Pinyon Jay Survey Protocol for Landscape Applications[1]

Version 2.0 (Final)

Pinyon Jay Working Group

Photo: Carlos González Sanchez

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[1] A companion survey protocol that focuses on project-scale applications will be available here by mid-2023.

Recommended citation: Boone., J.D., S.G. Somershoe, E.M. Ammon, C. Borgman, R. Chi, E. Duvuvuei, S. Gibson, K. Johnson, E. Juarez, E. Masters, R. Norvell, and L. Rossi. 2023. Pinyon Jay Survey Protocol for Landscape Applications. Partners in Flight Western Working Group. 26 p.

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Section 1. Overview

Due to the growing interest in Pinyon Jay conservation and research (Boone et al., 2018; Somershoe et al., 2020; Zeller et al., 2021), the [Pinyon Jay Working Group](#) (PJWG) has identified a need to standardize the collection of biologically relevant data across the species' range. Similar considerations for other birds of conservation concern have led to the development of successful and widely used survey protocols for [Yellow-billed Cuckoo](#), [Southwestern Willow Flycatcher](#), and [desert thrashers](#). In accordance with this precedent, the PJWG has developed this Survey Protocol for Landscape Applications (hereafter, "Protocol") which is designed around the Pinyon Jay's unique natural history and ecology.[2] **This Protocol is specifically intended for situations where a sampling approach is required to characterize larger (i.e., "landscape-scale") study areas.** A second survey protocol being prepared by the PJWG will focus on smaller project-scale applications such as a woodland treatment polygon where a sampling approach is not required.[3] The PJWG strongly encourages all parties collecting data on Pinyon Jays to use this Protocol whenever possible to advance our collective knowledge about this declining species and improve our ability to manage it effectively.

The Protocol is well-suited for documenting and analyzing spatial and temporal patterns of Pinyon Jay distribution and occurrence. It can also be used to investigate activity-specific habitat use or for other purposes where a sampling approach is appropriate. Applications of the Protocol are illustrated in Figure 1 and discussed in more detail in Appendix 1.

The Protocol has two distinct parts:

1) A *Survey Method* (Section 2) describes the standardized technique for conducting Pinyon Jay surveys,
2) A *Data Dictionary* (Section 3) defines the data attributes and attribute values used for data collection.

This Protocol does not specify or require a specific sampling design, study design, or analytical design. Decisions about these design elements should be made by each Protocol user to ensure that data collected are appropriate for their needs and questions. Several important considerations about design are discussed in Appendix 2. There is currently no shared repository for Pinyon Jay data collected under this Protocol. However, the PJWG is working with the [Department of Defense Partners in Flight](#) program, [Klamath Bird Observatory](#), and [Point Blue Conservation Science](#) to create a secure, online, shared repository within the [Avian Knowledge Network](#) for all Protocol data. This resource is expected to become available by the end of 2023.

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[2]A version 1 protocol was released in 2021 and piloted in Arizona and New Mexico in 2021-2022. This updated version incorporates revisions based on feedback and analysis of version 1 pilot testing.

[3] Anticipated availability by mid-2023.
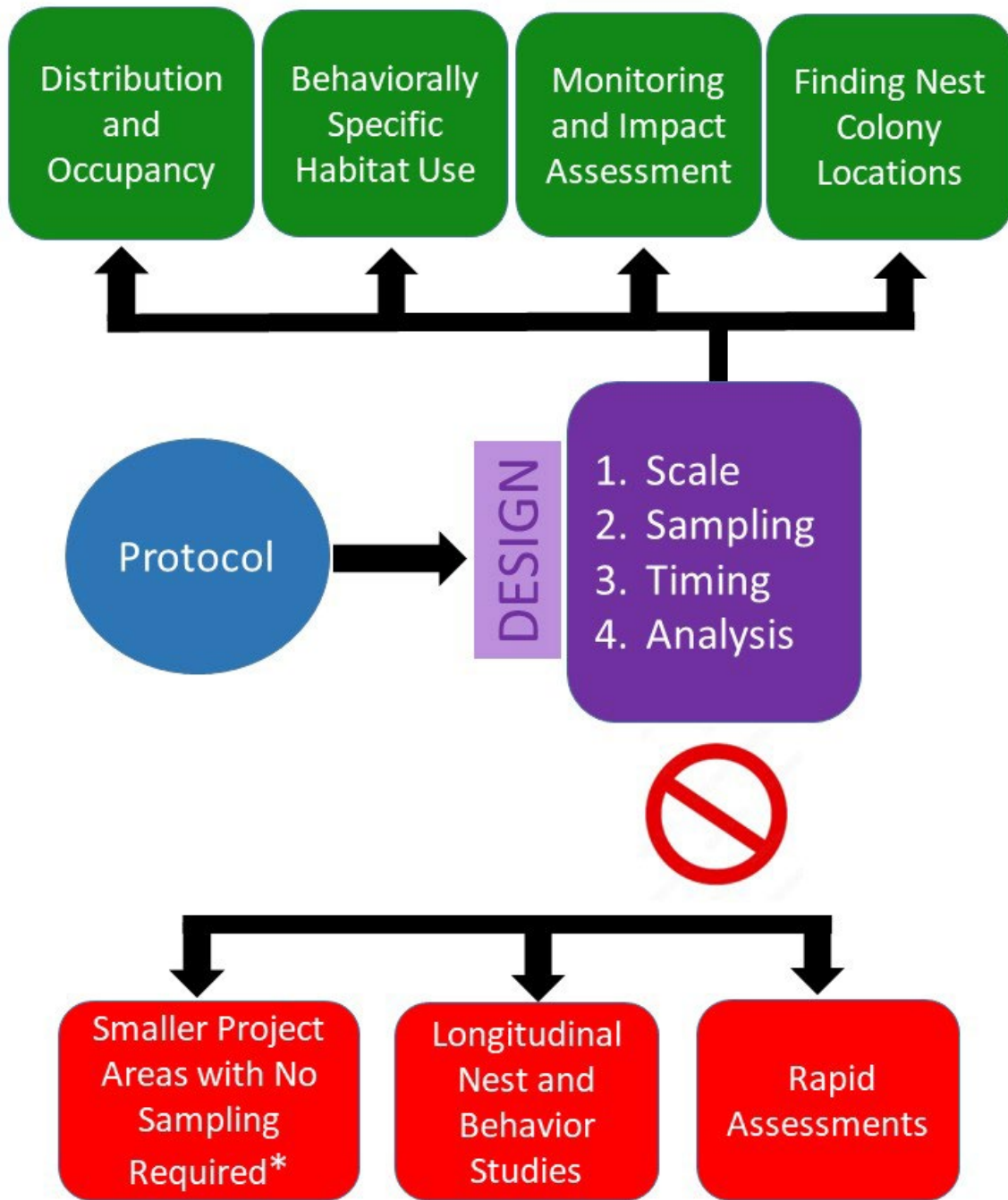
Figure 1. Diagram showing applications for which this Protocol is well suited (green squares) or poorly suited (red squares). As illustrated, user-specific decisions about design are important in optimizing the Protocol for a particular purpose. Note that the PJWG is currently developing another survey protocol for smaller project areas (see red square marked with asterisk).

Section 2. Survey Method

Introduction: Wide use of a standardized survey method has significant benefits, as seen in the [North American Breeding Bird Survey (BBS)](#), the [Integrated Monitoring in Bird Conservation Regions (IMBCR)](#) program, and others. These benefits include the ability to generate robust inference about distribution, occurrence, trends, and habitat use by pooling data from multiple contributors. Existing multi-species bird survey protocols, however, are not ideal for Pinyon Jays given the species' unique characteristics, which include year-round flocking, an early but variable breeding season, large home ranges, activity-specific habitat use, "clumpy" distributions, and significant daily movements (Johnson et al., 2016; Johnson and Balda, 2020; Boone et al., 2021). The Survey Method described in this section was designed to explicitly address these issues.

Survey Method Features: The key characteristics of the Protocol's Survey Method are as follows:

Sample and Survey Units: The standardized geographical units used for sampling and surveying are 2.5 x 2.5 km plots. This plot size was chosen as a balance between the typical breeding season home range size, typical scale of Pinyon Jay habitat selection (as currently understood), and logistical considerations such as the duration of each survey visit. Plots that will be surveyed should be selected from a grid of contiguous plots to provide an appropriate representative sample of the study area that has been defined by the user.[4] A 2.5 x 2.5 km grid layer aligned with the UTM military grid can be downloaded [here](#) for the entire Pinyon Jay geographical range or for any of the individual states within this range.

Basic Survey Design: Surveys can be conducted by one surveyor, but we recommend completing them with two surveyors, when possible, for safety and more complete and accurate data collection. Selected plots are surveyed using a walking area search approach. One area search of a plot is a "survey visit" and a series of three successive survey visits on different days (a "survey visit group") is required to fully survey a plot and classify it with regard to Pinyon Jay "presence" or "absence".[5] The same surveyor(s) should conduct the entire survey visit group to a plot whenever possible for continuity in determining Flock ID values (Appendix 3 – Table 1).

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[4] The specific method used for plot selection should be documented as described in the Data Dictionary (Section 3). Some considerations relevant to sampling design and plot selection are discussed in Appendix 2.

[5] Analysis of data from Arizona collected in 2021-2022 using version 1 of the Protocol indicated that risk of a false absence classification was < 5% after three survey visits. Further information about plot classification, the circumstances under which the three-visit requirement may be relaxed, and related considerations are provided in Appendix 2.

Seasonality: The PJWG recommends implementing surveys during the breeding season to standardize seasonality. Breeding season is generally from mid-February to mid-May but may vary somewhat with elevation and region.[6]

Survey Visit Interval and Diurnal Timing: Time between the survey visits that comprise a survey visit group should not be less than five days, and survey visits should be spaced across the entire three-month breeding period to the greatest extent possible. Surveys should begin at sunrise for most applications, but users should be aware that time of day may influence Pinyon Jay presence and detections.[7]

Survey Visit Duration: The time required to complete an area search during each survey visit is typically 3 - 4 hours, with a required minimum time of 2.5 hours. In practice, survey duration will vary with terrain, vegetation density, amount of suitable habitat in a plot, number of Pinyon Jay detections, and time required to obtain good observations. No maximum survey time is stipulated so that a surveyor may spend the time required to observe Pinyon Jays and record locations and activity types.

Data Aggregation: Area searches will often generate multiple Pinyon Jay records within a single occupied plot, both within and across survey visits. **These records will typically represent a single flock at different locations within the plot, exhibiting different activity types, or on different dates** (Section 3). For some applications, these non-independent, within-plot Pinyon Jay records will need to be aggregated up to the plot level prior to analysis or summarization, as discussed in Appendix 2. The Data Dictionary (Section 3) specifies data attributes that facilitate this aggregation.

Survey Instructions:

Before the Survey:

1) Prepare the data collection system (Section 4), ensuring it includes the required data attributes in the correct format (Section 3).
2) Equip surveyors with binoculars and data recording devices or data sheets. If data are recorded on paper, GPS units are also needed.
3) Train surveyors to:
   a. Identify Pinyon Jays by sight and sound,
   b. Fully understand all parts of the Protocol and implement it correctly[8], and

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[6] Users can, however, perform surveys outside the breeding season if they wish to investigate seasonal patterns of habitat use. Surveys conducted outside the breeding season may locate birds in different habitats and/or different locations than in the breeding season and detections may be distant from breeding sites.

[7] This issue is discussed in more detail in Appendix 2.

[8] Surveyors should fully understand the attributes and attribute values in Appendix 3. In particular, if there is any uncertainly about how to correctly identify the activity types or breeding behaviors of Pinyon Jays, please consult with one of the PJWG contacts listed in Section 5.

      c.   Use the selected data collection system (Section 4) correctly.
4) Postpone surveys if there is steady precipitation or an average wind speed ≥ 38 kph (24 mph).

Area Survey Instructions:

1) To conduct an area search, the surveyor should walk a search track through the plot that takes advantage of good points for visual scanning with binoculars and listening. The surveyor may select a search track that avoids inaccessible terrain, but at the conclusion of the survey visit, no point within the plot should be farther than 1 km from the track walked by the surveyor to ensure full plot coverage.[9]

2) During the area search, **the surveyor should stop frequently** at good vantage points to scan with binoculars and listen for Pinyon Jays. Although survey duration may vary, a minimum of 2.5 hours is required. If a surveyor completes a survey in less than three hours, they are probably not stopping often enough or devoting enough time to observing and listening, and additional time should be spent in the plot.

3) Upon detecting a Pinyon Jay flock, the surveyor should change position as needed to secure visual contact. The surveyor should seek a good vantage point (e.g., ridge top) to sit quietly and observe the flock long enough to determine the primary activity type and any additional activity types (Appendix 3 - Tables 1 and 4) whenever possible. **However, the surveyor should not come any closer to the flock than necessary for these observations to avoid influencing its movements and behaviors**.

4) In most circumstances, sequential detections of Pinyon Jays during a survey visit will represent the same flock as it moves around the plot. The surveyor should collect multiple records for the flock so long as each record represents a different location or a different activity type (Appendix 3 - Table 4).

5) Specific steps for recording data during the survey will depend on the data collection system used (Section 4). Detailed instructions for using the ArcGIS Field Maps app to collect data are given in Appendix 4.

6) The geographical coordinates recorded for each Pinyon Jay sighting should represent the approximate center of the flock's location, or the location of a bird or pair, not the location of the surveyor.[10] For aural-only detections (Section 3), the surveyor should estimate flock position as well as possible. If the observed or estimated flock location lies

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[9] Visualizing plot coverage and assessing the adequacy of coverage is greatly simplified when using the ArcGIS Field Maps app for data collection (Section 4).

[10] Placing the coordinates at the estimated flock location is easily accomplished in ArcGIS Field Maps (Appendix 4). Users will need to determine an appropriate way to place or estimate flock coordinates if they are using a different data collection system that does not have this functionality. One option is to record surveyor coordinates, direction to flock, and estimated distance to flock. Estimated flock position can then be determined from these attributes in GIS or trigonometrically.

outside plot boundaries, the flock can still be recorded but should be designated as an incidental observation (Section 3).

Section 3. Data Dictionary

The Data Dictionary specifies a set of standardized data attributes (also called "fields") to use when collecting Pinyon Jay data. For many of these attributes, the Data Dictionary also specifies allowable attribute values, which are chosen from a "pick list" (also called a "domain"). The attributes and attribute values in the Data Dictionary were chosen specifically for their relevance to the Pinyon Jay's unique biology and natural history. The full Data Dictionary, with details on all attributes and attribute values, is given in Appendix 3.

 Data Dictionary attributes are organized in three hierarchical categories:

1) Sighting-level attributes: These attributes describe each Pinyon Jay sighting. Examples include "Flock Size" and "Flock Activity Type". Data records made using sighting-level attributes correspond to the data lines in the main body of a traditional paper data sheet.
2) Visit-level attributes: These attributes characterize a single survey visit to a specific plot. Examples include "Plot ID" and "Temperature". Data records made using visit-level attributes correspond to the header of a traditional paper data sheet.
3) Project-level attributes: These attributes characterize whole projects and their data sets. Examples include the project's purpose, spatial and temporal extent, and relevant details about project design and sampling approach.

Within the data collection and data management system, sighting-level records should be clearly linked to their parent visit-level records. This linkage is implicit in traditional paper data sheets with a header and subsequent data lines. In electronic data collection systems, this link is based on a common data field, or "key", that is shared by the sighting-level and visit-level data (see Section 4, Appendix 3, and Appendix 4 for details).

Protocol users must collect data for all sighting-level and visit-level attributes specified in the Data Dictionary except for attributes that are explicitly identified as "optional" in Appendix 3. Users may add additional non-Data Dictionary attributes to their data collection program at their discretion. For example, the Data Dictionary contains no attributes describing habitat characteristics, but some users may want to incorporate habitat descriptors into their data collection.

Section 4. Data Collection and Data Management Systems

The PJWG encourages Protocol users to record field data using an electronic data collection system such as ESRI's ArcGIS Field Maps app (Appendix 4). Alternatives to ArcGIS Field Maps for data collection include other electronic data collection systems[11] and paper data sheets with subsequent manual data entry. An appropriate paper data sheet template is provided in Appendix 5. The AKN repository is being designed based on the Survey Method and Data Dictionary structure to facilitate data upload.

Section 5. Additional Information and Assistance

For additional information or assistance with the Protocol, please contact:

John Boone, Great Basin Bird Observatory (jboone@gbbo.org)

Scott Somershoe, U.S. Fish and Wildlife Service (scott_somershoe@fws.gov)

Section 6. Literature Cited

Boone, J.D., E. Ammon, and K. Johnson. 2018. Long-term declines in the Pinyon Jay and management implications for piñon–juniper woodlands, in Trends and traditions: Avifaunal change in western North America (W.D. Shuford, R.E. Gill Jr., and C.M. Handel, eds.), pp. 190–197. Studies of Western Birds 3. Western Field Ornithologists, Camarillo, CA; doi 10.21199/SWB3.10.

Boone, J.D., C. Witt, and E.M. Ammon. 2021. Behavior-specific occurrence patterns of Pinyon Jays (*Gymnorhinus cyanocephalus*) in three Great Basin study areas and significance for pinyon-juniper woodland management. PLoS ONE 16(1): e0237621. https://doi.org/10.1371/journal.pone.0237621

Johnson, K., T.B. Neville, J.W. Smith, and M.W. Horner. 2016. Home range- and colony-scale habitat models for Pinyon Jays in piñon-juniper woodlands of New Mexico, USA. Avian Conservation and Ecology 11(2):6. http://dx.doi.org/10.5751/ACE-00890-110206

Johnson, K. and R.P. Balda. 2020. Pinyon Jay (*Gymnorhinus cyanocephalus*), version 2.0. In Birds of the World (P.G. Rodewald and B.K. Keeney, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.pinjay.02

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[11] Including ESRI's ArcGIS Survey123 and Epicollect, among others.

Somershoe, S.G., E.M. Ammon, J.D. Boone, K. Johnson, M. Darr, C. Witt, and E. Duvuvuei. 2020. Conservation Strategy for the Pinyon Jay (*Gymnorhinus cyanocephalus*). Partners in Flight Western Working Group and U.S. Fish and Wildlife Service. https://partnersinflight.org/wp-content/uploads/2019/10/Conservation-Strategy-for-Pinyon-Jay_Version-1_February-2020_LowRes.pdf

Zeller, K.A., S.A. Cushman, N.J. Van Lanen, J.D. Boone, and E.M. Ammon. 2021. Targeting conifer removal to create an even playing field for birds in the Great Basin. Biological Conservation 257:109130. https://doi.org/10.1016/j.biocon.2021.109130

Appendix 1. Applications of Protocol

The Protocol can be used for many different applications that require sampling of a larger study area. These may include (but are not limited to):

1) Creating species distribution models using presence-absence or presence-only data.
2) Monitoring long-term trends.
3) Assessing the impacts of disturbances or management activities in larger study areas.
4) Finding breeding locations for more intensive follow-up study.
5) Investigating activity-specific habitat requirements and habitat use.

The key to using the Protocol successfully for a user-defined purpose is selecting an appropriate sampling frame, sampling plan, survey schedule, data processing scheme, and analytical approach. These topics are discussed further in Appendix 2.

Although the Protocol is versatile, it is not appropriate for every application. Most specifically, smaller-scale projects (<2,500 ha as a rough rule of thumb) where a sampling approach is not needed should use the forthcoming PJWG Survey Protocol for Project Applications (expected by mid-2023), which will be available here. Some other applications may lie entirely outside the PJWG survey protocol sphere. Examples include:

1) <u>Rapid Assessment of Large Areas</u>: Road-based surveys may be useful to obtain data from the largest-possible area given available resources. This approach could also be used for initial scouting to help define an appropriate sampling frame for subsequent work using the PJWG Survey Protocol.[12]
2) <u>Longitudinal Nest Studies:</u> If the goal of a project is to monitor nest productivity and outcomes, a more intensive survey protocol will be required. The PJWG has developed guidance for locating nests and avoiding impacts of intensive studies on nest success.
3) <u>Telemetry and Behavioral Studies</u>: Employing telemetry or extended observational techniques to investigate movement patterns, activity budgets, and social biology will require a different protocol.
4) <u>Community Science</u>: Community science projects may benefit from simpler and less time-consuming survey protocol.[13]

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[12] For information on this approach, contact Kris Johnson at krisjohns@gmail.com

[13] See the Pinyon Jay Community Science Hub for one example.

Appendix 2. Considerations for Sampling, Study Design, Classification, and Analysis

This Protocol does not stipulate specific approaches to sampling design, study design, data aggregation and classification, or data analysis. However, the PJWG has identified a number of relevant issues that Protocol users should consider, organized below by topic.

Plot Selection: For most purposes, random or stratified-random selection of plots within the user-defined survey frame is appropriate. However, some user-specific objectives may dictate a different approach. For example, users who wish to use the Protocol to find as many breeding locations as possible may define plot selection criteria that maximize the chance of detection of Pinyon Jays.

Survey Seasonality: For most purposes the PJWG's recommendation to conduct surveys during the breeding season is appropriate. Some projects, however, may wish to introduce a cross-seasonal element into their data collection effort, which is acceptable. Surveys conducted outside the breeding season may locate birds in different habitats and/or different locations than in the breeding season and detections may be distant from breeding sites.

Survey Visit Groups: The Protocol recommends three survey visits to each plot, which collectively form a survey visit group. However, Protocol users that aim to maximize the number of plots surveyed may see advantages in discontinuing survey visits for some plots where Pinyon Jay presence is confirmed on the first or second survey visits. This is acceptable as long as: 1) at least some occupied plots receive the full course of three survey visits, and 2) absence is confirmed only after three survey visits.

Flock Identities, Data Independence, and Data Aggregation: Pinyon Jay flocks range across relatively large areas and are thought to have relatively little spatial overlap with neighboring flocks. Therefore, multiple Pinyon Jay sighting-level records obtained within or across survey visits to a given plot are likely to represent the same flock. These data in their original form contain valuable information about a flock's activity-specific habitat use and movements, but they cannot be treated as independent records of occurrence. Instead, to address questions about distribution and occurrence across a whole study area, within-plot data for a survey visit group will typically need to be aggregated to the plot-level. This process can generate, for example, a set of independent plot-level records characterizing Pinyon Jay presence and absence, or independent plot-level records for maximum observed flock size (which could be treated as an index of local abundance). The Data Dictionary contains several attributes ("Plot ID", "Flock Resight?", "Flock ID", and "Protocol Replicate") that simplify and facilitate data aggregation. Similarly, records from adjacent or adjoining plots could potentially be attributable to the same flock. This problem can be mostly avoided by selecting survey plots that are a minimum distance apart. If nearby or adjoining plots are surveyed, however, the

potential for duplicate detections of the same flock across plots can be accounted for using the "Flock ID" attribute or based on plot proximity.

Relation of Flock Activity Type to Presence and Absence: Home ranges of Pinyon Jay flocks may be comprised of discontinuous patches, with flocks flying over areas that are not otherwise used. Therefore, Pinyon Jay records with the "Flyover" activity type (Appendix 3 – Table 4) should not be considered as evidence of Pinyon Jay presence within the plot in most circumstances. Additionally, certain parts of the home range may be used solely or predominantly for one activity type. For instance, a flock may fly in the evening to a roosting area (potentially disconnected from the rest of the home range) that is not used for other kinds of activities. In these cases, occurrence could be treated as an activity-specific characteristic of a plot. By a similar logic, "Incidental" (i.e., off-plot) records, if recorded, should not be considered as evidence of Pinyon Jay presence on the plot.

Detectability: Users should be aware of how detectability may influence data collected using this Protocol. One estimate of detectability associated with the Protocol comes from the analysis of 2021-22 data from Arizona during the breeding season using version 1 of this Protocol. After excluding flyover records, this analysis derived an estimated detectability per survey visit of 0.59 (95% confidence interval = 0.50 – 0.67) (J. Boone, unpubl. data). This translates into ~95% confidence that over a survey visit group (three survey visits), Pinyon Jays will be detected if they are present on the plot during the season and the time of day during which surveys occur. This same analysis found that detectability varies relatively little with time of day, multiple breeding seasons, temperature, or the range of wind conditions that fall within Protocol limits. In contrast, analysis of data from road-based surveys in New Mexico in 2022 suggested that detectability (estimated using a removal design within each point visit) is significantly higher in the morning and again later in the afternoon (K. Johnson, unpubl. data). Further investigation will likely provide better information about how detectability varies regionally, as well as how it may vary according to various environmental and survey characteristics. Until then, project designers should be aware that choice of time of day for surveys and whether to vary time of day across survey visits may affect outcomes.

Coordinated Range-wide Study Design: Developing a coordinated range-wide, long-term monitoring program with a shared study design and sampling plan would have these benefits:

1) Facilitate a straightforward range-wide analysis with minimal assumptions.
2) Reduce analytical costs and time required to generate results.
3) Simplify comparison of occupancy estimates across the species' range to provide a more holistic understanding of range-wide habitat use, trends, and threats.
4) Facilitate experimental studies (e.g., before-after-control-impact) by leveraging the baseline monitoring data as controls.

The PJWG plans to initiate stakeholder discussions in 2023 aimed at producing a coordinated monitoring design.

Appendix 3. Data Dictionary Attributes and Attribute Values

The Data Dictionary is organized into:

1) <u>Sighting-level data attributes</u> shown in Table 1 that describe each unique Pinyon Jay observation.
2) <u>Visit-level data attributes</u> shown in Table 2 that describe each unique survey visit to a selected plot.
3) <u>Project-level data attributes</u> shown in Table 3 that describe entire projects or data collection efforts.
4) <u>Pick-list attribute values</u> shown in Table 4 that specify acceptable values for many of the sighting-level and visit-level attributes from Tables 1 and 2.

The distinction between sighting-level and visit-level attributes corresponds to the organization of the familiar paper data sheet, which has a single header section for entering visit-level data and multiple data entry lines for entering sighting-level data. In electronic data collection systems, establishing a link between each visit-level record and its associated sighting-level records requires creating a shared, unique "key", as indicated in Tables 1 and 2.

Data collected by Survey Protocol users must comply fully with the Data Dictionary regardless of the data collection system used (Section 4).[14]

Major changes that have been made to the Data Dictionary since version 1 of the Protocol are listed at the end of this Appendix. For users that require a detailed list of all changes in order to transform older data into the new format, please contact John Boone (boone@gbbo.org).

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[14] For ArcGIS Field Maps users, a file geodatabase template has been preconfigured to ensure compliance (Appendix 4). Preconfigured elements include attribute names, pick list values, and automatically generated "keys" to link sighting-level and visit-level records. Footnotes throughout the remainder of this Appendix referencing ArcGIS Field Maps assume use of this preconfigured geodatabase and may not be accurate otherwise.

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)

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[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

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[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

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[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

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[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.

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[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)

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[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.

Major Changes in the Data Protocol with this Version

Substantial changes to the data protocol from Version 1 are as follows:

1) Multiple attributes and attribute values that were specific to the optional point count approach have been eliminated from Tables 1, 2, and 4 because the point count option was eliminated from this version of the Survey Protocol.
2) Two new pick list values for the "Flock Activity Type" attribute have been added to Table 4:
    a. "Flying" indicates that the flock is actively flying within the plot but is also landing in trees or on the ground. This is different than the "Flyover" value, which describes a flock that is flying over the plot without ever landing. Note that while the "Flyover" activity type is <u>not</u> a sufficient basis for determining Pinyon Jay presence within the plot, the "Flying" activity type is evidence of presence.
    b. "Feeder" indicates a flock that is visiting an artificial feeder or feeding station.
3) A new field called "Flock ID" has been added to Table 1 to aid in aggregating data according to flock identity.
4) A "Temperature" attribute has been added to Table 2.
5) Attribute pick list values for "Survey Type" in Table 4 have been greatly simplified.
6) The pick list values for "Sky Conditions" and "Wind Speed" in Table 4 have been converted from ordinals to text. Additionally, a "Clear Skies" values has been added to the "Sky Conditions" pick list.

Appendix 4. ArcGIS Field Maps for Data Collection and Management

The PJWG recommends using the ArcGIS Field Maps app for data collection and AGOL for data management[31] for reasons previously described in Section 4. This system allows the surveyor to easily visualize plot boundaries, survey tracks, and imagery, and to directly position sighting-level records to reflect flock location. Additional advantages of this system include use of pre-configured pick lists to reduce data entry errors, a system-generated data "key" to link visit-level and sighting-level records, ability to attach photographs to data records, and full off-line and cross-device functionality. Data collected in ArcGIS Field Maps adhere to the file geodatabase format and are synched to the cloud and managed in ArcGIS Online (AGOL).[32] To facilitate use of ArcGIS Field Maps and AGOL, the PJWG has created a pre-configured file geodatabase template that is fully compliant with the Data Dictionary along with a full configuration guide and user guide (Appendix 4). This electronic data system is relatively simple and straightforward for the end-user, but it does require some important configuration steps prior to deployment. Some, but not all, of this configuration has already been performed on behalf of Protocol users by the PJWG.

Requirements for using ArcGIS Field Maps include:

1) An ArcGIS organizational account
2) Enough named AGOL user accounts within the organization account to cover field crew, with "location tracking" extensions enabled.
3) Devices for field crew (Android or IOS phones or tablets). WIFI connectivity is required for synching devices with cloud and downloading survey area basemaps for offline use prior to surveys, but LTE connectivity is not required for field use.

Online resources created by the PJWG to support the use of ArcGIS Field Maps when implementing this Protocol include:

1) A Configuration Guide for ArcGIS Field Maps and ArcGIS Online that contains all detailed information needed to prepare ArcGIS Field Maps and its underlying data management system for use. The configuration guide assumes basic knowledge of GIS terminology and processes, and configuration is best undertaken by an organization's GIS specialist. If this expertise is not available, the PJWG may be able to assist.
2) A Field User Guide to ArcGIS Field Maps providing step-by-step instructions for using ArcGIS Field Maps for data collection. This is written for all users with no assumption of previous knowledge or familiarity.
3) A data layer catalogue containing the layers required to use the ArcGIS Field Maps system.

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[31] ArcGIS Enterprise can be used instead of AGOL, but it is not described in this Appendix or in its linked resources.

[32] ArcGIS Enterprise can be used instead of AGOL, but it is not covered in Appendix 4.

Appendix 5. Paper-Based Data Collection

Some Protocol users may opt to collect field data on paper data sheets and enter the data into an electronic format later. An MS Excel template for a printed data sheet suitable for field use with the Protocol is provided here. Users may wish to modify this data sheet template to change layout and formatting or to add attributes. Specifically, additional attributes may be needed to facilitate later estimation of flock location from the surveyor location recorded in the field, as discussed in Appendix 3 – Table 1.

The structure of this data sheet template generally parallels the Data Dictionary but does not reflect it in all details. It is the responsibility of the user to ensure that full compliance with the Data Dictionary is accomplished during the electronic data entry process by formatting attribute names and values appropriately. In some cases, attributes and attribute values that are implicit in the paper data sheet but not explicitly shown (for instance, "Jays Present?" from Appendix 3 – Table 2) may need to be created during data entry.