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Successful Performance of Satellite Transmitters Attached to Migrating Lesser Snow Geese

We conducted the largest experimental avian satellite tracking study ever with the smallest mass-produced transmitters yet available. Preliminary results indicate that the lightweight transmitters will provide the long-awaited technology for avian migration studies. During 1991, the Northern Prairie Wildlife Research Center (NPWRC) initiated a cooperative study with Nippon Telegraph and Telephone of Japan (NTT), the Alaska Fish and Wildlife Research Center (AFWRC), and several biologists from Russia, Canada, and Pacific Flyway states to track the southward migration of Wrangel Island lesser snow geese (*Anser caerulescens*) by satellite telemetry. Primary objectives were to document the migration of Wrangel Island lesser snow geese and test a 54-g ARGOS-certified satellite transmitter recently developed by NTT. We present preliminary results of transmitter performance for researchers considering or planning the use of satellite transmitters to track birds and small mammals.

Attachments and Duty Cycles Tested

NPWRC cast 29 NTT transmitters in an epoxy polymer to protect the electronic components. Fifteen transmitters were adapted to modified Dwyer backpack harnesses and another 14 were affixed to plastic neck collars. Total weight of each transmitter and attachment averaged 85 g. The transmitters were configured by NTT to transmit at either 50-s intervals for 3 h each day (50s/3h) or 80-s intervals for 5 h each day (80s/5h). The expected battery life for each configuration was approximately 125 days. On July 29, 1991, the 29 transmitters were deployed on adult male lesser snow geese at Wrangel Island, Russia. Data were received by two polar-orbiting NOAA satellites, processed by ARGOS, and sent to AFWRC. ARGOS data processing included the "Class-0 Service," which contained locations typically screened by the standard ARGOS quality control criteria.

More Neck Collars Successfully Tracked

Satellite tracking confirmed the movement of 21 geese from Wrangel Island to Alaska, and 9 geese were tracked to their wintering areas in northwestern Washington and central California. For the 9 transmitters that successfully reached the wintering areas, locations were obtained for an average of 116.7 days (range 107–124), transmissions were recovered for an average of 118.8 days (range 107–129), and there was no difference in transmitter longevity between the 50s/3h and 80s/5h configurations (t-test, $P = .83$). A greater proportion ($P = .01$, Fisher's Exact Test) of the transmitters attached to neck collars were successfully tracked to the wintering areas (Table 1). For geese wearing neck collars, there was no difference ($P = 1.0$) between the proportions of transmitters withof 5 50s/3h and 80s/5h configurations that arrived at the wintering areas (Table 1).

Backpacks Recovered More Data

Transmitters attached to backpack harnesses recovered significantly more data than transmitters attached to neck collars (Table 2). Transmitters operating with a 80s/5h configuration were detected by more satellite overpasses and provided a greater number of mean total locations than a 50s/3h configuration (Table 2). Results shown in Table 2 only describe August and September data, a period when all birds were migrating together in eastern Siberia and Alaska. During this period, satellite coverage was assumed to be relatively constant for all transmitters.

Careful Planning Improves Data

During a satellite overflight, a shorter pulse rate can increase the probability of acquiring at least four transmitter messages over a period >240 s, which is an ARGOS criterion for attaining a standard-quality location with <1 km error. Also, a longer daily transmission period can increase the number of satellite overpasses that detect the transmitter. The longer transmission period of 5 h per day at the longer 80-s pulse rate resulted in a significantly greater number of total locations in our northern latitude study area. It is important to note that, at more southern latitudes where a 5-h period may include ≥2 h without satellite visibility, the 5-h transmission period may have no advantage over the 3-h period, and the additional battery expenditure would be pointless. Such examples demonstrate the importance of optimizing the transmission periods with predicted satellite coverage for a given study area—in both space and time.

Compromise Required to Meet Objectives

Results clearly showed that more data were obtained from transmitters attached to backpack harnesses. A superior line-of-sight orientation of the antenna to the satellite was achieved by the harness. In comparison, the antenna in the neck collar hung below the bird, interfering with line-of-sight satellite visibility. Minimizing physical interference between the antenna and the satellite is an important consideration for improving data reception. However, significantly fewer geese with harnesses were successfully tracked to their wintering areas. Because the primary objective of the study was to document migration, we concluded that neck collars were a superior attachment for the 85-g transmitter package. Although harness attachments have performed well for many avian applications, we suspect that neck-collar attachment may be better than harness attachment for long distance migration studies of geese because of reduced feather wear and drag.

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Table 1. *Number of satellite transmitters successfully tracked to wintering areas (numerator) and total number of transmitters deployed on male lesser snow geese (denominator), with modes of attachment and transmission configuration.*

Attachment	Configuration 50s/3h	80s/5h
Harness	0/7	1/8
Neck Collar	5/8	3/6

Table 2. *Amounts of data recovered by the ARGOS system from transmitters with different attachments and transmission configurations on migrating lesser snow geese during August and September 1991. Means that were not significantly different (separate ANOVA for each measure, P > .05) are followed by the same upper-case letter. The effect of configuration was significant for each attachment and the effect of attachment was significant for each configuration when all measures were considered simultaneously (MANOVA, P ≤ .05).*

Variable tested (total and mean number)	Configuration	Attachment: Backpack harness	Attachment: Neck collar
Messages received by all satellite overflights	50s/3h	1,572 A(3)[a]	438 C(6)
	80s/5h	1,420 B(5)	611 C(3)
Satellite overflights with one or more messages	50s/3h	188 A	127 C
	80s/5h	286 B	224 D
Standard quality and class-0 locations	50s/3h	170 A	84 C
	80s/5h	248 B	139 D
Standard quality locations	50s/3h	81 A	26 B
	80s/5h	101 A	37 B

[a] Number of transmitters in parentheses (sample size) were the same for all four variables tested.