J. Field Ornithol., 63(2):169-176

EFFECTS OF TAIL-MOUNTED DEVICES ON THE ATTENDANCE BEHAVIOR OF KITTIWAKES DURING CHICK REARING

S. WANLESS

Applied Ornithology Unit
Department of Zoology
Glasgow University
Glasgow G12 8QQ United Kingdom and
Institute of Terrestrial Ecology
Hill of Brathens Banchory
Kincardineshire AB31 4BY United Kingdom

Abstract.—Trials to determine the impact of carrying tail-mounted devices on attendance patterns of Kittiwakes (*Rissa tridactyla*) during chick rearing were carried out on the Isle of May, Scotland in 1989. Patterns of attendance and six behavior variables were determined initially for 51 undisturbed pairs with chicks. Packages closely resembling radio transmitters both in shape and weight were then attached to the central tail feathers of one member of each of 15 of these pairs. One member of five other pairs was caught and handled in the same way (except that a dummy was not attached) to act as controls. Three dawn-to-dusk watches subsequently indicated that although attendance patterns changed during the season, experimental, control and undisturbed birds were affected to a similar degree. Thus behavioral changes were probably due to a deterioration in feeding conditions around the colony rather than device-related disturbance. Kittiwakes carrying functional tail-mounted devices weighing <1% of adult body mass should, therefore, provide representative behavioral data even when feeding conditions are unfavorable.

EFECTO DE ARTEFACTOS MONTADOS EN LA COLA DE INDIVIDUOS DE *RISSA TRIDACTYLA* EN LA CONDUCTA DE CUIDADO DE PICHONES

Sinopsis.—En un estudio que se llevó a cabo durante el 1989 en la isla de May, Escocia, se condujeron una serie de ensayos para determinar el efecto de artefactos montados en la cola de individuos de *Rissa tridactyla* en la conducta de cuidado de pichones. El patrón de cuidar a los pichones y seis variables de conducta fueron previamente determinados para 51 parejas de aves con pichones, que no fueron perturbadas. A uno de los miembros de 15 parejas se le montó, en la pluma central de la cola, un artefacto que asemejaba en forma y peso a radiotransmisores. Un miembro de otras cinco parejas fue capturado y manejado en la misma forma, como si se le fuera a instalar un radiotransmisor, para utilizarse como grupo control. Tres días de observación (de amanecer a obscurecer) indicaron que aunque los patrones de atención a los pichones cambiaron durante la temporada, las aves experimentales, de control y las no perturbadas, se afectaron de igual forma. Es probable que los cambios ocurridos en conducta se deban al deterioro de las condiciones alimenticias alrededor de la colonia en vez que a los artefactos. Individuos de *R. tridactyla* al cual se les ha colocado un artefacto en la cola con peso <1% de su masa corporal, deben por tanto proveer de conducta representativa de la especie aun cuando las condiciones de alimento sean desfavorables.

Although the use of radio-transmitters and activity recorders can greatly enhance our knowledge of the behavior and ecology of free-living animals, such devices can cause animals to behave abnormally (Boag 1972, Perry 1981, Wanless et al. 1988). Thus, prior to any work involving the attachment of instruments to free-living individuals, it is essential to carry out trials to determine their impact. Before initiating a radio-tracking

study of activity budgets and foraging behavior of Kittiwakes (*Rissa tridactyla*) during chick rearing, dummy devices of the same shape, size and weight as the transmitters I proposed to use, were attached to the tails of 15 birds with young, and their performance and behavior compared with unencumbered individuals. This paper reports on the results of these comparisons.

METHODS

The study was carried out under license on a group of 51 pairs of breeding Kittiwakes on the Isle of May, Firth of Forth, Scotland (56°11'N, 2°33'W) in 1989. Some of the birds had been individually color-banded in previous years, but to aid identification, one member of each pair studied was marked with a small spot of picric acid 3 d before the first observation period (see later). This marking was carried out without handling the bird by attaching a wad of cotton wool soaked in picric acid to the end of a 6 m pole, which was then carefully dabbed somewhere on the bird's head or body (but not tail). Some of the undyed mates were similarly marked with green dye 2 d later. The following day (13 June) a watch was carried out from a blind 20 m away. The nests were scanned systematically every 20 min from dawn-to-dusk (03:00–21:00 GMT, a total of 55 checks). During each check I recorded which birds were present on the nest.

On 14 June, one member of each of 15 of these pairs was caught and fitted with a dummy radio transmitter made of solder wire coated with fiberglass resin and measuring 25 × 10 mm. Ten dummies resembled transmitters with external aerials, and each had a 250 mm horizontal whip antenna protruding from the posterior end. The other five resembled transmitters with internal looped aerials and had no visible antennas. The weights of the external and internal aerial dummies varied from 1.86–3.04 g and from 1.35–2.37 g, respectively. To keep handling time to a minimum, birds given dummies were not weighed, but 26 Kittiwakes with chicks caught on the same day had a mean weight of 347 g (SE = 7), which indicated that the devices constituted approximately 0.4–0.9% of adult body weight. The dummies were attached to the base of the two central tail feathers with white Tesa tape (Wilson and Wilson 1989) and the ends of the tail feathers were dipped in picric acid. The complete procedure took less than 5 min. One member of an additional five pairs was caught, handled and marked in exactly the same way except that no dummy was attached. Kittiwakes carrying dummies are subsequently referred to as "experimental birds" and those caught and released without dummies as "controls." The member of the pair that was present at each of the 31 undisturbed nests at the time of the attachment is referred to as a "normal bird." I did not know the sex of birds in the various categories. Males and females do not show marked differences in attendance patterns or reproductive effort (Coulson and Wooller 1984, Roberts 1988), so it was unlikely that any observed differences between the categories would be caused by different sex ratios.

The three post-attachment dawn-to-dusk watches were carried out 1, 7 and 23 d after the attachment of the dummies (15 June, 21 June and 7 July, respectively). For each of the four watches, six variables were recorded for birds in each of the three treatments: (1) the number of feeding trips (absences from the nest) made by each bird, including trips not completed during the observation period; (2) the duration of complete feeding trips (assuming that departures and arrivals occurred midway between consecutive checks and when a bird made more than one complete trip during a watch, selecting one at random); (3) the total time spent away from the nest; (4) the difference between the total time that the focal (experimental, control or normal) bird and its mate were away from the nest; (5) the number of checks on which both members of a pair were present on the nest; (6) the number of checks that the brood was unattended.

Differences between mean values for normal, experimental and control birds on each date were tested using one-way ANOVA; pair-wise comparisons between treatments were made using least squares differences.

The number and approximate age of the chicks in each nest was recorded during the initial observation period. The subsequent fate of each brood up to the time that the young left the nest was determined from checks made every 5 d.

RESULTS

Initial adjustments by birds.—The 15 experimental birds and the five controls all returned to their nests within 10 min of being handled. Although some birds subsequently lost their chicks, all were still in the colony when observations ceased. One dummy was lost from the bird 4 d after attachment but the remaining 14 remained in place throughout the study. Data from this bird after the dummy was lost are not included in Table 1. Two birds were seen pecking at dummies with external aerials, but in general, Kittiwakes paid little attention to their devices while they were in the colony.

Breeding success.—For the 2 wk after the dummies were attached there were no breeding failures in any of the categories of bird. When attendance behaviour was disrupted (see later), however, four experimental and two normal (but no control), birds lost their chicks. Although the frequency of breeding failure among experimental birds was higher, the difference between experimental and normal individuals was not statistically significant (Fisher Exact $P = 0.18$). Failure did not appear to be related to the weight of the device (mean weight of dummies carried by successful birds = 2.24 g, SE = 0.16, $n = 11$, unsuccessful birds mean = 2.20 g, SE = 0.24, $n = 4$; Mann Whitney $U = 25$, $P > 0.05$.

Attendance patterns.—The behavior of Kittiwakes prior to the attachment of dummies (Table 1) was very similar to that recorded previously (Coulson and Wooller 1984, Galbraith 1983, Pearson 1968). One bird was present on the nest at first light, mates returned soon after dawn, a changeover occurred within 1–2 min of the incoming bird's arrival and

TABLE 1. Behavior of experimental Kittiwakes carrying dummy radio transmitters, control birds that had been caught but not given dummies and normal, undisturbed birds during four all-day watches on the Isle of May in 1989.[a]

	Pre-attachment		Post-attachment					
	−1 d		+1 d		+7 d		+23 d	
	n	Mean ± SE	*n*	Mean ± SE	*n*	Mean ± SE	*n*	Mean ± SE
Number of trips								
Normal	31	2.5 ± 0.1	31	2.2 ± 0.1	31	2.0 ± 0.1	30	1.9 ± 0.1
Experimental	15	2.5 ± 0.3	15	2.5 ± 0.2	14	2.3 ± 0.1	10	2.0 ± 0.2
Control	5	2.8 ± 0.2	5	3.4 ± 0.2	5	2.8 ± 0.2	5	2.0 ± 0
		n.s.		**		**		n.s.
Duration of trip (h)								
Normal	28	4.0 ± 0.4	31	5.0 ± 0.4	29	5.3 ± 0.5		—
Experimental	15	5.2 ± 0.9	15	5.2 ± 0.5	13	3.9 ± 0.8		—
Control	5	3.9 ± 1.0	5	4.4 ± 0.7	5	3.4 ± 0.8		—
		n.s.		n.s.		n.s.		
Total time away (h)								
Normal	31	8.5 ± 0.5	31	8.6 ± 0.4	31	8.8 ± 0.6	30	14.2 ± 0.7
Experimental	15	8.0 ± 1.0	15	8.2 ± 0.5	14	8.6 ± 1.0	10	13.8 ± 1.1
Control	5	6.9 ± 0.9	5	8.5 ± 0.4	5	7.7 ± 0.9	5	9.4 ± 1.8
		n.s.		n.s.		n.s.		*
Within-pair difference in time away (h)								
Normal	31	−0.8 ± 1.1	31	−0.5 ± 0.8	31	0.4 ± 1.1	30	0.6 ± 0.9
Experimental	15	−1.9 ± 2.1	15	−1.5 ± 1.1	14	−0.4 ± 2.0	10	2.0 ± 1.9
Control	5	−4.0 ± 1.8	5	−1.0 ± 0.9	5	−2.5 ± 1.8	5	−3.2 ± 1.6
		n.s.		n.s.		n.s.		n.s.

TABLE 1. Continued.

	Pre-attachment		Post-attachment					
	−1 d		+1 d		+7 d		+23 d	
	n	Mean ± SE	*n*	Mean ± SE	*n*	Mean ± SE	*n*	Mean ± SE
Number of checks pair together								
Normal	31	0.5 ± 0.2	31	0.3 ± 0.1	31	0.7 ± 0.2	30	0.1 ± 0.1
Experimental	15	0.5 ± 0.2	15	0.4 ± 0.2	14	1.3 ± 0.9	10	0 ± 0
Control	5	0.8 ± 0.4	5	0.4 ± 0.2	5	0.4 ± 0.2	5	0.6 ± 0.4
		n.s.		n.s.		n.s.		**
Number of checks brood unattended								
Normal	31	0 ± 0	31	0 ± 0	31	0.2 ± 0.2	30	29.1 ± 3.1
Experimental	15	0 ± 0	15	0 ± 0	14	1.1 ± 1.0	10	24.0 ± 6.4
Control	5	0 ± 0	5	0 ± 0	5	0 ± 0	5	12.8 ± 9.2
		n.s.		n.s.		n.s.		n.s.

[a] Nests were checked every 20 min between 03:00 and 21:00 GMT, a total of 55 checks during each watch. Sample sizes vary because one experimental bird lost its dummy after the +1 d watch, one normal and four experimental birds had failed by the last watch. No complete trip durations were recorded for three and two normal birds during the −1 d and +7 d watches, respectively. Too few complete trips were obtained during the last watch to calculate a meaningful mean duration. Significant values for one-way ANOVA to test for differences between the treatments within each watch are indicated by * ($P < 0.05$), ** ($P < 0.01$) and n.s. ($P > 0.05$).

the original occupier departed immediately. Members of the pair then made alternate trips throughout the remainder of the day. Birds never left their broods unattended (Table 1). For the other variables there was considerable heterogeneity in attendance behavior between birds, reflected by large variances about the mean. Similarly, Coulson and Wooller (1984) found a high degree of inter-pair variation in changeover rates and percentage contributions during incubation. For none of the six attendance variables measured during pre-attachment was there a significant difference between birds subsequently assigned to the normal, experimental and control categories (Table 1; one-way ANOVA; all $P > 0.05$).

Patterns of attendance during watches made 1 and 7 d after dummy attachment were similar to those in the pre-attachment watch, but observations made on 7 July, 23 d after attachment revealed marked changes in parental activity with more than 80% of broods unattended at dawn. Adults arrived sporadically throughout the day, but generally departed again before their mates returned and thus, on average, broods were unattended on 26 of 55 checks (47%). Feeding trips had become so long that too few were completed during the 18-h observation period to provide an estimate of mean trip duration. Neither in this watch nor those made 1 and 7 d after attachment, however, was there any evidence that carrying the dummies affected the birds' attendance patterns. Only four of the 17 comparisons between treatments showed a significant effect and pair-wise tests indicated that in every case, the difference was between the control birds and the other two categories, values for experimental and normal individuals never differed significantly (Table 1). Why the control birds differed was obscure. The tendency for them to make more frequent and shorter trips was also apparent in the watch prior to the dummies being attached, however, so it seemed possible that the effect was produced by high individual variability in attendance behavior coupled with small sample size.

DISCUSSION

Lightweight, tail-mounted devices attached with tape were quick and easy to deploy on Kittiwakes, and 90% remained attached for at least 3 wk. I have subsequently used two small cable ties over the tape to provide an even more secure attachment for functional radio transmitters, and with this method devices have remained in place for at least 6 wk. Apart from a couple of occasions when birds were seen pecking at their dummies, individuals did not appear unduly bothered by their devices while they were at the nest. Wilson et al. (1990) reported that almost all pecking of devices by Adelie Penguins (*Pygoscelis adeliae*) occurred at sea and therefore our colony-based observations could have under recorded any effect. Functional transmitters recovered from Kittiwakes after 1–3 wk deployment in 1990, however, showed no signs of damage (M. P. Harris, pers. comm.; pers. obs.), which implies that the birds had not tried to dislodge them.

The attachment of recording devices has previously been shown to

affect adversely foraging behavior of diving seabirds (Wanless et al. 1988, 1989; Wilson et al. 1986) and small, surface feeders (Massey et al. 1988). Therefore the lack of any major differences in attendance patterns between experimental and normal Kittiwakes in this study was particularly encouraging, and indicated that radiotelemetry and/or the use of other small, electronic devices might be successfully employed to collect data on foraging behavior for this species. Acceptance of this conclusion rests on the assumption that differences that were not statistically significant ($P < 0.05$) were not biologically significant. A previous study of undisturbed birds indicated considerable individual variation in all aspects of Kittiwake attendance behavior (Coulson and Wooller 1984). Therefore with the relatively small sample sizes in my study, only large differences between treatments were likely to be statistically significant. To have increased sample sizes and thus improved the sensitivity of the comparisons, however, would have involved a marked increase in disturbance to the colony which in itself might have affected the results. Gabrielsen and Mehlum (1989) used harnesses to attach much heavier (32 g; 9% of body weight) activity recorders to the backs of five Kittiwakes in Svalbard and found no evidence of any adverse effects during the period that birds were carrying the instruments. They did not compare foraging patterns directly, however, and did not consider the possibility that successful breeding had been achieved due to the mates of the experimental birds compensating for any disruption by working harder, as has been recorded in Guillemots (*Uria aalge*) and Starlings (*Sturnus vulgaris*) (Wanless et al. 1988, Wright and Cuthill 1989). Thus the lack of any effect was not demonstrated unequivocally.

The impact of any device is also likely to be influenced by the conditions prevailing at the time. Gabrielsen and Mehlum (1989) were confident that conditions were favorable during their study, whereas at least toward the end of the season on the Isle of May, Kittiwakes appeared to be stressed to the extent that they left their chicks unattended for long periods (Wanless and Harris 1989). The absence of any significant differences between experimental and normal birds recorded here indicated that functional transmitters of this design would have provided data which could have been used to investigate foraging behavior under sub-optimal feeding conditions.

ACKNOWLEDGMENTS

I am grateful to M. P. Harris, V. Birt-Friesen, K. Ferry, S. Holloway, R. Proctor and S. Russell for help in the field and the Nature Conservancy Council, South-east Region, Scotland for permission to work on the Isle of May. I thank S. Buckland for statistical advice and P. Monaghan and M. P. Harris for critically reading the manuscript. Part of this work was carried out under contract with the Department of the Environment to the Applied Ornithology Unit, University of Glasgow and is published with the Department's agreement.

LITERATURE CITED

BOAG, D. A. 1972. Effect of radio packages on behaviour of captive red grouse. J. Wildl. Manage. 36:511–518.

COULSON, J. C., AND R. D. WOOLLER. 1984. Incubation under natural conditions in the Kittiwake gull, *Rissa tridactyla*. Anim. Behav. 32:1204–1215.

GABRIELSEN, G. W., AND F. MEHLUM. 1989. Kittiwake activity monitored by telemetry. Pp. 421–429, *in* C. J. Amlaner, Jr., ed. Biotelemetry X: Proceedings of the Tenth International Symposium on Biotelemetry, Fayetteville, Arkansas.

GALBRAITH, H. 1983. The diet and feeding ecology of breeding Kittiwakes *Rissa tridactyla*. Bird Study 30:109–120.

MASSEY, B. W., K. KEANE, AND C. BOARDMAN. 1988. Adverse effects of radio transmitters on the behavior of nesting least terns. Condor 90:945–947.

PEARSON, T. H. 1968. The feeding biology of sea-bird species breeding on the Farne Islands, Northumberland. J. Anim. Ecol. 37:521–552.

PERRY, M. C. 1981. Abnormal behaviour of Canvas-backs equipped with radio transmitters. J. Wildl. Manage. 45:786–789.

ROBERTS, B. D. 1988. The behavioral ecology of breeding Black-legged Kittiwakes (*Rissa tridactyla*) on Middleton Island, Alaska. M.A. thesis, Univ. California, Santa Barbara, California.

WANLESS, S., AND M. P. HARRIS. 1989. Kittiwake attendance patterns during chick rearing on the Isle of May. Scott. Birds 15:156–161.

———, ———, AND J. A. MORRIS. 1988. The effect of radio transmitters on the behavior of Common Murres and Razorbills during chick rearing. Condor 90:816–823.

———, ———, AND ———. 1989. Behavior of alcids with tail-mounted radio transmitters. Colonial Waterbirds 12:158–163.

WILSON, R. P., AND M. P. T. J. WILSON. 1989. Tape: a package attachment technique for penguins. Wildl. Soc. Bull. 17:77–79.

———, W. S. GRANT, AND D. C. DUFFY. 1986. Recording devices on free-ranging marine animals: does measurement affect foraging performance? Ecology 67:1091–1093.

———, H. J. SPAIRANI, N. R. CORIA, B. M. CULIK, AND D. ADELUNG. 1990. Packages for attachment to seabirds: what color do adelie penguines dislike least? J. Wildl. Manage. 54:447–451.

WRIGHT, J., AND I. CUTHILL. 1989. Manipulation of sex differences in parental care. Behav. Ecol. Sociobiol. 25:171–181.

Received 19 Feb. 1991; accepted 10 Aug. 1991.

THE BIRDS OF NORTH AMERICA PROJECT

The Birds of North America Project invites inquiries from ornithologists interested in producing thorough accounts of the biology of avian species breeding in the USA and Canada. Modern authoritative accounts are needed for sound conservation planning and management of game and nongame species, as well as to catalyze further research. Each account, 30–40 double-spaced typewritten pages in length, will be available electronically and as an individuals printed fascicle fitted to an attractive loose-leaf binder, ensuring rapid, economical distribution and accessibility without the rigid sequence constraints and production delays of book publication. Contributors, amateur and professional alike, can expect a modest administrative subsidy, a discount on the series, and recognition as an authority on their species. If you would like to participate, call or write soon; species are being assigned quickly. Alan F. Poole, Managing Director, Birds of N. America/ANSP, 1900 Franklin Pkwy, Philadelphia, PA 19103-1195.