Executive Summary

Female polar bears in Alaska excavate dens in drifted snow to give birth and nurse offspring. The sow and cub(s) typically emerge from the den in early spring when the cub(s) is more physically prepared to survive the outside Arctic conditions. Disturbance from anthropogenic activities, weather events, other wildlife, etc., could cause the family unit to abandon the den before cubs are adequately developed, which could significantly impact cub survival (Rode et al. 2018). While den abandonment has been documented, such events are rare due to the potential negative consequences for reproductive success (Larson et al. 2020).

Aerial infrared (AIR) surveys are an established method for detecting maternal polar bear dens (Amstrup et al. 2004; Shideler 2013; USFWS 2021). Body heat emitted from the bear within the den permeates to the snow surface and is detectable by infrared sensors. Once detected, a polar bear den can be avoided to afford sows and cubs protections during the denning period. North Slope oil and gas operators have conducted AIR surveys of denning habitat since the early 2000s to prevent potential disturbance from anthropogenic activities.

This report describes the 2022/2023 AIR surveys conducted by ConocoPhillips Alaska, Inc. (CPAI), as required by Letters of Authorization (22-INC-09, 22-INC-10) for the incidental take of polar bears. Surveys were conducted in accordance with USFWS’s Protocol for Using FLIR to Detect Polar Bear Dens from a Fixed-wing Aircraft. Applicable regulations and rationale are described in more detail in the Southern Beaufort Sea Incidental Take Regulations (ITRs; USFWS 2021). The geographical extent of the AIR surveys spanned from the Kalikpik River in the National Petroleum Reserve-Alaska (NPR-A) east to Pump Station 1 near Deadhorse (Figure 1). The surveys targeted polar bear denning habitat within one mile of planned or ongoing industry activity. All areas were surveyed twice, with select areas receiving additional overflights to bolster data quality or verify survey findings. Denning habitat with high probability of use (Durner et al. 2020), outside of the planned areas of activity, was also surveyed opportunistically to calibrate the IR equipment and to provide the survey team with a current search image. The calibration flights were conducted after consultation with USFWS, and at an altitude of 1,500 feet (ft) or greater above ground level (agl). Some non-CPAI surveys were completed concurrently and appear in Figure 1. Those surveys are not otherwise addressed in this document as they reflect areas used or operated by other entities. No dens were found within the survey area encompassing CPAI winter 2022-2023 activities.
Methods

Survey Effort

Prime terrestrial maternal polar bear denning habitat in northern Alaska has been identified as snow drifts that form on banks or bluffs that measure ≥16° in slope and ≥1.4 meters in height (Durner et al. 2003). These landscape features have been mapped as denning habitat (Durner et al. 2001; Durner et al. 2006; Blank 2012; Durner et al. 2013) and were targeted by the AIR surveys when located within one mile of ongoing or planned industrial activity.

The Southern Beaufort Sea ITRs and issued LOAs dictate AIR survey date ranges depending on the type of activity that is proposed to occur (USFWS, 2021): CPAI’s LOAs state that the survey area should be first be flown between December 1 and 25 and then repeated between December 15 and January 10. Specific survey dates were chosen based on known polar bear denning phenology, typical snow accumulation, and historical AIR survey data. Annual variability in snowfall and weather conditions can affect polar bear den entrance timing, and survey repetitions are temporally spaced to increase the likelihood of den detection. CPAI began their first AIR surveys in early December. The second surveys commenced at the end of December (Figure 1; Table 1).

The survey aircraft was flown at speeds between 80 and 110 knots and at altitudes between 800 and 1,500 feet above ground level (AGL), with a target speed of 100 knots and a target altitude of 1,200 feet.

Survey Equipment

A Viking Twin Otter DHC6-400 fixed wing aircraft (Figure 2), based at CPAI’s Alpine Operations Center and a VulcanAir P68C fixed-wing aircraft (Figure 3) based at the Deadhorse airport were used to complete the requisite surveys. Both aircraft were equipped with a Star SAFIRE® 380-HDc imaging system and utilized computer hardware and software developed by Shotover to direct data collection. The 380-HDc is a gimballed turret housing electro-optical (EO) and mid-wave infrared (MWIR) sensors, among other components (Figure 4).

Environmental Conditions

Infrared imagery is affected by wind, airborne precipitation, atmospheric humidity, and solar radiation (Amstrup et al. 2004; Robinson et al. 2014; Smith et al. 2020). In general, clear, calm, dry, and dark conditions are considered best for AIR surveys. The project area was surveyed when reported weather (Tables 2-14) and real-time weather conditions were conducive to high-quality data collection. When necessary, the distance between the sensor and the target (e.g., flying lower or closer) was reduced to improve image quality. Survey effort was also redirected in-flight to areas with more favorable conditions or aborted altogether when image quality standards could not be achieved.
The Alaska Department of Natural Resources (ADNR) reported typical levels of snow accumulation in November and December; however, unusually warm temperatures and mixed snow/rain precipitation formed an icy crust on the snow surface. This hampered windborne transport of the existing snow and resulted in a lack of snowdrifts in many areas across the North Slope during the first survey period. Drifted snow was abundant across the North Slope during the second survey period due to additional precipitation and windy periods. Several flights during the second survey period were postponed while inclement weather subsided.

Survey Team

Depending on the aircraft used, the survey team consisted of one or two pilots, sensor operator, survey coordinator, CPAI on-board observers, data managers, and image analysts. Survey team members and designated roles are presented in Table 15.

The pilot(s) operated the aircraft with direction from the survey coordinator on flight parameters such as speed, altitude, and direction. The sensor operator controlled the infrared sensor with direction from the survey coordinator on imagery parameters such as zoom level, pan speed, contrast, and search area. The survey coordinator directed survey effort and evaluated the imagery real-time. The CPAI observers have been trained in infrared den detection, are familiar with the survey areas, and focus solely on viewing the infrared imagery.

The data managers and image analysts typically did not fly in the survey aircraft. They reviewed the imagery post-flight to evaluate data quality and survey coverage, as well as to identify areas that warranted resurvey. See In-Air Data Collection and Post-Flight Data Review.

Data Classification

Heat anomalies observed on the landscape are evaluated and classified as follows:

- **Point of Interest (POI):** A warm spot that appears in the right location (away from the tundra or ice found at the terminal ends of a snowdrift) and is not easily discounted during review but is missing some of the obvious signs of a polar bear den (e.g., tailings pile, signs of animal activity, appropriate shape or size). These locations may be resurveyed during subsequent flights and either eliminated from further consideration or upgraded to a Hotspot or Putative Den.

- **Hotspot (HS):** A warm spot of appropriate shape and size located near the middle of the snow drift. Signs of wildlife activity (e.g., digging, tracks) may be present. Suspected den sites that are found still open (not drifted closed by snow) are considered hotspots. A polar bear may excavate exploratory dens when searching for suitable habitat (Durner et al. 2020), and these hotspots will eventually cool down and be eliminated from further consideration. Hotspots are resurveyed during subsequent flights and may be eliminated from further consideration or upgraded to a Putative Den.
• **Putative Den (PD)**: A distinct thermal signature that persists for several days, may show evidence of animal presence, is in the appropriate habitat, and cannot be definitively attributed to a non-polar bear cause (e.g., exposed ice, exposed tundra, fox or other animal digging). The final disposition of identified putative dens (whether it was truly a den, how many cubs were produced, when the bears emerged and departed) is often unknown as they are not further investigated, monitored, or revisited in the spring for confirmation.

### In-Air Data Collection

The infrared data is interpreted in real-time by the airborne survey crew. When suspect heat signatures are located, the crew discuss and interrogate them by committee. The aircraft may circle the location, change altitude or speed, etc. The infrared sensor is toggled through various zooms and settings to make the heat signature more apparent. Often this process makes clear that a landscape feature (i.e., ice under thin snow, vegetation, exposed tundra), is the cause of the heat signature and it can be dismissed. If not dismissed, heat signatures are classified as described above (POI, HS, PD) and noted for discussion during Post-flight Data Review.

The airborne survey crew is also tasked with regularly evaluating imagery quality and weather conditions to maximize data confidence. Adjustments to survey parameters (e.g., location, altitude, infrared sensor calibration) are made as needed.

Immediately after aircraft landing the on-board crew again evaluates the overall mission, weather, equipment functionality, and data quality before the survey is adjourned.

### Post-flight Data Review

Data managers and image analysts review the data (typically within 12 hours of survey end) in its entirety to document and confirm survey results. Members of the airborne survey crew are consulted during the review process and consensus is sought. All survey imagery is transmitted via file share to the USFWS for their review. USFWS noted heat signatures are reviewed by the survey team and discussed with the USFWS.

When determining if a detection should be dismissed, upgraded, or resurveyed during the post-flight review the survey imagery, aerial photography, and local topography are considered. Detections not dismissed are assigned a unique identifier and classified as POI, HS, or PD.

### Results

Five POIs were detected in the CPAI survey area, but all were determined to be either surface features, wind scour, or man-made objects and were dismissed. One putative den (PD) was located on nearby Howe Island, away from CPAI activities (Figure 5). See Figure 1 and Table 16. One polar bear was detected on the surface of the tundra away
from CPAI activities. It remained near the same location for several days. The sighting was reported to USFWS.

**Conclusions**

AIR surveys aim to identify maternal polar bear dens so they can be avoided by anthropogenic activity. Slight deviations to projects (i.e., timing, location, scope) comply with the applicable LOA(s) and are communicated to the USFWS.

Image quality ranged from excellent to fair with weather being the primary cause of degradation. When necessary, survey parameters were adjusted (lower altitude and/or decreasing the distance to the targeted area) or survey effort was redirected in-flight to an area with more favorable weather. Areas with poor weather were resurveyed when conditions improved.

AIR survey equipment and techniques, while recognized as a standard method for locating and evaluating potential polar bear dens, may not detect all dens. Operations should be conducted with caution in all areas. USFWS will advise on any supplemental findings (e.g., collared bears, observation of den evidence, anecdotal accounts).
References
USFWS. (n.d.). Protocol for using FLIR to detect polar bear dens from a fixed-wing aircraft.
Figure 1. 2022/2023 CPAI AIR Survey Area and Flight Tracks
Figure 2. Viking Twin Otter DHC6-400

Figure 3. Vulcanair P68 Observer Survey Aircraft

Figure 4. FLIR SAFIRE 380 HDc Infrared Camera
Figure 5. PD 2023 A on Howe Island December 11, 2022
### Table 1. 2022/2023 CPAI AIR Survey Effort

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<td>Visibility (mi)</td>
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<tr>
<td>Ceiling (ft)</td>
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<td>Cloud Cover (ft)</td>
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<td>SKC</td>
<td>SKC</td>
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| Table 7. December 12 AM Aviation Weather Center METAR Data |
|-----------------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Time (UTC) | Alpine (PALP) | Deadhorse (PASC) | Kuparuk (PAKU) | Nuiqsut (PAQT) | Point Thomson (PAAD) |
| 1545 | 1553 | 1545 | 1553 | - |
| 0645 | 0653 | 0645 | 0653 | - |
| Temp (C) | -16 | -17.2 | -16 | -15 | - |
| Dew Pt (C) | -18 | -20 | -19 | -17.8 | - |
| Pressure (inHg) | 29.38 | 29.35 | 29.36 | 29.38 | - |
| Wind Dir (mag) | Calm | 90 | 70 | 250 | - |
| Wind Sp (kts) | - | 4 | 6 | 8 | - |
| Visibility (mi) | 10 | 10 | 10 | 10 | - |
| Ceiling (ft) | 4,600 | 10,000 | 9,500 | 7,000 | - |
| Cloud Cover (ft) | BKN@4,600 | BKN@10,000 | SKC | BKN @9,500 | OVC@7,000 |
| Notes | - | - | - | - | - |

| Table 8. December 29 PM Aviation Weather Center METAR Data |
|-----------------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Time (UTC) | Alpine (PALP) | Deadhorse (PASC) | Kuparuk (PAKU) | Nuiqsut (PAQT) | Point Thomson (PAAD) |
| 0150 | 0153 | 0145 | 0153 | 0155 |
| 1650 | 1653 | 1645 | 1653 | 1655 |
| Temp (C) | -18 | -18.3 | -18 | -18 | -19.7 |
| Dew Pt (C) | -21 | -20.6 | -20 | -21.1 | -21.7 |
| Pressure (inHg) | 29.49 | 29.45 | 29.46 | 29.48 | 29.45 |
| Wind Dir (mag) | 60 | 90 | 80 | 60 | 100 |
| Wind Sp (kts) | 14 | 11 | 15 | 11 | 18 |
| Visibility (mi) | 10 | 7 | 10 | 10 | 5 |
| Ceiling (ft) | 1,400 | 1,500 | 1,500 | 1,600 | - |
| Cloud Cover (ft) | OVC@1,400 | OVC@1,500 | OVC@1,500 | OVC@1,500 | OVC@1,600 |
| Notes | - | - | - | - | - |
### Table 9. January 7 PM Aviation Weather Center METAR Data

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<th>Time (UTC)</th>
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<th>Kuparuk (PAKU)</th>
<th>Nuiqsut (PAQT)</th>
<th>Point Thomson (PAAD)</th>
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### Table 10. January 8 AM Aviation Weather Center METAR Data

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<td>Visibility (mi)</td>
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### Table 11. January 8 PM Aviation Weather Center METAR Data

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### Table 12. January 9 AM Aviation Weather Center METAR Data

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### Table 13. January 9 PM Aviation Weather Center METAR Data

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### Table 14. January 10 AM Aviation Weather Center METAR Data

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<tr>
<td></td>
<td>Cloud Cover (ft)</td>
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Table 15: 2022/2023 AIR Survey Team Members

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<tr>
<th>Survey Period 1</th>
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<tr>
<td><strong>Dates</strong></td>
<td>December 7-12, 2022 and January 7-10, 2023</td>
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<tr>
<td><strong>Aircraft</strong></td>
<td>Twin Otter DHC6-400 and Vulcan Air P68C (N170WL)</td>
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<tr>
<td><strong>Sensor</strong></td>
<td>STAR SAFIRE® 380-HDc FLIR</td>
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<tr>
<td><strong>Pilot</strong></td>
<td>Craig Briske (PIC) Josh Goertzen (PIC) Jeff Martin (SIC)</td>
</tr>
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<td><strong>Sensor Operator</strong></td>
<td>Edward Macabalo (CPAI)</td>
</tr>
<tr>
<td><strong>Survey Coordinator</strong></td>
<td>Nathan Visser (ERC) Justin Blank (ERC)</td>
</tr>
<tr>
<td><strong>CPAI Observers</strong></td>
<td>Don Grakia Joe MacClaughlin Jamie Brewer Wendy Mahan Trent Land Ari Haunschild Edward Oglesby Adam Richmond Christina Pohl</td>
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<tr>
<td><strong>Data Manager/Lead Analyst</strong></td>
<td>Tiffany Carey Josh Walters Ari Haunschild Paula Compton Don Grakia Al Bergh Tobias Sandberg Edward Oglesby Wendy Mahan Trent Land Matthew Kale Christina Pohl</td>
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<td><strong>Image Analysts</strong></td>
<td>Kristine Lindberg (ERC) Nate Visser (ERC)</td>
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Table 16. 2022/2023 POI Detections

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<tr>
<th>Location</th>
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<th>Location ID</th>
<th>Date and Time</th>
<th>Detection Type</th>
<th>Comments</th>
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<tr>
<td>70.316628-148.003697</td>
<td>AIR_2023_010</td>
<td>2023_A</td>
<td>12/10/22 16:27</td>
<td>PD</td>
<td>Bear observed in the act of den construction December 7, 2022. Data indicated that the den was still occupied on December 13.</td>
<td>It is believed the bear continued to use this den location.</td>
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<tr>
<td>70.257176-150.326372</td>
<td>AIR_2023_003 AIR_2023_006</td>
<td>2023_B</td>
<td>12/7/22 17:42, 12/9/22 18:13</td>
<td>POI</td>
<td>Faint orb in likely habitat location. Post flight review inconclusive.</td>
<td>Dismissed - tundra</td>
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<tr>
<td>70.285075-149.474144</td>
<td>AIR_2023_011</td>
<td>2023_N</td>
<td>12/11/2022 16:15</td>
<td>USFWS POI</td>
<td>USFWS (POI #23): Bright spot 7 ft across with fuzzy edges. ERC: Middle of Ugnu River with no relief; Possible area of thin snow on ice</td>
<td>Dismissed – not in acceptable habitat</td>
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<tr>
<td>70.160932-150.39687</td>
<td>AIR_2023_018</td>
<td>2023_R</td>
<td>1/7/23 16:37</td>
<td>USFWS POI</td>
<td>USFWS (POI #43): Bright spot ~3 ft wide in riverbed. ERC: This is in the bottom of the channel and is likely ice.</td>
<td>Dismissed – not in acceptable habitat</td>
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<td>70.147483-151.948987</td>
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<td>2023_S</td>
<td>1/7/23 18:10</td>
<td>USFWS POI</td>
<td>USFWS (POI #41): Bright spot ~2-3 ft. ERC: This is in the bottom of the channel and is likely ice.</td>
<td>Dismissed – not in acceptable habitat</td>
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<td>70.280214-150.925011</td>
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<td>2023_T</td>
<td>1/8/23 17:16, 1/9/23 08:33</td>
<td>USFWS POI</td>
<td>USFWS (POI #62): Bright spot ~3-4 ft wide; Revisited 1/9 AM in video 225158Z at video time 0:05:16. ERC: Too small, too low, and doesn't appear to be sufficient snow.</td>
<td>Dismissed – Too small, too low, and doesn't appear to be sufficient snow.</td>
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