DATA STORY: Avian Community Change in Fragmented Cloud Forests and Agricultural Landscapes of the Peruvian Andes

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**SAMPLE STORYLINE**

SETTING: Amazonas, Peru in the mountains.

THEMES:

* How to balance human well-being with biodiversity conservation in rural agricultural landscapes of the tropics?
* How to conduct field research in a foreign culture?

CHARACTERS:

* Local child: 10-15 years old, loves to go out walking/exploring in the forest
* Child’s mother: a member of a women’s association dedicated towards managing the local forest
* Researcher: From USA, studies birds, setting up a new research program

SCENE 1: Child is exploring in forest and comes across ancient ruins from Chachapoyan culture. Finds rock walls, house foundations, and pottery shards with bird paintings.

SCENE 2: Child is milking family’s cow next morning in middle of pasture and is looking at the pottery shard, wondering what the bird is.

SCENE 3: Goes to talk with mother, who is harvesting various local products from her chakra (e.g., arracacha, bituka, maushan). They talk about how it had been here before the roads arrived. There were more animals, like bears, deer, and large birds (guans). How the people made their houses out of palm trees.

SCENE 4: They are walking back to their house when they see the Researcher walking on the side of the road. He has binoculars and appears looking for something. They start talking.

SCENE 5: The researcher loves tropical birds and wants to do a project looking at how avian biodiversity is affected by agriculture. He came here, because he heard that there was a large tract of good cloud forest with lots of birds.

SCENE 5: The mother invites him to stay the night with them, and they continue talking over dinner. She explains that all their vegetables come from their chakra, and the milk and cheese comes from their cows. The Researcher comes to appreciate that her life is completely linked to the local landscape.

SCENE 6: The next day she shows how they make cheese by adding a coagulant and straining out the whey. This leaves behind the curd, which they mill into cheese. The whey goes to the pigs. Nothing is ever wasted in their house.

SCENE 7: The two develop trust and the next day the Mother invites the Researcher to meet with the women’s association. They give him permission to start a study in their community forest.

SCENE 8+: Various scenes about conducing field research: auditory surveys, mist netting, telemetry, etc.

SCENE ??: The researcher shares information about birds to the local schools.

**DATASETS**

**Data Collection.** The following data were collected 2016 – 2019 in Amazonas, Peru near the capital of Chachapoyas. Sites were located across seven independent landscape blocks. Landscape locations are provided in the attached KML file. At each landscape bird communities were sampled within several habitat types: contiguous forest tracts, remnant forest fragments (1 – 300 ha), regenerating shrublands (15-30 ha), and agricultural plots. Birds detected within agricultural plots were further organized into three categories based on their location: fencerows (remnant shrubs), residual pasture trees, and pasture/crop fields.

Birds were surveyed using three techniques designed to sample different components of the bird community: point count surveys, flock surveys, and mist netting surveys.

* Point count surveys occurred in all habitats and consisted of 10 minute counts at points located at 100m intervals. Most detections were auditory.
* Flock surveys occurred in all habitats and consisted of intentional and opportunistic descriptions of mixed-species foraging flocks encountered along transects.
* Mist netting surveys occurred in forest, fragments, and shrubland habitats. Birds were passively captured and banded using a standard protocol.

**Analysis.** Species-specific occupancy correcting for detection error was calculated for each survey technique at each site using multi-species hierarchical occupancy models. Occupancies were then pooled across techniques for each site, with occupancies < 1 being selected from the technique with the highest detection probability.

**Datasets.** There are three datasets included in the attached RData file:

* *all*: Site-specific species richness across the whole study.
  + *site*: Site code
  + *block*: Landscape block
  + *elevation*: Approximate in meters
  + *rich*: Modelled species richness (sum of all species-specific occupancy probabilities, so is not an integer)
  + *raw*: Raw species richness (pooled species list)
  + *ha*: Fragment size in ha
  + *matrix*: Proportion of a 300m buffer area around each fragment composed of forest/shrub habitat. Preliminary analyses indicate that this buffer width is best predictive.
  + *habitat*: Contiguous forest, forest fragment, regenerating shrublands, fencerows (residual shrubs within agricultural plots), pasture trees (residual trees within pastures and ag plots), and pasture/crop fields.
* *sp*: Species-specific modelled occupancy probabilities for each site.
* *silvo*: Raw richness for each point count survey point within only the agricultural survey transects. I have not yet completed the occupancy model for specific points, so richness is based on raw species lists. Includes shrub cover calculated by digitizing high resolution satellite imagery at 50m and 100m buffers around each point, and number of trees > 10DBH counted in the field within 50m and 100m buffers around each point.

**ECOLOGICAL AND CONSERVATION CONCEPTS**

CONCEPT 1: Biological Communities and Environmental Gradients

Ecology Learning Objectives: Biodiversity varies across different types of environmental gradients, such as temperature, rainfall, or soil type. This exercise examines how avian communities change across (1) a natural gradient in elevation, and (2) an anthropomorphic gradient in agricultural land use. Major related concepts are the “Latitudinal Gradient of Biodiversity Hypothesis”, the idea of “Countryside Biogeography”, and the “Land Sharing Land Sparing” paradigm.

Conservation Implications: Small-scale agriculture is the primary economic outlet for millions of farmers across the global tropics. Understanding how biological communities change across different habitat components within tropical countrysides is the first to step towards developing conservation strategies for mitigating biodiversity across agricultural landscapes.

Analytical Objectives: Multiple linear regression and model selection using AIC. Assessment of model fit using R-squared. Descriptive statistics using ordinations.

Results: Two clear patterns emerge. Both richness and community composition change with (1) elevation and (2) habitat. Richness declines with elevation and across the agricultural land use gradient. The ordination plot shows that communities become progressively less similar with increasing elevation. The ordination plot also shows a clear gradient in community dissimilarity across the land use gradient.

CONCEPT 2: Species-area Relationship

Ecological Concept: Larger areas have more species, one of the few laws in ecology. Likewise, species-richness within islands and habitat fragments is hypothesized to be a function of patch size and isolation. Major related concepts are the “Theory of Island Biogeography” and the Single Large or Several Small (SLOSS) debate regarding biological reserve design.

Conservation Implications: Tropical countrysides can enhance biodiversity by maintaining forest remnants. Farmers can be encouraged to conserve remnant fragments, the larger the better.

Analytical Objectives: Multiple linear regression and model selection using AIC. Assessment of model fit using R-squared.

Results: Species richness increases with fragment size and the amount of Forest/Shrub habitat within a 300m buffer surrounding each fragment, indicating that both patch size and isolation are predictive.

CONCEPT 3: Habitat Associations

Ecological Concept: Species use different habitat components, a phenomenon known as species-specific habitat associations. Here we only use the point count survey data collected within agricultural plots (ie., chakras or pasture) and compare species richness at each survey point to the amount of shrubs and number of residual trees within a 50-100m buffer of each point.

Conservation Implications: Species richness within agricultural plots can be improved by retaining shrubs/fencerows and residual trees.

Analytical Objectives: Multiple linear regression and model selection using AIC.

Results: Species richness increases with the amount of shrub cover and number of remnant trees. Most remnant shrubs within agricultural plots are fencerows demarcating public trails or property boundaries, so there is a clear biological incentive for maintaining such social norms.

CONCEPT 4: Space Use

If there is time it would be cool to include some of the radio telemetry data. As an example I include the KML file “PIFU\_SANL03” which shows the home range of a *Picoides fumigatus* woodpecker that we captured in a fragment and then tracked across pasture as it flew among trees.