South Dakota Breeding Bird Atlas II
2010 Field Season Report

December 31, 2010

Rocky Mountain Bird Observatory
Tech. Report # M-SDBBA2-04

ROCKY MOUNTAIN BIRD OBSERVATORY

***Mission**: To conserve birds and their habitats*

***Vision**: Native bird populations are sustained in healthy ecosystems*

***Core Values**:*

1. ***Science** provides the foundation for effective bird conservation.*
2. ***Education** is critical to the success of bird conservation.*
3. ***Stewardship** of birds and their habitats is a shared responsibility.*

RMBO accomplishes its mission by:

- ***Partnering** with state and federal natural resource agencies, private landowners, schools, and other nonprofits for conservation.*
- ***Studying** bird responses to habitat conditions, ecological processes, and management actions to provide scientific information that guides bird conservation efforts.*
- ***Monitoring** long-term trends in bird populations for our region.*
- ***Providing** active, experiential, education programs that create an awareness and appreciation for birds.*
- ***Sharing** the latest information in land management and bird conservation practices.*
- ***Developing** voluntary, working partnerships with landowners to engage them in conservation.*
- ***Working** across political and jurisdictional boundaries including, counties, states, regions, and national boundaries. Our conservation work emphasizes the Western United States, including the Great Plains, as well as Latin America.*
- ***Creating** informed publics and building consensus for bird conservation needs.*

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***Cover Photo**:* Atlas logo designed by Michael Retter

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EXECUTIVE SUMMARY

The Breeding Bird Atlas is a relatively simple, repeatable, probabilistic grid-based survey that aims to monitor and document changes in the distribution of breeding birds on a large scale. Results of the first South Dakota Breeding Bird Atlas, conducted from 1988-1992, were extremely valuable in describing the status and distribution of South Dakota's breeding birds and established a baseline against which future changes in breeding bird populations will be measured. Since the first Breeding Bird Atlas, South Dakota's landscape has changed, and most likely, these changes are impacting South Dakota's breeding birds. The second South Dakota Breeding Bird Atlas is scheduled for 2008 - 2012 and aims to survey 433 3mi x 3mi blocks. The goal of SDBBA2 is to document the current distribution of every bird species that nests in South Dakota and to compare these distributions to those of the first South Dakota Breeding Bird Atlas. These data will support the efforts of land-use planners, decision-makers, researchers, educators, students, and bird enthusiasts to maintain healthy bird populations and conserve avian diversity within the state.

During the first three years of the project, volunteers and paid staff have visited 353 blocks at least once (81% of all blocks), with a total of 1,326 visits. Observers have spent 4,510 hours on blocks and submitted 19,168 individual bird records. On 135 'finished' blocks observers found an average of 59 species (range 28-88 species). Blocks in the prairie pothole region of the state have the highest number of species while West River grassland blocks have the lowest.

Thus far, 242 breeding species have been documented; 86% of which have been confirmed breeding within the state. Nine additional species either are non-breeding summer residents or are currently awaiting verification from the state Rare Bird Committee. Western Meadowlark is the most frequently reported species (362 records), Brown-headed Cowbird has been reported within the highest percentage of blocks (94%), and seven species have been reported from all 66 counties. Fourteen species have been recorded during SDBBA2 that were not reported during the first South Dakota Atlas and atlasers have confirmed breeding by eight of these: Sandhill Crane, Herring Gull, Snowy Plover, Black-necked Stilt, Black Rail, Eurasian Collared-dove, Prothonotary Warbler, and Cassin's Sparrow. Only one species, the Evening Grosbeak, was confirmed breeding during the first atlas, but has not yet been documented during the current atlas.

In 2009 and 2010, paid field workers collected data on 85 blocks to estimate species detection probabilities (D_p) using occupancy modeling. Of 105 species, 86% had estimated detection probabilities greater than 50%. Sedge Wren (13%), Sora (20%) and Wilson's Snipe (23%) had the lowest detection probabilities. Estimating detection probabilities gives us valuable information to evaluate

distribution maps and has not impeded the ability of observers to collect primary data for the atlas.

ACKNOWLEDGEMENTS

The second South Dakota Breeding Bird Atlas (SDBBA2) is a team effort, both organizationally and financially.

Coordination and organization:

- Eileen Dowd-Stukel, SDGFP, Wildlife Diversity Program
- Nancy Drilling, Rocky Mountain Bird Observatory (RMBO)

Technical Committee:

- Doug Backlund, SDGFP, Wildlife Diversity Program
- Kristel Bakker, Dakota State University
- Silka Kempema, SDGFP, Wildlife Diversity Program
- Jeff Palmer, Dakota State University
- Richard Peterson, coordinator of SDBBA 1, Wewela
- Dave Swanson, University of South Dakota

GIS, database, and web site development:

- Rob Sparks, RMBO
- Chandman Sambuu, RMBO

SDBBA2 Logo design: Michael Retter

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We especially thank the 35 volunteers and numerous observers who have submitted both block and extra observation data. In particular we thank the following for contributing unpublished data: Larry Igl (Northern Prairie Wildlife Research Center), the Rocky Mountain Bird Observatory (Science Team), and South Dakota Ornithologists' Union (bird database).

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INTRODUCTION

The Breeding Bird Atlas is a relatively simple, repeatable, grid-based survey that aims to monitor and document changes in the distribution of breeding birds on a large scale (Smith 1990). The first South Dakota Breeding Bird Atlas (SDBBA) began 20 years ago (Peterson 1995). During that ambitious project, 71 volunteers collected data over six years of fieldwork and submitted more than 24,000 breeding records, representing 219 bird species. The resulting resource has been extremely valuable in describing the status and distribution of South Dakota's breeding game and nongame species. The first atlas database also represents a baseline against which future changes in breeding bird populations can be measured.

Since the first Breeding Bird Atlas commenced in 1988, South Dakota's landscape has changed (e.g., Bakker and Higgins, 1998, Higgins *et al*. 2002, Grant *et al*. 2004). In addition, land-use changes in the upcoming few years could be staggering. Increasing CRP conversion, bio-fuels production, wind farm development, and urbanization, are a few landscape alterations of concern to conservation biologists (Stephens et al. 2006, Stubbs 2007). South Dakota's Wildlife Action Plan (SD GFP 2006) explicitly notes the link between habitat quality/quantity and the health of animal populations. Most likely, these landscape-level changes are impacting South Dakota's breeding birds. Regular monitoring of all breeding species on a large scale allows us to detect impacts of such large-scale landscape changes. Repeating the Breeding Bird Atlas approximately every 20 years not only documents bird response to habitat deterioration and loss, but also can improve our understanding of bird response to management actions designed to improve wildlife habitat quality and quantity. In addition, each Breeding Bird Atlas serves as a baseline to which future changes can be compared.

The goal of the second South Dakota Breeding Bird Atlas is to document the current distribution of every bird species that nests in South Dakota and to compare these distributions to those of the first South Dakota Breeding Bird Atlas (1988-1992). These data will support the efforts of land-use planners, conservation decision-makers, researchers, educators, students, and bird enthusiasts to maintain healthy bird populations and conserve avian diversity within the state. Specific objectives include:

1. Document current distribution of all breeding bird species, including under-surveyed species such as owls and secretive marshbirds.
2. Assess changes in distributions of breeding birds since the first SDBBA (1988-1992).
3. Identify habitat associations and requirements for all breeding species.
4. Produce a report and interactive web site with species distribution maps and analyses results.

Scientific questions to be addressed are:

1. What is the current statewide distribution of occurrences and nesting of every breeding bird species?
2. Which species have declined or increased in distribution since 1988-1992?
3. Are non-native bird populations increasing within or throughout the state?
4. What are the habitat associations or requirements of each breeding species?

Expected Benefits include:

1. More complete and up-to-date knowledge of breeding bird species status and distribution.
2. Improved understanding of changes in breeding bird populations over last 20 years.
3. More complete knowledge of bird-habitat associations.
4. Identification of species that have declined in distribution over the past 20 years and may require active management to keep from becoming a Species of Greatest Conservation Need.
5. An established baseline of species distribution for future surveys and atlases.
6. Contribution to a better understanding of regional breeding bird status and distribution, in conjunction with simultaneous atlases being conducted in Minnesota, Iowa, and Nebraska.
7. Provision of a resource for researchers, land managers, land-use planners, students, agency personnel, educators, and others.
8. An increased interest in birds by the general public and an opportunity for knowledgeable birders to engage in citizen science.

One important issue is that not all species are detected, no matter how much effort one puts into the survey (MacKenzie *et al*. 2006). Detectability, the probability that a species is detected when present, is affected by time of day, season, weather, observer abilities, species-specific characteristics, and habitat, among other factors. Failing to record a species that is actually there (false absence) biases the resulting maps and analyses, and makes interpretation of survey results more difficult. When detectability is quantified, we can make statements about the 'completeness' of a distribution map or account for this nuisance error during analyses, especially when comparing first and second atlas results. In addition, estimating detectability allows us to estimate occupancy rates (proportion of an area occupied by a species). In conjunction with a covariate, such as habitat type, estimated occupancy rates allow us to predict where species may occur in areas that are not surveyed. In 2009 and 2010, we collected data to estimate species detection probabilities on atlas blocks. The objectives were to estimate detection probabilities for as many species as possible, and to evaluate whether collecting these sort of data 1) interferes with or detracts from collecting primary atlas data (species presence and breeding confirmation) and 2) contributes to our understanding of species distributions within the state.

METHODS

GENERAL METHODS

Data collection for the Breeding Bird Atlas involves visiting pre-selected 3-mile x 3-mile areas ('blocks') and surveying all habitats within each block for bird presence and evidence of breeding for all bird species. Each summer, 2-5 paid full-time technicians survey atlas blocks for 4-10 weeks. The goal is for paid technicians to survey 200 - 250 blocks during the 4 - 5 year atlas period. The remaining 175 - 225 blocks will be surveyed by volunteers, including agency personnel and both novice and experienced birders. A special emphasis is placed on encouraging young people to participate.

Surveys during SDBBA2 follow the standardized protocols as recommended by the North American Ornithological Atlas Committee (Smith 1990) with some minor modifications. Atlasers are encouraged to visit their block during the breeding season at least three times during the day and once in the evening. Visits should be at least 10 days apart and can be spread out over multiple breeding seasons. Atlasers are asked to tabulate the number of person-hours spent surveying their blocks with a minimum effort of at least 20 hours on their block. The entire block does not need to be surveyed; rather, efforts are focused on surveying each habitat type within a block.

The primary focus of surveys is to document all breeding birds within a block. Bird observations are categorized as *Possible* breeding, *Probable* breeding, or *Confirmed* breeding, based upon a series of standardized breeding behavior criteria, within that species' breeding season. To document breeding phenology, emphasis is placed on recording ALL observations, not just the 'highest' breeding category observed for each species. In addition, the habitat each bird is observed in is recorded. Outside of designated blocks, the atlas encourages all interested persons to submit observations of *Confirmed* breeding by any species anywhere within the state.

The SDBBA2 Handbook, available from the Project Coordinator (Nancy Drilling) or at the SDBBA2 web site (http://www.rmbo.org/sdbba2), gives detailed protocol information and breeding status and habitat code descriptions.

ATLAS BLOCK SELECTION

Number of Blocks The second breeding bird atlas will attempt to completely survey 425 random blocks and eight special blocks (Figure 1). Of these blocks, 124 are the same random blocks covered in the first South Dakota Breeding Bird Atlas. The remaining 301 random blocks are newly selected for the second atlas.

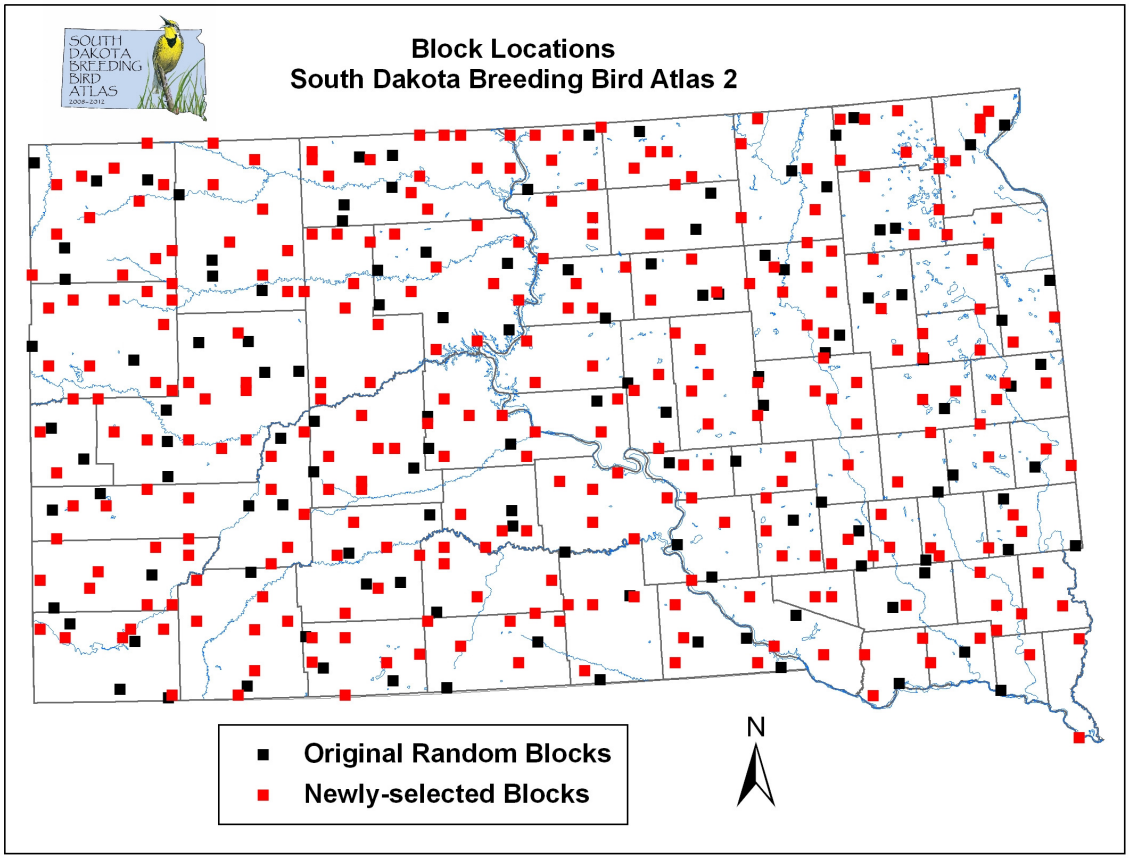

Figure 1. Location of blocks to be surveyed during the second South Dakota Breeding Bird Atlas. Note that block size is enlarged and not to scale.

Eight special blocks were added because they contain rare habitats that are not represented in the randomly-chosen blocks. These blocks include forested buttes in Harding County (3 blocks), mountain mahogany shrubland in Custer County (1 block), bluffs of the Missouri River (1 block), southwest sage grassland-sage shrubland in Fall River (2 blocks) and coteau forested ravines in Roberts County (1 block).

Block size and grid system. All blocks are 3 miles x 3 miles in size. Blocks selected in the two different atlases are based on different grid systems. The original blocks comprise nine Public Land Survey System (PLSS) sections. The SDBBA2 blocks are based on a uniform 3x3 mile grid placed over the entire state rather than on the PLSS sections.

Selection of original random blocks. The original 124 blocks were selected in 1988 for the first Breeding Bird Atlas. The state was divided into 62 equal-sized 'superblocks' and two 3-section x 3-section blocks were randomly selected within each superblock.

Selection of new blocks. The 301 new blocks were selected using a spatially-balanced sampling design (Stevens *et al*. 2004, Theobald *et al*. 2007). This probabilistic sampling design accounts for the fact that sites close together probably are more similar and produces a more spread out sample distribution. In ArcGIS v.9.0, a uniform grid of 8,819 3-mile x 3-mile blocks was placed over the entire state. Eight hundred blocks were randomly selected using the RRQRR algorithm developed by David Theobald at Colorado State University (Theobald *et al*. 2007). The first 301 samples 'drawn' in this procedure represented the new blocks to be surveyed during the second atlas. The center points of seven selected blocks fell outside the state border and were replaced by the next seven samples in the 800 sample list. One important assumption of spatially-balanced sampling is that blocks are surveyed in the order in which they are drawn. If they are not, the resulting design is not spatially balanced nor is it random. Thus, block # 276 only can be surveyed if blocks 1-275 are also surveyed.

SPECIES DETECTION PROBABILITIES

In 2009 and 2010, paid staff collected data to estimate species detection probabilities using occupancy modeling (MacKenzie *et al*. 2006). Of the 433 atlas blocks, 130 were randomly chosen to receive special surveys that will allow us to calculate species detectability and occupancy.

Each block targeted for the special surveys was visited three times within a four-week period. These blocks could be surveyed on three consecutive days, three consecutive weeks, or at irregular intervals. Each survey lasted four hours and was finished by 10:00 AM CDT. The survey was conducted along the exact same route in each of the three visits. Observers were not required to survey the entire block or visit every habitat during the four-hour survey. If some portions of the block or certain habitats were missed during the four hours, they were to be surveyed at another time; these data are used as general atlas data but not used in estimating detection probabilities. During the survey, observers recorded the same data as in a regular Atlas survey (species, breeding status, habitat code, and location). Observers also estimated the percentage of the block surveyed during the four hours. These data were recorded on separate forms and entered in a separate database for analyses but were also are included in the general atlas database of species occurrence and breeding status.

We use program PRESENCE v. 2.4 (Hines 2006) to estimate the probability of detecting a species given its presence on a block (D_p) and the proportion of atlas blocks occupied by a species (P_{si}) (Mackenzie *et al*. 2002). The occupancy model uses the detection probability to account for species that were present but undetected and adjusts the estimated proportion of blocks occupied accordingly. For the breeding bird atlas analyses, we used a single season, constant P model. We evaluated the fit of each species' occupancy model using Pearson χ^2 goodness of fit test with 1,000 bootstrap iterations (MacKenzie and Bailey 2004).

When probability of the χ^2 statistic was less than 0.20, we multiplied the D_p standard errors by the square root of ĉ (test statistic/average test statistic) (MacKenzie and Bailey 2004). Because the estimator is unstable when a species is too rare or too common (Mackenzie *et al*. 2006), only species which were detected on more than 10% of blocks and less than 90% of blocks are included in the analyses.

To determine whether detection probabilities differed between years for each species, we combined 2009-2010 data and compared a NULL model to a YEAR model using Akaike's Criteria (AIC) in program PRESENCE. The NULL model assumed equal probabilities between years while the YEAR model incorporated a year effect. The two models were considered equally likely when delta AIC was less than 2. For species in which the NULL model either was superior to the YEAR model or the two models were equal, data from 2009 and 2010 were combined to calculate an overall detection probability. For species which showed a year effect (i.e., YEAR model less than 2 delta AIC compared to NULL model), we report the individual detection probabilities per year.

PROJECT ORGANIZATION

The second South Dakota Breeding Bird Atlas is administered by two committees - a Steering Committee and a Technical Committee. The Steering Committee is responsible for overall guidance of project planning and implementation, as well as publicity and fund-raising. Members of the Steering Committee include a Project Director, Project Coordinator, representatives of federal, state, and tribal agencies, representatives of scientific and ornithological organizations and universities, and at-large and youth representatives. The Project Coordinator is in charge of actual planning, implementation, and coordination of all aspects of the Atlas. The Technical Committee is responsible for providing guidance on all scientific issues, such as appropriate methods of block selection and data collection, and data analyses and presentation. Members of the Technical Committee include the Project Coordinator, SD GFP Wildlife Diversity scientists, and three University scientists.

RESULTS

PERSONNEL

Thus far, 44 volunteers have signed up for 109 blocks. In the summer of 2010, 31 of these volunteers spent 368 hours conducting surveys on 57 blocks during 121 visits (Table 1). Five paid staff spent 1640 hours on 219 blocks during 551 visits. In 2010, atlasers submitted 10,460 records from blocks and an additional 1,633 Extra Observations.

Table 1. Summary of annual and total block results of the South Dakota Breeding Bird Atlas II.

	2008	2009	2010	Total
Num. blocks visited at least once	101	162	257	354
Total num. visits to blocks	205	448	672	1326
Num. counties visited	32	53	57	66
Average num. species recorded per block (range)*	39 (5-74)	42** (9-78)	45** (10-85)	N/A
Average % species confirmed per block (range)*	23 (3-49%)	23** (0-73%)	18** (0-50%)	N/A
Num. blocks 'finished'	7	38	90	135

* Minimum two hours spent on block

** Excludes blocks only visited at night for owl surveys in March-May

BLOCKS

During the first three years of the survey, atlasers visited 354 random and special blocks at least once (81% of all blocks) (Figure 2). Of these, 135 blocks are considered 'finished' - enough hours and species detected so that future visits probably would not result in new species' discoveries. One-fifth of visited blocks have been visited once during 2008-2010, while 22% have been visited twice, 15% visited three times, and 41% visited four or more times (maximum 22 visits). More than half of visited blocks have received less than 10 hours of total survey effort while 31% have received more than the recommended 15 hours of survey effort (Figure 3).

Atlasers that spent at least two total hours on a block detected an average of 51 species and confirmed breeding by an average of 22% of species detected. Atlasers averaged 59 species per 'finished' block with 25% of those species confirmed breeding and an average of 19.3 hours spent on the block.

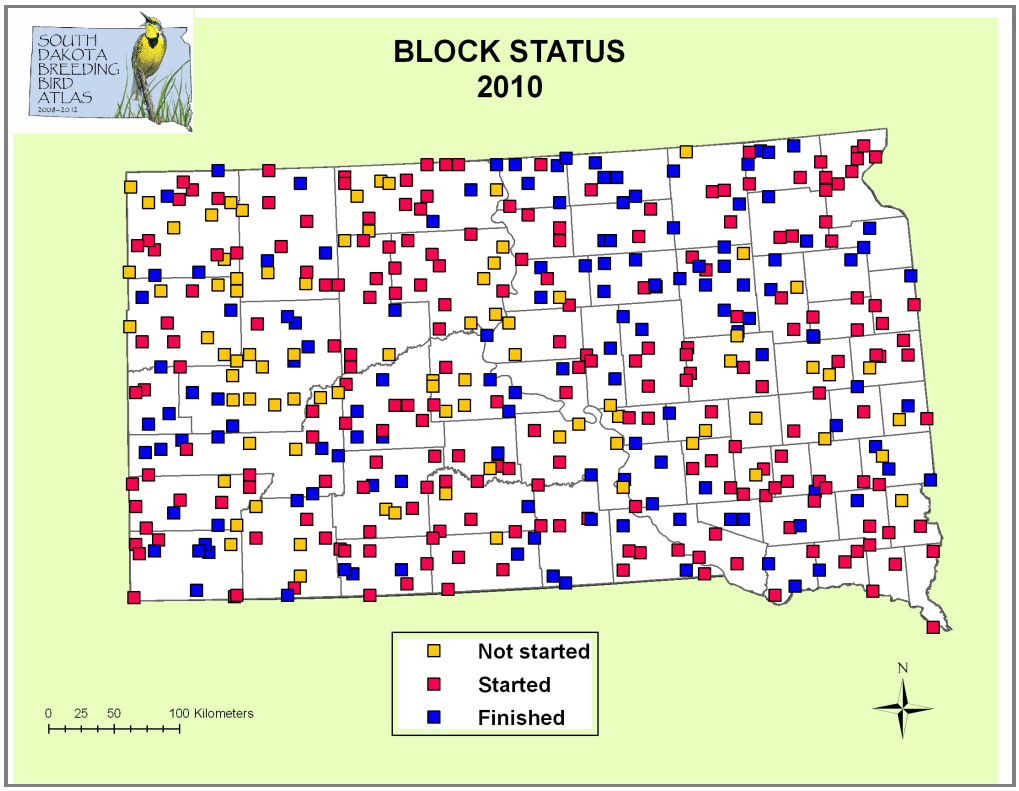

Figure 2. Survey status of atlas blocks at the end of 2010, the third year of the South Dakota's second Breeding Bird Atlas. Yellow blocks have not been visited nor assigned to anyone yet. Red blocks have been visited at least once and blue blocks are finished and will not be visited again. Note that block size is enlarged and not to scale.

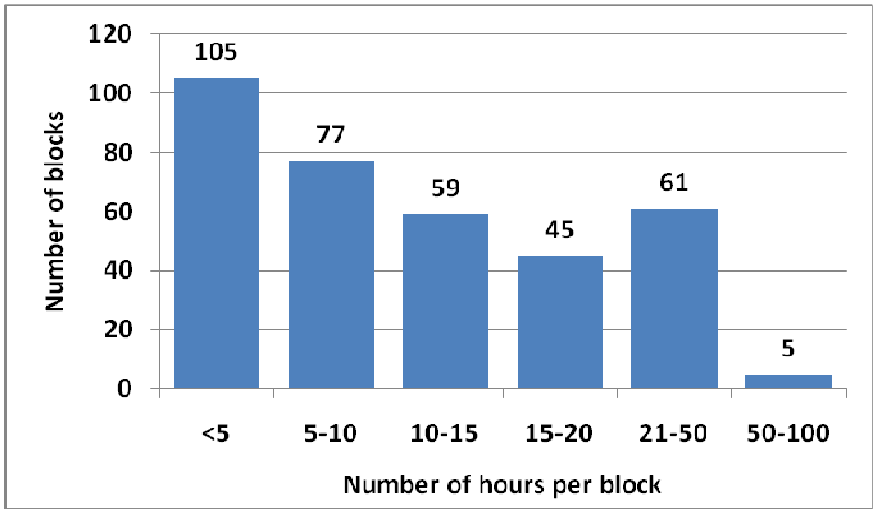

Figure 3. Frequency distribution of number of survey hours per atlas block during 2008-2010.

Overall, paid staff that spent at least two hours on a block recorded an average of 50 species per block and confirmed breeding by an average of 24% of observed species per block while volunteers recorded an average of 49 species per block and confirmed breeding by an average of 21% of observed species per block.

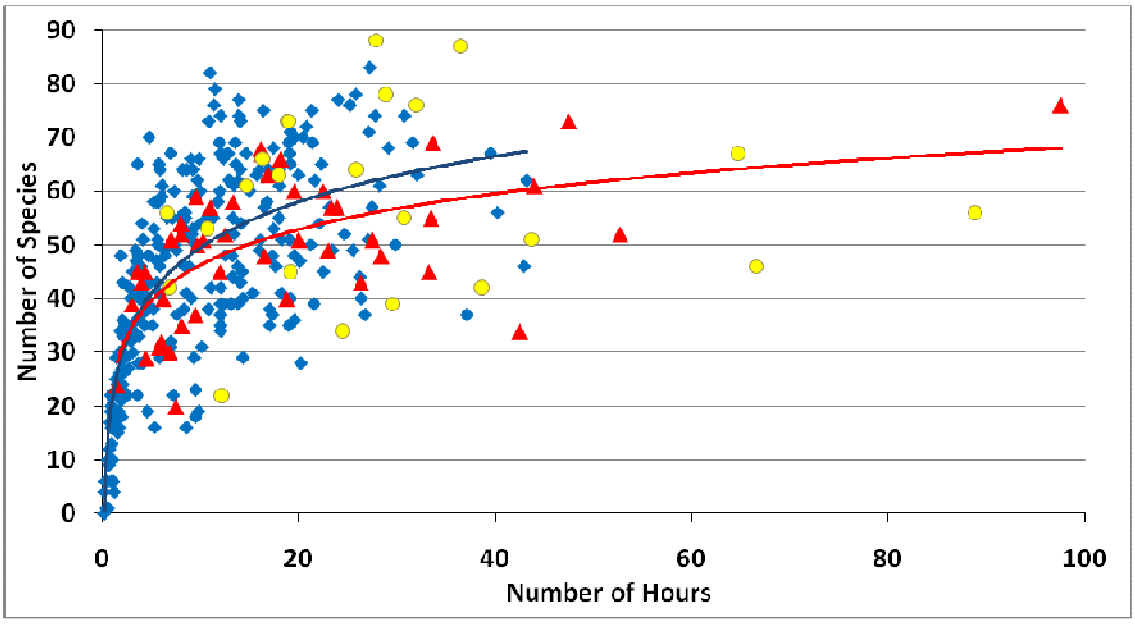

Figure 4. Relationship between number of survey hours on a block and number of species observed during 2008-2010 breeding bird atlas surveys. Blue symbols and predicted-values line represent data of paid field workers while red symbols and line represent volunteers' data. Yellow symbols represent blocks where both paid and volunteer observers have collected data.

Atlasers have recorded 70 or more species (excluding non-breeding species) on 24 atlas blocks thus far (Appendix A). Of this list, Sica Hollow still requires more visits. Another 29 blocks have 65-69 recorded species.

Species totals on the 135 finished blocks ranged from 28 - 88 species (Figure 5). Blocks with lower species richness occur in the James River Valley, higher elevations or burn areas of the Black Hills, and grassland blocks throughout the western part of the state. Blocks with higher species richness are located in the prairie pothole regions of the east, along the Missouri River, and along wooded rivers and creeks in the west.

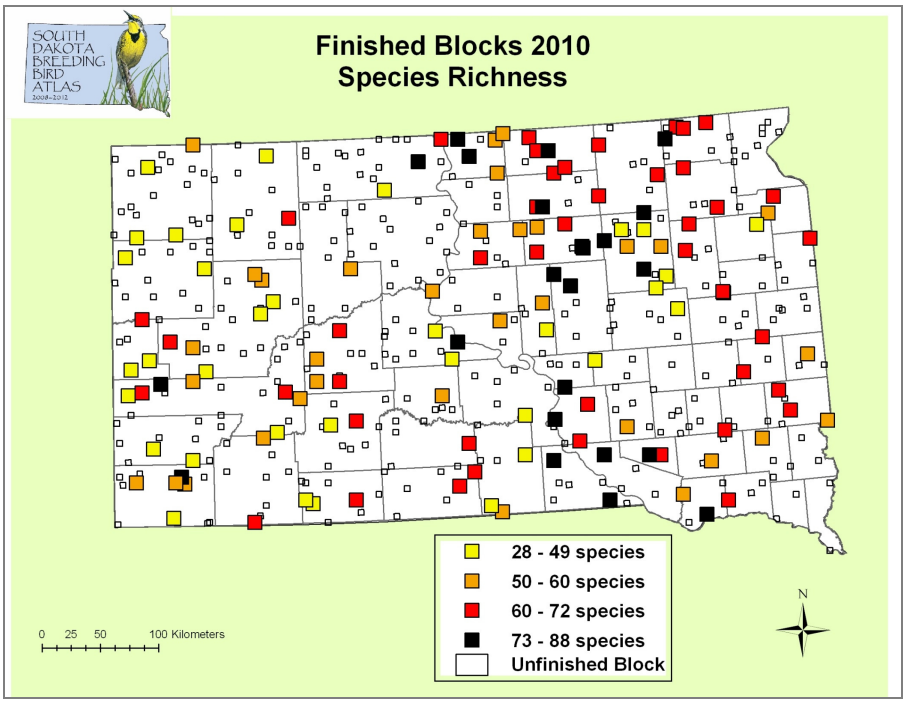

Figure 5. Spatial distribution of 135 breeding bird atlas blocks on which surveys are deemed finished, and total number of species recorded on those blocks. Note that finished block size is not to scale.

By the end of the 2010 field season, atlas blocks had been surveyed in all 66 counties. Thus far, Pennington, Campbell and Stanley counties have the highest species counts in the state. (Appendix B).

SPECIES

Based on 19,169 records submitted during 2008-2010, 242 species have been recorded at least once in the state. Of these, 209 (86%) have been confirmed as breeding, 25 (10%) are 'probable' breeders, and eight are 'observed' or 'possible' breeders (Little Blue Heron, Sharp-shinned Hawk, Sage Thrasher, Olive-sided Flycatcher, White-winged Crossbill, Cinnamon Teal, Cassin's Kingbird and Hermit Thrush). This tally does not include two species (Bewick's Wren, Pine Grosbeak) that are awaiting verification from the SD Rare Bird Committee, one hybrid (Indigo-Lazuli Bunting), or seven non-breeding summer residents (Snow Goose, Peregrine Falcon, Glossy Ibis, Mottled Duck, Scissor-tailed Flycatcher, Orange-billed Nightingale-Thrush and White-throated Sparrow).

Between 2008 and 2010, 226 species were recorded at least once on blocks while 16 species were only reported as extra observations (Table 2). Evening Grosbeak

was confirmed breeding during the first atlas but has not yet been detected during the second atlas. An additional 22 species that were confirmed breeding during the first atlas have been reported but not confirmed breeding during the second atlas (Table 3).

Table 2. Species only recorded as extra observations during 2008-2010.

Species	# Extra Observat.	# Extr Obs Confirmed	# County Detected	# County Confirmed
Barred Owl	2	2	2	2
Greater Sandhill Crane	1	1	1	1
Snowy Plover	1	1	1	1
Common Moorhen	2	2	1	1
Black Rail	1	1	1	1
Black-backed Woodpecker	5	2	1	1
Chuck-will's Widow	1	0	1	0
Cassin's Kingbird	1	0	1	0
American Dipper	5	5	1	1
Winter Wren	1	0	1	0
Pinyon Jay	1	0	1	0
Hermit Thrush	1	0	1	0
Prothonotary Warbler	1	1	1	1
Cassin's Sparrow	2	1	2	1
Lesser Goldfinch	1	0	1	0

Table 3. Species confirmed breeding during the first breeding bird atlas that have not yet been confirmed breeding during the second atlas.

1. Broad-winged Hawk	2. Sharp-shinned Hawk
3. Bufflehead	4. Hooded Merganser
5. Least Bittern	6. Northern Bobwhite
7. Whip-poor-will	8. American Woodcock
9. Cassin’s Kingbird	10. Northern Mockingbird
11. Pinyon Jay	12. Pygmy Nuthatch
13. Winter Wren	14. Brown Creeper
15. Golden-crowned Kinglet	16. Sage Thrasher
17. Veery	18. Wood Thrush
19. Scarlet Tanager	20. Nelson’s Sparrow
21. Eastern Meadowlark	22. Cassin’s Finch

Combining 2008-2010 data, Western Meadowlark is the most frequently reported species, Brown-headed Cowbird has been reported from the highest percentage of blocks, and seven species have been reported from all 66 counties (Table 4).

Table 4. Most common species reported during 2008-2010, defined as those with at least 300 records, in at least 80% of all blocks, or in all 66 counties.

Species	Total # records	% Blocks detected	# County detected
Western Meadowlark	362	93	66
Red-winged Blackbird	353	92	65
Mourning Dove	344	92	66
Brown-headed Cowbird	342	94	65
Mallard	331	75	65
Eastern Kingbird	323	87	65
Killdeer	320	88	66
Common Grackle	309	81	66
American Robin	308	81	66
Barn Swallow	303	81	65
Horned Lark	269	76	66
Northern Flicker	250	69	66

Fourteen species have been detected during SDBBA2 that were not reported during the first South Dakota Breeding Bird Atlas (Table 5). In addition, nine species (Barred Owl, Common Moorhen, Horned Grebe, Caspian Tern, Broad-tailed Hummingbird, Canyon Wren, Clark's Nutcracker, Sprague's Pipit, and LeConte's Sparrow) were reported but never confirmed nesting during the first atlas but have been confirmed breeding during the current atlas.

Table 5. Species reported during 2008-2010 field seasons that were not detected during the first breeding bird atlas.

Confirmed during 2nd atlas	Reported but not confirmed
Sandhill Crane	Chuck-will's-widow
Herring Gull	Hermit Thrush
Snowy Plover	Virginia's Warbler
Black-necked Stilt	Henslow's Sparrow
Black Rail	Great-tailed Grackle
Eurasian Collared-Dove	Lesser Goldfinch
Prothonotary Warbler	
Cassin's Sparrow	

SPECIES DETECTION PROBABILITIES

Paid staff collected data on 85 of 130 randomly-selected atlas blocks; 43 were surveyed in 2009 and 42 in 2010 (Figure 6). Staff covered an estimated 5 - 80% of the block's total area during the four hour surveys, depending on the block. At the end of the 12 hours of survey effort per block, observers recorded an average of 53 species (range 29 - 80) and confirmed breeding by an average of 11 species (range 2 - 27). Subsequent visits to the same blocks added an average of five species not detected during the 12-hour detectability surveys (range 2 - 15) and confirmed breeding by an additional three species on average (range 0 - 10).

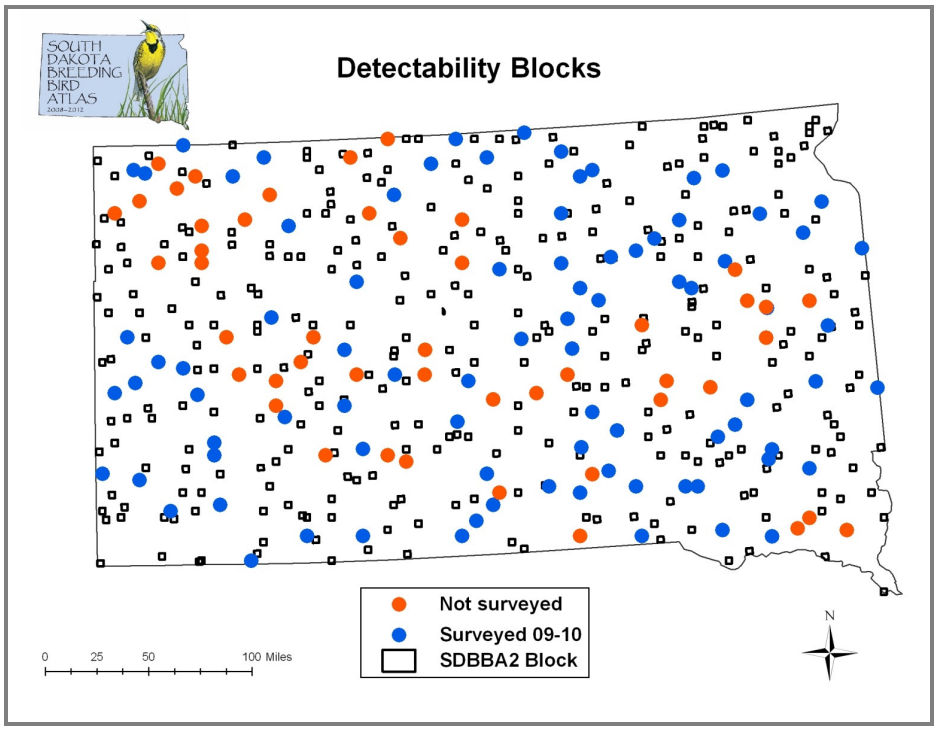

Figure 6. Location of breeding bird atlas blocks randomly selected for collecting species detectability data. Orange dots indicate locations of blocks where surveys have been completed; blue dots indicate locations of blocks not done yet, squares are blocks that were not selected.

Of the 183 species detected during surveys used to estimate detection probabilities, four species were too common to analyze and 74 species were too rare. Estimated detection probabilities for the remaining 105 species averaged 68.5% (median 67.5%, range 13-96%); 86% of all species had estimated detection probabilities greater than 50% (Appendix C, Figure 7). In 2009, Sedge Wren (13%), Sora (20%), and Wilson's Snipe (23%) had the lowest probability of

detection while Western Wood-pewee (93%), American Robin (93%) and Orchard Oriole (93%) had the highest. In 2010, Turkey Vulture (14%) and Spotted Sandpiper (31%) had the lowest probability of detection while Dickcissel (100%), Ring-necked Pheasant (97%), and Chestnut-collared Longspur (96%) had the highest.

We analyzed whether detection probabilities differed between years for 92 species (Appendix C). The YEAR model was the best-fitting model, compared to the NULL model of equal probabilities, for 29 of these species (31%). For these species, we estimated a separate detection probability for each year. For the remaining 63 species where the NULL model either was superior to the YEAR model or the two models were equal, data from 2009 and 2010 were combined to calculate an overall detection probability (Appendix C).

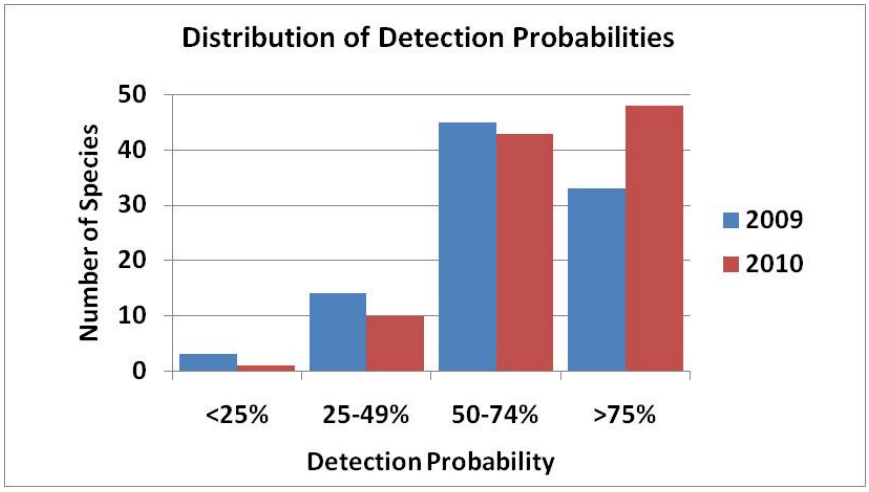

Figure 7. Frequency distribution of estimated detection probabilities for species recorded during four-hour special breeding bird atlas surveys in 2009 and 2010.

DISCUSSION

With 354 blocks receiving at least one visit in the first three years of data collection, the SDBBA2 is on track to collect data on all 433 blocks within five years. We aim to visit all blocks by the end of the 2011 field season but the task will not be easy. Most of the remaining 79 unvisited blocks have landowner permission or access issues that will require at least two staff to resolve. Another issue is the number of hours spent on blocks - 30% of blocks have received less than five hours of survey effort. In 2009, paid staff began a strategy of making quick first visits (usually less than three hours) to as many blocks as possible. Besides recording atlas data, the purposes of the quick visit were to identify the best birding areas in the block, determine if these areas require landowner contacts, and identify above-average blocks that should receive extra attention. This has allowed us to prioritize our efforts and be more efficient. With the information gained from these quick visits, we will shift our emphasis to increase the number of hours per block to ensure that as many blocks as possible receive adequate coverage.

After the 2009 field season, we were concerned that only 11% of blocks had received enough coverage to be considered 'finished'. Now we are less concerned because the number of finished blocks has increased from 7 blocks in 2008 to 38 blocks in 2009 to 135 blocks in 2010. As atlasers continue to visit partially-finished blocks, the number of finished blocks will increase in each of the upcoming years. Nevertheless, it will take a concerted effort to finish all blocks within five years.

During the first atlas, an average of 49 species were recorded per random block (Peterson 1996) while in this atlas, an average of 59 species have been recorded on finished blocks. In addition, SDBBA2 already has 24 blocks with more than 72 species, the maximum number of species recorded on first atlas random blocks. In part, higher species totals for the second atlas are because of the use of paid staff, who tend to survey with greater efficiency than volunteers (Figure 4) and detect more species per block on average. Another likely contributing factor is that atlasers have focused on more 'interesting' blocks - those with considerable amounts of natural habitat or in areas of the state with higher bird diversity or density. This has pushed species totals upward. Many of the remaining blocks have a preponderance of row crops or pasture, which typically host fewer species. As these blocks are finished, the overall average should revert towards the average recorded during the first atlas.

Enough data has been collected for the second atlas that we can begin to examine patterns of bird species diversity across the state and possible reasons for those patterns (Figure 5). Habitat in many of the low diversity blocks are grassland-pasture or grassland-pasture-wheat field habitats. Low-diversity blocks in the Black Hills consist of monoculture, even-aged ponderosa pine stands where atlasers struggled to find any other habitats (riparian, shrubby, deciduous, or

spruce) which would host additional bird species. The fact that an adjacent block can have double the number of species highlights the importance of land management on bird species diversity. The cluster of high-diversity blocks in the north-central portion of the state has surprised some observers. None of these blocks contain large, well-known protected areas. Instead, these blocks are characterized by having several types of good-quality semi-natural habitat, such as ponds of various depths and sizes, large dense shelterbelts, pastures and grasslands with different grazing regimes, and very little row crop or residential habitats.

With three years of data collection, SDBBA2 (242 species, 209 confirmed breeding) already has 23 more species than recorded 20 years ago during the first atlas (219 species, 212 confirmed). The current list includes two 'new' species which have been split from Rufous-sided Towhee (now Spotted and Eastern Towhee) and Northern Oriole (now Bullock's and Baltimore Oriole) since the first atlas. The South Dakota breeding bird species total is similar to totals recorded in states of similar size but with thousands of atlasers, such as Pennsylvania (6 years, 3282 atlasers, 217 species, 189 confirmed) and New York (5 years, 1187 atlasers, 242 species, 240 confirmed). Hopefully we will be able to add to the species total and confirm more species during the next two years. The challenge now is to obtain enough records to be able to define each species' distribution accurately. This can be done by spending more time on blocks and obtaining more data from outside sources (i.e., other research projects, RMBO monitoring database, state and federal survey results, etc.).

For common species, first and second atlas results are similar. The following were most frequently reported species on first atlas random blocks (in decreasing order of frequency): Mourning Dove, Western Meadowlark, Brown-headed Cowbird, Killdeer, Red-winged Blackbird, Eastern Kingbird, Barn Swallow, Common Grackle, American Robin, and Mallard (Peterson 1995). This list is identical to the SDBBA2 data (Table 4).

Breeding bird highlights of 2010 were located in and around wetlands, as most of the state is recovering from the recent drought and is 2-3 years into a wet cycle. This has turned much of the northeast quarter of the state into a large marsh, resulting in the first state record (and breeding record) for Black Rail, several Common Moorhen broods (second state breeding record), return of breeding Horned Grebe (last breeding record was in 1994), and the westward expansion of breeding Red-necked Grebes, White-faced Ibis, three Egret species, Piping Plover and Black-necked Stilts. Grassland birds, such as LeConte's, Nelson's, Baird's, and Henslow's Sparrows, and Sprague's Pipits, have also responded to better grassland habitat produced by the wet conditions.

To our knowledge the SDBBA2 is the first breeding bird atlas to estimate species detectability. Because we felt that conducting point counts (one common way to derive detection probabilities) would distract from and reduce our ability to

adequately survey all blocks for bird presence, we decided to use occupancy modeling, which uses multiple visits from atlas presence/absence data to estimate detection probabilities. We successfully estimated probabilities for about half of the species found on the blocks used to estimate detection. Of the species with insufficient detections to estimate probabilities, some, such as Cooper's Hawk or Northern Mockingbird are quite rare. Others, such as Mountain Bluebird are relatively common but only occur in a portion of the state. Hopefully we will be able to calculate detection probabilities for many of these species, after another year or two of data collection.

One objective of this study was to evaluate the efficacy of utilizing occupancy modeling. One concern was that this method of data collection would interfere or detract from the primary goal of determining species presence and confirming breeding. This concern was not supported as requiring the paid field worker to spend a certain amount of time on a block per day and to repeat visits over a short period of time resulted in more efficient data collection. Observers were able to concentrate their efforts in a relatively small geographic area over a several-day period, which most said helped them in scheduling and travel time. Theoretically, volunteers also could collect these data - the methods are the same as their usual atlasing. However, some volunteers may be unwilling or unable to visit a block three times within a fairly short time frame.

Collecting detectability data also did not seem to reduce the total number of species recorded for a block. Paid staff averaged 53 species detected during the 12 hours of detection surveys with an average of 5 species added in subsequent visits. This compares favorably with species totals documented by paid staff in other blocks. Overall, it appears that collecting atlas data in a way that allows us to estimate detectability does not detract from the primary purpose of the breeding bird atlas.

The data used to estimate detection probabilities will be most useful for interpreting distribution maps of species that seem to be rarer than expected. Spotted Sandpiper (SPSA) and Pied-billed Grebe (PBGR) are two good examples. Both species were reported 'less frequently than expected' during the first atlas (Peterson 1995). We now know that SPSA have a low detectability when present. Thus, although the species is reported on about 26% of blocks (naive occupancy), the estimated true occupancy is 62%. Most likely the unexpectedly low number of reports was because of an inability to detect sandpipers that were there. In contrast, PBGR have a relatively high detectability (56%) and both 'naive' (28%) and estimated true (31%) occupancies are similar. Thus, the perceived rareness probably is a real phenomenon that has conservation and management implications.

In the upcoming year, we will be conducting the following activities to improve the scope, efficiency, and usefulness of SDBBA2:

1. Finish owl surveys in the Black Hills and continue surveys in Pine Ridge and Rosebud areas
2. Continue collecting species detection data to increase sample sizes for rarer species.
3. Make at least one visit to the remaining 79 blocks that have not been visited yet
4. Give presentations at bird club and other scientific meetings
5. Publish newspaper and newsletter articles

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APPENDIX A. BLOCKS WITH HIGHEST SPECIES RICHNESS

Breeding Bird Atlas blocks with at least 70 recorded species,
excluding observed (non-breeding) species.

Block ID	Block Name	County	Num. Species	1st Atlas Total
2R0212	VenJohn WPA	Hand	88	N/A
1R1107	Boyer GPA	Brule	87	49 spp
2S0001	Sica Hollow	Roberts	83	N/A
2R0301	Jct. Hwy 10/45-112 St.	McPherson	82	N/A
1R1707	Lewis and Clark Lake	Bon Homme	79	56 spp
2R0134	Cheyenne River	Fall River	78	N/A
2R0232	Platte Creek	Charles Mix	78	N/A
2R0047	Fairview-Alden Twps.	Hand	77	N/A
2R0266	Mahto Road	Corson	77	N/A
1R0203	Silver City	Pennington	76	58 spp
2R0115	Glendale Colony	Spink	76	N/A
2R0199	East of Pollock	Campbell	76	N/A
2R0303	Grandview Township	Douglas	76	N/A
2R0015	Dry Run/County line	Spink	75	N/A
2R0198	Smith Creek	Buffalo	75	N/A
1R1502	East Renziehausen	Marshall	74	58 spp
2R0137	Fairfax	Gregory	74	N/A
2R0171	Landing Creek	Gregory	74	N/A
2R0222	S. Fork Snake Creek@164 St.	Spink	74	N/A
1R1102	Gerkin Lake	Faulk	73	61 spp
2R0026	Olson Creek	Campbell	73	N/A
2R0136	LaFramboise Island	Stanley	73	N/A
2R0188	Dove Creek	Faulk	73	N/A
2R0281	Jct.342Av-141St.	Edmunds	73	N/A
2R0132	Homer Township	Day	72	N/A
1R1601	Garfield Township	Clark	71	46 spp
2R0129	Beaver Creek @ county line	Yankton	71	N/A
1R1605	Johnsons Slough	Hamlin	70	56 spp
2R0203	Dayton Township	Marshall	70	N/A
2R0227	East of Sturgis	Meade	70	N/A

APPENDIX B. COUNTY SUMMARY STATISTICS

Summary statistics by county, counties ordered from highest to lowest species totals. Columns include total number of species recorded in the county (Num Species), total number (Num CO) and percent (% CO) of species confirmed breeding, number of atlas blocks in the county (Num Blocks), number (# Blks Visited) and percent (% Blks Visited) of atlas blocks visited through 2010, total number of visits (Num Visits) to and total number of hours (Total Hours) spent on all blocks in the county.

County	Num Species	Num CO	% CO	Num Blocks	# Blks Visited	% Blks Visited	Num Visits	Total Hours
Pennington	148	79	0.53	16	12	0.75	74	309
Campbell	134	63	0.47	8	8	1.00	31	102
Stanley	131	69	0.53	12	6	0.50	57	171
Fall River	130	56	0.43	12	11	0.92	62	187
Marshall	130	58	0.45	7	7	1.00	18	55
Custer	129	70	0.54	11	9	0.82	71	248
Brown	129	60	0.47	6	5	0.83	28	58
Harding	127	88	0.69	20	13	0.65	62	271
McPherson	126	73	0.58	5	5	1.00	22	57
Spink	125	54	0.43	13	12	0.92	41	151
Meade	120	59	0.49	18	10	0.56	37	170
Brule	120	56	0.47	4	4	1.00	23	85
Roberts	117	37	0.32	9	9	1.00	16	72
Minnehaha	114	65	0.57	6	5	0.83	43	134
Hand	113	41	0.36	6	6	1.00	19	70
Edmunds	112	43	0.38	6	6	1.00	21	55
Todd	111	33	0.30	8	7	0.88	24	110
Day	110	58	0.53	5	5	1.00	16	51
Shannon	109	32	0.29	9	6	0.67	25	127
Bennett	109	43	0.39	9	9	1.00	39	125
Haakon	109	55	0.50	10	10	1.00	33	105
Jackson	108	48	0.44	10	8	0.80	34	112
Lawrence	108	55	0.51	5	5	1.00	40	118
Potter	107	53	0.50	6	5	0.83	16	53
Ziebach	107	34	0.32	9	8	0.89	16	31
Gregory	106	36	0.34	7	7	1.00	27	99
Walworth	103	40	0.39	4	4	1.00	7	19
Bon Homme	102	34	0.33	4	4	1.00	18	55
Buffalo	101	31	0.31	4	3	0.75	11	35.3
Perkins	101	48	0.48	13	10	0.77	33	103
Charles Mix	100	30	0.30	4	4	1.00	16	49
Clark	98	45	0.46	5	4	0.80	13	45

Appendix B: County Summary Statistics (cont.)

County	Num Species	Num CO	% CO	Num Blocks	# Blks Visited	% Blks Visited	Num Visits	Total Hours
Yankton	98	26	0.27	3	3	1.00	9	37
Tripp	96	33	0.34	7	7	1.00	29	62
Corson	95	26	0.27	17	12	0.71	21	47
Hughes	95	54	0.57	3	3	1.00	10	35
Brookings	94	40	0.43	6	5	0.83	18	52
Faulk	94	44	0.47	6	6	1.00	28	70
Dewey	93	26	0.28	15	9	0.60	12	23
Grant	93	24	0.26	2	2	1.00	8	18
Deuel	92	38	0.41	4	4	1.00	9	33
Douglas	89	30	0.34	2	2	1.00	17	59
Beadle	86	41	0.48	8	6	0.75	11	43
Aurora	86	35	0.41	5	4	0.8	8	26
Lake	86	21	0.24	2	2	1.00	9	34
Sully	83	33	0.40	3	2	0.67	8	29
Mellette	83	22	0.27	5	4	0.80	12	43
Hamlin	81	29	0.36	4	4	1.00	12	51
McCook	80	21	0.26	3	3	1.00	7	27
Lyman	79	26	0.33	7	3	0.43	7	30
Kingsbury	77	23	0.30	3	2	0.67	5	22
Jones	77	36	0.47	6	5	0.83	14	35
Hyde	76	41	0.54	5	4	0.80	14	43
Codington	76	27	0.36	3	3	1.00	10	34
Moody	75	25	0.33	3	2	0.67	9	42
Union	73	28	0.38	2	2	1.00	3	19
Clay	72	26	0.36	2	2	1.00	5	12
Turner	72	26	0.36	4	4	1.00	6	22
Hutchinson	71	21	0.30	3	3	1.00	6	14
Jerauld	70	16	0.23	3	2	0.67	3	10
Hanson	61	8	0.13	3	3	1.00	5	22
Butte	60	28	0.47	14	6	0.43	14	32
Miner	58	10	0.17	3	2	0.67	4	16
Davison	57	10	0.18	4	3	0.75	6	19
Lincoln	54	16	0.30	2	1	0.50	3	12
Sanborn	31	1	0.03	2	1	0.50	2	1.8

APPENDIX C. SPECIES DETECTION PROBABILITIES

Estimated Detection Probabilities (D_p), year effect, and number of blocks in which the species was detected in 2009 and 2010 for 105 species during special detectability field surveys on atlas blocks. The list is ordered by species with highest D_p to species with lowest D_p.

Species	D_P 2009	D_P 2010	Year Diff?	# blks 2009	# blks 2010
Dickcissel	0.82	1.00	Yes	23	30
Ring-necked Pheasant	0.88	0.97	Yes	32	36
Chestnut-collared Longspur	0.76	0.96	Yes	9	17
Yellow-headed Blackbird	0.79	0.96	Yes	29	23
Eastern Kingbird	---	0.96	N/A	41	37
Marsh Wren	0.81	0.95	Yes	16	19
Yellow Warbler	0.74	0.95	Yes	35	31
Grasshopper Sparrow	0.74	0.94	Yes	38	39
Brown Thrasher	0.82	0.94	Yes	37	31
Sedge Wren	0.13	0.93	Yes	4	17
Western Wood-pewee	0.93	0.93	No	5	5
American Robin	0.93	0.93	No	39	39
Orchard Oriole	0.93	0.93	No	40	37
American Coot	0.68	0.92	Yes	16	22
American Goldfinch	0.78	0.91	Yes	36	33
Savannah Sparrow	0.69	0.90	Yes	15	17
Eastern Bluebird	0.90	0.90	No	5	8
Barn Swallow	---	0.89	N/A	42	38
Common Yellowthroat	0.89	0.89	No	37	35
Common Grackle	---	0.89	N/A	40	37
Upland Sandpiper	0.76	0.89	Yes	36	36
Bobolink	0.77	0.89	Yes	32	30
Wild Turkey	0.89	0.53	Yes	9	14
Mallard	0.89	0.89	No	35	36
Blue-winged Teal	0.87	0.87	No	31	30
Bell's Vireo	0.86	0.86	No	5	10
House Wren	0.86	0.86	No	33	36
Song Sparrow	0.86	0.86	No	31	25
Baltimore Oriole	0.63	0.86	Yes	23	15
Western Kingbird	0.85	0.85	No	37	37
Horned Lark	0.85	---	N/A	31	40
Willow Flycatcher	0.62	0.84	Yes	17	23
Vesper Sparrow	0.83	0.83	No	28	21
Redhead	0.50	0.83	Yes	16	16

APPENDIX C - Species Detection Probabilities (cont.)

Species	D_P 2009	D_P 2010	Year Diff?	# blks 2009	# blks 2010
Northern Shoveler	0.50	0.83	Yes	24	22
European Starling	0.82	0.82	No	39	35
Northern Flicker	0.81	0.81	No	34	36
American Bittern	0.41	0.81	Yes	5	13
House Sparrow	0.81	0.81	No	33	29
Field Sparrow	0.79	0.79	No	9	6
Canvasback	---	0.79	N/A	1	5
Lark Bunting	0.79	0.79	No	15	16
Sora	0.20	0.78	Yes	8	17
Gadwall	0.77	0.77	No	29	26
Cliff Swallow	0.77	0.77	No	25	25
Lark Sparrow	0.76	0.76	No	13	21
Spotted Towhee	0.76	0.76	No	10	12
Blue Grosbeal	0.43	0.76	Yes	11	16
Northern Pintail	0.36	0.75	Yes	18	25
American Crow	0.52	0.75	Yes	16	23
Clay-colored Sparrow	0.74	0.74	No	11	15
Tree Swallow	0.72	0.72	No	31	26
Lesser Scaup	---	0.72	N/A	2	5
Bullock's Oriole	0.72	---	N/A	5	3
Ruddy Duck	0.71	0.71	No	14	12
Warbling Vireo	0.63	0.70	Yes	25	26
Wilson's Phalarope	0.70	0.70	No	10	21
Least Flycatcher	0.70	0.70	No	17	8
Lazuli Bunting	---	0.69	N/A	1	7
Say's Phoebe	0.68	0.68	No	7	11
Chipping Sparrow	0.68	0.68	No	28	28
Burrowing Owl	0.68	0.68	No	4	6
Pied-billed Grebe	0.67	0.67	No	12	19
Wilson's Snipe	0.23	0.67	Yes	6	12
Blue Jay	0.67	0.67	No	19	17
Red-eyed Vireo	0.66	0.66	No	7	8
Red-headed Woodpecker	0.66	0.66	No	27	13
Canada Goose	0.65	0.65	No	18	18
Northern Harrier	0.64	0.64	No	20	20
Indigo Bunting	0.64	0.64	No	5	7
Black Tern	0.27	0.64	Yes	8	10
American Avocet	0.63	0.63	No	6	8
Black-capped Chickadee	0.63	0.63	No	7	19

APPENDIX C - Species Detection Probabilities (cont.)

Species	D_P 2009	D_P 2010	Year Diff?	# blks 2009	# blks 2010
Marbled Godwit	0.63	0.63	No	10	16
N. Rough-winged Swallow	0.63	0.63	No	8	15
Rock Pigeon	0.63	0.63	No	28	23
Brewer's Blackbird	---	0.63	N/A	4	5
Bank Swallow	0.63	---	N/A	6	3
Red-tailed Hawk	0.62	0.62	No	36	33
Black-headed Grosbeak	0.60	0.60	No	5	10
Great-crested Flycatcher	0.60	0.60	No	8	5
Wood Duck	0.60	0.60	No	11	13
American Wigeon	0.59	0.59	No	7	4
Gray Catbird	0.59	0.59	No	17	13
Loggerhead Shrike	0.59	0.59	No	15	5
Yellow-breasted Chat	---	0.59	N/A	3	10
Hairy Woodpecker	0.59	0.59	No	13	16
Common Nighthawk	0.57	0.57	No	16	19
American Kestrel	0.57	0.57	No	24	10
Green-winged Teal	0.28	0.56	Yes	9	16
Eurasian Collared-Dove	0.55	0.55	No	7	9
White-breasted Nuthatch	0.54	0.54	No	8	11
Swainson's Hawk	0.52	0.52	No	19	24
Cedar Waxwing	0.50	0.50	No	19	9
Belted Kingfisher	0.48	0.48	No	11	11
Rose-breasted Grosbeak	0.47	0.47	No	7	6
Eastern Phoebe	0.46	0.46	No	9	5
Great Horned Owl	0.44	0.44	No	17	15
Downy Woodpecker	0.43	0.43	No	13	13
Great Blue Heron	0.41	0.41	No	25	20
Virginia Rail	---	0.41	N/A	4	9
Sharp-tailed Grouse	0.38	0.38	No	8	10
Black-billed Cuckoo	---	0.38	N/A	1	6
Turkey Vulture	0.38	0.14	Yes	11	7
Spotted Sandpiper	0.31	0.31	No	11	12