

Bird Monitoring Protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas

Standard Operating Procedure (SOP) # 8

Data Analysis

Version 1.00 (July 18, 2003)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP gives step-by-step instructions for analyzing Variable Circular Plot (VCP) bird count and habitat survey data collected at Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. This SOP is divided into two sections: Section A, annual data summary and analysis and Section B, long-term trend and species-habitat relationship analysis. Section A methods consist of 1) determining individual occurrence by bird species, 2) determining bird species diversity, richness and distribution evenness by habitat and 3) calculating descriptive statistics for habitat variables. Section B methods consist of 1) estimating bird species abundance adjusted for detectability (using Distance analysis), 2) examining the relationships between bird species abundance and habitat conditions by way of correlation analysis and 3) consideration of other possible approaches including, but not limited to; data visualization, geostatistics and time-series analysis are reviewed. Section B will not be fully developed until after several years (> 5 yr.) of data have been collected.

I. Section – Annual Data Summary and Analysis

Bird Data Summaries and Reports

The bird community variables and indices selected for data summary purposes are complete, descriptive and easily interpretable and will provide resource managers timely feedback to help assess management practices (Pickett et al. 1992). Prior to summary analysis, the resident status (permanent resident, summer resident, migrant) of each bird species recorded at Agate Fossil Beds National Monument and Tallgrass Prairie National Preserve are determined. Identification of the residency of each species is needed in order to exclude migrants from analysis of breeding birds within each park. Also the likelihood of encountering a species during a plot visit (individuals / plot visit) is determined. Results are plotted from most to least common species within a habitat on a park.

Bird diversity, richness and distribution evenness are calculated by plot with means ($\pm$ SE) estimated by habitat from these calculations. Bird diversity for each plot is calculated using Shannon Diversity Index:

$H' = -\sum(n_i/N)\ln(n_i/N)$, where n_i/N is the proportion of the total number of individuals in a population consisting of the i^{th} species (Shannon, 1949).

Species richness is determined as the total number of bird taxa recorded per plot. Species distribution evenness is calculated by plot using Pielou (J):

$J' = H' / H_{\text{max}}$, where H' is the Shannon Diversity Index and H_{max} is the maximum possible diversity for a given number of species if all species are present in equal numbers ($\ln(\text{species richness})$). J' is a measure of how evenly individuals are distributed within a community when compared to the equal distribution and maximum diversity a community can have (Pielou, 1969).

Annual data summaries and reports for bird observation data should be generated using the database front-end called BirdVCP. When BirdVCP is opened, a switchboard form is displayed which includes the heading “National Park Service Inventory and Monitoring - Land Bird Monitoring: Variable Circular Plots” (see Figure 8.01.1). Bird observation summaries should be obtained in the following way:

Click on the Data Summaries and Reports button to see the various options for data analysis available. The data summary form is divided into bird summary reports and habitat summary reports. The upper half of the form addresses bird observation data (see Figure 8.01.2). Bird observations data are divided into three parts: 1) summaries for the entire database, 2) summaries for select surveys and 3) an export utility for moving bird data into Distance 4.0 software for population density estimation.

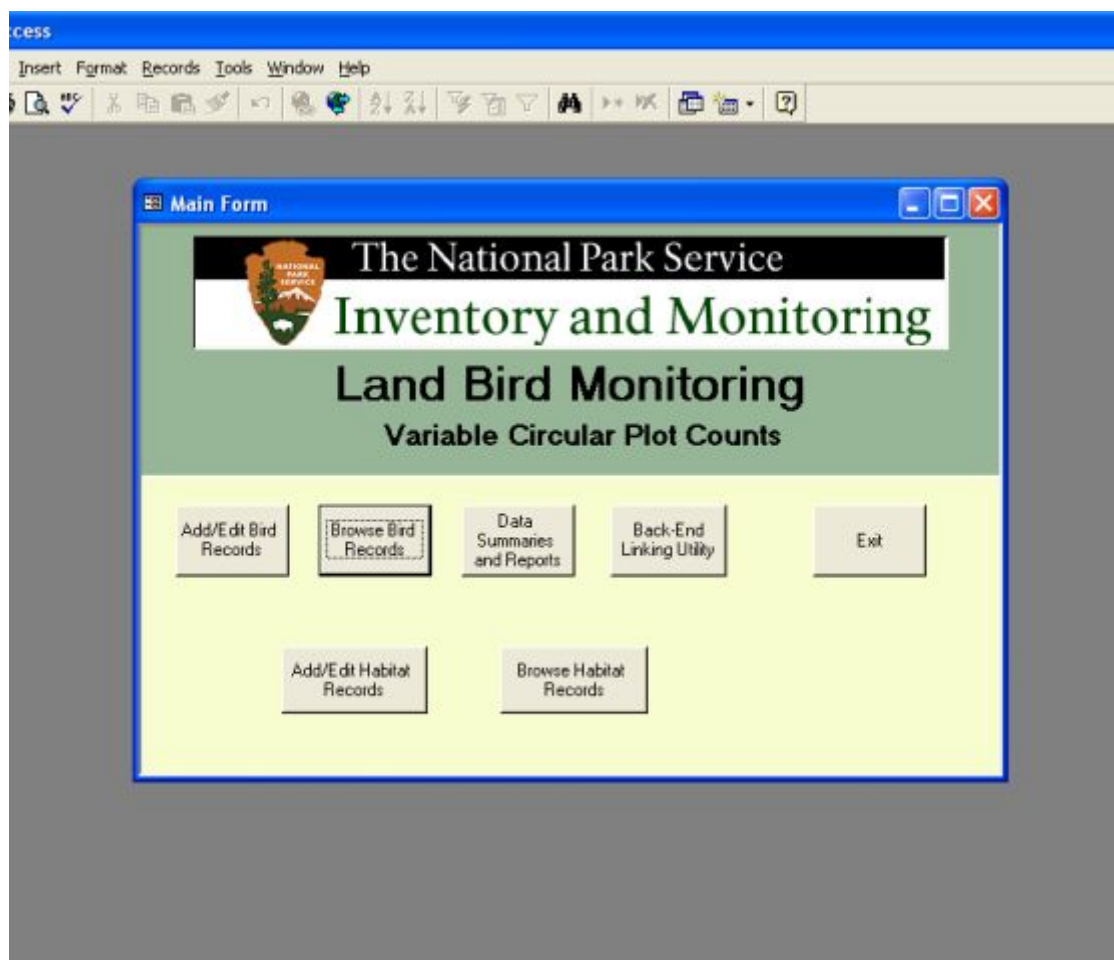


Figure 8.01.1: Main switch board for Land Bird Monitoring: Variable Circular Plot Counts database front-end.

Summary Bird Reports for Entire Database --

1. The first option is to provide an overview of each survey conducted including starting and ending dates and number of plots surveyed. This button displays a query which summarizes all of the data by PeriodID and LocationID.
2. The next option, labeled “# of individuals, Species Richness, Diversity and Evenness by Plot”, list totals for individuals observed, species richness, bird diversity index (H') and evenness (J') statistic for each plot in a sampling event. In cases where species richness equals 1, as sometimes occurs with small sample sizes, J' is undefined since $H_{max} = 0$. The value for J' in the summary report is adjusted so when species richness equals 1, $J' = 0$. This is accomplished by adding a very small number to the denominator of the statistic. Specifically, $J'_{adjusted}$ is calculated as $H' / H_{max} + 0.00001$.
3. The third option in the first group for bird summary reports is a listing of all data for all surveys. This is a listing of every bird observation stored in the database. It is sorted by sampling period ID, sampling event date and time and survey location. Observation records include the sampling interval (0 – 3 min., 3 – 5 min. or > 5 min.), species observed, observation distance (when possible to determine), detection type (heard first, seen first or heard first then seen), sex, age, flock size, number flyover (birds not interacting with the habitat below) and comments associated with bird observations.

Figure 8.01.2. Data Summaries and Reports form for the Land Bird Monitoring database front-end. Options in the upper half of the form provide summaries of bird observation data. Options in the lower half of the form provide summaries of habitat data.

Summary Bird Reports for a Selected Survey -- In this section, you must first select a survey before summarizing reports. Surveys are named by concatenating park name and start-date. The reports may be generated as follows:

1. Select a survey from the combo box.
2. Click the “Go” button for Step 1. This generates a cross-tab query which sums the total detections of birds by species at each location.

3. Click the “Go” button for Step 2. Based on the calculations in Step 1, this generates a summary report organized by species. The report gives the total number of detected individuals by species for a given survey including the mean and standard error per plot. Two other statistics reported here are the total number of plots where this species has been observed and the percent of the total plots where this species has been observed.

Habitat Data Summaries and Reports

The procedures for documenting habitat characteristics are described in SOP # 6. Data are collected at the plot (50 m radius) and subplot (5 m radius) level.

Summary Habitat Reports for 50 m Plot-Level Data -- Grassland bird monitoring locations are used to sample habitat data at the 50 m radius plot level. Summary reports for habitat attributes at the 50 m radius plot level are provided for “permanent” and “semi-permanent” features. For permanent features, the generated report is a listing of the values for slope of plot, aspect of slope and topographic features. These values are measured only once and are assigned to a permanent locations table. Semi-permanent plot features are not expected to change much. However, semi-permanent plot features include percent cover of upland prairie, riparian woodland, road and water, and are recorded each time a survey is conducted. Values in the semi-permanent plot attributes report represent the median value of cover for its appropriate cover class.

Summary Habitat Reports for 5 m radius Plot Data -- The bulk of habitat data is collected from four 5 m radius subplots, the first located at plot center and three others located at a 50 m distance from plot center and 120° offset from one another. Location and permanent abiotic measures on each subplot are recorded. For riparian subplots at Tallgrass Prairie National Preserve, trees tallied in DBH classes (<1.0 cm, 1.1-2.5 cm, 2.6-8.0 cm, 8.1-15.0 cm, 15.1-38.0 cm and >38.0 cm) are summed to illustrate size distribution of riparian trees. Average canopy height, canopy cover and basal area are also calculated for each riparian plot at Tallgrass Prairie National Preserve with a mean ($\pm$ SE) estimated. Using calculated plot averages or values, means ($\pm$ SE) for horizontal vegetation profiles between 0 – 0.5, 0.5 – 1.0, 1.0 – 1.5 and 1.5 – 2.0 meters and vertical structure diversity are estimated across habitats. Structural diversity values are determined for each plot using a modified Shannon Diversity Index (Shannon, 1949):

$H' = -\sum(n_i/N)\ln(n_i/N)$, where n_i/N is the proportion of vegetation touching a measuring rod in the i^{th} meter increment to the total number of touches from vegetation along the rod consisting. Within each plot, ground cover, including deciduous, conifer and grass litter, bare soil, rock, woody debris (>2.5 cm DBH) and un-vegetated are averaged across subplots with means ($\pm$ SE) estimated across habitats using these averages. Foliar cover, by guild of warm and cool season grasses, forbs, moss and lichens, shrubs and vines, tree seedlings and total foliar cover (<1.5 m tall) are averaged across subplots with means ($\pm$ SE) estimated across habitats using these averages. There are seven options in the database front-end to generate analysis reports for these data:

1. The 1st option under summary habitat reports for 5 m radius subplots provides a listing of permanent features. This listing includes azimuth (direction from plot center), slope across subplot and aspect of slope. Azimuth only applies to the 3 subplots located at 50 m distances from plot center. Like permanent attributes measured for plot locations,

permanent features for subplots are measured only once and stored in a separate table with subplot IDs.

2. The 2nd option, Tree Tally – species frequency by size class, gives a report of size-class frequency distribution of trees observed at each plot. Observations are summed across subplots within a plot. The data are organized by survey and locationID (plot number). There are seven size classes ranging from < 1.0 cm to > 38 cm.
3. The 3rd option, Woodland Measures: canopy height, % canopy cover and basal area, summarizes tree density and canopy data, generally (but not always) from riparian areas. The values in this report represent the averages across four subplots and are reported by survey and LocationID (plot number).
4. The 4th option is Percent Ground Cover. Values represent averages across all four subplots and are reported by survey and LocationID (plot number). Percent cover is measured on 1.78 m radius sample plot nested in the center of each subplot. Cover is measured for bare soil, conifer litter, deciduous litter, grass litter, rock, unvegetated surface and woody debris (>2.5 cm diameter).
5. The 5th option is Percent Foliar Cover. Values represent averages across all four subplots and are reported by survey and LocationID (plot number). Percent cover is measured on 1.78 m radius sample plot nested in the center of each subplot. Cover is measured for cool season grass, forbs, moss and lichen, shrubs and vines, total vegetation cover (< 1.5 m), tree seedlings and warm season grass.
6. The 6th option under Summary Reports for 5 m radius Subplots is Horizontal Vegetation Profile – Average Coverage for each height class recorded at 15 m distance. Values represent the average area obscured by vegetation of a .15m x 0.5 m area centered at each height class. Values were recorded at 15-m distance north of each subplot center. Subplot values were averaged to report a single value for each height class at a given plot. Height classes in 2001 and 2002 were 0.5 m, 1.0 m, 1.5 m, and 2.0 m. Height classes of 0.75 m, 1.25 m, and 1.75 m were added in 2003 to increase detectability of height variation, particularly at Agate Fossil Beds National Monument.
7. The 7th option is Structural Diversity Index – Shannon Diversity Index (H') for vegetation across 1 m incremental height classes to 7.5 m in height. The index for structural diversity of vegetation is calculated:

$H' = -\sum(n_i/N)\ln(n_i/N)$, where n_i/N is the proportion of vegetation touching a measuring rod in the i^{th} meter increment to the total number of touches from vegetation along the rod consisting.

Values represent the combined observations of herbaceous, deciduous and coniferous vegetation touching the rod. The riparian plot presence/absences are reported to indicate whether areas of high structural diversity are occurring in riparian or upland habitats. High diversity values are expected in riparian areas. High diversity values in upland areas may be of special interest.

II. Section B – Trend Analysis

Distance Analysis

Users should read two primary references for Distance 4.0: Buckland et al. 2001, "Introduction to Distance Sampling: Estimating abundance of biological populations" and Distance 4.0 "User's Guide". Additional information about Distance 4.0 software and

supporting references may be obtained from the Distance website hosted by the Research Unit for Wildlife Population Assessment, University of St. Andrews, St. Andrews, Scotland at <http://www.ruwpa.st-and.ac.uk/distance>.

Preparing Bird Data for Export to Distance Software -- Basically, to determine distance calculations for population density estimates, you minimally need species, flock-size and distance data, all of which are located in tblBirdVCP. The data-summary-user-interface has a feature (1st option) which allows you to create separate records for individuals based on flock-size. In the second option, you get one record for each observation regardless of flock-size. The results are passed to a table (1st option -- tblExportToDistance) or a query (2nd option -- qryExportToDistance) which can be exported to Distance 4.0 software. Either way, the data will need to be cleaned up before it can be imported into Distance for analysis. Records with null values in the distance column or with null values in the flock-size column need to be removed. These represent either incomplete records (where distance estimation was not possible) or “flyovers” (individuals that are flying over the study area) and should be discarded from the Distance analysis. Details about data formatting prior to analysis are given in the section below call “Distance Analysis”.

Distance analysis is not limited to the output from the user-interface. Because each table in the database is linked by primary/foreign keys, you can create your own queries based on habitat type or management unit, flock size and distance from observer in tblExportToDistance. Note: using certain habitat variables may lead to sample sizes that are too small for meaningful analysis. Procedures are given below to stratify grassland bird abundance data by Riparian vs. Upland habitat and to conduct the analysis. The following procedures describe how to transfer bird observation data and associated habitat data into Distance 4.0:

Custom Export from MS Access --

1. Create the export table tblExportToDistance using the Data Summaries and Reports form.
2. Examine tblExportToDistance. Are there any habitat variables that you would like to add? In these procedures, we will create a query to link the riparian vs. upland field to the export data.
3. Close the table and go to Queries in the database container. Click on New. Select Okay for the Design view (see Figure 8.01.3). Add the table tblExportToDistance. Add the table tbl_Locations.

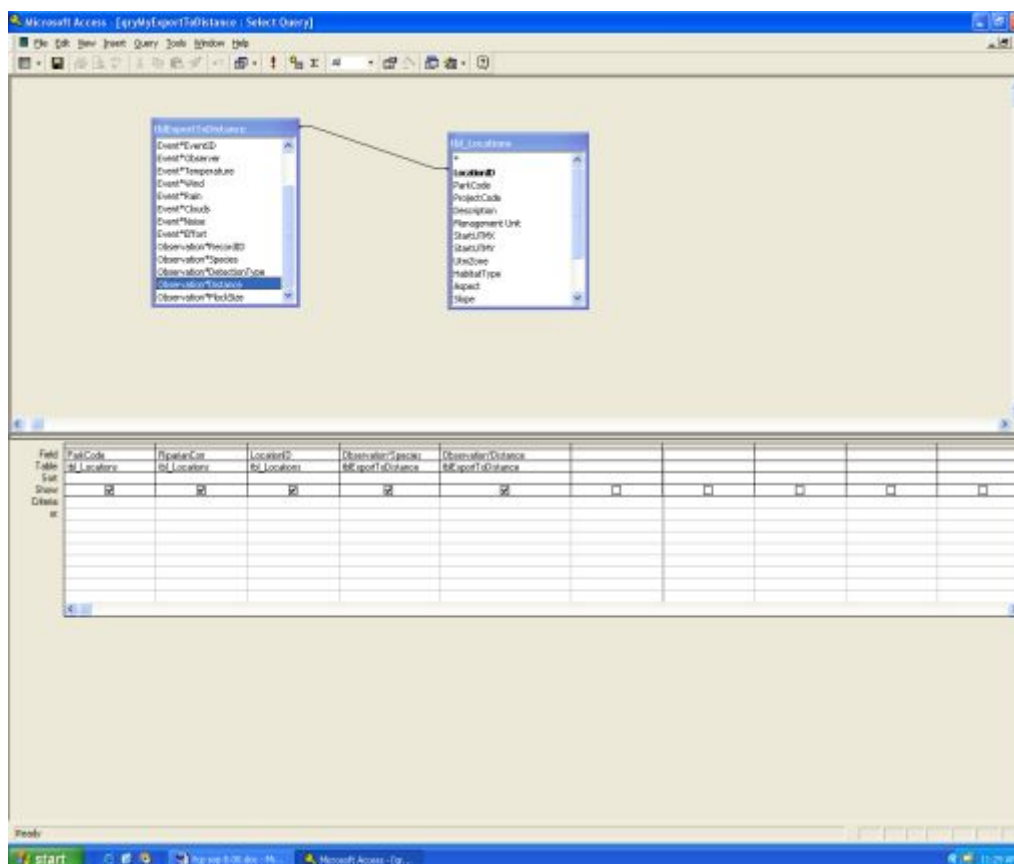


Figure 8.01.3: Creating a query in Design view for export to Distance 4.0.

4. Link the two tables in the upper window by dragging the field LocationsID from one table to the other. From tbl_Locations, select on the following fields by double-clicking on them: ParkCode, Riparian Plot, and LocationID. From tblExportToDistance, select on the following fields by double-clicking on them: Observation*Species and Observation*Distance.
5. Click the “save” icon on the upper left corner of the window and name the query “qryMyExportToDistance”.
6. We are now ready to export the data. Go to “File → Save As/Export...” Choose Save To an External File or Database. Under file type, select Text Files. Click on the Export button. You now have a choice of using delimiters or using fixed width form. You will probably want to clean up the data in a spreadsheet before importing it into Distance. For example, you may want to analyze data for just a single species at one park. All of this can be accomplished from within Access or using a spreadsheet such as Excel. If you do create new export tables from Access, be sure to work with back-up copies of tables.

Importing into Distance 4.0 -- There are many ways to stratify point transect data as it is imported into Distance. In our example the data could be stratified as:

Data Layer

Field Name

Study Area

Park

Region	Riparian Plot
Point Transect	LocationID
Observation	Distance

The example is for Red-winged Blackbirds which occur in both riparian and prairie habitats at Tallgrass Prairie National Preserve and Agate Fossil Beds National Monument, but at very different densities. For convenience, the import file should be tab-delimited text with the fields from right to left sorted ascending. Fields include: park, riparian plot, locationID and distance. This is easy to do with a spreadsheet such as MS Excel. Start Distance 4.0 and follow the procedures as follows:

New Project Wizard --

1. Create a new project with the icon in the upper left window. For example, RWBL_Prairie. In the next window (Step 1) select I want to: analyze a survey that has been completed. Click on Next.
2. Step 2, reviews your choices and the basic data structure.
3. Step 3, make the following choices: Type of survey – point transect; accept all other (default) selections on this window. Click on Next.
4. Step 4, accept the default units of measure (meters, hectares). Click on Next.
5. Step 5, do not select multipliers. Leave these boxes blank. Click Next.
6. Under Step 6, choose Destinations: Proceed to Data Import Wizard.

Data Import Wizard --

1. Step 1, is an introduction to the data import process. Click Next.
2. Step 2, select the text file you are importing into Distance. Click on Next.
3. Step 3, data destination. Use default destination settings. Click on Next.
4. Step 4, at this point, the Distance software is attempting to look at your data. The default delimiter is tab. If you used comma, semicolon or space, indicate that here.
5. Step 5, you now can label columns in the data (Figure 8.01.4).

This is where you tell Distance which columns in your data file correspond with which fields (columns) in the Distance database. To do this, click on the layer name and field name of each column, and choose from the list. Click Help for more information.

Shortcuts

☐ Columns are in the same order as they will appear in the data sheet

☐ First row contains layer names and field names of each column

Delimiter: * Example: Region*Area

Grid size

Rows: 212

Columns: 4

Layer name:	Region	Region	Point transect	Observation
Field name:	Park	Habitat	LocationID	Radial distance
Field type:	Text	Text	Text	Decimal
1 AGFO	PRAIRIE	PRAIRIE	AGFOTweety38	240
2 AGFO	PRAIRIE	PRAIRIE	AGFOTweety40	245
3 AGFO	PRAIRIE	PRAIRIE	AGFOTweety46	80
4 AGFO	PRAIRIE	PRAIRIE	AGFOTweety49	61
5 AGFO	PRAIRIE	PRAIRIE	AGFOTweety49	95
6 AGFO	PRAIRIE	PRAIRIE	AGFOTweety49	99
7 AGFO	PRAIRIE	PRAIRIE	AGFOTweety51	30
8 AGFO	PRAIRIE	PRAIRIE	AGFOTweety51	30
9 AGFO	PRAIRIE	PRAIRIE	AGFOTweety51	30
10 AGFO	PRAIRIE	PRAIRIE	AGFOTweety51	30
11 AGFO	PRAIRIE	PRAIRIE	AGFOTweety51	30

Help Cancel < Back Next > Finish

Figure 8.01.4. Importing grassland bird distance data into Distance 4.0. Step 5 of the Import Data Wizard is to identify the data file structure including field names.

- Step 6, ends the import procedure. You may choose to overwrite existing data or add to existing data. The default is to overwrite, which we accept here. Click on Finish. At this point the data will be loading into Distance 4.0
- Click on the Data folder to confirm that your data are actually in Distance 4.0. Click on the binoculars. The entire data structure should appear including study area, region, point transect and observation (see Figure 8.01.5).

Study area		Region		Point transect		Observation	
ID	Label	ID	Label	Area	Park	Habitat	Survey effort
ID	Label	ID	Label	Decimal	Text	Text	LocationID
n/a	n/a	n/a	n/a	ha	n/a	n/a	n/a
Int	Int	Int	Int	Int	Int	Int	Int
1	Default	0	AGFO	PRAIRIE	1	Default	1
2	Default	1	AGFO	PRAIRIE	1	Default	1
3	Default	1	AGFO	PRAIRIE	1	Default	1
4	Default	1	AGFO	PRAIRIE	1	Default	1
5	Default	1	AGFO	PRAIRIE	1	Default	1
6	Default	1	AGFO	PRAIRIE	1	Default	1
7	Default	1	AGFO	PRAIRIE	1	Default	1
8	Default	1	AGFO	PRAIRIE	1	Default	1
9	Default	1	AGFO	PRAIRIE	1	Default	1
10	Default	1	AGFO	PRAIRIE	1	Default	1
11	Default	1	AGFO	PRAIRIE	1	Default	1
12	Default	1	AGFO	PRAIRIE	1	Default	1
13	Default	1	AGFO	PRAIRIE	1	Default	1
14	Default	1	AGFO	PRAIRIE	1	Default	1
15	Default	1	AGFO	PRAIRIE	1	Default	1
16	Default	1	AGFO	PRAIRIE	1	Default	1
17	Default	1	AGFO	PRAIRIE	1	Default	1
18	Default	1	AGFO	PRAIRIE	1	Default	1
19	Default	1	AGFO	PRAIRIE	1	Default	1
20	Default	1	AGFO	PRAIRIE	1	Default	1
21	Default	1	AGFO	PRAIRIE	1	Default	1
22	Default	1	AGFO	PRAIRIE	1	Default	1
23	Default	1	AGFO	PRAIRIE	1	Default	1
24	Default	1	AGFO	PRAIRIE	1	Default	1
25	Default	1	AGFO	PRAIRIE	1	Default	1
26	Default	1	AGFO	PRAIRIE	1	Default	1
27	Default	1	AGFO	PRAIRIE	1	Default	1
28	Default	1	AGFO	PRAIRIE	1	Default	1
29	Default	1	AGFO	PRAIRIE	1	Default	1
30	Default	1	AGFO	PRAIRIE	1	Default	1
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33	Default	1	AGFO	PRAIRIE	1	Default	1
34	Default	1	AGFO	PRAIRIE	1	Default	1
35	Default	1	AGFO	PRAIRIE	1	Default	1
36	Default	1	AGFO	PRAIRIE	1	Default	1
37	Default	1	AGFO	PRAIRIE	1	Default	1
38	Default	1	AGFO	PRAIRIE	1	Default	1
39	Default	1	AGFO	PRAIRIE	1	Default	1
40	Default	1	AGFO	PRAIRIE	1	Default	1
41	Default	1	AGFO	PRAIRIE	1	Default	1
42	Default	1	AGFO	PRAIRIE	1	Default	1

Figure 8.01.5. Data screen in Distance 4.0 with Red-winged Blackbird distance values at Agate Fossil Beds National Monument.

Analysis --

1. With a sample of bird abundance survey data in Distance 4.0, we are now in a position to take a look at the status of Red-wing Blackbirds populations at Agate Fossil Beds National Monument and Tallgrass Prairie National Preserve.
2. Select the analysis tab from the upper portion of the window. Select Analysis, Analysis Details from the Menu at the top of the window. To try out the software with a preliminary analysis using the default distance models, click Run.
3. The analysis run will generate three tab windows. The Inputs window provides information about which data set was run, and which model was used in the analysis. The log provides information about the analysis run which might include warnings such as critical assumption violations and how the software is addressing them. The output results contain descriptions about the data and models being used in the analysis, a glossary of terms used in the models (which is really nice!!), model parameter values

used to fit the data, graphical output of the distance distribution (note: you will have to click on the Next button, to get through all of the output), and goodness-of-fit tests. Again, software users are urged to get really familiar with Buckland *et al.* 2001 which describes the theory and gives plenty of real-world examples. There is also a list-serve available to discuss application of the theory or use of the software.

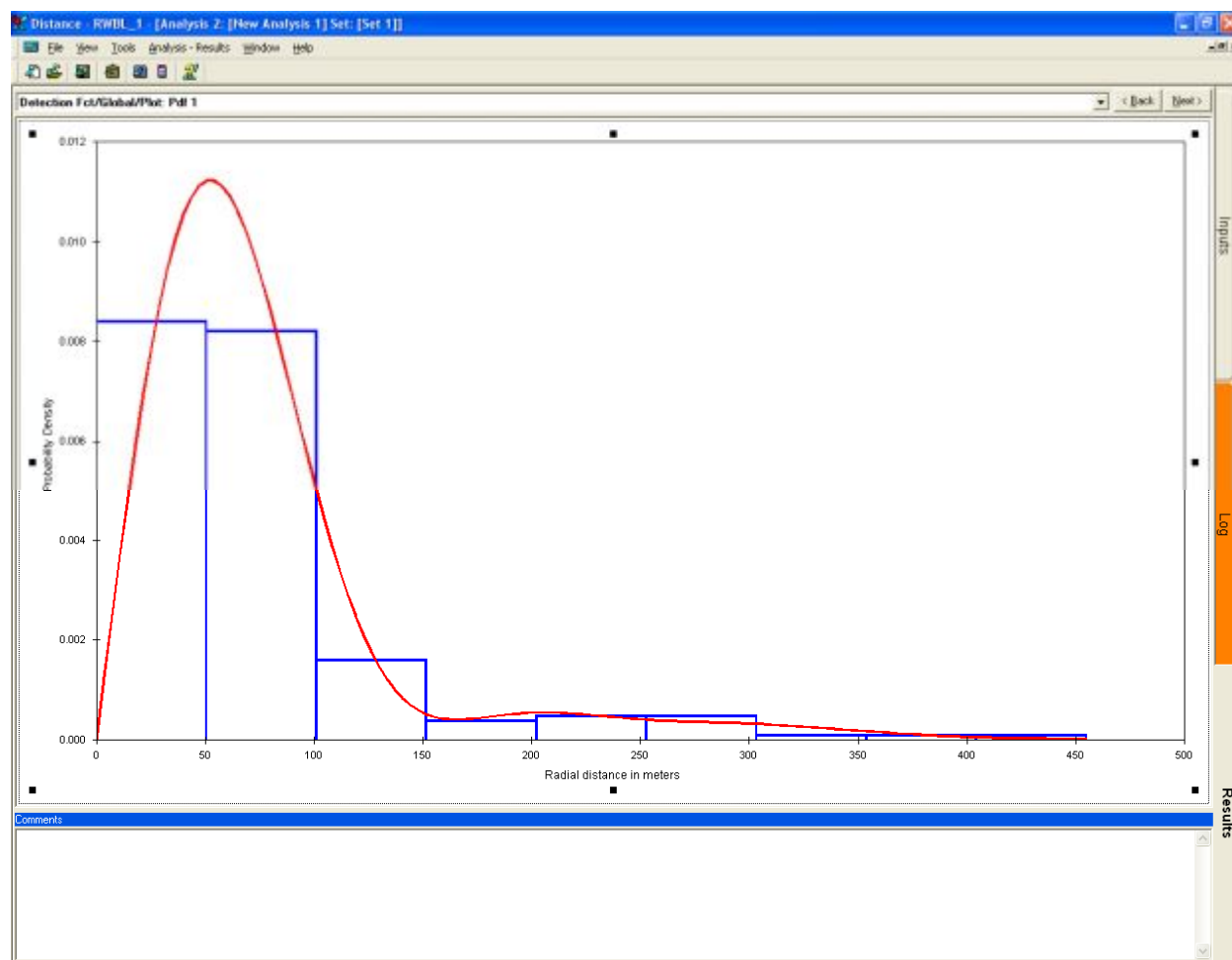


Figure 8.01.6 Distance distribution for Red-winged Blackbird for all observations pooled.

Species-Habitat Correlation Analysis (in development)

Other Data Analysis Techniques (in development)

Data visualization --

Geostatistics --

Time-series analysis --

III. Literature Cited

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