Post-Den Emergence Behavior of Polar Bears in Northern Alaska

A Summary of Research from 2002 to 2008

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ABSTRACT

Polar bear (*Ursus maritimus*) maternity den sites were observed along Alaska's North Slope from February to April of 2002—2008 in an effort to describe bears' post-den emergence behavior and bear-human interactions. From 2002—2008, 19 adult females and 38 dependent cubs were observed at 19 den sites. The 8 adult females and cubs observed in 2002—2003 were observed outside their dens a total of 37.5 hours (8.2% of the total observation time). The 11 adult female polar bears observed from 2005—2008 were observed outside their dens a total of 34.8 hours (0.6% of total observation time). The mean length of stay at den sites post-breakout was 6.6 days. In 2005—2008, the average length of stay in dens for adult females between emergent, active periods was 2.25 hours, and was significantly longer than the average time spent outside dens, 0.20 hours (12minutes). Adult females emerged from dens unaccompanied 67% of the time, cubs lagging in their exit up to several minutes. Standing was the most prevalent adult female activity (25.2%), followed by walking (21.7%), rolling in the snow (10.4%), sitting (8.6%), digging in the snow (6.2 %), nursing (4.4%), resting (3.9%), and running (0.1%). Cubs were engaged in walking more than any other activity (31.6%), followed by standing (11.8%), nursing (10.7%), playing (10.35%), sitting (2.5%), resting (2.1%), and rolling in the snow (0.2%). Bears were not observed foraging during the 2005—2008 study. From 2002-2008 a total of 77 bear-human interactions were recorded. Polar bears largely ignored anthropogenic stimuli (82%), followed by a small number that responded moderately (14%), and very few that exhibited a strong negative reaction (4%). Several dens' activity patterns were strongly correlated with wind chill but not with other weather factors. Examples of research findings applied to management are presented.

KEYWORDS

Alaska, behavior, den emergence, maternity den, North Slope, polar bear, *Ursus maritimus.*

INTRODUCTION

Several studies of polar bear post-denning behavior have been conducted in areas where den concentrations are > 12 dens/km^2, such as on Russia's Wrangel and Herald Islands (Ovsyanikov 1998), and Norway's Kongsøya Island (Hansson and Thomassen 1983). Estimates of polar bear den density for the Southern Beaufort Sea are unavailable, but are likely in the range of <1den/1000 km^2. An intensively studied area along the North Slope is the Jones Island Group, north of Milne Point (Fig. 1), and in a typical year there may be 2-4 dens present within its 32 km length. Consequently, no studies of post-denning polar bear behavior had been conducted along Alaska's North Slope prior to this study given the low density of den sites and associated logistical hardships. Initiation of this research was timely, however, as use by both bears and humans of the North Slope has escalated in the past decade.

Dramatic increases in the global demand for petroleum have reinvigorated oil exploration and production activity in Alaska. Alaska's North Slope is the one of the largest producers of domestic oil in America with approximately 640,000 barrels produced daily (State of Alaska 2008). New technologies (e.g., 3D seismic modeling, sea water injection, and directional drilling) have enabled oil producers to find and extract more oil than previously possible, thus extending the life of the Prudhoe Bay oil field decades beyond initial estimates.

Concurrent with a marked increase in oil exploration and production activity on the North Slope, have been dramatic decreases in polar ice extent and thickness (Comiso et al. 2008). Consequently, polar bear populations will likely exhibit large geographic and temporal changes in patterns of activity (Derocher et al. 2004). As ice extent and thickness decrease, polar bears respond by selecting den sites on land rather than unstable sea ice, thereby increasing the probability for bear-human conflict on the North Slope (Fischbach et al. 2007). To address concerns regarding the potential for conflict between denned bears and ongoing oil industry activity, Smith et al. (2007) initiated research in 2002. Research objectives included:

1. document the timing of den breakout and abandonment
2. estimate the activity budgets of polar bears at den sites

3. document the response of polar bears at den sites to human disturbance
4. determine variables that influence patterns of activity at den sites

Without baseline knowledge of the activity patterns of undisturbed polar bears at den sites, it is impossible to accurately assess polar bear responses to human activity. Hence, without the information provided by this research, the following questions cannot be answered:

1. When do undisturbed bears normally emerge from their dens for the first time?
2. How long do undisturbed bears normally remain at their den sites before abandoning them?
3. How do undisturbed bears partition their time when at the den site?
4. Which bear behaviors are responses to disturbance?
5. What are the likely consequences of disturbance?

Although this study cannot definitively answer every question, it will provide a basis for cogent discussion. Beyond elucidating polar bear denning ecology, this work can foster more effective management of human activities near polar bear den sites. This report presents findings from field work conducted along Alaska's North Slope from 2002—2008 during which time 19 dens were observed closely. Since the 2002—2003 data have been previously analyzed and published (Smith et al. 2007), and because data collection methods have changed significantly (i.e., from human observers to automated camera systems), this report focuses largely on research conducted from 2005—2008.

METHODS

Study Area

We conducted this research along the coastal plain of northern Alaska (North Slope), with the main area of focus extending from Milne to Beechey Points on land and to the Jones Islands in the Simpson Lagoon (Fig. 1). In the southern Beaufort Sea, terrestrial polar bear dens occur primarily along the cutbanks of barrier islands and the nearby coastal plain, although some bears have been documented denning as far inland as 50 km (Durner et al. 2003). This region lacks the

steep topography associated with polar bear denning areas on Wrangell Island, Russia (Uspenski and Kistchinski 1972), Herald Island, Russia (Ovsyanikov 1998), and Svalbard, Norway (Larsen 1985). Consequently, dens are restricted to coastal islands, riverbank bluffs, and landforms capable of holding sufficient snow for den construction (Durner et al. 2003).

Detection of Den Site Locations

For the purposes of this study we define "den site" as the den cavity, entrance, and area immediately surrounding the entrance (<50 m). Prior to den breakout in late February-March, den sites are virtually indistinguishable from the surrounding terrain. Although Durner et al's (2006) polar bear den habitat selection model significantly delimits the search area, locating dens prior to breakout is a difficult challenge. Consequently, we relied on 4 methods to locate dens for observation: 1) radio-telemetry, 2) aircraft-based forward-looking infrared imagery (FLIR Systems, Inc., Portland, OR), 3) hand-held FLIR, and 4) Karelian Bear Dogs (Fig. 2).

Locating Dens with Radio-Telemetry

Scientists from the USGS Alaska Science Center in Anchorage have been radio-tagging polar bears in the Southern Beaufort Sea population since the early 1980s. In recent years approximately 30-40 female polar bears have been radio-tagged annually in the region. In any given year, however, only a small number (<10) of tagged bears become pregnant and construct dens, and only a few (≤ 2) den in this study area. When radio-tagged bears den within the study area we use a conventional VHF radio-telemetry receiver and directional Yagi antenna to precisely locate den sites. Without approaching closer than 100 m, we have been able to use triangulate den locations for camera unit positioning. Often a surface disturbance, a pushup, is visible over the den entrance further assisting camera placement. Pushups occur when the adult female breaks open the entrance, presumably to permit fresh air to enter the otherwise tightly sealed den.

Locating Dens with FLIR

In the late 1990s, USGS researchers investigated the use of forward looking infra-red cameras (FLIR) for locating polar bear dens (Amstrup et al. 2004). FLIR cameras detect temperature differences as slight as 0.025 deg C and depict them visually as differing shades of gray or colors. Hence, when using a gray scale palette with the FLIR imager, polar bear dens appear in lighter shades of gray than the surrounding snow drifts (darker, colder) in which they exist (York et al. 2004). Although an effective tool for den detection, polar bear den surveys using helicopter-mounted FLIR are very expensive. For example, a FLIR survey along 38 km of a proposed ice road route cost approximately $30,000 in December 2005 (W. Streever, Environmental Studies Chief, BPXA, personal communications). Considerably more cost-effective FLIR surveys can be conducted using fixed-wing aircraft; however the benefits of slow flight and the ability to hover for a better image are lost. A DeHavilland DHC-6 (Twin Otter) belonging to Shared Services (aircraft operations jointly funded by North Slope oil companies British Petroleum and Conoco-Phillips) has a FLIR unit on board that is used for the pipeline surveillance. This fixed-wing aircraft-FLIR combination has been successfully used to survey and locate polar bear dens along the North Slope coastline and is considerably more cost-effective than the helicopter-mounted configuration (i.e., approximately 25% the cost of helicopter-FLIR), but scheduling can be difficult given the high demand for this aircraft's services. To circumvent this problem we tested the utility of hand-held FLIR for den location. The hand-held FLIR model used was a FLIR P695 (© 2009 FLIR Systems). Hand-held units are readily available on the North Slope, are as sensitive as aircraft-based FLIR, and can be used to search relatively small areas of interest. Using a snowmachine and hand-held FLIR unit we have been able to locate and verify a number of den site locations. False positives, warm spots that turned out to not be den sites, have been a problem, however. To resolve that problem, we have occasionally used Karelian Bear Dogs (KBD) to verify the presence of denned bears at warm spots found with hand-held FLIR.

Locating Dens with Dogs

Harington (1968) details the long history of the use of First Nations sled dogs for locating polar

bear dens. More recently, specially bred bear dogs are used for locating dens. The KBD is a Finnish, or Karelian, breed of dog. In Finland they are more often used for hunting moose and elk although they will hunt any kind of animal. Tests using live bears and moose are conducted in Finland, Sweden and Norway to determine an individual's ability as a bear-dog and weighs heavily in the dog's breeding potential. It was the breed's ability to hunt and offer protection against bears that earned the breed its name (Wikipedia 2008). By deploying KBDs to FLIR-detected hotspots, R. Shideler (Alaska Department of Fish and Game) and C. Perham (US Fish and Wildlife Service) have been able to verify the presence of bears beneath the snow, a crucial step prior to deploying remote camera technology to record den site activities. When dogs survey an area of interest they zig-zag, nose down, as they search for scent. When encountering bear's scent KBDs strike a rigid 'alert' pose and bark sharply, verifying a bear's presence in a nearby snow den.

Behavioral Data Recording and Analysis

For the first 2 years of study (2002—2003), we employed a variety of structures from which to observe polar bear dens (e.g., canvas tents, trucks, and track vehicles). However, difficulties associated with the use of tents, trucks, and Tucker snowcats as observation blinds, as well as the increased likelihood of interacting with bears while manning these stations, underscored the need for a less invasive method of observation. To address these problems we constructed video-camera systems that permitted scan sampling of bear activity at den sites without human presence (Fig. 3). Sony digital Handycams® with interval recording capability were used to record bear activity at den sites. Cameras were set to record 0.5 sec of videotape (15 image frames) every 30 seconds until the videotape was full, or approximately 4.7 days. Cameras were housed in heavily insulated coolers containing two 100 ampere hours (aH), 12V gel cell batteries. These batteries provided power for both the video camera and a 0.25 aH light bulb which generated enough heat to maintain an operating environment of approximately 20 deg C within the enclosure. After 4 days each camera was revisited, checked for internal temperature and operational status, batteries and videotape replaced. Each site visit required about 10 minutes and was accessed by snowmachines. Camera units were positioned approximately 125m from den entrances.

Each frame of video has a unique date/time stamps so that the precise timing of specific events is possible. Using this approach to capture data, polar bear activities were instantaneously scan sampled, not continuously sampled (Lehner 1996). Following the field portion of research, videotapes were reviewed and bear activity encoded on data sheets for later analysis. We used bear activity states, events and modifiers to describe polar bear behavior in a manner consistent with definitions used by previous workers (Hansson and Thomassen 1983, Larsen 1985, Ovsyanikov 1998). These definitions included the following:

Resting: The bear is in a predominantly inactive state while lying on the ground. This behavioral category can be modified with the following: **lying**, **sleeping**, **scanning** (looking around with head up but body down), and **comfort behaviors** (grooming, scratching, rubbing, and stretching.).

Sitting: The bear is sitting on its rear haunches. This category can be modified as follows: **scanning** (the bear is peering around), **sleeping** (eyes closed), **attentive** (aka alertness; an event, it is paying attention in the direction of a perceived stimulus), and **comfort behaviors** (grooming, scratching, rubbing, and stretching).

Standing: The bear is stationary and is on all fours. This may be modified as follows: **scanning** (the bear is peering around), **attentive** (aka alertness; an event, it is paying attention in the direction of a perceived stimulus), and **comfort behaviors** (grooming, scratching, rubbing, and stretching).

Digging: The bear is excavating snow with its forepaws. Digging may be modified as follows: **single paw** (using only a paw at a time to dig) and **double paws** (vigorously digging with both paws).

Walking: The bear is moving at a normal traveling gait, approximately 30 paces/minute (per one leg). This can be modified as follows: **searching** (the bear frequently stops to sniff and dig in the snow), and **sliding** (a method of locomotion).

Running: The bear is moving at a fast gait (from a slow gallop to a full run); this gait is > 30 paces/minute. Running can be modified with: **avoidance** (in response to a perceived threat), and **aggressive** (in response to a perceived threat such as another bear), **unknown** (motivation unknown). When the motivation is unknown it is acceptable to not modify the activity.

Playing: The bear is exhibiting rapid movements and frequent, irregular shifts of behavior. Play is predominantly a cub behavior although adult females occasionally engage in play. Modifiers of play include: **sliding** (a modifier of play when repeated in the same place), **agonistic** (play fighting between bears including nipping, chasing, swatting, standing to face other bear, etc.), and **searching** (the main activity is play but it is interrupted by exploration of the surroundings with a quick return to play behavior).

Ingesting: This includes chewing activity which is often interrupted by digging or searching. When the observed activity is 'ingestion' the bear is actively eating/chewing grass (or other herbaceous material), snow, feces, urine or other unidentifiable material. Ingestive behavior is modified with the following: **grass**, **herbaceous material**, **feces**, **snow**, **urine**, **other** (specify in notes), or **unknown materials** when known.

Nursing: The adult female is feeding her cubs with her milk. Before taking a nursing position the female usually finds, or digs, a pit in which she will sit. Modifiers of nursing include: **1 cub**, **2 cubs**, **3 cubs**, **position** (on back, frontally, upright sitting), and **initiator** (cubs or mother).

Vigilance: A bear that suddenly stops what it is doing and scans the terrain is exhibiting an "alert" behavior. Both scanning and alert behaviors are forms of vigilance, or watchfulness.

Unobservable: a bear is out of its den but walks out of the camera's fixed field of view.

There are a number of discrete ***events*** or behavioral patterns without measurable or relevant duration that can be observed. Behavioral events include: **bipedal stance** (standing full height, likely in response to a stimulus such as another bear, vehicle, human, etc.), **urination**,

defecation, **vocalization** (one cannot often hear vocalizations but bears' open mouths and choppy movement of the lower jaw while issuing sharp exhalations or huffs are indicative of vocalizations), **head swing** (in direction of a stimulus), **den entry** (the bear enters the den), and **den exit** (the bear exits the den). We also record **nose pokes** and **head pokes**, during which the bear either pokes just its nose or head out of the den without fully emerging**. Nose pokes** often precede **den exit** events.

For the purposes of this study the term **den breakout** refers to the first time that bears fully emerge from dens, a definition which specifically excludes nose and head pokes from being breakout events. Denned bears occasionally punch up through the snowpack creating what are termed **pushups**, small mounds of snow directly over the den entrance tunnel, that can be seen December through March. Of the 19 dens we've studied to date, many have had easily discernible pushups that helped locate the den prior to emergence and none had identifiable 'vents' for air exchange. As den breakout approaches, occasional nose and head pokes may a) recharge the chamber with fresh air, and/or b) allow the mother to sample the weather conditions so she can determine whether or not to bring the cubs out.

Polar bear activity budgets were derived by totaling the number of scans per activity type and dividing the time in any one activity type by the total time observed. Comparisons of mother and cub behavior were conducted using the Students t-test for statistical significance.

Polar Bear Response to Human Activity

Polar bear reactions to human activity were anecdotally collected. From 2002-2003 all bear-human interactions were recorded by on-site observers. After 2003, however, video-cameras were used, except when bear-human interactions occurred while servicing den monitoring camera gear. For each incident the following data were recorded:
1) location, 2) anthropogenic source (e.g., truck, aircraft, person, etc.), 3) date and time, 4) distance to bear in meters, 5) bear's response, and 6) response intensity. For response intensity a bear's response was classified as one of the following 3 categories:

1. Minimal overt response: the bear may or may not have acknowledged the stimulus (e.g., head turn, stare, paused activity), but otherwise did not respond.
2. Moderate response: signaled by a change in behavior, but brief in duration.
3. Strong response: include cessation of pre-interaction behavior, running, and/or re-entering the den.

Weather Monitoring and Recording

The U.S. Minerals Management Service (MMS) maintained 5 meteorological monitoring sites in the vicinity (< 50 km) of dens we observed. Wind speed (m/s) and temperature (ºC) were recorded as hourly averages. Precipitation was also recorded hourly. Windchill was calculated using the following formula:

$$\text{Wind chill temperature (ºC)} = 13.12 + 0.6215T_a - 11.37V^{0.16} + 0.3965T_aV^{0.16}$$

Where T_a is the air temperature in ºC and V is the airspeed in km/h.

Statistical Analyses

I used the *Student's t-test* to compare den emergence dates, length of stay at dens, bear behaviors, and weather variables for significance; linear regression, and the *Pearson correlation coefficient* to measure the degree of association between various measures of bear activity and weather variables; and *one-way analysis of variance* to explore activity patterns within, and between, polar bear cohorts (Zar 1984). We used both the S statistical package (Becker et al. 1988) and the statistical analysis module of Microsoft Excel to perform all analyses and generate graphics. Statistical significance was set at $\alpha = 0.05$.

RESULTS

From 2002—2008 we observed 19 dens for a total of 260 days of observation, or for an average of 13.7 days per den (Table 1). Eight dens were directly observed by people in 2002—2003,

whereas an additional 11 dens were monitored using remote camera systems from 2005—2008. Camera systems were active a total of 241 days from 2005—2008. Inclement weather occasionally impeded visibility and there were a few time when cameras experienced mechanical failures. Additionally, few observations were recorded at night when light levels were too low for cameras to record. Camera monitoring continued daily until bears abandoned dens. After den breakout, maternal polar bear groups remained at the 19 den sites a total of 164 days, or 63% of total observation time. Over the course of the entire study (2002—2008), 19 adult females and 38 dependent cubs were observed at 19 den sites. The 8 adult females and cubs observed in 2002—2003 were outside their dens a combined total of 37.5 hours (8.2% of the total observation time; Smith et al. 2007). The 11 adult female polar bears observed from 2005—2008 were outside their dens a total of 34.8 hours (0.6% of total observation time). From 2005—2008, 22 cubs were observed outside dens for a total of 18.0 hours (0.3% of total observation time). These figures cannot be compared however, due to the different modes of observation used from 2002—2003 (humans) and from 2005—2008 (video cameras).

No polar bear den site activity data were collected in 2004 due, in part, to what appeared to be a series of den predation events (Amstrup et al. 2006). In January 2004, a large male polar bear attacked, killed, and consumed an adult female at her den site on Pingok Island, her two cubs perishing in the conflict. Amstrup et al. (2006) speculated that other dens in the area, abruptly abandoned mid-winter, may also have been the targets of intraspecific predation, hence no dens were available in the study area in 2004 for observation.

Timing of Denning Events
2005—2008

The mean date of den emergence for all bears studied was 13 March (SD ± 7.7 d, n = 11), the mean date of den abandonment 19 March (SD ± 7.8 d, n = 11; Table 1). The timing of den emergence and abandonment for all 19 dens is presented in Figure 4. Polar bear families remained at den sites from 2—18 days ($\bar{x}$ = 6.6 ± 4.5 d, n = 11), following initial emergence, or breakout, from their dens. We regressed den exit dates with years of the study (2002—2008, 19 dens) to see if any trends in emergence existed. A weakly positive trend was apparent in the

data, suggesting earlier emergence dates across the 7 years of study, but the trend was not statistically significant (*R-squared* = 0.0728, Fig. 5).

Temporal Activity Patterns

2005—2008

Of the 1,406 hours cameras monitored 11 dens, adult females and cubs remained in-den 97.5% and 98.8% of the time, respectively (Table 2). Following den breakout, family groups remained mostly in the den (adult females = 97.5%; cubs = 98.8%; Table 2). The average length of stay in dens for adult females between emergent, active periods was 2.25 h (2 h, 14 min, 56 sec; *n* = 124), and was significantly longer than the average time spent outside dens, 0.20 h (11 min 47 sec; *n* =176, *Students t* = -13.29, *P* = 0.00). The average length of stay in dens for cubs between emergent, active periods was 2.57 h (2 h, 34 min, 57 sec; *n* = 66), and was significantly longer than the average time spent outside dens, 0.27 h (16 min 24 sec; *n* =40, *Students t* = -7.45, *P* = 0.00).

Diurnal activity patterns for each maternal group studied are presented in detail in Appendix A. Patterns of activity were summed for all polar bear families (*n* = 11) to generate a composite time-of-day activity graph (Fig. 6). No specific diurnal activity pattern is apparent; hence a bear can be expected to emerge at anytime during the daylight hours.

Adult females and dependent cubs exhibited different patterns of activity with regard to the frequency and order of appearance when exiting dens. From 2005—2008, we observed adult females exiting dens a total of 176 times, whereas their cubs exited 65 times, or approximately one-third as often. Adult females emerged from their dens unaccompanied 67% of the time, cubs lagging in their exit up to several minutes. When cubs exited dens, 26% of the time their mothers preceded them. In 7% of all den exits observed, mothers and cubs exited together. In only 2 of 184 exit events (< 1%) cubs exited alone, during which time they remained outside for 1—2 minutes (Fig. 7). Mothers and cubs significantly varied in the mean number of exits per active day, with mothers averaging 2.3 exits per day and cubs 1.0 (*n* =22, *Students t* = 3.17, *P* = 0.002; Fig. 8). A comparison of the time mothers and cubs spent out of den as they approached

den abandonment did not show any trends; that is, mothers and cubs did not spend increasingly longer periods outside as den abandonment approached (adult females: *R-square* = 0.007, cubs: *R-square* = 0.001; Figs. 9 and 10).

Activity Budgets
2005—2008

Standing was the most prevalent adult female activity (25.2%), followed by walking (21.7%), rolling in the snow (10.4%), sitting (8.6%), digging in the snow (6.2 %), nursing (4.4%), resting (3.9%), and running (0.1%; Fig. 11). No ingestive activity was observed. Due to the camera's fixed field of view, 19.8% of the time adult females were unobservable, having wandered out of view. Adult female polar bears were active 42.8% of total observable time while out of the den.

Cubs were engaged in walking more than any other activity (31.6%), followed by standing (11.8%), nursing (10.7%), playing (10.35%), sitting (2.5%), resting (2.1%), and rolling in the snow (0.2%; Fig. 11). No ingestive activity was observed. Cubs were unobservable 30.8% of the time, due to having moved out of the camera's view, or by being obscured by the mother. Cubs were active 52.8% of the observable time while out of the den.

Prior to exiting the den, bears often poked their noses and heads out, presumably sampling the weather and surroundings (Appendix A). Bears were rarely active during the twilight and dark hours of this study. Of the 184 instances bears were observed out of den, they were active in low light conditions (i.e., civil twilight) on only 6 occasions (3% of exits), 2 of which were at dawn and 4 at dusk. Cameras captured bear activity that continued into darkness on only 2 occasions (Appendix A). It was light enough to detect activity on 5 of 108 (5%) nights due to ample moonlight, but bears were not active outside the den.

Polar Bear Response to Human Activity
2002—2008

From 2002-2008 a total of 77 bear-human interactions were recorded: 59 in 2003, 13 in 2003, 1

in 2004, 1 in 2005, 0 in 2006, 3 in 2007 and 0 in 2008 (Table 3, Appendix B). Because humans directly observed bears at their dens in 2002-2003 the majority of bear-human interactions occurred in those years (n = 72, 94%). Having people on-site for hours provided ample opportunities for bears to interact with them. Additionally, human observers were able to place a sudden den re-entry or vigilant gaze into the broader context necessary to infer disturbance. Consequently, very few incidents were recorded from 2005-2008 since cameras replaced human observers and cameras were unable to provide the broader context into which bear behaviors could be placed.

Of the 77 bear-human interactions recorded, 30 involved trucks, 15 with tent camps, 13 Tucker Snow Cats, 7 with research persons, 7 with snowmachines, 3 with aircraft, and 2 with truck-mounted snow blowers (Table 3, Fig. 12). The mean distance for interactions was 987 m (SD ± 620 m). Polar bears largely ignored anthropogenic stimuli (n = 63, 82% no overt response), followed by a small number that responded moderately to stimuli (n = 11, 14% moderate response), and very few that exhibited strong negative reactions to stimuli (n = 3, 4% strong response; Fig. 13). No pattern was apparent regarding the intensity of response to specific stimuli (Fig. 14).

Bear response to industrial activity in 2002-2003 was analyzed by Smith et al. (2007). In summary, the authors reported that polar bears at den sites exposed to vehicular activity on a nearby ice road (n = 2) were significantly less wary than bears at dens in undisturbed areas (n = 4). Maternal groups not exposed to truck traffic on the ice road spent four times as much time engaged in vigilant behaviors than bears denned near roads. Additionally, bears not denned near roads exhibited vigilance behaviors five times more frequently than bears denned near the road.

Relationship of Polar Bear Activity and Weather

Previously we explored relationships between polar bear activity patterns and weather, but failed to identify any significant relationships in the 2002—2003 data (Smith et al. 2007). The same held for the 2005—2008 data except for bears' response to wind chill. Using wind speed and ambient temperature, wind chill was calculated and compared to the total time bears were out of

den. As a result, several dens' activity patterns were strongly correlated with wind chill (Fig. 15). For example, the Pingok West (2005) polar bear group's outside activity was significantly correlated with wind chill (*R-square* = 0.46, *p* = 0.03), as was that of the Staging Pad maternal group in 2005 (*R-square* = 0.046, *p* = 0.05), and the Cottle East den in 2007 (*R-square* = 0.38, *p* = 0.32). Activity patterns observed at other dens were either not correlated with the wind chill index or lacked sufficient data for a meaningful, comparative analysis. To get a better representation, we pooled all den emergence and wind chill data and calculated Pearson correlation coefficients (*n* = 97; correlation value = 0.29, *P* = 0.0037).

Mean temperature for den breakout days across years was –32.1 C, and was not significantly different from the mean temperature for March across years (range = -44 to -19 C; $\bar{x}$ = –28.9 C, *t* = -1.169, *P* = 0.13). Den breakout events were as early as sunup (6:13 A.M.) and as late as mid-afternoon (14:21 P.M.), with a mean around midday ($\bar{x}$ = 10:12 A.M.).

Den Location and Structure

The dimensions of only 11 of 19 dens were measured because we did not visit them until at least a week had passed post-abandonment and drifting snows frequently obscured them. Ten of 11 dens investigated were either west (*n* = 2) or south facing (*n* = 8). Only one den (Pingok North) was oriented to the north. In all cases, large snow banks slope from island cutbanks down to the sea ice, providing ample snow for den construction. Most dens were constructed of a single chamber (Fig. 16), were less than a meter in height ($\bar{x}$ = 87.5 ± 25.0 cm), 4 meters in length ($\bar{x}$ = 225.0 ± 24.5 cm), by 4 meters in width ($\bar{x}$ = 375.0 ± 50 cm), with a mean volume of 7.4 m^3. The mean snow depth overlaying chambers was 76 cm (range 35—102 cm; Table 4). No dens had open vents to the surface, as verified by the use of FLIR prior to den breakout, as an open vent would have been easily identified.

DISCUSSION

Timing of Denning Events

Polar bear family groups in this study emerged from dens earlier than those on Herald Island,

Russia (Ovsyanikov 1998). Mean emergence dates for polar bear maternal groups on Herald Island and the North Slope varied by 12 days (this study: Alaska: $\bar{x}$ = 13 March (SD ± 7.7 d, *n* = 11), Russia: $\bar{x}$ = 25 Mar ± 1.5 days, *n* = 7). Satellite radio-tagged polar bears (*n* = 40, from 2000—2002) of the southern Beaufort Sea population had a mean emergence date of 20 Mar ± 2.0 days, (S. Amstrup, unpublished data). We determined emergence dates in this study by direct observation (i.e., by person or camera) whereas radio-tagged bears' dates were inferred by sudden changes in collar temperatures, a less precise method. By contrast, den emergence at both the North Slope and Herald Island (north latitudes 70° and 71° respectively), lagged nearly 1 month behind the mean emergence date for polar bears in the vicinity of Churchill, Manitoba (north latitude 54º; $\bar{x}$ = 25 February, *n* = 9; Lunn et al. 2004). Given the dramatic changes in sea ice extent and thickness during the period of this study (Comiso et al. 2008) one might expect changes in the timing of den breakout. However, an analysis of 19 den breakout dates and year failed to reveal any significant trend (ANOVA, R^2 = 0.0728, Fig. 5), although regression analysis suggests a statistically insignificant trend towards earlier dates. Barry et al. (1979) reported that the first continuous fast ice reached the shores of the Prudhoe Bay area in mid-October up through the decade of the 1970s. In recent times, however, formation of the first continuous fast ice is now delayed until 1 December (Mahoney et al. 2007). Sea ice provides a pathway from pack ice to land, so delayed ice formation likely hinders the migration of pregnant polar bears off sea ice south to Alaska's North Slope for denning. We conducted an analysis of 233 den entry events in the Southern Beaufort Sea using data provided by S. Amstrup (USGS, unpublished data; Fig. 18). From 1982—2005, 64% of radio-tagged bears were denned by 1 December. Hence a delay in ice formation as reported by Mahoney et al. (2007) can be expected to have a profound effect upon the onset of denning. Barry et al. (1979) indicated that ice breakup in the Prudhoe Bay region occurred historically around 30 June. More recent studies, however, reveal that breakup now occurs around 4 June, nearly 1 month earlier (Mahoney et al. 2007). As the ice-free period expands in the Southern Beaufort Sea there will be impacts on denning bears, affecting both their ability to migrate to, and leave, the continental land mass where denning takes place for a growing number of polar bears (Fischbach et al. 2007). However, at this point in time sea ice reductions do not appear to have significantly impacted denning chronology in this study area along North Slope of Alaska.

ice-up

break up

Ice-in 1 Dec - 4 June

The time that polar bear family groups in this study remained at den sites following breakout (2—18 d), was similar to those in Hudson Bay (4—18 d, Lunn et al. 2004), but shorter than those on Herald Island (8—27 d, Ovsyanikov 1998) . The mean length of stay at dens post-emergence for Alaskan bears ($\bar{x}$ = 6.6 ± 4.5 d, n = 11) was comparable to those of Hudson Bay ($\bar{x}$ = 8.7±1.8 d), but significantly shorter than those on Herald Island ($\bar{x}$ = 15.5 ± 6.3 d).

Diurnal patterns of den emergence activity varied greatly among maternal groups (Appendix A). Hansson and Thomassen (1983) observed similar patterns, noting the high variability among family groups. North Slope maternal groups were not observed ranging > 100 m from den entrances prior to den site abandonment, although adult female bears were out of the camera's view nearly 20% of the time and may have ranged farther (Table 2). In contrast, post-denning bears on Wrangel Island were observed ranging up to 1 km from den entrances, creating extensive networks of trails and daybeds in a gradual and progressive movement away from den sites (Uspenski and Kistchinski 1972), a pattern not observed on the North Slope, nor supported by track patterns surrounding dens. When North Slope maternal groups abandoned den sites, their initial departure placed them several kilometers northward, not to return again, as validated by radio-tagged bear movement data (S. Amstrup, pers. comm.).

Temporal Activity Patterns
2005—2008

Polar bear cubs exited dens on the North Slope even less than their mothers (Table 2). In the earlier years of this study (2002—2003), Smith et al. (2007) found that the mean out-of-den period for North Slope maternal groups was 10 minutes 25 seconds, significantly longer than dens studied from 2005—2008 ($\bar{x}$ = 4 minutes 46 seconds, t-statistic = 168, p = 0.00). These differences, though statistically significant, vary only by a few minutes and likely reflect the difference in sampling techniques (i.e., observers recording data real time versus cameras set on interval recording) more than real differences in time. What is clear, however, is that denned polar bears on the North Slope spend most of their time in their dens, punctuated occasionally by short out-of-den periods (Appendix A).

From den breakout to abandonment, polar bears rarely emerged from dens during daylight hours

(Norway = 80.6% and 85.5% for adults and cubs respectively; Russia = 94.9% for adults, no data for cubs; this study = 97.5% and 98.8% for mothers and cubs respectively). We did not record any bear activity out of den during nights when observation was possible (*n* = 5 nights). This is consistent with nighttime observations made by Russian researcher N. Ovsyanikov who has been studying maternal dens on Wrangel Island for > 20 years and reports he has never seen a bear outside of a den at night (N. Ovsyanikov, personal communication).

Blix and Lentfer (1979) reported that at the time of den breakout, cubs have a lower critical temperature of -30 C and are quite tolerant to wind chill. However, the colder temperatures of northern Alaska (cite wind chill values for dens) may account for maternal groups spending less time outside than polar bears in either the Svalbard or Wrangel Island studies.

Activity Budgets

2005—2008

In any given year, den site densities are low along Alaska's North Slope, thus precluding social interactions with other family groups. Where dens are densely situated (e.g., Wrangel and Herald Island, Russia and Svalbard, Norway), adult female polar bears spent time guarding dens, socializing with other maternal groups, and occasionally occupying other bears' dens prior to leaving the general area. North Slope bears spent most of their time inactive (i.e., either in their dens or resting, 91.1%), similar to those at Svalbard (93.5%). Temperature profiles at the North Slope and Svalbard were relatively similar (Smith et al. 2007, Hansson and Thomassen 1983) and likely did not contribute to differences observed between in-den times.

Mothers and cubs partitioned their time differently, although both cohorts spent the majority of their time walking (25.8% vs. 44.9% for mothers and cubs respectively) and standing (25.9% and 17.8% for mothers and cubs respectively; Fig. 11). North Slope adult female polar bears were never observed playing with their cubs, an observation consistent with those of maternal groups at Svalbard (Hansson and Thomassen 1983). Although mothers occasionally sat in the den entrance scanning the terrain (4% of their time), cubs did not. Mother's occasionally dug in the snow (6%), whereas cubs did not. Mothers sat more often (9.1%) than cubs (2.6%). Mothers

groomed their fur by rolling in the snow often (17.9%), whereas cubs rarely did (1.2%). These differences reflect the differing needs of these cohorts: mothers to be watchful and conserve energy and cubs to explore their world while developing motor skills, and perhaps acclimating to the harsh arctic environment.

Polar Bear Response to Human Activity

From 2002—2008, a total of 77 bear-human interactions were recorded: 59 in 2003, 13 in 2003, 1 in 2004, 1 in 2005, 0 in 2006, 3 in 2007 and 0 in 2008 (Table 3). Because people directly observed bears at their dens in 2002—2003, the majority of bear-human interactions occurred during those years (n = 72, 94%). People on-site were able to place a sudden den re-entry or vigilant gaze into the broader context necessary to infer disturbance. Consequently, very few incidents were recorded from 2005—2008 since cameras precluded the broader context into which den site bear behaviors could be placed and because cameras did not require us to be on site but every few days and for only 10 minutes or less per visit.

Frid and Dill (2002) maintained that an animal's vigilance increases as the perceived risk of predation increases. However, bears can, and do, habituate to stimuli that have no significant consequences (positive or negative) readily associated with them. The majority of polar bear-human interactions documented in this study yielded no overt response (82%) to a variety of human activities. However, the mean distance separating people and bears during interactions was nearly a kilometer, which distance may account for bears' general lack of concern (Table 3). Interestingly, bears that responded strongly to an approaching snowmachine one day failed to elicit an overt response on others. Clearly, an individual bear's response at any given time is the result of many factors, not just the human activity involved. Research expressly focused on this issue would promote a better understanding of this multivariate problem.

Polar bear-human interactions data from 2002-2003 strongly suggest that polar bears exposed to heavy truck traffic habituated to it (Smith et al. 2007). However, paying less attention to the environment may have negative consequences; it may also be true that the higher frequency of vigilant behaviors observed at 'undisturbed' sites isn't reflective of risk associated with denning,

but rather of times spent out on the ice with conspecifics and is habitual rather than adaptive.

Linking disturbance to den site abandonment is tenuous at best given that the bears we studied remained at den sites an average of only 6.6 days (Table 1; Appendix B). In one unfortunate instance, we drove snowmachines to the mouth of a newly opened den, placing us mere meters from the mother and cubs within. Undoubtedly these bears heard and felt snowmachines idling at their entrances yet this family remained at the den site 12 days beyond this incident (Staging Pad den, March 2005, T. Smith and J. Wilder). Conversely, there were a few incidents where persons interacted with a bear at the den and the family group left later that day (Appendix B). Were those departures precipitated by human activity or just the normal course of events, given that these bears had been at their den sites and active for days previously? These are important, yet elusive, questions that cannot be answered at this time with the data we have collected to date. It is our opinion that only carefully constructed hypotheses tested through experimental manipulation will be able to satisfactorily address such questions.

Relationship of Polar Bear Activity and Weather

We found that the duration a polar bear spent outside its den was strongly correlated with wind chill when < -30 C. This observation is consistent with Blix and Lentfer's claim that cubs have a lower critical temperature of -30 C, below which they are intolerant of wind chill and curtail outside activity.

Den breakout on the North Slope occurred at a range of colder temperatures (-44 to -19 C; $\bar{x}$ = -28.9 C) than those reported for Svalbard (Hansson and Thomassen 1983) and Wrangel Island (Belikov, et al. 1977), which temperatures ranged from -20 to -25 C at those sites. Hansson and Thomassen (1983) suggested that temperature should not normally be a limiting factor in den breakout, and indeed den breakout occurred across a wide range of temperatures in this study.

Den Location and Structure

All dens observed (n = 11) were very similar in structure to the 22 maternal dens documented by

Durner et al. (2003). To avoid bears at dens we waited weeks before approaching and measuring them. Unfortunately, many den entrances could not be located, having filled with snow. All of the dens we measured had a primary chamber where the family group gathered; several had secondary, or more, chambers (Figs. 6 & 7). Consistent with Durner et al. (2003), primary chambers were distinguished from secondary chambers by the presence of ice on the floor and ceiling and were often discolored by fur oils and urine. Primary chambers included a depression where the family group spent most of their time (Fig. 16). One particular den at the Staging Pad in 2005 was noteworthy in that it had 4 entrances, 5 chambers and one tunnel 11 m in length connecting two chambers (Fig. 18). This, however, was an anomaly as most were single chambered. Ventilation holes as described by Harington (1968) and Uspenski and Kistchinski (1972) were not seen before or after den breakout, or found when investigating dens. The lack of ventilation holes was also noted by Hansson and Thomassen (1983) for bear dens in Svalbard, Norway. Some of the dens we investigated had exposed soil or gravel, the cubs sometimes creating long crawlways beneath the overhanging banks of islands. Consistent with Harington's (1968) summary of den characteristics in northern Canada, northern Alaska polar bear dens were most commonly located on the leeward side of islands in thick snow banks (n = 10, 91%)

Unlike bears denned on Russia's Herald and Wrangel Islands or those on Svalbard, Norway, bears on Alaska's North Slope rarely denned in close proximity to one another. In 2004, we observed two dens on Eskimo Island, 160 km west of Prudhoe Bay, positioned approximately 100 m from one another. However, those bears did not interact. Although areas like Pingok Island frequently sustain multiple maternal dens, they are always well spaced out (> 1 km), suggesting active avoidance of one another.

Management Implications

Information from this study may be used to minimize human disturbance of denned bears. Clearly more research is needed to better understand polar bear response to human activity, but the following insights may prove useful to managers of both polar bear populations and oil exploration and processing:

1. All den breakouts occurred after March 1st with the mean date of breakout 13 March. However, some polar bear activity (nose and head pokes) preceded breakouts by as much as several weeks.
2. Adult polar bears rarely emerged from dens (2.5% of total time observed), and when they did it was for an average of approximately 12 minutes per bout. Cubs emerged less often than their mothers (1.2% of total time observed) but spent a slightly longer period when outside the den (16 minutes).
3. No diel pattern of activity was observed for the 19 dens studied, hence a bear could be expected to emerge at any time of day.
4. Bears remained at den sites for an average of 6.6 days following initial den breakout before abandoning.
5. Bears were not observed (on camera) outside their dens at night (i.e., from evening civil twilight to onset of civil twilight in the morning).
6. Bears generally remained within 50 m of den entrances and only rarely strayed 100 m before abandoning their dens.
7. Departing bears always headed due north (away from land) upon abandoning a den.
8. Once a den site was abandoned no bears returned; rather all bears moved a few kilometers to the north, and then continued on until resuming hunting.
9. Polar bear out-of-den activity strongly correlated with wind chill, ceasing when temperatures were < -30 deg C.
10. The majority (82%) of bear-human interactions observed in this study failed to elicit a significant response.

Because North Slope polar bears rarely emerge prior to 1 March, human activities prior to breakout will have no visual impact and greatly reduced auditory/seismic impact on bears in closed dens. Research conducted by MacGillivray et al. (2003) regarding the penetration of sound and vibration into polar bear dens indicates that bears in sealed dens are considerably less sensitive than those in open dens, although additional research is needed to define the limits of acceptable sound and vibration penetration within dens. Knowing that bears rarely emerge from their dens between the time of breakout and abandonment, and that when they do it is for very short periods, are useful facts. Perhaps in difficult situations where a previously undetected den

is located near industrial activity, work could be staged around bear emergent periods thus allowing work to be completed without a total cessation of activity. Similarly, bears have not been observed exiting at night in this, or another long term den observation study (Herald Island, Russia). This suggests that an ice road that is close to a formerly undetected den might be able to support traffic if activity on the road were restricted to nighttime only. That fact that bears rarely strayed far (>100 m) from dens prior to abandonment is also important to know. During the course of this study (7 years) we have not had any gear damaged by bears even though most has been within 100—150 m and easily reachable by denned bears. Knowing that departing maternal groups head northward is useful when considering the likelihood of human interactions. In the case of camera monitoring, cameras placed south of the den have never been approached by bears, whereas the only unit placed to the north was investigated by an adult female but was not damaged. Finally, we have not seen any bears return to dens once the mother and cubs wander > 100 m and remain beyond that distance for a few hours. This information may be useful for determining how soon following den emergence an activity can resume in the vicinity of formerly occupied den sites.

To date a total of 19 dens have been observed directly as a part of the research project. From these observations a pattern of den emergence events is emerging but yet incomplete. The nature of denning along Alaska's North Slope precludes more intensive data gathering but additional observations will help to define activity patterns of the now threatened species.

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Table 1. Location dates and observational data for 11 polar bear maternal den sites observed in Mar (2005-2008), North Slope, Alaska.

Year	Dates Observed	Location	Total Observation Days[a]	Den Breakout	Den Abandonment	Number of Days at Den[b]	Number of Cubs at Den	Adult Total Time Out of Den (Hours)	Cub Total Time Out of Den (Hours)	Number of Adult Sessions	Number of Cub Observation Sessions
2005	3/11-4/9	Staging Pad	30	12-Mar	29-Mar	18	2	12.3	8.8	50	35
2005	3/3-3/17	Pingok West	15	4-Mar	13-Mar	10	2	3.2	1.3	28	7
2006	3/3-3/24	Pingok East	22	22-Mar	24-Mar	3	2	2.4	1.2	11	9
2006	3/3-3/24	Pingok North	22	20-Mar	24-Mar	5	2	4.0	0.1	21	2
2007	3/15-3/23	Pingok East	9	16-Mar	21-Mar	6	2	2.0	0.1	28	5
2007	3/12-3/28	Pingok West	17	14-Mar	17-Mar	4	2	3.0	1.0	9	13
2007	3/10-3/22	Cottle West	13	11-Mar	20-Mar	10	2	3.1	1.9	23	4
2007	3/13-3/26	Cottle East	14	16-Mar	20-Mar	5	2	0.6	0.1	7	1
2008	3/5-3/25	Cottle	21	6-Mar	9-Mar	4	2	1.9	0.8	6	1
2008	3/1-4/13	Pingok West	44	1-Mar	2-Mar	2	2	1.7	2.4	12	6
2008	3/1-4/3	Staging Pad	34	26-Mar	31-Mar	6	2	0.6	0.3	6	3
		Totals	241	-	-	73	22	34.8	18.0	201	86
		Average	22	-	-	6.6	2	3.2	2	18	8

[a] Total days camera was observing den site.
[b] Number of days bears were at den site from breakout to abandonment.

Table 2. Activity budgets of adult female polar bears (*n* = 11) and dependent cubs (*n* = 22) at their den sites in March 2005—2008, Northern Alaska.

	Total Observation Hours		Percent total observation time		Percent time outside		Percent time outside excluding Unobservable	
Activity	Females	Cubs	Females	Cubs	Females	Cubs	Females	Cubs
In den	1370.9	1389.1	97.5	98.8	-	-	-	-
Standing	8.8	2.0	0.6	0.1	25.1	11.8	31.3	17.0
Sitting	3.0	0.4	0.2	0.1	8.6	2.5	10.7	3.7
Resting	1.4	0.4	0.1	0.1	3.9	2.1	4.8	3.1
Nursing	1.5	1.8	0.1	0.1	4.4	10.7	5.4	15.5
Walking	7.6	5.2	0.5	0.4	21.7	31.6	27.0	45.6
Digging	2.2	0.0	0.2	0.0	6.2	0.0	7.7	0.0
Playing	0.1	1.7	0.0	0.1	0.0	10.3	0.0	14.8
Rolling	3.7	0.1	0.3	0.1	10.4	0.2	13.0	0.3
Running	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
Unobservable	6.9	5.1	0.5	0.4	19.8	30.8	-	-
Totals	1406.0	1405.7	100.0	100.0	100.0	100.0	100.0	100.0

Table 3. Summary of observations of polar bears exposed to human activities at den sites, 2002-2008, North Slope, Alaska.

Den	Perturbation	Date of Disturbance	Distance of Disturbance (m)	Behavioral Response	Response Intensity[a]
Bullen Pt 2002	Snow blower	8-Mar	1600	Ran back to den	3
Bullen Pt 2002	Truck	8-Mar	1600	Glanced at road	1
Bullen Pt 2002	Tucker	8-Mar	400	Glanced in direction	1
Bullen Pt 2002	Tucker	9-Mar	400	Glanced in direction	1
Bullen Pt 2002	Truck	9-Mar	1600	Gets up and stared intently	1
Bullen Pt 2002	Tucker	9-Mar	400	No apparent response	1
Bullen Pt 2002	Tucker	9-Mar	400	No apparent response	1
Bullen Pt 2002	Truck	9-Mar	1600	Stares intently	1
Bullen Pt 2002	Tucker	9-Mar	400	No apparent response	1
Bullen Pt 2002	Tucker	10-Mar	400	Stares intently	1
Bullen Pt 2002	Tucker	10-Mar	400	Stares intently	1
Bullen Pt 2002	Truck	10-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	10-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	10-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	10-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	10-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	10-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	10-Mar	1600	No apparent response	1
Bullen Pt. 2002	Tucker	11-Mar	400	Began backing towards den	2

[a] 1 = Acknowledged stimulus but no overt response
2 = Moderate response (change in behavior, brief)
3 = Strong response (run/den entry)

Table 3 continued.

Den	Perturbation	Date of Disturbance	Distance of Disturbance (m)	Behavioral Response	Response Intensity[a]
Bullen Pt 2002	Tucker	11-Mar	400	Stares intently	1
Bullen Pt 2002	Truck	11-Mar	1600	Stares intently	1
Bullen Pt 2002	Truck	11-Mar	1600	Stares intently	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	Scans towards road	1
Bullen Pt 2002	Truck	11-Mar	1600	Scans towards road	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Tucker	11-Mar	300	No apparent response	1
Bullen Pt 2002	Tucker	11-Mar	300	Scans towards tucker	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt. 2002	Truck	11-Mar	1600	No apparent response	1

[a] 1 = Acknowledged stimulus but no overt response
2 = Moderate response (change in behavior, brief)
3 = Strong response (run/den entry)

Table 3 continued.

Den	Perturbation	Date of Disturbance	Distance of Disturbance (m)	Behavioral Response	Response Intensity[a]
Bullen Pt 2002	Snow blower	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Aircraft	11-Mar		No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Bullen Pt 2002	Tucker	11-Mar	400	No apparent response	1
Bullen Pt 2002	Truck	11-Mar	1600	No apparent response	1
Cottle East 2002	Person	19-Mar	400	Scanned camp	1
Cottle East 2002	Tent	19-Mar	400	Looked attentively at tents	1
Cottle East 2002	Tent	20-Mar	400	Looked attentively at tents	1
Cottle East 2002	Aircraft	21-Mar		Runs back into den	3
Cottle East 2002	Tent	21-Mar	400	Looked attentively at tents	1
Cottle East 2002	Tent	21-Mar	400	Looked attentively at tents	1
Cottle East 2002	Radio beeper	22-Mar	400	Looked attentively at tents	1
Cottle East 2002	Snow machine	22-Mar	1750	Walked back to den	2
Cottle East 2002	Snow machine	22-Mar	1750	Ran back to den	3
Cottle East 2002	Tent	27-Mar	400	Looked attentively at tents	1
Cottle East 2002	Person	27-Mar	400	Ran back to den	3
Cottle West 2002	Snow machine	19-Mar	1750	Ran back to den	3

[a] 1 = Acknowledged stimulus but no overt response
2 = Moderate response (change in behavior, brief)
3 = Strong response (run/den entry)

Table 3 continued.

Den	Perturbation	Date of Disturbance	Distance of Disturbance (m)	Behavioral Response	Response Intensity[a]
Cottle West 2002	Tent	20-Mar	400	Looked attentively at tents	1
Flaxman 2002	Tucker	19-Mar	450	Ran back to den	3
Eskimo 2003	Tent	18-Mar	400	Looked attentively at tents	1
Eskimo 2003	Tent	18-Mar	400	Looked attentively at tents	1
Eskimo 2003	Tent	19-Mar	400	Looked attentively at tents	1
Eskimo 2003	Tent	19-Mar	400	Looked attentively at tents	1
Eskimo 2003	Tent	22-Mar	400	Looked attentively at tents	1
Eskimo 2003	Tent	22-Mar	400	Looked attentively at tents	1
Eskimo 2003	Tent	23-Mar	400	Looked attentively at tents	1
Eskimo 2003	Tent	23-Mar	400	Looked attentively at tents	1
Eskimo II 2003	Aircraft	30-Mar		Ran back to den	3
Eskimo II 2003	Tent	30-Mar	400	Looked attentively at tents	1
Cottle 2003	Person	25-Mar	400	Partially re-enters den	2
Badami 2003	Person	20-Mar	400	Peered out of den, then re-dens	1
Badami 2003	Snow machine	24-Mar	400	Watched snow machine	1
Cottle 2004	Snow machine	Late March	50	Ran west with her cub	3
Staging Pad 2005	Snow machine	29-Mar	1000	Re-entered den	3
Cottle 2007	Person	10-Mar	125	Poked head out	1

[a] 1 = Acknowledged stimulus but no overt response
2 = Moderate response (change in behavior, brief)
3 = Strong response (run/den entry)

Table 3 continued.

Den	Perturbation	Date of Disturbance	Distance of Disturbance (m)	Behavioral Response	Response Intensity[a]
Cottle 2007	Person/Snow machine	12-Mar	125	Bear emerged, walked briskly around, and re-entered den	3
Pingok East 2007	Snow machine	14-Mar	200-250	Ran back to den	3
Pingok 2009	Person	7-Mar	150	Poked head out	1
Pingok 2009	Snow machine	10-Mar	400	Glanced in direction	1
Pingok 2009	Person	10-Mar	150	Poked head out	1
South Foggy 2009	Person/Snow machine	30-Mar	110	Emerged from den, then noticed people and ran back to den	3
Badami 2009	Person	30-Mar	0	People digging in den, not knowing the bear was still there. Bear stuck its nose out.	1

[a] 1 = Acknowledged stimulus but otherwise no response
2 = Moderate response (change in behavior, brief)
3 = Strong response (run/den entry)

Table 4. Measurements of polar bear maternal den snow structures (cm) recorded in northern Alaska during March and April in 2005–2008. Length of den includes both tunnels and chambers. Snow depth is the minimum measurement over tunnels and primary and secondary chamber ceilings.

	Number of Dens	Mean	S.D.	Minimum	Maximum
Height of Tunnel	2	55	7	50	60
Width of Tunnel	1	100	n/a	100	100
Length of Den	3	400	0	400	400
Height of Chamber	3	83	29	50	100
Width of Chamber	3	250	50	200	300
Snow Depth above Tunnel	3	61	36	40	102
Snow Depth above Chamber	3	76	36	35	102

LIST OF FIGURES

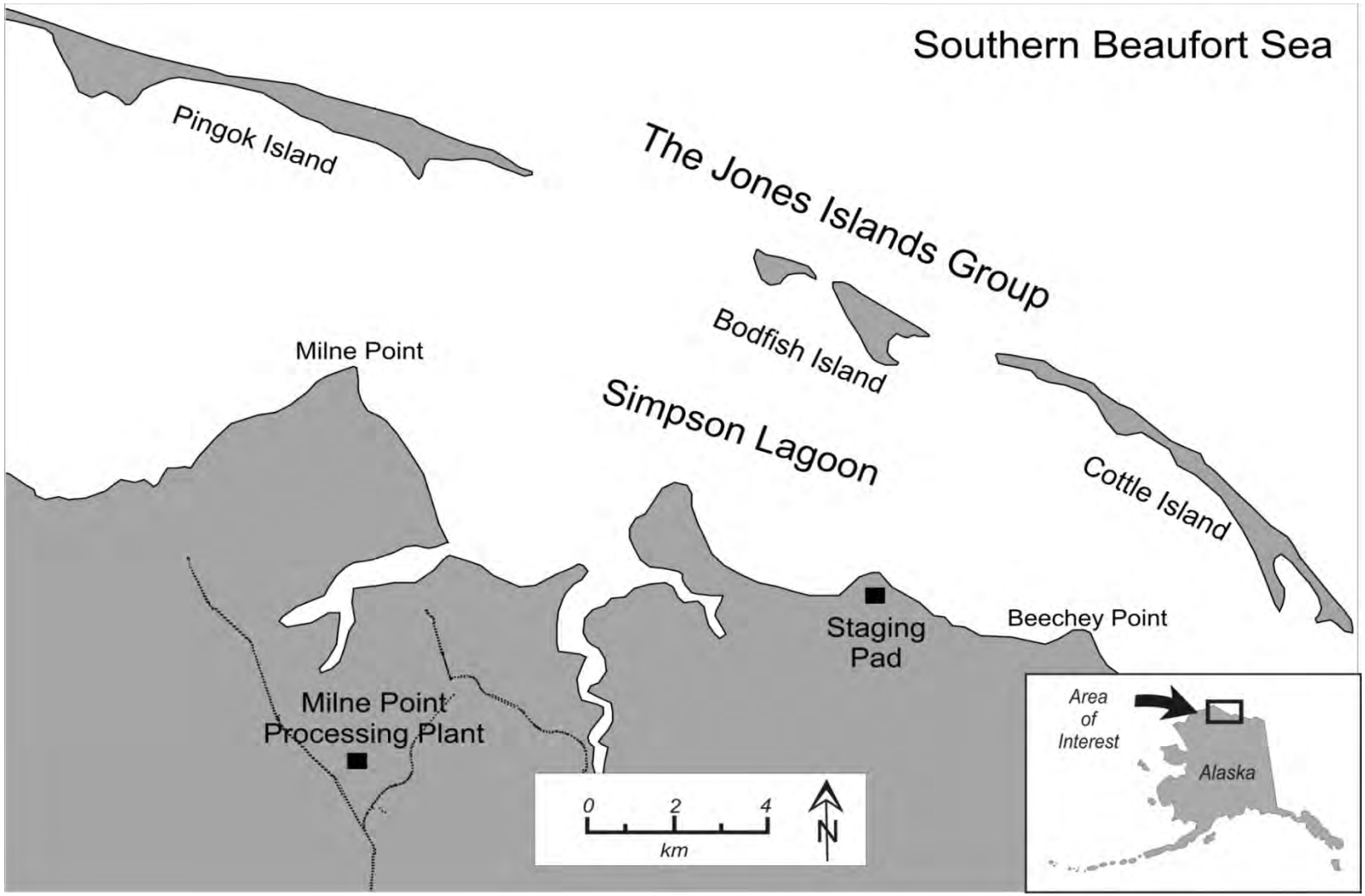


Figure 1. Location of the polar bear maternal den study area, 2002-2008, North Slope, Alaska.

Figure 2. Methods for locating polar bear dens: A. Radio-tagged bear, B. Aircraft mounted FLIR, C. Hand-held FLIR, D. Karelian Bear Dogs.

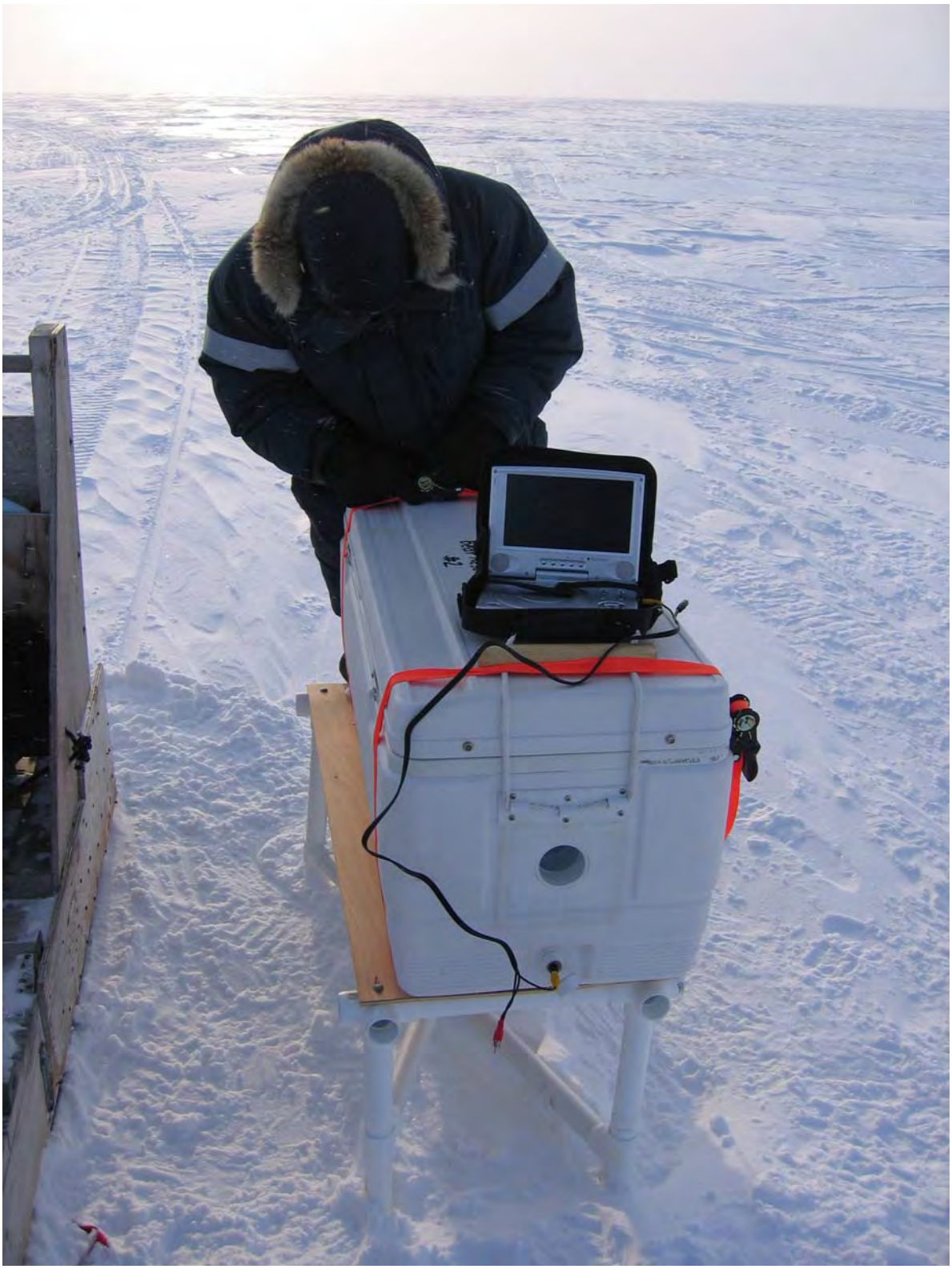


Figure 3. The self-contained camera system used for recording polar bear activity at den sites. The person is positioning the camera by observing the camera's field of view through an external monitor.

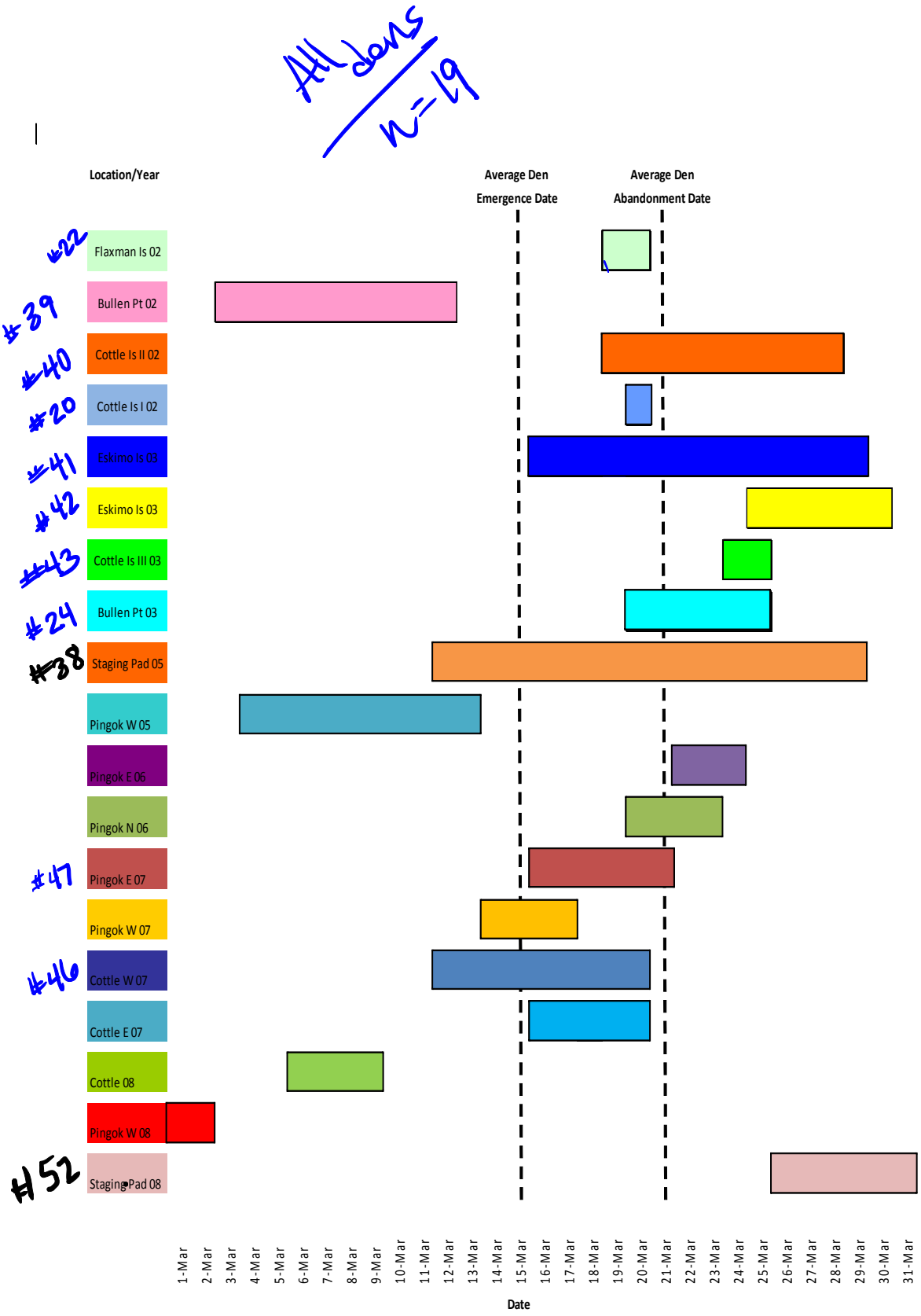


Figure 4. Den emergence and abandonment dates for 19 maternal dens 2002—2008, North Slope, Alaska.

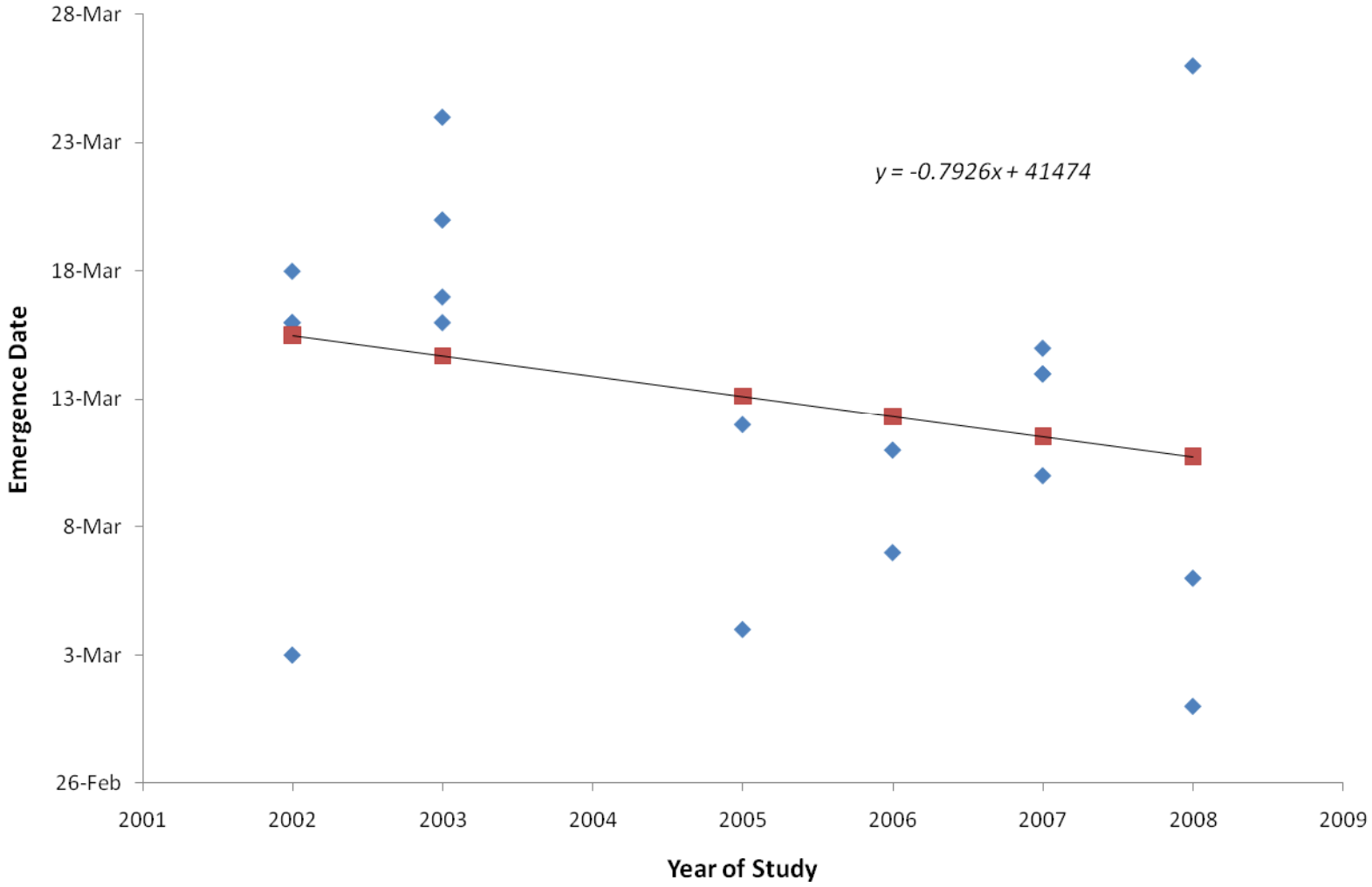


Figure 5. Analysis of den emergence dates and year of emergence for 19 dens studied on the North Slope, Alaska, 2002—2008.

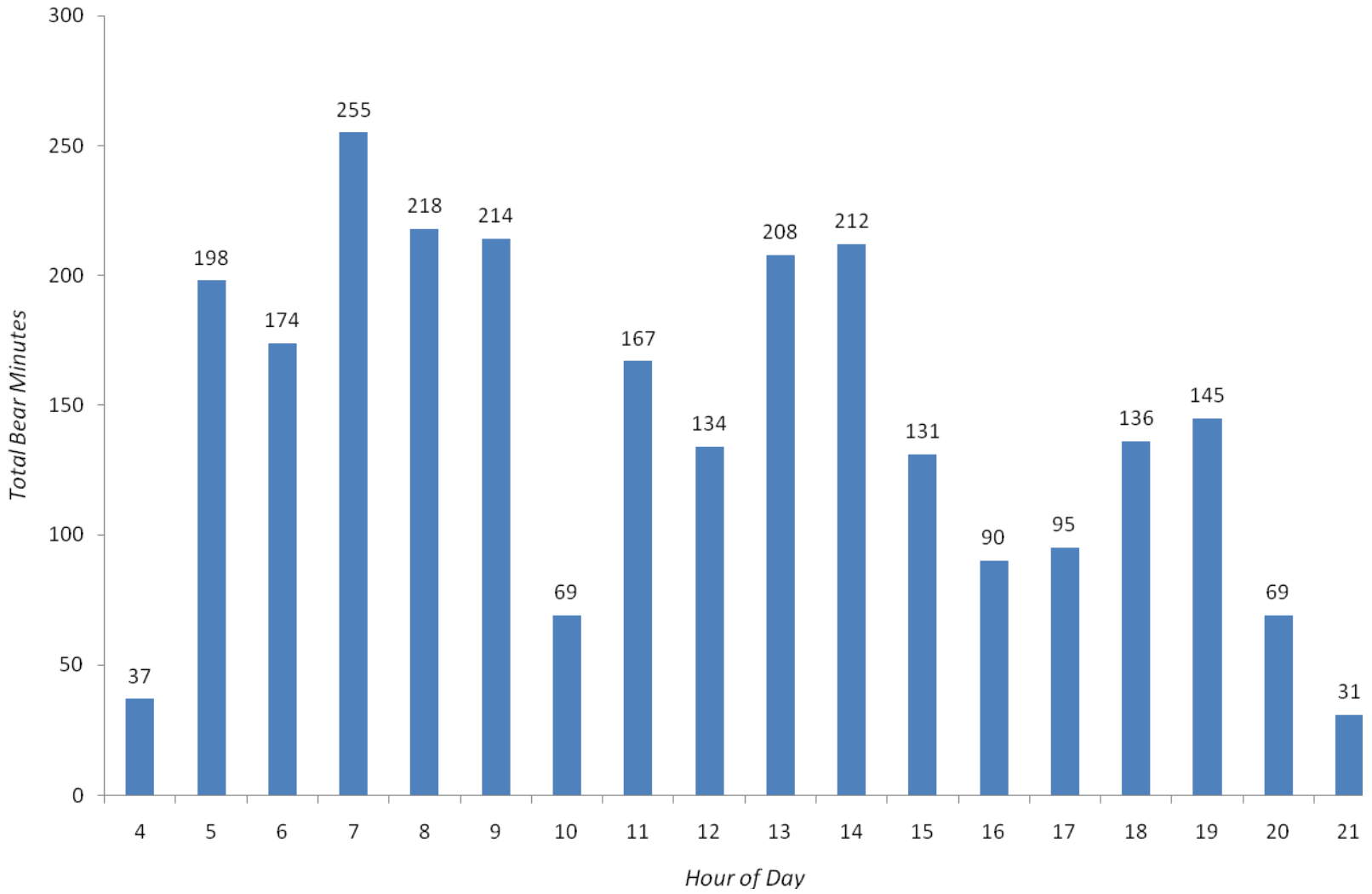


Figure 6. Composite activity pattern for 11 polar bear families observed 2005—2008, North Slope, Alaska.

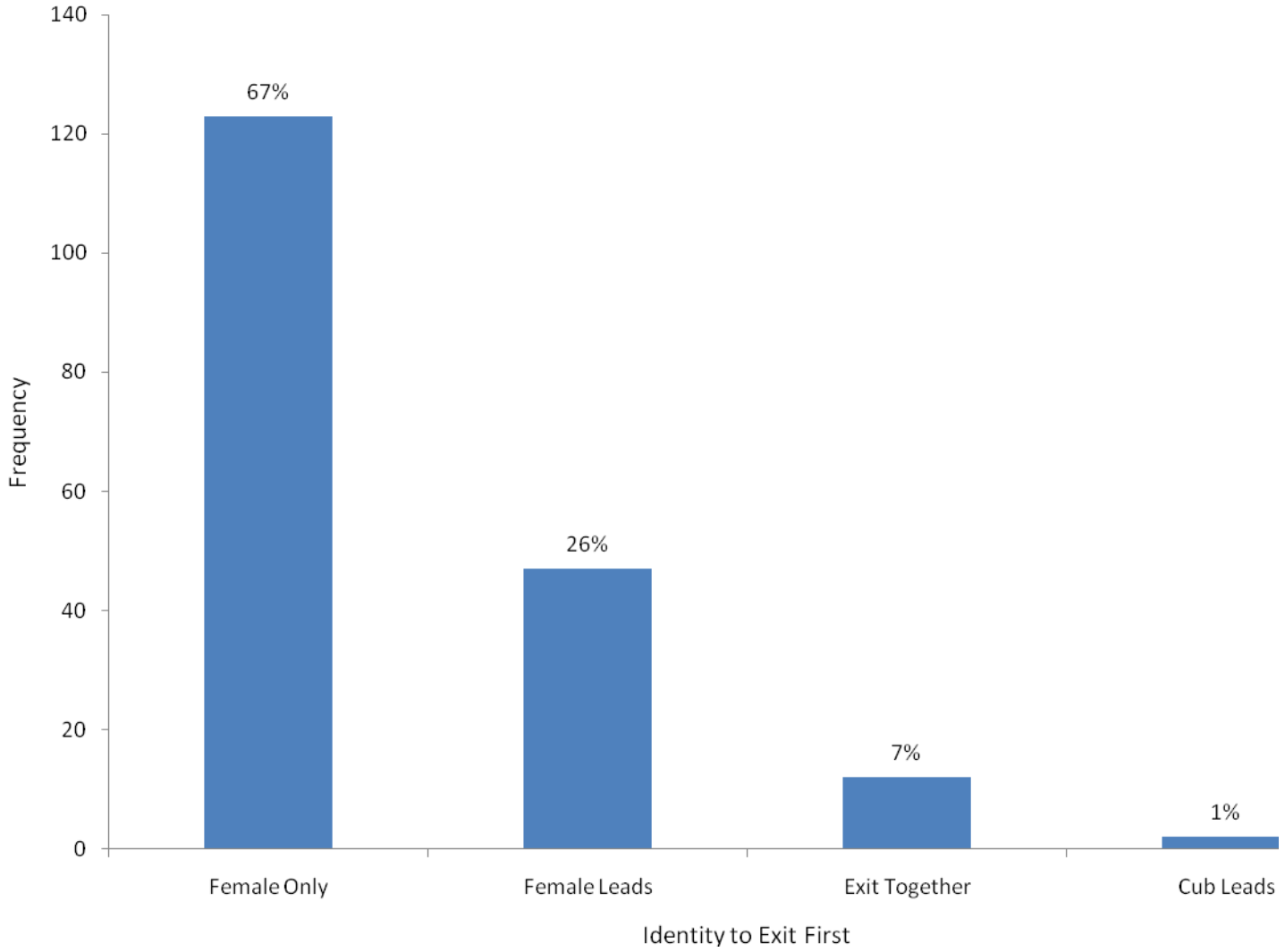


Figure 7. Order of den exit for polar bears at maternal den sites, North Slope, Alaska, 2005-2008 (*n* = 184).

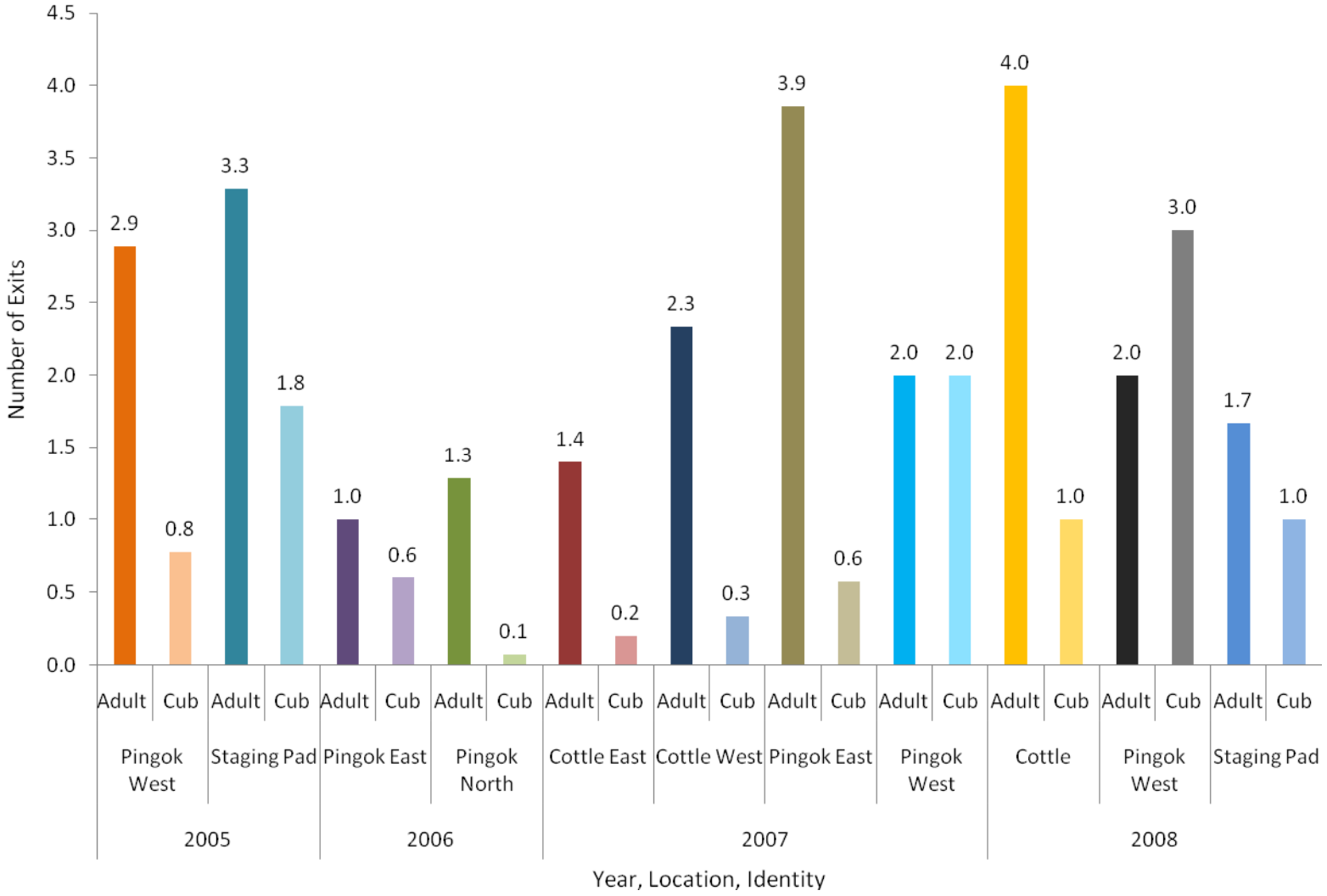


Figure 8. Average number of den exits per active day for 11 maternal dens, North Slope, Alaska, 2005-2008.

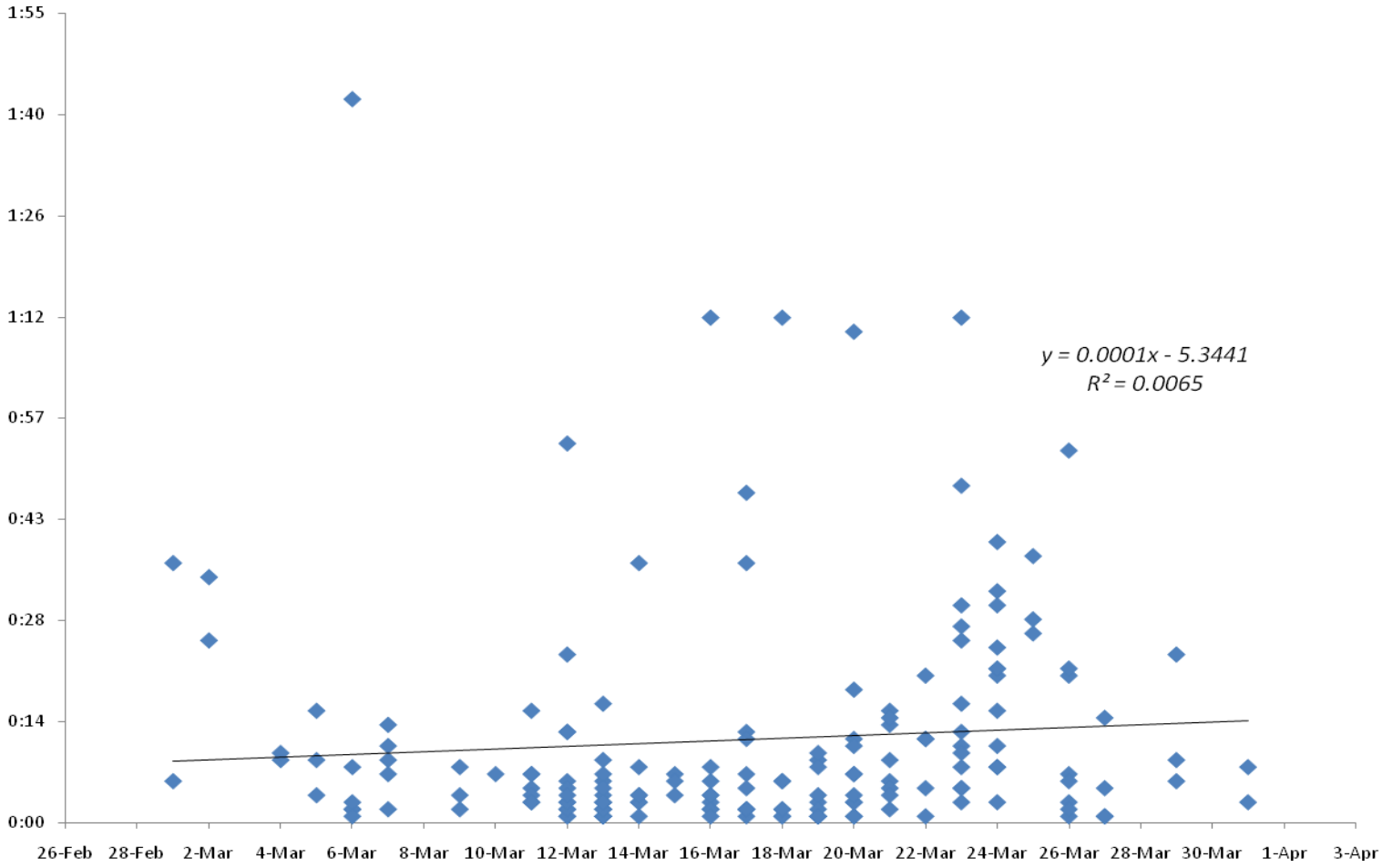


Figure 9. Analysis of duration of emergent periods from den breakout to abandonment, 2005—2008, North Slope, Alaska (n = 176)

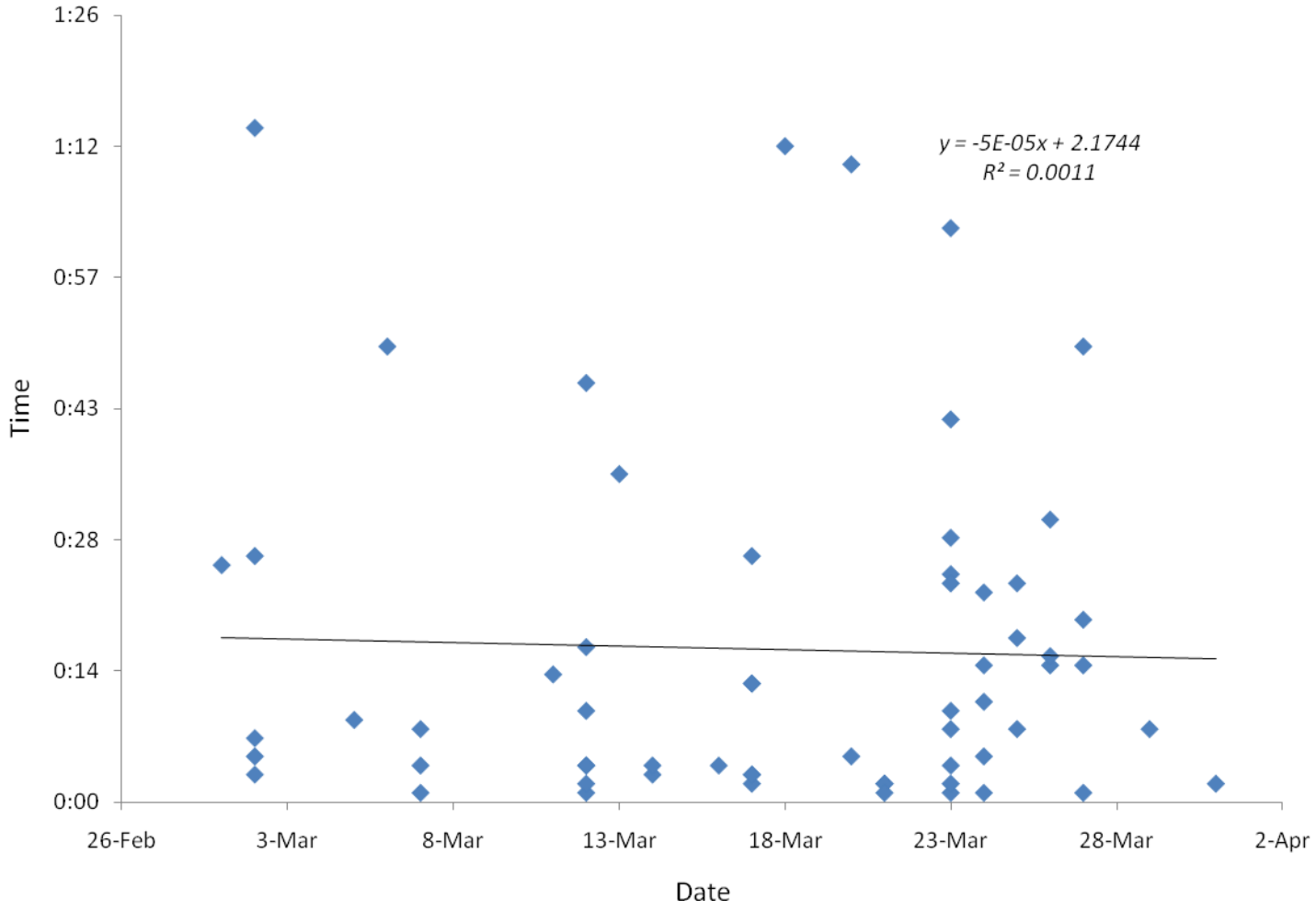


Figure 10. Analysis of the duration of time polar bear cubs spent outside of the den from emergence to abandonment, North Slope, Alaska, 2005-2008.

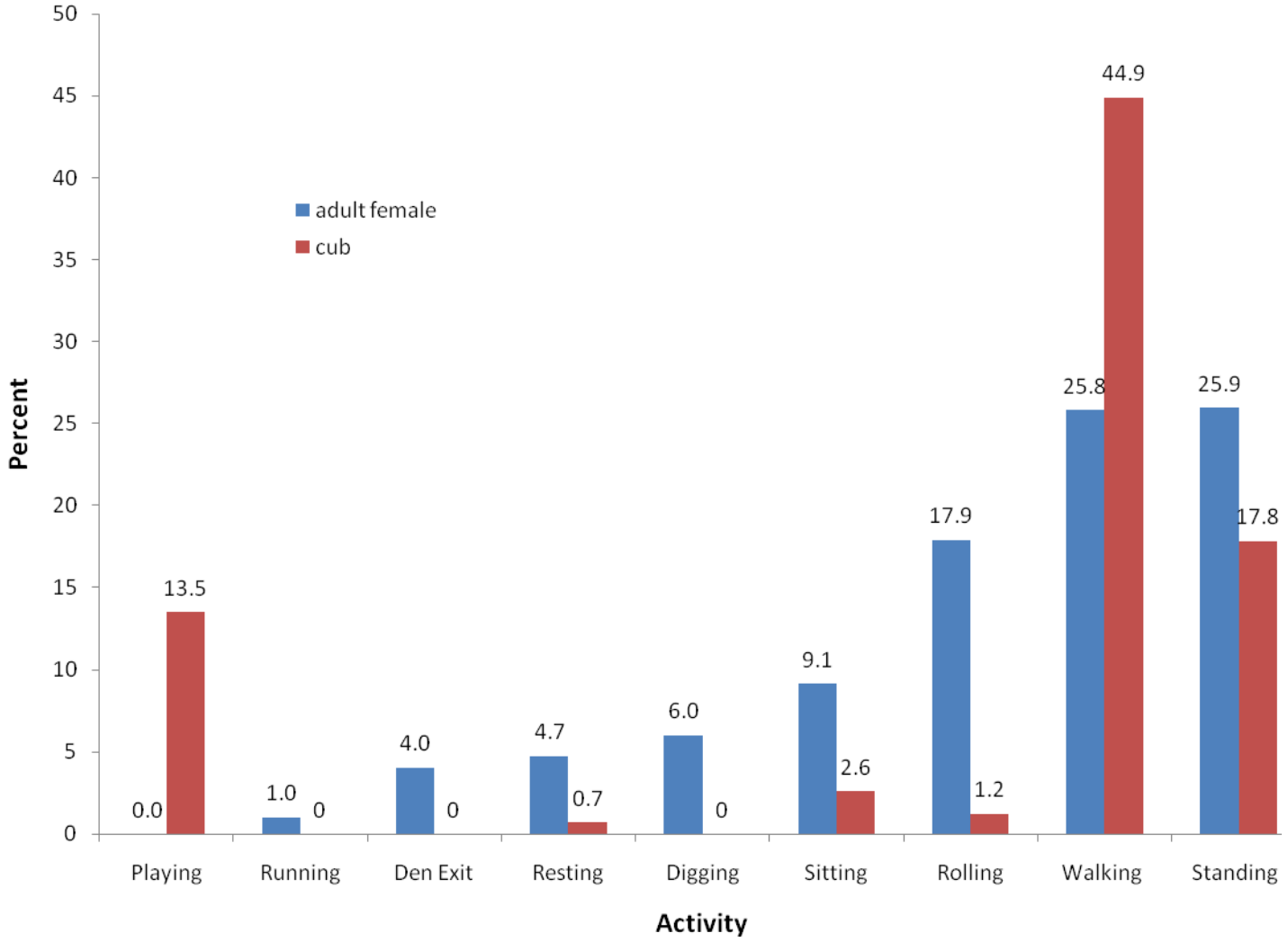


Figure 11. A comparison of adult female and cub activities at den sites, 2005—2008, North Slope, Alaska.

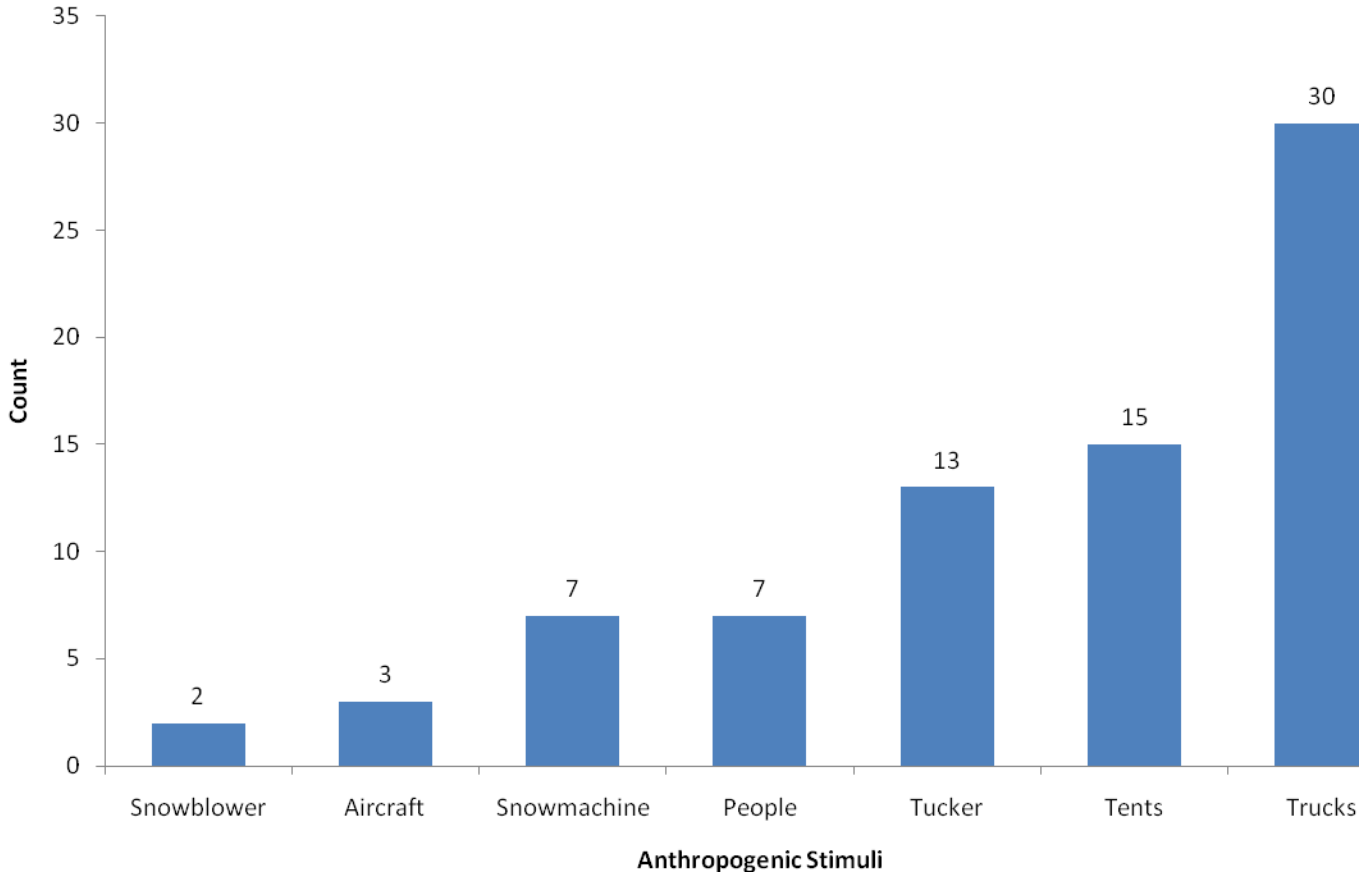


Figure 12. Anthropogenic stimuli involved in polar bear-human interactions 2002—2008, North Slope, Alaska (*n* = 77).

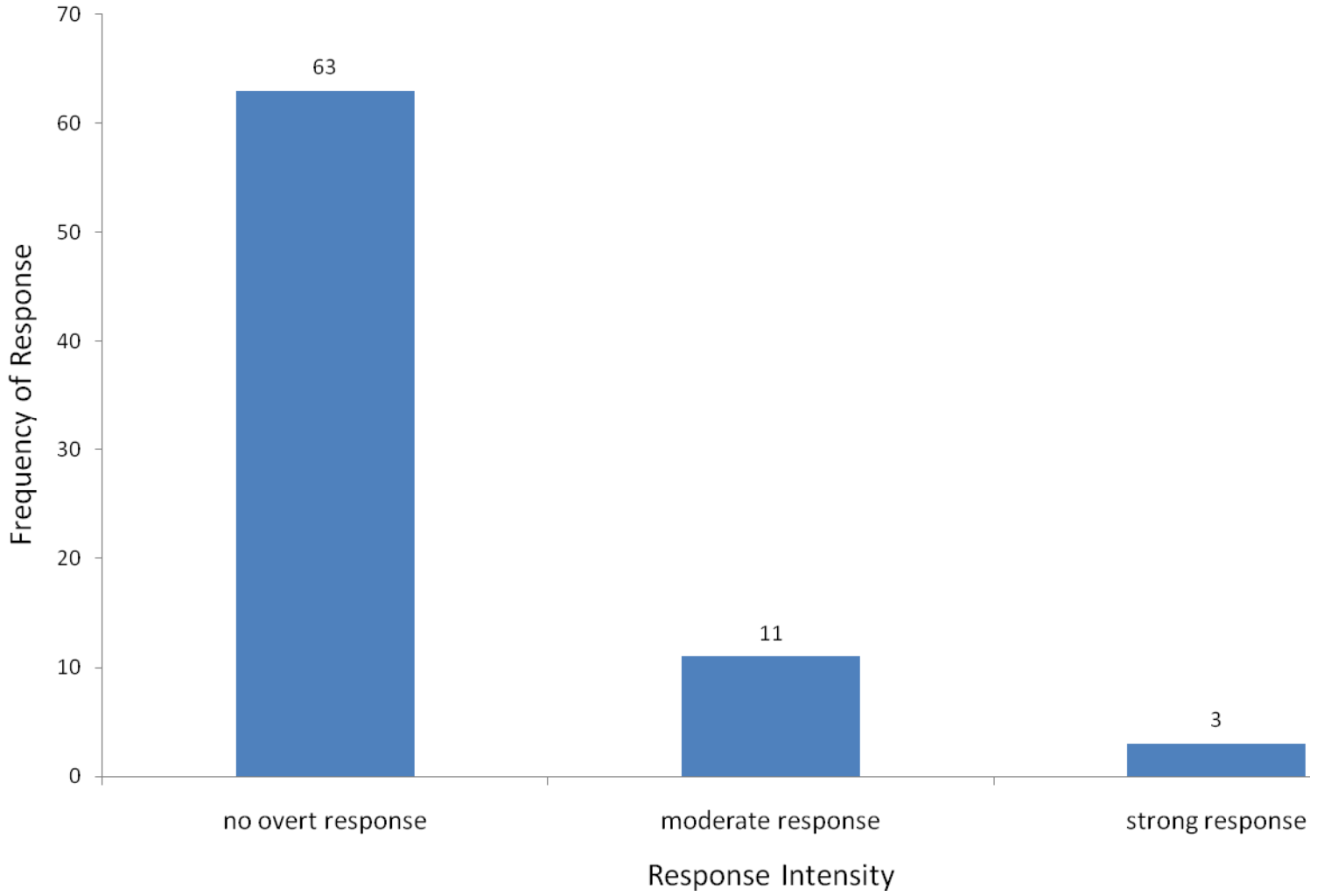


Figure 13. Polar bear response to human activity 2002—2008, North Slope, Alaska (n = 77).

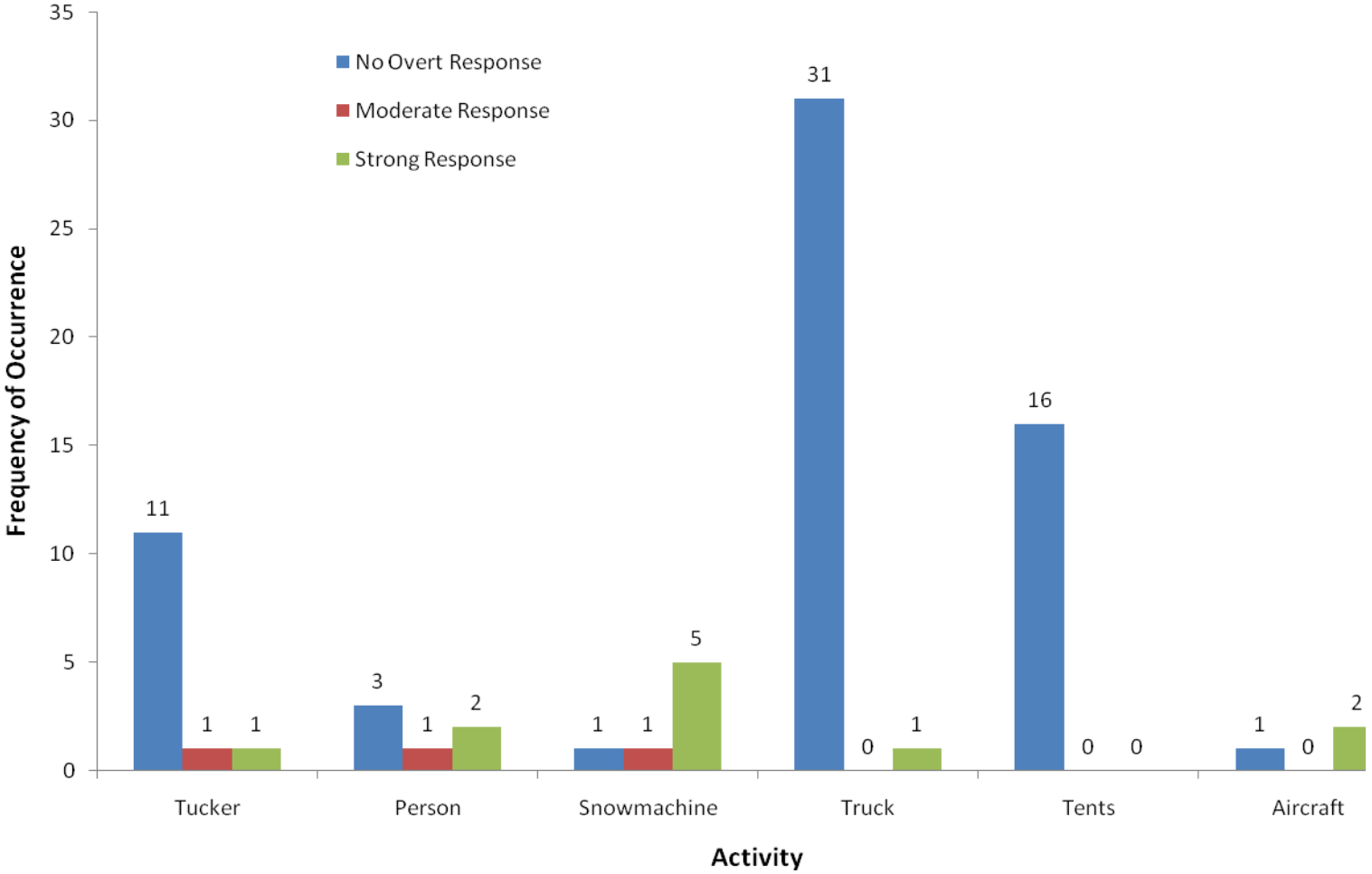


Figure 14. Intensity of polar bear response to human activity 2002—2008, North Slope, Alaska (n = 77).

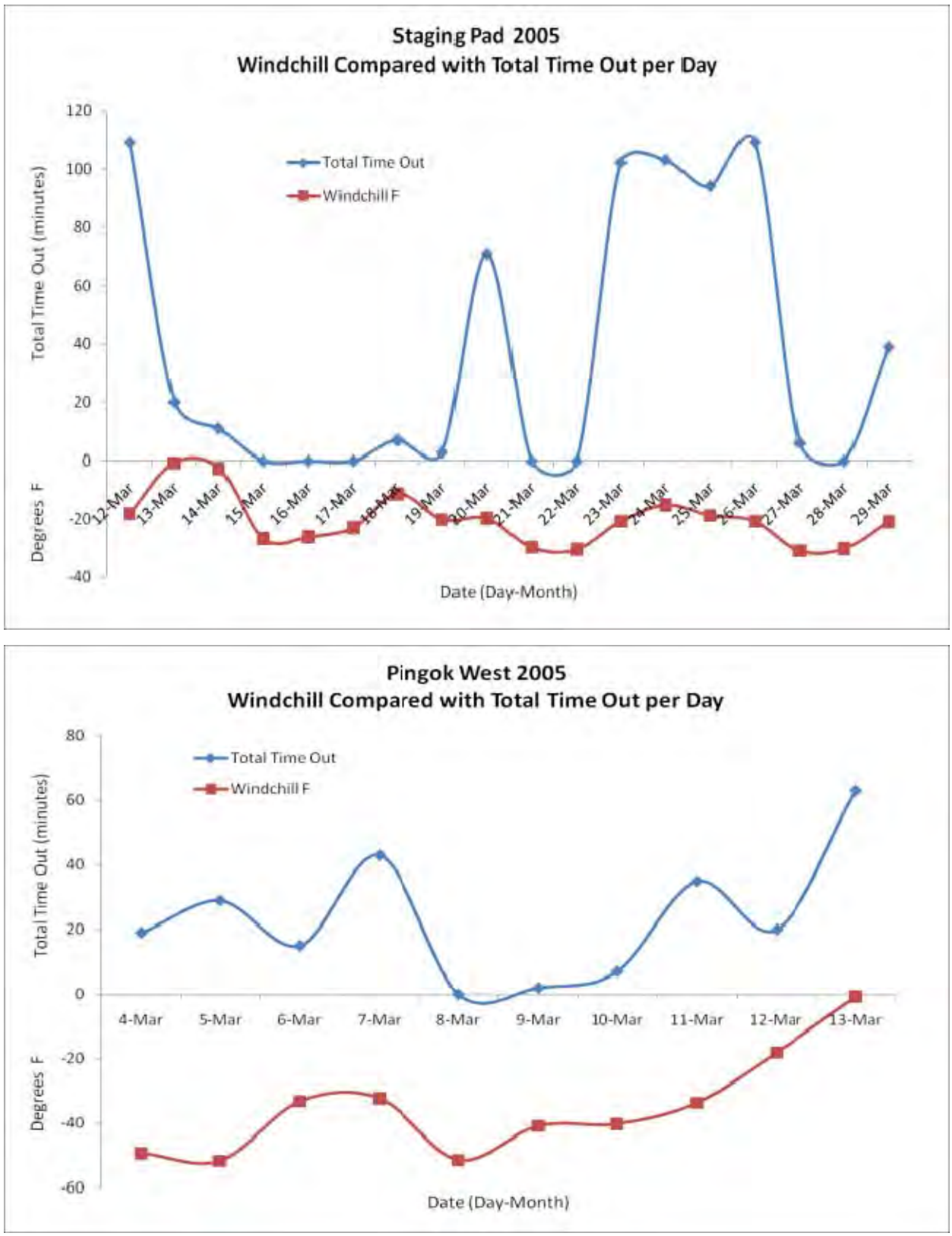
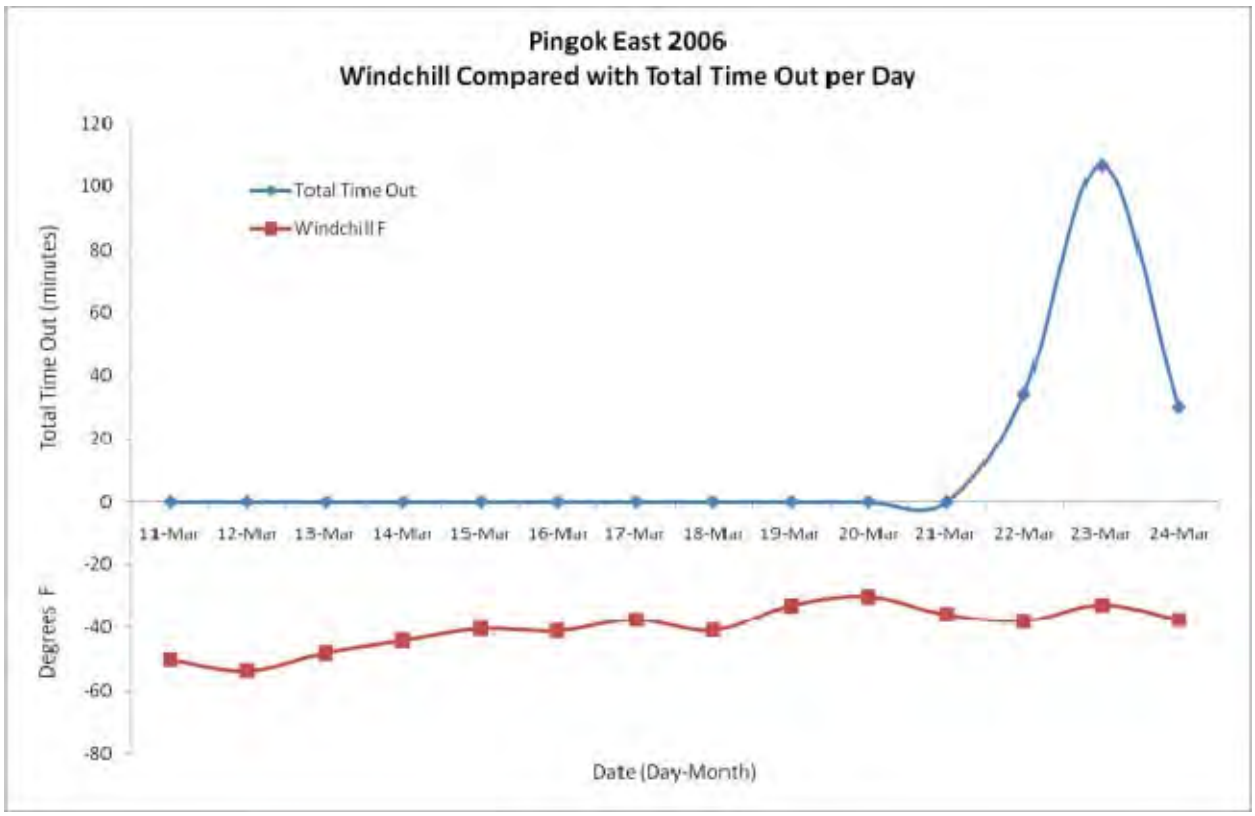


Figure 15. A comparison of polar bear activity at den sites as related to windchill, 2005—2008, North Slope, Alaska.



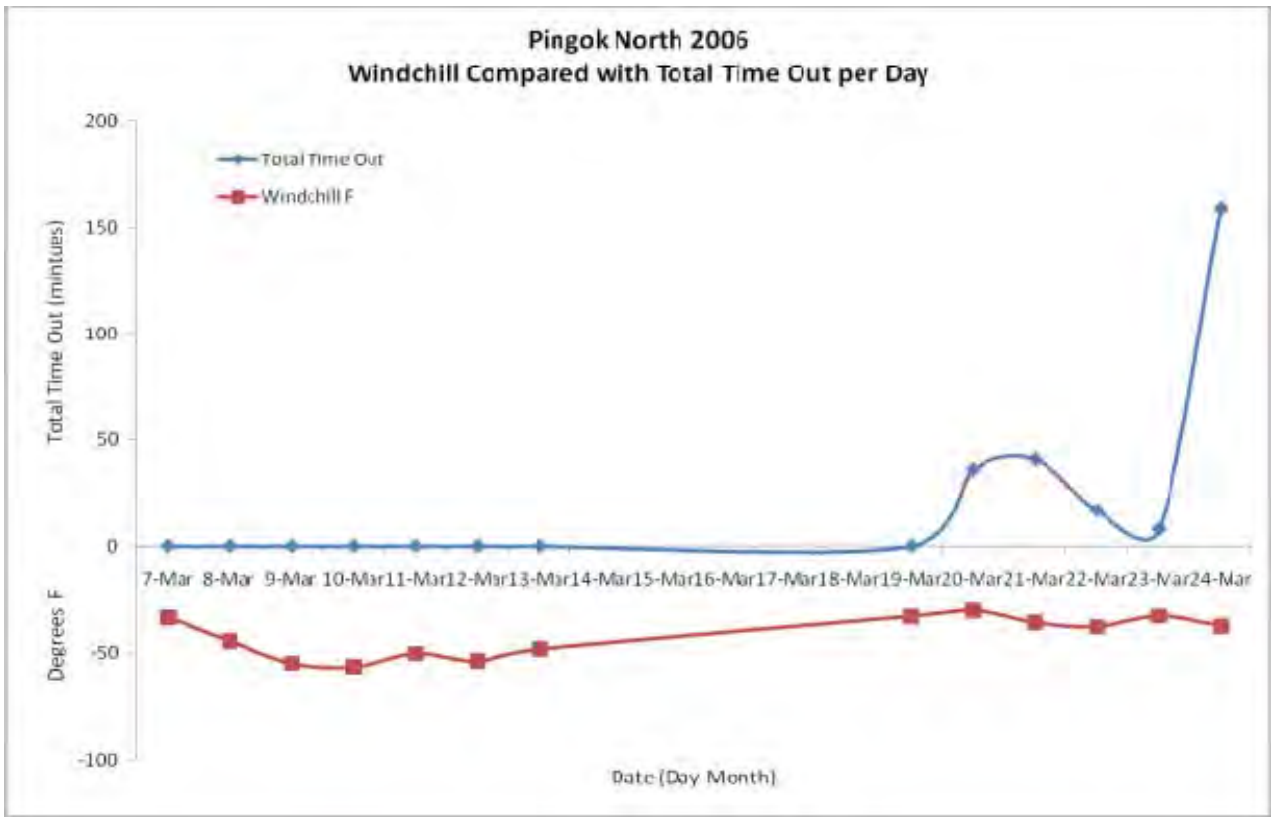
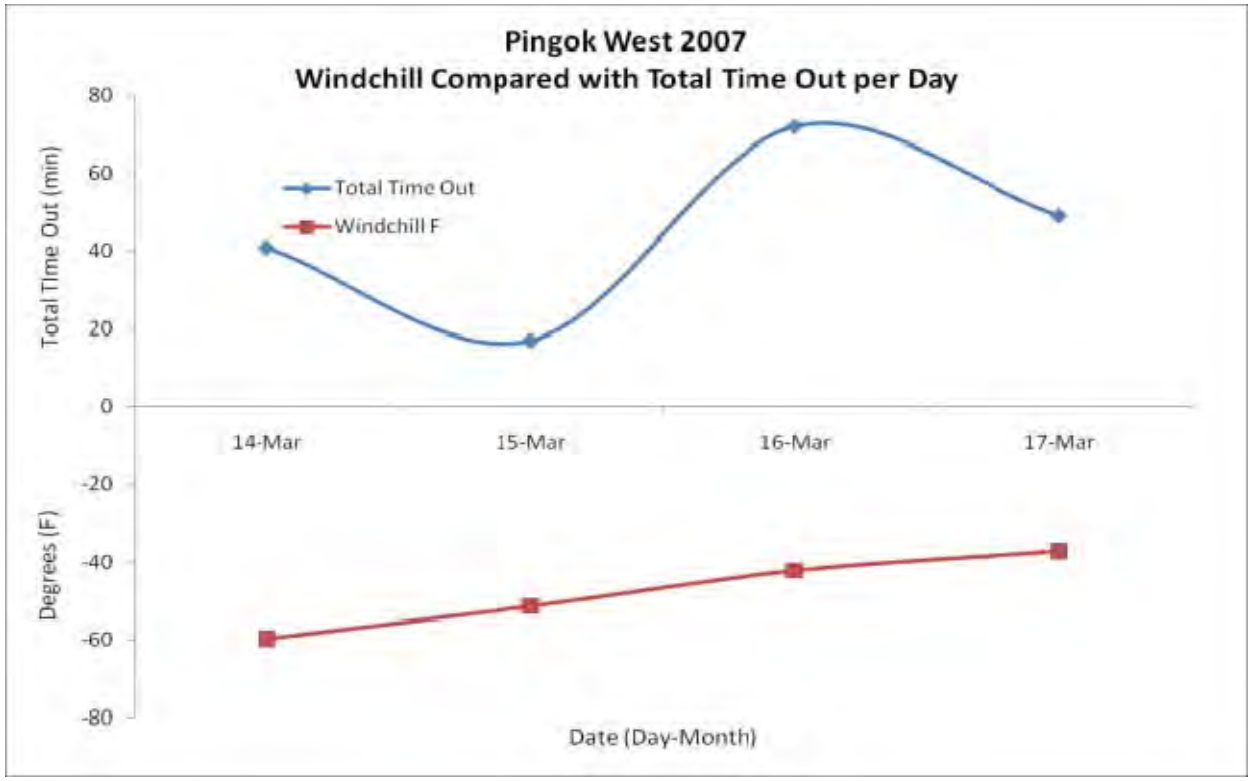


Figure 15. continued.



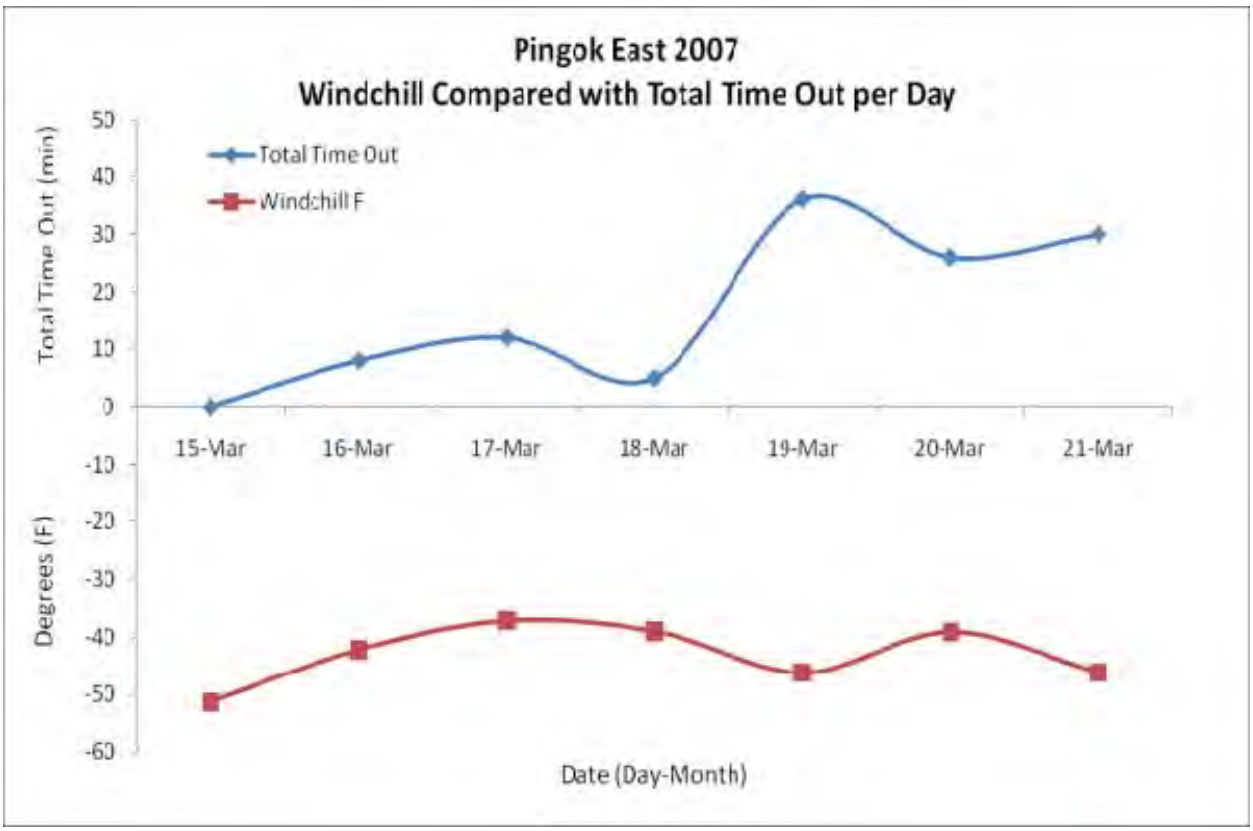
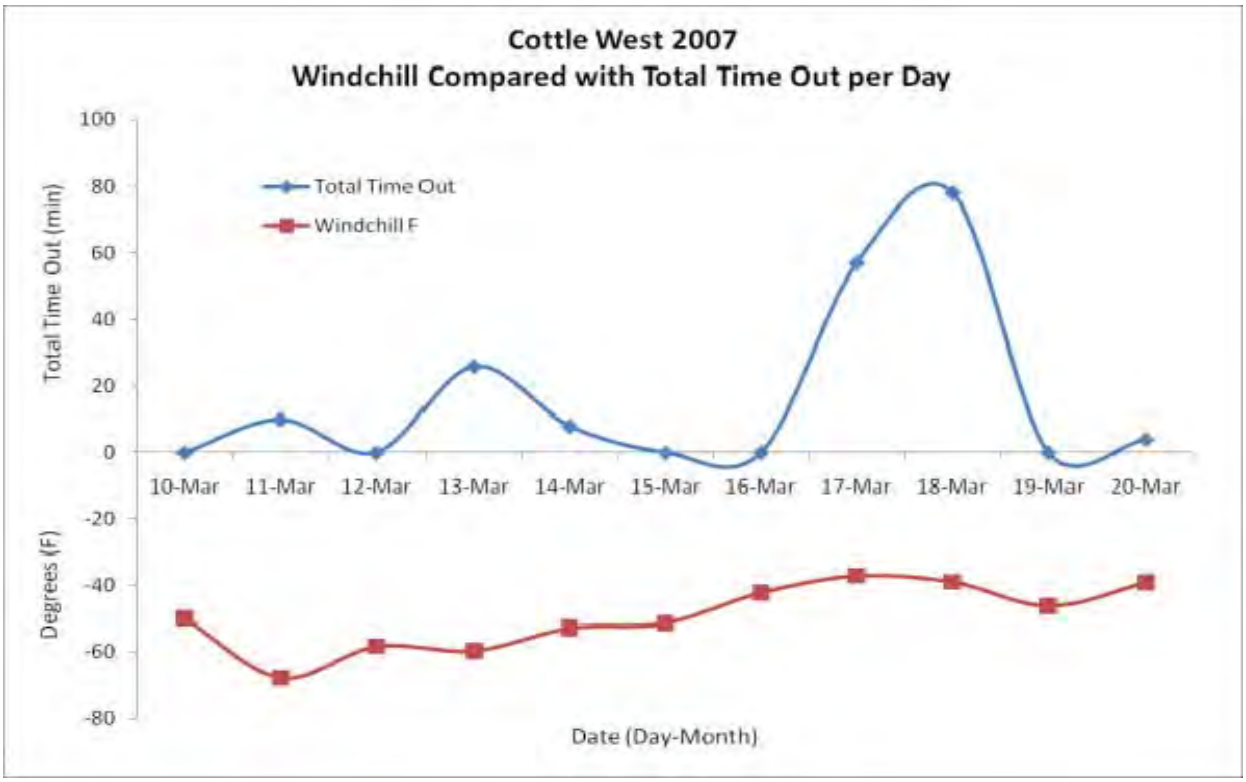


Figure 15. continued.



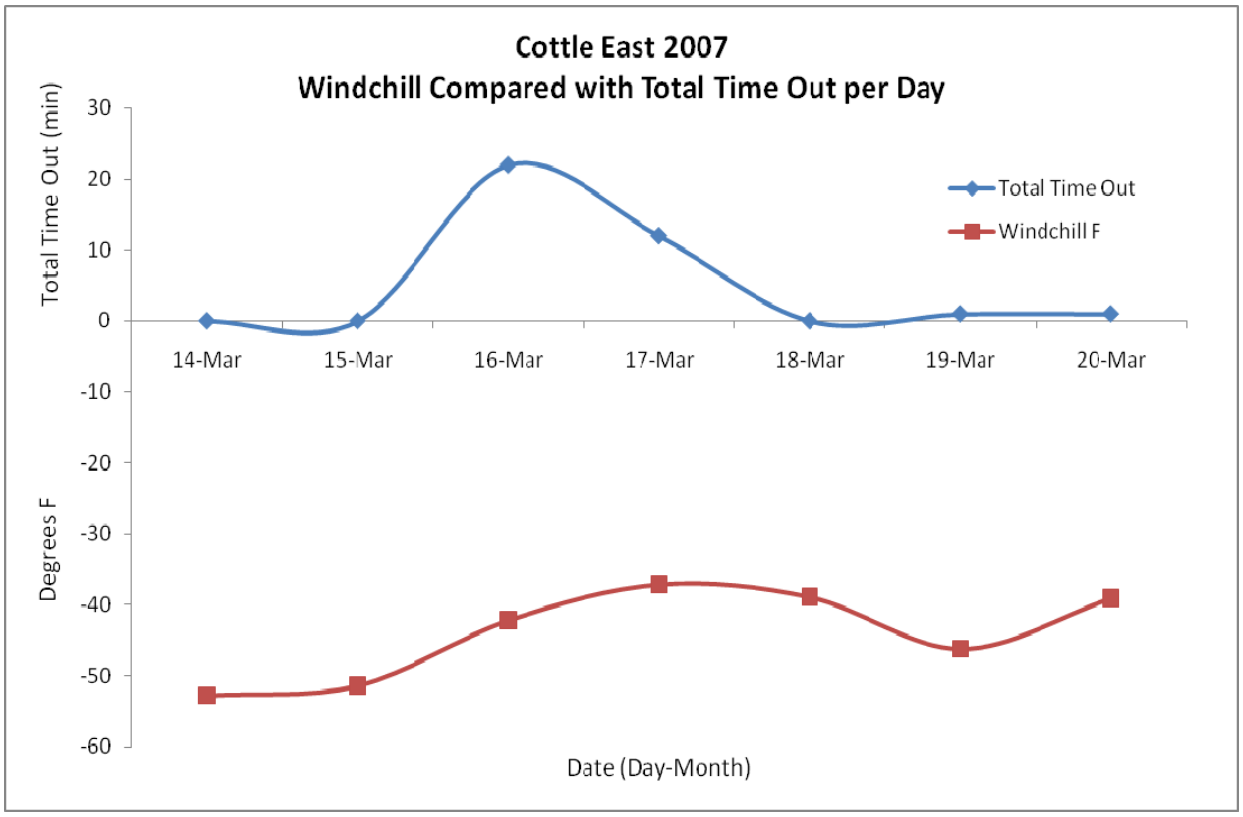
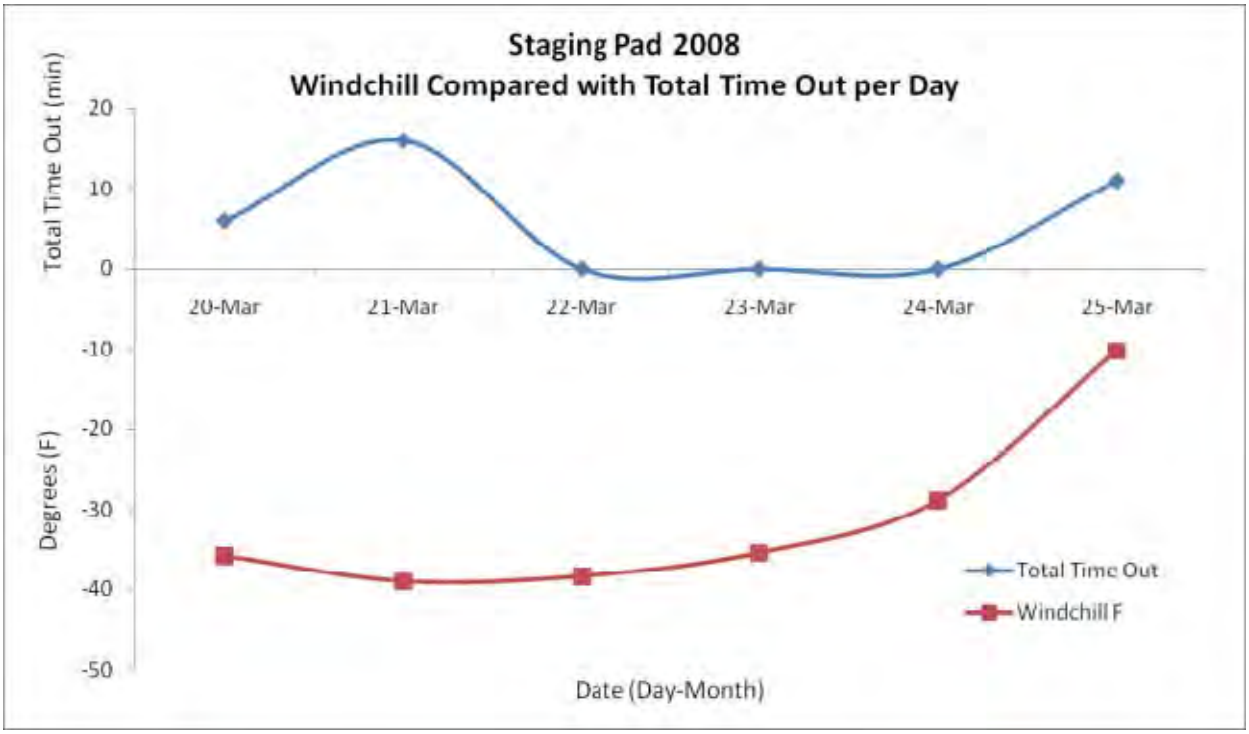


Figure 15. continued.



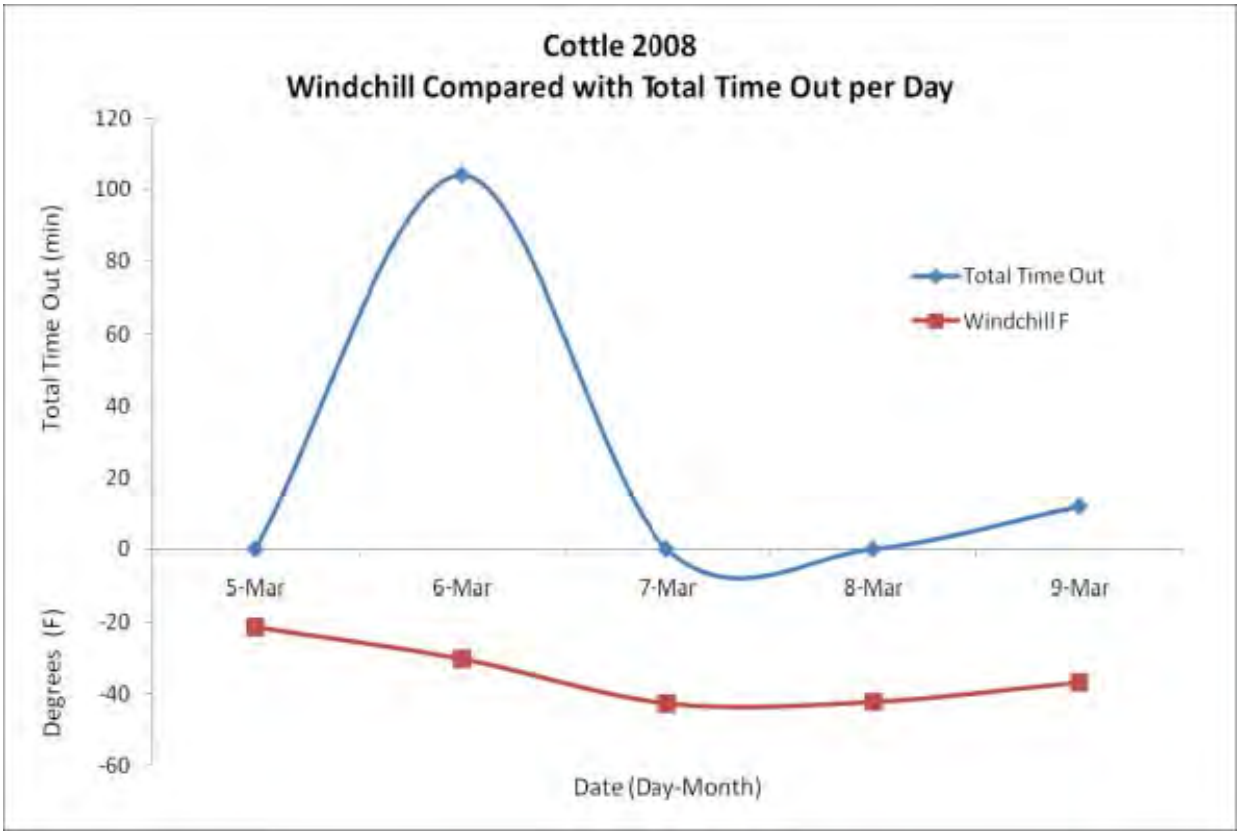


Figure 15. continued.

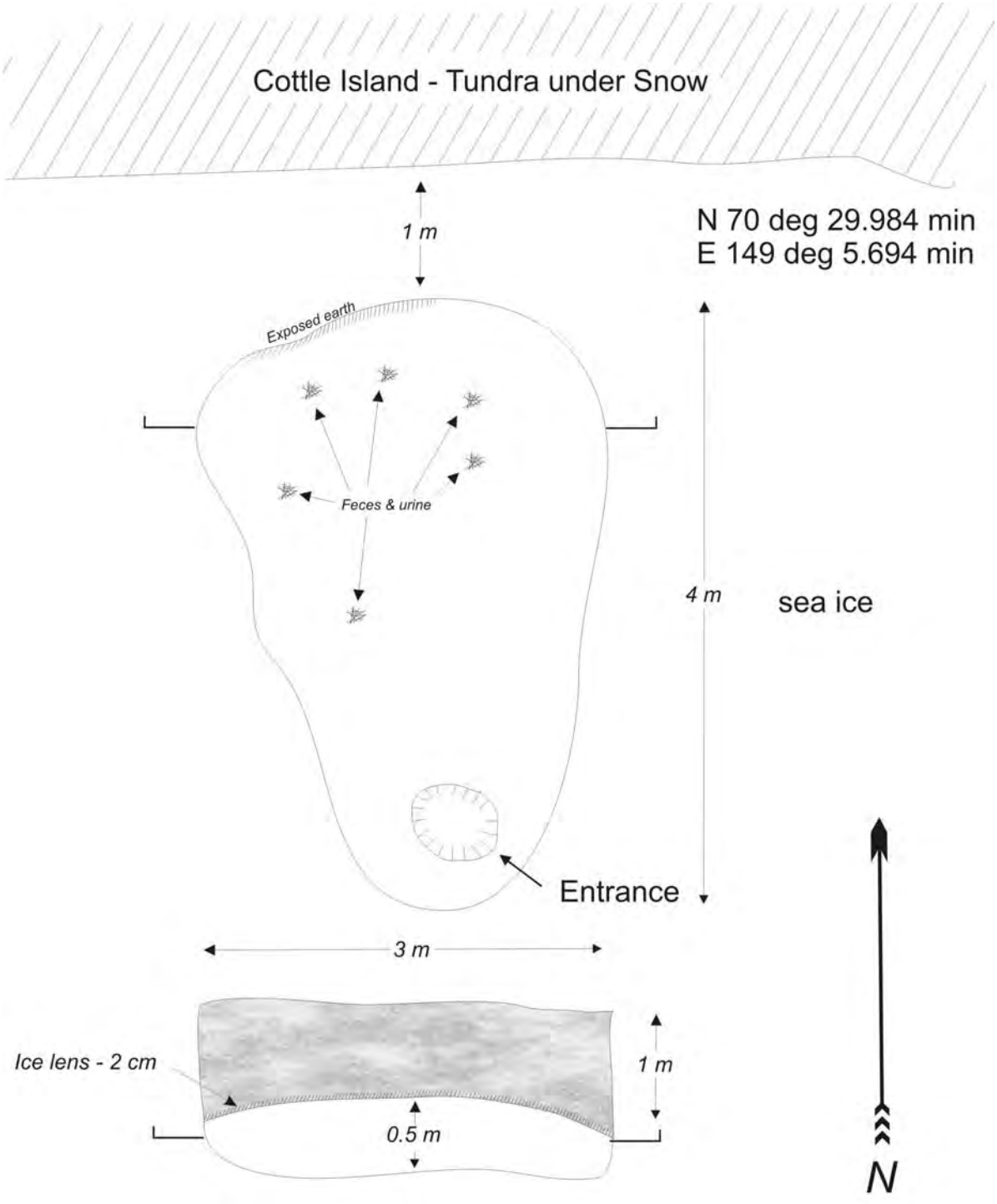


Figure 16. Schematic drawing of the 2007 Cottle Island West den.

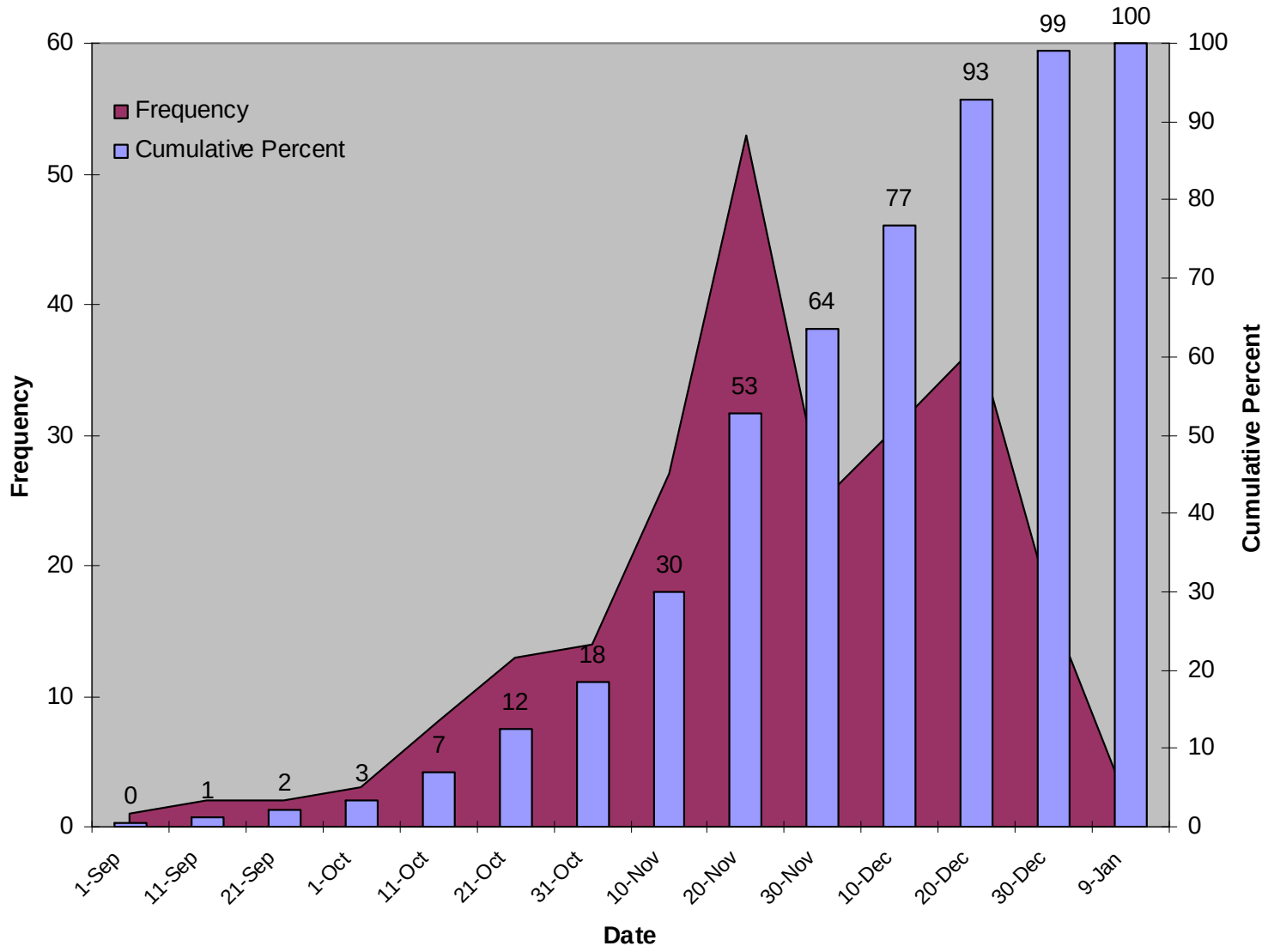


Figure 17. Polar bear den entry chronology based on data from 233 radio-tagged bears, North Slope of Alaska, 1982-2005.

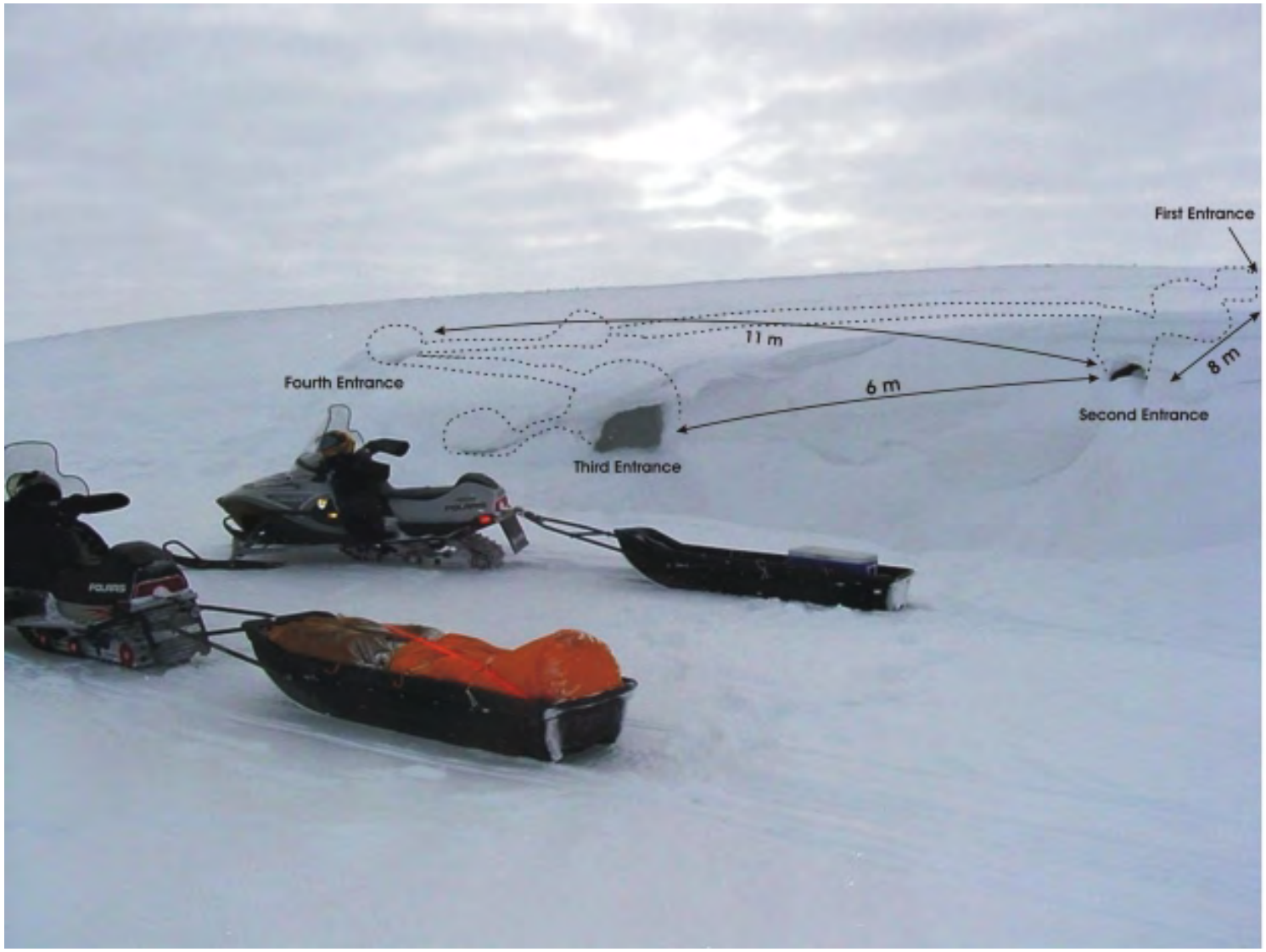


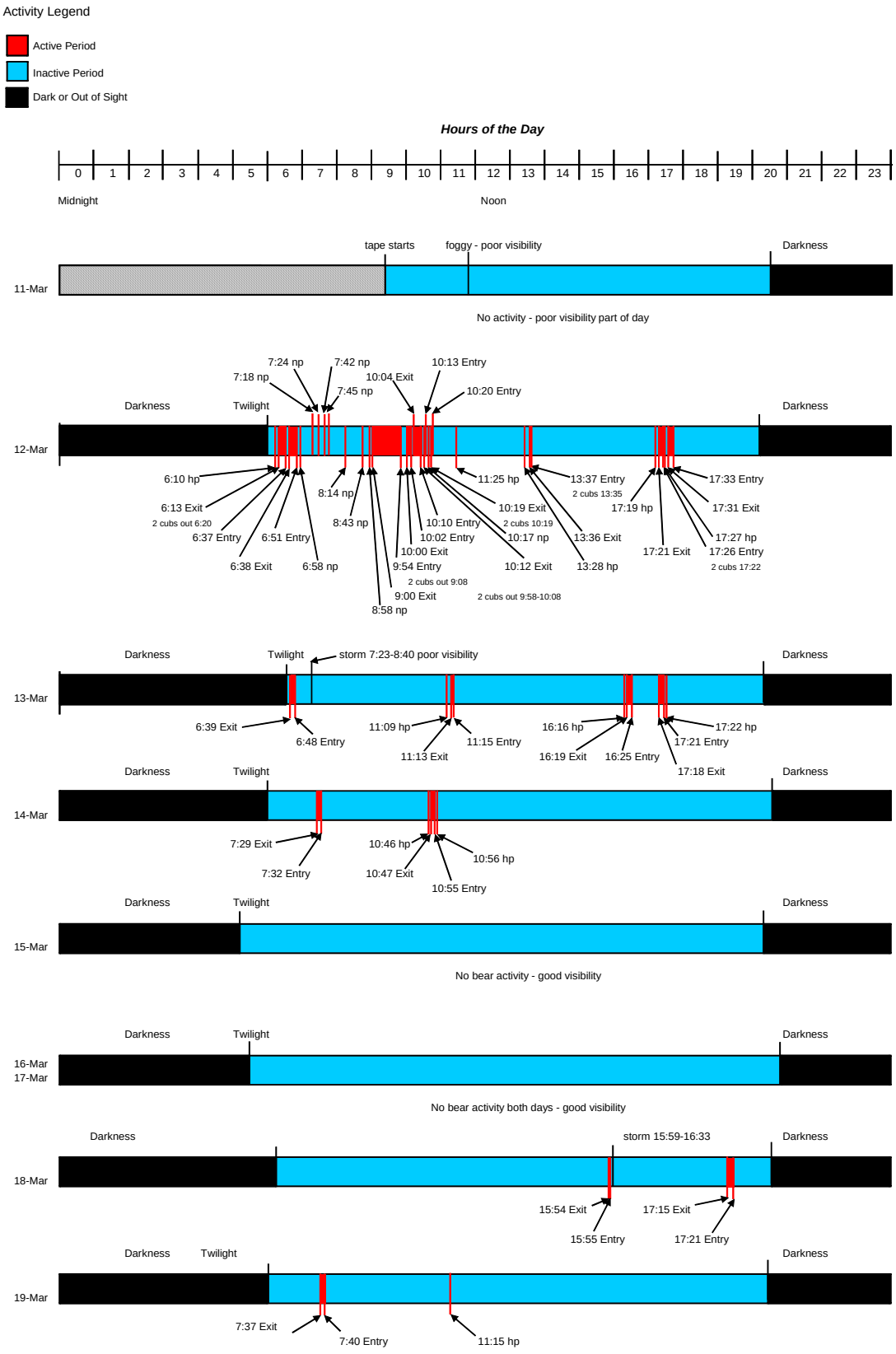
Figure 18. The Staging Pad den complex with four entrances, five chambers and long, interconnecting tunnels.

APPENDIX A

GRAPHS OF

INDIVIDUAL DEN EMERGENCE PATTERNS

Figure 1. Activity patterns for the Staging Pad den site, 2005.



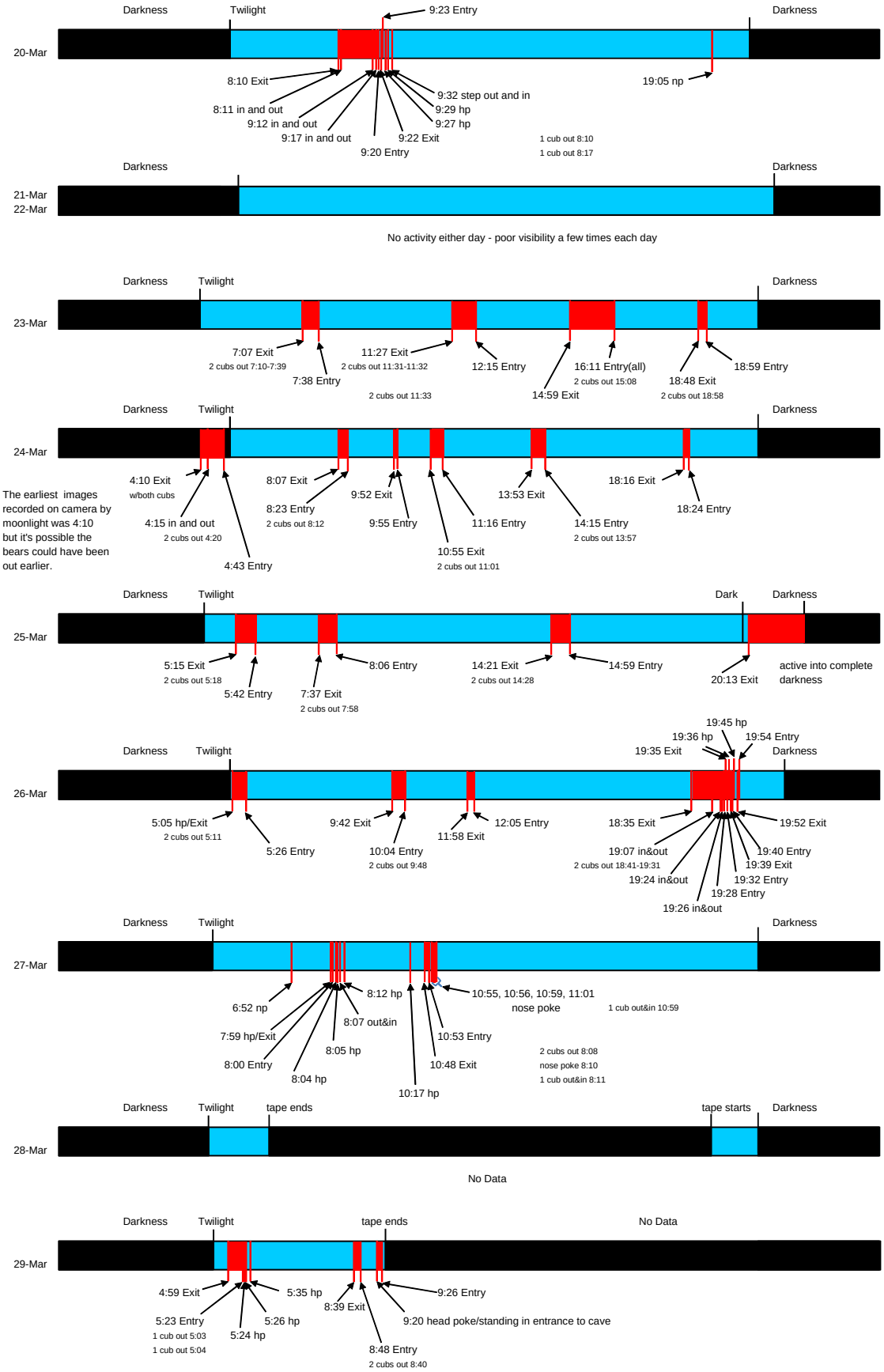
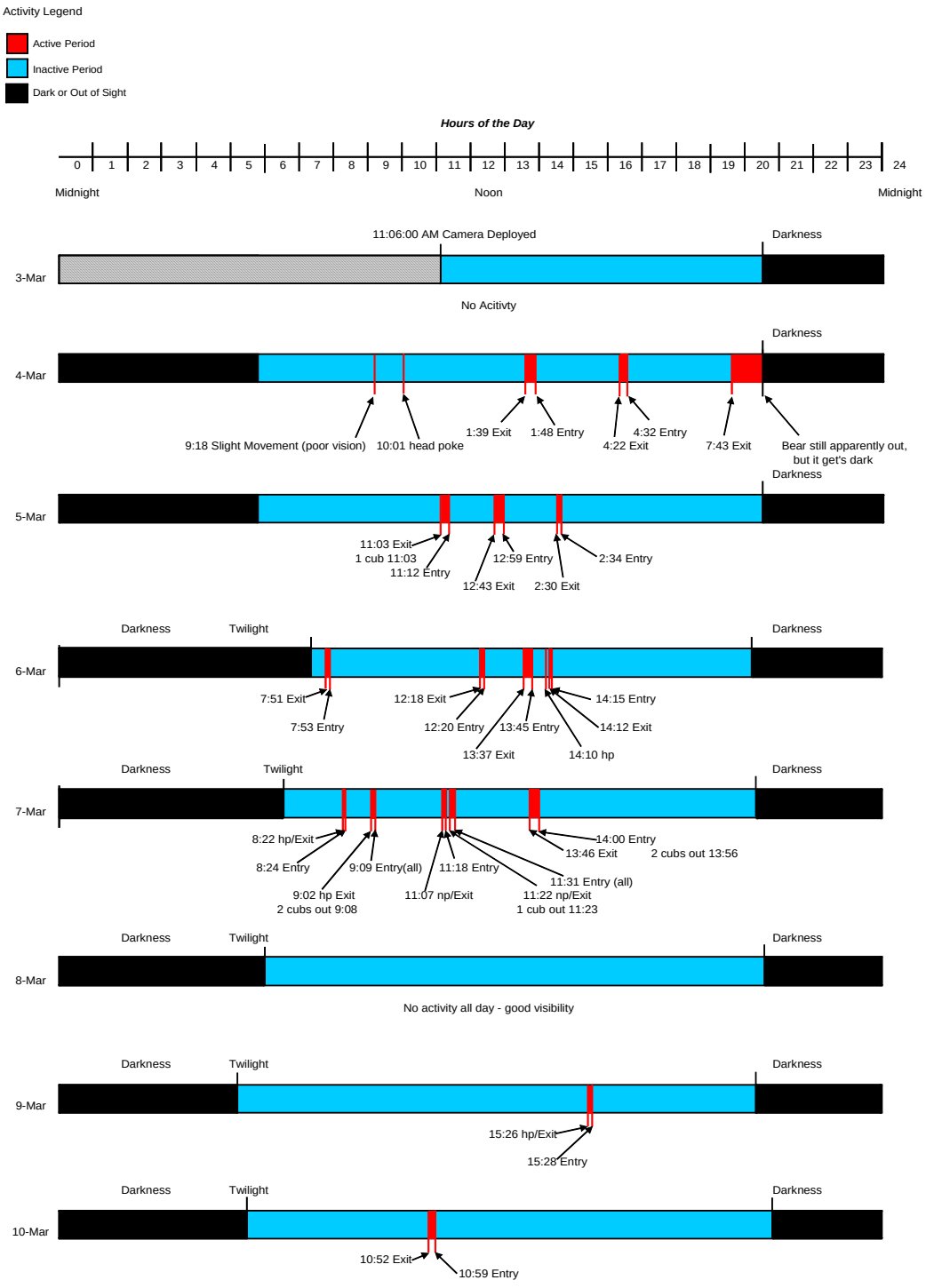

20-Mar
Darkness
Twilight
9:23 Entry
Darkness
8:10 Exit
8:11 in and out
9:12 in and out
9:17 in and out
9:20 Entry
9:22 Exit
9:32 step out and in
9:29 hp
9:27 hp
19:05 np
1 cub out 8:10
1 cub out 8:17
21-Mar
22-Mar
Darkness
Darkness
No activity either day - poor visibility a few times each day
23-Mar
Darkness
Twilight
Darkness
7:07 Exit
2 cubs out 7:10-7:39
7:38 Entry
11:27 Exit
2 cubs out 11:31-11:32
2 cubs out 11:33
12:15 Entry
14:59 Exit
16:11 Entry(all)
2 cubs out 15:08
18:48 Exit
2 cubs out 18:58
18:59 Entry
24-Mar
Darkness
Twilight
Darkness
The earliest images recorded on camera by moonlight was 4:10 but it's possible the bears could have been out earlier.
4:10 Exit
w/both cubs
4:15 in and out
2 cubs out 4:20
4:43 Entry
8:07 Exit
8:23 Entry
2 cubs out 8:12
9:52 Exit
9:55 Entry
10:55 Exit
2 cubs out 11:01
11:16 Entry
13:53 Exit
14:15 Entry
2 cubs out 13:57
18:16 Exit
18:24 Entry
25-Mar
Darkness
Twilight
Dark
Darkness
5:15 Exit
2 cubs out 5:18
5:42 Entry
7:37 Exit
2 cubs out 7:58
8:06 Entry
14:21 Exit
2 cubs out 14:28
14:59 Entry
20:13 Exit
active into complete darkness
26-Mar
Darkness
Twilight
19:45 hp
19:36 hp
19:54 Entry
19:35 Exit
Darkness
5:05 hp/Exit
2 cubs out 5:11
5:26 Entry
9:42 Exit
10:04 Entry
2 cubs out 9:48
11:58 Exit
12:05 Entry
18:35 Exit
19:07 in&out
2 cubs out 18:41-19:31
19:24 in&out
19:26 in&out
19:28 Entry
19:32 Entry
19:39 Exit
19:40 Entry
19:52 Exit
27-Mar
Darkness
Twilight
Darkness
6:52 np
7:59 hp/Exit
8:00 Entry
8:04 hp
8:05 hp
8:07 out&in
8:12 hp
10:17 hp
10:48 Exit
10:53 Entry
10:55, 10:56, 10:59, 11:01
nose poke
1 cub out&in 10:59
2 cubs out 8:08
nose poke 8:10
1 cub out&in 8:11
28-Mar
Darkness
Twilight
tape ends
tape starts
Darkness
No Data
29-Mar
Darkness
Twilight
tape ends
No Data
4:59 Exit
5:23 Entry
1 cub out 5:03
1 cub out 5:04
5:24 hp
5:26 hp
5:35 hp
8:39 Exit
8:48 Entry
2 cubs out 8:40
9:20 head poke/standing in entrance to cave
9:26 Entry

Figure 2. Activity Patterns for the Pingok West Den Site, 2005.



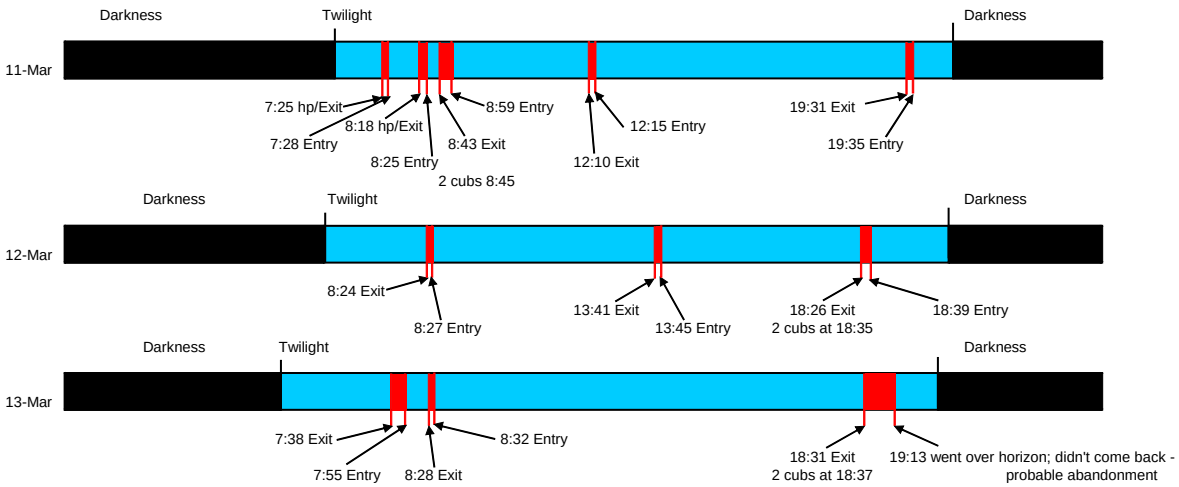
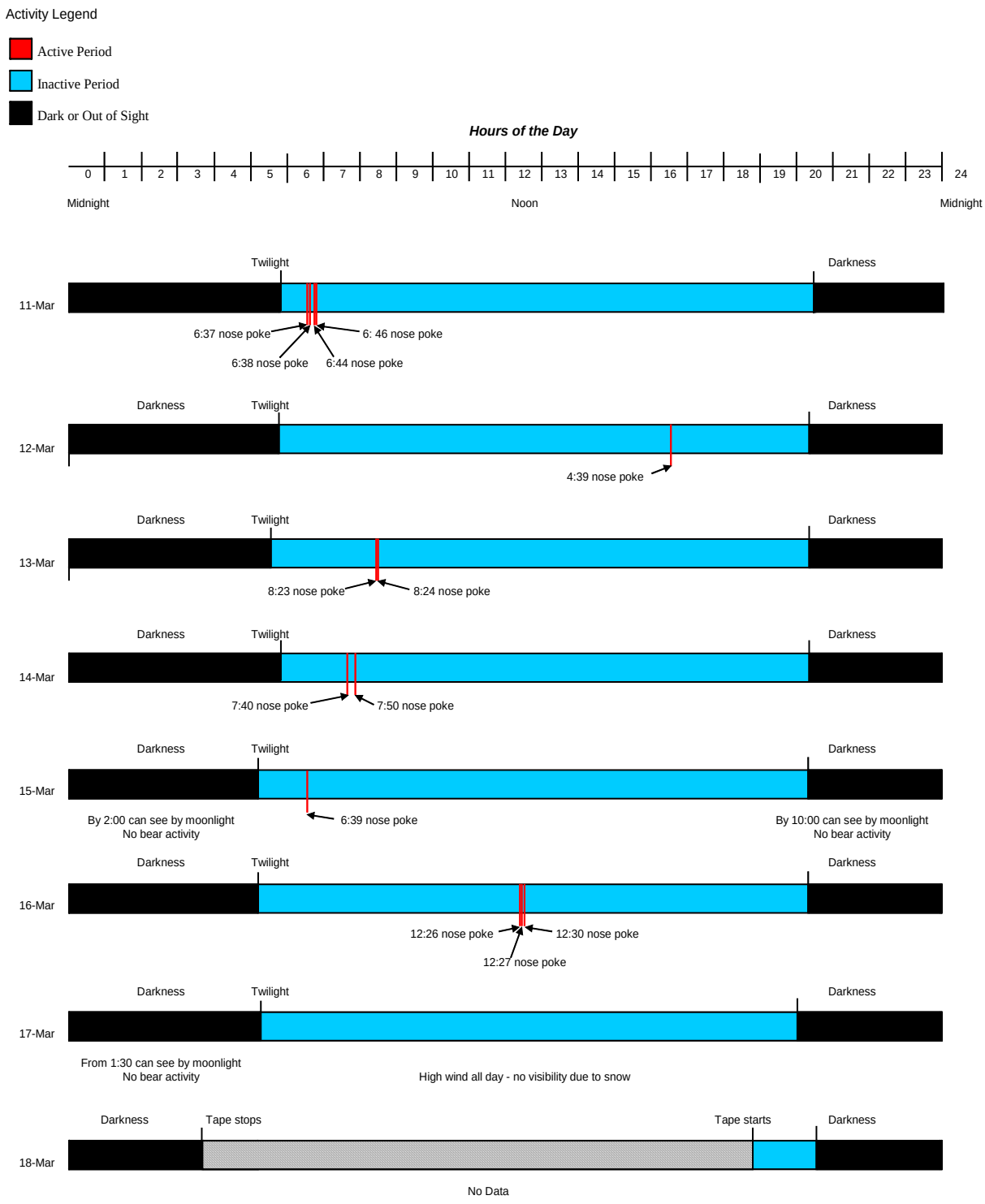

Darkness
Twilight
Darkness
11-Mar
7:25 hp/Exit
8:18 hp/Exit
7:28 Entry
8:25 Entry
8:43 Exit
2 cubs 8:45
8:59 Entry
12:10 Exit
12:15 Entry
19:31 Exit
19:35 Entry
Darkness
Twilight
Darkness
12-Mar
8:24 Exit
8:27 Entry
13:41 Exit
13:45 Entry
18:26 Exit
2 cubs at 18:35
18:39 Entry
Darkness
Twilight
Darkness
13-Mar
7:38 Exit
7:55 Entry
8:28 Exit
8:32 Entry
18:31 Exit
2 cubs at 18:37
19:13 went over horizon; didn't come back - probable abandonment

Figure 3. Activity Patterns for the Pingok East Den Site, 2006.



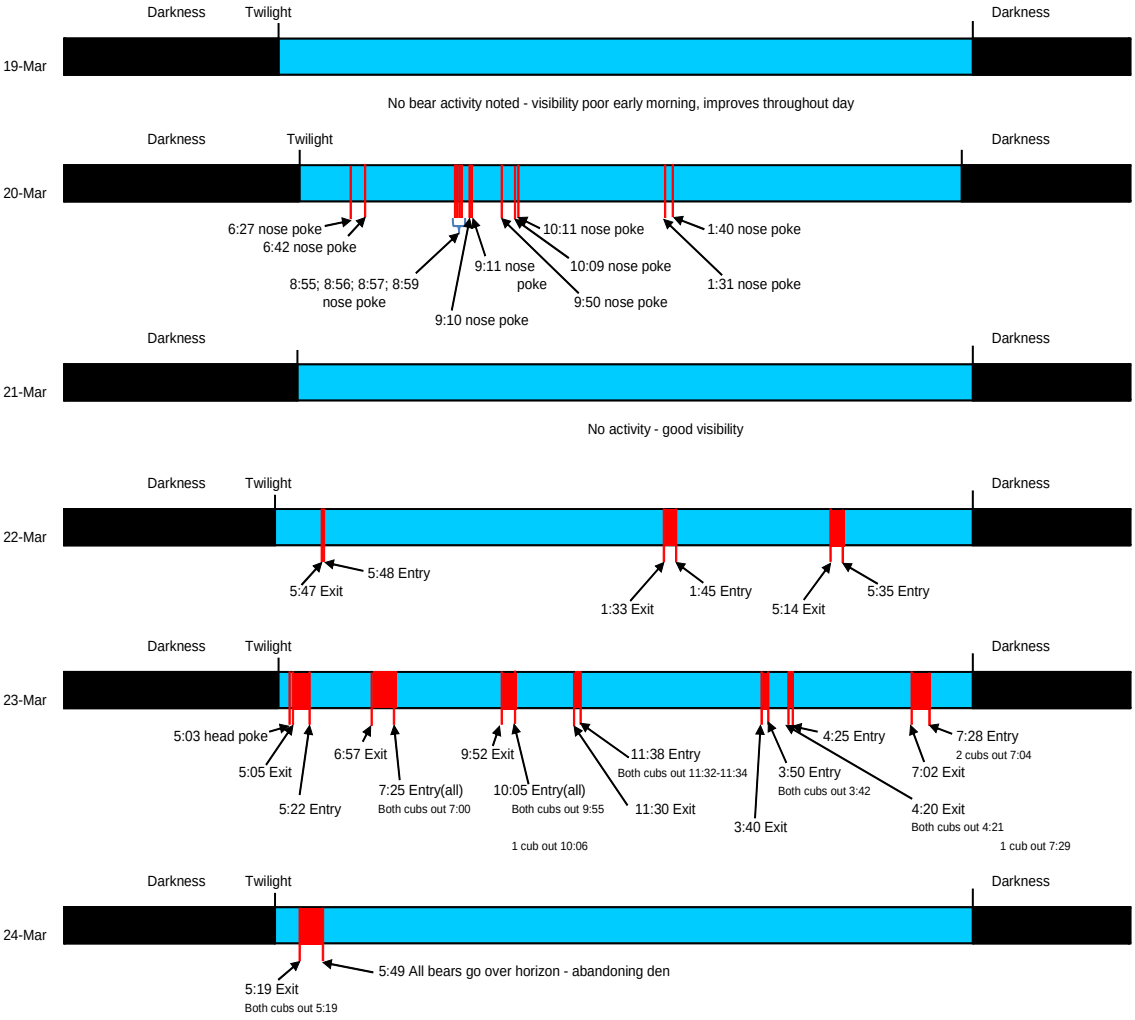
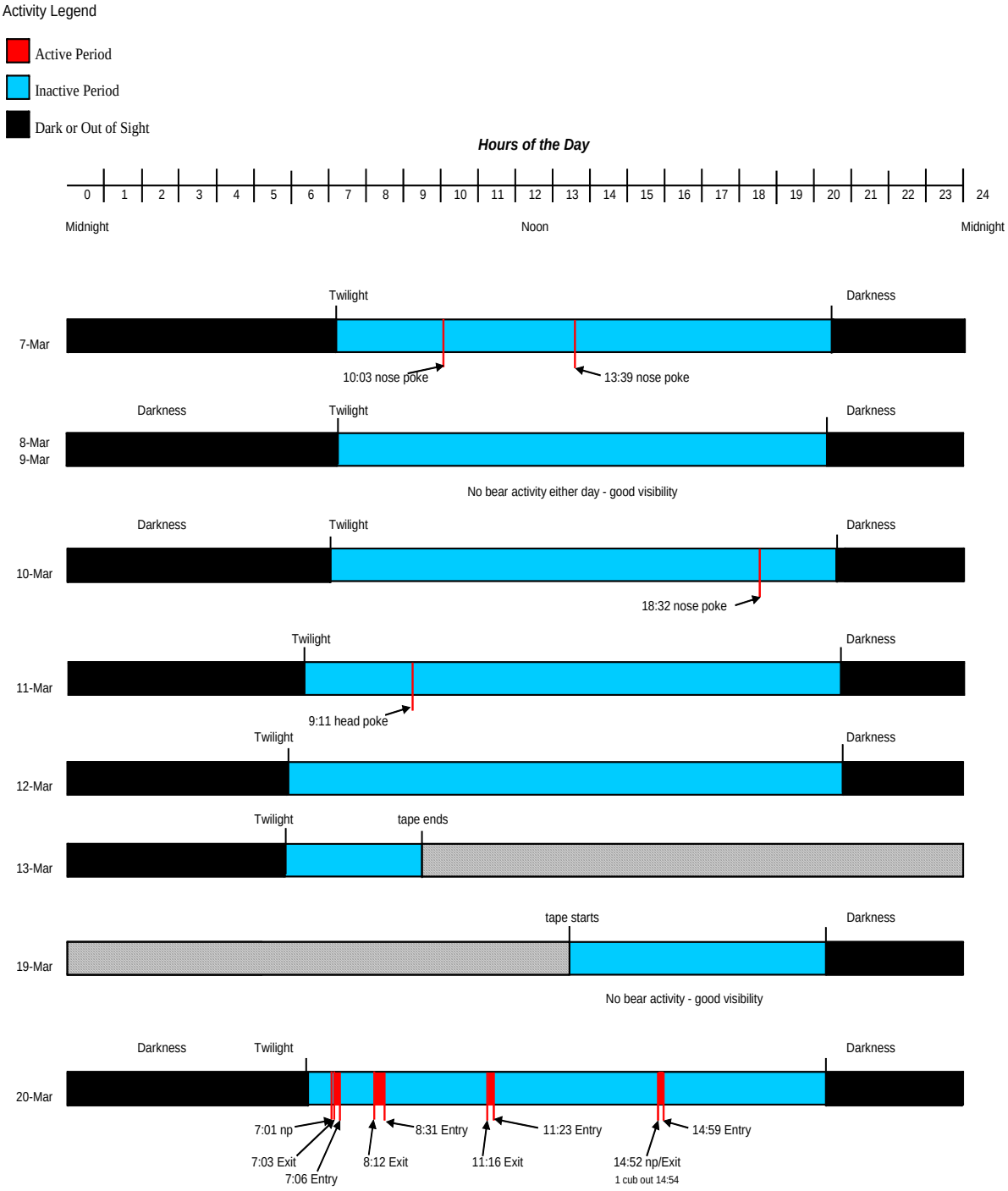

Darkness
Twilight
Darkness
19-Mar
No bear activity noted - visibility poor early morning, improves throughout day
Darkness
Twilight
Darkness
20-Mar
6:27 nose poke
6:42 nose poke
8:55; 8:56; 8:57; 8:59
nose poke
9:10 nose poke
9:11 nose
poke
9:50 nose poke
10:09 nose poke
10:11 nose poke
1:31 nose poke
1:40 nose poke
Darkness
Darkness
21-Mar
No activity - good visibility
Darkness
Twilight
Darkness
22-Mar
5:47 Exit
5:48 Entry
1:33 Exit
1:45 Entry
5:14 Exit
5:35 Entry
Darkness
Twilight
Darkness
23-Mar
5:03 head poke
5:05 Exit
5:22 Entry
6:57 Exit
7:25 Entry(all)
Both cubs out 7:00
9:52 Exit
10:05 Entry(all)
Both cubs out 9:55
1 cub out 10:06
11:38 Entry
Both cubs out 11:32-11:34
11:30 Exit
3:40 Exit
4:25 Entry
3:50 Entry
Both cubs out 3:42
4:20 Exit
Both cubs out 4:21
7:02 Exit
7:28 Entry
2 cubs out 7:04
1 cub out 7:29
Darkness
Twilight
Darkness
24-Mar
5:19 Exit
Both cubs out 5:19
5:49 All bears go over horizon - abandoning den

Figure 4. Activity Patterns for the Pingok North Den Site, 2006.



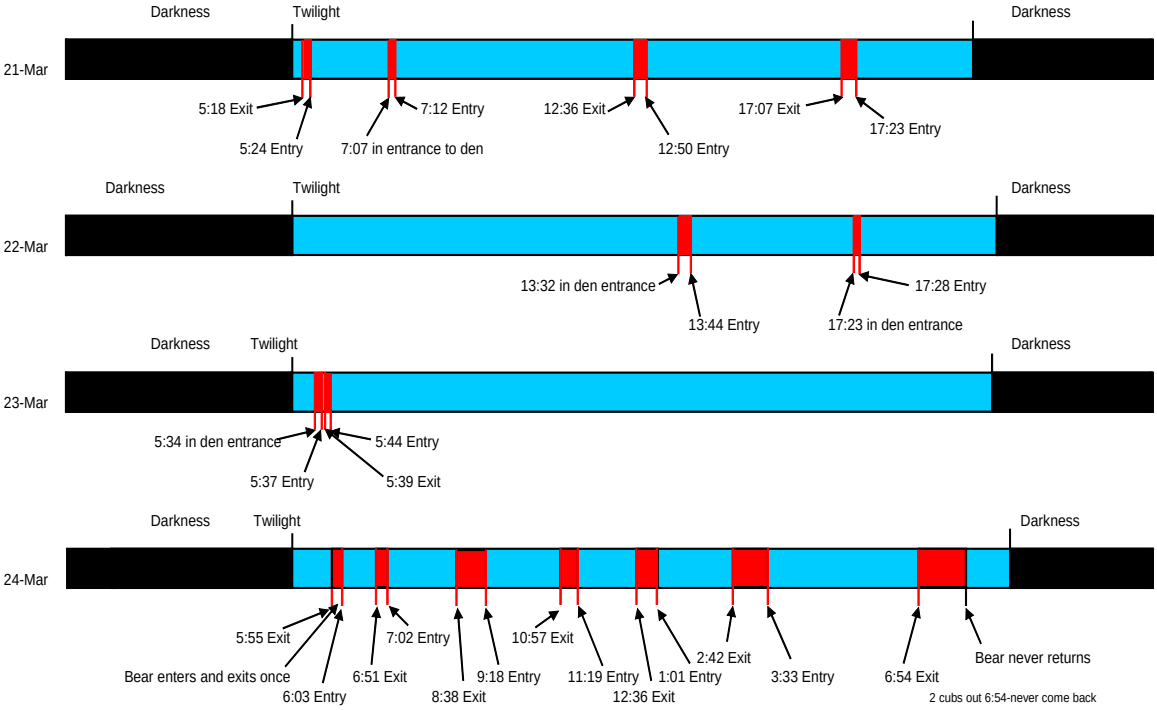

Darkness
Twilight
Darkness
21-Mar
5:18 Exit
5:24 Entry
7:07 in entrance to den
7:12 Entry
12:36 Exit
12:50 Entry
17:07 Exit
17:23 Entry
Darkness
Twilight
Darkness
22-Mar
13:32 in den entrance
13:44 Entry
17:23 in den entrance
17:28 Entry
Darkness
Twilight
Darkness
23-Mar
5:34 in den entrance
5:37 Entry
5:39 Exit
5:44 Entry
Darkness
Twilight
Darkness
24-Mar
5:55 Exit
Bear enters and exits once
6:03 Entry
6:51 Exit
7:02 Entry
8:38 Exit
9:18 Entry
10:57 Exit
11:19 Entry
12:36 Exit
1:01 Entry
2:42 Exit
3:33 Entry
6:54 Exit
Bear never returns
2 cubs out 6:54-never come back

Figure 5. Activity Patterns for the Cottle East Den Site, 2007.

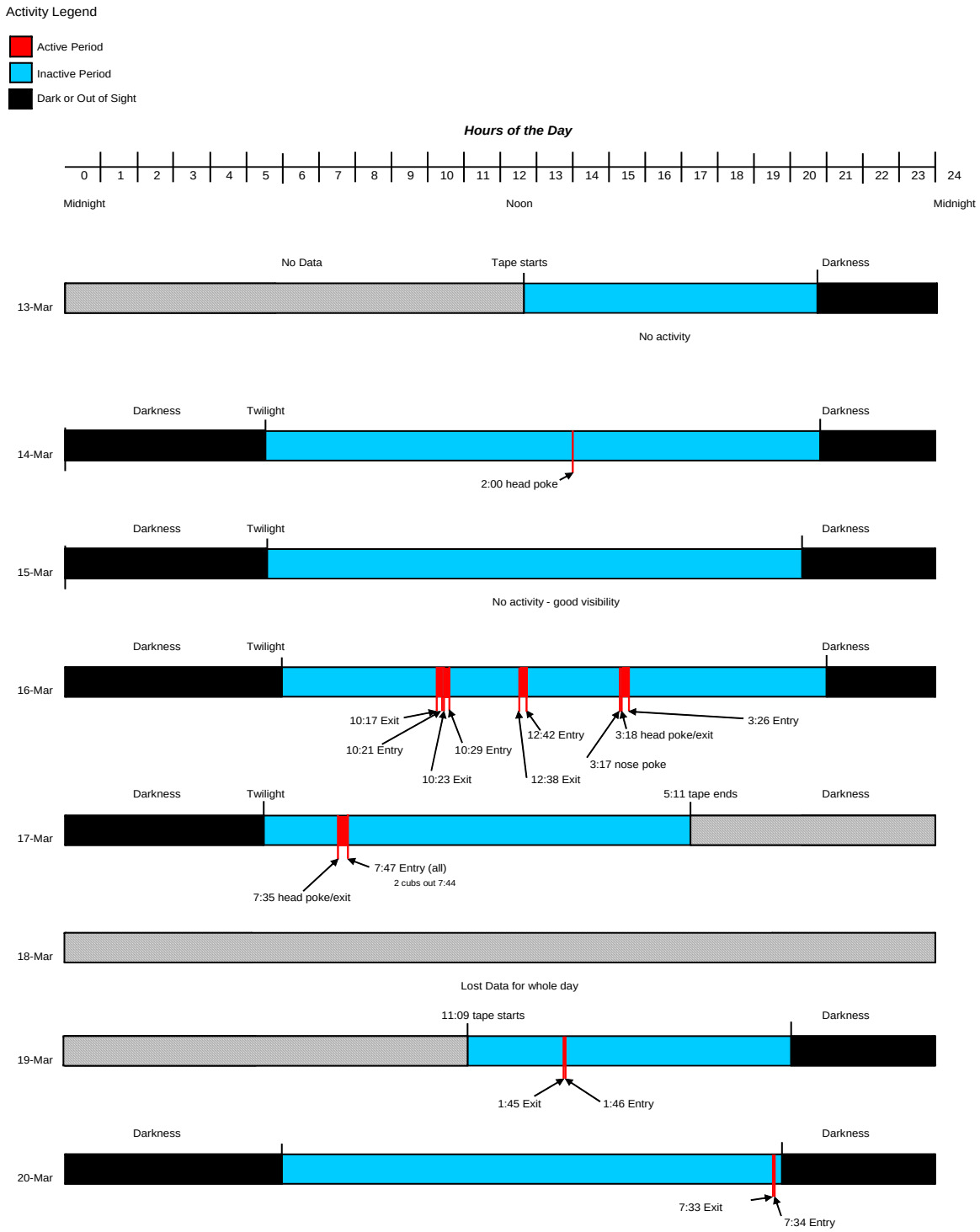
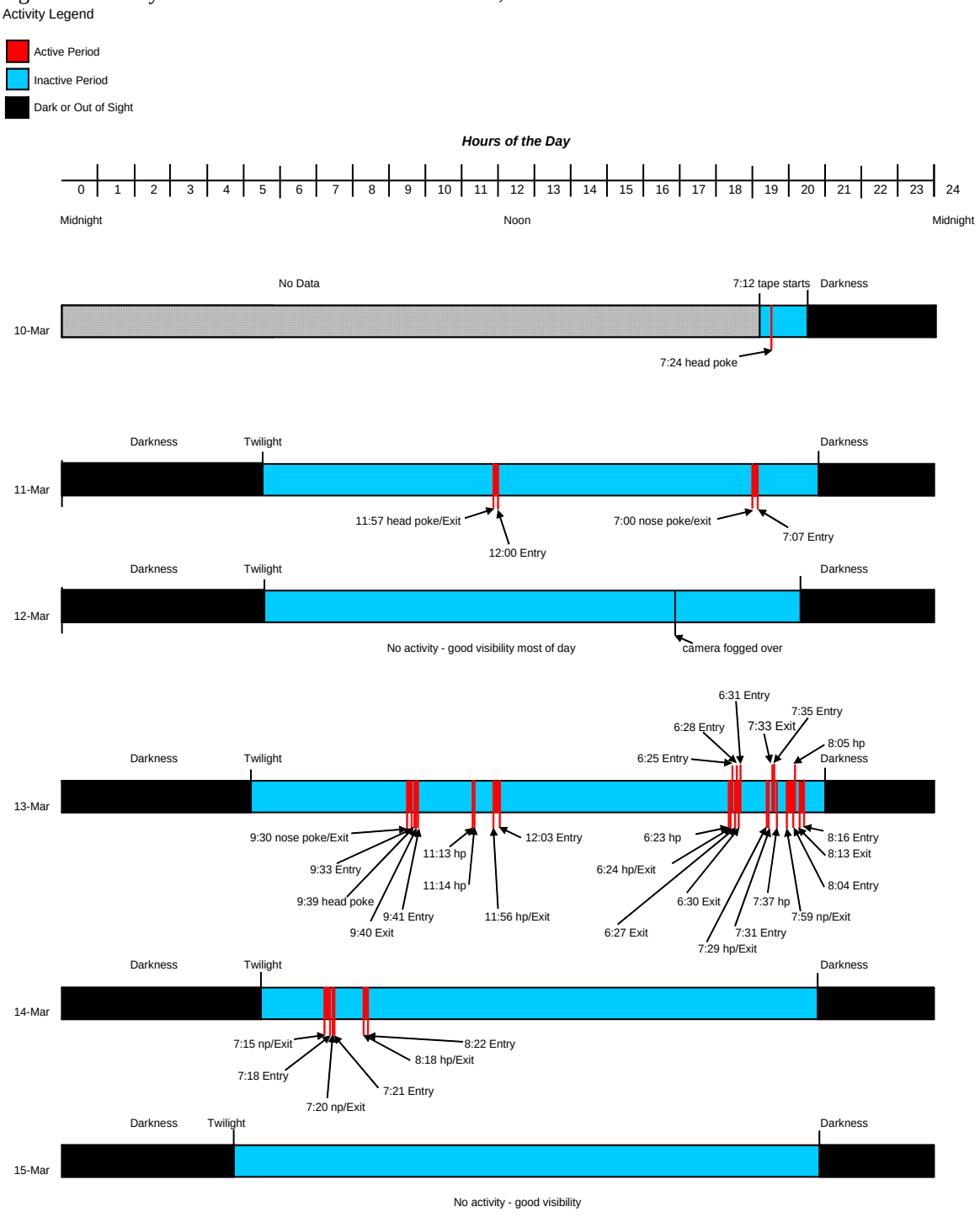


Figure 6. Activity Patterns for the Cottle West Den Site, 2007.



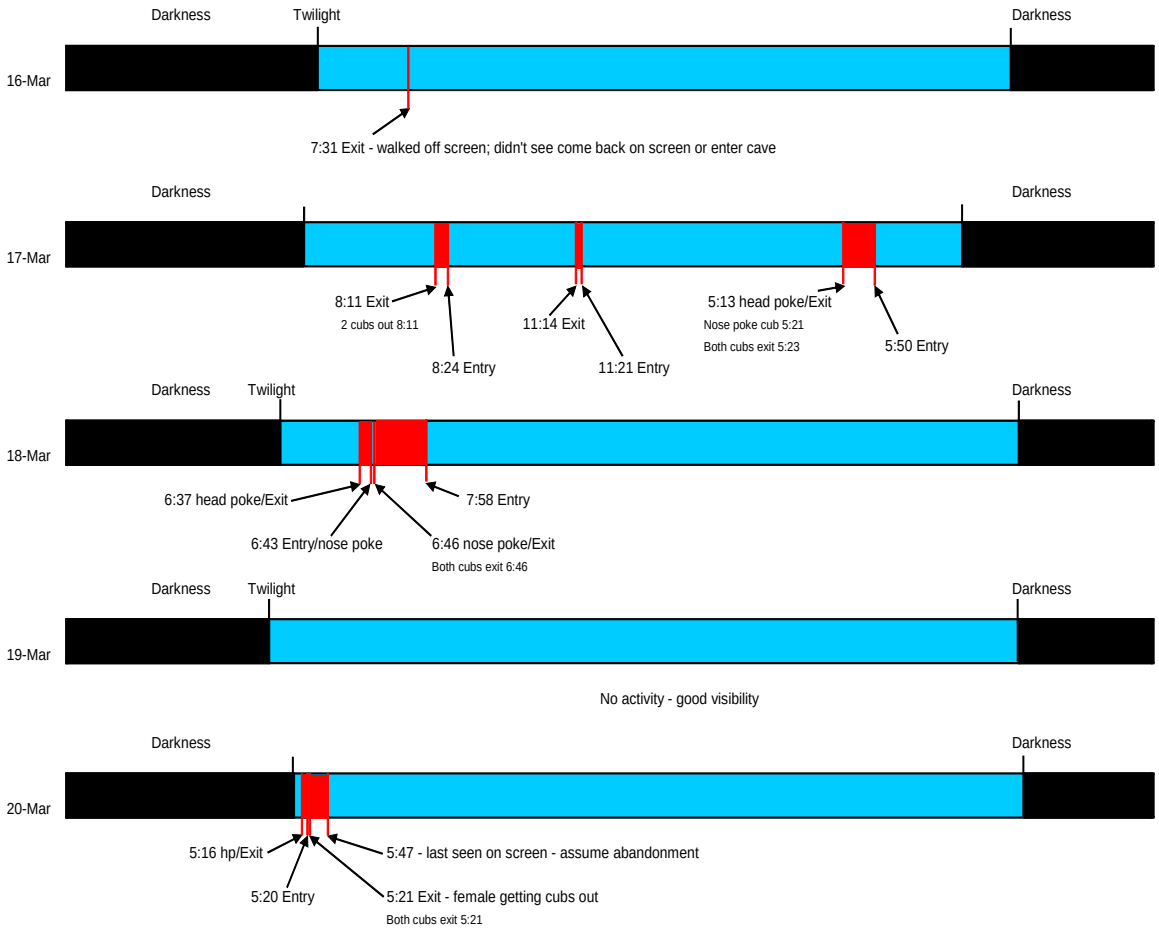

Darkness
Twilight
Darkness
16-Mar
7:31 Exit - walked off screen; didn't see come back on screen or enter cave
Darkness
Darkness
17-Mar
8:11 Exit
2 cubs out 8:11
8:24 Entry
11:14 Exit
11:21 Entry
5:13 head poke/Exit
Nose poke cub 5:21
Both cubs exit 5:23
5:50 Entry
Darkness
Twilight
Darkness
18-Mar
6:37 head poke/Exit
6:43 Entry/nose poke
6:46 nose poke/Exit
Both cubs exit 6:46
7:58 Entry
Darkness
Twilight
Darkness
19-Mar
No activity - good visibility
Darkness
Darkness
20-Mar
5:16 hp/Exit
5:20 Entry
5:21 Exit - female getting cubs out
Both cubs exit 5:21
5:47 - last seen on screen - assume abandonment

Figure 7. Activity Patterns for the Pingok East Den Site, 2007.

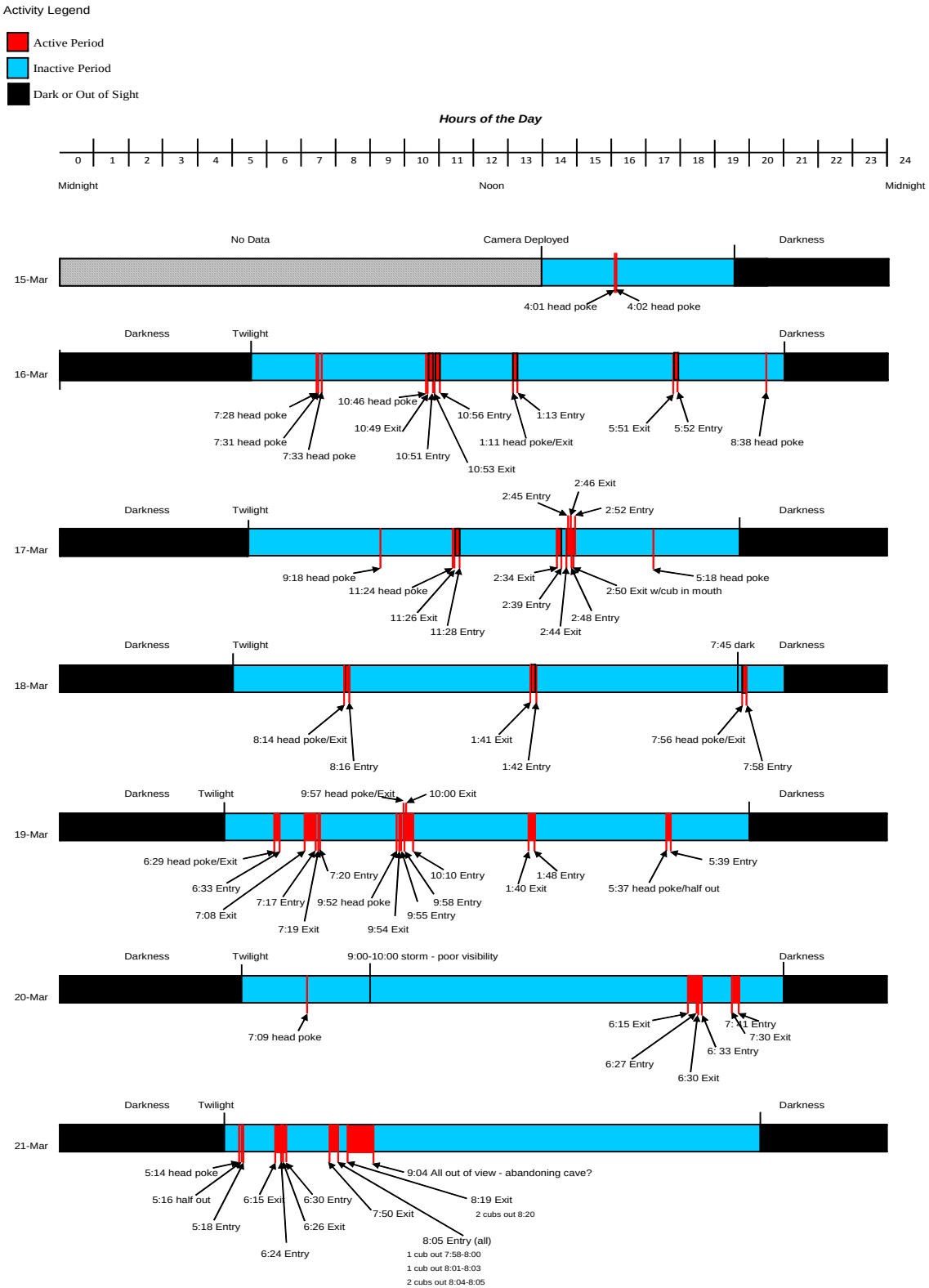


Figure 8. Activity Patterns for the Pingok West Den Site, 2007.

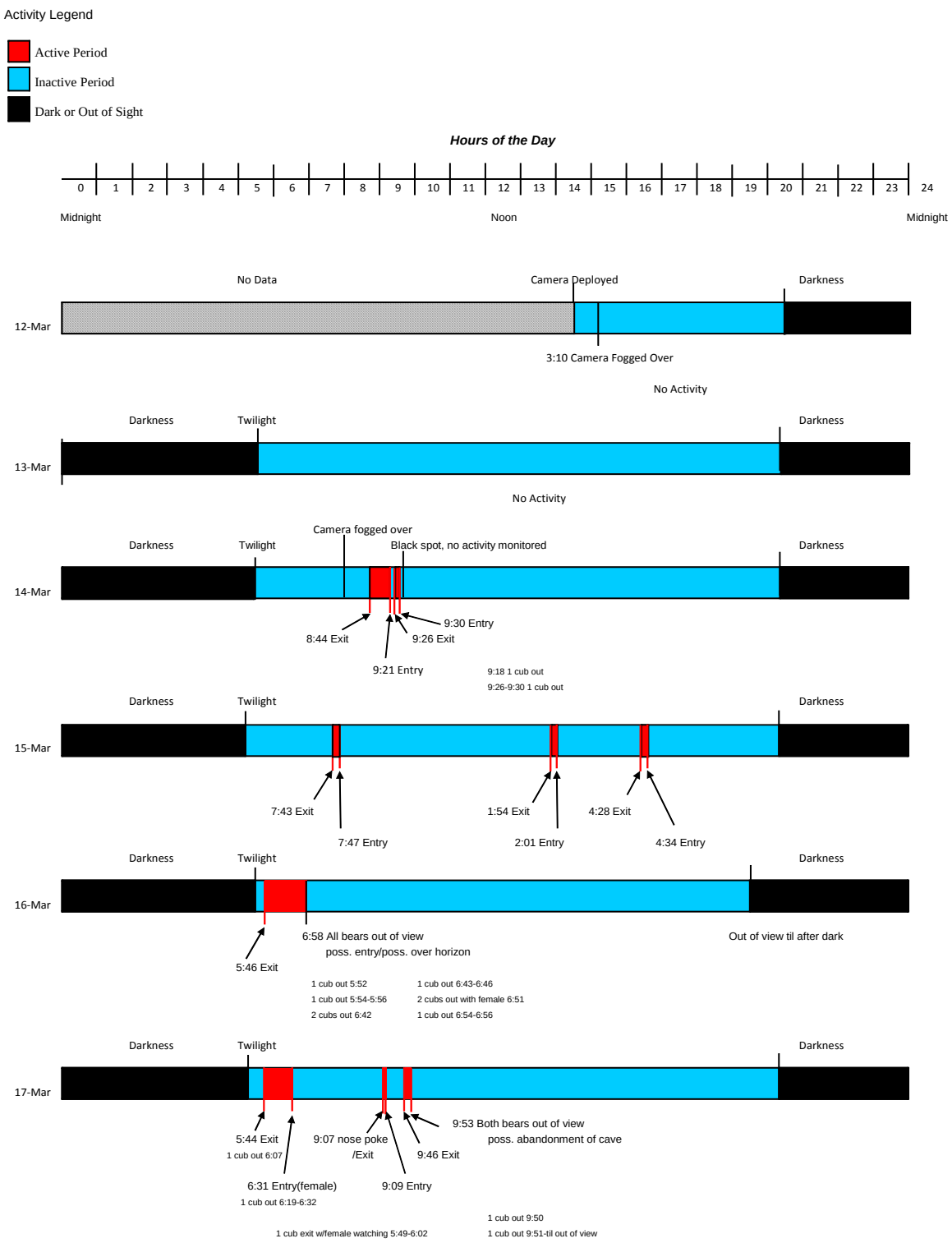


Figure 9. Activity Patterns for the Cottle Den Site, 2008.

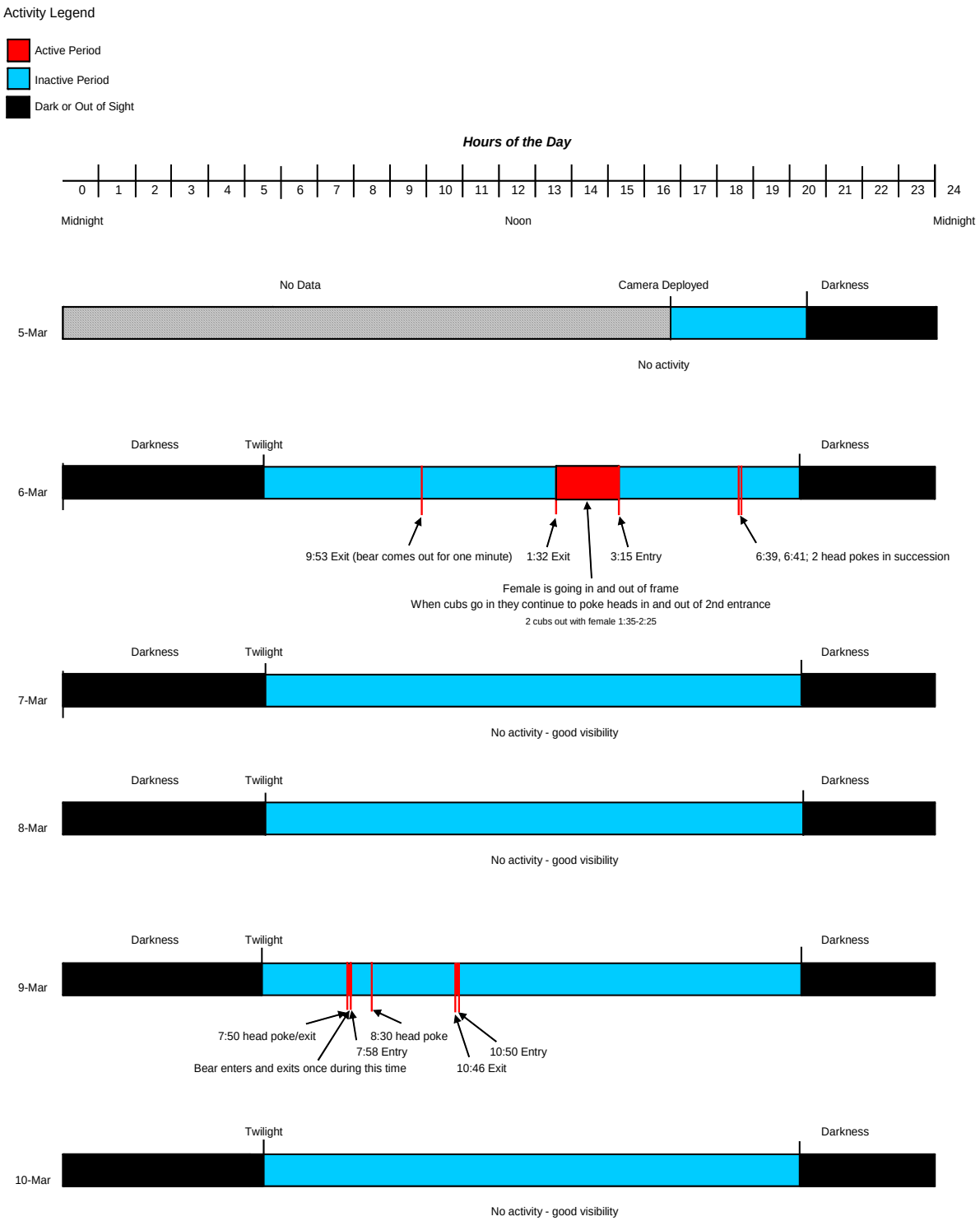
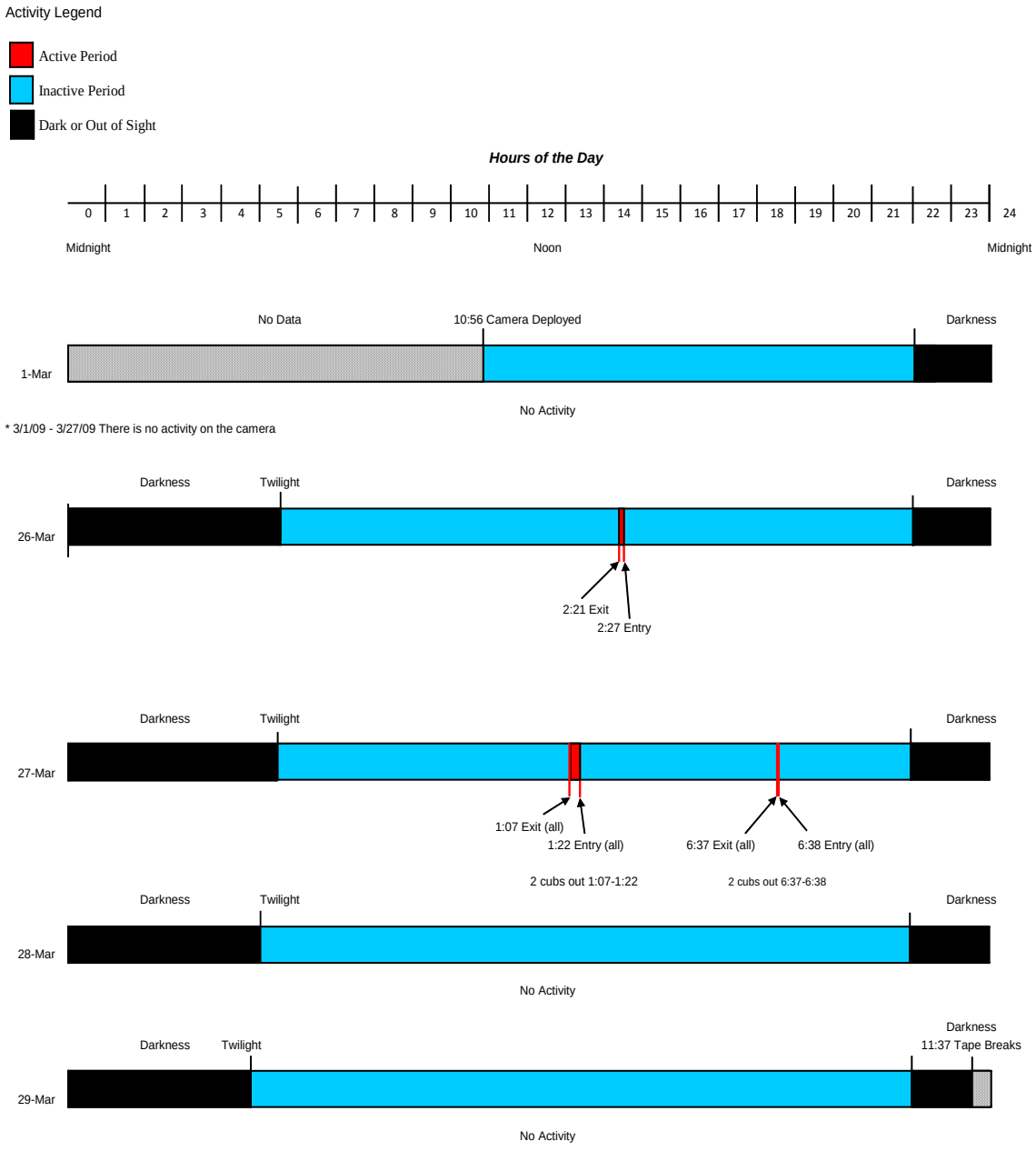


Figure 10. Activity Patterns for the Staging Pad Den Site, 2008.



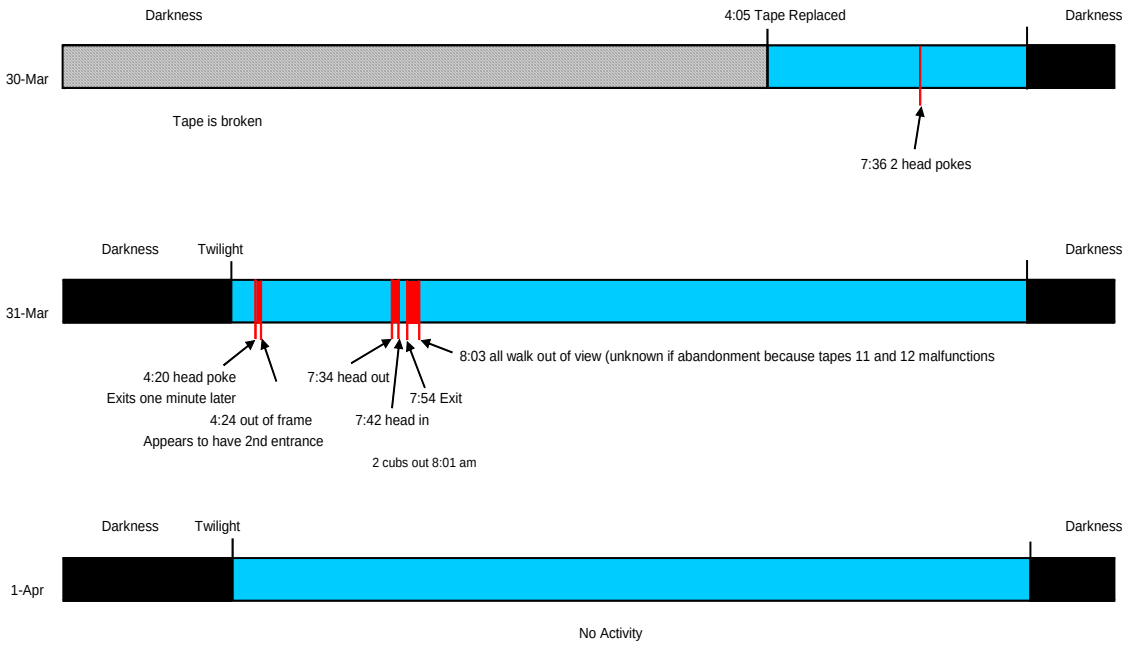
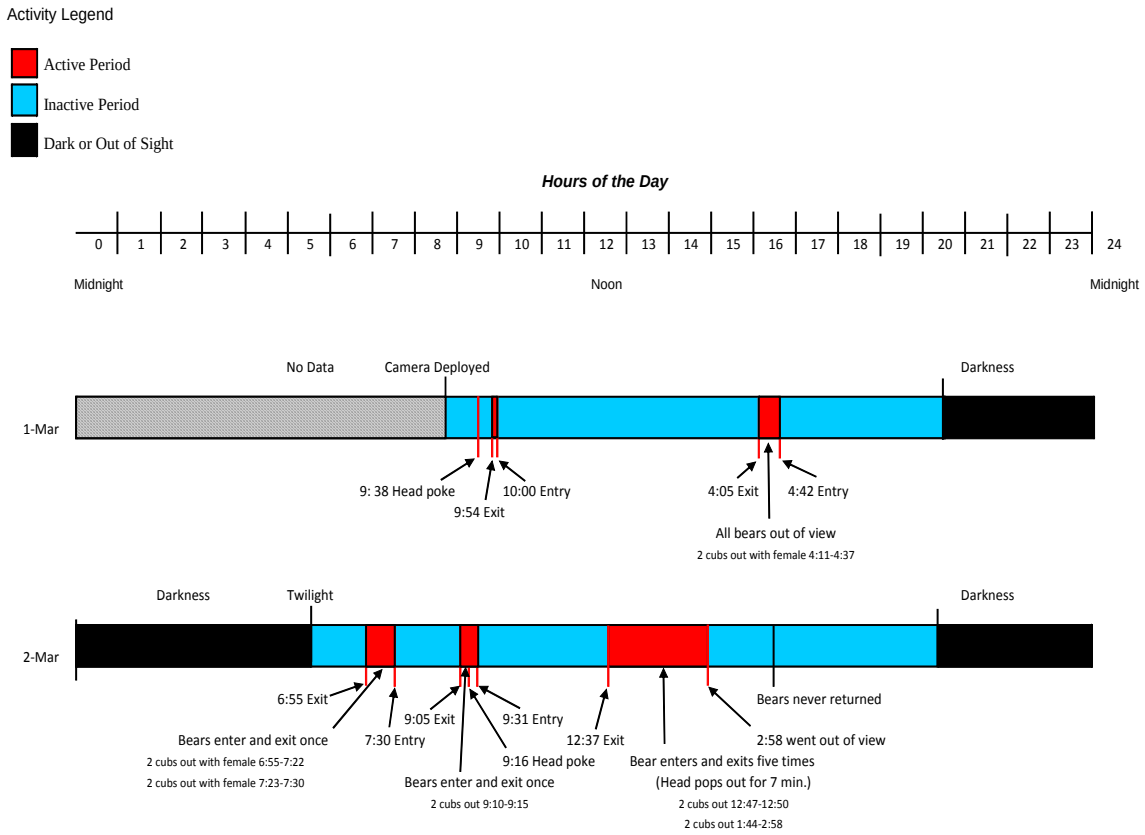

Darkness
4:05 Tape Replaced
Darkness
30-Mar
Tape is broken
7:36 2 head pokes
Darkness
Twilight
Darkness
31-Mar
4:20 head poke
Exits one minute later
4:24 out of frame
Appears to have 2nd entrance
7:34 head out
7:42 head in
7:54 Exit
8:03 all walk out of view (unknown if abandonment because tapes 11 and 12 malfunctions
2 cubs out 8:01 am
Darkness
Twilight
Darkness
1-Apr
No Activity

Figure 11. Activity Patterns for the Pingok West Den Site, 2008.



APPENDIX B

Polar Bear—Human Interactions
North Slope, Alaska
2002—2009

Polar Bear—Human Interactions
North Slope, Alaska
2002-2009

The following incidents were recorded in our field journals. They represent all bear-researcher interactions that occurred during the course of implementing the den emergence study for the years 2002-2009.

8 March 2002

- At 5:12 PM, the Bullen Point adult female and cubs suddenly halted activity in response to sounds associated with crews repairing heavy equipment on the ice road (approximately 1.6 km distant). This noise was unlike that of vehicular traffic and elicited a strong response. The adult female hurriedly ran to the den and re-entered, cubs close behind. Throughout the 4 days of observation at Bullen Point, the adult female frequently gazed towards the ice road when vehicles passed, particularly the noisier snow blowers or road graders. Interestingly, the adult female did not outwardly exhibit a response to the Tucker Snow Cat (we used as an observation post) as it approached to within 0.8 km of the den site each morning, nor when it fired up its engines on one occasion prior to leaving for the day.

The Tucker Snow Cat provided a blind for observation.

The mother and 2 cubs abandoned this den site on 12 March, 4 days later.

9 March 2002

- At 9:14 AM, the Bullen Point adult female was out of her den when we approached in the Tucker Snow Cat. The bear acknowledged our approach with a gaze but didn't re-den or appear overtly stressed by our presence.

- From 1:10 PM to 4:33 PM the adult female was out of den. During that period, 5 large trucks came down the ice road during that time. The bear was resting near the den entrance and occasionally scanned the terrain, but only once got up and stared attentively towards the road. She did not respond as if disturbed, however, simply aware of road traffic. During this time, there were also several movements of the Tucker Snow Cat that failed to elicit any overt response.

  The mother and two cubs abandoned this den site on 12 March, 3 days later.

10 March 2002

- At 7:46 AM, we arrived at the Bullen Point den to find the adult female already out. She remained out of den until 10:23 AM. During this observation period several trucks passed by and Tucker Snow Cat (parked at 0.8 km from the den) emitted noise (e.g., we periodically fired the engine up for heat) but again, these were acknowledged without any overt response.

  The mother and two cubs abandoned this site on 12 March, 2 days later.

11 March 2002

- At 7:46 AM, the Bullen Point adult female seemed more wary by the presence of the Tucker Snow Cat than on previous days. She was very attentive and started backing up towards the den over the course of observation. Once closer to the den, she calmed and seemed less concerned, as evidenced by a lack of fixed gaze in our direction. We speculate that the farther from the den, the less secure she felt; at least that is what appeared to be happening.

- From 7:46 AM to 10:23 AM, the adult female was out of den. During this time there were many vehicles passing by on the nearby ice road. We also fired up the Tucker Snow Cat on multiple occasions but beyond a furtive glance the bear elicited no other overt signs of concern or stress.

  The mother and two cubs abandoned this site on 12 March, 1 day later.

A variety of vehicles used the ice road near Bullen Point.

12 March 2002

- At 2:35 PM, the Bullen Point adult female and cubs approached to within 0.5 km of the Tucker Snow Cat (parked without engines running) and remained there for hours, appearing wholly unconcerned about its presence.

  The mother and 2 cubs left the den site later this day.

19 March 2002

#40

- At 1:09 PM, the Cottle Island East Den's adult female emerged from the den as we were setting up camp (i.e., pitching tents, building a snow wall around the tents, etc). Upon seeing our camp she lay down, scanned the terrain, but did not appear overtly stressed. On several occasions, she permitted her cub to play outside the den alone. On March 19 and March 20, she did acknowledge our tent camp by staring in its direction, but did not seem overtly stressed by it.

We used white tents at 500 m from dens for observation posts.

This bear abandoned this site on the 27th of March, 8 days later.

#20

- At 6:27 PM, a snow machine approached the Cottle Island West den from the east. The adult female focused her attention in the direction of the approaching machine and when it drew within 1 km she began walking backward to the den and re-entered it.

This bear abandoned this site on the 20th of March, the following day.

#22

- At 11:24 AM, the Tucker directly approached the Flaxman Island den site in order to reduce the observation distance from 0.6 km to 0.4 km to improve visibility. As the Tucker motored over snow and ice toward the den the adult female and cubs suddenly appeared, the driver unaware. As the vehicle continued its slow approach the adult female stared intently, backed up to the den entrance and, after several minutes, re-entered the den with her cubs.

A Tucker Snow Cat approaches the densite.

This mother and 2 cubs abandoned the den site on 22 March, 2 days later.

20 March 2002

- At 5:42 PM, the Flaxman Island adult female stared in the direction of the construction camp then suddenly entered the den with her cubs. Moments later a pickup truck appeared (< 0.2 km), the adult female having apparently heard it coming.

The Flaxman Island Construction Camp, approximately 0.8 km from den site.

This mother and 2 cubs abandoned the den site on 22 March, 2 days later.

- At 10:56 AM, the Cottle Island West adult female stared attentively at the tent, but showed no other signs of stress.

This bear likely abandoned this site on the 20th of March, later this day.

21 March 2002

- At 2:34 PM a small fixed wing aircraft flew over the Cottle Island East den site at an altitude of approximately 150 m. The adult female and cub had been out of the den for 10 minutes as the plane approached. Both bears ran to the den entrance at once and re-entered.

- Twice later that day, between 4:54 PM and 8:43 PM, the bear came out and stared attentively at the tents, but showed no other overt behaviors. She stayed out for a long period of time for both of these instances.

The mother and cub abandoned this den site on 27 March, 6 days later.

22 March 2002

- Between 7:17 AM and 7:24 AM, a beeper on a radio went off and caused the Cottle Island East adult female to stare attentively at the tent for a moment before resuming activity. The day was perfectly quiet and the sound carried the 400m from our camp to the den entrance where the female was sitting at the time.

The Cottle Island East adult female at the den pushup by the Mineral Management Service weather station.

- At 12:43 PM the Cottle Island East adult female repeatedly stared to the southwest then suddenly re-entered her den. Uncertain as to what had disturbed her, I (S. Partridge) stepped out of blind and with binoculars saw 3 snowmachines approaching, but were yet 2.4 to 3.3 km distant. I had not heard the snowmachines and was surprised that the female had detected, and responded to, them at that distance.

- At 13:18 PM the Cottle Island East adult female and cub suddenly ran to the den entrance and quickly re-entered in apparent response to 3 snowmachines leaving the Cottle Island West observation blind, some 1.8 km distant.

  The mother and cub abandoned this den site on 27 March, 5 days later.

27 March 2002

- At 7:31 PM a researcher stepped outside the Cottle Island East den site blind and the adult female responded immediately by running to the den entrance. The cub followed and promptly re-entered the den, but the adult female remained outside the entrance, staring in the direction of the blind (500 m distant). After the person re-entered the blind, the female backed down into the den. The adult's sudden reaction to a person's presence was unexpected, as she had come out of her den twice upon arrival of the observers earlier in the day, had peered in the direction of the blind, seen people, but reacted in no overt manner and appeared undisturbed.

  The mother and cub abandoned this site later that evening or early the next morning before observations resumed.

18 March 2003

- At 7:13 AM, the Eskimo Island den 889 bear was out and looked attentively at the tent. She did this again later in the day 7:10 PM. She continued to do this up to March 23. After that, she paid a lot less attention to the tent and showed no overt signs of stress.

The Eskimo Island campsite, well hidden behind a high snow wall from den entrances.

This bear abandoned this den site on the 29th of March, 11 days later.

20 March 2003

- As the researchers were setting up camp near the Badami den site, the adult female came out of den and stared intently towards the camp. The bear then re-denned and did not come back out that day.

  This bear abandoned this site on the 24th of March, 4 days later.

24 March 2003

- At 7:45 am, the Badami adult female and cubs were out as the snow machines pulled up. The adult female sat down and watched the machines until the researchers entered the tent, after which she resumed her previous activity.

  This bear abandoned this site later today.

25 March 2003

- At the Cottle Island den, the bear saw a researcher (I. Martin) outside of the tent and partially re-entered her den.

  This bear abandoned this den site later that night.

- At the Eskimo Island west den the adult female emerged and was active for a bit today. She seemed attentive but paid no attention to our tent pitched 400 m to the south.

26 March 2003

- Eskimo Island west den adult female was out a bit today, looked north over the island quite often, occasionally stood on hind legs while peering about. She did not seem interested in our camp, rarely looking our direction or fixing a gaze on it.

27 March 2003

- Eskimo Island west den adult female was out today. She re-entered her den after sniffing the air intently. At that time the breeze was blowing past den site 889 towards 884, and that may have been the cause. The wind was clearly not moving from our camp to the den sites. This adult female did not pay any attention to our camp. Again bear looked attentively out over ice a lot.

28 March 2003

- The Eskimo Island west den adult female polar bear was out today, yet paid no attention whatsoever to our camp. Weather was noted as particularly bad, lots of wind and blowing snow.

30 March 2003

- At 5:14 PM the Eskimo Island west den adult female came out of her den quite a bit and brought her 2 cubs out for the first time. As a group they wandered a distance from the den. While out an airplane flew overhead and the bears responded by running back to their den and re-entering immediately. After this aircraft hazing the adult female appeared much more nervous and interested in camp. She headed north out to the sea ice later this day and was not seen again.

Late March 2004

- (precise date unrecorded) T. Smith and T. DeBruyn interacted with a single adult female and cub while searching for open dens around Cottle Island by snow machine. No bears had been seen all month, save the mother and cubs killed by an adult male on Pingok Island, so daily surveys were conducted by snowmachine of formerly high use denning areas in search of an active den. While cruising the shoreline along Cottle Island, about 500 m west of the weather station, we rounded a small hill on the bank and saw an adult female and cub about 50 m distant. We turned away immediately and, in response to our sudden appearance, she ran west with her cub. They presumably left the island that day or the next as they were no longer seen or evidence of them found during subsequent trips.

#38

29 March 2005

- In the morning we (T. Smith and J. Wilder) snow machined over to the Staging Pad den site to swap batteries and video tape. It wasn't until reviewing the tape later that day that it was clear that the mother and cubs had been outside of the den, had heard the snow machines approaching and had re-entered the den in response. We could not tell how distant the snow machines were but guessing from the time elapsed on tape until the bears re-entered the den, we must have been the better part of 1 km distant.

A researcher secures the camera unit after putting new batteries and video tape within.

10 March 2007

- By mid-afternoon the weather had not lifted but seemed manageable, so J. Whiting and I (T. Smith) loaded up two video camera units and drove out to Cottle Island to get them up and running. Snow was blowing, thus making efforts to initialize the camera units quite difficult. Worse, we could not clearly see the active den's entrance in the fading light and blowing snow so we set the camera up at about 125m south on sea ice. We later moved it due to its close proximity (see March 12th below). We then moved to what appeared to be a den entrance pushup near the Cottle Island weather station and set that camera up. While working on initializing the camera, Jericho saw the head of the bear at pushup poke out of the entrance, crane around then retreat to within. She repeated this a second time, never fully emerging but looking around. Later when we reviewed the video of this bear we recognized this as a pattern she often repeated before emerging from the den. What effect we may have had is unknown.

#46

This bear abandoned this den site with cubs on March 22nd, 12 days later.

March 12th, 2007

- The day dawned much calmer, and warmer (-20 deg F) so we readied our gear and traveled to Cottle Island to retrieve videocassettes to insure proper functioning of camera units. While unloading film from the Cottle west den site, the adult female bear fully emerged from her den. She was aware of our presence as we had not turned our snow machines off in order to keep the hot grips warm and to facilitate our departure (the machine with the broken electric starter was difficult to pull start if it sat more than 20 minutes). Glancing at us, the female walked briskly to the nearby island bluff, stretched her neck low while scanning in all directions, began back towards the den, halted, then moved swiftly to the den opening and re-entered.

#46

No doubt our presence caused her some concern, as evidenced by her sudden movements and furtive glances in our direction. We decided to move both cameras farther from dens so as to minimize our presence in the future, moving them from 100 m to 125 m from the entrance. Notably, in recent years only rarely have we had bears emerge while servicing cameras, largely because bears exit their dens < 3-5 times daily and for only a few minutes each time. This day, however, our timing had been off. In cases such as this it is difficult to attempt to imply an impact of significance. What if this family remains yet for days? One would conclude our interaction had little impact. But what if she left that very day? One might be tempted to conclude that our presence had disturbed her, yet bears come and go and our timing could simply have been that we showed up on the day she was going to leave anyway. These are difficult questions to answer. In this instance, however, it was clear that she was aware of our presence (for the second time in as many days) and that she acted concerned (as evidenced by her furtive glances and sudden movements). It will be interesting to see how long she remains at the den site.

As noted in the previous entry, this bear abandoned this den site with her 2 cubs on March 22nd, 12 days later.

March 14th, 2007

- T. Evans (USFWS) arrived at Milne Point around 11:30 AM. The weather was relatively mild (-15 deg F, slight wind, and sunny), and we (T. Evans and J. Whiting) were on the snow machines by 1:00 PM and serviced all three cameras by 7 PM. After we serviced the camera at the Pingok West den site, we drove east to the area where a USGS over-flight identified the location of a collared bear. As we approached the area (~ 200-250 m) we saw an adult female run and re-enter her den. No cubs were seen at this time. Upon arrival we used telemetry gear to confirm the den site. On the way to Milne, we passed the Staging Pad and saw no signs of den exit activity.

This bear abandoned this den site with her 2 cubs on March 28th, 14 days later.

2008

- No incidents were noted in the 2008 field season, worked largely by Tom Smith, Brad Jessop and Jericho Whiting.

March 7th, 2009

- We (R. Robinson and BJ Kirschhoffer) attempted to locate a radio-tagged bear on Pingok Island with telemetry so that we could deploy the camera unit in the proper location pre-den breakout. While scanning the bluff system where we presumed the den location to be (~150m distant) we noticed the bear sticking its head out of the den looking at us. It stared at us for a minute or two before withdrawing back into the den. We then quickly deployed the camera unit and drove away.

This group abandoned the den somewhere between March 18 and March 22nd, approximately 11-15 days later.

March 10th, 2009

#48

- Again on March 10 while approaching the Pingok den to service the camera we spotted the adult female (~ 400 m) nursing her cubs. We stopped, turned off our snow machines, and waited 10-15 minutes until these bears returned into the den. The female acknowledged our presence by looking our direction but otherwise did not overtly respond. After these bears had been inside the den for a significant amount of time we approached the camera. While at the camera (~150m from the den entrance) the female again poked her head out and looked at us briefly. Upon excavation of the den (weeks later) we noticed that it was very small and shallow den, significantly closer to the surface of the snow than other dens we observed, perhaps explaining why we were acknowledged and examined by the bear while at the camera and during the previous visit.

  This group abandoned the den somewhere between March 18 and March 22nd, approximately 8-12 days later.

March 30th, 2009

#49

- While performing routine camera service (~ 110 m) at the South Foggy Island den site we observed the bear emerge from the den and shake off snow from her fur. She didn't seem to notice us at first even though our snow machines were still running. After a few seconds she looked in our direction and paused. When we began walking to our machines she hurriedly returned into the den.

  This group abandoned the den later that night.

March 30th, 2009

#26

- We received a phone call from the FWS this morning stating that a polar bear den had been found 100 m from the Badami ice road, that the bear had left the area, and would we inspect the den. As we approached the den site by truck on the ice road to take measurements and record its location's GPS coordinates, we met up with Z. Henning (Savant employee) who showed us where the entrance was. Even though the den was close to the road (100 m) we took snow machines as a safety precaution. We rode to the top of the bluff adjacent to the entrance and rode a small perimeter looking for bear sign before we parked the machines. As a safety precaution we left the snow machines running and pointed away from the den entrance for a speedy retreat should we need it. Next we approached the den, and I (R. Robinson) stood by with bear spray in hand while BJ probed the snow to determine the den's perimeter. When we had probed what we believed to be the entire den hollow we began digging

a second access hole. Once we broke through with the second hole the added light made it clear that the den went deeper into the snow drift than we originally thought or probed. Simultaneously BJ jumped up from where he was digging at the second access point and yelled "BEAR! BEAR!" We quickly jumped on the our idling snow machines and rode back to the truck. According to BJ, the bear had stuck its nose through the small hole where he was digging. In that brief moment of close inspection of one another, there was no sign of aggression. The bear simply slipped back into the darkness within. We immediately drove 10 miles to Badami where we called T. Evans of the FWS and informed him of the incident.

Excavating the Foggy Island den while bear is within.

This bear with her two cubs abandoned the den two days later on April 1st.

- After the above incident and reassessment of the situation by FWS, it was decided that a camera unit would be placed beyond the ice road such that it took in both the den entrance and road. Consequently a number of bear-human interactions (i.e., the bear responding to trucks on the road) were recorded. Those have not been fully detailed but will be provided to the FWS as soon as they are completed.