A Survey Protocol for Pinyon Jay Road-based Point Count Surveys

Version 1, March 2023

The road-based survey is a useful method of surveying for Pinyon Jays under certain circumstances and can be used in conjunction with or as an alternative to the Pinyon Jay Working Group (PJWG) pedestrian-based area search survey protocol (Boone et al. 2023; https://partnersinflight.org/resources/pinyon-jay-working-group/). Table 1 compares the two protocols.

The PJWG protocol consists of pedestrian surveys of 2.5 x 2.5 km blocks. That method is useful for discrete survey areas known or suspected to have Pinyon Jays, surveys with adequate personnel and funding to complete the time-intensive pedestrian surveys, and areas where foot traffic is allowed.

In some situations, however, road-based surveys may be more appropriate than pedestrian surveys. For example, pedestrian surveys or multiple visits may not be feasible in areas where no information on Pinyon Jay presence exists; in extremely large, previously un-surveyed areas; when financial and personnel resources are limited; or where foot traffic is prohibited, such as some areas on DoD installations.

The key elements of the road-based protocol are:

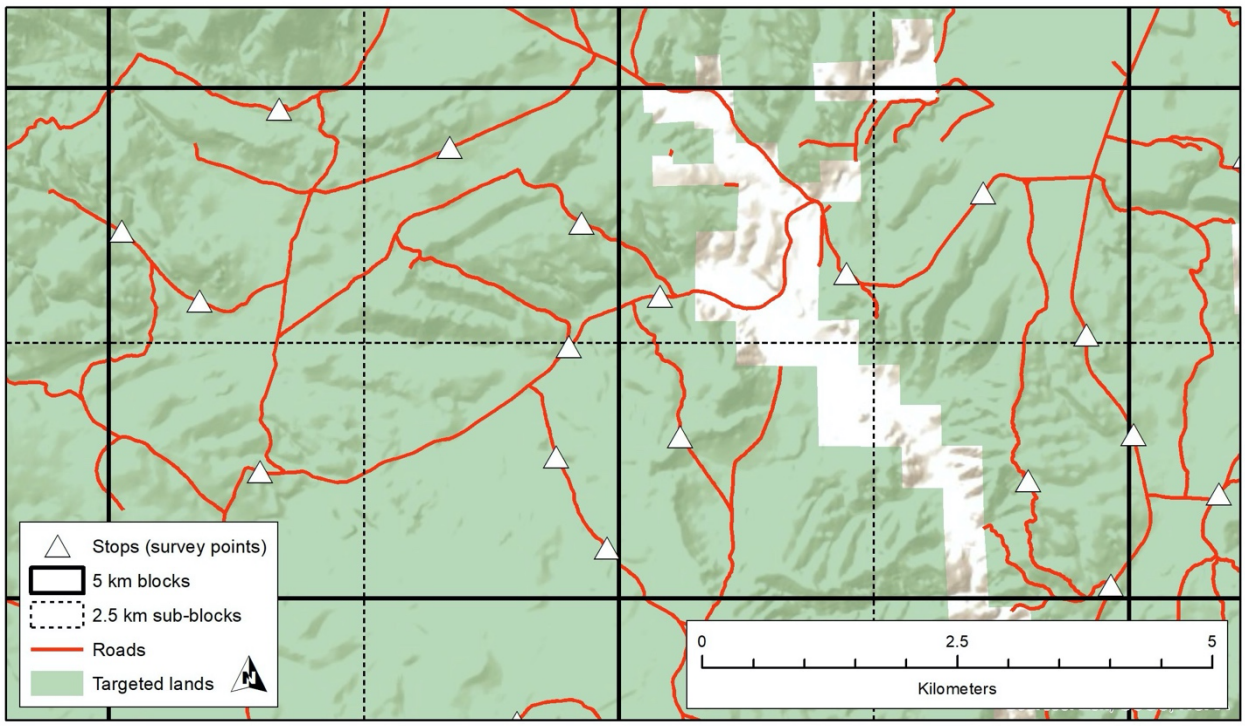
1) Use of 5 x 5 km blocks as the primary survey units. For analysis consistent with 2.5 km surveys, 5 km blocks can be sub-divided into 2.5 km blocks ("plots" in the PJWG protocol).

   The 5 km blocks (25 km^2) are recommended because of the greater geographical coverage possible with road-based surveys. This block size is based on radio telemetry studies of Pinyon Jay flocks and approximates known breeding season home ranges. [Examples include: 43.05 km^2 (including two colonies of 16.67 km^2 and 26.38 km^2) (Johnson et al. 2014); 25.51 km^2 (Johnson et al. 2014); 26.99 km^2 (Novak 2019).] It is designed to reduce the possibility that a) a single flock moving over its home range will be counted two or more times, and b) more than one flock will be counted as a single flock (resulting in undercounts in a survey block that is too large). Either double-counting or under-counting is undesirable for a species of conservation concern, where accurate population estimates, trends, and occupancy are necessary for conservation and management. Road-based sampling can cover a block rapidly, before a flock can move into a neighboring block, potentially reducing both types of errors.

2) Delineation of survey routes along selected roads within the blocks (Figure 1). Blocks must include enough accessible road length to allow at least three point-count stops. If blocks will be subdivided into 2.5 km blocks for analysis, it is desirable to include at least three point-count stops in each 2.5 km block analyzed. However, this may not be possible and is not critical for every 2.5 km block.
3) Stops spaced every 1 km along roads, with 6-minute point counts at each stop and minute of detection recorded (Figure 1).
4) If possible, stops should be at least 200 m from block boundaries to reduce likelihood of counting Pinyon Jays outside the block.

5) Surveys of multiple blocks can be completed within a 4-hour period or less.
6) Flexible number of visits to each block. Three visits at least five days apart have a better chance of capturing Pinyon Jays that nest earlier or later than the usual peak season in March/April. However, three visits separated in time by days or weeks violate the closure assumption of occupancy modeling and should not be used in that context. A single visit with 6-minute point counts divided into 1-minute periods can be used for occupancy modeling (see Appendix 1). If three visits are made, each visit can be modeled for occupancy separately, provided that the minute of detection is recorded.

Figure 1. Example of 5 km survey block grid, showing 2.5 km sub-blocks for smaller-scale analysis, roads, survey points, and targeted lands.



The number of visits needed to verify presence or absence is not well known. Based on one survey in Arizona, The PJWG recommends three separate survey visits to each block to determine Pinyon Jay presence or absence, but more information is necessary to address this question. The number of visits necessary to verify absence may vary depending on timing of surveys and bird behavior. For example, if the three surveys were completed in March and the birds did not arrive at the colony site until April, as happens sometimes in New Mexico, absence could be incorrectly assumed. For the road-based protocol, to verify absence in the breeding season, we recommend at least three surveys, one in late March, one in early April, and one in late April, provided survey conditions are good, the surveyor is experienced, and the block is well covered. Additional, repeated surveys would be required to verify absence in other seasons.

To determine flock home range or seasonal use, surveys can be repeated in multiple seasons. Seasons of interest might be:

1. fall, when a post-breeding flock will be foraging and caching, August to November,

2. winter, when a flock could be foraging or retrieving caches, roughly November to January/February,
3. early spring, when a flock may still be roaming prior to breaking up into nesting sub-flocks, February to March,
4. nesting season, from March/April to May, when nesting sub-flocks are typically settled at colony sites,
5. summer, when post-breeding flocks leave nesting colonies and begin roaming through the home range.

These blocks can be configured to fit evenly into the military grid system. Within each block, decisions about which road segments to survey and total length of the survey route should be determined based on a previous assessment of suitable habitat, road density, and pattern. In addition, for analysis, 5 x 5 km blocks can be subdivided into four 2.5 x 2.5 km blocks (Figure 1). Field survey methods would be unaffected and comparison with results from the smaller block sizes of the PJWG area search protocol are possible.

Data may be recorded in the field electronically or on printable paper data sheets. Advantages of electronic data collection include the ability to visualize block boundaries, imagery, and surveyor position in the field; embedding photographs within data records; and reduction in data entry errors and omissions (Boone et al. 2023). With the proper technical and organizational support (ArcGIS license fees may not be within the budget of small organizations), ArcGIS Field Maps is an excellent option for field data collection and navigation. Data collection forms and map layers can be standardized across all survey efforts. All data can be collected via tablet or smartphone, eliminating the need for paper datasheets. When in range of a Wi-Fi network, all data can be uploaded to a designated database, eliminating the need for data entry. This provides nearly real-time access to all collected data.

The PJWG recommended approach is electronic data collection using ESRI's ArcGIS Field Maps app and data storage and management in ESRI's ArcGIS Online (AGOL)[1]. The PJWG pedestrian survey protocol Appendix 4 provides detailed instructions for configuring and using Field Maps and AGOL, along with a preconfigured geodatabase template that is fully compliant with the PJWG Data Protocol.

In lieu of Field Maps, apps such as Gaia GPS can be used for navigation in conjunction with paper datasheets. Gaia has a number of useful layers that can make navigation easy, such as Gaia Overland, USGS Topo, USFS Roads and Trails, NPS Visitor, and a variety of satellite imagery options. Gaia GPS supports GPX, KNL, and GeoJSON file types, allowing the user to import their own data, such as survey points, blocks, and routes. If all roads in a survey area are known or routes will be designated in advanced, a handheld GPS unit should suffice for navigation.

If the surveyor is unfamiliar with the area to be surveyed, paper maps can be a useful tool for navigation, as well as becoming more familiar with the survey area. On USFS lands, Motor Vehicle Use Maps (MUVM) show all public roads as well as any seasonal road closures. On BLM land, Surface Management Status maps are a good overview tool. Coordination with the area land management office should be considered for information concerning closures, planned prescribed fires, and road condition reports.

[1] ArcGIS Enterprise can be used instead of AGOL, but it is not covered in this document.

Road condition, point accessibility, and driving convenience can dictate survey routes, which may be revised in the field as necessary. When repeating a route, it is generally recommended to survey in reverse order. For example, the US Fish and Wildlife Service suggests that both Mexican Spotted Owl and Yellow-billed Cuckoo survey routes be done in the opposite order on consecutive surveys. The priority for the road-based protocol is to survey all points in a block on repeated surveys.

However, in a smaller survey area where the road system is familiar and surveyors are new to the protocol or the area, specifying a road route could be useful to make sure that surveyors are visiting all of the required survey points. The same routes can be traveled in reverse on repeated surveys.

Field Methods

The surveyor should drive slowly along the route with windows down, to allow incidental visual detection along the route. Vehicle noise prevents consistent, reliable auditory detection. The noise of an ATV could scare birds away from a survey point; we therefore recommend against ATV use, unless it is the only way to access remote survey areas. If it is necessary to drive ATVs, the surveyor should slow down to <10 mph as they approach a survey point, wait several minutes before surveying, and note ATV use in the data sheet comments field.

Along the driving route, stops should be made at predetermined locations separated by 1 km. A 6-minute point count should be conducted at each stop. Pinyon Jays can be heard up to 1 km away, and easily 0.5 km away, so this placement of point count stops covers an area at least a 1 km wide along the entire road route. Extended time at the stop is acceptable if necessary to obtain a good estimate of flock size or activity type (Appendix 2) for a flock initially detected within the 6-minute period, but only the 6-minute period should be considered as survey time. If Pinyon Jays are detected after the 6 minutes and before driving away, the detection should be treated as an incidental detection.

In the initial survey, it is permissible to move the stops in the field up to 200 m from the pre-planned spacing to take advantage of good observation and listening points. Points may also need to be moved due to road condition, road use (road now closed, UTV only roads, etc.), observed habitat in the field, and previous detections. Waypoints should be collected for any stops at points assigned in the field and not on the initial survey plan/map.

At each stop, surveyors shall turn off the engine, listen for Pinyon Jay calls, and visually scan the area with binoculars. All of the required data fields specific to point counts (Appendix 2) shall be recorded at each point, including the distance category and time category (using a timer) of each Pinyon Jay sighting. The distance from the surveyor to detected birds is used to create detection functions for occupancy modeling. Distance bins of 0–100, 100-200, 200-300, 300-400, and >400 m have worked well in past surveys and are recommended (with possible exceptions in the case of specific analysis questions). Time bins should be 1-minute, though they can be combined to into fewer, larger bins for analysis; e.g., three, 2-minute bins. This allows for flexibility in analysis; e.g., for comparison with other studies that use different bin sizes. The coordinates associated with the record should be the coordinates of the point, not the flock. However, if using an electronic field form with a base map, additional data fields can optionally be created to directly record estimated flock position. If Pinyon Jays are detected between point counts or

outside the block, this is considered an incidental observation (Appendix 2). Birds flying over and not stopping within 500 m surrounding the point should be noted in the appropriate field on the data sheet but are not considered detections on the point. However, they may be analyzed as deemed appropriate. Other incidental bird species can be noted on the data sheet in comments at the end of each point count station but do not need to be recorded in bins.

Surveys should avoid times of day when Pinyon Jays may be less active, which may vary by region and season. In one New Mexico survey, peak detections occurred two hours after sunrise and in late afternoon around 5 pm. Results of surveys conducted during all daylight hours can be used to investigate time-of-day as a detection covariate. For projects wishing to standardize time-of-day, the morning hours starting after sunrise are recommended. The time required to complete a road survey within a given block will be highly variable depending on the type and location of roads and number of blocks and points present within a given block.

Table 1. Comparisons of PJWG and road-based survey protocols.

Protocol Feature	PJWG Protocol	Road-based Protocol
Point Count or Area Search	Area Search	Point Count
Pedestrian or Road-based	Pedestrian	Road-based, with stops every 1 km
Size of Plot to Define Survey Units	2.5 x 2.5 km	5 x 5 km; can be analyzed in 2.5 x 2.5 km blocks
Minimum time to complete one survey (not counting travel to/from site)	3-4 hours	For 5 point-count stops, ~60 minutes (6 min per station + 5 min driving between stations)
Time allotted per point on point counts	N/A	6 minutes, with minute of detection noted
Survey multiple blocks per day?	No	Yes
Suitable for proposed treatment areas where clearance surveys are required	No	No
Suitable for large areas to determine if Pinyon Jays occur	No, unless high level of funding, personnel.	Yes
Data suitable for occupancy modeling	No	Yes
Flexible number of visits to each plot	Yes	Yes
Possibility that a single flock will be counted 2 or more times on a survey	Possible	Unlikely

Possibility that more than one flock will be counted as a single flock	Possible	Unlikely
Can be used to identify nesting colony sites	Yes	Yes, with additional pedestrian surveys off point
Can be used to determine flock size	Possibly	Possibly
Can be used to determine seasonal home range use	Possibly	Likely, with surveys repeated over seasons and sufficient number of survey blocks
Can be used to monitor population trends	Yes, with caveats	Yes, with caveats
Uses PJWG data model with variables suitable for AKN (Avian Knowledge Network)	Yes	Yes (with minor differences in some variables for road surveys)

Data Dictionary

For survey data to be useful for multi-jurisdictional analysis and comparisons across management plans, studies, geographies, etc., it is helpful to have a common data model; i.e., variables and values which are the same across data sets. The PJWG has designated the Avian Knowledge Network (AKN, https://avianknowledge.net/) as the primary data repository for Pinyon Jay rangewide data, although data also reside with individual management agencies, researchers, and databases such as NatureServe's Biotics. AKN representatives are working to ensure that data from the road survey protocol can be entered directly into AKN. We adopt the PJWG data definitions to make road survey data compatible with data from PJWG area search protocol, with a few exceptions due to differences in the two protocols.

Regardless of which survey protocol is used, the goal is to collect reliable data on Pinyon Jay occurrence in one useful database. This protocol is and AKN databases will be designed to allow rangewide data collected with either protocol to be combined and compared.

Questions or Comments?

This road-based protocol was developed by Kristine Johnson, Giancarlo Sadoti, and Nathan Petersen and employed with occupancy modeling in the Gila National Forest in 2021, 2022, and 2023. It was written by the above researchers and Trish Cutler, White Sands Missile Range. It has also been used in the field by Trish Cutler and Bianca Sicich and Martha Desmond, New Mexico State University. It will be revised and updated as necessary. Please send questions or comments about this protocol to Kristine Johnson (krisjohns@gmail.com) or Trish Cutler (patricia.l.cutler.civ@army.mil).

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Appendix 1. Occupancy Modeling

Road-based point count survey data can be used for occupancy modeling. It is not necessary to perform occupancy modeling on Pinyon Jay survey data; however, the additional step of modeling provides a potentially more accurate picture of Pinyon Jay occurrence in the study area than raw field survey data.

Occupancy modeling is a method that accounts for imperfect detection in surveys of birds and other animals via spatially or temporally repeated surveys. It provides an estimate of true occurrence in a surveyed area (MacKenzie et al. 2017). These models use information from repeated observations at each site to estimate and account for detectability, which may vary with site or survey characteristics. Most published studies of bird surveys currently model occupancy, and we recommend this approach to estimate true occurrence of Pinyon Jays in the surveyed area.

The use of repeated point count visits using 100-m (or similar) radius areas as sites in occupancy models is often suitable for birds with small territories but is not ideal for Pinyon Jays, which range over several thousand hectares during the breeding season and may travel thousands of meters within the course of a day. Pinyon Jays are known to exhibit behaviors that result in imperfect detection within areas of breeding season use. These behaviors present a general challenge to the closure assumption of occupancy models (i.e., that the true occupancy and availability for detection do not vary over a sampling period). This challenge can be illustrated in two slightly different ways:

1) Spatially: Although birds may occupy a home range over a breeding season that encompasses a given point-sampling location, they may not be available for detection on a given sampling occasion (e.g., they may not be locally present, but may be in another area >1 km away).
2) Temporally: Although birds may be observed in the local area (e.g., 200 m radius) surrounding a point on one occasion, they are not guaranteed to be present in this local area on the next occasion, even if this next occasion is within the hour.

The road-based survey method was developed to employ the multi-scale occupancy model of Nichols et al. (2008) and Pavlacky et al. (2012) with Pinyon Jay survey data. Occupancy modeling depends on repeated sampling in time and/or space over a closed period. In this method, stops are treated as secondary/nested sampling units within blocks and unique visits (or minutes within visits, if using a single-visit protocol) are tertiary sampling units.

We are interested in predicting the **actual occurrence** at a site, **ψ, or psi**, given imperfect availability for detection at each survey location and varying rates of detection. Psi is also known as **"site-level occupancy"** or, for the survey approach and example detailed here, **"block-level occupancy.**" Here we refer to **ψ** as "**site occupancy**."

To model site occupancy (ψ, psi), it is necessary to address variation in the local occurrence of birds within the site due to underlying preferences for foraging, caching, and nesting habitat characteristics. This variation in the proportion of local units on which birds are observed is **theta, or θ**, also called "**local occupancy**" or "**availability for detection**." Throughout this report, we refer to **θ** as "**local occupancy**." Further information can be found in Pavlack et al. (2012).

The probability of detecting the bird if present is also a consideration. This is estimated at the point level to better approximate local occupancy and, in turn, site occupancy at the block level. In our implementation of the multi-scale model with a removal design, up to three consecutive two-minute intervals provide the probability, ***p***, of detecting the bird within an interval, also called **"detectability."** Here we refer to ***p*** as **"detectability."**

An Application from the Gila National Forest

To address the challenges of modeling Pinyon Jay breeding season occupancy using road survey data from the Gila National Forest, we sampled hierarchically by first defining sites as 5 x 5-km blocks in which roaming, breeding-season Pinyon Jay flocks, if present, are likely to nest and exploit food resources. Second, to address the tendency for birds to cluster temporarily (except where nesting) in small areas across the home range and to improve the probability of detecting birds at least once within sites, we selected multiple sampling locations within each site. Our sampling approach (Johnson et al. 2022) is ideally suited for the "multi-scale" occupancy (MSO) model of Nichols et al. (2008), which was later modified by Pavlacky et al. (2012). In these models, spatially-replicated points are used to model θ (local occupancy). This is essentially the estimated proportion of local sampling units (for this study, points) within a site where a species is likely to be detected if it is present in the site.

These models employ temporally repeated sampling at each point to estimate the detectability of a species under the assumptions of the robust design (Pollock 1982), given site and local occupancy. In the original model formulation (Nichols et al. 2008), multiple detection types (e.g., animal sign, cameras, auditory surveys) were used as repeated samples, although other types of repeated surveys have been employed in other studies (e.g., multiple observers; Jeffress et al. 2011). The study by Pavlacky et al. (2012), although not specific to Pinyon Jays, suggested treating individual intervals (i.e., single or multi-minute periods) within point visits as repeated sampling occasions using a removal design, in which counts are truncated at first detection of a species at a point. This single-visit, repeat-interval approach has been noted elsewhere (Rota et al. 2009) and, although not necessary for the MSO model, is ideally suited for the Pinyon Jay due to their highly mobile behaviors. We binned the six, one-minute increments of each survey into three, two-minute bins as repeated sampling events in our approach. We employed a removal design such that no positive or negative observation was recorded after the two-minute interval in which Pinyon Jays were first recorded. This removal design approach to sampling has been found to yield identical results to models in which full detection histories were included (Kery and Royle 2015). We conducted occupancy modeling in R (R Development Core Team 2019) using the RMark package (Laake 2019), which serves as a front-end for Program MARK (White and Burnham 1999). Support packages included AICcmodavg (Mazerolle 2017) and AUC (Ballings and Van den Poel 2013). Additional details of our modeling process for Gila National Forest survey data are available in Johnson et al. (2022).

Appendix 2. Two data sheet examples and explanation of fields. Rows can be copied and added as needed. The first row or top of the data sheet contains information on the survey and is only entered once for each block or grid cell. Below the first row, each row contains data for the count at each point, with the row below reserved for comments from that point (example data sheet 1). If additional comments are needed, such as for detailed behavior observations, they can be added on the back of the sheet with the associated point number noted. The sheet can be formatted as needed, as long as all required fields are included, and additional project-specific fields can be added, as shown in the two example data sheets. The fields included on these sheets will be necessary for AKN and are required, except where indicated as optional. Distance and minute bins are required for occupancy modeling. E and N fields are for recording UTMs of survey points which were moved in the field.

Permissible codes for multiple-choice fields are listed in the right margin of the data sheet example 1 and below the cells in example data sheet 2. Data tables from the PJWG protocol are included in Appendix 3. Descriptions of fields in the two data sheets and fields in the data sheet which differ from the PJWG ArcGIS Field Maps fields are listed below.

'Survey type" from the PJWG is assumed to be a road-based point count and can be provided, if necessary, when data are entered into AKN.

"Visit ID" and "sighting ID" from the PJWG are a key codes which match sighting data with visit data. They are specific to the Field Maps database, and are not included here.

Project contact, organization, project description, and project design are database fields which can be provided when data are uploaded or entered into the AKN database; they are not collected during surveys.

Fields for the road-based survey (optional fields are noted).

Date – date of survey

Observer – name of surveyor

Wind, sky, temp – Choose a code from the list on the right margin.

Type - type of survey, road or hiking. Choose code.

Re-survey – Is this a re-survey of the same grid block? Yes or No

Grid ID – the ID letter or number of the 5 x 5 km block containing the points. If a 2.5 km block is to be used for analysis, the sub-blocks should be named accordingly; e.g., grid ID = B3 would indicate grid B, sub-block 3.

Point – number assigned to the survey point, which should be unique within each 5 x 5 km block.
Incidental observations (birds detected not on point counts) on example data sheet 1 are recorded the same as point count detections, except that "incidental" is recorded in the point field. Data sheet 2 uses a separate sheet for incidental observations.

Transect –route name OPTIONAL (example data sheet 2).

Start – The start times for the 6-minute point count. “Stop time” from the PJWG is not necessary, as all point counts are 6 minutes.

Minute – minute (1-6) that birds are detected. Choose code.

DM – Detection method, auditory, visual or both. Choose code.

Distance – estimated distance to birds, in bins of 100. Choose bin number from list.

Number of birds – Enter count or estimate of number of birds detected.

Behavior –The PJWG fields “flock activity” and “breeding behavior” are combined into one field, with coded listed under “behavior” on the data sheet. Choose behavior code from list.

Re-sight? – Is this a re-sighting of birds already recorded for this survey, Yes or No? If so, note additional information in comment field.

E, N – If point is moved from the original location, enter UTMs. We use UTM WGS84, but the datum can be converted to/from lat-long, etc.

Azimuth – from surveyor to bird, useful with distance to indicate bird location, if a mapping GPS or software is not used in the field OPTIONAL (example data sheet 2).

Habitat – Enter dominant plant species if available or, if not, type (e.g., meadow) OPTIONAL. Codes can be added to data sheet.

Treatment – Enter treatment type; e.g., burn, thin, herbicide OPTIONAL. Codes can be added to data sheet.

Data Sheet Example 1.

Date		**Observer**		**Wind**		**Sky**		**Temp**				**Type**		**Re-Survey?**				**Grid ID**
Point		Start		Min		DM		Dist.		# Birds		Behavior		Re-sight?		E		N
Habitat:												TR:						
Point		Start		Min		DM		Dist.		# Birds		Behavior		Re-sight?		E		N
Habitat:												TR:						
Point		Start		Min		DM		Dist.		# Birds		Behavior		Re-sight?		E		N
Habitat:												TR:						
Point		Start		Min		DM		Dist.		# Birds		Behavior		Re-sight?		E		N
Habitat:												TR:						
Point		Start		Min		DM		Dist.		# Birds		Behavior		Re-sight?		E		N
Habitat:												TR:						
Point		Start		Min		DM		Dist.		# Birds		Behavior		Re-sight?		E		N
Habitat:												TR:						
Date		**Observ**		**Wind**		**Clouds**		**Temp**				**Type**		**Re-Survey?**				**Grid ID**
Point		Start		Min		DM		Dist.		# Birds		Behavior		Re-sight?		E		N
Habitat:												TR:						
Point		Start		Min		DM		Dist.		# Birds		Behavior		Re-sight?		E		N
Habitat:											TR:							
Point		Start		Min		DM		Dist.		# Birds		Behavior		Re-sight?		E		N

Type

R = road **H** =

Detection Me

A = aural **V** =

Distance (m)

1 = 0-100 **2** =

3 = 201-300

4 = 301-400

Behavior

FO = flyover

FG = foraging

FT = foraging i

CA = caching

R = roosting

CC = courtship

RC = rattle cal

NM = nest ma

BA = begging a

BJ = begging ju

C = creche

N = nesting

Treatment (TF

T = thinned

B = burned

C = chemical

Habitat:											TR:						
Point		Start		Min		DM		Dist.		# Birds	Behavior		Re-sight?		E		N
Habitat:											TR:						
Point		Start		Min		DM		Dist.		# Birds	Behavior		Re-sight?		E		N
Habitat:											TR:						
Point		Start		Min		DM		Dist.		# Birds	Behavior		Re-sight?		E		N
Habitat:											TR:						

Wind Start/Er

0 = < 1 **1** = 1-

3 = 7-10 **4** = 1

5 = 17-21

Sky

1 = clear **2** = p

3 = cloudy **4** =

5 = drizzle **6** =

Datasheet example 2.

Date: **Observer:** **Cloud (%):** **Temp (Start/Stop) (F):**

Transect: **Wind (Start/Stop) (mph):**

Start Time	Grid ID	Point #	MIN	PIJA Detected (Y/N)	PIJA Resight (Y/N)	# PIJA - A,J,N (Adult, Juv, Nest)	Distance (m)	Azimuth	Behavior	PJ Habitat Type	Nest Location		PJ treatment Type	Incidental Spp.
											Distance (m)	Azimuth		

Behavior: **FO** - Fly over, **FG** - Foraging on ground, **FT** - foraging in trees, **CA** - Caching, **P** - Perching, **R** - Roosting, **CC** - Courtship Call, **RC** - Rattle Call, **NM** - Nest Material, **BA** - Begging Adult, **BJ** - Begging Juvenile, **C** - Creche

PJ habitat type: 1 - Persistent woodland, 2 - PJ savanna, 3 - Juniper savanna, 4 - Other (describe)

PJ Treatment Type: None, PB - Prescribed Burn, TH - Thinning, HE - Herbicide

Additional comments:

Start Time	Grid ID	Point #	MIN	PIJA Detected (Y/N)	PIJA Resight?	# PIJA - A,J,N (Adult, Juv, Nest)	Distance (m)	Azimuth	Behavior	PJ Habitat Type	Nest Location		PJ treatment Type	Inc. Spp.
											Distance (m)	Azimuth		

Behavior: **FO** - Fly over, **FG** - Foraging on ground, **FT** - foraging in trees, **CA** - Caching, **P** - Perching, **R** - Roosting, **CC** - Courtship Call, **RC** - Rattle Call, **NM** - Nest Material, **BA** - Begging Adult, **BJ** - Begging Juvenile, **C** - Creche

PJ habitat type: 1 - Persistent woodland, 2 - PJ savanna, 3 - Juniper savanna, 4 - Other (describe)

PJ Treatment Type: NO - None, PB - Prescribed Burn, TH - Thinning, HE - Herbicide

Additional comments:

Appendix 3. Tables from the PJWG protocol. The fields therein were designed for data collection with ArcGIS Field Maps. The road-based protocol does not require use of Field Maps. However, the required fields in the data sheet and appendices will be compatible with the AKN database and should be collected. Slight differences between the PJWG data fields and the road-based fields are noted in Appendix 2.

Table 1. Sighting-level attributes for the Data Dictionary. The first column shows attribute names in both a longer descriptive format ("Alias") and shorter format ("Database") that adheres to the nine-character limit of some database systems. The second column shows the attribute type and indicates whether there is an associated pick list of allowable values in Table 4. The third column provides a description of the attribute. Field data entry is required for all attributes in this table unless they are described as "OPTIONAL" in the third column.

Attribute Name (Alias / Database)	Attribute Type	Description
Date and Time[15] / DateTime	Date	YYYY-MM-DD, HH:MM format
Latitude and Longitude[16] / Lat, Lon	Geographical Coordinates	Use decimal degrees and the WGS 1984 Web Mercator (auxiliary sphere) coordinate system, which facilitates integration of data across multiple projects that span a wide geographical area
Surveyor[17] / Surveyor	Text (Optional User-Created Pick List)	OPTIONAL: Name of the surveyor. Users can create a project-specific pick list or allow free-form data entry.
Observation Method / ObsMethod	Text (Pick List)	Indicates whether the observation is visual, aural, or both
Observation Type / ObsType	Text (Pick List)	Indicates whether the observation is made while performing the Survey Protocol or incidentally
Flock Size / FlockSize	Integer	Estimated size of the observed flock (# of individuals)

[15] Date and time are automatically recorded (as "created_date") in ArcGIS Field Maps.

[16] Coordinates are automatically recorded in the correct format in ArcGIS Field Maps.

[17] The surveyor's unique username is automatically recorded (as "created_user") in ArcGIS Field Maps.

Attribute Name (Alias / Database)	Attribute Type	Description
Flock Resight? / FlockRes	Text (Yes-No)	OPTIONAL: "Yes" indicates that in the judgment of the surveyor, the flock being recorded has previously been detected and recorded on the surveyed plot. "No" indicates the first record for a particular flock.
Flock ID / FlockID	Text	OPTIONAL: Unique alphanumeric identifier for each unique flock
Flock Activity Type / FlActType	Text (Pick List)	Primary activity type for the flock at the time when the record is made. If the primary activity type changes, a new data record should be made.
Breeding Behaviors / BreedBeh[18]	Text (Pick List)	OPTIONAL: Type(s) of breeding evidence observed
Comments / Comments	Text	OPTIONAL: Miscellaneous information about the sighting
Visit ID[19] / VisitID	Alpha-numeric	"Key" that allows matching sighting-level data with associated visit-level data

[18] Because ArcGIS Field Maps only allows single selections to be made from pick lists, this field will recur up to four times in ArcGIS Field Maps if a non-blank value is entered. This allows up to four different breeding behaviors to be recorded for a given sighting-level record.

[19] Visit ID is recorded automatically in ArcGIS Field Maps.

Table 2. Visit-level attributes for the Data Dictionary. The first column shows attribute names in both a longer descriptive format ("Alias") and shorter format ("Database") that adheres to the nine-character limit of some database systems. The second column shows the attribute type and indicates whether there is a pick list of allowable values in Table 4. The third column provides a description of the attribute. Field data entry is required for all attributes in this table unless they are described as "OPTIONAL" in the third column.

Attribute Name (Alias / Database)	Attribute Type	Description
Date[20] / Date	Date	YYYY-MM-DD format
Latitude and Longitude[21] / Lat, Lon	Geographical Coordinates	Use decimal degrees and the WGS 1984 Web Mercator (auxiliary sphere) coordinate system, which facilitates integration of data across multiple projects that span a wide geographical area
Survey Type / SurvyType	Text (Pick List)	Indicates whether the survey complies with the Survey Protocol described in this document or not
Surveyor[22] / Surveyor	Text (Optional Pick List)	OPTIONAL: Name of the surveyor. Users can create a project-specific pick list or allow free-form data entry.
Plot/Polygon ID[23] / PloPolID	Text (Optional Pick List)	OPTIONAL: Unique identifier of the plot or polygon being surveyed. Users can either create a project-specific pick list or allow free-form data entry.
Survey Visit Group Replicate / SVGRep	Ordinal (1, 2, 3)	Indicates the first, second, or third survey visit to the plot within a survey visit group

[20] Date is recorded automatically (as "created_date") in ArcGIS Field Maps.

[21] Coordinates are automatically recorded in the correct format in ArcGIS Field Maps.

[22] The surveyor's unique username is automatically recorded (as "created_user") in ArcGIS Field Maps.

[23] "Polygon" is used in the attribute name because this attribute is also used in the PJWG Survey Protocol for project-scale applications, which allows for user-defined survey polygons instead of standardized plots.

Attribute Name (Alias / Database)	Attribute Type	Description
Monitoring Replicate / MonitRep	Ordinal (1,2,3, etc.)	OPTIONAL: Identifies a series of sequential survey visit groups to a plot over time. For example, if a plot is monitored annually, then each of the three survey visits in the first year's survey visit group would receive a value of "1". All three survey visits during the second year would receive a value of "2", etc.
Wind Speed Category / WindSpeed	Text (Pick List)	Wind speed category at the beginning of the survey visit
Temperature (C) / Temperature	Integer	Temperature in °C
Sky Condition Category / SkyCond	Text (Pick List)	Categories describing amount of cloudiness or precipitation at the beginning of the survey visit
Start Time / StartTime	Time	Time when the survey visit begins in HH:MM 24-hr format
Comments[24] / Comments	Text	OPTIONAL attribute to record miscellaneous information about the survey
Stop Time[25] / StopTime	Time	Time when the survey visit ends in HH:MM 24-hr format
Jays Present?[25] / JaysPres	Text (Yes-No)	"Yes" if any Pinyon Jays were present on the plot during the survey (do not treat the "Flyover" Activity Type as an indication of presence); "No" if no jays were present on the plot during the survey

[24] Most visit-level attributes should be recorded at the beginning of the survey visit. However, comments can be entered at the beginning or the end of a survey visit.

[25] Most visit-level attributes should be recorded at the beginning of the survey visit. However, these two attributes must be finalized at the end of the survey visit.

Attribute Name (Alias / Database)	Attribute Type	Description
Sighting ID[26] / SightingID	Alpha-numeric	"Key" that allows matching visit-level data with associated sighting-level data

Table 3. Project-level attributes for the Data Dictionary. These attributes are not recorded in the field but should be included in project data sets as metadata.

Item	Description
Project Contact	Name, email address, and phone number of the project's main point of contact
Agency	Agency or organization conducting the project
Project Description	Description of project purpose, goals, and schedule
Project Design	Description of the study area and sampling design. If surveys are not fully compliant with the PIJWG Survey Protocol, describe the variances.
Coordinate System	Coordinate system used for project data. If the project data are stored in a GIS-based system, this information will be automatically generated. This document's Data Dictionary specifies decimal degrees using the WGS 1984 Web Mercator (auxiliary sphere) coordinate system.
Data Set Format	Indicate the format of your data set. Possibilities include an ArcGIS file geodatabase, an ArcGIS shape file, a relational data base, an excel workbook, or a csv file. If using ArcGIS Field Maps, the format is ArcGIS file geodatabase and does not need to be specified.
Other Comments	Additional information needed to fully understand your methods and data set

[26] Sighting ID is recorded automatically (as “GlobalID”) in ArcGIS Field Maps.

Table 4. Pick list values for relevant attributes listed in the order presented in Tables 1 and 2. Suggested default values for electronic data collection systems are shown in bold + italic for some attributes.[27] Pick lists with only "Yes" or "No" options (Tables 1 and 2) must be configured but are not shown in this table. Pick lists described as "optional" in Tables 1 and 2 are not shown below but must be configured by the user.

Attribute Name	Pick List Values	Description
Observation Method	Visual	Observation primarily or exclusively visual
	Aural	Observation primarily or exclusively aural
	Visual and Aural	Observation both visual and aural
Observation Type	***PJWG Survey Protocol***	Observation made within the surveyed plot while conducting the PJWG Survey Protocol
	Incidental	Observation made outside the surveyed plot and / or not during a formal PJWG Survey Protocol survey
Flock Activity Type	Unknown or Other	The main flock activity type cannot be determined or is an unlisted type. This will often be the case for aural detections.
	Flyover	The flock is flying over the site but is not landing in trees or on the ground.
	Flying	Most or all of the flock is flying within the site and periodically landing on trees or the ground.
	Foraging on Ground	Most or all of the flock is foraging on the ground.
	Foraging in Trees	Most or all of the flock is foraging in trees.
	Caching	Most or all of the flock is caching or retrieving caches.
	Perching	Most or all of the flock is perched but not actively foraging.

[27] These defaults are pre-configured for ArcGIS Field Maps.

Attribute Name	Pick List Values	Description
	Nesting	Some of the flock is engaged in nesting-related activities.
	Roosting	Most or all of the flock is roosting for the night.
	Feeder	Most or all of the flock is visiting a feeder.
Breeding Behaviors[28]	Courtship Chasing	Two or more birds engaged in courtship chasing
	Courtship Behavior	One or more birds engaged in silent sitting, manipulating sticks, or copulation
	Perching at or near Nest	One or more birds perched at or near a nest
	Breeding Vocalizations	One or more birds giving breeding vocalizations (piping rattle, female begging)
	Carrying Nest Materials	One or more birds carrying nest materials
	Constructing Nest	One or more birds constructing a nest
	Incubating or Brooding	One or more birds on a nest incubating or brooding
	Feeding Nestlings	Parents feeding young in nest
	Feeding Fledglings	Parents feeding fledglings outside nest
Survey Type	***PJWG Survey Protocol – Landscape***	Survey fully adheres to the PJWG Survey Protocol for Landscape Applications (as described in this document)

[28] Users should record as many pick list values as are applicable for a given sighting-level record. Because ArcGIS Field Maps allows only single selections to be made from pick lists, this field and its associated pick list will recur up to four times if a non-blank value is entered. This allows up to four different breeding behaviors to be recorded for the sighting.

Attribute Name	Pick List Values	Description
	PJWG Survey Protocol - Project[29]	Survey fully adheres to the PJWG Survey Protocol for Project Applications
	Non-Protocol	Survey uses a non-PJWG protocol or no protocol
Wind Speed Category[30]	< 2 kph / <1 mph	No wind, smoke rises vertically
	2–5 kph / 1–3 mph	Very light wind, direction shown by smoke drift
	6–12 kph / 4–7 mph	Wind felt on face, leaves rustle
	13–19 kph / 8–12 mph	Leaves, small twigs in constant motion
	20–29 kph / 13–18 mph	Dust rises, small branches move
	30–38 kph / 19–24 mph	Small trees in leaf begin to sway
Sky Conditions[30]	Clear Skies	Clear skies
	Partly Cloudy	Partly cloudy or variably cloudy
	Cloudy	Cloudy or overcast
	Fog or Smoke	Fog or smoke
	Drizzle	Drizzle
	Snow	Snow or flurries
	Shower	Shower

[29] This attribute value is shown because the same pick list is used in the PJWG Survey Protocol for Project Applications.

[30] The protocol precludes surveying at wind speeds exceeding 38 kph / 24 mph, or during heavy precipitation. Therefore, no categories exist that cover these conditions.