----- GENERAL INFORMATION -----

DATA TITLE: Miniature temperature data-logger use for monitoring avian nest survival

DATA ABSTRACT: This dataset was used to (1) examine the possible effect of thermal data-loggers on nest success through hatching for grass- and shrub-nesting songbirds that differed in their parasite egg-accepting and -rejecting behavior, (2) examine the effect of using daily temperature data versus less-frequent nest-visit data on statistical power, bias, and precision when estimating nest daily survival rate (DSR), and (3) compare these two approaches using a simulation study and field data. We monitored survival of nests found in agricultural landscapes and used a binomial logistic regression with main effects for data logger and parasite accepting or rejecting status and an interaction. It is based on nest survival records collected in Iowa, U.S. between 2015-2017 and simulated data produced within.

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Stephenson, M.D., L.A. Schulte, R.W. Klaver, J. Niemi. 2021. Journal of Field Ornithology. 10.1111/jofo.12389

Stephenson, M.D. 2017. Quantifying methods to improve statistical power in grassland and passerine bird nesting studies. M. S. thesis, Iowa State University.

COLLECTION INFORMATION:

Time period(s): May-Aug 2015-2017
Location(s): Locations within 100 km of Ames, Iowa, U.S.

----- FILE DIRECTORY -----

----- FILE LIST-----

'iButton loss rate.R' – R code for calculating the loss rate of iButtons from monitored nests. Requires 'nests.csv'. No output files.

'iButton Precision.R' – R code for comparing effective sample size and standard errors of estimated daily survival rates calculated using daily iButton checks vs. 2-7 day interval checks for Red-winged blackbirds, Dickcissels, and Vesper Sparrows. Requires 'Nests.fine.csv' and 'Nests.coarse.csv'.

'lost ibutton corrections.csv' – Contains reversions to in-person check data for fields FirstFound, LastPresent, and LastChecked in nests where an iButton was inserted but lost. Used in 'Real nest visit intervals.R' One row equals one nest. Foreign key is nestID.

'multiplot.R' – A function for creating side-by-side ggplots. Used in several scripts.

'Nest temp plot.R' – A script for creating annotated temperature plots from iButton output files. Requires 'VESP15051202_in.csv', 'VESP15051202_out.csv', and 'RWBL16052705_in.csv'.

'nest.checks.csv' – A table containing information on in-person nest visits. Each row is an in-person nest visit. The foreign key to relate to 'Nests.csv' is NestID and the file is used in 'Visit Intervals.R'

'Nests.coarse.csv' – Version of 'Nests.csv' where iButton information is ignored when determining survival dates. The only difference from 'Nests.csv' will be in the AgeDay1, FirstFound, LastPresent, LastChecked, and Fate fields.

'Nests.csv' – Real nest data collected in Iowa, USA from 2015-2017. Contains critical dates required for daily survival rate estimation in Program MARK implemented through package 'RMark'. Also contains many environmental covariates used in other analyses. One row equals one nest. 'nestID' is the primary key for joining nest data in other files.

'Nests.fine.csv' - Version of 'Nests.csv' if iButton data is consulted when determining survival dates. The only difference from 'Nests.csv' will be in the AgeDay1, FirstFound, LastPresent, LastChecked, and Fate fields.

'RWBL16052705_in.csv' – iButton Thermochron temperature output file. Used in 'Nest temp plot.R' One row equals one temperature measurement. 10-digit nest name in filename is the foreign key for relating to other nest data.

'sim output ##n dsr## ##### nests # day.csv' - Intermediate simulation output files produced and used by 'Simulated vs real data.R' containing a daily survival estimate and associated precision and bias measurements. Each simulation iteration produces one row for 'fine' visit interval and one row for 'coarse'. Naming format is 'sim output' 'effective sample size' 'daily survival rate * 100' 'number of iterations' 'nests' 'visit interval comparison'.

‘Sim Standard Errors.csv’ – Summary document assembled from summaries calculated within ‘Simulation vs real data.R’ One row equals one combination of sample size, visit interval, and visit scale. Used as input data within ‘Simulation vs real data.R’

‘Simulated vs real data.R’ – R code that simulates a nest visit dataset and estimates daily survival rate from varying visit intervals. Computationally intensive (required many hours per run with 2018 computation power). Stores individual run results in csv files and reads them back in for later comparison.

‘Summarizing bias.R’ – An R script for demonstrating a systematic difference (bias) in daily survival rate estimates between nest visit data with shorter vs longer visit intervals. Requires simulation output csv files as input.

‘Survival through hatch GLM.R’ – R script for running a basic generalized linear modeling analysis of bird nest survival through hatch comparing nests with and without iButtons. Requires ‘Nests.csv’ as input.

‘VESP15051202_in.csv’ – iButton Thermochron temperature output file. Used in ‘Nest temp plot.R’ 10-digit nest name in filename is the foreign key for relating to other nest data.

‘VESP15051202_out.csv’ – iButton Thermochron temperature output file. Used in ‘Nest temp plot.R’ 10-digit nest name in filename is the foreign key for relating to other nest data.

‘Visit intervals.R’ – Script for calculating length of uncertainty period and average visit intervals in real nest visit dataset. Requires ‘Nests.fine.csv’, ‘Nests.coarse.csv’ and ‘nest.checks.csv’

----- VARIABLES -----

lost ibutton corrections.csv

Name *[variable name]*	Description *[what is it?]*	Values *[units, valid data types, etc.]*
nestID	Foreign key to link entries to Nests.csv table.	Factor
nest_name	Unique formulaic name for nest. The ABA four letter species code, a six-digit discovery date, and a two-digit number to distinguish nests found on the same date.	Factor
field_season	Year in which nest was monitored.	Integer
i_best_comb	Date. MM/DD/YYYY. First day nest was discovered to be active based on both iButton and in-person visit data. Program MARK field “FirstFound”	Date (MM/DD/YYYY)
j_best_comb	Date. MM/DD/YYYY. Last day nest was known to be active based on both iButton and in-person visit data. Program MARK field “LastPresent”	Date (MM/DD/YYYY)

k_best_comb	Date. MM/DD/YYYY. Last day nest status was checked based on both iButton and in-person visit data. Program MARK field "LastChecked"	Date (MM/DD/YYYY)
i_ibut_only	Date. MM/DD/YYYY. First day nest was discovered to be active based only on iButton data. Program MARK field "FirstFound"	Date (MM/DD/YYYY)
j_ibut_only	Date. MM/DD/YYYY. Last day nest was known to be active based only on iButton data. Program MARK field "LastPresent"	Date (MM/DD/YYYY)
k_ibut_only	Date.. Last day nest status was checked based only on iButton data. Program MARK field "LastChecked"	Date (MM/DD/YYYY)

`nest.checks.csv`

Name *[variable name]*	Description *[what is it?]*	Values *[units, valid data types, etc.]*
NestCheckID	Primary key. Unique identifier for each nest visit.	Factor
NestID	Foreign key for the Nests.csv table.	Factor
Check_Date	Date of the nest visit.	Date (MM/DD/YYYY)
Check_Time	Time of the nest visit. Missing values designated with a blank entry.	Time (U.S. Central Daylight Time, UTC+5)
Under_Construction	Indicator variable if the nest was still being built. (1-yes, 0-no)	Indicator
Adult	Ordinal factor for strength of evidence for an active nest based on adult activity. From strongest to weakest: On Nest, Present, Possibly Present, Not Present. Missing values designated with a blank entry.	Categorical
Egg_Temp	Qualitative assessment of egg temperature: Cold, Lukewarm, Warm, Hot. Temperature assessed holding in hand or touched to cheek. Used to assess likelihood nest was still being attended. Missing values designated with a blank entry.	Categorical
Nest_Condition	Categorical assessment of nest condition: (1) Early construction (few structural elements); (2) Late construction (major structure finished, no lining); (3) Pristine; (4) Used; (5) Light damage; (6) Heavy damage; (SL) Slight lean; (HL) Heavy	Categorical

	lean. Used to assess likelihood of nest being attended and the nest outcome. Missing values designated with a blank entry.	
Trampling	Categorical assessment of observer-caused vegetation tramping within 5 meters of the nest after the check was completed and observers had retreated. Minimal, Light, Moderate, Heavy, Severe. For potential use in estimating observer effects. Missing values designated with a blank entry.	Categorical
Host_Eggs	Count of total number of host eggs present. Inviable eggs noted in comments. Missing values designated with a blank entry.	Integer
Host_Young	Count of number of hatched host young present. Missing values designated with a blank entry.	Integer
Est_Host_Age	Estimate of host age in days since incubation or hatch. Egg development viewed by candling and ages determined by comparison to reference images (unpublished). Missing values designated with a blank entry.	Integer, often expressed in a range (character).
BHCO_Eggs	Count of total number of brown-headed cowbird eggs present. Inviable eggs noted in comments. Missing values designated with a blank entry.	Integer
BHCO_Young	Count of number of brown-headed cowbird young present. Missing values designated with a blank entry.	Integer
Est_BHCO_Age	Estimate of brown-headed cowbird age in days since incubation or hatch. Egg development viewed by candling and ages determined by comparison to reference images (unpublished). Missing values designated with a blank entry.	Integer, often expressed in a range (character).
Observer	Foreign key to observer table (redacted for personally identifiable information). The observer who was standing at the nest conducting the check. Missing values designated with a blank entry.	Factor
Comments	General comments	Character

Nests.csv

Name *[variable name]*	Description *[what is it?]*	Values *[units, valid data types, etc.]*
nest_name	Unique formulaic name for nest. The ABA four letter species code, a six-digit discovery date, and a two-digit number to distinguish nests found on the same date.	Factor
nestID	Primary key for the NestID table. This table contains the core information from each nest studied.	Factor
Species	American Birding Association 4-letter species code. "MESP" is a lumped category for EAME and WEME, which were not distinguished.	Factor
AccRej	Indication if this species was treated as accepting or rejecting brown-headed cowbird eggs.	Factor
field_season	The year in which the nest was active.	Integer
Site	Three letter code for research site. Foreign key to other STRIPS research datasets.	Factor
field	General description of nest location. Missing values designated with a blank entry.	Factor
Group	Nesting guild for this species.	Factor
BHCO	Indicator variable for if this nest was parasitized at any point. 1-yes, 0-no.	Indicator
egg_age_discovery	The age of the eggs at discovery. Usually based on candling the egg, but sometimes refined by known incubation or hatching dates. Missing values designated with "NA".	Integer, sometimes expressed as a range (character)
young_age_discovery	The age of the young at discovery. Usually based on examination of plumage, but sometimes refined by	Integer, sometimes expressed as

	known incubation or hatching dates. Missing values designated with “NA”.	a range (character)
FirstFound.egg	The date the nest was discovered to have at least one egg. A critical date (i) for Program MARK. Missing values designated with “NA”.	Integer day-of-season (beginning April 1)
LastPresent.egg	The date the nest was last checked and found to have at least one living egg. A critical date (j) for Program MARK. Missing values designated with “NA”.	Integer day-of-season (beginning April 1)
LastChecked.egg	The date the nest was checked and found to have hatched or failed. For nests that hatched, should be the same as "last_live_check_j_egg". A critical date (k) for Program MARK. Missing values designated with “NA”.	Integer day-of-season (beginning April 1)
Hatched	Indicator if eggs hatched. 1-yes, 0-no.	Indicator
AgeDay1.egg	The age of the eggs on season day 1 (April 1). Age at discovery usually based on candling the egg, but sometimes refined by known incubation or hatching dates. Missing values designated with “NA”.	Integer
FirstFound.nest	The date the nest was discovered to have at least one egg or young. A critical date (i) for Program MARK. Missing values designated with “NA”.	Integer day-of-season (beginning April 1)
LastPresent.nest	The date the nest was last checked and found to have at least one living egg or young. A critical date (j) for Program MARK. Missing values designated with “NA”.	Integer day-of-season (beginning April 1)
LastChecked.nest	The date the nest was checked and found to have fledged or failed. For nests that fledged, should be the same as "last_live_check_j_egg". A critical date (k) for Program MARK.	Integer day-of-season (beginning April 1)

	Missing values designated with "NA".	
AgeDay1.young	The age of the young on season day 1 (April 1). Age at discovery usually based on candling the egg or comparing young to reference photos, but sometimes refined by known incubation or hatching dates. Missing values designated with "NA".	Integer
AgeDay1.nest	The age of the eggs on season day 1 (April 1). Age at discovery usually based on candling the egg or comparing young to reference photos, but sometimes refined by known incubation or hatching dates. Missing values designated with "NA".	Integer
date_discovered_i_egg_no_ibutton	The date the nest would have been discovered to have at least one egg if no iButton were used. A critical date (i) for Program MARK. Missing values designated with "NA".	Date (MM/DD/YYYY)
last_live_check_j_egg_no_ibutton	The date the nest would have been last checked and found to have at least one living egg if no iButton were used. A critical date (j) for Program MARK. Missing values designated with "NA".	Date (MM/DD/YYYY)
last_check_k_egg_no_ibutton	The date the nest would have been checked and found to have hatched or failed if no iButton were used. For nests that hatched, should be the same as "last_live_check_j_egg_no_ibutton". A critical date (k) for Program MARK. Missing values designated with "NA".	Date (MM/DD/YYYY)
date_discovered_i_young_no_ibutton	The date the nest would have been discovered to have at least one young if no iButton were used. A critical date (i) for Program MARK. NA values designated with "NA".	Date (MM/DD/YYYY)

last_live_check_j_young_no_ibutton	The date the nest would have been last checked and found to have at least one living young if no iButton were used. A critical date (j) for Program MARK. Missing values designated with “NA”.	Date (MM/DD/YYYY)
last_check_k_young_no_ibutton	The date the nest would have been checked and found to have fledged or failed if no iButton were used. For nests that fledged, should be the same as "last_live_check_j_young_no_ibutton". A critical date (k) for Program MARK. Missing values designated with “NA”.	Date (MM/DD/YYYY)
outcome	The specific fate of this nest.	Factor
host_young_fledged	Number of young fledged of the nest-building species. Missing values designated with “NA”.	Integer
cowbird_young_fledged	Number of brown-headed cowbird young fledged. Missing values designated with “NA”.	Integer
ibutton_treatment_group	A formal treatment designation for a study on iButton effect on nest survival. Treatments were assigned randomly as "Yes" (received iButton) or "No" (no iButton) or "NA_deployed" or "NA_not_deployed" if the nest was not a part of the study (iButton not randomized). Missing values designated with “NA”.	Factor
iButton	Indicator variable if the nest had an iButton installed. 1-yes, 0-no	Indicator
iButtonStudy	Indicator variable if the nest was randomly assigned an iButton or no iButton. 1-randomized, 0-not randomized	Indicator

ibuttondep	Indicator variable if the nest had an iButton installed. 1-yes, 0-no	Indicator
ibuttonret	Indicator variable if the nest had an iButton retrieved. 1-yes, 0-no	Indicator
camera	Indicator variable for if the nest was monitored with a trail camera. 1-yes, 0-no.	Indicator
NestHt	The height of the nest rim above ground in centimeters. Missing values designated with blank space.	Numeric
Conceal	The estimated concealment of the nest bowl when viewed from above. Measured on the first visit after the predicted fledging date. Estimated with an 8-sectioned black-and-white disk the size of the nest opening viewed from four directions and above, or a simple ocular estimation if a disk measurement was not available. Missing values designated with a blank space.	Percent
DTE	The distance to the nearest hard vegetation feature edge (e.g. crop/grass, grass/mowed path) in meters. Values under 5 m typically estimated in the field. Values greater than 5 m measured in GIS program.	Numeric
nest_landcover	Categorical assessment of landcover in the patch containing the nest. Low diversity, prairie strip, large block grassland, woody, row crop.	Factor
PchAge	Patch age in years.	Integer

logPchAge	Log transformation on PchAge.	Numeric
patch_year	Year patch was planted, determined from historic aerial photos. Older imagery only available on decadal scale or less frequent, in which case age is estimated as the midpoint between available imagery.	Integer, with oldest patches indicated with a “Pre” prefix
PchPAR	The perimeter to area ratio of the patch containing the nest. Meters per hectare.	Numeric
flood_zone	An indicator variable for whether the nest was in a flood-prone low-lying area. 1-yes, 0-no.	Indicator
VegHeight	The height at which 80% of the mass of vegetation is below (visually estimated) during the final vegetation survey. Missing values designated with a blank space.	Numeric
litter_depth_initial.centimeters	The depth of vegetation litter during the initial vegetation survey. Missing values designated with “NA”.	Numeric
litter_depth_final.centimeters	The depth of vegetation litter during the final vegetation survey. Missing values designated with “NA”.	Numeric
dead_vegetation_depth_final.centimeters	The depth/height of dead (mostly vertical, still rooted) vegetation during the initial vegetation survey. Missing values designated with “NA”.	Numeric
VOR	The visual obstruction reading (centimeters obscured) on a Robel pole measured from 5 meters away and 1 meter high from four	Integer

	directions during the final vegetation survey. Values from 10-150.	
LiveGrassCover	The mean percent coverage of live grass in a 1 square meter quadrat at the nest and three points 5 m away. Missing values designated with “NA”.	Numeric
LiveForbsCover	The mean percent coverage of live forbs in a 1 square meter quadrat at the nest and three points 5 m away. Missing values designated with “NA”.	Numeric
DeadVegCover	The mean percent coverage of dead vegetation in a 1 square meter quadrat at the nest and three points 5 m away. Missing values designated with “NA”.	Numeric
LitterCover	The mean percent coverage of dead vegetation litter in a 1 square meter quadrat at the nest and three points 5 m away. Missing values designated with “NA”.	Numeric
BareGroundCover	The mean percent coverage of bare ground in a 1 square meter quadrat at the nest and three points 5 m away. Missing values designated with “NA”.	Numeric
WaterCover	The mean percent coverage of water in a 1 square meter quadrat at the nest and three points 5 m away. Missing values designated with “NA”.	Numeric
mowed	Indicator variable if the nest was mowed over between discovery and the final vegetation survey. Used to	Indicator

	partition the variance from vegetation surveys, since they were much less accurate after being mowed. 1-yes, 0-no.	
Div	Shannon-Wiener diversity index of area within 5 meters of the nest. Missing values designated with “NA”.	Numeric
SpCount	Plant species richness of area within 5 meters of the nest. Missing values designated with “NA”.	Integer
feature_width_at_nest.meters	The minimum distance between hard habitat edges when drawn as a straight line passing through the nest (meters). Missing values designated with “NA”.	Numeric
HighDiv20	The proportion of landcover within 20 m of the nest in high-diversity grassland.	Numeric
Ppn20LowDiv	The proportion of landcover within 20 m of the nest in low-diversity grassland.	Numeric
Ppn20Woody	The proportion of landcover within 20 m of the nest in woody landcover.	Numeric
Ppn20RowCrop	The proportion of landcover within 20 m of the nest in row crop.	Numeric
Ppn20Dev	The proportion of landcover within 20 m of the nest developed (roads, lawns, buildings).	Numeric
HighDiv100	The proportion of landcover within 100 m of the nest in high-diversity grassland.	Numeric

Ppn100LowDiv	The proportion of landcover within 100 m of the nest in low-diversity grassland.	Numeric
Ppn100Woody	The proportion of landcover within 100 m of the nest in woody landcover.	Numeric
Ppn100RowCrop	The proportion of landcover within 100 m of the nest in row crop.	Numeric
Ppn100Dev	The proportion of landcover within 100 m of the nest developed (roads, lawns, buildings).	Numeric
Fate.nest	Indicator variable for if the nest fledged young (host or cowbird). 1-yes, 0-no.	Indicator

----- METHODS AND MATERIALS -----

----- DATA COLLECTION METHODS -----

Field data collection
We searched for nests of grass- and shrub-nesting birds in Iowa, USA, during the 2015–2017 breeding seasons. Study areas were selected for the presence of prairie strips and other grass conservation features and were located within 100 km of Ames, Iowa (42.031175°N, 93.631528°W).

Perennial vegetation, fencerows, and crop fields were searched for bird nests by 2–4 observers walking abreast and watching for birds flushing from nests. In 2015, most nests encountered were monitored with a miniature thermal data-logger as part of a larger nest survival study, but assignment of data-loggers was not randomized. In 2016 and 2017, when we located a nest in the laying, incubation, or nestling stages, we flipped a coin to determine if it received a data-logger or was held as a control. In 2017, only nests of nest parasite egg-rejecter species were included in our study. We attempted to visit all nests every 2–4 days regardless of data-logger presence. Incubation stage was determined by candling eggs on the day of discovery and again on the first revisit, and nests were revisited and data-loggers retrieved after predicted fledge dates. Nest fate was determined by nest condition, presence of feather sheaths or fecal sacs, and behavioral cues from parents.

We used the iButton Thermochron as the temperature data-logger for this study. iButton brand data-loggers record temperatures at a constant interval between 1–255 min. We used model DS1921G, which was accurate to ±1°C (Celsius) at temperatures between −30°C to +70°C with a resolution of 0.5°C and memory to store 2048 temperature readings. We programmed them to record temperatures every 20 min, allowing the units to operate for 28.4 days before running out of memory.

After activation, monofilament lines with two 15–20 cm strings were attached to data-loggers using hot-melt adhesive thermoplastic to provide a method of securely tying them inside nests. Finally, data-loggers were dipped into clear PlastiDip brand liquid plastic coating to provide additional weatherproofing and improve the attachment of the hot glue and monofilament line to the steel case. The finished color was dull grey. The two monofilament lines could be passed through the wall of a nest using a 10- cm drapery sewing needle and securely tied outside the nest, securing the data-loggers at the bottom of nest bowls in contact with eggs or young. For ground nests with minimal structure, we affixed data-loggers to 7.6-cm nails with hot glue and dipped them in liquid plastic so they could be anchored to the ground. Installation took 1-5 min, depending on nest substrate, height, and investigator access. Environmental control data-loggers were not needed to recognize the time at which the nest temperature returned to ambient conditions.

Vegetation surveys

On both the discovery visit and the visit after predicted fledge date, we visually estimated the percent of the nest bowl obscured by vegetation from 1 m overhead unaided and estimated again from above and each cardinal direction using a black-and-white-sectioned disk. We measured height of the nest rim above ground as well as the height which contained 80% of the visually estimated mass of living vegetation, dead vegetation, and litter within 10 cm of the nest. To minimize footfalls, if the nearest habitat edge was within 5 m, we visually estimated the distance-to-edge using a 1 or 1.5 m reference. If the distance to nearest edge was further than 5 m, we measured it using a GIS system at a later date.

On the first visit when the nest was no longer active we noted the nest condition, number and condition of non-viable eggs and young, and retrieved the temperature data logger. Any clues as to the fate of the nest were also recorded, such as damage to the nest, remaining eggs and their condition, flattening of the rim, or presence of fecal sacs or feather sheaths.

After a nest succeeded or failed and had reached the predicted fledging date, we conducted more disruptive vegetation measurements. We re-measured heights of live vegetation, dead vegetation, and litter and re-estimated nest concealment. We determined vegetation composition in 4, 1 m2 quadrats with one centered on the nest and three spread around the nest 5 m away in the 0°, 120°, and 240° directions. Directions were estimated based on N-S or E-W references and distances were typically paced out. Within each quadrat, percent covers of live grass, live forbs, dead vegetation, litter, bare ground, and water were visually estimated. We identified vegetation within quadrats to species when possible, otherwise to genus level and estimated percent covers. We conducted a search of up to 5 person-minutes within 5 m of the nest to locate and identify any plant species not already recorded within one of the four quadrats. Notes were taken on mowing, spraying, or other human disturbance within 5 m of the nest.

Landscape measures

Patch and landscape-level landcover metrics were calculated in R using package `landscapemetrics` and a landcover polygon layer that was hand-digitized in ArcMap 10. Landcover classes were determined based on interpretation of NAIP aerial images, LiDAR, and on-the-ground verification. Polygon-based landcovers were converted to a 1 m pixel landcover raster with patches defined using rook's case. Landscape metrics calculated included the patch perimeter-area ratio, nest distance to edge, and proportion of low- and high-diversity grassland, woody cover, row crop cover, and developed landcover at 20, and 100 m radii.

Data simulation

Nest data were generated in R and analyzed using package RMark to interface with Program MARK. Datasets of nests were simulated using code modified from Gibson et al. (2016). We modeled nest histories on a 12-day incubation period, with nests surviving 12 days (until hatch) considered successful. We applied a constant daily survival rate (DSR) of 0.91, which was the value we estimated using our dataset of 141 Red-winged blackbird nests. With each simulation iteration, we created datasets starting with 40, 100, and 400 nests, with each nest having a start date of the first day of incubation and a random failure date that had a geometric distribution with a DSR of 0.91.

We then applied a binomial trial for detection versus non-detection with a detection probability of 0.75 for each day each nest was active. Each nest was entered into the detection history on the date of first discovery. Completed nest detection histories held fewer than the starting number of nests because some nests failed before simulated discovery. A detection probability of 0.75 was chosen because the resulting distribution of age at first discovery approximated the distribution in our real data. We assumed nests were aged correctly upon discovery and that all incubation periods were exactly 12 days so that fate was accurately known.

Two encounter histories were then created from each nest detection history. The in-person encounter history (j-day) was created by determining the first day a nest was detected in the detection history, its status starting on the day discovered, and its status at a fixed interval of j days thereafter where we investigated j = {2, 3, 4, 5, 6, 7}. We also created a data-logger-based encounter history (1-day) by determining the first day a nest was detected in the same detection history and checking its status every day thereafter (i.e., j = {1}). We assumed that nest fate could be accurately assessed on the next regularly scheduled visit. Each pair of encounter histories based on the same set of simulated nests was then analyzed using package RMark in Program R to compare effective sample size, estimated DSR, and standard error of the estimated DSR. Each run of the simulation created paired 1-day and j-day encounter histories for every combination of starting nest count (40, 100, or 400 nests) and visit intervals (j = {2–7} days). The simulation was iterated 5000 times to produce 5000 pairs of encounter histories for each of 18 nest count and visit interval combinations.

To further investigate our second objective, we also analyzed real nest data for species where we found more than 30 nests. For each species, we created two sets of encounter histories for nests monitored with data-loggers in 2015 and 2016. The first encounter history (j-day) was based only on data obtained from in-person visits made to the nest and the second encounter history (1-day) was based only on data-logger data and one in-person visit near the predicted hatching date. Encounter histories for the real nest data were analyzed using the RMark package in R for differences in effective sample size, estimated DSR, and the associated precision.

----- DATA PROCESSING METHODS -----

Nest covariates were screened for outliers by viewing histograms and other summary data. Very high or low values were checked for data entry errors by viewing the paper data sheet. Database entries that were clearly typos were corrected in the original database but extreme values that matched the paper datasheet were not modified. Aside from this data-entry-error screening, the field data included is raw except for any calculations noted in the data dictionary. Missing values are donated by “NA” or a blank entry.

------- SOFTWARE -------

Name: R
Version: 4.0.2
Developer: R Core Team
Additional Notes: Developed under versions going back to 2015, but compatible with 4.0.2

Name: Program MARK
Version: 9.X
System Requirements:
URL: www.phidot.org
Developer: Gary White
Additional Notes: Required to run R package RMark

------- LICENSING -------