

Standard Operating Procedure (SOP) 6: Flying Surveys and Collecting Data, Version 1.0

Protocol for Monitoring Brown Bears

Arctic (ARCN) Inventory and Monitoring Network

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The main Narrative for the Protocol for Monitoring Brown Bears in Arctic (ARCN) Inventory and Monitoring Networks is available from the NPS Inventory and Monitoring Arctic Network website (<http://science.nature.nps.gov/im/units/arcn/>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>)

SOP 6 – Flying Surveys and Collecting Data

Standard Operating Procedure #6
Version 1.0 (09/01/2017)

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
Add rows as needed for each change or set of changes associated with each version.					

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SOP 6.0 – Introduction

SOP 6 outlines the roles and responsibilities of the pilot and the observer when flying aerial surveys and collecting data for ARCN's Brown Bear monitoring program. The pilot and observer have separate responsibilities, but must communicate frequently and work closely together to fly safely and to search for brown bears, bear tracks, and bear dens while surveying units and completely collect all data while surveying. See also SOP 2 (Field iPad Set Up), SOP 4 (GPS Set Up), SOP 5 (Equipment Lists) and prior to conducting surveys.

Prior to each day of the survey, all crew members will conduct an aviation safety and survey briefing to determine the optimal route to fly the surveys based on weather, fuel usage and flight path efficiency. Each morning the field project manager will consult with the pilots to identify which units will be flown by which pilot-observer teams that day and to identify alternate assignments in case plans need to change due to weather. Partner planes will travel together as much as possible during the survey for safety and increased efficiency. Constant communication between all aircraft will continue throughout the survey to ensure all units are flown and to enhance aircraft safety when planes are flying in close proximity to one another. A master overview poster (e.g., Figure 1) of all units to be surveyed in the study area will be referred to each morning prior to surveying and updated daily to track which units are completed by each aircraft.

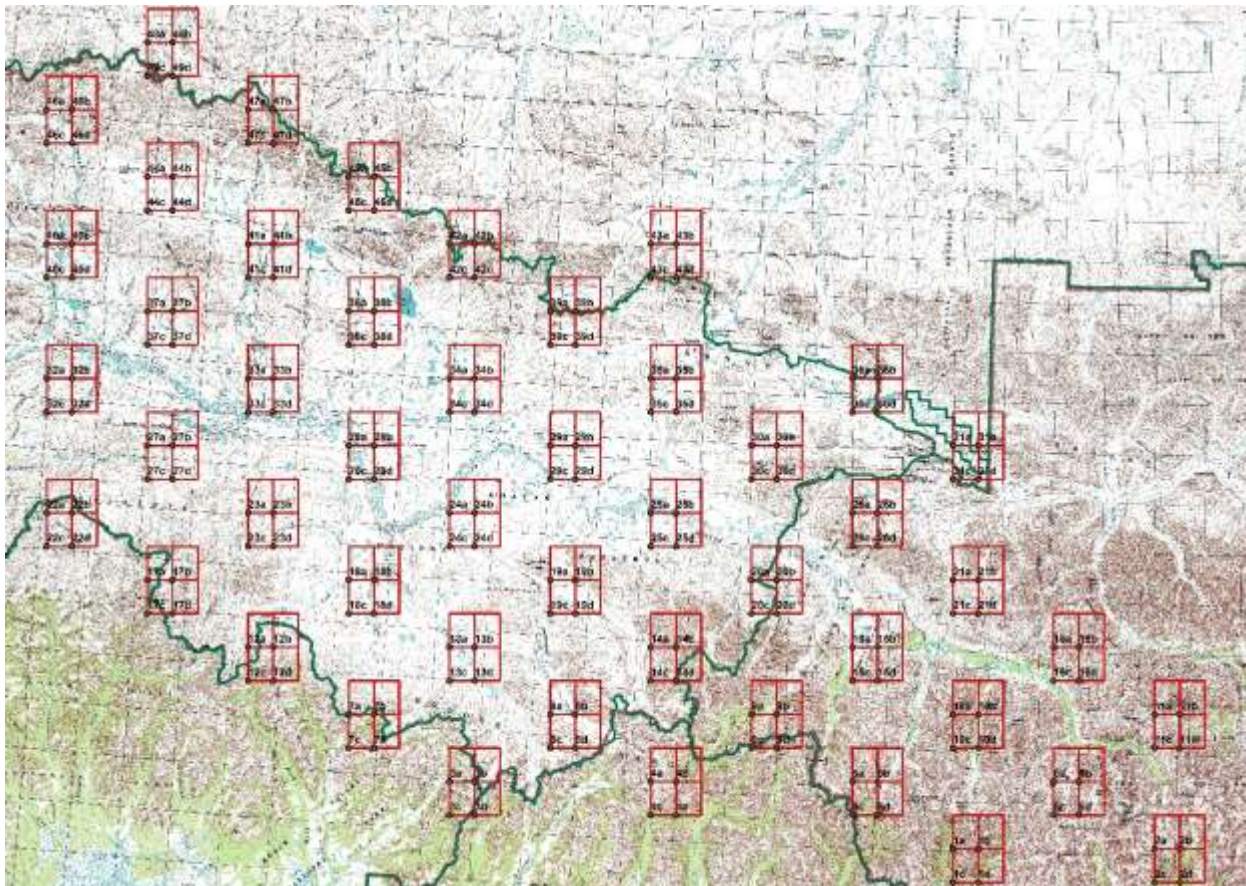


Figure 1. Example - Sample units for the Upper Noatak bear survey area in NOAT and GAAR. The units are numbered a, b, c, d and the SW corner of each sample unit is indicated with a point.

SOP 6.1.1 – Survey Methods

The survey method is a systematic sampling design with double-sampling and mark-recapture components. **Photographs must be taken of all individual bears and bear groups** to uniquely identify bears and to eliminate bias from multiple sightings of the same bear(s). **The goal is to temporarily “mark” each bear group using a combination of photos and GPS locations (i.e., waypoints) taken directly over the bear(s).** For this reason, photograph quality is very important because bear size and color patterns are used to help distinguish between bears. **Each evening, the paired pilot-observer teams will compare photos and locations for each sighted bear group** to identify which groups were sighted by each team and where and to identify unique groups only seen by one team. In situations where the two teams cannot agree whether a bear group is the same or different, other teams should be consulted to come to a final decision. If there is substantial uncertainty as to whether groups are the same or different, please note this on the datasheet and in the Excel spreadsheet rather than making an arbitrary decision.

Teams should also search for and **record and get an accurate waypoint directly over** (if it is safe to do so) **any NEW bear dens** found in each unit – these are dens that have **FRESH SIGN OF BEING USED THIS YEAR** (Figure 5). **Dens should be photographed** and marked using the pilot’s GPS and the iPad (SOP 2, SOP 3) and should be recorded on the iPad and on the paper datasheet back-up (Figure

6) in the same manner as bear groups. **Bear tracks should be recorded** on the iPad and the paper datasheet back-up (SOP 2, SOP 3), but photos and GPS locations are not necessary. The observer will record on the iPad and the paper datasheet the number of sets of bear tracks seen while in that unit: none, 1 set, or multiple sets. These additional metrics will be used to help improve estimates of bear occupancy and/or abundance in the final analysis.

This sampling method minimizes recounting previously sighted bears in adjacent units over the survey period, covers all habitat types, and gives good coverage across the survey area in both E-W and N-S gradients (Schmidt et al. 2017). Sample units (little squares, Figure 1) are clustered in groups of 4 to be flown consecutively by two pilot-observer teams. Sample unit size (~31 km²) and arrangement in groups of 4 are based on results of previous surveys. Each pilot-observer team will be able to sample approximately 6-8 sample units/8-hr flight-day.

SOP 6.1.2 – Double-Sampling

Pilot-observer teams will be paired daily and will work in close proximity. Each paired team will be assigned 8 sample units and at least 8 alternate sample units. Depending upon the terrain and wind, paired teams can sample the 4 sample units comprising each large square in any spatial order. **Planes should communicate to coordinate when they switch to each other's sample unit to accomplish the double sample.** Teams should try to **start on cells diagonal from one another** and work in a clockwise or counterclockwise direction until all 4 sample units have been covered by each plane. Some sample units will go faster than others, so separation by 1 sample unit will minimize wait times. Each plane will do only 1 sample unit at a time (i.e., don't do adjacent sample units simultaneously even if terrain permits). Pilots will have to be aware of shared boundaries. **Paired teams should not share real-time information on bears sighted in or out of sample units.** It is imperative that each pilot-observer team verifies they are in the correct unit and are the only plane in the unit. When a bear group or bear den is sighted, **mark the location** with the **pilot's GPS** and the **iPad**, **record the data** (e.g., group number, species, group composition, activity, etc.) **on the iPad and the paper datasheet**, and take as many photos as necessary to positively identify the bear(s)/den(s) later. **If you find a bear(s) outside the border of your sample unit** (e.g., on a turn), record the same information, including photos, and note that the bear was outside the sample unit. This will help identify bear movements between surveys by each team.

Mark the locations of fresh/this year's dens in each sample unit on the pilot's GPS and the iPad and record the data on the iPad and the paper datasheet – also, **take photos** (see **Figure 5** for examples). The den locations can be used in a separate mark-recapture analysis and the den photos will assist in determining use this season compared with older dens persisting from earlier years.

SOP 6.2 – Pilot Responsibilities

The pilot's main job is to operate the aircraft safely. All communications between aircraft will be on the radio frequency used by aircraft in the area (e.g., 122.7 or another frequency). CTAFs should be monitored in the vicinity of airports. Pilots are responsible for being in the correct sample unit. Mistakes can be catastrophic so don't enter units until it is confirmed that you are the only aircraft in that sample unit. If you are unsure, communicate with your partner aircraft and other aircraft until a potential conflict is resolved. In addition, do not survey units that are not on your list for the day without consulting with all other aircraft.

Pilot GPS Set-up: The pilot's GPS is the primary data GPS. Use the following setup:

- a. Set **GPS datum** to WGS 84 (Default) (Ensures that points read to observer are all the WGS format on data sheet)
- b. Set **tracklog** to record at 3 second intervals
- c. Display **Clock** time on a page for sample unit start, stop, and location times
- d. Set **Lat/Lon to Decimal Minutes** (dddmm.mmm)

You can use whatever page setup works for you. Each pilot will be provided with a Garmin chip that has maps, sample units, and waypoints for the SW of each sample unit (SOP 4). The waypoint of the SW corner is provided to aid the pilot in navigating to the sample unit. Pilot-observer teams will also have paper maps with sample unit numbers and a list of the sample units' corners corner Latitude and Longitude (SOP 1, see PASP).

SOP 6.2.1 – Flying Sample Units

Sampling flights should begin early in the morning (7-8 am AST) prior to the formation of clouds and winds associated with daily warming. Flight conditions often deteriorate by 1pm AST each day. Flights should be terminated if winds exceed 15 knots in mountainous terrain because sightability of bears will be compromised.

Additionally, when flying sample units along the coast, aircraft must first look for and avoid disturbing subsistence users camping and hunting in the area and disturbing seals on the beach. It is recommended that we also prioritize these units to be flown early in the survey. We will be in contact with the [insert appropriate NPS office, e.g., Kotzebue, Nome, etc.] NPS office to receive updates about subsistence activity in the area and will let them know the days that we intend to survey that area as weather allows.

SOP 6.2.2 – Search Pattern

The pilot's priority is to safely maneuver the aircraft for an efficient and complete survey of the habitat within each sample unit. The pilot will also have an unrestricted view for observing bears. Search pattern is determined by topography and wind. Each of the sample units is approximately 3.3-3.6 mi (5.3-5.8 km) on the side. Aircraft ground speed will vary between 60 and 90 mph (52-78 knots) depending upon terrain, vegetation, and wind. Transects and contours are suggested, however the sample unit may be flown at the pilot's discretion (e.g., maximizing effort in bear habitat in flat tundra) so long as it is sufficiently covered in its entirety. Remember that your partner plane (i.e., the other pilot-observer team) will be in there after you or before you so all areas must be covered to some degree.

Transects should be flown in areas of low relief, and flight paths should follow elevation contours in mountainous terrain (Figures 2 and 3). Parallel transects separated by 450-500 m (0.25-.0.30 mi) are recommended in flat terrain with minimal vegetation (Figure 2). Transects should be more closely spaced when surveying areas with more shrubs and/or trees. Flight altitude for low-relief sample units should be between 152m and 305m (500 ft and 1000ft) depending upon vegetation.

Contour flight lines should be spaced between 91m and 152 m (300ft-500ft) depending upon terrain steepness and ruggedness (Figure 3). Flight altitude in mountainous terrain varies substantially depending on slope and ruggedness.

SOP 6.2.3 – Search Effort

Search effort will be measured as minutes per square mile (min/mi²). Search effort for a mark-recapture study in the Noatak River valley averaged 2.35 min/mi² (0.91 min/km²) (Ballard et al 1990). Search effort has varied between 3 and 6 min/mi² (1.16-2.32 min/km²) for previous surveys, but these times included data retrieval time (e.g., photographs and data recording). The primary objective is to achieve a **minimum search intensity of 3 min/mi²** not including time spent recording attribute data or photographing each bear group. **Target search times are between 33 and 60 minutes per sample unit**, longer if bears are seen and shorter for coastal units where only a portion is on land. **Use the time you need to adequately cover the each sample unit. Target search times should not constrain search teams from searching longer if sightability of bears is difficult** because of snow, light, wind, or vegetation conditions. Using this search method in 2013, the mean search time was 57 minutes per sample unit.

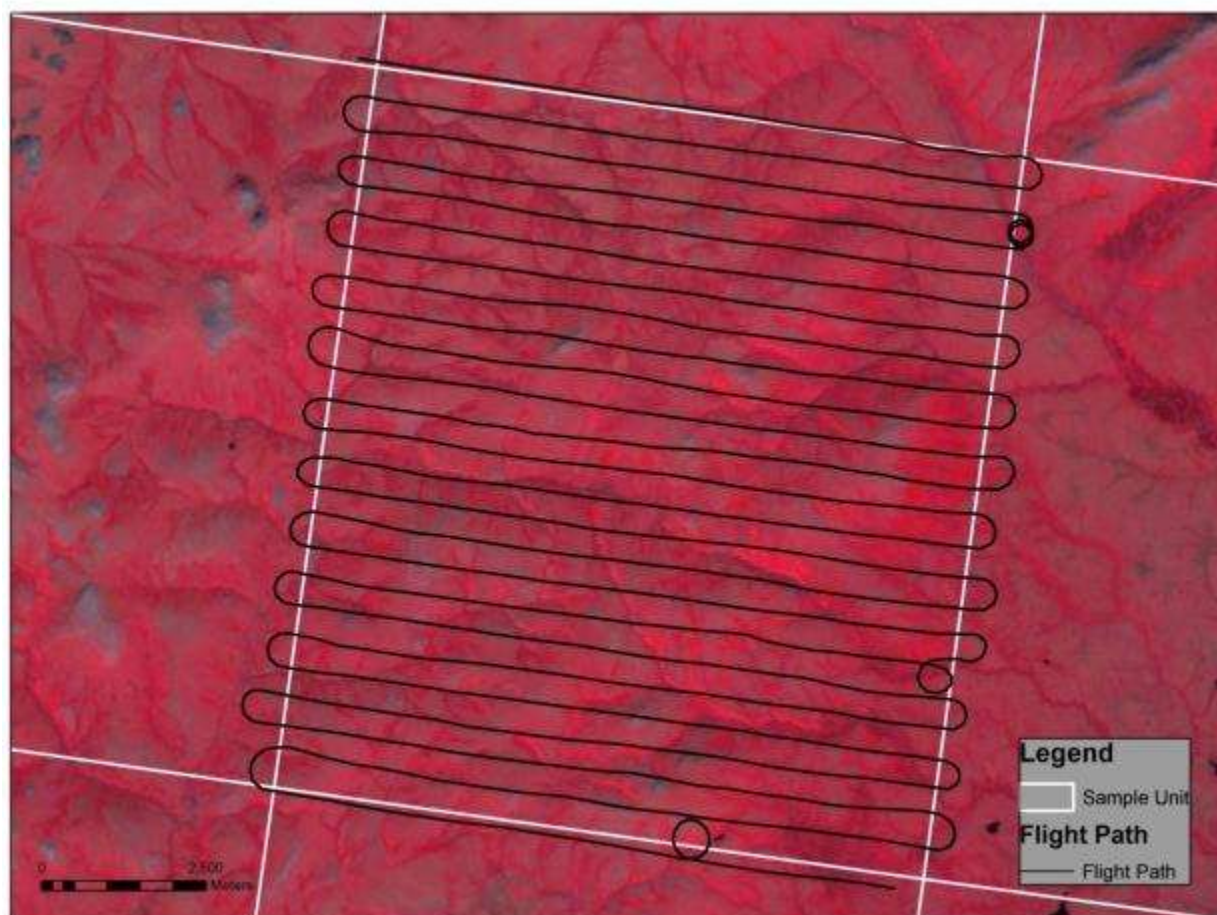


Figure 2. Recommended flight path for searching sample units in low-relief terrain. Transect spacing is approximately 460m (0.25 mi). Note: this photo is from a previous survey with a different design and larger survey units.

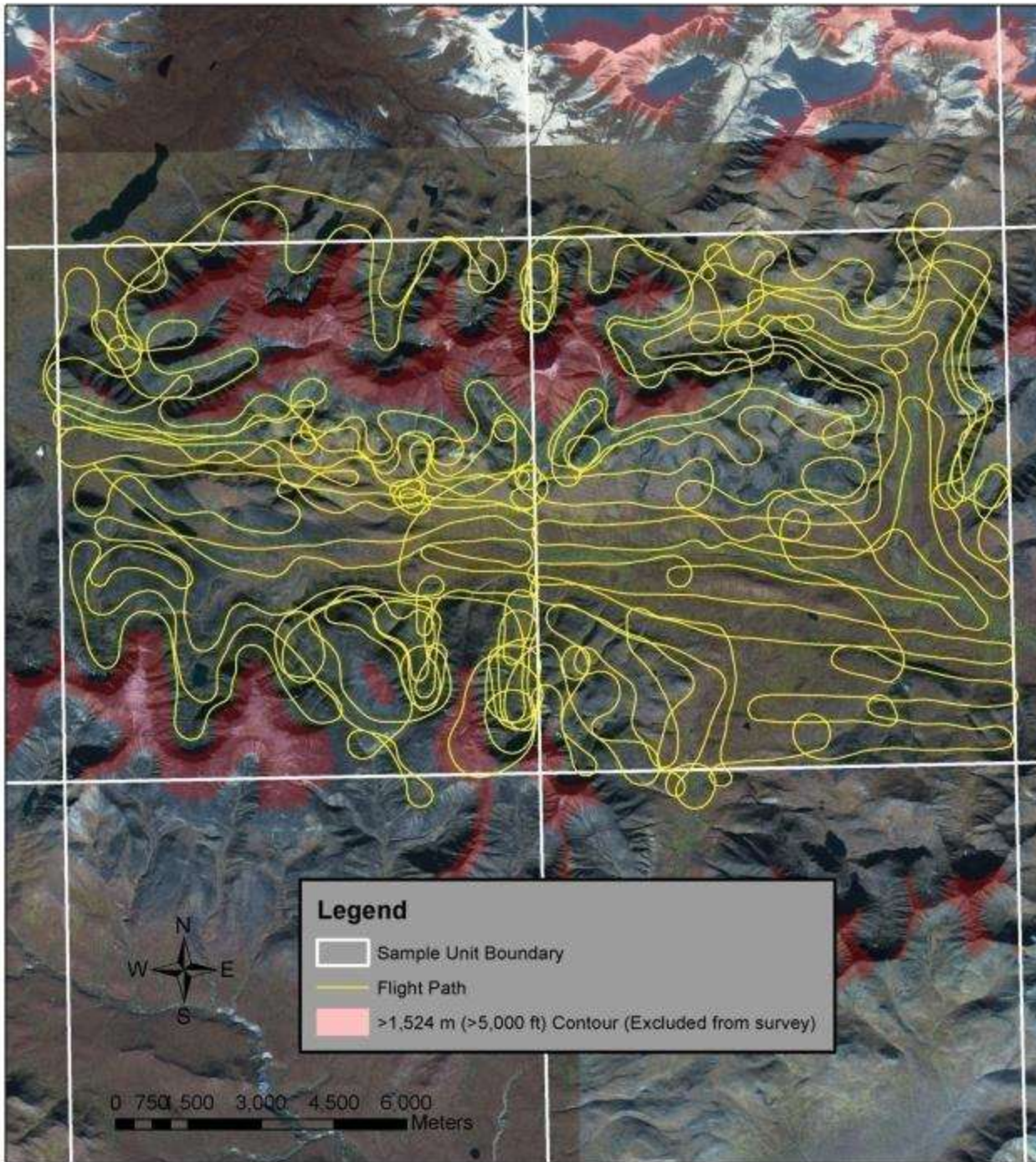


Figure 3. Typical contour flight pattern for mountainous terrain. Note this photo is from a previous survey in Gates of the Arctic with a different design, larger survey units and an upper elevation limit of 5000 ft. Nevertheless the contour flying plan applies in this survey.

SOP 6.3 – Observer Responsibilities

The observer is responsible for observing bears, taking photographs of bears, obtaining a location of bears and dens, and recording the required attribute data for each observation on the iPad and paper back-up data sheet (SOP 2, SOP 3, SOP 5, Figure 10).

SOP 6.3.1 – Pre-Flight Checklist

- ☐ Personal protective gear
- ☐ iPad
- ☐ Long leash USB lightning cable
- ☐ Cigarette lighter plus with 2 USB ports (with which to plug in the iPad)
- ☐ 2 back-up battery packs for the iPad (charged)
- ☐ Stylus (if desired)
- ☐ Dual Bluetooth external GPS (if desired, charged)
- ☐ Camera (charged, spare battery, empty memory card)
- ☐ 9V Batteries (for cell set)
- ☐ Synchronize camera clock with GPS
- ☐ Data forms (paper back-up)
- ☐ Pencils
- ☐ Sample unit maps
- ☐ Survey Protocol Summary (e.g., “PROTOCOLS FOR 20xx BROWN BEAR SURVEY.doc”)
- ☐ PASP
- ☐ 8.5”x11” or 11”x17” map of survey units
- ☐ Satellite phone + cell set
- ☐ 2-3 Spare satellite phone batteries
- ☐ Percent Vegetation Cover Class Reference Sheet
- ☐ Take a picture of GPS unit showing GPS time in wide format (seconds).

SOP 6.3.2 – Configure Cameras

Clock

Set the camera’s clock as closely as possible to the time on the pilot’s GPS that will be used for the survey. The time does not need to be exact but should be very close. This is done so that images taken with the camera can be geolocated to GPS trackpoints or waypoints based on time.

Batteries

Ensure the camera's batteries are sufficiently charged for a day or surveying. Bring extra batteries if needed.

Memory Card

Ensure the memory card has enough room for the day’s pictures. Ideally the card will have been cleared and existing survey images archived during post-survey data management activities.

Image Capture Mode

Inexperienced observers should set their cameras in “Sport” mode, and verify that image stabilization on the lens is turned ON. More experienced observers may want to set their camera in “Aperture priority” mode and utilize a large aperture (smaller number) combined with an ISO of 1600.

GPS Clock Settings

1. Page through the GPS settings until the clock shows.
2. Ensure the clock shows the time in wide format (showing seconds).
3. Capture an image of the pilot's GPS using the camera that will be used with the GPS for the duration of the day

Note: This is done as a means to synchronize the time any survey images are captured with the location data contained in the GPS track log or waypoints files during the image geolocating process.

SOP 6.3.3 – Data Collection

The **observer will collect data using the application Park Observer on an iPad** configured for the survey (see SOP 2, SOP 3) and on a paper data sheet as a back-up. **Figure 4 below** (also in SOP 2, Figure 3) shows instructions on how to use Park Observer that correspond with the numbers below (1-6). Steps 1-5 are described in SOP 2. Steps 4 and 5 are reiterated here and step 6 is described.

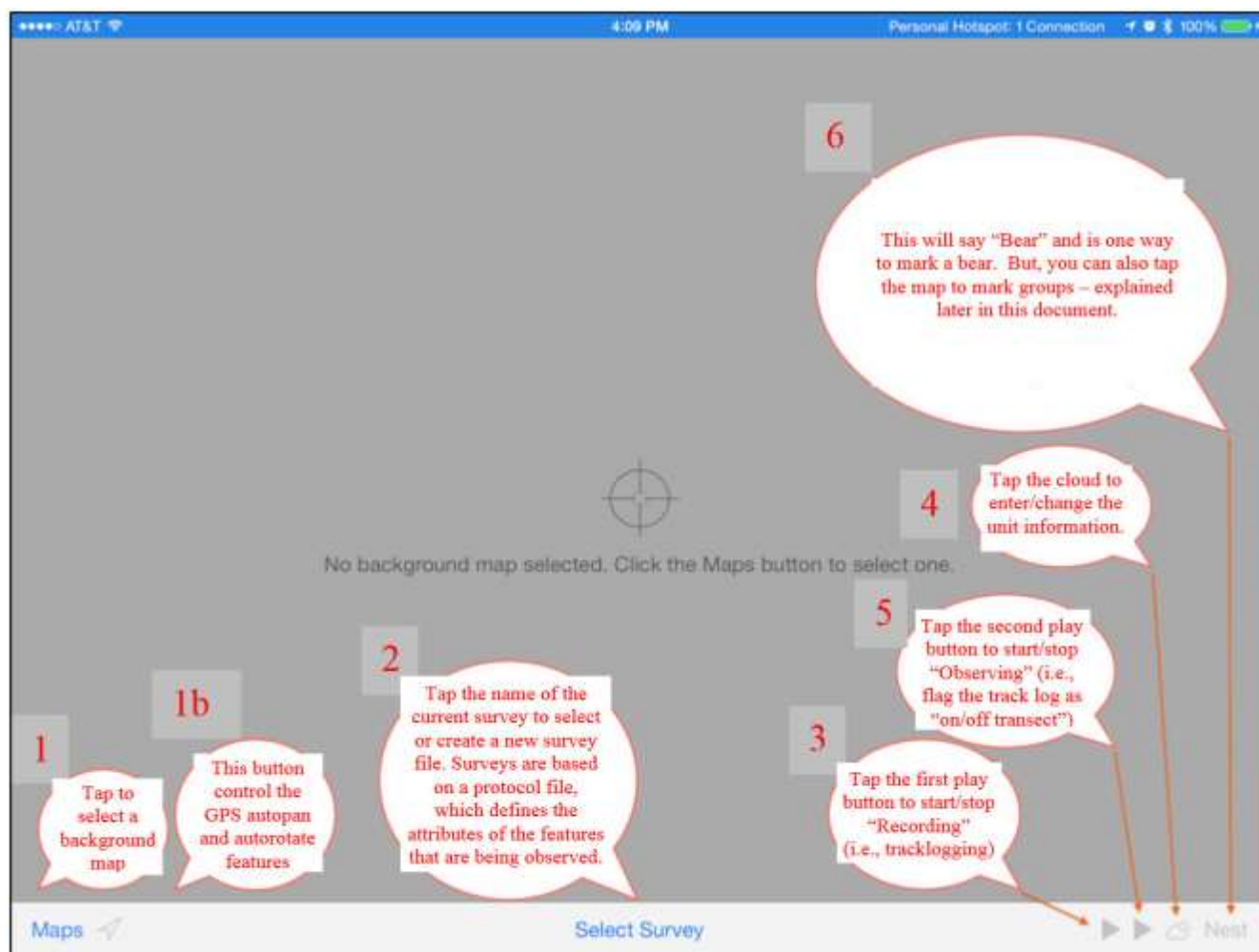


Figure 4. Schematic from SOP 2 showing steps 1 through 6 (SOP 2.3 – Setting Up Park Observer for Collecting Brown Bear Data).

4. Step 4 – (as described in SOP 2, Figure 3, step 4): **Each time the pilot-observer team goes into a new unit, enter pilot/observer/plane and weather information using the cloud button before starting the unit (Figure 5 [Figure 11 in SOP 2]).**

The Mission Properties window (Figure 6 below [also Figure 12 in SOP 2]) will open and have entries from your last unit or it will be blank at the start of the day. **Enter** Unit ID, Survey ID (survey area and year; e.g., UpperNoatak2017), Pilot initials, Observer initials, Aircraft tail number, and tail number of your Partner plane if you know it (i.e., the plane double sampling the same unit).

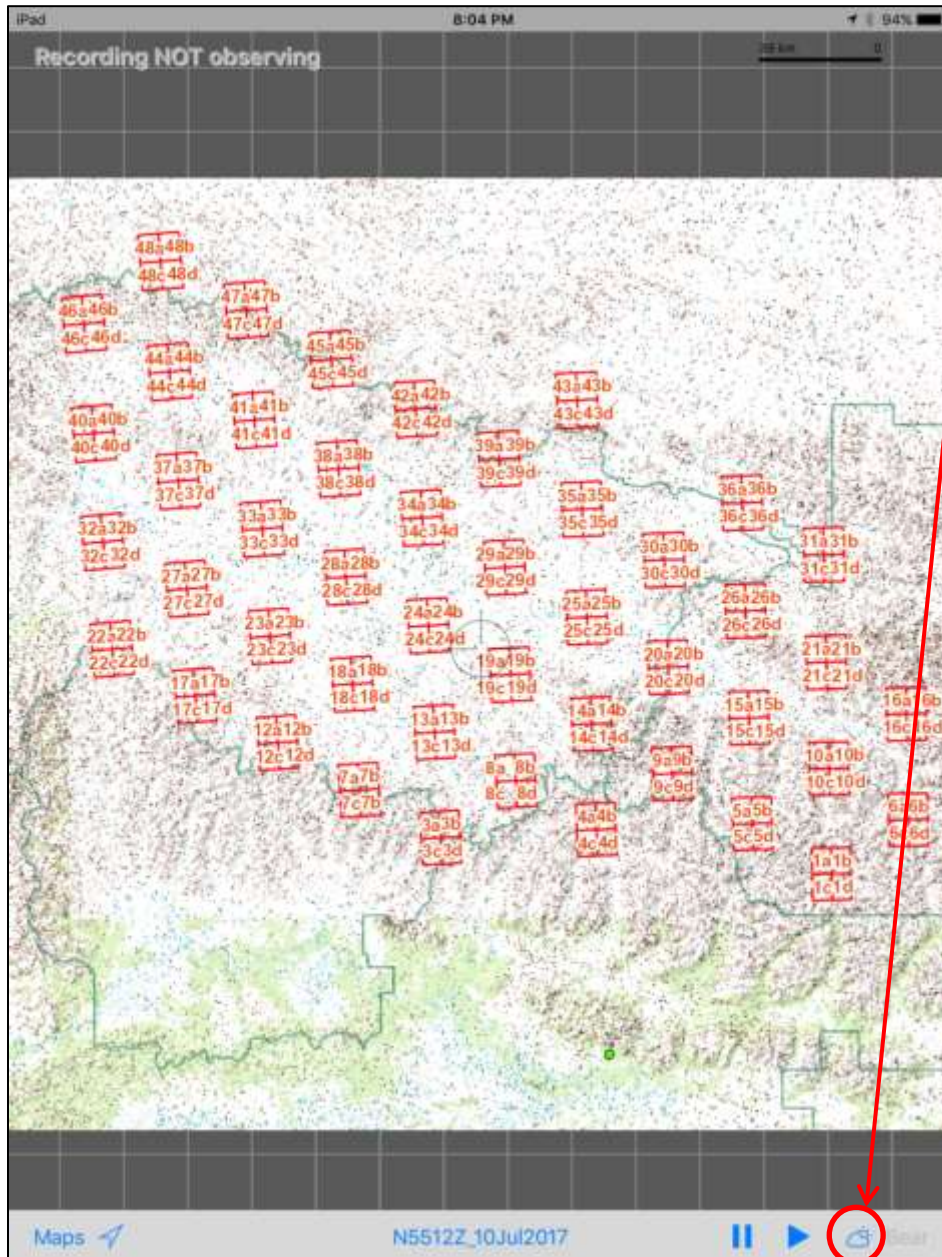


Figure 5. Mission Properties and weather data for each unit, part 1.

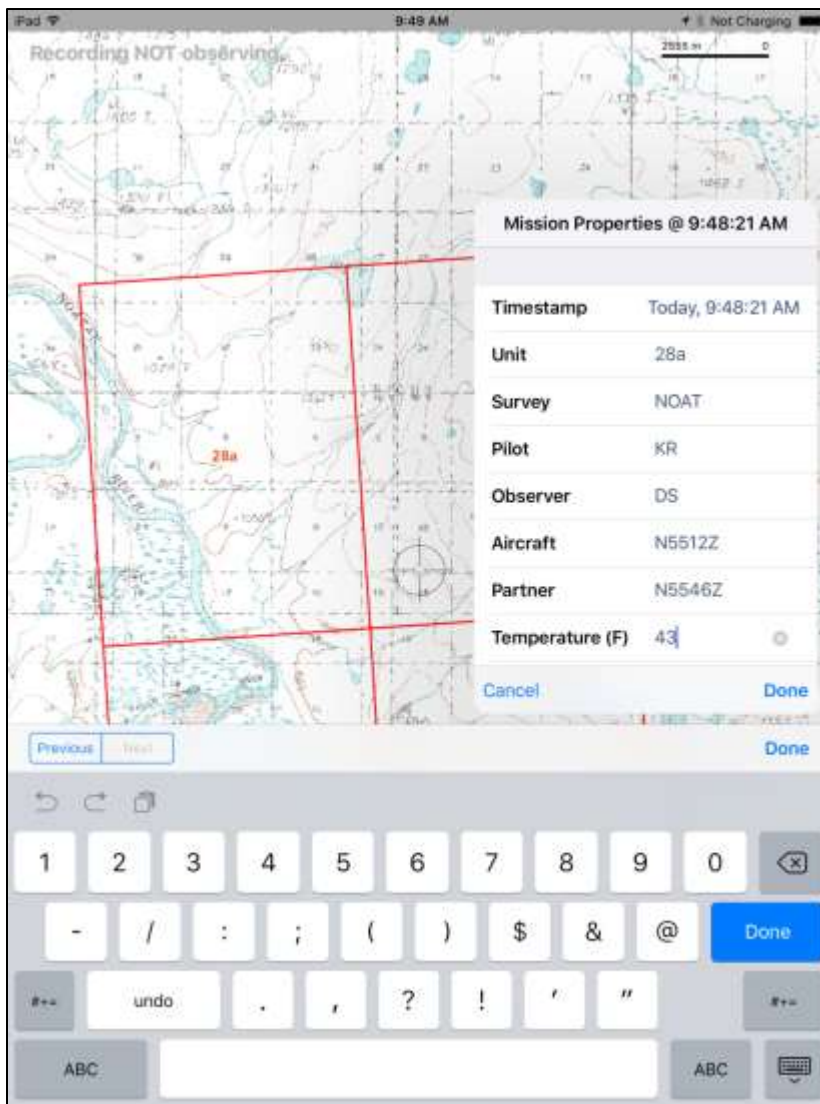


Figure 6. Mission Properties and weather data for each unit, part 2.

5. Step 5 - When you enter the unit, press the second blue play button to indicate you're "ON Transect" (Figure 5 above and Figure 7 below [also SOP 2 Figure 3, step 5; Figure 11]). Both play buttons should now look like pause buttons. The "Bear" button on the far right will now be active (blue) as well (Figure 7 below). At the top left of your screen you will see "On Transect" in pink as your status. A green square will mark your start point and a green line will track your movements on the map (see screenshot on page 16 below). The data for the unit will be attached to this green tracklog line.

Now you will fly the sample unit and collect data on bear groups and dens observed – see Step 6 below (Figure 4, step 6 below [also SOP 2 Figure 3, step 6]).

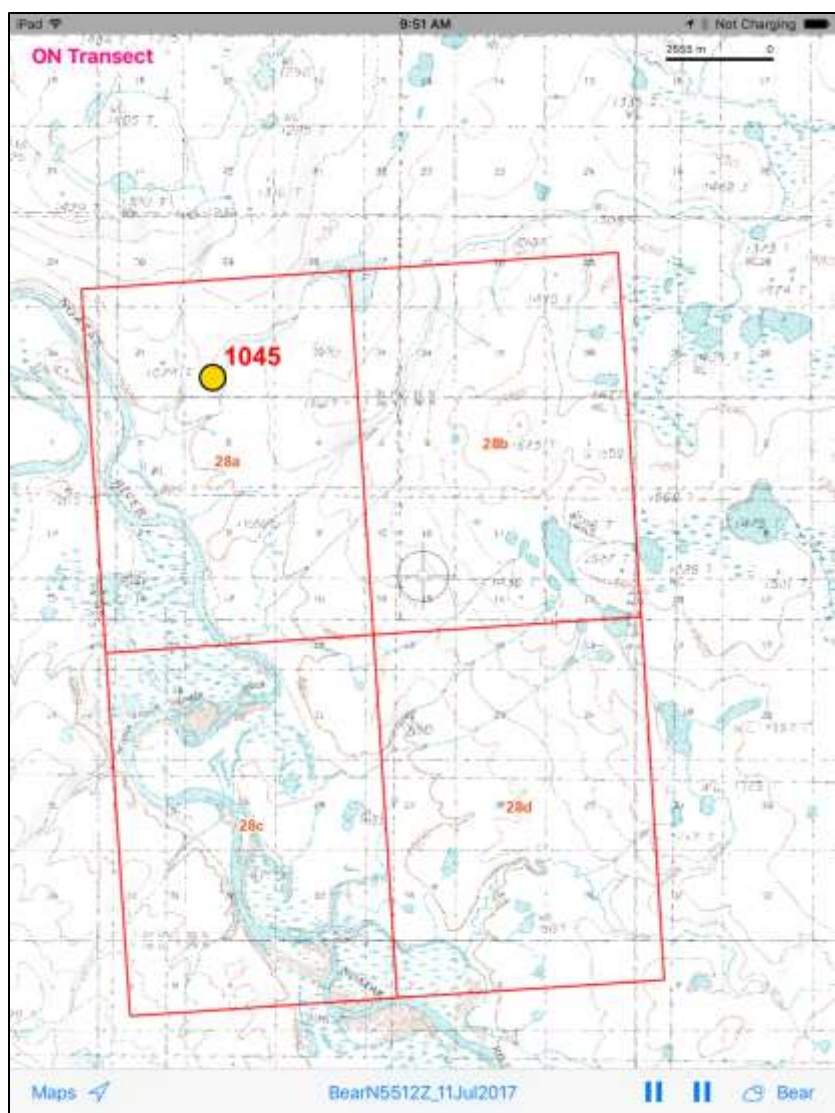


Figure 7. Indicating you are “On Transect” and observing.

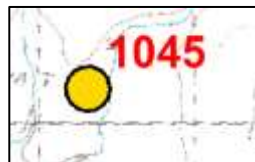
Each pilot will have been assigned a series of waypoints (these are assigned each year in a document such as “PROTOCOLS FOR 20xx BROWN BEAR SURVEY.doc,” Table 1).

Table 1. Aircraft, Pilots, Observers and waypoint series for pilots’ GPSs

Aircraft	Plane #	Pilot	Observer	Waypoint Numbers	Base Location
NxxxxxE	1	John Doe1	Jane Doe4 (ADFG)	1000-1999	[insert]
NxxxxxZ	2	John Doe2	Jane Doe5 (NPW-WEAR)	2000-2999	[insert]
NxxxxxY	3	John Doe3	John Doe4 (NPS-YUGA)	3000-3999	[insert]
NxxxxxZ	4	Jane Doe1	John Doe5 (NPS-WEAR)	4000-4999	[insert]
NxxxxxD	5	Jane Doe2	John Doe6 (ADFG)	5000-5999	[insert]
NxxxxxY	6	Jane Doe3	Jane Doe6 (NPS-CAKN)	6000-7999	[insert]

6. **Step 6 - When you see a bear or bear den tap anywhere on the screen to drop a waypoint on the map.** A yellow dot will appear and the Bear form will show. You can fill out the Bear form now or close the form by tapping elsewhere on the map.

- Fill out pertinent information:** bear species or den, # adult bears, # COY (cubs of the year), # yearling cubs, # cubs ≥ 2 year old (work with pilot to determine cub age). Use the +/- buttons or tap where the 0 is and the number pad will show. Scroll down (red arrow).
- Select Activity, Observer** (who saw the bear first – Pilot, Observer [you] or Both), **Vegetation Cover** (see key on survey flying protocols), **Snow Cover**, then if the pilot has already collected a waypoint, enter the waypoint number here. The waypoint will be the label for the sheep group on the iPad map (see below, waypoint 1045). Scroll down.
- When the pilot flies over the bear (or den) to take a waypoint with their GPS, the observer selects “Move to GPS Location” to mark the waypoint on the iPad at the same location.** Fill in the Waypoint # from pilot, Unit ID, Photos yes or no (did you take photos of the bear(s) or den?), and Comments like bear color, activity, proximity to unit edge, age of den.
- Click **“Done”** on the form.
- Take photos** if you haven’t done so already.
- Record the same data on your datasheet** for backup.
- If you need to cancel this point, hit **“Cancel”**.
- If you need to edit a bear group, select the yellow dot on the screen, and the Bear form should reappear.
- If you need to move a bear (or den) waypoint, hold your finger or stylus on the yellow dot then swipe the screen to where you want it.



****NOTE**** – *on occasion you may see some ghost groups* (yellow points) on the screen such as the first one of the day or after you select Move to GPS Location. You may not be able to select them if you tap on them and there are likely no data associated with them. If you close the Survey Form you're working on (bottom center) and reopen it and start your track (first arrow), those ghost points will likely disappear.

7. **End the unit** by selecting the 2nd (right-hand) pause button.

8. Select the **light green square** at the start of your tracklog for the unit. The Mission Properties window for the tracklog will open and you can enter/update weather, turbulence, veg cover, snow cover, **enter # sets of bear tracks** and Unit Comments (keep scrolling down to fill out everything). Click "Done" on the Mission Properties form to close it.



9. **Repeat steps 4-8 for each new unit.** Don't forget to update unit ID with the cloud button before each unit as the Mission Properties form retains the data from the previous tracklog.

10. **At the end of the day or as you're heading home, hit the first play button to stop recording an active tracklog.**

11. **You can share today's file with iTunes now (see below) or back in the office/bunkhouse.**

12. **Turn off the iPad.**

****NOTE**** – **Record observations, composition, location, and photograph of any bears seen outside of survey units. This is important in reconciling bear groups seen.** This can be very important for bears that leave the sample unit between team visits, but may be detected by the second team. These observations will help to distinguish between lack of detection and bear movements.

Mission Properties @ 9:48:21 AM		
Temperature (F) 43		
Cloud Cover		
Clear	<50% scat... >50% bro...	Overcast
Precipitation		
None	Rain	Snow
Lighting		
Bright	Flat Light	
Turbulence		
None	Light	Moderate
Vegetation Cover		
<10%	10-30%	>30%
Snow Cover		
None	Patchy	Complete
Bear Track Sets		
0	1	>1
Comments		
Cancel		Done

SOP 6.3.4 – Photography Recommendations

- See **Figure 8** regarding photo quality for mark-recapture of bear groups and **Figure 9** for photos of dens.
- **Inexperienced observers** should set their cameras in “Sport” mode
- Verify that image stabilization on the lens is turned ON.
- Experienced observers may want to set their camera in “Aperture priority” mode and utilize a large aperture (smaller number) combined with an ISO of 1600.
- The key is to produce as sharp an image as possible.
- Get as close as possible.
- **Photographing the bear group in direct light** (as opposed to it being backlit from the shadowed side) will make the images more consistent. Work with the pilot to make this happen if possible.
- If there are two or more bears in a loose group the observer should also take a wide photo which shows the bears in relation to each other.
- **Image the entire group.**
- **Take a photo of the data sheet** between bear group sightings – this will help when reconciling detections in the evening.



Figure 8. Examples of good/useful and bad bear photos.



Figure 9. Representative examples of fresh/recently used brown bear dens in a variety of habitats.

SOP 6.3.5 – Datasheets

A new datasheet (**Figure 10**) should be filled out for each unit (i.e., ~8 sheets/day). Attribute data will be recorded on the paper data form by the observer. **Since bears may be disturbed by the aircraft, observers should take the photographs of the group before recording attribute data.** Attribute data include:

1. **Group Number**
2. **Group Composition** – indicate the number of:

- a. Single (adults)
 - b. Cubs of the year (COY)
 - c. Yearling cubs
 - d. Cubs $\geq$ 2 years old
- 3. Total Bears**
4. **Activity.** Details (feeding, bedded down, etc.) can be added to the Comments.
- a. Stationary
 - b. Walking
 - c. Running
- 5. Which Observer detected the bear**
- a. Pilot Only
 - b. Observer Only
 - c. Both
6. **Percent Shrub/Tree Cover** (None, 10-30%, >30%) within 10 m around the bear where it was first sighted. See **Figure 11** for guidance on percent cover.
7. **Snow cover** (None, Patchy, Complete) within 10m of where the bear was first sighted.
8. **Waypoint Number** from Pilot GPS (4 digit assigned to aircraft) and Latitude and Longitude in degrees/decimal minutes or decimal degrees.
9. **Photographs Taken** (Yes or No)
10. **Comments** - include detailed information that might be useful in identifying whether the bear was detected by the other team (e.g., color, movement direction/speed). Please also indicate if this was a breeding pair or siblings if known. Also, if the bear was running in or out of the unit, please note this as it may affect sightability by your partner plane.
11. **Dens** - Use the same datasheet but a new line for any dens seen in the unit. **ONLY PHOTOGRAPH AND WAYPOINT FRESH/RECENT DENS** with signs of fresh digging (or dirt debris on snow). See **Figure 6**.
12. **Data for bears seen outside of the unit should be** recorded on the datasheet (i.e., the sheet for the adjacent unit or any other for the same day if seen far from sample units), with appropriate notation in the attribute columns and a note in the Comments column that the bear(s) were seen outside of the unit.
13. **Tracks** - Circle one of the selections for the number of track sets seen in the unit (0, 1, >1). This is within the Unit Comments box. Note substrate (dirt, snow).
14. Ensure the data sheet is fully filled out including the date, sample unit, personnel, conditions while flying the survey unit, search start and stop times, etc.
15. **The column “Seen by partner plane Y/N/U”** will be filled out during data processing in the evening after both planes are back. (Yes/No/Unknown).

Date _____ Unit _____ Your Tail # _____
Pilot _____
Observer _____
Partner Tail # _____

Search Times (GPS clock)		
Start _____	Stop _____	Total _____
Start _____	Stop _____	Total _____
Start _____	Stop _____	Total _____

Attributes for bear observations:
Activity: 1 Stationary, 2 Walking, 3 Running
Observer: Pilot, Observer, Both

Temperature: _____ **Cloud cover:** Clear, Scattered (<50%), Broken (≥50%), Overcast **Precipitation:** None, Rain, Snow
Lighting: Bright, Flat Light **Turbulence:** None, Light, Moderate **Veg Cover:** 1 None, 2 (10-30%), 3 (>30%) **Snow:** None, Patchy, Complete

Bear Tracks in unit: 0, 1, >1

Comments about survey conditions:

Group or Den #	Adults	COY	Year-lings	≥ 2 Years	Total Bears	Activity	Observer P/O/B	Veg Cover	Snow Cover	Waypoint Lat/Long	Photo Y/N	Comments (Describe den or bear color, size, activity, running in/out of unit?)	Seen by partner? Y/N/U

Figure 10. Example – 2017 Datasheet

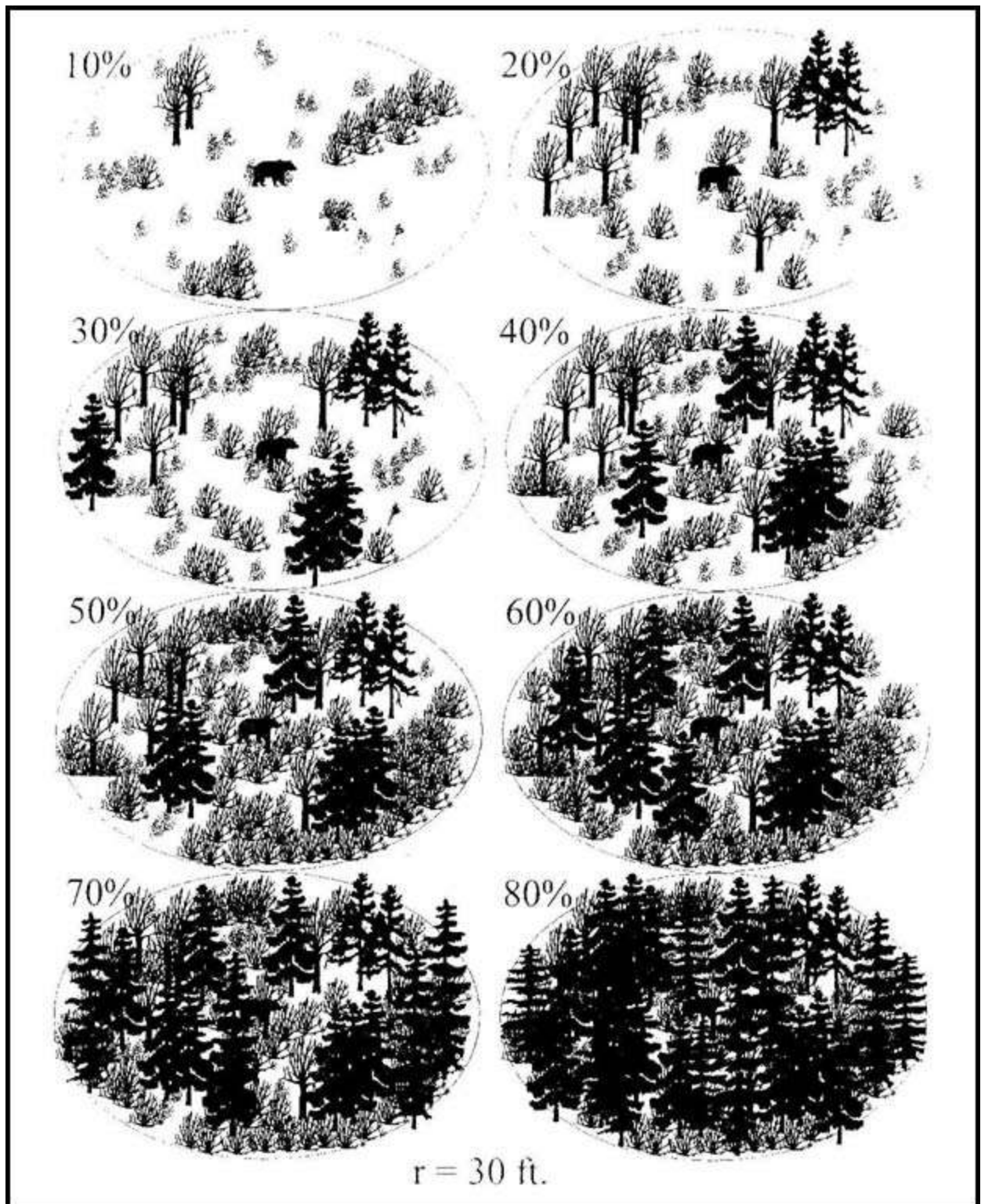


Figure 11. Vegetation Percent Cover Diagram.

SOP 6.4 – In-field Data Processing

An observer or data manager at the field site should do the following every evening after the pilot-observer teams return from flying.

1. Gather all iPads, paper datasheets, cameras, and pilot's GPS's. Download photos, pilot waypoints and tracklogs, and data from iPad. Use the naming convention of tail number and date (e.g., N527CC_12May2017).
2. Enter data into the spreadsheet or database.
3. Go through photos with the observer and rename them for the associated bear group. If necessary you may geotag photos if it's not clear which group they match.
4. After doing this for all pilot-observer teams/planes, work with the paired pilot-observer team to see if bears seen by plane 1 match any seen by plane 2. Indicate this in the database and in the appropriate column on the datasheet (Yes/No/Unknown).
5. Import data into ArcGIS for viewing and assisting with reconciling.

Literature Cited

- Ballard, W. B., K. E. Roney, L. Ayers, and D. N. Larsen. 1990. Estimating grizzly bear density in relation to development and exploitation in Northwest Alaska. *International Conference on Bear Research and Management* 8:405-413.
- Schmidt, J. H., K. L. Rattenbury, H. L. Robison, T. S. Gorn, and B. S. Shults. 2017. Using non-invasive mark-resight and sign occupancy surveys to monitor low-density brown bear populations across large landscapes. *Biological Conservation* 207:47-54.