Effects of fitting dummy satellite transmitters to geese

A pilot project using radio telemetry on wintering Greenland White-fronted geese

NERI Technical report, no. 169

Christian Glahder, *Arctic Environment*
Anthony D. Fox, *Coastal Zone Ecology*
Alyn J. Walsh, *Irish National Parks & Wildlife Service*

Ministry of Environment and Energy
National Environmental Research Institute
September 1996

Data sheet

Title:	Effects of fitting dummy satellite transmitters to geese
Subtitle:	A pilot project using radio telemetry on wintering Greenland White-fronted geese
Authors:	Christian Glahder[1], Anthony D. Fox[2] and Alyn Walsh[3]
Departments:	[1]Arctic Environment (NERI), [2]Coastal Zone Ecology (NERI) and [3]Irish National Parks & Wildlife Service
Serial title and number:	NERI Technical Report, no. 169
Publisher:	Ministry of Environment and Energy National Environmental Research Institute ©
Year of publication:	September 1996
Abstract:	Dummy satellite transmitters were attached with two harness types to 12 free-flying Greenland White-fronted geese. After three month the knicker elastic harness proved to be the most efficient and the behaviour of the geese appeared normal.
Please quote:	Glahder, C., Fox, A. D. & Walsh, A. J. (1996). Effects of fitting dummy satellite transmitters to geese. A pilot project using radio telemetry on wintering Greenland White-fronted geese. National Environmental Research Institute, Denmark. 38 pp. - NERI Technical Report, no. 169
	Reproduction permitted only when quoting is evident.
Keywords:	Greenland White-fronted Goose, *Anser albifrons flavirostris*, satellite, telemetry, dummy, harness, behaviour
ISBN:	87-7772-280-9
ISSN:	0905-815X
Printed by:	Scanprint as
Paper quality:	Cyclus Print 100g
Impression:	250
Number of pages:	38
Price:	DKK 40, - (incl. 25% VAT, excl. freight)
For sale at:	National Environmental Research Institute P. O. box 358, Frederiksborgvej 399 DK-4000 Roskilde, Denmark Tel: +45 46 30 11 00 Fax: +45 46 30 12 14 or Miljøbutikken Information & Books Læderstræde 1 1201 Copenhagen K Tel: +45 33 92 76 92 (Info) Tel: +45 33 37 92 92 (Books)

Contents

Preface

This study is a joint project between two departments of NERI, Arctic Environment and Coastal Zone Ecology, and the Irish National Parks & Wildlife Service.

The project was partly funded by the Commission for Scientific research in Greenland.

We wish to thank the following for their valuable support:

Alice and Oran Walsh, members of the cannon-netting team Paddy O´Sullivan and Chris Wilson, general operative Nicky Walsh and O´Daris Ireland Ltd for Neoprene supply.

Summary

Twelve Greenland White-fronted Geese were fitted with dummy satellite transmitters containing radiotags on the wintering grounds at Wexford Slobs in Southeast Ireland in January 1996. From mid January until late April, when the geese left for Iceland and Greenland, the birds were tracked and studied. In addition, two captive Greylag Geese were fitted with dummies and observed.

The ultimate objective of the project is to fit satellite transmitters to Greenland White-fronted Geese to study spring migration strategies and to identify spring staging areas in Iceland and Greenland. The part of the study reported here was a pilot study aimed at testing effects of different transmitter weights and different types of harnesses on the behaviour of the geese.

The pilot project tested two dummy weights, a "light" pack (average 38.0 g) and a "heavy" one (54.1 g). No difference in behaviour was observed between these two groups.

Two harness types were tested, one of knicker elastic fitted on seven White-fronted Geese and two Greylag Geese, and one of Neoprene fitted on five geese. One of the dummies attached with Neoprene harness was lost after four to six days, because the goose, an adult male, bit through the Neoprene tape, and three had slipped to the flank one to two months after attachment. Eight of the knicker elastic dummies were well attached after more than three months, and only one had slipped to the flank after at least two months. One of the geese attached with a dummy satellite transmitter has been reported from Iceland in May.

The geese preened the back and the dummy more than controls preened their back during the first days after attachment. Despite this, the time spent preening the back and dummy was less than 3% of the total time budget. After the first week, geese had grown accustomed to the attached dummy.

Behaviours such as site fidelity, strong family flock association, flying to roost, feeding and flying ability were apparently not affected by attachment of dummies.

Knicker elastic proved to be the best harness type of the two tested, and the findings suggest minimal effects of attaching transmitters below 55 g in weight (c. 2% of the body weight of the geese).

Resumé

På den grønlandske blisgås´ vinterkvarter i Wexford Slobs i det sydøstlige Irland fik 12 gæs i januar 1996 påsat satellitsender attrapper. Attrapperne blev sat på ryggen og indeholdt en lille radiosender. Fra midten af januar til slutningen af april blev gæssene pejlet og observeret indtil deres afrejse til Vestgrønland. Desuden fik 2 grågæs i fangenskab påsat attrapper og deres adfærd blev studeret.

Pilotprojektet der er beskrevet i denne rapport har til formål at vurdere gæssenes adfærd i forhold til forskellige vægte af satellitsendere og forskellige slags seletøj. Formålet med det egentlige satellitprojekt er at påsætte satellitsendere på grønlandske blisgæs for at studere forhold under forårstrækket, som f.eks. trækruter, - hastighed og - tidspunkter, samt at udpege forårsrastepladser i Island og på Grønland.

Pilotprojektet afprøvede 2 vægte af satellitsendere, en "let" (gennemsnit 38,0 g) og en "tung" (54,1 g), svarende til hvad der pt. findes på markedet af lettere sendere. Der kunne ikke påvises forskellig adfærd i de to gruper.

Desuden blev der afprøvet to typer seletøj, én type lavet af 7 mm bred bukseelastik og én lavet af 6 mm brede Neoprene (våddragt materiale) bånd. Af de 9 gæs (7 blisgæs og 2 grågæs) der fik påsat attrappen med bukseelastik, sad attrappen fint på 8 af gæssene efter mere end 3 måneder, mens den på den sidste gås var gledet ned på siden efter ca. 2 måneder. Af de 5 gæs med Neoprene påhæftning, sad kun én attrap på ryggen efter 3 måneder, mens én blev bidt af efter 4-6 dage og 3 var gledet ned på siden efter 1-2 måneder. En af gæssene med påsat attrap er blevet rapporteret fra Island i maj måned.

Gæssene pudsede ryggen inklusiv attrappen mere end kontrolgæssene pudsede deres ryg indenfor den første uge efter påsætning af attrappen. Derefter havde gæssene vænnet sig til attrappen. Den øgede pudsning af ryg og attrap udgjorde dog mindre end 3% af gæssenes samlede adfærdsbudget.

Andre typer af adfærd som f.eks. fødesøgning, flyvning, tilknytning til bestemte fødeområder og til familiemedlemmer, samt flyvning til overnatning adskilte sig ikke fra den normale adfærd.

Anvendelse af bukseelastik til fasthæftning af satellitsendere var klart at foretrække frem for Neoprene fasthæftning, og satellitsendere med en vægt under 55 g, svarende til ca. 2% af gæssenes kropsvægt, synes kun at påvirke gæssene i mindre omfang.

1 Introduction

Population

The Greenland White-fronted Goose *Anser albifrons flavirostris* is a population breeding exclusively in West Greenland. It winters in Ireland, Scotland and Wales, and uses Iceland as a stop-over site on spring and autumn migration (Salomonsen 1950, 1967). After a decline to a population size of 14,300-16,600 birds in the late 1970s (Ruttledge & Ogilvie 1979) protective legislation in the early 1980s has seen an increase in the population to its current level of about 30,000 (Fox et al. 1994).

Protection

Many of the major haunts on the wintering areas are protected under Irish and British legislation, and in Greenland approximately one quarter of the population is contained within the Ramsar wetland sites, whereas in Iceland no sites have any statutory protection (Greenland Home Rule 1990, Stroud 1992, Fox et al. 1994). For the time being there is no hunting of whitefronts in Ireland and Britain, while some limited legal hunting takes place in Greenland from 16 August to 30 April (Greenland Home Rule 1995). In Iceland whitefronts are legal quarry in autumn, and together with illegal spring hunting as many as 2,500 geese are considered shot per annum (Stroud 1992, Fox et al. 1994, A. Sigfússon in litt.).

Sensitive areas

Even though the population enjoys a relative high protection throughout the flyway, it is important to identify and designate specific sensitive areas and periods, since the population size on a world scale is small, has a restricted geographic distribution and low productivity (Fox et al. 1983). Such areas are spring staging areas, breeding and moulting grounds in Greenland and spring- and autumn staging areas in Iceland. At these sites many geese congregate in a limited time period to build up condition after or prior to migration.

Spring migration

It has been suggested by Fox & Ridgill (1985), that spring migration of the Greenland White-fronted Goose is rapid with only few short stops in south-western Iceland (Francis & Fox 1987) and Ammassalik (Salomonsen 1967, Stroud & Fox 1981) before the Ice-cap is crossed. A migration path from Scotland to the west coast of Greenland (Salomonsen 1967) has not yet been confirmed. When the geese reach West Greenland they must rely on pre-breeding feeding to supplement reserves in preparation for egg-laying (Fox & Madsen 1981, Fox & Stroud 1988).

Mineral exploration

In response to increasing mineral exploration in Greenland, breeding and moulting grounds for the Greenland White-fronted Goose have been designated as "areas important to wildlife" (MRA 1996a), and with the intensification in mineral exploration activities in the last few years (MRA 1996b) combined with an extension of the exploration period over the year, protection of spring staging areas is now considered important as well.

Satellite transmitters

Satellite transmitters attached to Greenland whitefronts prior to spring migration can give important information on the course and duration of spring migration from the wintering grounds in Ireland and Scotland to Iceland and further to West Greenland. Also, spring staging areas can be identified in Iceland and Greenland, and information gathered on the length of the stay and movements between areas prior to ultimate migration and dispersion onto breeding grounds.

This pilot project

This report describes a pilot project where dummy satellite transmitters were attached to wintering Greenland White-fronted Geese in Ireland. The objectives of the pilot project were to test the effects of different transmitter weights and different types of harnesses on the behaviour of geese.

Given satisfactory results from the pilot project, i.e. that the behaviour of the geese with dummies are not significantly different from geese without, and that the dummies are still attached to the geese after a 3-4 month period, the next step would be to equip a number of geese with satellite transmitters in future winters.

Work in Ireland

The first part of the study took place in Ireland from 3 to 24 January 1996. During this period dummy satellite transmitters were fitted to two captive Greylag Geese and twelve free-flying Greenland White-fronted Geese; the latter also contained radio transmitters. Intensive observations of behaviour of birds with and without transmitters were carried out to assess the effects of the harnesses and transmitters on the birds so fitted.

The second part also took place in Ireland, from 25 January to 21 April 1996. During this period the Greenland White-fronted Geese were tracked one to two times each week to check feeding sites, abdominal scores and the attachment of the dummies. The Greylags were also followed in their pen during this period.

Conclusions

Behaviours such as association with other family member, site fidelity, flying to roost, flying ability and feeding did not apparently differ from normal. The geese preened the back and dummy more than controls preened their back for up to one week after attachment. Knicker elastic proved to be the best harness type of the two types tested (Neoprene tape was the other type), and the findings suggests minimal effects of attaching transmitters below 55 g in weight (approximately 2% of the body weight of the geese).

2. Methods

2.1 Transmitters and harnesses

Previous work

In the last few years, satellite transmitters have been fitted to several different bird species such as Bald Eagle *Haliaetus leucocephalus*, Brent Goose *Branta bernicla*, Emperor Penguin *Aptenodytes forsteri*, Fulmar *Fulmarus glacialis*, Golden Eagle *Aquila chrysaetus*, Griffon Vulture *Gyps fulvus*, Gyr Falcon *Falco rusticolus*, Houbara Bustard *Chlamydotis undulata macqueeni*, Lesser White-fronted Goose *Anser erythropus*, Mute Swan *Cygnus olor*, Peregrine Falcon *Falco peregrinus*, Spectacled Eider *Somateria fischeri*, Wandering Albatross *Diomeda exulans*, White-fronted Goose *Anser albifrons* , White Stork *Ciconia ciconia* and Whooper Swan *Cygnus cygnus* (Jouventin & Weimerskirch 1990, Nowak & Berthold 1991, Ancel et al. 1992, French & Goriup 1992, Griesinger et al. 1992, Howey 1992, Weimerskirch et al. 1993, Falk & Møller 1995, Gudmundsson et al. 1995, Petersen et al. 1995).

Weights of the transmitters

The first satellite transmitters applied to birds were fitted on Bald Eagle in 1984 (Howey 1992), Whooper and Mute swans in the late 1980s (Priede 1988) and on Wandering Albatrosses in January 1989 (Jouventin & Weimerskirch 1990). The weights of the Platform Transmitter Terminals (PTTs) were between 145 and 180 grams. Today, the weights of such devices range between 5.8 and 75 grams, depending on product, type, housing, battery power and other sensors. A selection of devices currently available are listed in Appendix 7.1. For practical purposes, the most realistic PTTs for the time being are made by Microwave and Toyocom weighing between 25 and 54 grams. The sizes available vary between 62x18x16 mm, 41x33x19mm and 70x34x25 mm.

Attachment types

The most common method used to fit satellite transmitters on the birds has been with some form of harness. This is most often made of Teflon-coated ribbon or wire, which is strong and non-absorbent (Falk & Møller 1995). Neoprene tape - a material used in wet-suits - has been used on Whooper Swans by Pennycuick and Hesketh (pers. comm.). In contrast to Teflon, Neoprene is elastic. The transmitters are sometimes additionally secured with glue or with glue alone (Gudmundsson et al. 1995). One of the first satellite transmitters was fitted on an albatross with a harness made of 15 mm flexible leather and elastic strips. Most recently implanted satellite transmitters have been used in studies of the Spectacled Eider (Petersen et al. 1995).

Knicker elastic harness

Small radio transmitters or tags have often simply been glued to the feathers and on skin on the back or fixed to the tail by ratchet strips (Giroux et al 1990). Yet, in Ireland radio transmitters have

been fitted on Woodcocks *Scolopax rusticola* with a knicker elastic harness yielding good results (H. J. Wilson, pers. comm.).

Impact studies

Few studies have been made on the impacts of harnesses and transmitters. Two Wandering Albatrosses fitted with dummies (about 2 % of the body weight) had gained 7 and 15 % of their departure weights on their return from foraging trips. These values are typical of weight gains at sea (Jouventin & Weimerskirch 1990).

Falk & Møller (1995) reported that two out of five transmitters fell off Fulmars shortly after attachment, and all Fulmars deserted their nests. Flight ability did not seem to be significantly hindered, and three recaptured birds seemed in good health. The breeding failures are thought to be a combined effect of handling, PTTs and harnesses.

French & Goriup (1992) studied the condition and behaviour of three captive Houbara Bustards fitted with dummies weighing 10-14% of their body weights. Over a period of 55 days the two birds with the heaviest dummies lost 4 and 9% of their body weight compared to only small changes in controls. The general behaviour of the test birds were not significantly different from controls, but they spent more time preening the dummy and the harness. No physical injury from the dummy or the harness was found.

In Scotland a Mute Swan *Cygnus olor* with a 145 grams transmitter fitted with a Teflon harness showed normal social behaviour with other birds and was observed in flight, where it was unaffected by the presence of the transmitter (Priede 1988).

Two Whooper Swans were fitted in Iceland with satellite transmitters using Neoprene harnesses. After about 200 days they were recaught in Britain in February 1995. The condition of the two birds was good, no mites or lice were observed on the swans and only a very minor irritation under the Neoprene was seen on one of the birds. The Neoprene had retained elasticity and tension. In February two males were caught, and observations over a month showed that the swans paid no special attention to the transmitters or harness (Pennycuick and Hesketh, pers. comm.).

In a study on adult female Brent geese *Branta bernicla nigricans* attached with radio transmitters Ward & Flint (1995) concluded, that arrival and departure schedules at a fall staging area did not differ from the entire population; return rates to the breeding colony were significantly lower compared to other neck collared birds without transmitters, and most radio tagged females were unpaired.

2.2 Dummy satellite transmitter production

Two dummy weights

As a starting point in our production of dummy satellite transmitters we chose the PTTs made by Microwave and Toyocom weighing between 25 and 54 grams as being the most likely and practical to be used in future study. The two lightest ones were Toyocom 2050 weighing 25 grams and Microwave 100 of 30 grams. If we wanted to add a waterproof housing and to measure altitude above sea level with a pressure sensor, this would bring up the weight of the Toyocom 2050 II transmitters to 43 and 53.5 grams respectively. At this early stage of the satellite project we have not chosen any product, housing or pressure sensor. Therefore we decided to test two dummy types weighing about 25 grams and 50 grams. We did not chose the 5.8 gram PTT from Satellite Image Systems in South Africa because of various uncertainties relating to its use and procurement for the time being.

Size of dummies

We decided to use the size of the Microwave PTT-100 as a model for the satellite dummies, mainly because of the size of the TW-2 radio transmitters from Biotrack (36x16x16 mm) which needed to be housed within the dummy pack. Our dummies ended up at a size approximately 65x16x25 mm. The dummies were made of blocks of epoxy resin with the radio transmitter embedded within them. Lead shot pellets were added into the resin to produce the 50 gram dummies.

Actual weights

The actual weight of the "light" dummies turned out to be on average 38.0 g, SD±2.3 g (n=6) because the weight of the radio transmitter alone was 16 grams. The actual weight of the "heavy" ones was on average 54.1 g, SD±2.2 g (n=6).

Two holes were drilled in front of the dummy and at the back above the antenna, and a 50 mm long plastic tube, diameter 4 mm, was glued into each hole. Harness loops were put through the tubes, and the satellite dummies were ready for the geese.

Harness types tested

We decided to test knicker elastic and Neoprene as harness materials, because they both were strong and elastic, but at the same time had the ability to fall off the birds after an appropriate period. We rejected the idea of a wire-Teflon harness, mainly because of its lack of elasticity. The harness would need to remain in place during the period of rapid fat accumulation and subsequent use prior to and during the migration period. Hence it is important that the harness is not rigid to become too loose or to tight. If it is too loose it could easily fall off e.g. when the bird is flying, and if it is too tight it could injure the skin. A flexible harness, on the other hand, would adjust to the physiological changes of the body.

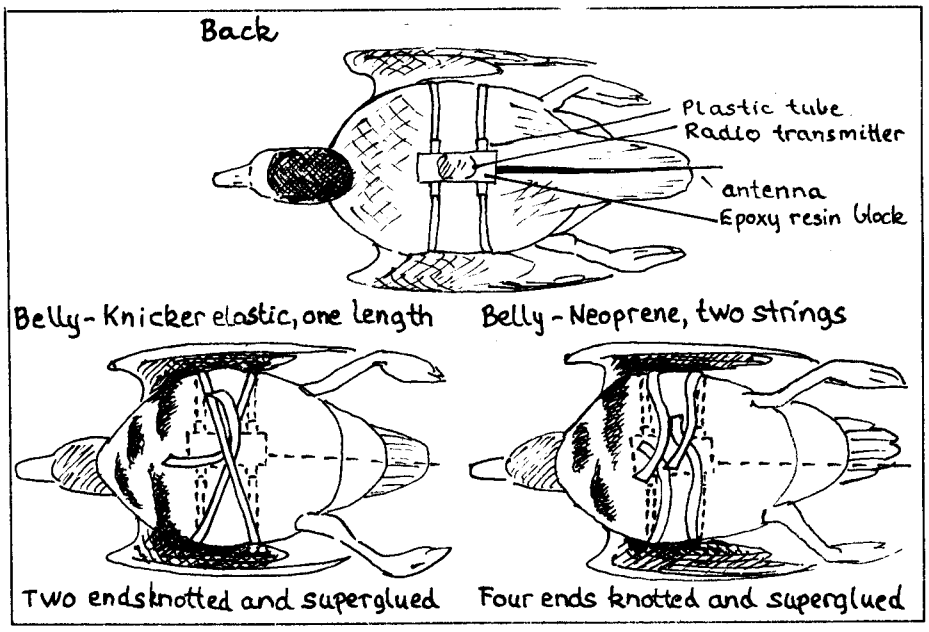

Figure 1. Diagrams showing how dummies were attached with knicker elastic (left) and Neoprene (right) harnesses, respectively.

Using knicker elastic, one length of elastic was looped twice around the belly of the bird and the two ends knotted and secured by Superglue under the body. The elastic used was 7 mm and weighed 7.0 gram per metre; a little less then one meter was used for each harness. Two strings of Neoprene were used and all four ends joint in one knot and superglued. The Neoprene was 6 mm wide and weighed 5.5 grams per metre. The harness went round the body just forward of the legs. The dummy therefore sat on the middle of the back, which allowed the goose to roost with the head on the back without being hampered by the dummy (cf. dummies on the Greylag Geese, chapter 2.4).

2.3 Catching the geese

The first catch

Six days before the actual catch, on 7 January, the catching area was prepared. Straw was spread over an area of 20x30 metres in the grass field and on top of this sugar beet was cut into pieces. The area was left and after two to three days one or two family flocks began to feed on the area. On the evening of 12 January, after the geese gone to roost, a cannon net was prepared and the six cannons buried in the field. The next day before dawn we were ready in an old barn some 300 metres from the catching area. A family of 10 geese arrived at the site, and nine were successfully caught a few hours later.

Dummies fitted on the geese

All geese were ringed with a darvic ring, white leg ring with three characters and an orange neck collar with the same three characters. The geese were weighed, sexed and aged, and measurements were taken of tarsus, wing and head. Six of the

birds were fitted with a dummy satellite transmitter; all harnesses were made of knicker elastic (refer to Appendix 7.2). The "light" dummies (average weight 37.5 g, SD±2.6 g, n=3) were fitted on three geese with an average weight of 2,550 g, SD±150 g. Hence, the weight of an average "light" dummy was 1.5% of the average goose. The "heavy" dummies (average weight of 52.9 g, SD±1.4 g, n=4) were fitted on three geese with an average weight of 2,617 g, SD±76 g. Here the weight of the average "heavy" dummy was 2.0% of the average goose.

The second catch

The catching area was left and three days later 20 to 30 geese were observed on the site. A second catch took place on 19 January when 19 birds were caught. Again six birds were fitted with dummy satellite transmitters, five with a Neoprene harness and one with knicker elastic (refer to Appendix 7.2). The "light" dummies (average weight 38.5 g, SD±2.3 g, n=3) were fitted on three geese (average 2,317 g, SD±161 g). The average dummy was 1.7 % of the weight of the average goose. The "heavy" dummies (average 56.5 g, SD±0.7 g) were fitted on two geese (average 2,650 g, SD±354 g). The average weight of the dummy represented 2.1 % of the weight of the average goose.

Transmitter signals

Before the dummies were attached to the geese the battery of the radio transmitter was connected, sealed with epoxy glue and checked. The battery was a TW-2, ½AA, 3.5 volt with a life of 5-7 months. The length of the plastic coated antenna was 28 cm, projecting out of the dummies down the back of the geese. The signal range was 3-6 km ground-to-ground and 6-12 km above ground. The 12 transmitters send signals in frequency intervals between 151,003-151,152 MHz. The actual frequencies turned out to be 3-7 MHz lower when we tracked the geese on the Wexford Slobs using a M-57 Mariner Radar receiver with a standard 3-element Yagi antenna.

After handling, the geese were placed in a tent for at least 20 minutes to calm down. The geese were then released together and in both cases they left in one flock.

2.4 Behavioural studies

Tracking the geese

After the geese were released, they were tracked on the Wexford Slobs and at their roost site on the sand banks south of Raven Point. The positions of the geese in the fields or on the sand banks were plotted onto maps (Figures 3 and 4), and the abdominal index (Owen 1981) was scored.

Video records

Where possible, behavioural studies were carried out. From the Landrover the geese were filmed with a video camera with 8x magnification. A second observer read the neck collars using a 30-60x telescope, repeatedly informing the video camera sound track of the neck collar characters and the position of the geese relative

to each other. Afterwards behavioural studies were made from the films.

Video records of knicker elastic geese

Geese with a harness of knicker elastic were filmed on 15 (two periods) and 20 January, i.e. 2 and 7 days after their attachment. In total about 50 minutes were taken. On both days the geese were filmed in the afternoon. The behavioural study included five (F6L, F7L, F8L, F0L and F1N) out of the six geese attached with a dummy, and two (F4L and F5L) out of the three geese without a dummy, i.e. controls.

Video records of Neoprene geese

Geese with a Neoprene harness plus one with a knicker elastic harness were filmed over two periods late in the morning on 22 January, i.e. 3 days after the catch. The total tape length was about 42 minutes. The behavioural study only included group I (see page 23) with two (F4N and F4S) out of three geese attached with a dummy, and five (F2N, F6S, F7S, F8S and F9S) out of six geese without a dummy.

Activity budgets for the knicker elastic geese studied on 15 January and for Neoprene geese studied on 22 January were pooled to examine differences between dummy geese and controls shortly after the handling (Table 2). The differences were tested with paired t-tests on each behaviour after data were normalised with an arcsine transformation.

Captive Greylag Geese

The behaviour of the two Greylag geese in the Wexford Wildfowl Reserve pen, fitted with wooden dummy satellite transmitters with knicker elastic, was studied from the Wexford Wildfowl Reserve tower. The size of these dummies were about the same as those fitted on the Greenland White-fronted Geese, i.e. 65x16x25 mm. The weights were approximately 25 g and the antenna was the length of the radio transmitters, but made of 2 mm wire uncoated with plastic. The harness was either placed behind the wings and forward of the legs (goose HA), or on both sides of the wings (HI). In the latter way the dummy was placed on the back just behind the neck which made it difficult for the goose to place the head at roost. Behavioural data was collected in periods of 10 minutes shifting between one of the dummy-fitted birds and a randomly chosen Greylag Goose from the same flock of 25 birds.

Studies on HA

On 6 January, 24 hours after attachment, HA was observed from 2.26 p.m. for a continuous period of 6,140 seconds. No controls were observed. The weather was overcast, with rain and windspeeds of 18-20 m/sec. On 8 January, HA was observed again from 2.30 p.m. for five periods of 10 minutes alternating with randomly chosen controls for six periods of 10 minutes. The weather was almost as bad as on 6 January with rain and windspeeds of 11-17 m/sec.

Studies on HI

The other Greylag Goose fitted with a dummy satellite transmitter, HI, was observed on 7 and 8 January. On both days it was observed together with a control, each for 10 minute periods.

On 7 January, HI was observed from 1.22 p.m. for six periods of 10 minutes, the controls for five periods of 10 minutes. The weather was fine with few clouds and wind speeds of c. 15 m/sec. On 8 January HI and the controls were observed from 10.30 a.m. in alternating 10 minutes intervals, each for 60 minutes.

Activity states

The following different behaviours of Greenland White-fronted Geese and Greylag Geese were noted in 5 seconds intervals: sit, stand, sleep, alert, walk, swim, feed, drink, bathe, aggressive and preen. Preening was divided into preening of: neck, breast, flanks, belly, under tail, upper tail, back, back plus antenna, under wing, upper wing, wing stretch, leg ring, foot and bill in water. The observations of the Greylag Geese were done with a telescope (30x) or binoculars (10x40) and read to a Dictaphone. The end of the 10 minutes period was marked with a "bip" from a stop watch.

Photo 1. The dummy satellite transmitter is fitted on F6L, a juvenile male, with a knicker elastic harness. This Whitefront is from the first family group caught on 13 January.

3. Results

The results from this pilot project are presented in two ways. The first concerns how the geese reacted to the presence of the dummy on their back, the other involves retention times of pack and harness on individual geese.

3.1 Behaviour of captive Greylag Geese

From 6 to 8 January, the behaviour of the two Greylag Geese together with control Greylags were studied from the observation tower.

Behaviour of HA

On 6 January, 24 hours after attachment, HA preened for about 1/5 of the total observation period, and it preened the dummy for 3.4 % of the time (Table 1 and Fig. 2). It was especially "preening" the antenna, which was bitten 32 times. Interestingly, HA was biting the leg ring for 2.7 % of the time, almost the same as "preening" the dummy. "Preening" the two foreign bodies consumed more time than preening of other parts.

Two days later HA only preened for 0.8 % of the 3,000 seconds, despite sleeping for less time than on 6 January and sitting and standing for over half the period. It did not preen the back, in contrast to the controls.

Behaviour of HI

Two days after attachment HI preened less than 1/5 of the total period. Only 0.4 % of the time (see Table 1 and Fig. 2) did it preen the dummy transmitter and it bit the antenna three times. HI bit its leg ring 1.0 % of the time. The controls preened for ¼ of the total period and preened the back for the same amount of time as HI, i.e. 0.7 % of the time.

On the following day, on 8 January, HI only preened for 6.5 % of the time, with 2.2 % of the time being used for preening the dummy and biting at the antenna (16 times). HI bit the leg ring less, 0.4 %. The controls only preened for 1.5 % of the time, and the back was not preened.

Table 1. Activity budgets of two captive Greylag Geese fitted with dummy satellite transmitters (HA and HI) and randomly chosen control Greylag Geese. Behaviour is separated in "preening" and "other". The dummies were attached on 5 January 1996 and the geese were observed from the 6 to the 8 January.

	Greylag Goose % of obs. time						
Behaviour	HA (6/1)	HA (8/1)	HA- control (8/1)	HI (7/1)	HI-control (7/1)	HI (8/1)	HI-control (8/1)
Preen dummy	3.4	0	-	0.4	-	2.2	-
Preen back	2.6	0	0.7	0.4	0.7	1.1	0
Preen leg ring	2.7	0	-	1.0	-	0.4	-
Preen rest	12.4	0.8	1.0	15.0	25.5	2.8	1.5
behaviour, other	78.9	99.2	98.3	83.2	73.8	93.5	98.5
observation time seconds	6,140	3,000	3,000	3,600	2,975	3,600	3,600

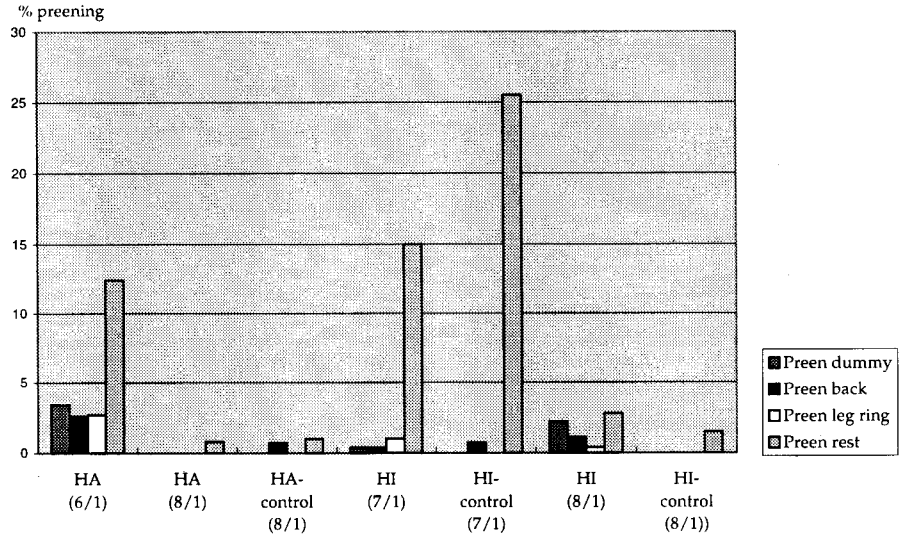

Figure 2. Percent preening of the two captive Greylag Geese fitted with dummy satellite transmitters (HA and HI) compared to control Greylag Geese. The Greylags were fitted with dummies on 5 January 1996, and observed from the 6 to the 8 January.

Preening the dummy for 2% of total time

The two marked birds, HA and HI, show different trends in their behaviour to the attached dummies. After the second day HA paid hardly attention to the dummy transmitter, whereas HI preened the dummy more on the second day. Yet, three days after the dummies were attached to the birds, they used less than 2.5 % of their time to peck the dummy. The leg ring was pecked almost as much as the dummy during these three days. The dummies were still attached to both Greylags late April.

3.2 Behaviour of free-flying Greenland White-fronted Goose

The behaviour of the Greenland White-fronted Geese fitted with dummy satellite transmitters was studied from video tapes two, three and seven days after the attachment.

Geese attached with dummy satellite transmitters preened significantly more than controls two to three days after the attachment ("preen all" in Table 2). The back and neck were preened significantly more by geese attached with a dummy than by controls, and preening the flanks was almost significantly different from controls (P=0.052, Table 2). The dummy birds preened their back for 2.4% of the time, which is comparable to the behaviour of the Greylag Geese attached with dummy satellite transmitters.

Table 2. Activity budgets of Greenland White-fronted Geese attached with dummy satellite transmitters ("Dummies") and controls from the same family group. Mean activity budgets are calculated from behavioural studies of two family groups performed 2 and 3 days after the catch. "Preening rest" includes: preening breast and upper wing, wing stretch and shake feathers.

Behaviour	Dummies mean (%) (SE)	Controls mean (%) (SE)	P
Preen back	2.4 (0.6)	0.6 (0.4)	**0.007**
Preen flank	3.9 (1.3)	1.1 (0.8)	0.052
Preen neck	10.9 (3.5)	3.3 (1.1)	**0.038**
Preen belly	0.2 (0.1)	0.0 (0.0)	0.137
Preen rest	6.1 (1.5)	3.5 (1.7)	0.118
Preen all	23.4 (6.5)	8.6 (3.0)	**0.030**
Sit & stand	22.1 (4.9)	22.1 (6.4)	0.731
Sleep	10.4 (5.8)	11.0 (6.9)	0.855
Walk	3.8 (0.8)	5.9 (1.5)	0.638
Feed	38.9 (6.1)	50.3 (6.6)	0.256
Drink	1.3 (0.7)	2.1 (1.2)	0.840
Obs. time (bird mins)	142.3	166.8	
Number of birds (n)	11	13	

The differences were tested with a t-test on each behaviour after the data were normalised with an arcsine transformation. The F-test on variances showed no differences.

The material shows considerable individual differences, with dummy birds preening their back for 0 to 5.9% of the time, the flanks for 0 to 12.2% and the neck for 0.5 to 39.2%; corresponding differences in controls were 0 - 5.2%, 0 - 10.9% and 0.8 - 11.7%.

On 20 January, seven days after the handling of the knicker elastic geese, dummy birds and controls showed almost exactly the same behaviour, and none of the groups were observed preening (Appendix 7.3).

3.3. Tracking of Greenland White-fronted Geese on the Slobs

Tracking the geese

From the day the geese were caught, i.e. on 13 and on 19 January, they were tracked on the North Slobs every day until the 22. January. From this day and until 21 April they were tracked for one or two days every week. Some evenings they were tracked on their roost site as well. Details on each bird are described in Appendix 7.2. The signal from each radio transmitter was checked and sightings of the birds were plotted on to maps (see Figures 3 and 4). The majority of geese on the Wexford Slobs migrated north between 27 and 29 April.

Knicker elastic harness

All the seven knicker elastic birds, F6L, F7L, F8L, F9L, F0L, F1N and F4S had their dummy satellite transmitter attached on 21 April after 99 days. The dummies were well attached on the back of six of the geese; on the seventh goose the dummy was on the back for 72-86 days and on the flank for 13-27 days. When sighted the dummies were normally not visible except for the antenna. The position of the antenna gave indication of the position of the dummy, and only ripped-off plastic coating showed that the geese had been biting the antenna.

Fig. 3 shows the position of F6L, F7L, F8L, F9L, F0L and F1N, all members of the same family group. Of the 30 field sightings 10 (33%) were in the sugar beet field, 10 (33%) were less than 200 m from this field and 5 (17%) were between 200-400 m from the sugar beet field. So, the family group shows high site fidelity, which is the normal behaviour of the geese (Wilson et al. 1991).

On fourteen evenings over the whole period, the family group was tracked to the sand banks south of Raven Point.

The difference in abdominal score from 29 January to 21 April does not seem to be different between the group with dummies, 1.0 (n=6) and the group without, 0.8 (n=3). The abdominal score difference for "heavy" dummies were 1.2 (n=3), and for "light" 0.8 (n=3). It must be noted that numbers in each group are small and no statistical comparison was possible.

Neoprene harness

On the 21 April, after 93 days, presumable only one of the five Neoprene birds (F4N, F6N, F0N, F3S and F5S) had the dummy satellite transmitter well attached. The dummy had slipped to the flank on three of the geese, two of those after 38-41 days, and one after 81-93 days. The fifth dummy was dropped after 4-6 days. On 22 January we observed that this dummy was only attached with two out of the four Neoprene strings. The goose often lifted it up on a vertical position or it was biting the antenna twisting the dummy sideways. We have 30 seconds of this behaviour on video tape. On 26 February the dummy was located in a receding pool. The Neoprene tapes and plastic tubes were gone, and the

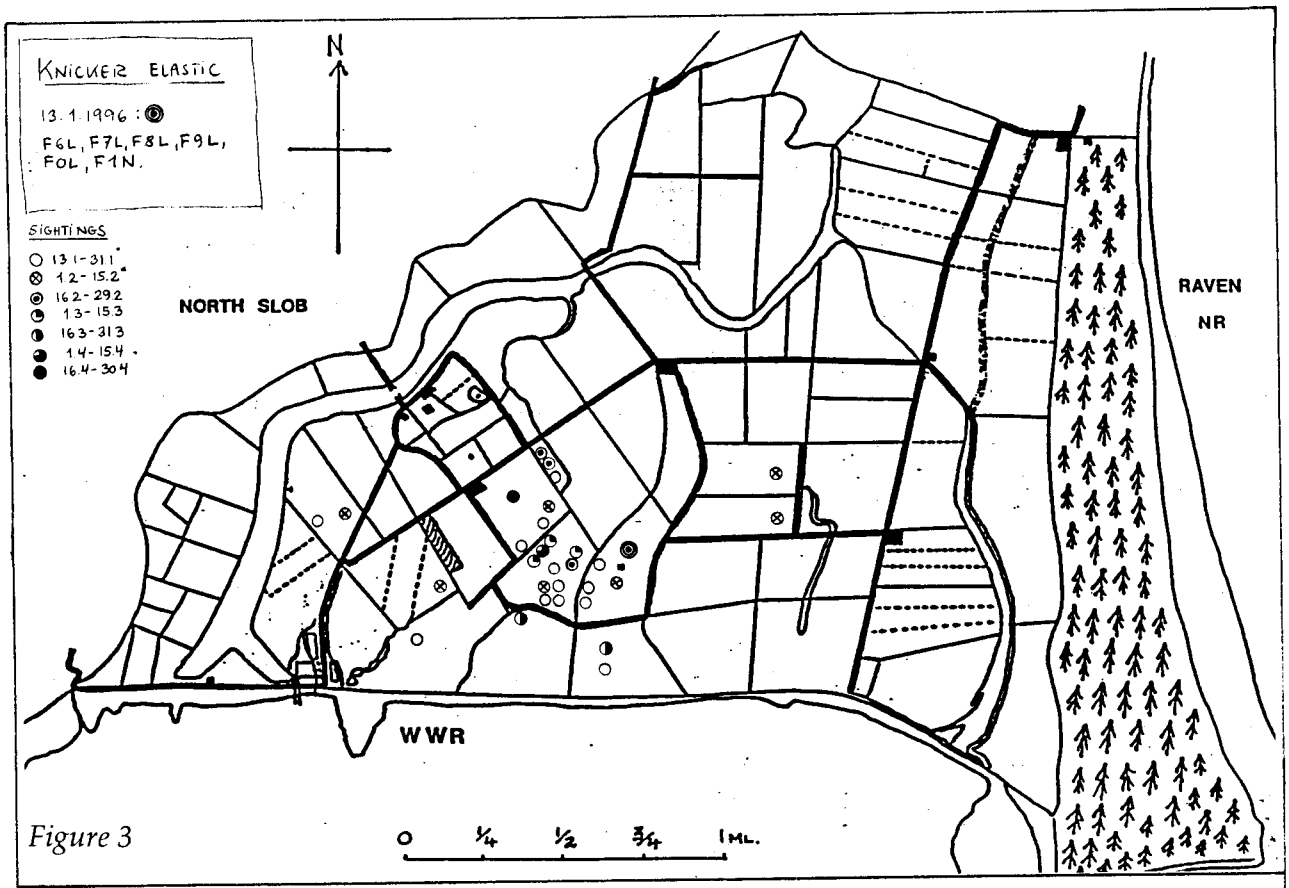

Figure 3

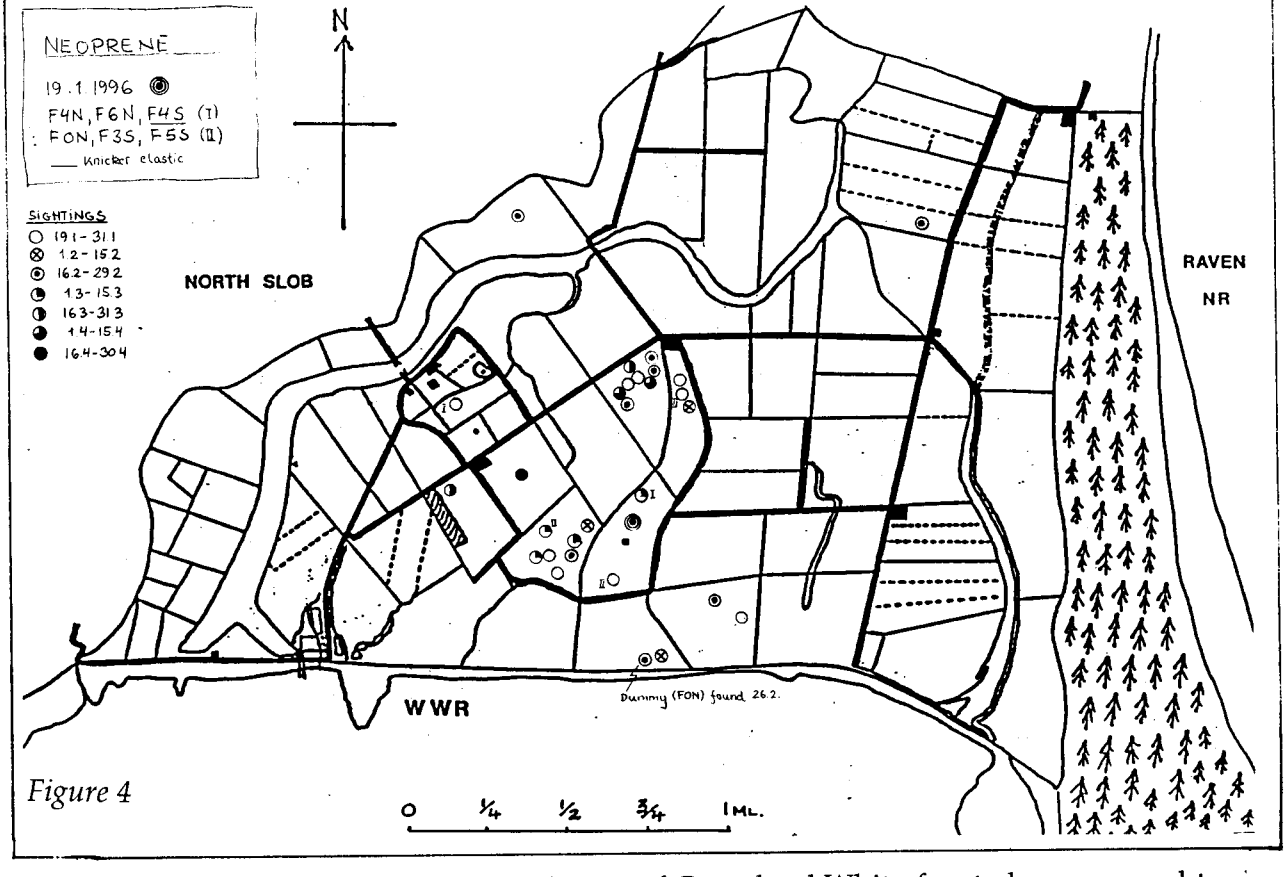

Figure 4

Figure 3 and 4. The two figures show sightings of Greenland White-fronted geese, caught on the North Slobs 13. and 19. January 1996. *Figure* 3 shows sightings of six geese fitted with knicker elastic harness, and *figure* 4 sightings of five geese with Neoprene and one with knicker elastic harness. Each circle represents a sighting. Sightings are divided into half months groups. The "target" signature is the catching area.

antenna was reduced from 28.0 to 15.3 cm. About ten mantle feathers were attached to the dummy.

The five Neoprene birds and the one knicker elastic bird (F4S) turned out to be members of two family groups of 11 (group I, including F4N, F6N, F4S) and 8 (group II, including F0N, F3S, F5S) birds. These two groups were related and were most often seen together (see Fig. 4). Figure 4 shows 29 field sightings of the two groups, and most sightings were from the sugar beet field (8 or 27%) and the field Northeast of the sugar beet field (12 or 42%). The sightings include one and four sightings less than 200 m from the fields, respectively. Also these two groups show high site fidelity, but here the geese alternate between two different fields.

On fourteen evenings the birds were tracked to the sand banks south of Raven Point.

The difference in abdominal score from 29 January to 5 April seem to be a little less in the group with dummies, 1.2 (n=5) than in the group without, 1.6 (n=9). The abdominal score difference for "heavy" dummies were 0.5 (n=2), and for "light" 1.7 (n=3). The difference between these two groups seem big, but numbers in each group are small.

Dummy bird in Iceland

F3S, with a Neoprene attached dummy has been reported from Leirarsveit, West Iceland on 1 May (Ó. Einarsson, pers. comm.).

Photo 2. The frequency is checked before F5S, a juvenile male, is released on 19 January. The dummy satellite transmitter is attached with a Neoprene harness.

4. Discussion

Transmitters affecting normal behaviour ?

Attaching satellite transmitters to Greenland White-fronted Geese is placing an extra artificial body on the birds. This can affect the normal behaviour in different ways, e.g. that the bird may preen more than without the attached transmitter, flight performance can be reduced, wounds and parasites can be introduced and reproduction can be affected.

Because the purpose of the satellite project is to study spring migration strategies under normal conditions, it is important to minimise the effects as much as possible. If for example flight performance was affected, it could delay arrival in Iceland and Greenland, and maybe prolong stays on the spring staging areas in these countries, giving a false impression of the spring migration. For this reason we felt it important to study the behaviour of free-flying Greenland White-fronted Geese in this pilot project testing different transmitter weights and harness types.

Few studies have been made on impacts from attached transmitters, with most knowledge gained from recaptured transmitter birds and transmitted data. Recaptured birds are often found in good condition and a small wound was seen in only one bird (Falk & Møller 1995, Pennyquick pers. comm.). Breeding failures have been reported in Fulmars interpreted as the combined effect of handling, transmitter and harness (Falk & Møller 1995) and in Brent Geese where only few returned to the breeding grounds and most were unpaired (Ward & Flint 1995). The transmitter weights were 2.5-3.4% of the body weight of the Brent Geese. Wandering Albatrosses had gained normal weights on foraging trips with dummies fitted on their backs (Jouventin & Weimerskirch 1990). The weight of the transmitters represented 5-6 % of the Fulmars body weight, and about 2 % of the Albatrosses body weight. Some times transmitters stop transmitting data either from the very start or after a short period (Johan Mooij and Svein-Håkon Lorenzen pers. comm., Falk & Møller 1995, Gudmundsson et al.1995). The reasons can be, that the bird is shot, the transmitter is dropped or bit off, or there is a transmitter fault.

Finding a "good" harness

The purpose of this pilot project was also to find a harness that can be used to attach the satellite transmitter in a safe way giving optimal data, bearing in mind that it is also important that the transmitters are not fixed too well to the birds, so that it can drop off after the battery is exhausted. This could be achieved by weathering of the harness or by moulting, if the satellite transmitter is only attached with glue (Gudmundsson et al. 1995).

Preening the dummy

From our behavioural studies it is clear that some birds are influenced by the dummy in the first days after the attachment. The one Greylag Goose preened the dummy a great deal the first

day after attachment, and then seemed to leave it be, while the other Greylag Goose preened the dummy more the third day than the second. This preening behaviour, however, only constituted some 2% of the total time budget. Greenland White-fronted Geese attached with dummy satellite transmitters preened back, neck and all significantly more than controls two and three days after the attachment, and flanks more than controls, but the difference was just not significant. With the dummy sitting on the back attached with a harness around flanks and belly it is not surprising, that these parts of the body were preened more by the dummy birds. It is more surprising that the dummy birds preened the neck more than controls, since both groups wore neck collars. An explanation could be that both dummy and harness would initiate more preening. The increase in time spent preening seems to suppress feeding the most (38.9% versus 50.3% in controls), but this difference was not significant. Preening the back constituted on average 2.4% of the time budget, compared to 0.6 for controls. One week after the handling, dummy birds and controls had apparently the same behaviour, and no preening on the back was observed. Only one bird, F0N, "preened" the dummy so vigorously, that the dummy was dropped after four or six days.

Other behaviour

All three family groups showed high site fidelity over the three month period, which is described as a characteristic behaviour in the Greenland White-fronted Goose (Wilson et al. 1991, Stroud 1992). The family groups also showed normal behaviour concerning family groups remaining together during the three month period, the geese flying to roost, feeding and flying ability.

Condition

The difference in abdominal score from January to April is a measure of the change in condition over this period. The abdominal score was here read in 0.5 values. In the two marked groups, all geese with and without attached dummies have increased their condition and no pronounced difference were found between geese fitted with dummies and controls. The weights of the dummies were between 1.5 and 2.1% of the body weights. In the different impact studies referred to in this report, normal conditions and weights were found in birds with transmitter weights between 1 and 6% of the body weight. At transmitter weights between 12 and 14% of the body weight, the Houbara Bustards lost 4 to 9% of their body weights over 55 days.

It is difficult to say if the increase in condition is different between geese with a "heavy" and a "light" dummy, because numbers are small in each group (n=2 or 3); also the weight of a "heavy" and a "light" dummy is not so different, i.e. 2.0-2.1% of the body weight for "heavy" dummies and 1.5-1.7% for "light" dummies. In "knicker elastic" geese there seem to be no difference in increased condition between the two groups; in "Neoprene geese" the difference in abdominal score is 0.5 for geese with a "heavy" dummy and 1.7 for "light" ones.

"Heavy" and "light" dummy

It is not possible to distinguish between the behaviour of the geese with a "light" (38.0g) dummy from a "heavy" (54.1 g) dummy except for the adult male, F0N. F0N carried a "heavy" dummy, and having bitten through one of the Neoprene strings, preening behaviour was probably aggravated by the loose transmitter. It is not possible to say if this behaviour is due to weight, Neoprene harness, or individual behaviour.

Knicker elastic harness the best

It is clear from this pilot project, that the knicker elastic harness is more effective than the Neoprene harness. Knicker elastic was tested on nine geese, i.e. seven white-fronts and the two captive greylags, and none of the dummies were lost over the testing period of 99 days; only one had slipped to the flank after 72-86 days. Neoprene was tested on five geese, and one was lost after 4 to 6 days. The remaining four were still on the geese after 93 days, but three had slipped to the flank after 38 to 81 days.

Probably the Neoprene tape is not elastic enough and it is easier to bite through. The elasticity of knicker elastic is much stronger, which makes it easier to attach with the right tension and instead of one string it consists of five strings, which makes it more resistant to goose bite.

5. Conclusions

Affecting the behaviour

It is shown in this study that dummy satellite transmitters can affect the behaviour of the geese for up to about one week after attachment. This influence is seen in two captive Greylag Geese and in the Greenland White-fronted Geese. The geese preened their back and dummy more than controls were preening their back, but three days after the attachment less than 3% of their total time was used preening the back. In the Greenland White-fronted Geese this resulted in the loss of one dummy fitted on an adult male with a Neoprene harness. The dummy was lost four or six days after the attachment. Other behaviour like site fidelity, association with other family members, flying to the evening roost, flying ability and feeding all appeared normal.

Weight and harness type

Two weight groups were tested, a "light" one with an average weight of 38.0 g, and a "heavy" one weighing on average 54.1 g. It was not possible to show any difference in behaviour or condition between these two groups. Two types of harnesses were tested, a knicker elastic harness and a Neoprene harness; eight out of nine dummies were fitted well with knicker elastic harness after 99 days, whereas only one out of five dummies was satisfactorily fitted with Neoprene harness after 93 days. No difference in behaviour was found in the two harness groups. From this pilot project it appears, that knicker elastic is a much better harness than the Neoprene one.

Dummy and body weight

The weight of the dummy satellite transmitters tested in this study represents between 1.5 and 2.1% of the body weight of the geese. No deviant behaviour was observed because of this extra load. As the Greenland White-fronted Geese are migrating over great distances, and as studies of transmitters of 2.5 to 6% of the body weight seem to affect birds behaviour , satellite transmitters on Greenland White-fronted Geese should not exceed 2% of their body weights or about 55 grams.

6. References

Ancel, A., Gendner, J-P., Lignon, J., Jouventin, P. & Le Maho, Y. 1992. Satellite radio-tracking of emperor penguins walking on sea-ice to refeed at sea: 201-202. - In: Priede, I. & Swift, S. M. (eds.). Wildlife telemetry. Remote monitoring and tracking of animals. - Ellis Horwood, Chichester, UK.

Falk, K. & Møller, S. 1995. Satellite tracking of high-arctic northern fulmars. - Polar Biol. 15: 495-502.

Fox, A. D. & Madsen, J. 1981. The pre-nesting behaviour of the Greenland White-fronted Goose. - Wildfowl 32: 48-54.

Fox, A. D., Madsen, J. & Stroud, D. A. 1983. A review of the summer ecology of the Greenland White-fronted Goose *Anser albifrons flavirostris*. - Dansk Orn. Foren. Tidsskr. 77: 43-55.

Fox. A. D. & Ridgill, S. C. 1985. Spring activity patterns of migrating Greenland White-fronted Geese in West Greenland. - Wildfowl 36: 21-28.

Fox. A. D. & Stroud, D. A. 1988. The breeding biology of the Greenland White-fronted Goose *Anser albifrons flavirostris*. - Meddr Grønland, Biosci. 27: 14 pp.

Fox, A. D., Norris, D. W., Stroud, D. A. & Wilson, H. J. 1994. Greenland White-fronted Geese in Ireland and Britain 1982/83-1993/94. - Greenland White-fronted Goose Study Research Report No. 8. Greenland White-fronted Goose Study and the NPWS/OPW, Dublin: 54 pp.

Francis, I. S. & Fox, A. D. 1987. Spring migration of Greenland White-fronted Geese through Iceland. - Wildfowl 38: 7-12.

French, J. & Goriup, P. 1992. Design of a small Argos PTT for the houbara bustard: 161-176. - In: Priede, I. & Swift, S. M. (eds.). Wildlife telemetry. Remote monitoring and tracking of animals. - Ellis Horwood, Chichester, UK.

Greenland Home Rule 1990. International wetlands in Greenland. Ramsar-sites. - Pamphlet, Dep. of Physical Planning and Nature Management, Nuuk.

Greenland Home Rule 1995. Piniarneq 1996, with "Hunting seasons" in English (p. 10-12). - Grønlands Hjemmestyre, Direktoratet for Fiskeri, Fangst & Landbrug: 32 pp.

Giroux, J. F., Bell, D. V., Percival, S. & Summers, R. W. 1990. Tail-mounted radio transmitters for waterfowl. - Journal of Field Ornithology 61: 303-309.

Griesinger, J., Bertold, P., Querner, U., Pedrocchi, C. & Nowak, E. 1992. Satellite tracking of a young griffon vulture in the north of Spain: 199-200. - In: Priede, I. & Swift, S. M. (eds.). Wildlife telemetry. Remote monitoring and tracking of animals. - Ellis Horwood, Chichester, UK.

Gudmundsson, G. A., Benvenuti, S., Alerstam, T., Papi, F., Liliendahl, K. & Åkesson, S. 1995. Examining the limits of flight and orientation performance: satellite tracking of brent geese migrating across the Greenland ice-cap. - Proc. R. Soc. London. B 261: 73-79.

Howey, W. 1992. Tracking of birds by satellite: 177-184. - In: Priede, I. & Swift, S. M. (eds.). Wildlife telemetry. Remote monitoring and tracking of animals. - Ellis Horwood, Chichester, UK.

Jouventin, P. & Weimerskirch, H. 1990. Satellite tracking of wandering albatrosses. - Nature 343: 746-748.

MRA, 1996a. Rules for field work and reporting regarding mineral resources (excluding hydrocarbons) in Greenland. - Mineral Resources Administration for Greenland, Ministry of Environment and Energy, Denmark: 41 pp.

MRA, 1996b. Beretning for Fællesrådet vedrørende Mineralske Råstoffer i Grønland, 1. juli 1994 - 31. december 1995. - Råstofforvaltningen for Grønland (Mineral Resources Administration for Greenland): 35 pp.

Nowak, E. & Berthold, P. 1991. Die Satelliten-Telemetrie in der Erforscherung von Tierwanderungen: eine Übersicht. - J. Ornithol. 128: 405-422.

Owen, M. 1981. Abdominal profile - a condition index for wild geese in the field. - Journal of Wildlife Management 45: 227-229.

Petersen, M. R., Douglas, D. C. & Mulcahy, D. M. 1995. Use of implanted satellite transmitters to locate spectacled eiders at sea. - Condor 97: 276-789.

Priede, I. G. 1988. Tracking of birds. - Arcos Newsletter No. 34: 1-3.

Ruttledge, R. F. & Ogilvie, M. A. 1979. The past and current status of the Greenland White-fronted Goose in Ireland and Britain. - Irish Birds I: 293-363.

Salomonsen, F. 1950. Grønlands Fugle - The Birds of Greenland. - Munksgaard, København: 609 pp.

Salomonsen, F. 1967. Fuglene på Grønland. - Rhodos, København: 341 pp.

Stroud, D. A. & Fox, A. D. 1981. The status of the Greenland White-front in East Greenland: 146-147. - In: Fox, A. D. & Stroud, D. A. (eds.). Report of the 1979 GWGS Expedition to Eqalungmiut Nunât, West Greenland. - GWGS Aberystwyth, 319 pp.

Stroud, D. A. 1992. Greenland White-fronted Goose Draft International Conservation Plan. - Prepared for NPWS/IWRB by JNCC, Peterborough: 184 pp.

Ward, D. H. & Flint, P. L. 1995. Effects of harness-attached transmitters on premigration and reproduction of Brant. - Journal of Wildlife Management 59 (1): 39-46.

Weimerskirch, H. 1990. Albatross tracking in the Southern ocean. - Arcos Newsletter No. 40: 1-5.

Weimerskirch, H., Salamolard, M., Sarrazin, F. & Jouventin, P. 1993. Foraging strategy of wandering albatrosses through the breeding season: a study using satellite telemetry. - Auk 110: 325-342.

Wilson, H. J., Norriss. D. W., Walsh, A., Fox, A. D. & Stroud, D. A. 1991. Winter site fidelity in Greenland White-fronted Geese *Anser albifrons flavirostris*: implications for conservation and management. - Ardea 79: 287-294.

7. Appendices

7.1 Satellite transmitter specifications

The table below lists specifications currently available for some types of satellite transmitters: weight, dimensions, price, housing and pressure sensor.

Note all prices except Satellite Imaging Systems exclude costs of PTT time (ground station tracking time).

PTT-type	Weight (grams)	Dimensions (mm)	Price ($)	Remarks
Toyocom T-2050	25.0	41x33x19	-	splash proof
Toyocom T-2050	38.7	46x34x20	-	water proof
Toyocom T-2050 II	43.0	55x34x25	4,300	splash proof, plus pressure sensor
Toyocom T-2050 II	40.0	55x34x25	3,740	splash proof, no pressure sensor
Toyocom T-2050 II	53.5	70x34x25	3,700	splash proof, plus pressure sensor
Toyocom T-2050 II	50.5	70x34x25	3,140	splash proof, no pressure sensor
Microwave PTT-100	30.0	62x18x16	2,900	splash proof, no pressure sensor
Telonics ST-10	75.0	92x48x20	1,935	no pressure sensor
Satellite Imaging Systems	5.8	-	2,500	price includes PTT-time

7.2 Data on Greenland White-fronted Geese fitted with dummies

The geese were caught and ringed at the Wexford North Slobs on 13 and 19 January and migrated north between 27 and 29 April.

Knicker-elastic harness

A dummy satellite transmitter was mounted with a knicker elastic harness on the following geese: F6L, F7L, F8L, F9L, F0L, F1N and F4S.

Conclusion: The *dummies* were well attached on six out of seven geese after 99 days. On the seventh goose the dummy was on the back for 72-86 days, on the flank for 13-27 days, and still on the goose after 99 days. A strong *signal* was received from two radios and a weak signal from one after 99 days, the remaining four did not send after 99 days, but between 86 and 99 days. The battery life time according to Biotrack is 150 to 210 days. The difference in *abdominal score* from 29 January to 21 April does not seem to be different between the group with dummies, 1.0 (n=6, because F4S was not read in April) and the group without, 0.8 (n=3). The abdominal score difference for "heavy" dummies was 1.2 (n=3), and for "light" 0.8 (n=3). Note that numbers in each group are small.

F6L

Juvenile, male, 2700 g. Frequency: 151,044 MHz, in the field: 151,041 MHz. Dummy weight: 51.0 g.

Summary: Everything OK.

Catch: *13 January:* Ten geese, where one escaped. Caught in field 057, Big Island, 08.25 and released 11.30. Code on the nine geese: F3L, F4L, F5L, F6L, F7L, F8L, F9L, F0L and F1N.

Sightings: *January: 14, 15, 16 (bearing), 17 (bearing), 18, 19, 20, 21, 22, 25. February: 2, 6, 7, 8, 26, 29. March: 6, 7, 11, 14, 25. April: 8, 21.*

Signal: OK until *21 April.*

Abdominal score: *29 February:* 2.0; *8 April:* 2.5; *21 April:* 3.0.

F7L

Adult, male, 2550 g. Frequency: 151,063 MHz, in the field: 151,061 MHz. Dummy weight: 53.0 g.

Summary: Signal weak *11 March*, strong again from *14 March* but disappeared *21 April.* Otherwise OK.

Catch: *13 January:* Ten geese, where one escaped. Caught in field 057, Big Island, 08.25 and released 11.30. Code on the nine geese: F3L, F4L, F5L, F6L, F7L, F8L, F9L, F0L and F1N.

Sightings: *January: 14, 15, 16 (bearing), 17 (bearing), 18, 19, 20, 21, 22, 25. February: 2, 6, 7, 8, 26, 29. March: 6, 7, 11, 14, 25. April: 8, 21.*

Signal: *11. March:* Signal weak, especially at a distance. *14 March:* Signal OK. *21 April:* no signal.

Abdominal score: *29 February:* 1.5; *8 April:* 2.0; *21 April:* 3.0.

F8L

Adult, female, 2400 g. Frequency: 151,086 MHz, in field: 151,081 MHz. Dummy weight: 38.5 g.

Summary: Everything OK.

Catch: *13 January:* Ten geese, where one escaped. Caught in field 057, Big Island, 08.25 and released 11.30. Code on the nine geese: F3L, F4L, F5L, F6L, F7L, F8L, F9L, F0L and F1N.

Sightings: *January: 14, 15, 16 (bearing), 17 (bearing), 18, 19, 20, 21, 22, 25. February: 2, 6, 7, 8, 26, 29. March: 6, 7, 11, 14, 25. April: 8, 21.*

Signal: OK to and on *21 April.*

Abdominal score: *29 February:* 2.0; *8 April:* 2.5; *21 April:* 3.0.

F9L

Juvenile, male, 2600 g. Frequency: 151,003 MHz, in field: 150,997 MHz. Dummy weight: 54.5 g.

Summary: No signal *21 April*; otherwise everything OK.

Catch: *13 January:* Ten geese, where one escaped. Caught in field 057, Big Island, 08.25 and released 11.30. Code on the nine geese: F3L, F4L, F5L, F6L, F7L, F8L, F9L, F0L and F1N.

Sightings: *January: 14, 15, 16 (bearing), 17 (bearing), 18, 19, 20, 21, 22, 25. February: 2, 6, 7, 8, 26, 29. March: 6, 7, 11, 14, 25. April: 8, 21.*

Signal: OK to and on *8 April.* No signal *21 April.*

Abdominal score: *29 February:* 2.0; *8 April:* 2.5; *21 April:* 3.0.

F0L

Juvenile, female, 2550 g. Frequency: 151,012 MHz, in field: 150,009 MHz. Dummy weight: 39.5 g.

Summary: Dummy on flank *8* and *21 April.* No signal *21 April,* otherwise OK signal.

Catch: *13 January:* Ten geese, where one escaped. Caught in field 057, Big Island, 08.25 and released 11.30. Code on the nine geese: F3L, F4L, F5L, F6L, F7L, F8L, F9L, F0L and F1N.

Sightings: *January: 14, 15, 16 (bearing), 17 (bearing), 18, 19, 20, 21, 22, 25. February: 2, 6, 7, 8, 26, 29. March: 6, 7, 11, 14, 25. April: 8, 21.*

Signal: OK to and on *25 March.* Dummy on flank, but signal OK, *8 April,* no signal *21 April.*

Abdominal score: *29 February:* 2.0; *8 April:* 2.5; *21 April:* 3.0.

F1N

Juvenile, male, 2700 g. Frequency: 151,124 MHz, in field: 150,117 MHz. Dummy weight: 34.5 g.

Summary: Signal weak *11 March.* OK to *21 April,* where weak again. Otherwise OK.

Catch: *13 January:* Ten geese, where one escaped. Caught in field 057, Big Island, 08.25 and released 11.30. Code on the nine geese: F3L, F4L, F5L, F6L, F7L, F8L, F9L, F0L and F1N.

Sightings: *January: 14, 15, 16 (bearing), 17 (bearing), 18, 19, 20, 21, 22, 25. February: 2, 6, 7, 8, 26, 29. March: 6, 7, 11, 14, 25. April: 8, 21.*

Signal: OK to and on *7 March.* Signal weak, especially at a distance, on *11 March.* Signal strong *14* and *25 March* and *8 April.* Signal weak *21 April.*

Abdominal score: *29 February:* 2.0; *8 April:* 2.5; *21 April:* 2.5.

F4S

Juvenile, male, 2750 g. Frequency: 151,083 MHz, in field: 150,079 MHz. Dummy weight: 53.0 g.

Summary: No signal *21 April,* otherwise everything OK.

Catch: *19 January:* A total of 19 geese caught in field 057, Big Island, 08.25 and released about 12.00. Three geese were recaptured (C1Y, C3U, CD→F9S). Code on the 17 geese: F2N, F3N, F4N, F5N, F6N, F8N, F9N, F0N, F1S, F2S, F3S, F4S, F5S, F6S, F7S, F8S, F9S (former CD).

Sightings: *January: 20, 21, 22, 25. February: 2, 6, 7, 20, 25, 26, 29. March: 6, 11, 14, 20, 25. April: 5, 9, 21.*

Signal: No signal *21 April,* otherwise signal OK.

Abdominal score: *29 February:* 2.5; *20 March:* 2.5.

Neoprene harness

A dummy satellite transmitter was mounted with a Neoprene harness on the following geese: F4N, F6N, F0N, F3S and F5S.

The 19 caught geese were separated in two groups (I and II) which most often were seen close together, separated by less than 100 meters.

I: F4N, F6N, F4S (knicker elastic) + F2N, F5N, F6S, F7S, F8S, F9S, C1Y, C3U;

II: F0N, F3S, F5S + F3N, F8N, F9N, F1S, F2S.

Conclusion: The *dummy* was, presumably, well attached to only one of the five geese after 93 days. The dummy slipped to the flank on three of the geese, two of those after 38-41 days, and one after 81-93 days. The fifth dummy was dropped after 4-6 days. A strong *signal* was received from two radios after 93 days. One send a strong signal after 47 days and a weak after 93 days, and one

send a signal for 47 days. The fifth was dropped and did not send while drowned. The battery life time according to Biotrack was 150-210 days. The difference in *abdominal score* from 29 January to 5 April seem to be a little less in the group with dummies, 1.2 (n=5) than in the group without, 1.6 (n=9). The abdominal score difference for "heavy" dummies was 0.5 (n=2), and for "light" 1.7 (n=3). The difference between these two groups seem big, but numbers in each group are small.

F4N

Adult, male, 2900 g. Frequency: 151,125 MHz, in field: 150,119 MHz. Dummy weight: 56.0 g.

Summary: The dummy was not visible on *25 March* and until *21 April*. Yet, it was probably attached to the goose the whole period because signal was received on *21 April*. No signal was received on *25 March*.

Catch: *19 January:* A total of 19 geese caught in field 057, Big Island, 08.25 and released about 12.00. Three geese were recaptured (C1Y, C3U, CD→F9S). Code on the 17 geese: F2N, F3N, F4N, F5N, F6N, F8N, F9N, F0N, F1S, F2S, F3S, F4S, F5S, F6S, F7S, F8S, F9S (former CD).

Sightings: *January: 20, 21, 22, 25. February: 2, 6, 7, 20, 25, 26, 29. March: 6, 11, 14, 20, 25. April: 5, 9, 21.*

Signal: *6 March:* Signal OK. *25 March:* No signal, dummy not visible. *5 April:* No signal, dummy not visible. *21 April:* Signal weak.

Abdominal score: *29 February:* 2.5; *20 March:* 2.5; *5 April:* 2.5; *21 April:* 3.0.

F6N

Juvenile, male, 2500 g. Frequency: 151,022 MHz, in field: 150,019 MHz. Dummy weight: 39.0 g.

Summary: Dummy on the flank on *29 February* and was sitting in the same position until at least *5 April*. No signal from *11 March*.

Catch: *19 January:* A total of 19 geese caught in field 057, Big Island, 08.25 and released about 12.00. Three geese were recaptured (C1Y, C3U, CD→F9S). Code on the 17 geese: F2N, F3N, F4N, F5N, F6N, F8N, F9N, F0N, F1S, F2S, F3S, F4S, F5S, F6S, F7S, F8S, F9S (former CD).

Sightings: *January: 20, 21, 22, 25. February: 2, 6, 7, 20, 25, 26, 29. March: 6, 11, 14, 20, 25. April: 5, 9, 21.*

Signal: *29 February:* The dummy slipped to left flank, signal OK. *6 March:* Signal OK. *11* and *14 March:* No signal, but the goose observed. *20 March:* Dummy still on the flank in the same position. *25 March* and *5 April:* Dummy still on the flank, but no signal. *21 April:* No signal.

Abdominal score: *29 February:* 2.0; *20 March:* 2.0; *5 April:* 3.0.

F0N

Adult, male, 2400 g. Frequency: 151,140 MHz, in field: 150,135 MHz. Dummy weight: 57.0 g.

Summary: The dummy was dropped between *22* and *25 January* (i.e. 4-6 days).

Catch: *19 January:* A total of 19 geese caught in field 057, Big Island, 08.25 and released about 12.00. Three geese were recaptured (C1Y, C3U, CD→F9S). Code on the 17 geese: F2N, F3N, F4N, F5N, F6N, F8N, F9N, F0N, F1S, F2S, F3S, F4S, F5S, F6S, F7S, F8S, F9S (former CD).

Sightings: *January: 20, 21, 22, 25. February: 2, 6, 7, 20, 25, 26, 29. March: 6, 11, 14, 20, 25. April: 5, 9, 21.*

Signal: *22 January:* The two hindmost Neoprene tapes were bit through and F0N often bit the antenna and thereby pulled the dummy into a vertical position. A video scene (30 sec.) of this behaviour was shot. *25 January:* The dummy was not visible and no signal was received. *26 February:* A very weak signal received. The dummy was located in field 055 in a receding pool with the antenna just above the surface. The Neoprene tapes and plastic tubes were gone, and the antenna was reduced from 28.0 to 15.3 cm. Some ten mantle feathers were attached to the dummy. A strong signal was received after the radio was recovered. No signal was received during February probably due to water that covered the antenna.

Abdominal score: *29 February:* 2.5; *20 March:* 3.0; *5 April:* 3.5; *21 April:* 3.5.

F3S

Adult, female, 2250 g. Frequency: 151,152 MHz, in field: 150,148 MHz. Dummy weight: 40.5 g.

Summary: The dummy had slipped to the flank on *29 February,* and slipped further down on *20 March,* but was still attached on *21 April.* Signal probably OK after *14 March.*

Catch: *19 January:* A total of 19 geese caught in field 057, Big Island, 08.25 and released about 12.00. Three geese were recaptured (C1Y, C3U, CD→F9S). Code on the 17 geese: F2N, F3N, F4N, F5N, F6N, F8N, F9N, F0N, F1S, F2S, F3S, F4S, F5S, F6S, F7S, F8S, F9S (former CD).

Sightings: *January: 20, 21, 22, 25. February: 2, 6, 7, 20, 25, 26, 29. March: 6, 11, 14, 20, 25. April: 5, 9, 21.*

Signal: *26 February:* Signal OK. *29 February:* The dummy had slipped to the right flank. *6, 11* and *14 March:* Signal OK. *20 March:* The dummy was still on the flank but slipped further so the antenna touched the ground. *21 April:* The dummy was still on the flank.

Abdominal score: *29 February:* 2.0; *20 March:* 3.0; *5 April:* 4.0, *21 April:* 3.5.

F5S

Juvenile, male, 2200 g. Frequency: 151,045 MHz, in field: 150,040 MHz. Dummy weight: 36.0 g.

Summary: The dummy had slipped to the flank on *21 April*. Signal OK the whole period.

Catch: *19 January:* A total of 19 geese caught in field 057, Big Island, 08.25 and released about 12.00. Three geese were recaptured (C1Y, C3U, CD→F9S). Code on the 17 geese: F2N, F3N, F4N, F5N, F6N, F8N, F9N, F0N, F1S, F2S, F3S, F4S, F5S, F6S, F7S, F8S, F9S (former CD).

Sightings: *January: 20, 21, 22, 25. February: 2, 6, 7, 20, 25, 26, 29. March: 6, 11, 14, 20, 25. April: 5, 9, 21.*

Signal: *26 February:* Signal OK. *6, 11* and *14 March:* Signal OK. *21 April:* The dummy on the flank.

Abdominal score: *29 February:* 2.0; *20 March:* 2.5; *5 April:* 4.0, *21 April:* 3.5.

7.3 Activity budgets of Greenland White-fronted Geese

The table shows mean activity budgets (in percent of total observation time with SE in brackets) of Greenland White-fronted Geese caught on the Wexford North Slobs. The geese were either fitted with af dummy satellite transmitter (attached with a knicker elastic or a Neoprene harness) or just banded (controls).

The Knicker elastic geese (9 in total) were caught on 13. January 1996 and the Neoprene geese (19 in total) were caught on 19. January 1996. Behavioural studies were performed only on group I (11 geese) of the Neoprene geese, where the * goose (F4S) had the dummy attached with a knicker elastic harness.

"Preen rest" includes: preen breast and wing upper, wing stretch and shake feathers. "Other behaviour" includes: sit, stand, sleep, walk, feed and drink.

Harness	**Knicker elastic**				**Neoprene**	
Date (hour)	15.1.96 (15.47-16.30)		20.1.96 (15.43-15.54)		22.1.96 (10.22-11.15)	
Behaviour	**dummy** F6L,F7L,F8L, F0L,F1N	**control** F4L,F5L	**dummy** F6L,F1N	**control** F4L,F5L	**dummy** F4N,F4S*	**control** F2N,F6S,F7S F8S,F9S
Preen back	3.3 (0.8)	0.7 (0.7)	0.0	0.0	0.8 (0.4)	0.6 (0.5)
Preen flank	5.3 (1.9)	0.6 (0.6)	0.0	0.0	1.3 (0.8)	1.3 (1.1)
Preen belly	0.2 (0.2)	0.0	0.0	0.0	0.1 (0.1)	0.0
Preen neck	14.1 (4.6)	5.2 (1.5)	0.0	0.0	5.4 (4.9)	2.7 (1.3)
Preen rest	8.1 (1.7)	10.8(5.4)	0.0	0.0	2.7 (2.1)	1.3 (0.7)
Other behaviour	69.0 (8.1)	82.7(5.6)	100.0	100.0	89.2(7.9)	94.0 (3.1)
Total obs. time (sec.)	5,735	2,055	810	910	3,290	7,955
Number of birds (n)	7	3	2	2	2	10

National Environmental Research Institute

The National Environmental Research Institute - NERI - is a research institute of the Ministry of the Environment and Energy. NERI's tasks are primarily to do research, collect data and give advice on problems related to the environment and Nature.

Addresses:

National Environmental
Research Institute
P.O. Box 358
DK-4000 Roskilde
Denmark
Tel.: +45 46 30 12 00
Fax.: +45 46 30 11 14

Management
Personnel and Economy Section
Research and Development Secretariat
Dep. of Policy Analysis
Dep. of Atmospheric Environment
Dep. of Environmental Chemistry
Dep. of Marine Ecology and Microbiology

National Environmental
Research Institute
Vejlsøvej 25
P.O. Box 413
DK-8600 Silkeborg
Denmark
Tel.: +45 89 20 14 00
Fax.: +45 89 20 14 14

Dep. of Terrestrial Ecology
Dep. of Streams and Riparian Areas
Dep. of Lake and Estuarine Ecology

National Environmental
Research Institute
Grenåvej 12, Kalø
DK-8410 Rønde
Denmark
Tel.: +45 89 20 14 00
Fax.: +45 89 20 15 14

Dep. of Landscape Ecology
Dep. of Coastal Zone Ecology

National Environmental
Research Institute
Tagensvej 135, 4.
DK-2200 Copenhagen N
Denmark
Tel.: +45 35 82 14 15
Fax.: +45 35 82 14 20

Dep. of Arctic Environment

NERI publishes professional reports, technical instructions, reprints of scientific and professional articles and an annual report.

Included in the annual report is a review of the publications from the year in question. The annual report and an up-to-date review of the year's publications are available upon request.