**Metadata for the hummingbird migration study**

**INTRODUCTION**

This metadata is to describe and explain the data and methods that accompany the hummingbird migration study conducted 13 August – 9 September 2013. The objectives of the study were to describe hummingbird diversity, abundance and activity at 7 sites located in the Chiricahua Mountains during peak migration. Hummingbirds were observed weekly during the study, and hummingbird sounds were continuously recorded using the Song Monitor from Wildlife Acoustics. Data on floral abundance, nectar production, species composition and local weather were also recorded.

**CLASS I. DATA SET DESCRIPTORS**

1. **Dataset identity:** Hummingbird species composition, abundance, and activity, and floral abundance, phenology, and nectar production at surveyed field sites in the Chirhicahua Mountains during peak migration.

*Hummingbird Data Set Title*:Surveys of migrating hummingbirds in the Chiricahua Mountains, Cochise County, Arizona.

*Floral Resource Data Set Title*: Surveys of floral resources (plant abundance, phenology, and nectar production) in the Chiricahua Mountains, Cochise County, Arizona.

*Weather Data Set Title*: Surveys of temperature, precipitation, and relative humidity in the Chiricahua Mountains, Cochise County, Arizona.

*Audio Data Set Title*: Surveys of the audio landscape in the Chiricahua Mountains, Cochise County, Arizona.

1. **Dataset identification code:** Hummingbird Migration and Floral Phenology Dataset (HMFP) *MigrationStudyDatabase.accdb*

**Hummingbirds:** *Data files --* pointcounts.csv

transects.csv

birdspecies.csv

**Floral Resources:** *Data files --* pointcounts.csv

transects.csv

standingcrop.csv

nectarproduction.csv

plantspecies.csv

**Descriptive:** *Data files* -- Sites.csv

Observers.csv

**Weather:** *Data files --* kestreldata.csv

**Audio:** *Data files --* audiomonitor.csv

recognizerdata.csv

annotateddata.csv

1. **Dataset description:**

XXXX records indicated the presence and abundance of hummingbird species and floral resources at 7 field sites in the Chirhicahua Mountains along an important migratory route.

1. **Keywords:** abundance, activity, migration, hummingbird, floral phenology, nectar production

**CLASS II. RESEARCH ORIGIN DESCRIPTORS**

1. **Overall project description**

**Identity:** Hummingbird species composition, abundance, and activity, and floral abundance, phenology, and nectar production at surveyed field sites in the Chirhicahua Mountains during peak migration.

**Originators:** Sarah R. Supp, Susan Wethington, Catherine Graham, Andrea Nieto, Gabriela Samaniego

**Fieldwork & Data Entry:** Andrea Nieto, Gabriela Samaniego, Sarah R. Supp

**Period of Study:** Data compiled in this project were taken from a field study conducted 13 August 2013 – 9 September 2013.

**Objectives:** To provide data for the analysis of hummingbird activity using remote audio monitors and to provide data for the analysis of the drivers of hummingbird migration, including climate and floral phenology. **1)** *Proof of Concept -* Can passive audio monitors be used to accurately estimate hummingbird activity? **2)** *Hummingbird Migration* - What are the primary drivers of hummingbird migration? Is migration driven by flowering plant phenology (nectar abundance, flower stage), weather events, day length, or other factors?

**Taxonomy:** Taxonomy follows current standards in USDA plants and in the Birds of North America.

**Sources of Funding:** NASA Biodiversity Grant and the Hummingbird Monitoring Network (PIs Catherine Graham, Susan Wethington, Pieter Beck, Scott Goetz, and Don Powers).

**Location of Study:** Chiricahua Mountains, Cochise County, AZ, USA (7 field sites)

**Site type:** The sites are located in the Chiricahua Mountains between XXXX m and XXXX m. Three sites are located near El Coronado Ranch, and four sites are high elevation sites near Onion Saddle and Rustler Park (Table 1). The sites are generally in mixed oak-conifer forest or riparian areas.

**Site description:** The 7 study sites were each established in a floral patch, with suitable resources for migrating hummingbirds. An acoustic recorder (AR; Song Meter SM2, Wildlife Acoustics, Inc.) and a weather station (Kestrel 4500 Pocket Weather Tracker) were mounted near the center of the floral patch. We returned to each patch to conduct point counts, floral census, and nectar census within a 30 m radius of the patch center every 6-8 days for 4 weeks. We established 8 evenly-spaced transects radiating outwards from the 30 m perimeter of the focal patch to estimate total patch area and extent, resource abundance, and hummingbird activity (Fig 1).

**Geography:**The study sites were located in the Chiricahua Mountains, Cochise County, AZ, USA (7 field sites). Sites were located near El Coronado Ranch (3), Onion Saddle (2), and Rustler Park (2).

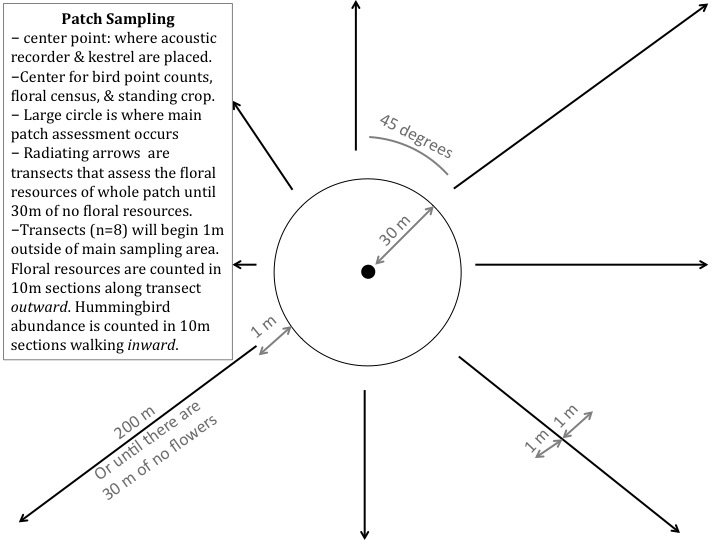
**Site history:** The sites occur on lands managed by the U.S. Forest Service. The sites near El Coronado have been previously grazed by cattle (Prior to 1980s?) and are under active restoration and conservation management. All of the sites experienced strong impacts from the Horseshoe 2 fire in 2011, which severely burned a large part of the mountain range.

**Climate:** There are two rainy seasons, occurring roughly from Oct-April and July-September. Typically 60% of the annual rainfall occurs in the summer during a summer monsoon (ref?). The summer monsoon results in a strong floral resource pulse, which potentially has large impacts on hummingbird migration timing, diversity, abundance and survival.

**Survey design:** The study consists of 7 field sites, where we used passive audio monitors to detect hummingbird presence and activity, focal point counts of hummingbirds, floral resource censuses, and weather monitors to track local weather conditions at each site.

**Survey Methods:** For full details, *Hummingbird\_migration\_study\_protocol.docx*.

**Data Problems/Issues:** For full details, see *Field\_notes.docx.*

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**Figure 1.** Each of the 7 field sites were centered within a floral patch where we expected to find migrating hummingbirds.

**CLASS III. DATA SET STATUS AND ACCESSBILITY**

1. **Status**

**Latest update:** 11 September 2013 for final data entry

**Latest Archive date:** September 2013

**Metadata status:**  The metadata are complete and up to date.

**Data verification:** Data quality has been carefully checked as described in class V, section B, below.

1. **Accessibility**

**Storage location and medium:** Copies of the latest version of the data files are being stored on 2 external hard drives owned by the principal investigator (Sl. Wethington) in Microsoft Access, CSV, and XML formats, and the original hard copies.

**Contact persons:**  Susan Wethington, Hummingbird Monitoring Network, Patagonia, AZ; [swethington@dakotacom.net](mailto:swethington@dakotacom.net) and Sarah R. Supp, Ecology and Evolution, Stony Brook University, Stony Brook, NY; [sarah@weecology.org](mailto:sarah@weecology.org)

**Copyright restrictions:** Owned by the PI.

**Proprietary restrictions:** Use with permission from the PI.

**Costs:** None.

**CLASS IV. DATA STRUCTURAL DESCRIPTORS**

**1. HUMMINGBIRD POINT DATA**

1. **Data Set File**

**Identity:** HummingbirdPointData.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| Id | Unique identifier for each row; primary key | Primary Key, Integer | N/A | N/A |
| Month | Month survey occurred | Integer | N/A | N/A |
| Day | Day survey occurred | Integer | N/A | N/A |
| Year | Year survey occurred | Integer | N/A | N/A |
| Site | Abbreviated code for survey location | Character | link to sites table | N/A |
| Observer | Person who recorded the data in the field | Character | Link to Observers table | N/A |
| Session | Time of day survey occurred; morning or afternoon | Character | N/A | N/A |
| PointID | Cardinal direction of the point count and if it occurred on the edge of 30 m radius, or in the center | Integer | N/A | N/A |
| StartTime | Time the observations began | Integer | N/A | N/A |
| CountMinute | When the observation occurred | Integer | N/A | N/A |
| SpeciesCode | Abbreviated code for the species | Character | Link to species table | Blank |
| Sex | Indicates the sex of the individual | Character | M = male, F = female, U = unknown | N/A |
| Detection | Method used to observe the hummingbird | Character | None = no birds detected, S = sight, WH = wing hum, V = , WT = | N/A |
| Distance | Estimated distance in meters from observer to hummingbird | Integer | N/A | N/A |
| Behavior | Observed behavior and activity of each hummingbird | Character | FO = , V = , H = , P = | Blank |
| PlantSpecies | If hummingbird was observed visiting or feeding from a plant species, the species code is indicated here | Character | Links to plant species table | NULL |
| Comments | Additional comments | Character | N/A | N/A |

**2. HUMMINGBIRD TRANSECT DATA**

1. **Data Set File**

**Identity:** HummingbirdTransectData.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| Id | Unique identifier for each row; primary key | Primary Key, Integer | N/A | N/A |
| Month | Month survey occurred | Integer | N/A | N/A |
| Day | Day survey occurred | Integer | N/A | N/A |
| Year | Year survey occurred | Integer | N/A | N/A |
| Site | Abbreviated code for survey location | Character | link to sites table | N/A |
| Observer | Person who recorded the data in the field | Character | Link to Observers table | N/A |
| Session | Time of day survey occurred; morning or afternoon | Character | N/A | N/A |
| TransectID | Direction from the central point of the transect | Character | S, SE, SW, W, N, NE, NW | N/A |
| StartTime | Time of the observation period began | Integer | N/A | N/A |
| ObservationTime | When the observation occurred | Integer | N/A | Blank |
| Detection | Method used to observe the hummingbird | Character | None = no birds detected, S = sight, WH = wing hum, V = , WT = | N/A |
| Distance | Estimated distance in meters from observer to hummingbird | Integer | N/A | Blank |
| Behavior | Observed behavior and activity of each hummingbird | Character | FO = , V = , H = , P = | Blank |
| PlantSpecies | If hummingbird was observed visiting or feeding from a plant species, the species code is indicated here, or NONE if not observed | Character | Links to plant species table | NULL |
| Comments | Additional comments | Character | N/A | N/A |

**3. HUMMINGBIRD SPECIES**

1. **Data Set File**

**Identity:** HummingbirdSpecies.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| SpeciesCode | Abbreviated code for the species | Primary Key, Character | N/A | N/A |
| Genus | Genus name of the species | Character | N/A | NULL |
| Species | Species epithet | Character | N/A | NULL |
| CommonName | Common name of the species | Character | N/A | NULL |

**4. FLORAL CENSUS PATCH DATA**

1. **Data Set File**

**Identity:** FloralCensusPatch.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| Id | Unique identifier for each row; primary key | Primary Key, Integer | N/A | N/A |
| Month | Month survey occurred | Integer | N/A | N/A |
| Day | Day survey occurred | Integer | N/A | N/A |
| Year | Year survey occurred | Integer | N/A | N/A |
| Site | Abbreviated code for survey location | Character | link to sites table | N/A |
| Observer | Person who recorded the data in the field | Character | Link to Observers table | N/A |
| PlantSpeciesCode | Abbreviated code for the species identity | Character | link to PlantSpecies table | N/A |
| TotalNumPlants | Number of individuals of the species counted within the site | Integer | N/A | N/A |
| Comments | Additional comments | Character | N/A | N/A |

**5. FLORAL CENSUS TRANSECT DATA**

1. **Data Set File**

**Identity:** FloralCensusTransect.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| Id | Unique identifier for each row; primary key | Primary Key, Integer | N/A | N/A |
| Month | Month survey occurred | Integer | N/A | N/A |
| Day | Day survey occurred | Integer | N/A | N/A |
| Year | Year survey occurred | Integer | N/A | N/A |
| Site | Abbreviated code for survey location | Character | link to sites table | N/A |
| Observer | Person who recorded the data in the field | Character | Link to Observers table | N/A |
| TransectID | Direction from the central point of the transect | Character | S, SE, SW, W, N, NE, NW | N/A |
| BeginDistance | Beginning distance from the edge of the focal patch | Integer | begin and end distance should be 10 m apart | N/A |
| EndDistance | Distance from the edge of the focal patch where floral observations end | Integer | begin and end distance should be 10 m apart | N/A |
| PlantSpeciesCode | Abbreviated code for the species | Character | Link to plant species table | N/A |
| NumOfPlants | Number of plants observed along the transect within the begin and end distance | Integer | N/A | Blank |
| Comments | Additional comments | Character | N/A | N/A |

**6. FLORAL PHENOLOGY PATCH DATA**

1. **Data Set File**

**Identity:** FloralPhenologyPatch.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| Id | Unique identifier for each row; primary key | Primary Key, Integer | N/A | N/A |
| Month | Month survey occurred | Integer | N/A | N/A |
| Day | Day survey occurred | Integer | N/A | N/A |
| Year | Year survey occurred | Integer | N/A | N/A |
| Site | Abbreviated code for survey location | Character | link to sites table | N/A |
| Observer | Person who recorded the data in the field | Character | Link to Observers table | N/A |
| PlantSpeciesCode | Abbreviated code for the species | Character | species table | N/A |
| PlantHeight | Estimated height of plant | Float | N/A | Blank |
| PlantWidth | Estimated width of plant | Float | N/A | Blank |
| TotalBuds | Estimated or counted total number of buds on observed individual | Integer | N/A | N/A |
| TotalFlowers | Estimated or counted total number of flowers on observed individual | Integer | N/A | N/A |
| TotalFruits | Estimated or observed total number of fruits on observed individual | Integer | N/A | N/A |

**6. STANDING CROP AND NECTAR PRODUCTION DATA**

1. **Data Set File**

**Identity:** StandingCropData.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| Id | Unique identifier for each row; primary key | Primary Key, Integer | N/A | N/A |
| Month | Month survey occurred | Integer | N/A | N/A |
| Day | Day survey occurred | Integer | N/A | N/A |
| Year | Year survey occurred | Integer | N/A | N/A |
| Site | Abbreviated code for survey location | Character | link to sites table | N/A |
| Observer | Person who recorded the data in the field | Character | Link to Observers table | N/A |
| PlantSpeciesCode | Abbreviated code for the species | Character | Link to PlantSpecies species table | N/A |
| StartTime | Time that flowers were picked. All measurements were taken within an hour. | DateTime | N/A | N/A |
| FlowerStage | Flower age stage | Integer | 1 = closed anthers, 2 = open anthers with pollen, 3, open anthers without pollen, 4 = dry or absent anthers | Blank |
| LengthNectar | Length of nectar in capillary tube, measured with calipers | Float | N/A | N/A |
| BrixDegrees | Percent sucrose reading from refractometer | Float | N/A | N/A |
| Molarity | Calculated from BrixDegrees as described in the methods | Float | N/A | N/A |
| Volume | Volume of nectar | Float | N/A | N/A |
| Calories | Calories of nectar | Float | N/A | N/A |
| SampleType | Designates if the measurement was standing crop (snapshot) or nectar production (24 hrs with bags) | Character | N/A | N/A |
| Comments | Additional comments | Character | N/A | N/A |

**8. PLANT SPECIES**

1. **Data Set File**

**Identity:** PlantSpecies.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| PlantSpeciesCode | Abbreviated species code for each species | Primary Key, Character | N/A | N/A |
| Family | Family name | Character | N/A | N/A |
| Genus | Genus of species | Character | N/A | N/A |
| Species | Species epithet | Character | N/A | N/A |
| CommonName | Common name of plant, taken from USDA plants | Character | N/A | N/A |
| FlowerColor | Main flower color | Character | N/A | N/A |

**9. SITES**

1. **Data Set File**

**Identity:** Sites.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| SiteCode | Abbreviated code for each site | Primary Key, Character | N/A | N/A |
| SiteName | Written out description of the site | Character | N/A | N/A |
| Longitude | Longitude of the site in UTMs, Zone 12 | Integer | N/A | N/A |
| Latitude | Latitude of the site in UTMs, Zone 12 | Integer | N/A | N/A |
| Elevation | Elevation of the site in meters | Integer | N/A | N/A |
| Comments | Additional comments on the description or condition of the site | Character | N/A | Blank |

**10. OBSERVERS**

1. **Data Set File**

**Identity:** Observers.csv

**Size:** XX records, not including header row, XXXX bytes.

**Format and storage mode:** ASCII text, comma delimited

**Header information:** The first row of the file contains the variable names. See section B below for detailed descriptions of the column contents

**Alphanumeric attributes:** Mixed.

**Special characters/fields:** If no information is available for a given record, this is indicated by NULL or blank.

1. **Variable information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes and definitions* | *Missing value codes* |
| ObserverID | Abbreviated code for each site | Primary Key, Character | N/A | N/A |
| FirstName | Written out description of the site | Character | N/A | N/A |
| LastName | Longitude of the site in UTMs, Zone 12 | Character | N/A | N/A |
| Description | Additonal comments on the observer(s) | Character | N/A | N/A |

**11. WEATHER DATA**

**12. AUDIO DATA**

**CLASS V. SUPPLEMENTAL DESCRIPTORS**

1. **Data Acquisition:** Field work
2. **Quality assurance/quality control procedures:**

Each record was entered by the data collector, and then carefully double-checked and spot checked for obvious errors using queries.

1. **Related material:** N/A
2. **Computer programs and data processing algorithms:** N/A, equations for standing crop measurements are in the methods docx.
3. **Archiving:** N/A
4. **Literature Cited:** Below
5. **History of data set usage:**

Data set update history: N/A

Review history: N/A

Questions and comments from secondary users: N/A

**ACKNOWLEDGEMENTS**

We thank El Coronado Ranch and Southwestern Research Station for helping with the logistics of this project by providing us places to base out of. We thank Eileen for helping us locate flower patches near Onion Saddle and Rustler Park. The U.S. Forest Service provided us with research permits (XXXX) and the project was funded by NASA and the Hummingbird Monitoring Network.

**REFERENCES**

Kearns and Inouye. 1993. Techniques for Pollination Biologists.