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Project Title: Comparison of techniques to detect denning polar bears

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Principle Investigator: Richard Shideler

Project Location: North Slope, Alaska

Cooperator: Craig Perham, U.S. Fish & Wildlife Service-Marine Mammals Management

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

On the North Slope, off-road oil and gas exploration and construction activities occur in winter, overlapping the period of maternal denning of polar bears (*Ursus maritimus*). Disturbance of denning bears has occurred in the course of oil exploration and equipment transport activities on the North Slope, although circumstances have not allowed a direct measure of effects on the Beaufort Sea polar bear population. In order to protect denning bears from disturbance and to reduce potential bear-human conflicts with industry personnel, stipulations by government agencies (Alaska Department of Natural Resources [ADNR], U.S. Bureau of Land Management, U.S. Fish and Wildlife Service [USFWS], North Slope Borough) require an avoidance zone of 1.6 km around active bear dens. However, these stipulations presume that the actual den location is known prior to commencement of off-road activities.

Polar bear den habitat along the Beaufort Sea coast has been identified by remote sensing (Durner et al. 2001, 2003, 2006). Approximate den locations of radio-marked bears can be determined by VHF radiotracking or from signals from satellite- or GPS-collared bears. However, the proportion of collared bears to the total number of maternal females in the Beaufort Sea is <10% and most polar bear dens cannot be detected visually. Therefore, accurate methods to detect active bear dens prior to the onset of off-road construction and exploration activities are necessary for industry to avoid conflicts with denning bears and fully comply with agency stipulations. However, in addition to measuring success (i.e., Probability of Detection--POD) of different techniques under experimental or simulated conditions, knowledge about the feasibility of each method's use under a variety of realistic conditions is also important. Furthermore, the measurements of each method's rate of false positives (i.e., the technique identifies an active den when there is none) and false negatives (i.e., the technique fails to identify an active den) are also important to comprehensively assess each technique.

II. REVIEW OF PRIOR RESEARCH

Several methods for polar bear den detection have been employed non-systematically. These include (1) airborne Forward Looking Infrared (FLIR) imaging from helicopter and fixed-wing platforms, (2) ground-based imaging with a hand-held infrared (IR) camera, and (3) scent detection by trained dogs. The U.S. Geological Survey (USGS) demonstrated experimentally that it was possible to use helicopter-based FLIR imagery to detect denning polar bears with success rates up to 83% for true positives, that is the “hotspot” (light-colored shape on the image that indicates an object hotter than its surroundings) on the infrared image was in fact a denned bear; Amstrup et al. 2004). From a sample of 23 dens of marked bears that had been surveyed up to 7 times/den, USGS was able to model the importance of several environmental and operational factors on the POD of a denned bear. These included: (1) surface wind speeds <11 km/hr; (2) dew point-ambient temperature spread of >3ºC ;(3) no visible moisture (e.g., fog, snow, ice crystals); (4) flight during dark or civil twilight; and (5) flight >1 day after a significant wind or snow event that could have heated the snow surface. Furthermore, USGS recommended that FLIR tapes be reviewed after each flight in order to detect low-intensity hotspots that could have been missed during the flight. Airborne FLIR surveys were flown at altitudes of 100–300 m above ground level and slightly offset from the bank, which provided an approximately perpendicular view into the bank habitat being surveyed.

Hand-held infrared (IR) imaging cameras have had mixed success in non-systematic tests on known den locations. Furthermore, environmental (e.g., wind speed, snow conditions, surface vs. air temperature) and operational constraints on successful imaging have yet to be investigated. Both techniques using IR imaging may give false positives that could result in area closures around putative den site which could unnecessarily restrict industry off-road winter activities there. Therefore, a method or methods for ground-truthing IR images must be developed and evaluated. Preliminary tests have employed trained scent dogs to confirm “hotspots” identified from IR imaging as active polar or grizzly bear (*Ursus arctos*) dens, and to identify the precise locations of these (R. Shideler, unpubl.data, ADFG). Preliminary findings suggested that dogs can be effective in confirming active dens and detecting putative dens that were missed by IR detection methods (Perham and Williams 2003, Shideler and Perham 2009). In addition, dogs may be able to “clear” IR false positives, thus allowing industry activities in areas that might have previously been restricted. However, there are limitations on success of dogs as a survey technique. For example, wind, humidity, and/or snow depth may limit scent dispersal or the ability of dogs to localize the source (Pearsall and Verbruggen 1982) and dogs are subject to fatigue, especially in the severe conditions that characterize the North Slope in winter.

Literature Cited

Amstrup, S. C., G. York, T. L. MacDonald, R. Neilson, and K. Simac. 2004. Detecting denning polar bears with Forward-Looking Infrared (FLIR) imagery. Bioscience 54: 337–344.

Durner, G. M., S. C. Amstrup, and K. J. Ambrosius. 2001. Remote identification of polar bear maternal den habitat in northern Alaska. Arctic 54: 115–121.

———, ———, and ———. 2006. Polar bear maternal habitat in the Arctic National Wildlife Refuge, Alaska. Arctic 59: 31–36.

———, ———, and A. S. Fischbach. 2003. Habitat characteristics of polar bear terrestrial maternal den sites in northern Alaska. Arctic 56: 55–62.

Pearsall, M. D., and H. Verbruggen. 1982. Scent: training to track, search, and rescue. Alpine Publications, Loveland, CO. 225 pp.

Perham, C. J., and M. T. Williams. 2003. A preliminary assessment of the use of trained dogs to verify polar bear den occupancy. Report (P641) by LGL Alaska Research Associates to ExxonMobil Production Company and U.S. Fish and Wildlife Service. Anchorage, AK. 19 pp.

Shideler, R. T., and C. J. Perham. 2009. Survey of maternal polar bear den habitat between Atigaru Point and North Kalikpik Well No. 1, National Petroleum Reserve-Alaska, March 2009. Unpublished report to Marsh Creek LLC by Aklaq Services and U.S. Fish and Wildlife Service-Marine Mammals Management. 11 pp.

Watts, P. D. 1983. Ecological energetics of denning polar bears and related species. Doctoral dissertation, University of Oslo, Norway.

York, G., S Amstrup, and K Simac. 2004. Using Forward-Looking Infrared (FLIR) imagery to detect polar bear maternal dens: an operations manual. Unpubl. rept. to U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, by U.S. Geological Survey, Alaska Science Center, Anchorage, AK

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVE 1: Evaluate the precision and operational constraints of the 3 techniques available for detecting denning polar bears (airborne FLIR, handheld IR camera, and trained scent dogs) in a study area located in known polar bear denning habitat (Fig. 1). During the summer following each series of test, we walked the perimeter of all islands and the Staging Pad to confirm evidence of a den (i.e., true positive) or, conversely, confirm that there was no den (i.e. false positive). Detection events for confirmed dens are summarized in Table 1.

Job/Activity 1a: Fly aerial FLIR surveys over polar bear denning habitat in the study area.

Accomplishments: In 2010, 2011 and 2012 we chartered an IFR-equipped helicopter and crew, rented a FLIR unit, and contracted with a FLIR operator who also installed the unit in the helicopter. Between February 19-24, 2010 weather conditions on the North Slope became severe, flights were grounded due to lack of visibility, and the surveys had to be cancelled.

Between January 19 and 22, 2011we conducted airborne FLIR surveys on Tigvariak, Foggy, Howe, Cottle, Bertoncini, Bodfish, and Pingok islands and the Staging Pad, a large, abandoned gravel stockpile on the mainland south of Cottle Island (Fig. 1). Temperatures were in the -35ºC to -45ºC range with suspended ice crystals and occasional ice fog. The low temperatures allowed us to make only 1-2 passes around each island before the helicopter turbine exhaust created a condensation trail (“contrail”) along our flight path. The contrail acted like a fog bank to partially block potential IR radiation from being detected by the FLIR unit. In some cases we were able to compensate by flying the leeward side of the island first and allowed the ice fog from the windward side to disperse downwind. We identified 1 “hotspot” each on Howe and Cottle islands and the Staging Pad, and 2 on Foggy Island. We did not detect any hotspots on Pingok Island. Although we intended to re-survey the hotspots, mechanical problems with the helicopter fuel system that were likely exacerbated by the cold weather forced us to end the mission prematurely.

Between January 20 and 22, 2012, we flew airborne FLIR surveys on Foggy, Howe, Cottle, Bertoncini, Bodfish, and Pingok islands and the Staging Pad. Because there was no ice road near Tigvariak Island for access to test either the handheld IR camera or the dogs we dropped the island from the study in 2011-2012. Temperatures were in the −21ºC to −45ºC range with some suspended ice crystals, occasional flurries, and ice fog near human activity areas. Like 2011, the low temperature (~−40°C) on 22 January prevented us from making more than 1–2 passes around each island before the contrail obscured the target. Furthermore, the GPS on the FLIR unit failed as did the laser rangefinder and targeting system. Therefore, we had to estimate the hotspot location and anticipated that the coordinate error could be >100 m from its true location. We identified 6 hotspots on Foggy Island, 1 on Howe Island, 8 on Pingok Island, 1 each on Bertoncini Island and the Staging Pad, 2 on Bodfish Island, and 4 on Cottle Island. On the initial pass at Howe Island we saw a very bright hotspot on the southern edge of the island. As we approached, the image sharpened to reveal a female with 2 older cubs who had apparently excavated a deep day bed in a drift. As she and her cubs walked away the FLIR could detect IR radiation from her tracks crossing the island. We encountered a similar situation at the Staging Pad. As we approached the Staging Pad we observed a bright hotspot on the southeastern edge. This hotspot revealed a subadult bear that had been in a shallow day bed but it moved off as we approached. On the west side of the Staging Pad we noticed a very diffuse but bright glow approximately midway along the higher part of the gravel stockpile where a large drift often forms. This hotspot was in a very large and steep cup-shaped drift at a location where bears had denned in previous years.

Job/Activity 1b: Test imagery from the hand-held IR camera by surveying the study area, prioritizing prospective dens identified from the aerial survey (as near real-time as feasible).

Accomplishments: In 2010 the same storm system that caused us to cancel the airborne FLIR flight also prevented us from obtaining a hand-held survey due not only to safety risk while off-road traveling but also because it would have been almost impossible to acquire an IR image.

Between February 28 and March 2, 2011we completed a hand-held IR survey of Cottle, Bertoncini, Bodfish, and Pingok islands and the Staging Pad. Due to poor weather and scheduling conflicts we could not survey Foggy Island, and did not survey Howe Island until March 26, after the dog survey. Weather conditions for the Cottle Island survey were marginal and we did not detect any putative dens nor could we detect hotspots from the January airborne FLIR survey. On Pingok Island we detected a hotspot on the northeastern side that was not visible on the airborne FLIR videotape. The dogs did not alert on this site, and by the time of the ground survey in August the bluff had eroded far enough to obliterate any evidence of a den. After re-inspection of the IR image, it appeared that the hotspot was actually a false positive likely caused by an anomaly such as a slumped block of turf that created a different IR reflectance than the overlying drift.

We surveyed Howe Island on March 26 when there were > 12 hours of daylight. Within a few hours after sunset bare ground on the bluff surface and some vertical snow/ice surfaces were still radiating heat absorbed earlier in the day. This masked IR radiation from an inhabited den difficult to detect against the background IR radiation. We did not detect a hotspot at the easternmost dog alert; however, as we subsequently discovered on the ground survey, its location in a deep gully blocked a direct view from the sea ice. There was a bright image on the westernmost alert where the female bear had pushed up a cone of snow ("pushup"), visible to the naked eye, at the den. However, the image seemed to be from IR radiation reflected off the pushup rather than radiating from a warm body through the snow. We viewed the middle dog alert location shortly after sundown when there should have been no reflected radiation. The camera detected a visible glow in the drift face that appeared to be radiating through the snow and we considered this site as another putative den.

Because the view is at ground level acquisition of the hand-held IR image is likely subject to the same weather restrictions as that of airborne FLIR and may be even more sensitive than airborne FLIR to snow blowing along the surface.

Job/Activity 1c: Test each of 2 dogs independently on each known or putative polar bear den identified by airborne FLIR or handheld IR camera and place a marker at the location of the dog alert (refer to dog survey protocols, Appendix A).

Accomplishments: In 2010, we surveyed 42.1 km of identified denning habitat (Table 2) in the study area with 2 Karelian Bear Dogs on 24–26 February and 16–22 March. For the Tigvariak and Foggy Island surveys we were able to drive an ice road constructed by ExxonMobil and run the dogs directly to the survey area. For the remaining sites we transported the dogs and emergency gear in a Hagglunds BearCat™ tracked vehicle to a location near the survey start and commenced the survey according to our protocols. The dogs alerted at a hotspot on the Staging Pad that had been identified during an industry FLIR flight, and at a location on Cottle Island that had not been previously identified (Table 1). Neither dog alerted at 2 putative dens on Foggy Island, one of which (the northern site) had been identified during an industry FLIR flight. We ran both dogs two different times on the northern location, and neither dog alerted either time—i.e., a false negative. The industry FLIR flight had not detected the southern site, and the dogs did not alert there either. At a den on Howe Island identified on an industry FLIR flight, a female with 2 cubs emerged the week before our scheduled dog survey time so we did not survey it.

During 2–6 March, 5 April, and 10–11 April 2012 we completed a scent dog survey of 38.5 km (Table 2) of denning habitat on Foggy, Howe, Cottle, Bertoncini, Bodfish and Pingok islands. On Howe Island the dogs alerted on 1 putative den, and did not alert on the hotspots identified during the airborne or hand-held FLIR surveys. The dogs also did not alert on any putative dens or hotspots on Foggy, Cottle, Bertoncini, Bodfish or

Pingok islands. Based on experience over the past decade we expected at least one den on Pingok Island. Although the dogs ran a good line on Pingok Island in the March survey, we elected to re-run the island on 10 April. In spite of near whiteout conditions the dogs covered the island well and, as in March, did not alert on any putative dens or hotspots, nor did they discover dens that would have been abandoned between after the previous survey. On 11 March the dogs resurveyed Cottle Island but did not alert on putative dens or hotspots.

On 6 March, 2012, we surveyed the Staging Pad. One dog alerted at the southern location identified as a hotspot on the hand-held FLIR survey. Neither dog performed a strong alert on the hotspot identified from both airborne and handheld IR surveys on the steep, tall drift on the west side. However, one dog returned to the area above the drift and worked back and forth with his nose low especially interested in the troughs between drifts. He was clearly interested in the scent but we believe the steep, wind-polished drift surface with overhanging cornice prevented him from moving lower on the drift to localize the source. We considered his behavior as an alert although he was prevented from localizing the scent. Furthermore, subsequent inspection of the trackline from his GPS collar clearly shows him concentrating on an area within about 10m above the actual den location.

Between March 7 and 12, 2013, we surveyed the Jones Island group, Howe and Foggy islands, and the Staging Pad. The dogs did not alert on any island locations. However they alerted on a location on the east side of the Staging Pad, which had been missed by an industry airborne FLIR survey. Visual observation by parties not associated with this project confirmed that it was a den—the bear exited the den on March 24.

Job/Activity 1d: Revisit each den the following summer and measure dog detection error and physical and habitat characteristics of each den.

Accomplishments: In August 2009, USFWS-MMM personnel had walked the study area and obtained coordinates of putative 2008–2009 dens and previous and current summer day beds. Therefore, we anticipated that any evidence of dens we found in 2010 or later would be from the previous winter.

From 18–23 August 2010, we walked all den habitat in the study area. Consistent with the dog survey we found no evidence of new dens on Tigvariak, Bertoncini, or Bodfish islands. We found no evidence of additional dens on Howe Island except at the known den. At the Cottle Island alert location, we found suitable habitat and hair, suggesting a true positive. At the Pingok east hotspot, we found suitable habitat but no evidence of a den, consistent with the lack of alert by the dogs—a true negative. At the Pingok west hotspot, where the dogs had expressed some interest but not a full alert, we found a good site for a den but no hair or other evidence. It is possible that this site had been abandoned before cubs were born, or the cubs were stillborn and the female left after the industry airborne FLIR flight in December 2009. We consider this alert inconclusive. At the Staging Pad there was evidence of a huge drift at the hotspot and dog alert and we found hair—another true positive. At Foggy Island-north hotspot we found evidence—hair and cub scat—of a den but neither dog had alerted at this location—a false negative.

During 16–22 August 2012, we walked all denning habitat on Foggy, Howe, Cottle, Bertoncini, Bodfish and Pingok islands and the Staging Pad. We encountered >11 polar bears resting on the Jones Island group (western islands in the study area, Fig. 1) which required “island-hopping” to find safe locations to survey without disturbing the bears. We installed colored-coded markers at den sites from winter 2011–2012. On Howe Island we confirmed the location of the putative den that was detected by the dogs (i.e., true positive) and confirmed results of the scent dog survey in that there was no evidence of a den at the hotspots identified on the airborne or hand-held FLIR surveys (i.e., false positives for IR methods, true negatives for dogs). At the Staging Pad we confirmed the location of the southern den identified by the hand-held FLIR and scent dog (i.e., true positives), and the northern den detected by the 2 IR methods and the scent dog (i.e., true positives).

We found no evidence of dens on the remaining islands in the study area. However, although the dogs had not alerted at the hotspot on the northeast side of Pingok Island that had been identified on the hand-held survey, we were unable to confirm the location as either a false negative or false positive. The northeast (seaward) side of Pingok Island was eroding rapidly and the hotspot coordinate was >30 m in the ocean as of 18 August.

Summer ground surveys to locate dens and to eliminate false positive hotspots confirmed that there were 15 dens within the study area during the course of the study (Table 1). Polar bear dens were detected by all 3 methods, with scent dogs having the highest rate of success (75%) followed by the handheld IR camera (56%). Industry airborne FLIR was more successful (50%) than project FLIR (22%) but for reasons we discuss later, this may reflect availability and operational problems between the two rather than differences in imaging or interpretation.

Results from the field inspection of putative den sites during summer indicated that positive identification of polar bear dens in the summer is not clear-cut. Because polar bears do not excavate dens in soil, evidence of denning visible the subsequent summer consists of presence of hair, cub and adult scat, and/or cub and adult claw marks on the bank adjacent to the snow den. We found ample evidence that polar bears (and a few grizzly bears) used the barrier islands as resting areas during the summer, and that they excavated day beds, deposited scat and hair, and may have scratched in adjacent banks. These signs can occasionally be confused with winter den use. Furthermore, wind and runoff from melting snow and rain as well as wave action from summer storms can erode evidence of the den before it can be confirmed. On the seaward side of several barrier islands (e.g., Pingok, Tigvariak, Howe) rapid coastal erosion would have eroded the bluff adjacent to the putative den before we could have found it.

OBJECTIVE 2: Develop a POD based on meteorological and snow conditions likely to be encountered during a den survey.

Job/Activity 2a: Measure snow conditions near den sites and random sites nearby.

Accomplishments: During the winter surveys we measured snow depth, slope of drift and bank height at selected locations near dens and at other locations in the study area. In addition, during the February and April surveys Dr. Glen Liston, a renowned snow physicist with the Cooperative Institute for Research in the Atmosphere at Colorado State University accompanied us to evaluate snow conditions at selected locations in the study area. Under the auspices of the USFWS's Arctic Landscape Conservation Cooperative and the National Fish & Wildlife Foundation, Dr. Liston has been applying a model of blowing and drifting snow deposition to more accurately predict the presence, timing, and evolution of snow drifts suitable for polar bear dens. We are integrating our snow measurement data and that he has collected while with us to validate his model. That effort is still in progress at this time.

Job/Activity 2b: During the following summer, survey repeatedly-used den habitat to detect signs of den use from the previous winter.

Accomplishments: See Job 1d.

Job/Activity 2c: Measure snow and weather conditions at each site during the ground visits to determine attributes that may affect detection.

Accomplishments: See Job 2b.

Job/Activity 2d: Evaluate the effects of snow conditions on POD by IR methods by constructing and monitoring an artificial snow den with a heat source that mimics a denning bear.

Accomplishments: On 9 December 2010 we excavated and instrumented the artificial den and installed the heaters. We conducted hand-held FLIR surveys on 10 December 2009, and 23 January, 27 February, and 9 April 2010. We recorded air and snow surface temperature and wind direction and velocity. We categorized the images as Very Bright, Bright, Dim, or Invisible at measured intervals of 1–3 m, 10 m, 20 m, 40 m, and 60 m from the den entrance. Images were Very Bright or Bright on both the initial survey and the January 23 survey, Dim at distances ≥10 m on 27 February, and Dim at distance >20 m on 9 April). On 13 December 2011, we excavated an artificial den in a snow drift in a gully near Kuparuk Drillsite 2M. Unlike the previous location in 2009–2010 and 2010–2011, this location ensured a steady source of electrical power without interruption by unsupervised employees. Images on February 22, 2012, were Dim at only 5m and invisible beyond that; yet a fox den nearby had a bright image indicating that the imager was working properly. We later confirmed that there had been a power outage at the drillsite and the outlet breaker had not been turned back on.

OBJECTIVE 3: Provide recommendations to industry regarding den detection methods; complete final report.

Job/Activity 3a: Develop a matrix of den detection techniques suitable for different types of industrial activities.

Accomplishments: My USFWS-Marine Mammals Management cooperator and I have prepared an initial draft of the matrix. Due to the small sample size of detected dens, we cannot compare PODs for the three methods under varying conditions. For example, we do not know the minimum weather conditions and snow depth that would allow acquisition of a handheld IR image. Instead, we are focusing on operational constraints for each method that would optimize detection rates (i.e. true positives), or conversely, reduce false negatives (i.e., assuming no dens when there are).

Job/Activity 3b: Prepare final report.

Accomplishments: Final report completed.

IV. MANAGEMENT IMPLICATIONS

None of the methods tested achieved 100% detection (Table 1), and one den was surveyed with all 3 methods and not detected by any. The discrepancy between the airborne FLIR detection rate for the project and the rate for industry is noticeable, but emphasizes that operational obstacles can have a greater effect on the effectiveness of surveys than image interpretation of other factors. Project airborne FLIR surveys required confirmation of survey dates months in advance whether or not the weather was optimal for image acquisition at flight time. Furthermore, neither the FLIR unit, FLIR operator, or helicopter was resident on the North Slope, and the units had to be fitted onsite. Small electrical or mechanical deviations between the rental FLIR unit and the helicopter's power and electronics delayed surveys when there was a suitable weather window. Charter and rental cost became prohibitive. Clearly, there would be a great advantage to have a helicopter outfitted with a suitable FLIR unit and experienced flight crew that is resident on the North Slope during the 2-3 week period when daylight is optimal for FLIR. Alternatively, development of an Unmanned Aerial Vehicle (UV) that has operational characteristics and imaging capability similar to manned helicopters may be a cost-effective alternative that should be tested.

Although airborne FLIR imagers may be best utilized where there is a long reach of polar bear habitat within an industry area of interest, the other techniques may be more useful on smaller portions or where there is a question about confirming a hotspot. Scent dogs and handheld IR cameras offer reasonable alternatives. However, both methods if not managed properly can increase disturbance at the den. Scent dogs had the highest success rate and can work in weather unsuitable for either IR imager. Nevertheless, at this time we do not understand all the effects of snow depth and characteristics, ice layers or weather influences on the detection probability for either method. Effects of these on handheld IR imagers can be resolved using artificial dens where snow characteristics and surface weather can be more systematically investigated. More experience with both methods is needed especially focusing on conditions that may result in false negatives. Identification of conditions that could lead to false negatives has been under-represented in previous surveys and in this study.

V. SUMMARY OF WORK COMPLETED ON JOBS

JOB/ACTIVITY 1: We conducted airborne FLIR and handheld IR surveys in 2011 and 2012. Although we mobilized for the 2010 surveys a long period of severe weather grounded the helicopter and the tracked vehicle and we were unable to complete either survey. Planned surveys in 2013 were dropped because of funding uncertainties with our USFWS-MMM colleague who could not travel. The airborne FLIR detection rate was only 22% (2 of 9) due to complications with the helicopter, FLIR unit, and weather effects on the image. We do not believe this represents the true effectiveness of airborne

FLIR. The handheld IR imager detection rate was 56% (5 of 9). We conducted dog surveys on 38.5 km of den habitat in 2010 through 2013. The dog detection rate was 75% (9 of 12), making it the most successful method of the 3 tested. We walked the entire study area each summer from 2010 to 2013 in order to ground-truth the surveys. We found evidence of 15 dens (Table 1).

JOB/ACTIVITY 2: We collected weather data at each site we visited on the ground during handheld IR and dog surveys. We collected snow depth at sites near active dens, and measured drift height and length. These data are being used in a model of drifting snow to predict where bears will den. We excavated and instrumented an artificial polar bear den in winters 2010 through 2012. Although we obtained some data, operational problems with reliable power for the heaters and weather-related failures to acquire an image limited our ability to use the information. Nevertheless, we were able to detect the dens at up to 40m under ideal conditions.

JOB/ACTIVITY 3: My USFW cooperator and I have prepared a draft matrix of criteria and methods to be used with each detection technique. These will be included in a technical report that we are also preparing.

VI. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT

While ground-truth denning habitat we noticed considerable evidence of summer use, primarily day beds, by polar bears and occasionally grizzly bears. Beginning in 2010 we identified day beds with a marker unique to each year, and collected coordinates, a verbal description, and pictures of each site. We intend to analyze these and prepare a technical report or publication with the findings.

During the 4 years that we walked Pingok Island to locate dens, we observed that the northeast side of the island was eroding rapidly. This side consisted of tall (3-5m) peat banks with underlying massive ice lenses. During the 2011 ground survey we installed several unofficial markers at 10m intervals from the bank edge to 35 m inland. By August 2012 all the markers had eroded away and the coordinates of the inland marker were 40 m into the ocean. We calculate that >80 m of bank had eroded since August 2010. In 2013 the northeast portion of Pingok Island had continued to erode, and that erosion seemed to have spread to the southeast (lagoon side) as well. At that rate this portion of the island will be gone within the next decade.

VII. PUBLICATIONS

Although not strictly a publication, a project description and short video are on the ADF&G website:
http://www.adfg.alaska.gov/index.cfm?adfg=wildliferesearch.polarden

VIII.   APPENDIX

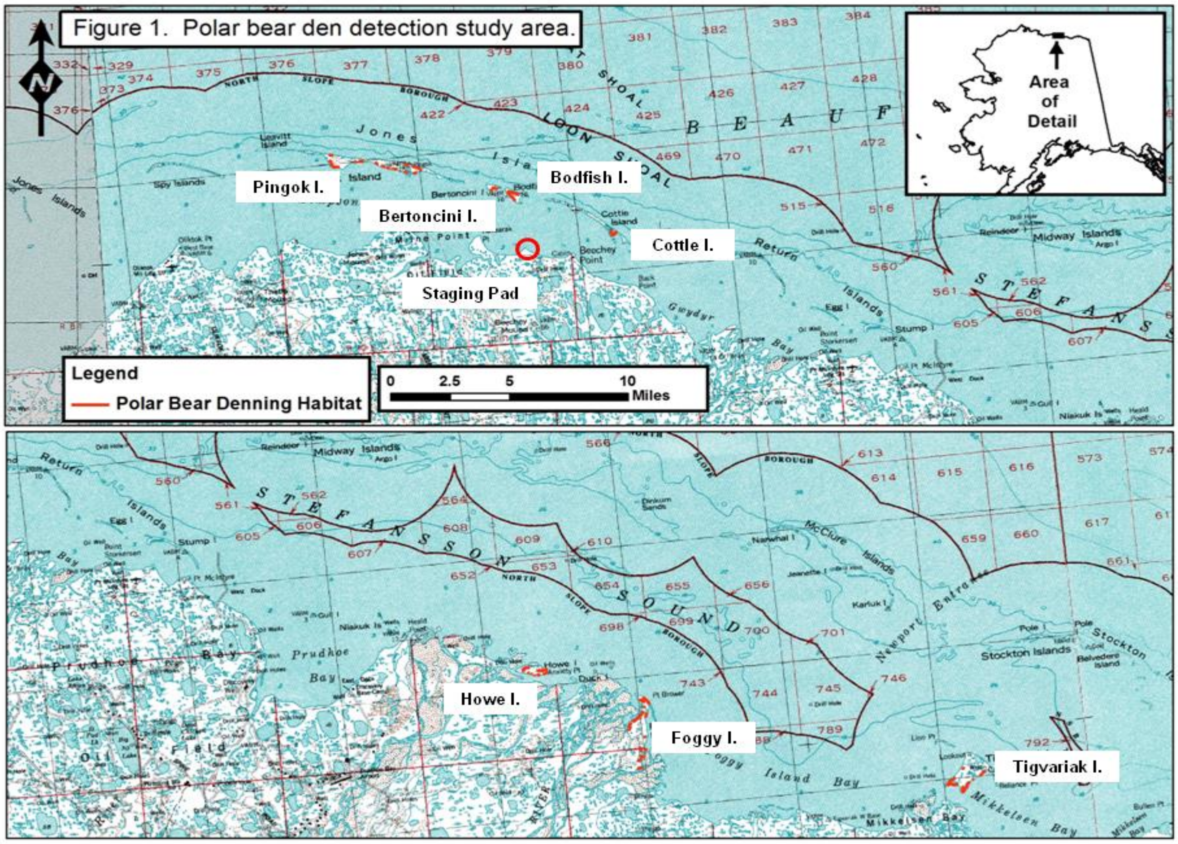

Figure 1. Polar bear den detection study area.

Table 1. Summary of polar bear dens detected by airborne Forward-Looking Infrared (FLIR) imager, handheld Infrared camera, and trained scent dogs. "FLIR-P" is project FLIR flight, "FLIR-I" is industry FLIR flight.

Den ID*	Den Year	Location	Airborne FLIR-P	Airborne FLIR-I	Handheld IR	Scent Dogs	Ground-Truthed
10-01	2009-2010	Howe Island	NS**	Y	NS	NS[1)]	Y
10-07	2009-2010	Foggy Island North	NS	Y	NS	ND**	Y
10-08	2009-2010	Cottle Island	NS	ND	NS	Y	Y
10-09	2009-2010	Foggy Island South	NS	ND	NS	ND	Y
10-10	2009-2010	Staging Pad	NS	Y	NS	Y	Y
11-01	2010-2011	Staging Pad	ND	Y	Y	NS[1)]	Y
11-03	2010-2011	Howe Island East	ND	NS	NS	NS[1)]	Y
11-04	2010-2011	Howe Island AL	ND	NS	ND	Y	Y
11-05	2010-2011	Howe Island Mid	ND	NS	Y[2)]	Y	Y
11-06	2010-2011	Howe Island West	ND	NS	Y[2)]	Y	Y
11-07	2010-2011	Pingok Island	ND	ND	ND	ND	Y
12-01	2011-2012	Staging Pad 1	Y	NS	Y	Y	Y
12-02	2011-2012	Staging Pad 2	ND	NS	Y	Y	Y
12-04	2011-12	Howe Island	Y	NS	ND	Y	Y
13-01	2012-2013	Staging Pad	NS	ND	ND[2)]	Y	Y
Proportion successful by method			2/9=0.22	4/11=0.36	4/9=0.44	9/12=0.75	15/15=1.00

**   USFWS-Marine Mammals Management den identification number*

***   NS: not surveyed*

**** ND: surveyed, but not detected*

1. Bear emerged prior to dog survey

2. Surveyed with Handheld IR after dog alert

Table 2. Length of polar bear maternal den habitat surveyed by dogs, 2009–2012.

Location	Distance	
	Miles (mi)	Kilometers (km)
Tigvariak Island*	2.9	4.6
Foggy Island	5.4	8.6
Howe Island	2.4	3.8
Cottle Island	3.3	5.3
Bodfish Island	1.8	2.9
Bertoncini Island	0.9	1.4
Pingok Island	9.1	14.6
Staging Pad	0.5	0.8
Total	26.3	42.1

*Dropped from 2010-2012 surveys due to lack of road access.

APPENDIX A. Dog survey protocols.

General Procedures. Unless conditions dictated otherwise, dogs were run singly. From 2009 through 2011, the dog selected to run the survey was outfitted with a vest containing 2 pockets, each with a Garmin *geko 201*™ GPS unit and chemical hand warmer to keep the unit at operating temperature. Dual units ensured that at least one records the track if the other failed. In 2012 and 2013, the dog wore a Garmin *Astro*™ GPS collar. In order to ensure redundancy, the handler also took a waypoint reading at the putative den location and left a conspicuous marker so the site could be visually located the following summer.

Depending on wind speed and direction, dogs were aligned to run either the top of the bank at the soil/snow interface or along the base of the drift extending outward from the bank to sea ice. Previous experience indicated that bears often excavated laterally into the drift until they hit soil on the bank face. Scent can disperse up this snow/soil interface, and may even exit through ground squirrel burrows, cracks in the bank face, or a crevice created between the bluff face and the drift. Positioning the dog on the base of the bluff allowed it to detect scent that percolated through the snowdrift to the surface and then dispersed in a cone-shaped pattern downwind. The dog handler on a snowmobile followed behind the dog at a distance of 30–50 m to allow the dog to work unimpeded but within voice range. A flanker paralleled the dog/handler team downwind on the sea ice at approximately 50 m–100 m off the bluff bank. The flanker kept track of survey segment beginning and ending waypoints, and scanned ahead for non-hibernating bears that may have been wandering in the area. If these were encountered, the team was to leave immediately. Likewise, when open dens were encountered, the investigators immediately left the area and either ended the survey or resumed at a safe distance from the den.

Description of alert. The Karelian Bear Dogs are hunting dogs bred and trained to chase bears. They do not require a trained alert to detect dens. Their natural response to interesting odors (e.g., fox scat or urine, small mammal carcasses) on the surface or buried under the snow is to dig briefly, sniff and move on. The alert to a den was a similar pattern but at higher intensity and longer duration. The location of their alert was a further clue—e.g., if the location was on or very near the face of a drift or at the drift/soil interface. The dogs alerted to the presence of a den by digging and, occasionally, vocalizing. Dogs were not allowed to dig into the den but were allowed to dig at the surface for several seconds to confirm the location. Occasionally, the source of the alert was questionable and was confirmed by calling the dog off and then allowing it to return within a minute or two. If the dog returned to the same site ("victim loyalty" in Search and Rescue terminology) we consider it a confirmed alert. It was the handler's responsibility to identify the alert and call the dog off so that it did not disturb the bear any more than necessary. Once the location was confirmed, the team immediately left.

Survey conditions. Dogs were worked only when weather and visibility allowed safe operations, during daylight hours, and when temperatures were generally warmer than -35°C and wind <45 km/hr. Immediately prior to each dog survey we measured wind speed and temperature with a Kestrel 2000™ wind gauge. We determined wind direction near ground level by observing the azimuth of blowing snow along the snow surface or indicated by the direction of spray pattern of powdered chalk. We record these not only for scientific interest, but also to align the dogs in the proper position to work downwind of the topographic feature. Although dogs can work in wind speeds up to 45 km/h (>25 mph), winds this strong can create scent eddy currents and by a process called “looping” can deposit the scent several hundred meters away from the scent source, making detection of the actual den location more subject to error.

Measures to reduce den disturbance. We conducted surveys only when visibility was sufficient to detect non-hibernating bears or evidence of dens. Prior to beginning the survey, the flanker circumnavigated the island at 100–200 m from the bluff system to ensure there were no open dens or ventilation holes. If these were encountered the team immediately left the area. The dogs were not allowed to dig into the den. Nevertheless, there was a small possibility that a denning bear may have responded to the noise. There was no way to calculate the level of response of polar bears within the den; however, on surveys conducted by Perham and Williams (2003), Shideler (2007), Shideler and Perham (2008), and Shideler and Perham (2009) none of the 9 bears that were detected by dogs emerged from their dens during or immediately after the survey.

Experience using the Karelian Bear Dogs to detect denning radio-collared grizzly bears was also instructive (Shideler, unpublished data). In all 57 instances in which dogs alerted on occupied grizzly bear dens, no bears emerged from dens. In the case of several radio-collared grizzly bears in dens, the radio signal did not change from inactive to active, suggesting that the bear was not aware of the activity at the surface or it was aware but did not move its head. In the cases in which the signal did change to active, the bears did not emerge even after the investigators left the area. Collectively, these observations suggest that even if the bears were aware of our activity, their responses were mild and they did not abandon the den.

Literature Cited in Appendix A

Perham, C. J., and M. W. Williams. 2003. A preliminary assessment of the use of trained dogs to verify polar bear den occupancy. Report by LGL Alaska Research Associates to ExxonMobil USA and U.S. Fish and Wildlife Service.

Shideler, R. T. 2007. Scent dog survey of maternal polar bear den habitat in the “North Shore” geophysical exploration area, March 2007. Unpublished report by Aklaq Services to Brooks Range Petroleum Company.

———, and C. J. Perham. 2008. Survey of maternal polar bear den habitat between Kaktovik and the KIC Well No. 1, February 2008. Unpublished report by Aklaq Services and USFWS-Marine Mammals Management to Marsh Creek LLC.

———, and ———. 2009. Survey of maternal polar bear den habitat between Atigaru Point and North Kalikpik Well No.1, National Petroleum Reserve-Alaska, March 2009. Unpublished report by Aklaq Services and USFWS-Marine Mammals Management to Marsh Creek LLC.

IX. SIGNIFICANT DEVIATIONS:

Although we intended to expend funding carried over from 2011-2012 to conduct a final airborne FLIR survey in January 2013, the sequestration of federal funding eliminated our USFWS cooperator's travel. Furthermore, because the USFWS-MMM had chartered the helicopter for ground-truthing dens in summer 2013 and that funding was suspended indefinitely, we decided to drop the airborne FLIR and handheld IR surveys in case we would be required to fund the helicopter charter in summer.

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