Metadata

Dataset title:

Data for integrated population models for white-headed woodpeckers in national forests of Oregon and Idaho, USA

Abstract

These data and code are for reproducing analyses in Miller-ter Kuile et al. *in review* "Effects of forest restoration on focal bird populations depend on life stage and underlying habitat and climate context". In this paper, we collate data on nesting and occupancy for white-headed woodpeckers (*Dryobates albolarvatus*) in three national forests in Oregon (Fremont-Winema and Malheur) and Idaho (Payette), USA. We develop a two-step integrated population model (IPM) that incorporates data on each life stage and covariates and covariate effects important to each life stage and estimates population-level estimates of 1) population trends and 2) relationships between population growth and life-stage survival for egg, nestling, and adult survival. We then used hierarchical partitioning to explore 3) the relative contribution of forest restoration, habitat, and climate variables to each stage and to population growth.

The code are divided into custom functions, data cleaning steps, analyses, and visualization steps. Data are divided by type, including response data (bird data) and covariate data.

Creators

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License

Keywords

avian ecology, dynamic occupancy models, *Dryobates albolarvatus,* focal species monitoring, hierarchical partitioning, integrated population modeling, *Pinus ponderosa*, white-headed woodpecker

Funding of this work

PI	Funding Agency	Funding Identification Number
Jamie Sanderlin	USFS	20-JV-11221635-196

Timeframe

- Begin Date: 2012
- End Date: 2025
- Data collection: compete

Geographic location

Fremont-Winema National Forest:

- Verbal Description: Fremont-Winema National Forest
- North bounding coordinate: 42.94
- South bounding coordinate: 42.46
- East bounding coordinate: -120.67
- West bounding coordinate: -121.48

Malheur National Forest:

- Verbal Description: Malheur National Forest
- North bounding coordinate: 44.46
- South bounding coordinate: 43.59
- East bounding coordinate: -118.11
- West bounding coordinate: -119.84

Payette National Forest:

- Verbal Description: Payette National Forest
- North bounding coordinate: 45.65
- South bounding coordinate: 44.64
- East bounding coordinate: -113.96
- West bounding coordinate: -116.38

Taxomonic species or groups

Dryobates albolarvatus (white-headed woodpecker)

Pinus ponderosa (ponderosa pine) ecosystems

Methods

Study sites and species

In this project, we compiled data for three populations of white-headed woodpeckers in Oregon and Idaho, USA. Each population was surveyed for 6-8 years during 2012-2021. The three populations of white-headed woodpeckers occurred in three forested landscapes that have been part of landscape-scale forest restoration efforts through the Collaborative Forest Landscape Restoration Program (CFLRP; https://www.fs.usda.gov/restoration/CFLRP/index.shtml). The landscapes included the Lakeview Stewardship Project (42.2° N, 120.2° W, Fremont-Winema National Forest) and Southern Blues Restoration Coalition (44.0° N, 118.7° W, Malheur National Forest) in Oregon, USA, and the Weiser-Little Salmon Headwaters Project (44.8° N, 116.5° W, Payette National Forest) in Idaho, USA. CFLRP landscapes experienced a combination of forest restoration management treatments, including tree removal (primarily of small trees of 13-51 cm diameter-at-breast-height) followed by prescribed burning. CFLRP landscapes were relatively insulated from other suitable habitat patches within and around each national forest due to a combination of habitat type and land use. Thus, treating these landscapes as relatively distinct population ranges allowed us to examine the direct effects of CFLRP management actions on white-headed woodpeckers while also comprising a landscape with relatively similar management history compared to surrounding areas (which consisted of private and state lands along with other portions of each national forest).

Bird surveys

Surveys were conducted to quantify adult woodpecker occupancy and locations and fates of nests, including how many eggs, nestlings, and fledglings were associated with each nest. We surveyed adult white-headed woodpeckers in each population along 27-30 transects. Transects were 2700 m long, with 10 survey points every 300 m along each transect. Approximately half of the transects were placed in areas that received forest restoration treatments (e.g., burning, thinning/harvesting, or both) and half in areas that did not receive forest restoration treatments within the timeframe of our study (2012-2021). At each transect point, field technicians performed call-broadcast surveys to determine the presence or absence of adult white-headed woodpeckers. If technicians observed an adult white-headed woodpecker, they also searched for nests in the surrounding area. Surveyors also re-visited nest trees that had been occupied by white-headed woodpeckers in previous years. When surveyors located active nests, they used pole-mounted cameras to observe nest contents. We revisited nests throughout the season and tracked the number of eggs, nestlings, and fledglings from each nest. We determined pre-fledgling sex ratios using color-photo and video camera data collected during nest visits. Numbers of female and male nestlings were determined for each nest from the number of red feathers on each nestling's pileum, males having noticeably more than females (J. Dudley unpublished data).

Environmental covariates

For nest stages, we used previously published information on covariates that shape egg number, egg survival, and nestling survival (see *Data Provenance* section of metadata). This study examined the relationships between each of these nesting stages and a set of covariates for each nest location that captured ecological variables related to physiology, foraging, and habitat risk (e.g., nest predation risk) at multiple spatial scales. These included nest-tree and stand-scale (2.25 ha) covariates collected during field surveys along with a set of variables at the landscape-scale (314 ha) that captured restoration treatment extent, climate, and forest habitat. In summary, white-headed woodpeckers lay four eggs on average, regardless of other factors (covariates). However, egg survival is shaped by stand-scale forest restoration treatment category, variation in the size of closed-forest (40-100% canopy cover) patches at the landscape scale, average monthly maximum temperature, and cumulative precipitation during the period when nests have eggs. Nestling survival is shaped by stand-scale forest restoration treatment category, landscape-scale percent burned, nest tree species, nest height, nest initiation date, average monthly maximum temperature, and cumulative precipitation during the period when nests have nestlings.

In addition to these known covariates for nesting stages, we also compiled a set of landscape-scale (1 km-radius, 314 ha) variables that can influence adult occupancy. These included covariates related to forest restoration treatment (percent burned and percent tree removal), canopy cover (closed [70-100%] and open [10-40%] canopy cover classes), and seasonal (winter and spring) climate variables (cumulative precipitation and mean temperature) at each transect survey point. We used the US Forest Service Activities Tracking System database (FACTS, https://www.fs.usda.gov/managing-land/natural-resource-manager) to determine the timing and aerial extent of forest restoration treatments. We compiled canopy cover classes annually from 2012-2021 using the US Forest Service Tree Canopy Cover product suite (Science TCC, version 2021.4, https://data.fs.usda.gov/geodata/rastergateway/treecanopycover/) after applying a mask using LANDFIRE EVT (CONUS LF 2022, https://landfire.gov/vegetation/nvc) that maintained all tree lifeforms for existing vegetation. We used ClimateNA for summarizing climate related covariates from 2012-2021 (Wang et al. 2016) and calculated all landscape metrics using ArcGIS Pro 3.0 focal statistics (ESRI 2022). We ran a model of adult occupancy with a full set of potential covariates and selected important covariates to include in the two-step population modeling methods.

Modeling framework

We aimed to understand the combined effects of forest restoration, climate, and habitat variables on the three white-headed woodpecker populations. To develop this understanding and to address our research questions, we implemented a two-step modeling process. First, we fit a Bayesian statistical model to each life-stage specific dataset available for each population: 1) egg production, 2) egg survival, 3) nestling survival, 4) dynamic adult occupancy (using the "persistence" term as a proxy for initial population size and adult survival), and 5) pre-fledgling sex ratios. Second, we used 1050 posterior samples of the regression coefficients (covariate effects and intercepts) from each statistical model as inputs, along with original nest- and landscape-scale covariates into a stage-structured, integrated population model (IPM).

More information on the modeling can be found in the main article, though we provide an overview here.

Step 1: Statistical models for population life-stage data

For egg production, egg survival, and nestling survival, we used covariates previously shown to be important for each life stage. For adult survival, we used a dynamic, multi-season occupancy model including only those covariates that had non-zero effects based on Bayesian p-values from a model with all potential covariates. We used covariates that drive year-to-year persistence at survey locations as covariates for both initial adult occupancy and as a proxy for adult apparent survival. We also determined that the proportion of female near-fledging nestlings was not related to variables that could potentially impact sex ratios in birds, including brood size and nest initiation date.

Step 2: Integrated population model overview

To incorporate the statistical models into the IPM, we built a stage-structured, female-only population model that included eggs, nestlings, fledglings, breeding adults, and non-breeding adults. This model included rates of egg production (f) and transitions between different population stages, including egg survival (ϕ_{egg}), nestling survival (ϕ_{nstl}), fledgling survival (ϕ_{fl}) (within a year), adult survival (ϕ_{ad}), and adult transition between breeding and non-breeding states (w) (at the end of a year). Fledglings that survive (within a year) are divided into the fraction that transitions to breeding (p_{Br}) and non-breeding (1-p_{Br}) adults. We did not estimate inputs/losses due to immigration/emigration because we assumed populations were relatively closed within the timeframe of data collection (nesting season; May-August). The dynamic IPM thus simulates the numbers of eggs (N_{egg}), nestlings (N_{nstl}), and fledglings (N_{fl}) within a year, and the numbers of breeding adults (N_{Br}) and non-breeding adults (N_{NBr}) at the end of a year within a CFLRP landscape.

The IPM includes modules for egg production, nestling survival, fledgling survival, and adult survival, all of which are informed by the life stage statistical models implemented in step 1. Hence, the IPM includes important environmental covariates for each vital rate based on the statistical models. Inputs to the IPM include: 1) relevant covariate timeseries for each nest location and a set of "potential occupancy" points for adults (more information below in this section) and 2) 1050 posterior samples of the covariate effects and intercept values from each life stage statistical model (i.e., 350 independent samples from each of three MCMC chains). We sampled from the posterior distributions by randomly drawing a posterior sample of associated parameters (intercepts and covariate effects) from the 1050 values for each complete simulation of the IPM. As a result, within a given complete run of the IPM, a vector of parameters was drawn from the posterior distributions generated by the statistical models, thus maintaining the posterior correlation structure of the parameters.

We summarized rates of transition between population stages at the yearly level by averaging across nests or potential adult occupancy locations within a year. When any of the three populations were not surveyed for a given vital rate in a given year, we estimated the missing transition probability values based on the mean of that vital rate for the year before and the year after for that population (to account for potential temporal correlation in forest management variables).

We assumed that nests were randomly sampled from the total "population" of nests for white-headed woodpeckers associated with each forest landscape such that nests represented the range of possible conditions for each of the three populations.

Conversely, because the adult occupancy survey design over-sampled areas that experienced forest management relative to the total national forest landscape, we did not assume that survey locations represented a random sample of possible occupied points. Instead, we used these data for fitting the adult occupancy life stage statistical model, from which we pulled the intercept and covariate effect posterior samples. We then generated a set of gridded "potential occupancy" points for each population (Fremont-Winema: n = 3925; Malheur: n = 4199; Payette: n = 3937) at a regular distance of 1 km across each entire CFLRP landscape. The distance between points was based on previous studies on space use and home range size for white-headed woodpeckers. We pulled covariate values for each of the gridded points from remotely sensed datasets (including: FACTS, ClimateNA, Science TCC, and LANDFIRE EVT, see section: *Environmental covariates*) to better represent the underlying distribution of important covariates for adult population rates.

Data Provenance

Data included in this paper are both novel to this project and previously published.

Dataset title	Dataset DOI/url	Creator	Contact
Data for: Forest management, forest vegetation, and climate influence nesting ecology of a focal bird species in the western USA	https://www.fs.usda.gov/rds/archive/catalog/RDS-2023-0053	A. Miller-ter Kuile J. Dudley V. Saab K. Ogle J. Sanderlin	Jonathan Dudley jonathan.dudley@usda.gov

Data objects

We describe the data objects in the "data_raw" folder, since these are the raw data we compiled for this project. Other data objects that are the product of data cleaning or analyses can be found in the "Other Objects" section with short descriptions below and can be found in the "data" folder.

Data Table: Birds01_nest_locations.csv

Column name	Description	Unit or code explanation or data format	Missing value code
Year_located	Year nest was located	YYYY	
Date_located	Date nest was located	YYYY-MM-DD	YYYY-99-99
Project_ID	Monitoring project when nest was located	EM_FWOR: Fremont-Winema EM_MAOR: Malheur EM_PAID: Payette	
Species	Species of bird observed	Four-letter species codes, usually WHWO: white-headed woodpecker	
1st_Observer	First person to observe nest	initials of the observer	

Column name	Description	Unit or code explanation or data format	Missing value code
Nest_ID	The specific ID given to each nest, which includes project, transect, point, and year IDs	Format: Project_Transect_Point_Year	
Cavity_ID	The ID of cavities without the project or year info, relevant when cavities are re-used across years	format of: Transect_point	
Nest_Trt	Forest restoration treatments that occurred at nest	Some combination of letters to include all treatment categories, including: U - untreated OB - other type of burn B - burn H - harvest of larger trees T - thinning of smaller trees OA - other aspen treatment OH - other harvest category	
Transect_ID	Identifier for the transect the nest was located one		
Point_ID	Identifier for the point on the transect nearest the nest location		
Direction	Direction from the transect point to the nest	Degrees	999
Distance	Distance from the transect point to the nest	Meters	999
UTM_E	Easting coordinate		
UTM_N	Northing Coordinate		
UTM_datum_zone	Datum zone for UTM		
Nest_Ht	Height of nest above ground	meters	
Cavity_age	Age of cavity	N - new O - old	
Decay_class	Decay class of cavity snag/tree		
Tree_Snag_Log	Whether the nest was in a living tree, a standing snag, or a log		

Column name	Description	Unit or code explanation or data format	Missing value code
Tree_sp	The species of tree that the cavity was located in	Four- or five-letter species code: JUOC PIPO - ponderosa pine CEDO - cedar ABCO - true fir POTR5 - quaking aspen PSME - Douglas-fir ABGR - true fir PSMEG - Douglas-fir	
Tree_ht	Height of tree or snag	meters	
DBH	Diameter at breast height of tree or snag	centimeters	
Orientation	Orientation of the cavity	degrees	
Aspect	Aspect of the slope tree or snag is located on	degrees	
Slope	The slope of the location of the snag/tree		
Comments	Any additional comments		

Data Table: Survey02_points.csv

Column name	Description	Unit or code explanation or data format	Missing value code
Point_ID	The identifier for the point on the transect		
UTM_E	Easting coordinate		
UTM_N	Northing coordinate		
DATUM	UTM zone for the coordinate		
ELEV	Elevation of the point	meters	
Transect_ID	ID for the transect where the point is located		
Point_no	The point number of the transect		
YR_Treated	Year that forest restoration treatments were enacted	YYYY	999

Column name	Description	Unit or code explanation or data format	Missing value code
Treatment_Description	Description of treatments drawn from facts		
FACTS_ID	ID from the FACTS database		
Sale_Name	Information on the sale name, if appropriate, from FACTS		

Data Table: Survey03_point_visits.csv

Column name	Description	Unit or code explanation or data format	Missing value code
Visit_ID	The visit ID for that point and that transect	format: Project_Transect_Point_Year_Date	
Point_ID	The point on the transect for that visit	Project_Transect_Point	
Survey_Date	The date of the visit	YYYY-MM-DD	
Visit_no	The repeat visit number, usually either the first or second		
St_time	The start time of the survey	H:MM:SS AM/PM	
Survey_length	The length of the survey		
Wind	wind speed	ordinal 0+	
Temp_C	Temperature in celcius	degrees C	999
Observer	Initials of person who was observing for birds		
Recorder	initials of person who was recording data		
Reviewer	Initials of person who was reviewing the data		
Comments	any comments on the visit		

Data Table: Survey04_point_detections.csv

Column name	Description	Unit or code explanation or data format	Missing value code
Visit_ID	The visit ID for that point and that transect	format: Project_Transect_Point_Year_Date	
Species	The species of bird observed	usually or always WHWO	
Detection	How the detection occurred	V - visual A - audio	
Distance_class	How far away the bird was, binned into distance classes	0_50: 0 to 50 m 50_150: 50 to 150 m ovr_150: over 150 m	blank
Time_left_min	minutes left in survey	minutes	999
Time_left_sec	seconds left in survey	seconds	999
Comments	Any comments on the observation		
Period	Whether or not the bird was counted before the survey started	TR - before DU - during AF - after	

Data Table: CFLRP_ClimateNA_data_transects_nests_2011-2021

Column name	Description	Unit or code explanation or data format	Missing value code
Location	the project ID for the point	EMFWOR - Fremont-Winema EMMAOR -Malheur EMPAID - Payette	
Pt_type	Whether it was a nest site or a transect point		
TransID	The transect ID for the data		
MeasurementID	More specific either PointID or NestID, depending on Pt_type		
ClimateYear	The year the climate data are from		
Tave01:Tave12	Monthly average temperature (C) data, with 01 corresponding to January; 12 to December	degrees C	

Column name	Description	Unit or code explanation or data format	Missing value code
PPT01:PPT12	Monthly cumulative precipitation (mm) data with 01 corresponding to January; 12 to December	mm	
Tave_wt	Average temperature in winter months	degrees C	
Tave_sp	Average temperature in spring months	degrees C	
Tave_sm	Average temperature in summer months	degrees C	
Tave_at	Average temperature in autumn months	degrees C	
PPT_wt	Cumulative precipitation in winter	mm	
PPT_sp	Cumulative precipitation in spring	mm	
PPT_sm	Cumulative precipitation in summer	mm	
PPT_at	Cumulative precipitation in autumn	mm	

Data Tables: IPM_backgroundpts_climatedata_2000-2023_n12061_reduced_variables_*.csv

There are three of these with the same structure. "LKV" corresponds to the Fremont-Winema, "MAL" to the Malheur, and "PAY" to the Payette. The structure of all three is the same.

Column name	Description	Unit or code explanation or data format	Missing value code
ID_Pt_YR	Identifier for the point and year of data		
ID_Pt	Identifier for just the point		
YR	Year of climate data	YYYY	
UTM_E	Easting coordinate		
UTM_N	Northing coordinate		
UTM_zone	UTM zone for UTM coordinates		
Latitude	latitude	degrees	
Longitude	longitude	degrees	
Elevation	Elevation of the point	meters	
Tave_wt	Winter average temperature	degrees C	
Tave_sp	Spring average temperature	degrees C	
Tave_sm	Summer average temperature	degrees C	
Tave_at	Autumn average temperature	degrees C	
PPT_wt	Winter cumulative precipitation	mm	

Column name	Description	Unit or code explanation or data format	Missing value code
PPT_sp	Spring cumulative precipitation	mm	
PPT_sm	Summer cumulative precipitation	mm	
PPT_at	Autumn cumulative precipitation	mm	

Data Table: *_SCIbased_IPMdata_backgroundpts_CCandFACTS_ThinData.csv

One for each of EMFWOR (Fremont-Winema), EMMAOR (Malheur) and EMPAID (Payette). Data are the same in each.

Column name	Description	Unit or code explanation or data format	Missing value code
ID	Identifier for the background point		
sci11_1040_1km: sci21_1040_1km	Value of canopy cover in the 10-40% canopy cover class (open canopy) between 2011-2021. Format is “sci”YY_canopy_scale	percent	
Thin0211: Thin0223	Value of percent of 1km landscape that has received harvest and thin treatments between 2011 - 2021. Format is “Thin02”YY	percent	

Data Table: *_SCIbased_IPMdata_n280_transect_pts_CCandFACTS_ThinData.csv

One for each of the three populations. EMFWOR: Fremont-Winema, EMMAOR: Malheur, EMPAID: Payette

Column name	Description	Unit or code explanation or data format	Missing value code
Point_ID	The ID for the point on the transect for the data		

Column name	Description	Unit or code explanation or data format	Missing value code
sci12_010_1km: sci21_010_1km	Percent of landscape in the 0-10% canopy cover class at the 1km radius scale. Format is sci"YY"_010_1km	percent	
sci11_1040_1km: sci21_1040_1km	Percent of landscape in the 10-40% canopy cover class at the 1km radius scale. Format is sci"YY"_1040_1km		
sci11_4070_1km: sci21_4070_1km	Percent of landscape in the 40-70% canopy cover class at the 1km radius scale. Format is sci"YY"_4070_1km		
sci12_GT70_1km: sci21_GT70_1km	Percent of landscape in the 70-100% canopy cover class at the 1km radius scale. Format is sci"YY"_GT70_1km		

Data Table: *_LF-based_OccupData_n270_transect_pts.csv

One for each landscape. EMFWOR: Fremont-Winema; EMMAOR: Malheur; EMPAID: Payette

Column name	Description	Unit or code explanation or data format	Missing value code
Ha211_1000: Ha221_1000	Percent of landscape with harvested treatment in each year at the 1km radius scale. Format is HA2"YY"_1000	percent	
Bu211_1000: Bu221_1000	Percent of landscape with burned treatment in each year at the 1km radius scale. Format is Bu2"YY"_1000	percent	
X1shdi211_1000: X1shdi221_1000	Shannon diversity of treatment at the 1km radius scale. Format is X1shdi2"YY"_1000	Shannon-diversity metric	

Data Table: Survey_points.csv

duplicate of Survey02_points.csv

Column name	Description	Unit or code explanation or data format	Missing value code
Point_ID	The identifier for the point on the transect		
UTM_E	Easting coordinate		
UTM_N	Northing coordinate		
DATUM	UTM zone for the coordinate		
ELEV	Elevation of the point	meters	
Transect_ID	ID for the transect where the point is located		
Point_no	The point number of the transect		
YR_Treated	Year that forest restoration treatments were enacted	YYYY	999
Treatment_Description	Description of treatments drawn from facts		
FACTS_ID	ID from the FACTS database		
Sale_Name	Information on the sale name, if appropriate, from FACTS		

Scripts/code (software)

in the "00_functions" folder

File name	Description	Scripting language
hp_functions.R	functions for hierarchical partitioning for the statistical models and IPM	R
rhat_functions.R	Functions for graphing convergence statistics	R
tidy_functions.R	Functions for tidying different datasets	R

in the "01_cleaning" folder

File name	Description	Scripting language
00_breeding_prop.R	script to determine the number of adults associated with nests in the occupancy survey as an estimate for breeding proportions	R

in the "02_parameter_models" folder:

File name	Description	Scripting lan-guage
egg_num_model_run.R	wrapper script to run the egg number model with intercepts by forest population	R
egg_number_byforest.R	the JAGS model for egg number	JAGS
egg_s_hierarchical_partitioning_*.R	one for each population: hierarchical partitioning wrapper script for egg survival model	R
egg_survival_model_run.R	wrapper script for running the egg survival model for each population	R
egg_survival_byforest.R	JAGS model for running the egg survival model	JAGS
eggs_*.R	one JAGS model for each of the nested combinations of covariate groups for hierarchical partitioning for egg survival model	JAGS
nestling_s_hierarchical_partitioning_*.R	one for each population: hierarchical partitioning wrapper script for nestling survival model	R
nestling_survival_model_run.R	wrapper script for running the nestling survival model for each population	R
nestling_survival_byforest.R	JAGS model for running the nestling survival model	JAGS
nstls_*.R	one JAGS model for each of the nested combinations of covariate groups for hierarchical partitioning for nestling survival model	JAGS
01_prep_observation_data.R	prep observed detection data for WHWO adult occupancy for full model	R
02_prep_climate_data.R	prep climate data for WHWO adult occupancy for full model	R
02c_landscape_variables.R	prep landscape data for WHWO adult occupancy for full model	R
03_combine_occupancy_data.R	combine occupancy data and covariates for WHWO adult occupancy for full model	R
04_prepand rundynmodel.R	prep data list and test for WHWO adult occupancy for full model (we ran on the computing cluster)	R

File name	Description	Scripting language
05_ModelConvergence.R	check model convergence from adult occupancy full model	R
06_pvalues.R	find important covariates based on Bayesian p-values for adult occupancy full model	R
adult_hierarchical_partitioning_*.R	one for each population: Hierarchical partitioning wrapper script for the adult occupancy model for EMFWOR (Fremont-Winema)	R
adult_occ_model_run_*.R	one for each population: Wrapper script to run the reduced occupancy model for Fremont-Winema	R
adult_occ_model_run.R	Wrapper script to run the reduced occupancy model for all data	R
adult_dyn_occupancy_full.R	JAGS model to run the full model with variable selection for adult occupancy	JAGS
adult_dyn_occupancy_reduced.R	JAGS model to run the reduced model for adult occupancy	JAGS
adult_*.R	one JAGS model for each of the nested combinations of covariate groups for hierarchical partitioning for adult occupancy model	JAGS
sex_ratio_model_run.R	wrapper script for the female ratio model - both full and reduced	R
sexratio_byforest_allcovariates.R	JAGS model with the full covariates for the female ratio model	JAGS
sexratio_byforest_nocovs.R	JAGS model without covariates for the female ratio model	JAGS

In the "01_Full_IPM" folder:

File name	Description	Scripting language
00_data_summaries.R	explorations of covariates for the IPM	R
00_prep_background_points.R	one for each of the three populations: prep the background occupancy points for the IPM	R
01_submodel_covariate_prep.R	one for each of the three populations: prep the covariates for each submodel for the IPM	R
01_submodel_posterior_array_prep_*.R	one for each of the three populations: prep the posterior covariate effect samples for the IPM	R

File name	Description	Scripting language
03_combine_data_list.R	one for each of the three populations: combine all data for each population for the IPM	R
04_run_model.R	one for each of the three populations: run the IPM	R
05_run_hp.R	one for each of the three populations: run hierarchical partitioning the IPM	R
IPM_November2024.R	The IPM model, which can be run for any population	R

In the "04_visualizations" folder:

File name	Description	Scripting language
covariate_figure.R	Figure to create the covariate categories and directions figures	R
hp_figures.R	Creates the hierarchical partitioning figure	R
pop_trends.R	Creates the population trends figure	R
population_relationships.R	Creates the figure with relationships between stages and population growth	R
SI_backgroundhabitat.R	Creates supplementary figures on the environmental variables of each population	R
SI_GOF.R	Supplementary figures to generate goodness-of-fit for occupancy model	R
SI_Kozma.R	supplementary figure to compare our adult survival values with those published from mark-recapture	R

Other objects

Our process involved incorporating raw data (described in data tables above) into a set of cleaned datasets and model outputs and summaries. Below we provide the names, descriptions, and locations of these objects in addition to the data objects we pulled directly from previous work (see Data Provenance section above).

File name	Description	Format	Location
01_occupancy_observations.csv	output of prepping the occupancy observation data	.csv	data -> 00_occupancy_all_vars
02_occupancy_climateseasonal.csv	climate data for occupancy model	.csv	data -> 00_occupancy_all_vars
04_occupancy_landscape.csv	landscape data for occupancy model	.csv	data -> 00_occupancy_all_vars
05_occupancy_observations_with_indexing.RDS	data prepped for running in the model with JAGS indexing	.RDS	data -> 00_occupancy_all_vars
Egg_production_data.csv	tidy data for the egg number model from previously-published work	.csv	data -> 01_parameter_model_inputs -> 01_egg_num
Egg_Nestling_survival_data.csv	tidy data for the egg and nestling survival models from previously-published work	.csv	data -> 01_parameter_model_inputs -> 02_egg_survival
egg_s_data_list_*.RDS	one for each population: JAGS input data for egg survival	.RDS	data -> 01_parameter_model_inputs -> 02_egg_survival
egg_s_data_list.RDS	JAGS input data for egg survival	.RDS	data -> 01_parameter_model_inputs -> 02_egg_survival
Egg_Nestling_survival_data.csv	tidy data for the egg and nestling survival models from previously-published work	.csv	data -> 01_parameter_model_inputs -> 03_nestling_survival
nestling_s_data_list_*.RDS	one for each population: JAGS input data for nestling survival	.RDS	data -> 01_parameter_model_inputs -> 03_nestling_survival
nestling_s_data_list.RDS	JAGS input data for nestling survival model	.RDS	data -> 01_parameter_model_inputs -> 03_nestling_survival
01_occupancy_observations.csv	data on occupancy presence absence data for adults	.csv	data -> 01_parameter_model_inputs -> 04_adult_occupancy
n_occ_covariates.csv	covariates compiled for the adult occupancy full model	.csv	data -> 01_parameter_model_inputs -> 04_adult_occupancy
adult_data_list.RDS	data list for JAGS model for all covariates for adult occupancy	.RDS	data -> 01_parameter_model_inputs -> 04_adult_occupancy

File name	Description	Format	Location
reduced_adult_ data_list_*.RDS	one for each population: data list for reduced JAGS model	.RDS	data -> 01_parame- ter_model_inputs -> 04_adult_occupancy
reduced_adult_ data_list.RDS	data list for reduced JAGS model	.RDS	data -> 01_parame- ter_model_inputs -> 04_adult_occupancy
Sex_ratio_data.csv	Tidy data for the female ratio model	.csv	data -> 01_parame- ter_model_inputs -> 05_sex_ratios
sexratio_data_ list.RDS	JAGS data input list for the female ratio model	.RDS	data -> 01_parame- ter_model_inputs -> 05_sex_ratios
egg_num_ parameters.RDS	parameter posterior samples for egg number model	.RDS	data -> 01_parame- ter_model_outputs -> 01_egg_num
egg_survival_ parameter_ summaries_*.RDS	one for each population: summaries for the covariate effects for each population	.RDS	data -> 01_parame- ter_model_outputs -> 02_egg_survival
egg_survival_ parameter_ summaries.RDS	overall for all populations parameter summaries	.RDS	data -> 01_parame- ter_model_outputs -> 02_egg_survival
egg_survival_ parameters_*.RDS	one for each population: posterior samples for the covariate effects for each population	.RDS	data -> 01_parame- ter_model_outputs -> 02_egg_survival
nestling_survival_ parameter_ summaries_*.RDS	one for each population: summaries for the covariate effects for each population	.RDS	data -> 01_parame- ter_model_outputs -> 02_nestling_survival
nestling_survival_ parameter_ summaries.RDS	overall for all populations parameter summaries	.RDS	data -> 01_parame- ter_model_outputs -> 02_nestling_survival
nestling_survival_ parameters_*.RDS	one for each population: posterior samples for the covariate effects for each population	.RDS	data -> 01_parame- ter_model_outputs -> 02_nestling_survival
adult_parameter_ summaries.RDS	overall for all populations parameter summaries	.RDS	data -> 01_parame- ter_model_outputs -> 04_adult_occupancy
adult_ parameters_*.RDS	one for each population: posterior samples for the covariate effects for each population	.RDS	data -> 01_parame- ter_model_outputs -> 04_adult_occupancy

File name	Description	Format	Location
sex_ratio_parameter_summaries.RDS	summaries for parameters for the female ratio model	.RDS	data -> 01_parameter_model_outputs -> 05_sex_ratios
sex_ratio_parameters.RDS	posterior sample for the parameters for the female ratio model	.RDS	data -> 01_parameter_model_outputs -> 05_sex_ratios
adult_hp_results_*.RDS	results from hierarchical partitioning for adults	.RDS	data -> 03_hierarchical_partitioning -> *population -> adult
egg_hp_results_*.RDS	one per population: results from hierarchical partitioning for egg survival	.RDS	data -> 03_hierarchical_partitioning -> *population -> egg_survival
eggs_*_samps_*.RDS	one for each population: covariate effect samples for each submodel from hierarchical partitioning	.RDS	data -> 03_hierarchical_partitioning -> *population -> egg_survival
ipm_hp_results_*.RDS	one per population: results from hierarchical partitioning for IPM	.RDS	data -> 03_hierarchical_partitioning -> *population -> ipm
nestling_hp_results_*.RDS	one per population: results from hierarchical partitioning for nestling survival	.RDS	data -> 03_hierarchical_partitioning -> *population -> nestling_survival
nstlss_*_samps_*.RDS	one for each population: covariate effect samples for each submodel from hierarchical partitioning	.RDS	data -> 03_hierarchical_partitioning -> *population -> nestling_survival
adult_bkgrnd_point_covariates_*.csv	one for each population: background point covariates for the IPM	.csv	data -> 03_ipm_data_prep
Egg_Nestling_survival_data.csv	tidy data from previous published work for egg and nestling survival	.csv	data -> 03_ipm_data_prep
covariate_data_list_*.RDS	one for each population: list of covariates for each forest for the IPM	.RDS	data -> 04_ipm_data_inputs
IPM_data_list_*.RDS	one for each population: full list of data for each population to run the IPM	.RDS	data -> 04_ipm_data_inputs

File name	Description	Format	Location
posterior_data_list_*.RDS	one for each population: list of posterior samples for each population	.RDS	data -> 04_ipm_data_inputs
*_ipm_correlations.RDS	one for each population: correlations between population growth and different stages	.RDS	data -> ipm_outputs
*_ipm_summary.RDS	one for each population: summary of all population stages for each population	.RDS	data -> ipm_outputs
*_lambda_summary.RDS	one for each population: summary of lambda for each population	.RDS	data -> ipm_outputs

In the "monsoon" folder

File name	Description	Format	Location
adult_*.R	one for each submodel: JAGS model for each submodel for hierarchical partitioning	.R (JAGS)	parameter_models -> adult_occupancy -> hierarchical_partitioning -> inputs
hp_script_*_*.R	one for each submodel and population: wrapper script for running each submodel for each population	.R	parameter_models -> adult_occupancy -> hierarchical_partitioning -> inputs
reduced_adult_data_list_*.RDS	one for each population: data list for the reduced JAGS model for adult occupancy	.RDS	parameter_models -> adult_occupancy -> hierarchical_partitioning -> inputs
adult_*_results_*.R	one for each submodel and each population: pulling results for each hierarchical partitioning model and population	.R	parameter_models -> adult_occupancy -> hierarchical_partitioning -> outputs
adult_*_parameter_samples_*.RDS	one for each model and each population: samples of outputs for each hierarchical partitioning model	.RDS	parameter_models -> adult_occupancy -> hierarchical_partitioning -> outputs -> *population_samples
adult_dyn_occupancy_phionly.R	occupancy model for full model with all covariates	.R (JAGS)	parameter_models -> adult_occupancy -> inputs

File name	Description	Format	Location
adult_occupancy_data.RDS	JAGS input data list	.RDS	parameter_models -> adult_occupancy -> inputs
convergence_check*.R	all scripts check convergence of different models	.R	parameter_models -> adult_occupancy -> inputs
script*.R	all scripts run the model and/or output model summaries for the model	.R	parameter_models -> adult_occupancy -> inputs