Monitoring Wolf Activity by Satellite

■ Steven G. Fancy and Warren B. Ballard

Indices of activity were monitored for 23 gray wolves in northwestern Alaska during 1987–1991 with a mercury tip switch and microprocessor in transmitters compatible with the Argos data collection and location system (Platform Transmitter Terminals [PTTs]). Wolves were more active during summer than winter. Activity indices in summer (May–September) were highest between 2200 and 0600 hours, but during winter wolves were most active between 0700 and 1600 hours. Activity indices in winter increased and became more variable as temperatures decreased. Activity sensors in PTTs can systematically monitor activity of wolves in remote areas throughout the year, but calibration studies with captive wolves are needed to determine the optimum tip switch orientation for discriminating among specific activities.

Introduction

Use of satellites to monitor movements and activities of free-ranging wildlife has expanded rapidly since 1984. The Argos Data Collection and Location System was used by the U.S. Fish and Wildlife Service and Alaska Department of Fish and Game during 1984–1990 to obtain more than 100,000 locations of caribou (*Rangifer tarandus*), polar bear (*Ursus maritimus*), muskoxen (*Ovibos moschatus*), and several other terrestrial mammals (Fancy et al. 1988, 1989, Harris et al. 1990). Recent advances in transmitter miniaturization and power supplies allow use of satellites for smaller species (e.g., wolves, geese [*Branta canadensis*]) under a wide range of study conditions.

In addition to providing animal location, sensors in the PTTs can monitor activity, ambient temperature, and other information by satellite (Fancy et al. 1988, Harris et al. 1990). We report here on the first use of satellites to monitor ambient temperature and activity of wolves. Accuracy, precision, and performance of wolf PTTs were described by Ballard et al. (this volume). Data on wolf movement patterns and comparisons of satellite telemetry with conventional VHF (very high frequency) telemetry will be presented elsewhere.

Methods

Fancy et al. (1988) presented a detailed description of the Argos system and its potential applications to wildlife research and management. Briefly, Argos instruments on two polar-orbiting satellites pass over Alaska approximately 24 times daily, receive signals from PTTs in the UHF (ultra high frequency) range, and relay data to ground stations in Alaska, Virginia, and France. Data are processed at Service Argos' computer facility in Landover, Maryland, and are received monthly on computer tapes or diskettes. Results may also be obtained three to eight hours following an overpass, using a telephone modem and computer access to the Argos computer (Fancy et al. 1988).

Beginning in April 1987, we deployed PTTs (Telonics Inc., Mesa, Arizona; mention of trade names does not constitute endorsement by the U.S. government) weighing 1.2 kg on 23 wolves weighing 28.6–51.7 kg (Table 1). Each collar was equipped with a UHF satellite transmitter and a conventional VHF radio transmitter that allowed wolves to be located from aircraft. Separate power supplies and antennas were used for each transmitter. Wolves were immobilized for collaring by darting them from a helicopter (Ballard et al. 1982, 1991c).

Each transmitter package cost approximately $3,500; annual data processing charges averaged $1,400 per PTT. To extend battery life, PTTs were programmed to transmit once each minute during the same six-hour period on alternate days. Unlike previous Telonics PTTs that used three D-size lithium batteries, prototype wolf PTTs used three C-size batteries. This smaller battery pack provided a theoretical life of six months based on six hours of operation every 48 hours at the anticipated ambient air temperatures. The electronics, antenna, and transmitted signal were similar to heavier transmitters that were tested on large mammals (Fancy et al. 1988, 1989, Harris et al. 1990).

Messages transmitted to the satellite contained both short-term (previous minute) and long-term (previous day) indices of wolf activity (Fancy et al. 1988). Six PTTs deployed in 1987 and 1988 also transmitted ambient temperature data, sensed by a thermistor in the PTT. The short-term activity index (range = 1–60) was a count of the number of seconds each minute that a mercury switch in the canister was activated. Higher counts indicated greater activity. The long-term index was the sum of short-term counts for a 24-hour period (maximum value = 86,400), and indicated total daily activity or mortality.

Table 1. Transmission dates and mercury tip-switch angles for satellite radio collars while deployed on wolves in northwest Alaska, 1987-1991.

Transmitter No.	*Wolf No.*	*Pack*	*Sex*	*Weight (kg)*	*Switch Angle*	*Dates On/Off Wolf*	*No. Days on Wolf*
7900	001	Rabbit Mountain	M	43.2	-4	17 Apr 87 - 29 Feb 88	319
7909	007	Jade Mountain	F	37.6	-4	25 Apr 88 - 21 Feb 89	303
7909	067	Pick River	F	39.0	+5	14 Apr 90 - 28 Jun 90	76
7910	016	Ingruksukruk	F	28.6	-4	26 Apr 88 - 13 Aug 88	110
7910	037	Pick River	F	44.9	-4	15 Apr 89 - 11 Jul 89	88
7911	012	Purcell Mountain	F	33.1	-4	13 Jun 88 - 19 Apr 89	311
7912	010	Nuna Creek	F	47.6	-4	28 Apr 88 - 6 Mar 89	313
7912	072	Upper Tag	F	39.0	+5	17 Apr 90 - 15 Jun 90	62
7913	024	Pick River	M	47.6	-4	16 Nov 88 - 18 Feb 89	95
7913	074	Ingruksukruk	M	49.4	+5	17 Apr 90 - 5 Jun 90	50
7914	014	Rabbit Mountain	F	44.9	-4	26 Apr 88 - 16 Feb 89	297
7914	032	Kiliovilik	F	36.7	+5	18 Apr 90 - 11 Jun 90	55
10908	030	Rabbit Mountain	F	37.2	-4	10 Apr 89 - 3 Jan 90	269
10909	048	Kateel River	M	51.7	-4	14 Apr 89 - 25 Jun 89	73
10910	033	Dunes	F	47.2	-4	10 Apr 89 - 1 Feb 90	298
10911	002	Purcell Mountain	F	45.4	-4	14 Apr 89 - 7 Aug 89	116
10912	040	Ingruksukruk	F	34.5	-4	14 Apr 89 - 19 Oct 89	188
10913	046	Upper Tag	F	38.1	-4	14 Apr 89 - 14 Apr 90	366
10914	033	Dunes	F	47.2	+5	18 Apr 90 - 27 Feb 91	316
10915	064	Purcell Mountain	F	39.9	+5	18 Apr 90 - 1 Dec 90	228
10916	057	Salmon River	F	50.8	+5	14 Apr 90 - 21 Jul 90	99
10917	055	Nuna Creek	F	46.7	+5	14 Apr 90 - 5 Jun 90	53
10918	050	Kiliovilik	M	40.4	+5	14 Apr 90 - 3 Jun 90	51

PTTs deployed in 1987–1989 (n = 14) had mercury tip switches oriented parallel to the wolf's spine with the anterior end angled -4° relative to the bottom of the PTT canister (Table 1). In 1990–1991, we deployed nine PTTs angled +5° to determine if activities could be better delineated.

The number of short-term activity counts received during a satellite overpass ranged from one to 13 (mean = 6.5 ± 2.0 [SD]), depending on the geometry of the overpass and the location of the wolf. We calculated a mean short-term activity index for each overpass and used it to subsequently calculate mean activity indices for each wolf and season. We compared means by two-way analysis of variance with season and switch angle as main effects (SAS 1987). To obtain hourly activity indices, we pooled data for all wolves having PTTs with the same switch angle within each season. Statistical significance was evaluated at the 95% confidence interval.

Results

Mean operation time (including days prior to deployment on the wolf and after the PTT was retrieved) for the 23 PTTs was 253 ± 79 (SE) days. This was 40% greater than their expected 180-day life. Five PTTs operated longer than one year, but five others failed within 100 days of deployment. The manufacturer cited premature battery failure as the primary reason for the short life of some PTTs.

Long-term (24-hour) activity counts were 144% (switch angle = -4°) and 820% (switch angle = +5°) higher in summer than in winter. For most wolves, activity counts were not highly correlated with movement rates. Long-term activity counts correlated with daily movement rates for only six of 22 wolves in summer and four of 12 wolves in winter. Similarly, short-term activity counts correlated with movement rates for only five of 22 wolves in summer and two of 12 wolves in winter.

Table 2. Short-term activity counts for wolves wearing PTTs (Platform Transmitter Terminals) with the anterior end of the mercury tip-switch angled -4 and +5 relative to the bottom of the PTT canister.

Switch Angle	*Season*	*n*	*Mean*	*SE*
-4	Summer	12	22.28	2.55
	Winter	9	12.27	1.38
+5	Summer	9	15.33	1.38
	Winter	2	1.91	0.29

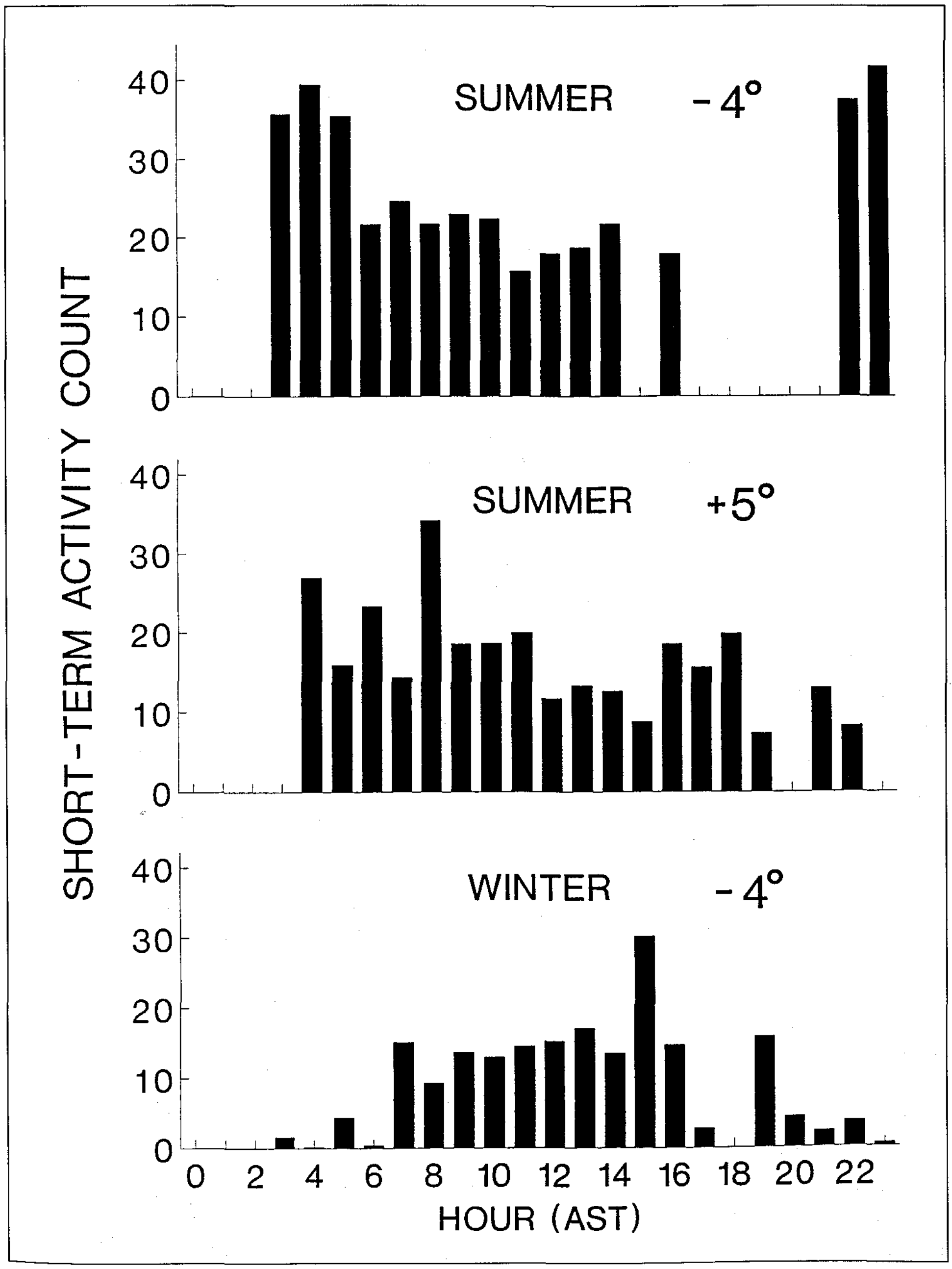

Fig. 1. *Mean hourly activity counts for 23 Gray Wolves in summer (May - September) and winter (October - April), northwestern Alaska, 1987-1991. The anterior end of mercury tip-switches in satellite transmitters were oriented -4 (n = 13, summer; n = 10, winter) or +5 (n = 9, summer) relative to the bottom of the canister.*

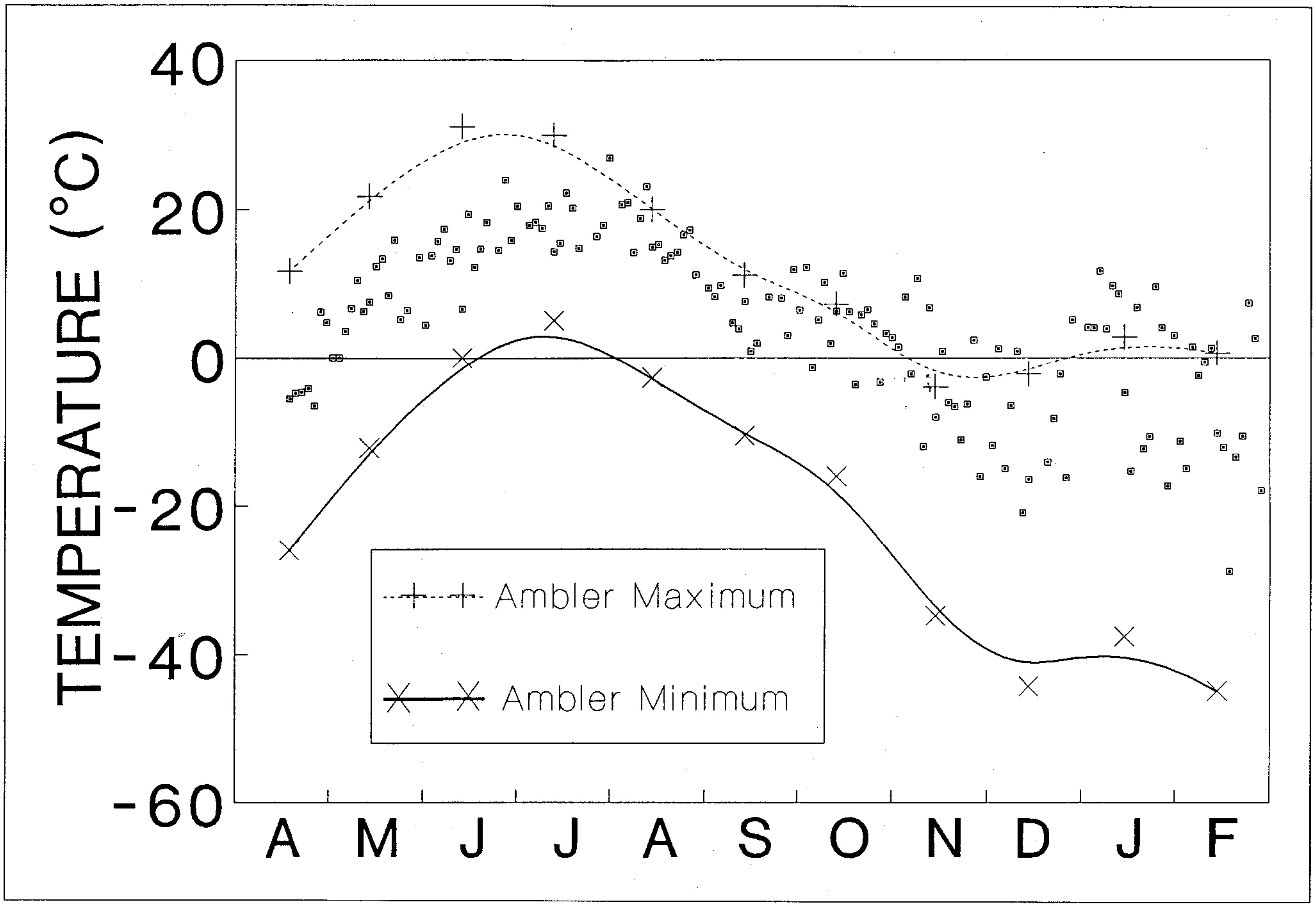

Fig. 2. *Temperatures recorded by a sensor in a PTT (Platform Transmitter Terminal) deployed on a wolf in northwestern Alaska. Monthly extreme temperatures (minimum and maximum) recorded at Ambler, Alaska, are shown.*

Mean short-term activity counts for PTTs with a -4° tip-switch angle were higher than those for PTTs with a +5° angle in both summer and winter ($F = 7.39$, $P = 0.011$). Activity counts were higher in summer than in winter for wolves wearing PTTs with either switch angle ($F = 13.54$, $P = 0.001$; Table 2). In summer, wolves appeared to be most active between 2200 and 0600 hours AST (Alaska Standard Time); in winter, activity counts were highest between 0700 and 1600 hours (Fig. 1).

Ambient temperatures transmitted by PTTs were within extremes recorded at nearby weather stations. Figure 2 shows transmitted temperatures from PTT 7900 in relation to monthly minimum and maximum temperatures recorded at Ambler, Alaska, 40 km from the wolf's territory. The wolf's winter temperatures were more variable than those in summer and frequently exceeded the maximum recorded temperature at Ambler. Behaviors such as curling the body to reduce heat loss, seeking relatively warm microenvironments, and basking on south-facing slopes probably account for the greater variation in winter temperatures.

We found significant inverse correlations between temperature and both mean short-term activity counts and standard deviation of activity counts for six of six wolves in winter, but for only one of six wolves in summer.

Discussion

Activity and temperature data for wolves were collected incidental to our primary objective of obtaining seasonal movement and home range data for determining wolf numbers (Ballard et al. 1990). Activity patterns of wolves have previously been studied at den and rendezvous sites (e.g., Mech 1970, Harrington and Mech 1982a, Ballard et al. 1991b), but this is the first study to systematically obtain activity data for wolves throughout the year.

Wolves were more active in summer than in winter, and during summer were most active between 2200 and 0600 hours. These findings agree with previous studies of wolf activity (e.g., Kolenosky and Johnston 1967, Mech 1970, Carbyn 1975, Ballard et al. 1991b). Mech (1970) and Harrington and Mech (1982a) thought the usual pattern of daytime attendance and nighttime absence of wolves from homesites was related to the wolf's inability to tolerate high summer temperatures, particularly in tundra areas where they cannot escape the heat because of lack of cover. Our finding that in winter, when temperatures were much lower, wolves were most active between 0700 and 1600 hours during the limited daylight hours, give some support to this hypothesis.

The mercury tip switches and software used to obtain activity counts may provide better discrimination among wolf activities than variable-pulse activity transmitters used by Gillingham and Bunnell (1985) and Beier and McCullough (1988), but calibration studies with captive wolves are needed (Kunkel et al. 1991). Fancy et al. (1988) found a high correlation between the short-term activity index and specific activities (e.g., lying, feeding, walking), and between the 24-hour activity index and daily movement rates for caribou, but several switch angles and counting intervals were tried with captive caribou before the best configuration for discriminating among activities was determined. Kunkel et al. (1991), using Wildlink collars (Wildlink Inc., Brooklyn Park, Minnesota 55444), were able to discriminate among three activity levels for captive wolves. Like the activity sensor used in Telonics PTTs, Wildlink collars contain a microprocessor that records the number of tip switch activations within a programmed time interval and stores the counts for later transmission.

We deployed PTTs with two switch angles on wild wolves, but lacked detailed observations needed to calibrate activity counts with specific wolf activities. The +5° tip switch angle required greater movements of the wolf's neck to activate the switch and therefore produced lower counts than the -4° angle, but neither angle produced counts that correlated with movement rates. Activity counts for wolves from PTTs appear to be useful as gross indices of wolf activity, but calibration studies with captive wolves are needed to determine the best switch orientation for discriminating among specific activities.

Acknowledgments

We thank L.A. Ayres, J.R. Dau, D.N. Larsen, S. Machida, K.E. Roney, T. Smith, M.A. Spindler, and T.H. Spraker for assistance with capture and radiotracking of wolves. D.J. Reed and J.C. Greslin helped with data analysis, and L.D. Mech, D.R. Klein, K.A. Keating, and A. Lovess reviewed drafts of the manuscript. Funding for this project was received from Federal Aid in Wildlife Restoration funds, Pittman-Robertson program administrative funds, and from the Alaska Department of Fish and Game, Selawik National Wildlife Refuge, and National Park Service.

Ecology and Conservation of Wolves in a Changing World

Ludwig N. Carbyn
Canadian Wildlife Service
and
Canadian Circumpolar Institute
University of Alberta
Edmonton, Alberta, Canada
and
Department of Renewable Resources
University of Alberta
Steven H. Fritts
U.S. Fish and Wildlife Service
Helena, Montana, USA
Dale R. Seip
British Columbia Forest Service
Prince George, B.C., Canada
Editors

Published by:
Canadian Circumpolar Institute
University of Alberta
Edmonton, Alberta, Canada