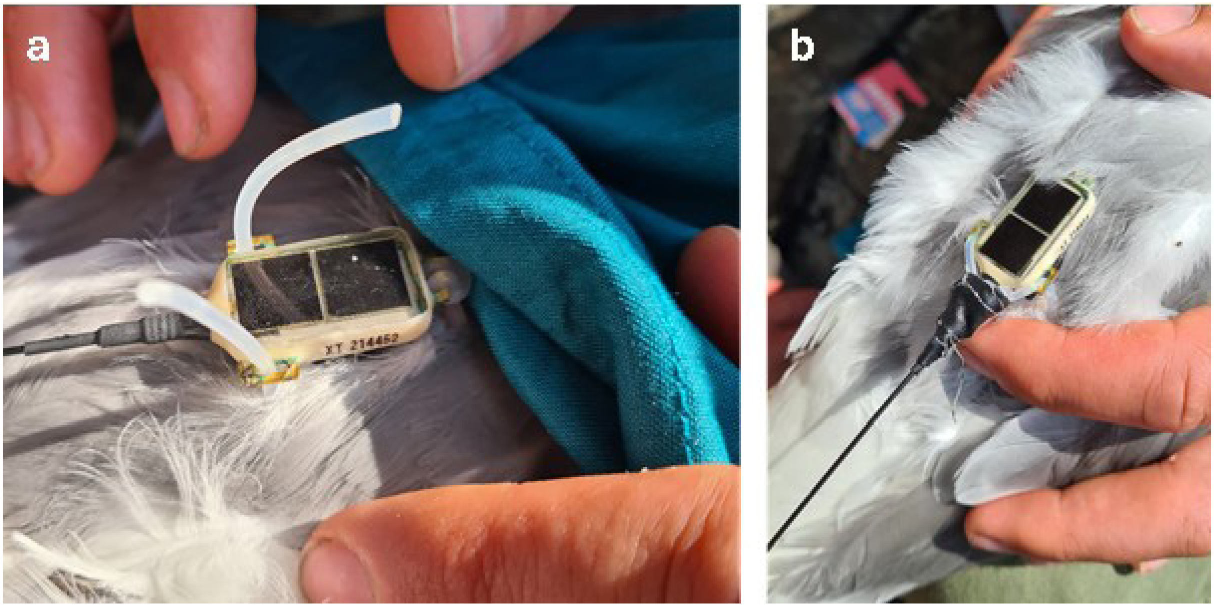

Figure A5. Photographs of the device and harness of Kittiwake 214452 showing that the back knot was still intact but the Tesa tape that had been put on around the silicone cord knot on the 25/06/2023 had been pecked at. There were no signs of abrasions from the silicone cord harness.

Figure A6. Map of the data downloaded from the six Solar PTT devices deployed on Kittiwakes focused on the study area off Whinnyfold, part of the Buchan Ness to Collieston Coast SPA (white star). Also shown are the operational offshore wind farms at the time of the study (black solid outline). The whole extent of the data for individual 214454 is shown in Figure A6.

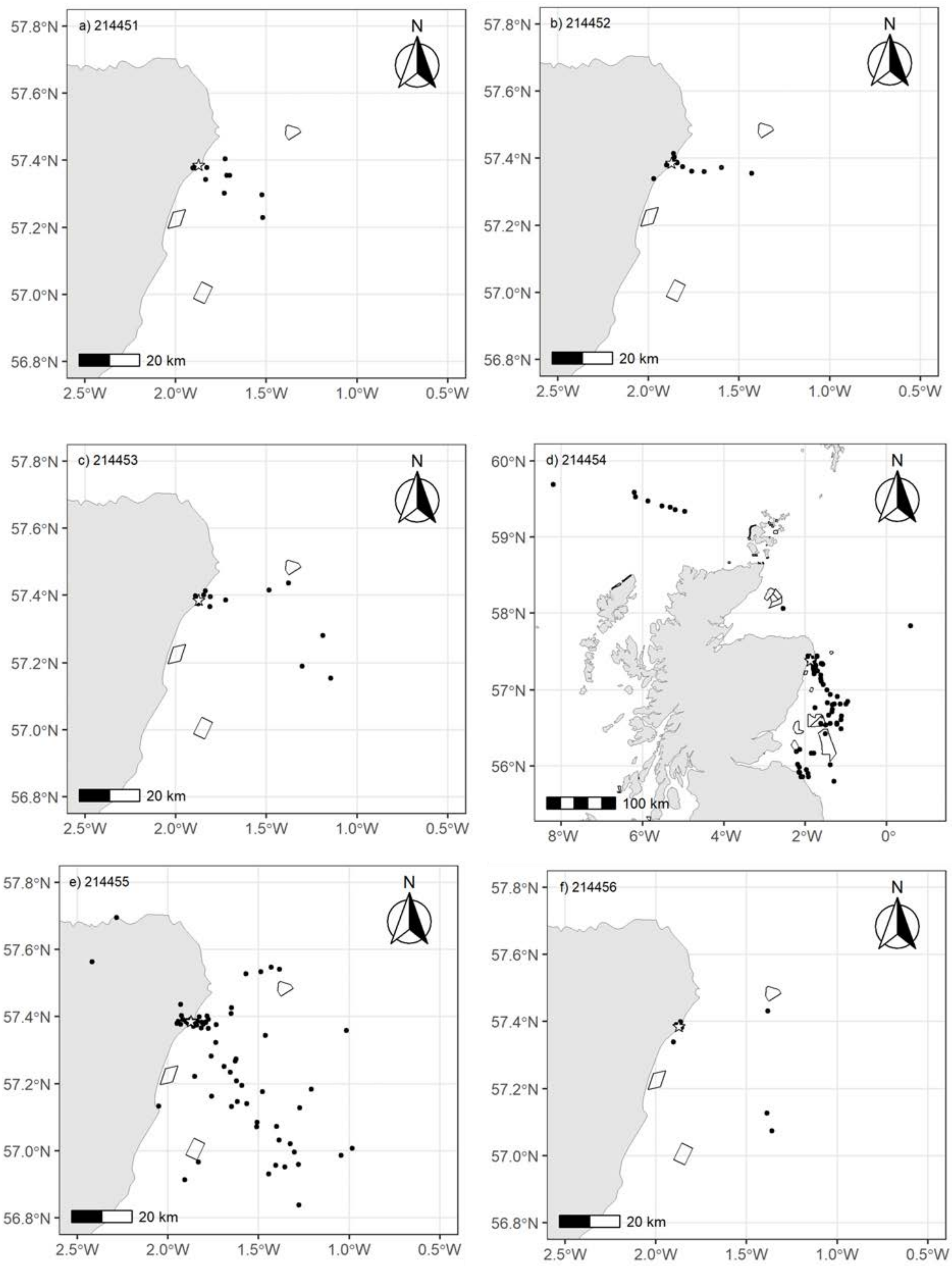

Figure A7. Map of all data downloaded from the Solar PTT device on Kittiwake individual 214454 deployed at Whinnyfold, part of the Buchan Ness to Collieston Coast SPA (white star).

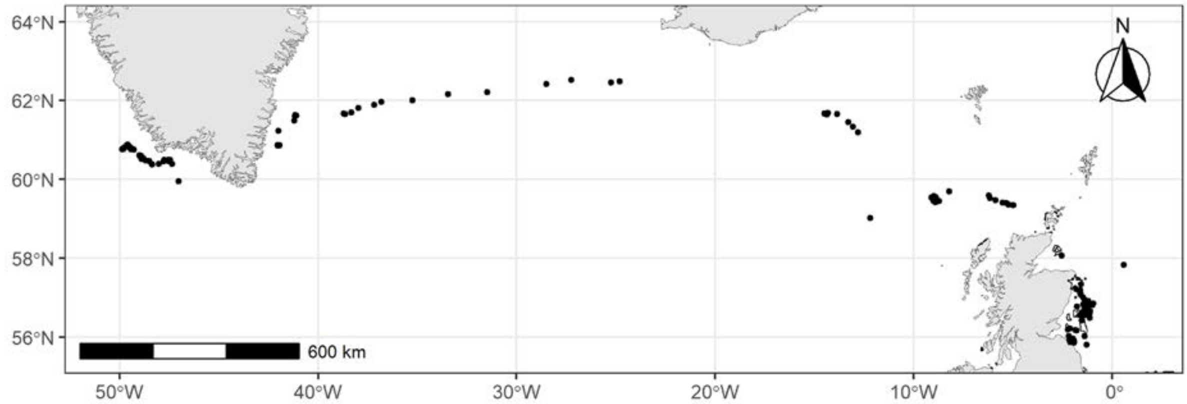

Figure A8. Photograph of Kittiwake 214454 on the nest and when recaptured on 09/07/2024. The device and harness were no longer attached and there were no signs of abrasions or scarring.

Front cover: Philip Croft / BTO; back cover: Ben Darvill /BTO

Trial of the use of silicone cord leg-loop harnesses on Black-legged Kittiwake during the 2023 breeding season

Understanding the importance of different pressures that seabirds face over the annual cycle requires year-round data. One factor limiting our ability to collect this information is the lack of suitable methods to attach devices long-term to individuals, without causing adverse effects on individuals in terms of their welfare, behaviour and demographic rates. Black-legged Kittiwakes *Rissa tridactyla* (hereafter Kittiwake) are one seabird species where year-round high-resolution data are required, especially in relation to informing decisions around the consent of offshore wind farm developments.

In 2021, a field trial was conducted at Whinnyfold, part of the Buchan Ness to Collieston Coast Special Protection Area (SPA), to assess the suitability of two harness designs (leg-loop and thoracic cross strap) using Teflon to attach devices long-term to six Kittiwakes. Due to adverse effects on the Kittiwakes associated with the Teflon harness material, a further trial was recommended using an alternative harness material, elastic silicone cord, with a leg-loop design.

Here we describe the outcome of this follow-up field trial during the 2023 breeding season to assess the feasibility of using silicone cord for the leg-loop harness attachment of devices to Kittiwakes on a sample size of six individuals.

Suggested citation: O'Hanlon, N.J., Clewley, G.D., Davies, J.G., Johnston, D.T., Booth Jones, K.A., Green, R.M.W., Weston, E., Humphreys, E.M. & Cook, A.S.C.P.(2024). Trial of the use of silicone cord leg-loop harnesses on Black-legged Kittiwake during the 2023 breeding season. BTO Research Report **772**. BTO, Thetford, UK.

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