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# The Gamebird Project

## Final Report 2018-2019

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### Development of optimal survey methods to provide reliable estimates of game bird populations on Hawai‘i Island

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## *Acknowledgments*

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# *Introduction*

Hunting of game species is a culturally, socially, and ecologically important activity in the Hawaiian Islands. Game bird hunting opportunities are offered on the six major islands in the state of Hawai‘i: (Kaua‘i, O‘ahu, Maui, Moloka‘i, Lana‘i and Hawai‘i). Each of these islands has one or more state-designated public hunting areas (called Hunting Units), which are open for hunting at certain times during each year (DLNR 2018).

Today, 14 nonnative game bird species can be hunted in the Hawaiian Islands, although historically a much higher number of species were introduced in the islands (DLNR 2018). On the island of Hawai‘i alone, there are records of more than 33 game bird species introductions in the last century (Lewin 1971), but today the most common are: California Quail (*Callipepla californica*), Kalij Pheasant (*Lophura leucomelanos*), Black Francolin (*Francolinus francolinus*), Erckel's Francolin (*Pternistis erckelii*) and the Wild Turkey (*Meleagris gallopavo*), see fig 1. In order to adequately manage the game bird species, and establish hunting regulations, standardized monitoring techniques are needed.

Bird surveys have been extensively used for studying bird populations (Bibby et al. 1992, Bart 2005), and have already been used successfully in Hawai‘i for other species (Baldwin 1941, Lewin 1971, Banko and Banko 1979, Smith and Conant 1980, Turner et al. 2006). Due to the ground-dwelling habits of gamebirds, these species require specific bird survey techniques, which include call surveys (DeMaso; et al. 1992), line transects (Bibby et al. 1992) or the use of hunting dogs (Warren and Baines 2011, Tanner et al. 2017).

Mauna Kea Game Management Area and Kapapala Game Management Area, on the island of Hawai‘i, are two important game bird reserves managed by the State of Hawai‘i, Division of Forestry and Wildlife, but their game bird populations are poorly studied. A better estimate of their population size is needed, not only to set appropriate hunting regulations, but also to improve conservation measures in case they are needed. In order to amend this situation, we aimed to compare game bird population estimates obtained with and without the use of hunting dogs. In this report we present the findings of the surveys carried out during autumn 2018 and spring 2019.



Fig 1a. California Quail male and female.



Fig 1b. Erkel's Francolin.



Fig 1c. Kalij Pheasant male.



Fig 1d. Kalij Pheasant female.



Fig 1e. Black Francolin male.



Fig 1f. Black Francolin female.



Fig 1g. Wild Turkey male.



Fig 1h. Wild Turkey female.

# Materials and Methods

## Study sites

Mauna Kea Game Management Area (MKK), has an extension of 2,900 hectares (although area covered during surveys is 6900 hectares) and is situated on the west slope of Mauna Kea, on the mid-northern side of the island of Hawai‘i (see figure 2). Kapapala Game Management Area (KPP), which has an extension of 11,700 hectares, is situated on the lower slopes of Mauna Loa on the southeastern side of the island of Hawai‘i. Kapapala GMA is adjoined to Hawaii Volcanoes National Park, Kapapala Forest Reserve and Ka‘ū Forest Reserve.

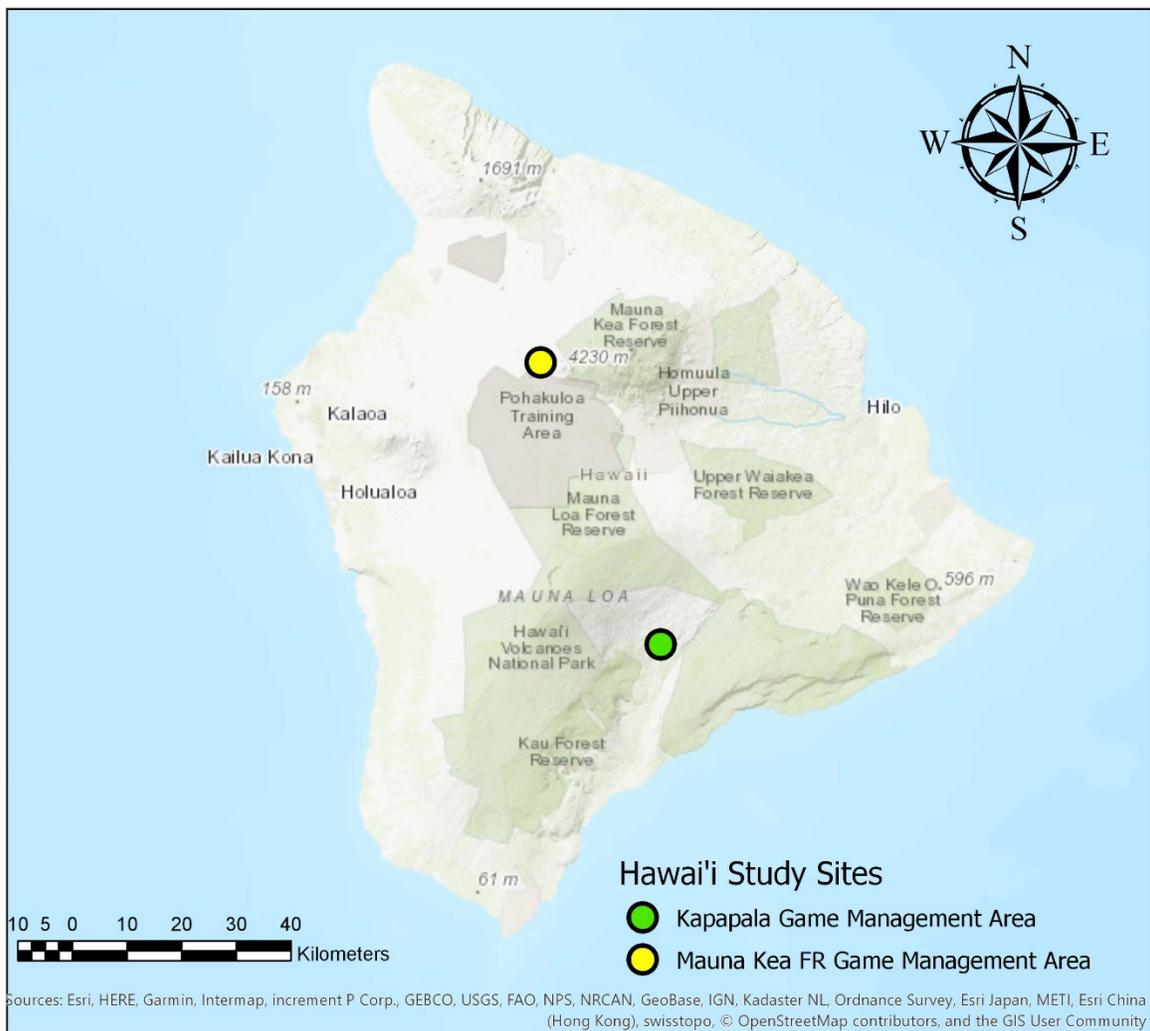


Figure 2. Study sites: Mauna Kea GMA and Kapapala GMA.



## Transects

For Kapapala 73 transects were selected, divided in 8 sections (see figure 3). Most of the transects were set along open roads or paths, due to the dense vegetation that most of the Kapapala Forest reserve presents.

For Mauna Kea 68 transects were selected, divided in 9 sections (see figure 4). Transects were off trail but following previous transects already marked designed for Palila surveys.

All transects had 1 km length, and were surveyed for each methodology (with the aid of dogs, and without dogs) following the survey protocol in appendix 2. Surveys were carried out in the fall 2018 and spring 2019.

## Species

The following Gamebird species were taken into consideration during the surveys. No passerine species were recorded. Owls (Barn owl and Pueo) were recorded, for sharing data with the Pueo project [www.pueoproject.com](http://www.pueoproject.com)

ALPHACODE	Species Name	Scientific Name
CAQU	California Quail	<i>Callipepla californica</i>
JAQU	Japanese Quail	<i>Coturnix japonica</i>
RPHE	Ring-necked Pheasant	<i>Phasianus colchicus</i>
BPHE	Blue Pheasant	<i>Phasianus colchicus mut. tenebrosis</i>
KAPH	Kalij Pheasant	<i>Lophura leucomelanos</i>
CHUK	Chukar	<i>Alectoris chukar</i>
GRAF	Gray Francolin	<i>Francolinus pondicerianus</i>
BLFR	Black Francolin	<i>Francolinus francolinus</i>
ERFR	Erckel's Francolin	<i>Pternistis erckelii</i>
WITU	Wild Turkey	<i>Meleagris gallopavo</i>
COMP	Common Peafowl	<i>Pavo cristatus</i>
MODO	Mourning Dove	<i>Zenaida macroura</i>
SPDO	Spotted Dove	<i>Spilopelia chinensis</i>
ZEBD	Zebra Dove	<i>Geopelia striata</i>
CBSG	Chestnut-bellied sand grouse	<i>Pterocles exustus</i>
PUEO	Pueo or Hawaiian Short-eared Owl	<i>Asio flammeus sandwichensis</i>
BOWL	Barn Owl	<i>Tyto alba</i>
UNBI	Unidentified Bird	

Table 1. Species recorded and codes used during the development of the transects.

## Analyses

Maps were created with ArcGIS pro. Analyses, graphs and models were carried out using SPSS v.23 and RStudio Team 2015.

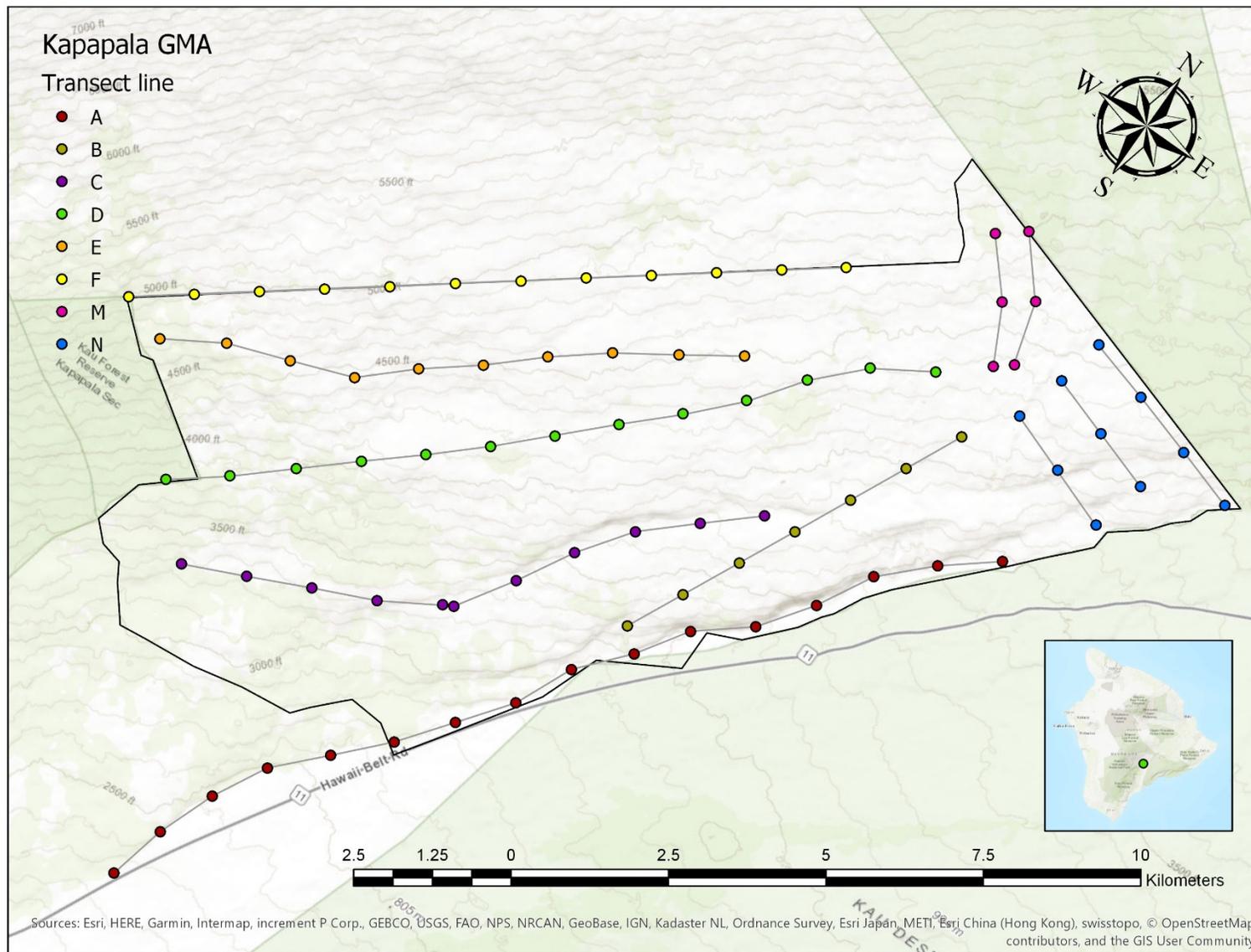


Figure 3. Location of Line transects on Kapapala Game Management Area.

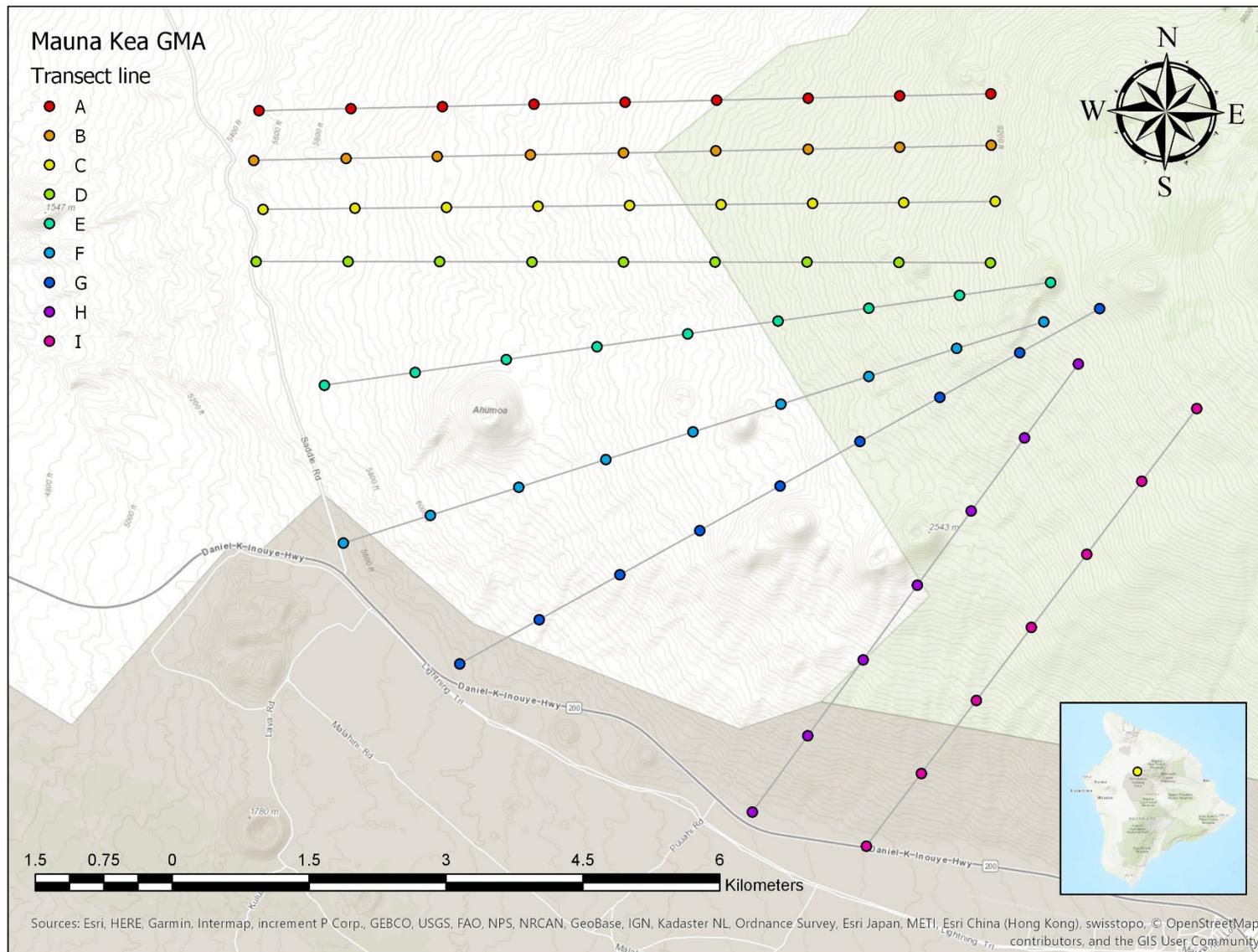


Figure 4. Location of Line transects on Mauna Kea Game Management Area.

## *Results and discussion*

### Survey dates and number of transects

Transect were carried out at Kapapala during September 2018 and April 2019, and during October 2018 and February 2019 at Mauna Kea.

Year	Kapapala		Mauna Kea	
	Dogs	No Dogs	Dogs	No Dogs
2018	73	73	43	54
2019	63	0	30	0

Table 2. Number of transects per site, type and year.

### Number of detections by species

Thirteen species of gamebirds were detected during surveys, with Kalij pheasant, Peafowl, Spotted and Zebra dove only detected at Kapapala while Black Francolin, Chukar, Gray Francolin, Japanese Quail, and Mourning Dove were only detected at Mauna kea.

		Kapapala Ranch	Mauna Kea
Species	Black Francolin	0	4
	California Quail	16	47
	Chukar	0	4
	Erkels Francolin	217	320
	Gray Francolin	0	2
	Japanese Quail	0	3
	Kalij Pheasant	38	0
	Mourning Dove	0	3
	Peafowl	1	0
	Pueo	1	1
	Ring-necked Pheasant	1	10
	Spotted Dove	2	0
	Wild Turkey	7	24
	Zebra Dove	7	0

Table 3. Number of detections per species by site.

Due to the number of detections, only Erkels francolin was used in the statistical analyses.



## Survey methodology. Use of hunting dogs.

We compared the two methodologies used in 2018 (use of hunting dogs, vs no hunting dogs). Overall encounter rates for Erkels francolin were higher with the use of hunting dogs. Differences are more apparent in Mauna Kea, being much higher with dogs. At Kapapala dogs had a slightly lower encounter rates than no dogs but maybe this was due to other factors like survey time or observer that this test did not account for.

Site	Treatment	number of transects	observations	Encounter rate
Kapapala Ranch	No Dogs	73	62	0.00084932
Kapapala Ranch	Dogs	73	44	0.00060274
Mauna Kea	No Dogs	54	77	0.00142593
Mauna Kea	Dogs	43	152	<b>0.00353488</b>
Total	No Dogs	127	139	0.00109449
Total	Dogs	116	196	<b>0.00168966</b>

Table 4. Erkels francolin encounter rates per site and treatment, fall 2018.

Density estimates for the treatment with hunting dogs have lower Coefficient of Variation (see table 5).

Label	Treatment	Estimate (birds/ha)	cv
Kapapala Ranch	No Dogs	0.26	0.36
Kapapala Ranch	Dogs	0.16	0.26
Mauna Kea	No Dogs	0.65	0.39
Mauna Kea	Dogs	1.0	0.19
Total	No Dogs	0.46	0.32
Total	Dogs	0.58	0.18

Table 5. Erkels francolin density estimate in birds per hectare, fall 2018.

In figure 5 we can observe that confidence intervals both with and without hunting dogs for Mauna Kea and Kapapala overlap, indicating that population estimates are the same. It is important to remark that as confidence intervals are all smaller when using hunting dogs in the survey, the use of dogs produce more accurate estimates than surveys without dogs.

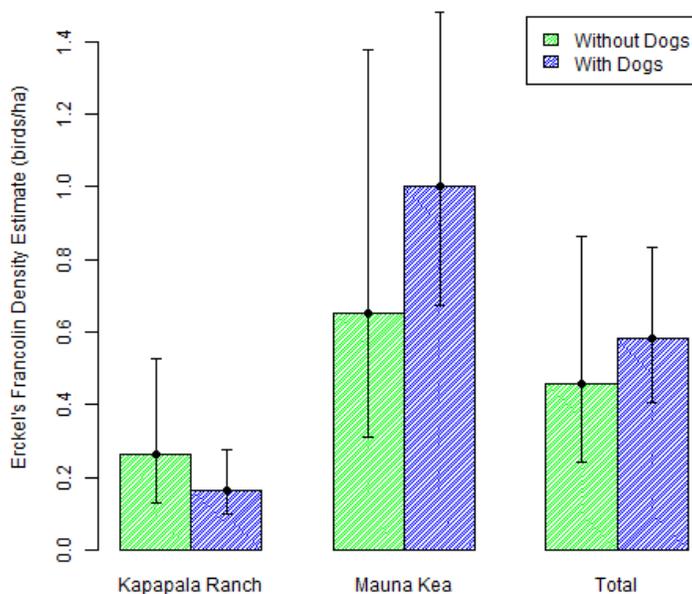


Figure 5. Erkel's Francolin density Estimate in Birds per hectare. Fall 2018.

## Bird densities: Erkel's francolin

Due to the low number of detections in other species, we only used Erkel's francolin for calculating the population densities and estimates.

We used only data from the surveys with hunting dogs, to avoid differences within protocols. We can observe that density estimates were larger in the spring than they were in the fall. More data is needed to properly identify the annual variation in spring and fall (density estimates and confidence interval limits for the spring and fall-dog density models in ERFR/ha):

Survey time	Site	Density			Population		
		Estimate	lcl	ucl	Estimate	lcl	ucl
Fall	Kapapala Ranch	0.17	0.10	0.28	1932	1149	3249
Spring	Kapapala Ranch	0.82	0.50	1.34	9627	5907	15687
Fall	Mauna Kea	1.00	0.68	1.48	6899	4659	10216
Spring	Mauna Kea	2.08	1.31	3.31	14356	9036	22810
Fall	Total	0.58	0.41	0.83	10834	7559	15529
Spring	Total	1.45	0.99	2.12	27002	18480	39452

Table 6. Density (in birds per hectare) and population estimates of Erkel's francolin.

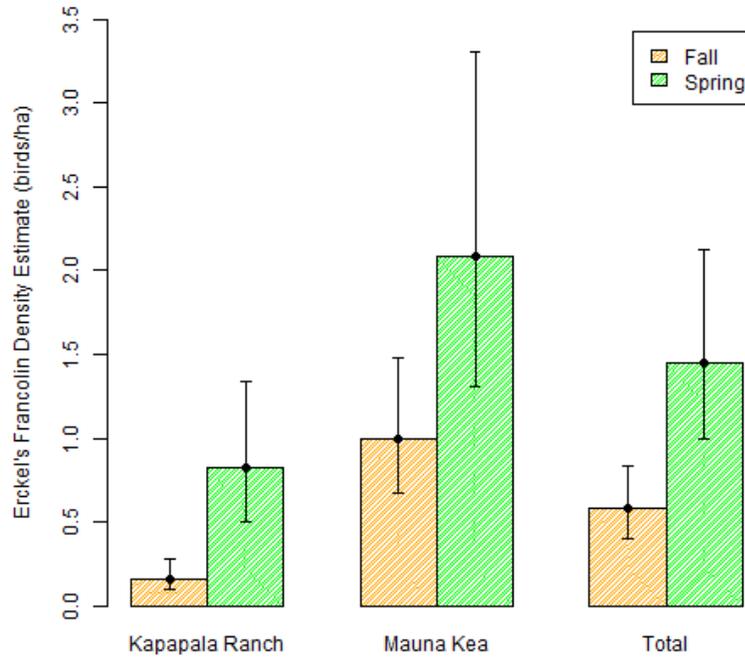


Figure 6. Density estimates and confidence interval limits for the fall 2018 and spring 2019 hunting dog density models in Erckell's francolin per hectare.

## *Conclusion*

The difference in survey efforts between sites was mainly due to terrain conditions. Mauna Kea is harsher and drier than Kapapala and transects in Mauna Kea are off-trail and that highly hampers the walking speed and number of transects carried out in one day.

The height of Mauna Kea and its drier climate, conditions the species that inhabit the area, favoring the ones adapted to drier condition and open vegetation (as Black francolin and Chukar). It is interesting to remark that Kalij Pheasant was only recorded at Kapapala ranch, in humid areas with abundant understory.

Due to the low number of detections, targeted surveys should be addressed in order to estimate the population of the other gamebird species.

As shown by our statistical models, encounter rates increase and population estimates are more robust and accurate with the use of hunting dogs. This factor is less visible at Kapapala, and this is likely caused by its vegetation structure. Kapapala has a network of roads and paths, with very thick brush or understory, which difficults working with dogs, and gamebirds are normally recorded within the tracks and paths in most of the transects. Mauna Kea, on the other hand, has higher densities of gamebirds and a more open habitat, which facilitates the surveys with hunting dogs. We can conclude that for continuity and for better gamebird population estimates, the use of hunting dogs is the methodology recommended for surveying gamebirds in Hawaii.

Regarding population estimates among study sites, Mauna Kea has 2.5 to 5 times higher densities of Erkels francolins, with an impressive estimate of more than 14.000 Erkels in the spring, making it a much better hunting area for this species. Also, the higher number of encounters of California Quail makes it more attractive for gamebird hunters.

Further data is needed in order to properly study population trends among fall and spring and we recommend the continuation of the gamebird surveys to analyze and increase the knowledge about their population and trends.

## *Literature cited*

- Baldwin, P. H. (1941). Checklist of birds of the Hawaii National Park, Kilauea-Mauna Loa section, with remarks on their present status and a field key for their identification. *Hawai'i National Park Natural History Bulletin* 7.
- Banko, P. C., and W. E. Banko (1979). Historical trends of passerine populations in Hawai'i Volcanoes National Park and vicinity. *Proceedings of the Second Conference on Scientific Research in the National Parks*. p. 8:108-125.
- Bart, J. (2005). Monitoring the abundance of bird populations. *The Auk* 122:15–25.
- Bibby, C. J., N. D. Burgess, and D. A. Hill (1992). *Bird Census Techniques*. Second Edition. Elsevier Science.
- DeMaso, S. J., F. S. Guthery, G. S. Spears, and S. M. Rice (1992). Morning Covey Calls as an Index of Northern Bobwhite Density (s):Published by : Wiley on behalf of the Wildlife Society Stable URL : <https://. Wildlife Society Bulletin 20:94–101>.
- DLNR (2018). Game bird hunting. [Online.] Available at <http://dlnr.hawaii.gov/recreation/hunting/bird/>.
- Lewin, V. (1971). Exotic Game Birds of the Puu Waawaa Ranch. Source: *The Journal of Wildlife Management* 35:141–155.
- Smith, C. W., and S. Conant (1980). Birds of the Kalapana extension. Tech Report 36. Pacific Cooperative Studies Unit. University of Hawaii at Manoa, Department of Botany, Honolulu.
- Tanner, E. P., R. D. Elmore, D. K. Dahlgren, C. A. Davis, and S. D. Fuhlendorf (2017). Comparison of Dog Surveys and Fall Covey Surveys in Estimating Fall Population Trends of Northern Bobwhite. *National Quail Symposium Proceedings* 8.
- Turner, K. E., R. J. Camp, and T. K. Pratt (2006). Lowland bird inventory Hawai'i Volcanoes National Park. Technical Report 137. Pacific Cooperative Studies Unit. University of Hawai'i at Mānoa. NPS Inventory and Monitoring Program, Pacific Island Network.
- Warren, P., and D. Baines (2011). Evaluation of the distance sampling technique to survey red grouse *Lagopus lagopus scoticus* on moors in northern England . *Wildlife Biology* 17:135–142.



*Appendices*



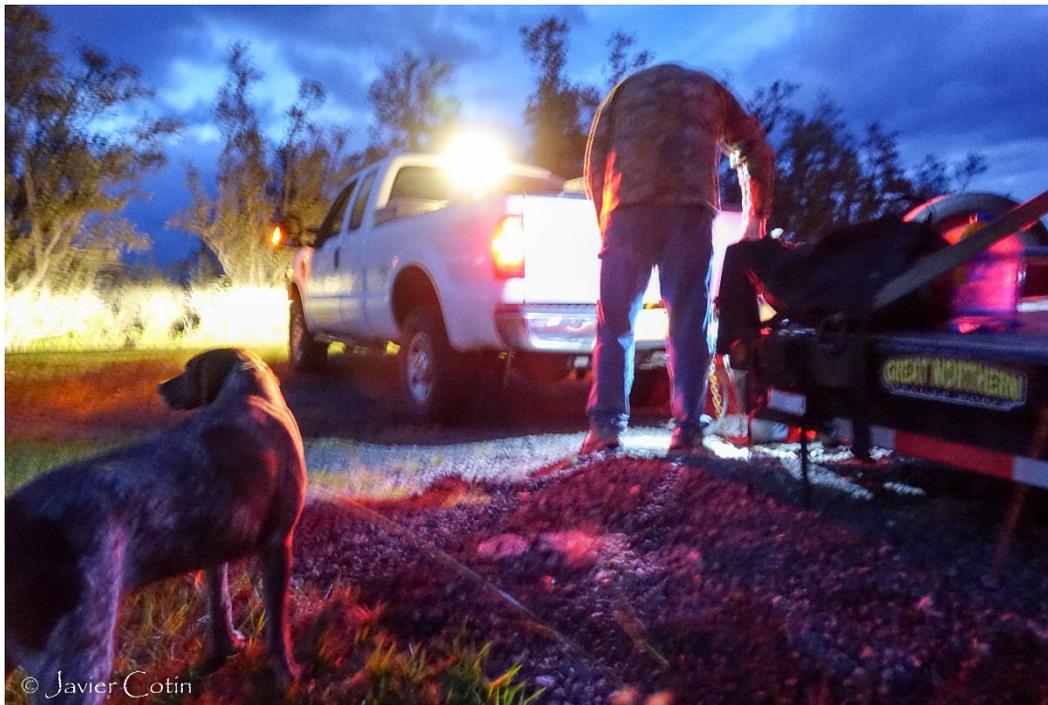
**Photographic documentation of  
the Kapapala and Mauna Kea Gamebird Surveys**



Photo 1. Sunrise at Kapapala Gamebird Reserve.

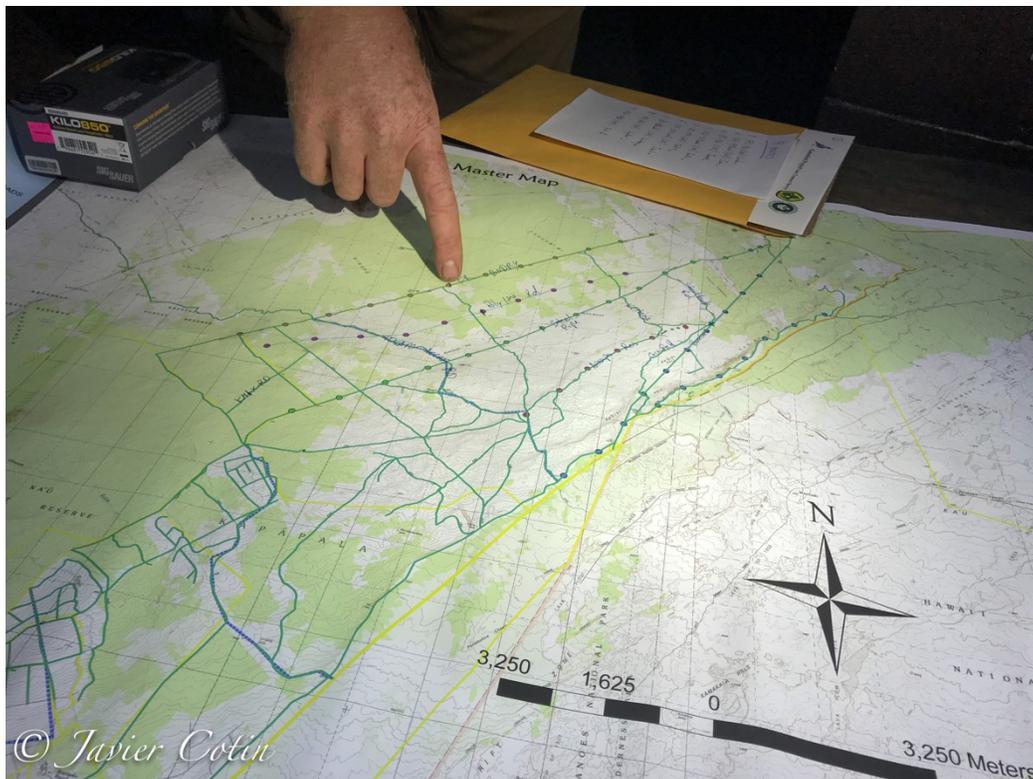


Photo 2. UTV offloading.



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Photo 3. UTV offloading.



© Javier Cotin

Photo 4. Planning the survey route before sunset.



Photo 5. It can take up to 60 minutes to reach to the further survey sites, sometimes crossing lava flows.



Photo 6. Ian Cole and Molly during gamebird surveys.



Photo 7. Ian Cole and Molly, after counting quite many gamebirds.



Photo 8. Landscape of Kapapala.



Photo 9. The core Kapapala gamebird team! From left to right, Ian Cole, Javier Cotin, Jupiter Crosson, Isaih Reynolds, Molly and Izzy.



Photo 10. Kapapala Team members



Photo 11. Loading the UTV. Gamebird surveys' daywork wrap-up at Kapapala.

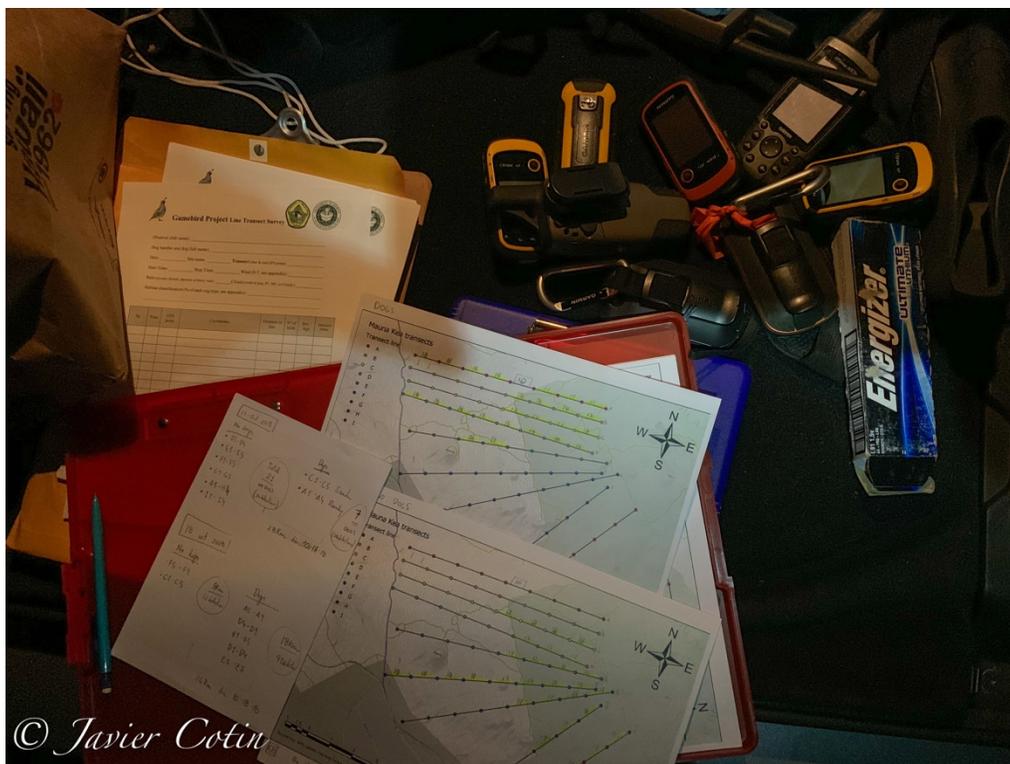


Photo 12. Survey gear at Mauna Kea.



Photo 13. Mauna Kea landscape. A very rugged terrain.



Photo 14. Wild Turkey (*Meleagris gallopavo*) sighted in the survey area.



Photo 15. Ring-necked Pheasant (*Phasianus colchicus*) sighted in the survey area.



Photo 16. Erkels Francolin (*Pternistis erckelii*) sighted in the survey area.



Photo 17. Male Kalij pheasant (*Lophura leucomelanos*) sighted in the survey area.



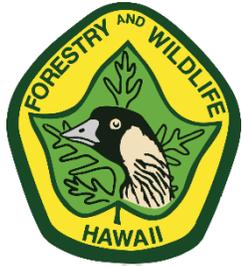
Photo 18. Female Kalij pheasant (*Lophura leucomelanos*) sighted in the survey area.



Photo 19. Pueo (*Asio flammeus sandwichensis*) perching close to the survey area.



Photo 20. Pueo (*Asio flammeus sandwichensis*) enjoying the sunset at Mauna kea.



# Gamebird Project

## Line Transect Survey Protocol

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### Materials

- **GPS** unit.
- Range finder.
- Datasheet and map, clipboard (or hard surface to write on) and writing utensil (pen preferred).
- Binoculars.
- Stopwatch or clock to keep track of minute-by-minute intervals of the survey.
- This survey protocol (for reference).
- One observer\*
- One dog handler + 1 or 2 dogs

\*If the dog handler has bird ID experience, he/she can also be the observer.

### Methods

- Line transects will have a length of one kilometer, and ideally will be placed at parallel 500 meters intervals. Line transects will be walked at a slow pace (20 to 40 minutes = 1 kilometer).
- Line transects can be concatenated.
- Time at the start and end of the transect will be recorded.
- Environmental variables (cloud cover, wind speed, temperature, precipitation) will be also recorded, and averaged at the end of each transect.
- Observer, dog handler and dog names will be recorded.
- The team (observer + dog handler + minimum of one dog) will traverse the lines. If more than one dog, normally one dog will run at a time.
- Dog handler will control the dog while the observer will keep track of the transect line using a compass or GPS.
- When the dog points, observer will stay on the line while dog handler approaches the dog and flushes the bird(s).
- **Of every gamebird observation**, the following measurements will be recorded:
  - o Coordinates at the transect line (GPS point)
  - o Perpendicular distance from the transect line (using a range finder) to where the birds were first seen to the nearest meter (if a bird is heard, GPS point should be taken at the closest perpendicular point of the transect, not when it was heard).
  - o Species, number of adults (males and females) and juveniles.
- **Pueo** observations (or **Barn Owl**) observations will be also recorded.

**Survey timing:** Surveys will be carried out in the morning, until 2.5-3 hours after sunrise.

**Weather:** Your survey should be completed during periods of good or fair weather. Clouds are fine, but you should avoid any steady rain. Breezy conditions are also ok, but strong winds should be avoided.



### Data collection

The following data fields will be collected:

#### General:

- **Observer(s) and dog(s)**
- **Date**
- **Site** and **transect** number (including start and end GPS point).
- **Time:** Start time (record finish time at end).

#### Environmental:

- **Wind** speed based on the Beaufort scale (see appendix 1).
- **Cloud Cover Classification** – measured at start point only. Classified as cloudy (100% cloud cover), mostly cloudy (50-99% cloud cover), partly cloudy (1-49% cloud cover), and clear (0% cloud cover).
- **Precipitation** (none, light fog or mist, light drizzle, scattered showers; no surveys in heavy fog or steady rain).
- **Habitat / Vegetation Cover Classification** (see appendix 2) with a % estimate within surveyed area, at the end of every transect.

**Gamebird (and Pueo) observations:** for each bird observation during a transect survey record the following variables.

- **Bird Code:** Standard four-letter species code (see appendix 4).
- **GPS point:** label the point following the coding (see appendix 3).
- **Observer GPS coordinates:** Location of observer along the line (distance from start of line) and GPS coordinates. We will use “decimal degrees” for all coordinates (e.g., UH Manoa is located at 21.302015°, -157.814769°). Please record at least 5 digits to the right of the decimal point. This may require a settings change on your GPS or Smart Phone. Some units may report the longitude as 157.814769 W instead of -157.814769. That is fine, we will drop the “W” and add the “-” later. Use GPS codes from Appendix 3.
- **Time of observation.**
- **Distance:** From the observer to the bird, in meters. Measured with laser rangefinder.
- **Number of individuals:** Number of adults (males and females) and juveniles (2AM, 1AF and 3J = 2 adult males, 1 adult female and 3 juveniles).
- **Detection status:** Record the first means of detection for an observation: visual (V), calling (C), flush (FL), flying over (FO).



## Appendix 2. Survey protocol

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### Appendix 1. Beaufort Scale:

Beaufort Scale for measuring wind speed:

- 0 = Calm: smoke rises vertically
- 1 = Light Air: Smoke drift indicates wind direction, still wind vanes
- 2 = Light Breeze: Wind felt on face, leaves rustle, vanes begin to move
- 3 = Gentle Breeze: Leaves and small twigs constantly moving, light flags extended
- 4 = Moderate Breeze: Dust, leaves, and loose paper lifted, small tree branches move

Do not survey if:

- 5 = Fresh Breeze: Small trees in leaf begin to sway
- 6 = Strong Breeze: Larger tree branches moving, whistling in wires
- 7 = Near Gale: Whole trees moving, resistance felt walking against wind
- 8-12 = Gale – Hurricane: generally impedes progress.

### Appendix 2. Habitat / Vegetation Cover Classification.

Measure at each transect, counting 50 meters at both sides of the line transect. Record values to the nearest **10%**. Values should total to 100%.

- **Developed** Land that is predominantly built-up or developed and vegetation associated with these land covers. This includes road surfaces, buildings and paved surfaces, and farmsteads.
- **Wetland/marsh/riparian** Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes (semi-permanent or permanent wetland vegetation, including swamps, sloughs, marshes etc.).
- **Agriculture** Annually cultivated cropland; lands that generally change from bare cover to green/vegetated cover during the growing season.
- **Grasslands:** may include a few shrubs, but there should not be many and should not be regular on the landscape.
  - **Short-grazed grassland**
  - **Medium grassland:** Below 75 cm.
  - **Tall Grassland** California grass or grass >75 cm tall.
- **Native Shrubland:** Predominantly native woody vegetation of relatively low height (generally 2 m). Also includes grass or grassland wetlands with woody vegetation and regenerating forest.
- **Non-native Shrubland.**
- **Non-native Forest:** Predominantly forested or treed areas, including at least 10-25% crown closure of coniferous, broadleaf and mixed wood.
- **Native Forest:** Predominantly forested or treed areas, including at least 10-25% crown closure of coniferous, broadleaf and mixed wood.

**Appendix 3. GPS points codes.** Coding for transects A, B, C... it is VERY important to use the following symbology.



**Bird observations within transect with NO dogs.**

Label as: **A1-1n** (Transect A1, 1<sup>st</sup> obs (after that 2, 3, 4, 5...), n = no dog). Use Gamebird symbol.



**Bird observations within transect WITH dogs.**



## Appendix 2. Survey protocol

Label as: **A1-1w** (Transect A1, 1<sup>st</sup> obs (after that 2, 3, 4, 5...), w= with dog). Use Gamebird symbol.

A1 = transect (A1, B2, B3, M1... name of the transect).

1n = number of the observation (1, 2, 3, 4) + n or w (did the transect was run with or with NO dogs?). examples below:

B4-3w = Transect B4, 3<sup>rd</sup> observation with dogs

F7-4n = Transect F7, 4<sup>rd</sup> observation, with NO dogs.

It is important that the GPS is in the following position format:

**Position format:** hddd.ddddd<sup>o</sup>

**Map datum:** WGS 84

**Map Spheroid:** WGS 84

## Appendix 4. Bird codes

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- 7 = Near Gale: Whole trees moving, resistance felt walking against wind
- 8-12 = Gale – Hurricane: generally impedes progress.

### Appendix 2. Habitat / Vegetation Cover Classification.

Measure at each transect, counting 50 meters at both sides of the line transect. Record values to the nearest **10%**. Values should total to 100%.

#### Developed

**Wetland/marsh/riparian** Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes (semi-permanent or permanent wetland vegetation, including swamps, sloughs, marshes etc.).

**Agriculture** Annually cultivated cropland; lands that generally change from bare cover to green/vegetated cover during the growing season.

**Grasslands:** may include a few shrubs, but there should not be many and should not be regular on the landscape.

#### Short-grazed grassland

**Medium grassland:** Below 75 cm.

**Tall Grassland** California grass or grass >75 cm tall.

**Native Shrubland:** Predominantly woody vegetation of relatively low height (generally 2 m). Also includes grass or grassland wetlands with woody vegetation and regenerating forest.

#### Non-native Shrubland.

**Non-native Forest:** Predominantly forested or treed areas, including at least 10-25% crown closure of coniferous, broadleaf and mixedwood.

#### Native Forest

### Appendix 3. GPS points codes.

Bird observations in transect with **NO** dogs. Bird

observations in transect **WITH** dogs.



A1 = transect (A1, B2, B3, M1... name of the transect).  
the transect was run with or with NO dogs?).



1n = number of the observation (1, 2, 3, 4) + n or w (did

**B4-3w** = Transect B4, 3<sup>rd</sup> observation with dogs. / **F7-4n** = Transect F7, 4<sup>rd</sup> observation, with NO dogs.

Important! GPS in the following **position format:** hddd.dddd<sup>e</sup> **Map datum:** WGS 84 **Map Spheroid:** WGS 84

### Appendix 4. Bird codes

ALPHACODE	Species Name	Scientific Name
CAQU	California Quail	<i>Callipepla californica</i>
JAQU	Japanese Quail	<i>Coturnix japonica</i>
RPHE	Ring-necked Pheasant	<i>Phasianus colchicus</i>
BPHE	Blue Pheasant	<i>Phasianus colchicus mut. tenebrosis</i>
KAPH	Kalij Pheasant	<i>Lophura leucomelanos</i>
CHUK	Chukar	<i>Alectoris chukar</i>
GRAF	Gray Francolin	<i>Francolinus pondicerianus</i>
BLFR	Black Francolin	<i>Francolinus francolinus</i>
ERFR	Erckel's Francolin	<i>Pternistis erckelii</i>
WITU	Wild Turkey	<i>Meleagris gallopavo</i>
COMP	Common Peafowl	<i>Pavo cristatus</i>
MODO	Mourning Dove	<i>Zenaida macroura</i>
SPDO	Spotted Dove	<i>Spilopelia chinensis</i>
ZEBD	Zebra Dove	<i>Geopelia striata</i>
CBSG	Chestnut-bellied sand grouse	<i>Pterocles exustus</i>
PUEO	Pueo or Hawaiian Short-eared Owl	<i>Asio flammeus sandwichensis</i>
BOWL	Barn Owl	<i>Tyto alba</i>
UNBI	Unidentified Bird	

**Number of individuals, sex and age:** Number of adults (males and females) and juveniles (2AM, 1AF and 3J = 2 adult males, 1 adult female and 3 juveniles).

**Detection status:** Record the first means of detection for an observation: visual (V), calling (C), flush (FL), flying over (FO)