Ecological Survey of Bird Populations and Floodplain Forest in the Vermillion/Cannon River

Bottoms Important Bird Area

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Executive summary: The Upper Mississippi River (UMR) is a Globally Important Bird Area recognized by the American Bird Conservancy, and the Vermillion/Cannon River Bottoms VCRB) area (Pool 3 and the upper portion of Pool 4 of the UMR) has been designated an Important Bird Area by the Minnesota Audubon Society. Floodplain forests of the UMR and conditions that maintain abundant and diverse bird communities are threatened. Altered hydrology and encroachment by invasive plant species are affecting forest regeneration and species and age/structural diversity. Active habitat management will probably be needed to maintain floodplain forest. This study was initiated to gather data on bird communities and species of greatest conservation need (SGCN) during the spring migration and breeding seasons, detailed habitat information, and to investigate habitat features that may favor migrating and breeding birds. In particular this study was set up to investigate bird responses to forest interior and edge. Of the SGCN, Cerulean Warblers (*Dendroica cerulea*) and Prothonotary Warblers (*Protonotaria citrea*) were the most often detected species in both seasons. However, detection probabilities (and site occupancy probabilities) for both these species were low which invalidates tests for habitat relations. Univariate measures of bird assemblages (i.e., number of birds, number of species per site per survey) for migration and the breeding season did not differ among interior, edge, and random site types (site types). Bird assemblage composition at sites did not differ among site types during migration but random sites differed from interior and edge sites during the breeding season. Diversity measures of bird assemblages during migration suggested that random sites differed from interior and edge sites, but there were no differences in diversity measures among site types for the breeding bird assemblages. These data suggest that bird assemblages do not seem to respond to edge or interior per se, but rather to forest width because areas with random points were not wide enough to have an “interior” area.

The forest of the VCRB are dominated by silver maple (*Acer saccharinum*), with strong components of green ash (Fraxinus pennsylvanica) and American elm (*Ulmus americanus*). No oaks (*Quercus* spp.) or river birch (*Betula nigra*) were detected. Principle components analyses

(PCA) of forest structure and tree importance value variables revealed no relation with site type. Although PCA of landscape variables collected from GIS within 250m of breeding bird survey points revealed a pattern related to site type, this pattern is an artifact of how sites type were defined based on landscape features. Ground cover vegetation usually was wood nettle (*Laportea canadensis*) or reed canary grass (*Phalaris arundinacea*, hereafter *Phalaris*). *Phalaris* is a serious invasive species and it was found far into forest interiors as well as at edge and random sites. The Cannon River Bottoms area in particular is heavily infested. Five other invasive plant species were documented (dodder [*Cuscuda* spp.], garlic mustard [*Alliaria petiolata*], buckthorn [*Rhamnus cathartica*], burdock [*Arctium* spp.], and plumeless thistle [*Carduus acanthoides*]); none of these are widespread as of yet. However, the patches of garlic mustard will quickly spread because they are at least two years old and setting seed.

Multivariate analyses (ANOSIM) revealed some relation between the forest habitat structure, including tree importance values, and breeding bird assemblage data sets, but this was not so for the migrating bird assemblage. Similarities among sites in migrating and breeding bird assemblages were influenced by several habitat variables (LINKTREE analyses). Bird assemblages at sites with little or no ground cover (because of spring flooding) differed greatly from assemblages at remaining sites. These sites were in the Vermillion River Bottoms, and typically had low bird species diversity and abundance but hosted Prothonotary Warblers. The next split(s) separated bird assemblages on Cannon River sites from assemblages on remaining sites based on having lower basal area and greater *Phalaris* cover. This result suggests how the bird assemblage shifts as the forest canopy becomes more open and *Phalaris* comes to dominate the ground cover. In general species associated with more open forest and shrubs will be favored and some common UMR forest birds will decline. Cannon River sites still had high bird diversity and abundance and attracted more of some transient migrant species.

Analysis of habitat relations for individual bird species was only legitimately possible for three common species. Common Yellowthroat was strongly associated with increased *Phalaris* cover. Yellow Warbler was strongly associated with lower tree height and somewhat associated with greater ground cover. Baltimore Oriole was somewhat associated with greater ground cover. Ground over may be a surrogate for mature forest in this area where wood nettle dominates under a closed canopy; however, Baltimore Orioles are not adverse to open canopy or forest edges.

The bird community of the VCRB is robust but SGCN are not abundant. Bird assemblage composition is primarily influenced by 1) lack of ground cover and 2) high cover of *Phalaris* and low basal area. Tree species composition and size/age composition did not vary much throughout the study area and hence no relations of bird assemblages to these features could be discerned. On a landscape scale, bird assemblages may respond to forest width, more than to edge versus interior, or to “patch size.” Prothonotary Warblers seem to favor sites with little ground cover. Cerulean Warblers were found at sites that had ground cover and typically did not have much *Phalaris*. *Phalaris* has the potential to spread throughout the study area if canopy gaps occur because it is widespread and occurs in interior areas as well as on edges.

INTRODUCTION

The Upper Mississippi River (UMR) is a Globally Important Bird Area recognized by the American Bird Conservancy, and the Vermillion/Cannon River Bottoms area (Pool 3 and the upper portion of Pool 4 of the UMR) has been designated an Important Bird Area by the Minnesota Audubon Society. Forest is the most prevalent terrestrial habitat on the UMR, and UMR floodplain forests are important to birds because they form a nearly contiguous connection between northern and southern forest ecoregions through the largely agricultural heart of the Midwest (Emlen et al. 1986, Grettenberger 1991). Breeding bird species composition differs and relative abundance of birds is almost twice as high on UMR floodplain forests as compared to adjacent upland forests (Knutson et al. 1996, Knutson et al. 1999). Several bird species such as Prothonotary Warbler (*Protonotaria citrea*), American Redstart (*Setophaga ruticilla*), Brown Creeper (*Certhia americana*), and Yellow-bellied Sapsucker (*Sphyrapicus varius*) are clearly more abundant in UMR floodplain forests compared to upland forests during the breeding season (Knutson et al. 1996).

Upper Mississippi River floodplain forests have a long history of alteration beginning with extensive logging and conversion to agricultural and urban development. Alterations to benefit navigation began in the mid 1800's as well, and culminated with the installation of a system of 27 locks and dams from Minneapolis, Minnesota to St. Louis, Missouri (finished in 1941). Roughly 50% of the existing floodplain forest was lost to flooding upon completion of the navigation system (Yin 1999). Operation and maintenance of the 3-m deep navigation channel continues to affect aquatic and terrestrial habitats (Fremling and Claflin 1984). The structure of the floodplain forests were also changed when mature American elms (*Ulmus americanus*), which formerly composed a super canopy layer, were killed by Dutch elm disease in the 1970's. Now elms only grow to reach the subcanopy before dying.

Altered river processes appear to be affecting composition and structure of the floodplain forest. Silver maple (*Acer saccharinum*) dominates UMR forests and is considered late successional in this system. Silver maple typically dominates the forest community but green ash (*Fraxinus* *pennsylvanica*), elm (*Ulmus* spp.), river birch (*Betula nigra*), and cottonwood (*Populus deltoides*) are frequently codominant or part of the subcanopy and understory. Historically pin (*Quercus palustris*), swamp white (*Q. bicolor*), red (*Q. rubra*) and black oaks (*Q. vetulina*) were present on terrace and other higher elevation areas. Cottonwoods and black willow (*Salix nigra*) occurred in areas with alluvial deposition. Tree diversity is now declining because mast trees can no longer survive elevated water levels and pioneering species are declining because new alluvium is rarely deposited, or when it is the timing does not coincide with seed dispersal (Yin and Nelson 1995, Yin et al. 1997, Knutson and Klaas 1998, Yin 1999, UMRCC 2002,). Furthermore, severe reduction in forest area and conversion to more grassland/savannah habitat is possible (Yin et al. 1997, Yin 1999, UMRCC 2002). Much of the forest canopy is composed of even-aged silver maple trees 55-75 years old and there are few saplings and seedlings of silver maple and other species in the understory (Yin 1999, UMRCC 2002). The life expectancy of silver maple is 125 years. In some areas, large silver maples and cottonwoods have been blown down or have died leaving gaps in the canopy (Fox et al. 2000, UMRCC 2002).

In Pools 2-13 of the UMR (approximately 325 river miles, 523km), an aggressive invasive, reed canary grass (*Phalaris arundinacea,* hereafter *Phalaris*), frequently invades canopy gaps. Without management intervention *Phalaris* prevents germination and growth of tree seedlings (Knutson and Klaas 1998, UMRCC 2002). As the even aged silver maple forest senesces, *Phalaris* may take over the understory, further retarding tree regeneration, which would result in a savannah-like habitat and eventually to losses of large areas of forest.

In 2005 Minnesota Department of Natural Resources wildlife biologists, foresters, and plant ecologists along with biologists from the US Geological Survey (USGS), US Fish and Wildlife Service, and non-governmental organizations finalized a working document (Pierce et al. 2005) to implement restoration, monitoring, and ecological research on the Vermillion Bottoms and Lower Cannon River (VCRB) areas of the UMR (Figure 1). This is an area of significance within the state of Minnesota harboring diverse bird and plant communities unique to the UMR, and it is one of the top sites in southeastern Minnesota for rare bird species (Dunevitz 2001). A total of 14 bird species of conservation concern have been documented in the site by the Minnesota County Biological Survey (unpublished data, cited in Pierce et al. 2005). The VCRB area contains one of the largest expanses of native floodplain plant communities in southeastern Minnesota, including floodplain forest, lowland hardwood forest, wet meadow, mixed emergent marsh and calcareous fen (Dunevitz 2001). To deepen the understanding of bird and plant communities we collected data on bird abundance, diversity, and site occupancy as well as forest structure and floristics, landscape features relevant to bird use of the area (i.e., distance from edge and edge type), and other variables of interest to forest managers. In particular they were interested in bird associations with edge versus interior forest and features of forest structure.

The Vermillion Bottoms Lower Cannon River plan (Pierce et al. 2005) sets out a vision for “ideal” forest structure and acreages for forest of different ages and canopy closure for the project area. One of the main goals of this vision is to restore and maintain forest for interior forest birds and species of conservation concern (i.e., Cerulean Warbler [*Dendroica cerulea*], Prothonotary Warbler [*Protonotaria citrea*], Red-shouldered Hawk [*Buteo lineatus*]) which breed in the area. To date, songbird use of the area for spring migration has not been studied. Recent work by USGS scientists suggests, however, that UMR floodplain forests in the Driftless Region support greater abundance of neotropical and short distance migrants than adjacent upland forest (Kirsch and Heglund in review). In particular, floodplain forest seems important for migrating Northern Waterthrush (*Seiurus noveboracensis*) and Yellow-rumped Warbler (Myrtle’s race, *Dendroica coronata*). Our goal was to determine habitat and landscape features in the area that are attractive for migrating and breeding songbirds, so that land managers can take these features into consideration. More detailed vegetation data collection and a sampling design to address questions relative to forest interior and edge would help discern habitat features that management can focus on to increase populations of these bird species in the study area.

Objectives:

The primary objective of this study was to collect data on bird species of greatest conservation need (SGCN) that use the floodplain forest within the Vermillion/Cannon River Bottoms Important Bird Area (IBA) during spring migration and for breeding; and to discover relations of bird species presence with floodplain forest habitat composition and structure especially with regard to forest interior and edge. Edge is an important landscape feature for birds during migration (Rodewald and Brittingham 2004, 2007), whereas interior forests may be important for several SGCN that may be area sensitive during the breeding season (Ambul and Temple 1983, Hamel 2000). Specific objectives include:

1) Identify bird species using this area and estimate occupancy rates of bird species of greatest conservation need during migration and breeding seasons.

2) Survey vegetation, to characterize floodplain forest vegetation composition and structure, including detailed information on presence and extent of *Phalaris* and other invasive plant species.

3) Analyze bird and vegetation data to determine habitat features associated with species presence or abundance for migrating and breeding birds in the area, including forest structure, landscape features, and presence and abundance of invasive plants.

METHODS

Survey site selection – Survey locations were placed in relation to interior forest patches, edges associated with interior patches and in random areas. Geographic information system (GIS) data on 1:24,000 scale land use land cover digitized from 2000 aerial photography available from the USGS, Upper Midwest Environmental Sciences Center (http://www.umesc.usgs.gov/data_library/land_cover_use/2000_lcu_umesc.html) was used to define and locate forest interiors in the study area using standard methods in ArcGIS 8.1 (Environmental Systems Research Institute, Redlands, CA). In the study area about 7% of the forest (108 patches) is greater than 100m from any type of edge; however, only 34 of these patches are five or more acres in size and large enough for transect surveys (see below) to fall entirely within the interior block. Sample sites were selected to balance the desire to make inferences related to these forest interior patches, associated edge, and the entire study area. First, a random sample of 21 interior patches greater than five acres in size was chosen. Edge locations were paired with each interior and placed in the 100 m buffer area outside of each interior (Figure 2). The location for each edge sample site in relation to the interior patch was randomly chosen between 0 and 360 degrees (in 10 degree increments) to indicate the radial direction from the center of the interior. Finally, to make inference related to the forests of the study area at large, an additional set of random points were selected from the remaining forest not within 100m of any interior patches greater than five acres in size. Thus, there were three sampling strata – interior patches, edge associated with interior patches, and remaining edge (which could include forest “interiors” less than 5 acres in size). Pairs of interior and associated edge sampling locations were a minimum of 250m from any other interior/edge pair and random sampling locations. Interior sampling locations were at least 125 to 250m from any edge, and as near the center of the interior patch as possible. Edge sampling locations were 25 to 50m from the actual forest edge. Fifty-one total sites were sampled, 17 in each category. The crew size that could be supported by available funding restricted the total number of sites that could logistically be surveyed three times in each season within the morning sampling period.

Spring migration surveys – We conducted line transect surveys (Hanowski et al. 1990, Rodewald and Matthews 2005) to sample birds from late April to the end of May. Transects are more appropriate for sampling birds during migration than point counts because they sample more area when most birds are mobile, patchily distributed and not territorial (Wilson et al. 2000). Transects were 150m long and took approximately 15 minutes to sample. All birds seen and heard within a 50m strip (25 m on either side of the transect) were identified to species and mapped. Transects, in each interior/edge pair were a minimum of 100 meters from center to center, so that there was at least 50m between the surveyed area of each transect. Some loud, large species with large territories (crows, jays, Pileated woodpecker [*Dryocopus pileatus*]) may have been double counted, but SGCN and other songbirds probably were not. Edge transects were within 25m of a forest edge, parallel to the open water/main channel or other edge type.

Three trained observers conducted surveys. Observers rotated among interior/edge pairs and random transects so that each transect was surveyed by each observer at least once during the season. Each transect was surveyed at least three times. Also, observers varied the order in which edge and interior transects pairs were surveyed, so that edge transects were not always surveyed first. Surveys were conducted between 30 minutes and four hours after civil sunrise. Surveys began shortly after sunrise to allow migrants time to settle into habitats after they arrive. Surveys were not conducted in rain, wind greater than 12kts, or dense fog.

Breeding bird surveys – Point counts are appropriate for breeding bird surveys because birds are territorial, more evenly distributed and not as mobile as during migration. Fifty-meter radius 10-minute point counts were conducted, keeping track of each five minute interval (Ralph et al. 1993). All birds seen and heard were recorded and approximate locations (of 1st detection) mapped on data sheets. These methods were similar to those used to survey birds in earlier studies along the UMR (Upper Mississippi River Fish and Wildlife Refuge [Thogmartin et al. 2009], MN DNR unpubl. data, Knutson 1995, Knutson and Klaas 1997, Kirsch and Heglund manuscript in review). Breeding bird point count locations were associated with transects used for spring migration. To minimize risk of double counting birds, interior survey points were at the starting or ending position along transects and edge point counts were near the end of the edge survey transect farthest from the interior point count, but 25 m further away from the habitat edge (so that the 50m radius would encompass only forest, and not include any edge habitat). This way the centers of the interior and edge point counts were 125 m apart and survey radii were separated by 25 meters. We realize that this was not ideal separation, but with trained observers and limiting observations to the 50 m survey radius we balanced the risk of double counting with the added logistical difficulty of separating point counts further and removing them from the spatial context of the transect surveys. Three observers conducted surveys. Just as for the spring surveys, observers alternated edge/interior surveys within each day of field work. Surveys were conducted within 30 minutes to four hours after civil sunrise. On the UMR the “dawn chorus” can be overwhelming and comprised of only a few species (Ralph et al. 1993, E. Kirsch pers. obs.). American Redstarts (*Setophaga ruticilla*) are likely to be undercounted if surveys are conducted too early, especially on cool mornings (E. Kirsch pers. obs.). Surveys were not conducted in rain, sustained wind greater than 12kts, or dense fog. To increase the likelihood of detecting rare species, points were surveyed three times during the breeding season.

Vegetation surveys – Information about leaf out progress was collected after each spring transect survey. Estimates of bud development were recorded from each woody vegetation layer present (canopy, subcanopy, understory). Observers recorded species and leaf out class for a representative individual in each vegetation layer. These data were collected at the beginning and end of each transect. Leaf development was placed into one of five classes 0-4 (0 = no apparent leaf development or buds slightly swollen; 1 = buds broken with small folded leaves and/or flower catkins; 2 = small unfolded leaves up to 33% of full size; 3 = leaves 33-66% of full size; 4 = leaves more than 66% of full size [Rodewald and Matthews 2005]).

After each point count survey, a releve technique (Mueller-Dombois and Ellenberg 1974) within 10 m of the survey center was used to estimate cover for canopy and ground vegetation layers, as well as list the three most prevalent tree/herbaceous species in the canopy, subcanopy, understory and ground layers, and cover of invasive plants if present.

Detailed point center quarter sampling (Mueller-Dombois and Ellenberg 1974) was conducted during late June along each 150-m long transect. Four plots were sampled corresponding to the start, 50m, 100m and end points of each transect. At each of these four sample plots, species, diameter at breast height (dbh) and distance from the center of the plot were recorded tor trees (>8cm dbh) and saplings (≤8cm dbh). Number of standing snags (>8cm dbh and over 2 m tall) within 25m of the plot center were counted. Total basal area of each plot was estimated using a size 10 angle gauge and averaged over the four plots in each transect. As well, height of a representative canopy tree and understory sapling or shrub for each plot was estimated using a clinometer. Percent cover of herbaceous vegetation (including *Phalaris* and other herbaceous invasive plants) within a 10m circle was visually estimated (Mueller-Dombois and Ellenberg 1974). All herbaceous species within that 10m circle were recorded and cover of invasive plant species estimated. Additionally, canopy and ground cover information was collected using a visual estimation (Mueller-Dombois and Ellenberg 1974) within 10-m radius of breeding bird point count locations.

Landscape variables – To gather landscape data that may influence the abundance of birds or presence of SGCN, certain landscape variables were estimated using land use land cover GIS datasets (http://www.umesc.usgs.gov/data_library/land_cover_use/2000_lcu_umesc.html) and standard procedures in ArcMap. Variables of interest within 250m of each point count location (buffer includes the entire migration survey transect) were area of forest and other habitat types, number of polygons for each habitat within 250m, distance to the main channel, and distance to the nearest forest edge. As an index of habitat fragmentation within 250m of each sample point, the total amount of each habitat was divided by the number of polygons of that habitat within the 250m buffer.

“Forest block” size is a variable of interest for SGCN and commonly estimated in bird studies in upland forests. In naturally fragmented riverine systems defining a forest block is subjective. For this study forest block size was defined as any contiguous area of forest, regardless of tree species composition. The same GIS coverages referenced in the preceding paragraph were used, and standard GIS techniques were applied in ArcGIS. First, all wet forest polygons (of which several types were defined in coverages, for example, *Populus* forest, silver maple forest, etc.) were selected and combined into a new coverage by eliminating all the polygon boundaries between adjacent forest polygons of different types and classifying resulting polygons as a single cover type — floodplain forest. Then, the area of each separate floodplain forest polygon was estimated.

Data analyses –

Bird data: Bird data were summarized for each transect and point for each survey. Occupancy sampling methods were used to estimate occurrence of SGCN in site types (interior, edge, random) and the entire study area each season. The probability of site occupancy, ψ, was estimated using zero-inflated binomial models and maximum likelihood (MacKenzie et al. 2006). Thus, models of ψ included those that allowed ψ and/or probability of detection (*p*) to vary by type, and a model where *p* was also allowed to vary as a random normal deviate on the logit-normal scale. These models were coded and run in SAS (SAS v9, SAS Institute 2003). Generalized linear models (SAS v9, SAS Institute 2003) were used to compare number of birds, species richness, and abundance of birds grouped by migratory guild among sample types for both spring migration and breeding seasons.

Nonmetric multidimensional scaling (NMS) and Cluster Analysis were used to examine patterns in the entire bird community (migration and breeding separately) using the program PRIMER-E version 6 (Clark and Gorley 2006). Counts of each species were averaged over all surveys at each site within a season. Data were then square root transformed to down-weight abundant species slightly, and all rare species were retained for analyses. Bray Curtis similarity values among samples were estimated and used in NMS and Cluster Analyses. For NMS, two- and three-dimensional solutions with the least amount of stress (least amount of multidimensional variability among samples) were estimated from 100 simulations in the hopes of finding global minimum stress values. The more frequently the minimum stress value is reached in those 100 runs the greater the confidence that a global minimum of stress has been found and hence the best solution. Plots of sample points produced by NMS depict the best possible estimation of similarities among samples along unitless axes. Thus, sites that are close to each other in plots contain more similar bird species composition and abundances than sites farther away. Stress values below 0.1 indicate a good ordination with no real prospect of misleading interpretations. Stress values up to 0.2 reflect ordinations that are useful, whereas details of ordinations with stress values approaching 0.3, while potentially useful for identifying general patterns, are not fully reliable. Stress values above 0.3 indicate that the ordination is largely arbitrary (paraphrased from Clark and Warwick 2001). Dispersion, or variance of the bird community within site types, was analyzed using the MVDISP routine in PRIMER-E. To assess the effect of site type on bird community composition, one-way analysis of site resemblances were assessed with ANOSIM in PRIMER-E. The ANOSIM test statistic, rho, is smaller when sites among a priori defined groups (site types) are more similar; and rho is larger as sites among a priori groups are more different. Finally, whether SGCN were indicative of bird community differences were investigated by examining bubble plots of SGCN abundance on NMS plots of sites.

Diversity indices: species richness (Margalef's D species richness), Pielou's evenness, Shannon diversity, and Simpson's index, were estimated for each site in PRIMER-E. Based on these estimated diversity indices Bray Curtis similarities among sites were estimated and Cluster and NMS analyses were run as above. Finally differences by type were estimated using ANOSIM.

Habitat data: Vegetation data (tree and shrub height, basal area, number of snags, cover of invasives) along each transect were averaged among the four points sampled. Tree species, distance and dbh data were used to estimate importance values for tree species sampled on each transect. Habitat in the study area was characterized using Principal Components Analysis (PCA) in PRIMER-E. Landscape and local variable datasets were analyzed separately because of differences in the scale at which the data were collected. Local variables examined for analysis were a combination of variables estimated during surveys along transects in June (average basal area, tree height, number of snags, *Phalaris* cover along each transect and importance values for tree species) and selected variables gathered during breeding bird surveys in June (canopy cover, ground cover). Tree importance values were square root transformed to normalize distribution somewhat. Average cover of *Phalaris* estimated along transects was highly correlated with cover of *Phalaris* estimated at breeding bird points (r=0.907). Average *Phalaris* cover from transect samples was used in the habitat dataset to compare to both bird datasets (see below) because it was gathered over a larger area. Numbers of variables used in analyses were reduced by eliminating variables with high correlations ($r^2 > 0.8$) with one or more other variables. Other variables were eliminated if they reduced cumulative variance accounted for by the first three principal components. Importance values for green and black ash were combined, and several tree species were eliminated from analyses because of extremely low frequency of occurrence. Sapling height also was eliminated because of low variance. Remaining variables in both datasets were normalized and Euclidean distances among sites were estimated and used in PCA. Dispersion among samples within site types was also estimated for landscape and local variable datasets. The same local habitat variable data set was used for comparison to both migration and breeding bird datasets. Although canopy cover and ground cover were lower during the first 10 days of sampling during migration, full canopy leaf-out and most ground cover had been achieved by the second two weeks of spring migration sampling.

During field work differences in forest structure were observed among the sites on the UMR, Vermillion River bottoms and the Cannon River Bottoms. Post-hoc analyses were conducted to examine how the forests in these areas differed. First the entire local habitat variable dataset was analyzed to look for differences among rivers with ANOSIM. Then a one way ANOVA was conducted to examine which variables may have differed most among rivers.

Relating bird and habitat data: Bird community and habitat data were compared using the RELATE routine in PRIMER-E. This method compares site similarity based on the bird community (Bray-Curtis) to site similarity based on habitat variables (Euclidian distance). In essence, if habitat features “determine” bird community features, then plots of sites in multidimensional space should be similar for both data sets. One thousand permutations were used to estimate the “matching” coefficient, rho. Under a null hypothesis that the similarity matrices do not match, rho would approximate zero. The next step was to see which habitat variables were correlated with the bird community structure using the BioEnv routine in PRIMER-E. This method takes just the variables of one dataset that produce the best match to site similarities based on the other dataset. That is, which habitat variables produce the best match to sites similarities based on the bird community data? For the RELATE analysis, 1,000 random permutations were run and a null hypothesis of no variables being related to similarities would have a test statistic, rho, approximately equal to zero.

The last step was to use the LINKTREE routine in PRIMER-E to show how these habitat variables were related to the bird data. LINKTREE finds splits in the bird community at sites that best correspond with breaks in values of habitat variables, starting with the largest splits clearly related to a habitat variable and working down to less clean splits somewhat less related to a habitat variable. The SIMPROF test (similarity profile, which is run on the bird data) was used to reduce the number of splits. The null hypothesis tested by this permutation test (1000 runs) is that a set of samples defined a posteriori (with LINKTREE) do not differ from each other in community structure, and the test statistic is an ANOSIM rho. Hence, all splits in trees displayed in the results have significantly different bird communities based on that habitat split, and the ANOSIM rho test statistic is rescaled and site similarities are re-ranked at each successive split. The other statistic reported for LINKTREE analyses is B%, which is an absolute measure of group differences from the original resemblance matrix. When B% is large, it indicates that the split group is that percentage different than the remainder of sites. With each split B% declines because the split and the remaining group becomes closer together in absolute terms in the original resemblance matrix. When groups get closer together (B% gets smaller), understanding which birds (and their detections/survey) account for the difference upon which the split was made can be difficult to tease apart.

Habitat relations of individual species can only be reliably modeled for species with site detection probabilities approaching one, which requires survey detection probabilities greater than 0.55. because site detection probabilities are 1 - (1-survey detection probability)^T, where T is the number of surveys at a site. Unfortunately, because survey detection probabilities for SCGN (see Results) were so low, any analysis investigating bird-habitat relations would be suspect. Therefore, in the hopes of finding some species for which to model habitat relations, survey and site detection probabilities were estimated post hoc on several relatively common species that are typically more common in floodplain forest than uplands in this area (American Redstart, Baltimore Oriole [*Icterus Galbula*], Common Grackle [*Quiscalus quiscula*], Great Crested Flycatcher [*Myiarchus crinitus*], Red-bellied Woodpecker [*Melanerpes carolinus*], Tree Swallow [*Tachycineta bicolor*], Yellow-bellied

Sapsucker [*Sphyrapicus varius*], and Yellow Warbler [*Dendroica petechia*]), as well as a couple habitat generalists that may indicate more open habitat with herbaceous or shrubby ground cover (Common Yellowthroat [*Geothlypis trichas*] and Song Sparrow [*Melospiza melodia*]). Analyses considered species whose site detection probabilities (computed from the formula above) were greater than 0.90. Also, ideally occupancy should be close to 50 percent so that there would be a greater chance of finding a difference related to habitat with a small sample of 51 sites. Species chosen for habitat modeling based as closely as possible on these criteria were: Baltimore Oriole, Common Yellowthroat and Yellow Warbler. A suite of a priori models, each with one variable that was likely to influence presence of a species, were run using PROC Logistic (SAS version 9.1, SAS Institute 2003). Fit was assessed for each model using Akaike weights, a derivative of the Akaike's Information Criterion (AIC; Akaike 1973, Burnham and Anderson 2002). Model AIC weights vary from zero to one, with larger weights indicating greater weight of evidence in favor of the given model being the best in the set of models for the purpose of representing the (finite) information in the data (Burnham and Anderson 2002).

RESULTS

Extensive flooding during April made accessing sites unsafe, and it was late April before we could access the study area to locate and set up transects. Surveys began in May. June rainstorms again caused river stages to rise, especially on the Vermillion River, and some sites became inaccessible for a week to 10 days in June. Forty-two sites were surveyed three times during spring migration but five sites were surveyed once and four sites surveyed twice because of flooding. All sites were surveyed at least three times during the June breeding season. Thus, a total of 138 surveys were conducted in May and 165 surveys were conducted in June 2008.

Due to late receipt of funds and extensive spring flooding, we were not able to complete surveys specific to Red-Shouldered Hawks (using a different protocol than the transect surveys reported here). We had allocated 1 week to conduct surveys for Red-shouldered Hawks. In consultation with Jon Stravers (National Audubon Society Upper Mississippi Campaign, Pella, IA), after receipt of funds it was determined that two broad areas of floodplain forest would be likely territory areas for these birds. Red-shouldered Hawks require broad and vast areas of nearly contiguous floodplain forest adjacent to wooded bluffs (Stravers 2003), and hence we focused our efforts on trying to access the forest in Management areas 1, the upper part of 2, and 5. On three days we attempted surveys on the lower Cannon River Bottoms area and upper Pool 3 along the Vermillion River. On two of those attempts water was too high to access sites. On the third attempt technicians were able to start, but the water was still too high to complete a full survey. The other two days of that week were spent looking for other ways to access sites from a boat. Field notes for the one attempted survey and observations of Red-shouldered hawks made during migration and breeding bird surveys are included in Appendix 1. Red-shouldered Hawks were consistently detected along the Cannon River Bottoms just below Highway 61 (random point 55, and interior/edge pair 20). Two birds were observed in the area and behavior indicated a mated pair. Any Red-shouldered Hawks detected during surveys were included in community analyses.

Objective 1. Identify bird species using VCRB area for migration and breeding, and estimate occupancy rates of bird species of greatest conservation need.

Spring Migration.

A total of 82 species were detected during migration (Appendix 2): 47 neotropical migrant species, of which 27 breed locally and 20 were transient neotropical migrants), 21 short distance migrant species that breed locally, two transient short distance migrant species, and 12 resident species. Post hoc estimation of species accumulation curves estimated from 1000 permutations of the 51 sample sites (in PRIMER-E) suggested that the number of sites sampled was adequate to detect most species in the study area. Curves reached 95% of species detected around 33 sites (Figure 3). The most frequently detected species were American Redstart, House Wren (*Troglodytes aedon*), American Robin (*Turdus migratorius*), Yellow Warbler, Warbling Vireo (*Vireo gilvus* 0, and American Goldfinch (C*arduelis tristis*). Detections of these six species comprised just over 51% of all detections. Thirty species (37% of species) comprised 90% of all detections. Of these 30 species, six were neotropical migrant transients.

There were a total of 3,588 bird detections identified to species during spring surveys, with an additional 19 only identified to genus. Total numbers detected among site types were comparable with 1,362 in interior sites, 1,161 in edge sites and 1,066 in random sites. On a per survey basis the total number of birds, total number of species, number of neotropical migrants, and number of short distance migrants detected per survey did not differ among the three survey site types (Table 1). Resident birds were more common in interior sites, however.

Very few SGCN were detected during spring migration surveys. Cerulean and Golden-winged Warblers (*Vermivora chrysoptera*) were detected most often with 14 detections each (Cerulean at 8 sites, Golden-winged at 10 sites). There were 11 detections of Prothonotary Warblers (10 sites), 10 detections of Canada Warblers (*Wilsonia canadensis*, 8 sites), and two detections of Wood Thrush (*Hylocichla mustelina*, 1 site). No Acadian flycatchers (*Empidonax virescens*), Cape May Warblers (*Dendroica tigrina*), Olive-side Flycatchers (*Contopus borealis*), Red-headed Woodpeckers (*Melanerpes erythrocephalis*), or Connecticut Warblers (*Oporornis agilis*) were detected in spring surveys. As an aside however, while the field crew was camping at Frontenac State Park, numerous Cape-may Warblers were seen on several occasions in the campground on top of the bluff, and a Connecticut Warbler was observed by one of the field technicians in the woods between the campground and picnic area in mid-May. Although only three Bald Eagles (*Haliaeetus leucocephalus*) were detected during surveys (our survey techniques were not suited to estimating their numbers), they were numerous along the main channel. On several occasions while traveling on the river between the Prairie Island Reservation public boat landing (RM 799.0) and points up river RM 810-812), we would count at least 10 Bald Eagles.

Of the SGCN, there were only sufficient detections of Cerulean, Golden-winged and Prothonotary Warblers to evaluate site occupancy (Table 2). Models with the greatest support (Burnham and Anderson 2002) were those without covariates (no adjustment for site type in detection probabilities and occupancy). Precision of estimates for individual models was low as indicated by broad 90% confidence intervals. This was largely due to these species being detected on very few sites, and even fewer sites had more than one detection.

For Cerulean Warblers there were three competing models 1) no covariates, 2) detection probability varies among types, and 3) occupancy varies among types but detection probabilities do not (Table 2). For the two models where occupancy or detection varied among type, the 90% confidence intervals for those type differences overlapped greatly. Thus, detection and occupancy do not differ by site type. Considering all models together, however, the overall detection probability is roughly in the low 20% range, whereas the occupancy estimates range from 30 to 45%.

For Golden-winged Warbler the only model to converge was one with no covariates, but it was not valid as evidenced by the unrealistically large confidence interval. This may have happened because this species was detected on more than one survey at only one site.

For Prothonotary Warbler four models converged and have some support. These are the same models as for Cerulean Warbler, plus one that accounts for observer related differences in detection probability. Once again, individual model confidence intervals for occupancy or detection probabilities for type (and observer) overlap so much that they are not useful. Considering overall detection and occupancy estimates (not adjusted for a covariate) from all models, probabilities seem to fall in a 20 to 30% range.

Breeding Season.

A total of 56 species were detected during the breeding season (Appendix 3): 24 neotropical migrant species, 19 short distance migrant species and 13 resident species. There were very few detections of neotropical migrant transient species (Alder Flycatcher [*Empidonax alnorum*] and Black and White Warbler [*Mniotilta varia*]) in early June which were not included in totals. Again, species accumulation curves suggested that a sample of 51 sites was adequate to detect most species in the study area. Curves reached 95% of species detected around 40 sites (Figure 4). The most frequently detected species were American Redstart, House Wren, Yellow Warbler, American Robin, Warbling Vireo, and Common Grackle. Detections of these six species comprised just over 53% of all detections. Twenty-two species (40% of species) comprised 91% of all detections.

There were a total of 2,999 detections identified to species during surveys (with another 8 detections identified to genus); with 1,003 detections in interior sites, 968 in edge sites, and 1,028 in random sites. Numbers of birds, species, neotropical migrants, short distance migrants, and resident birds detected per survey did not differ among the three survey site types (Table 1). Although the estimate for resident birds in random sites is almost twice that in edge and interior sites, the variance in numbers of resident birds in random sites was too great to detect a difference among site types.

Of the SGCN only Prothonotary Warbler (15 detections) and Cerulean Warbler (10 detections) were detected during breeding season point counts (Table 2). Although only singing males were counted, these numbers do not equate to number of individual males because sites were visited three times. Prothonotary Warblers were detected at seven sites, and multiple times at three of these sites. Cerulean Warblers were detected multiple times at two of the four sites were they were detected. On two separate occasions a singing Cerulean Warbler was detected far from a sample area. Locations of these observations are listed in Appendix 4. No Bald Eagles were detected on point counts, but Bald Eagles remained numerous on the study area through June, and two nests were found in large cottonwood trees on the main channel in the lower part of Pool 3.

Occupancy analysis for Cerulean Warblers suggested that four models had some support. The model with the most support allowed detection probability (not occupancy) to vary among site types; however, confidence intervals overlapped broadly. The model with the next most support had no covariates. Comparing equivalent models between breeding to the migration season, detection probabilities were higher during the breeding season, but occupancy probabilities were lower.

For Prothonotary Warblers five models had some support, but two were clearly better than the other three. The model with the most support had no covariates and the 2nd most supported model allowed occupancy probabilities to vary among site types, again with broadly overlapping confidence intervals. Comparing equivalent models between breeding and migration season, detection probabilities were higher during breeding season and occupancy probabilities were lower.

Detection probabilities and occurrence estimates of common floodplain forest birds varied widely (Table 3). American Redstarts are detected almost everywhere and on almost every survey. Occupancy modeling clearly shows that detection probabilities are rarely very close to one even for common species with loud, easily recognizable vocalizations. Habitat models were run for Baltimore Oriole, Common Yellowthroat and Yellow Warbler in spite of detection probabilities not approaching one because the occupancy estimates were not all that different from detection probabilities (see Results for *Habitat analyses for individual species* below). This lack of a small difference between detection probability and occurrence probability suggests that these species may not have occurred at many more sites than those on which they were detected.

Objective 2. Survey vegetation, to characterize floodplain forest vegetation composition and structure, including detailed information on reed canary grass and other invasive plant species.

Forest composition and structure

Thirteen tree species were detected during vegetation sampling in the study area, with 10 species detected in edge and interior sites (not always the same species) and nine species detected in random sites. The most diverse site, with eight species of trees detected, was edge 7. Six sites had six species (edge 11, interior 1, 5, and15, and random 11 and 37). There were five sites with only two tree species detected (edge 9, 15, 17, and 21, and random 30). There likely were other species present at sites where few tree species were detected during point center quarter (PCQ) sampling, and these were often picked up during releves or leaf-out surveys during bird surveys. There were many sampling areas where the forest had large mature trees but there were so many small elms and green ash closer to the center point that we rarely were able to sample the larger trees.

Tree importance values indicated the relative dominance of a species compared to others sampled. Floodplain forests of the project area are dominated by silver maple, with a strong component of green ash and American elm (*Ulmus americana*) (Table 4). Basal area, number of snags, tree height, and sapling height were similar among site types. Hackberry (*Celtis occidentalis*) and box elder (*Acer negundo*) importance values were relatively low. For cottonwood importance values were high relative to frequency indicating that sampled trees tended to be large. The order of tree species from most important to least important (for the common species listed in Table 4) was the same for edge and random sites, with silver maple > green ash > American elm > box elder >cottonwood > hackberry. For the interior sites green ash and American elm switch places but the remainder of the order remains the same.

On average cottonwood trees had the greatest dbh in all site types, followed by silver maple in edge and interior, but in random sites average dbh of black willow was the second greatest (Table 5). Also, in each site type a total of 272 trees could be sampled (four sample plots per site, four trees sampled per plot, and 17 sites), and yet only 45 to 49% of the trees sampled were silver maple. Green ash (14 to 29% of trees) and American elm (9 to 20% of trees) typically were the second most frequently encountered trees. It is also clear from Table 5 that American elm is less frequent in edge sites whereas hackberry is more frequent in edge sites. In random sites black willow is more frequent, but black ash is less frequent and has a smaller average dbh than in edge and interior sites. Other species detected in PCQ sampling included white mulberry (*Morus alba*), basswood (*Tilia americana*), black walnut (*Juglans nigra*), hawthorn (*Crataegus* spp.), and one unidentified small individual tree. No river birch or oaks of any species were observed during PCQ or releve sampling or during our travels throughout the study area.

Several forest features seem to differ among site “type” (interior, edge or random). Silver maple and box elder were had lower importance values and were slightly more frequent in random relative to edge and interior sites. Green ash had higher important values in random sites and lower importance values in interior sites relative to edge sites. Black ash was rare in edge sites and more frequent in random sites relative to interior sites. Frequency and importance value were fairly even across site types for hackberry. Black willow had relatively higher importance value in edge sites compared to interior, but none were sampled in random sites. Cottonwood was more frequent and had higher importance value in edge and random sites than interior sites.

However, for the local variable PCA there was not a suggestion of pattern related to site type (Figure 5; ANOSIM rho = -0.024, P = 0.870). The first three principle components (PC) accounted for only 56.8% of the variation in the data for the local variable dataset (Table 6). The first PC depicted a gradient from sites with high *Phalaris* cover (and black willow importance values) to sites with higher basal area and canopy cover (tree height and number of snags also were heavily weighted). The second PC depicted a gradient from sites with more tree species to sites with high silver maple importance values. And, the third PC depicted sites with high importance values for hackberry to sites with high importance values for cottonwood.

The first three PCs for landscape variables accounted for 75% of the variation in the data (Table 7). The first PC depicted a gradient from sites with more open water and shallow marsh to sites with more forest and wet meadow (Figure 6). The second PC depicted a gradient from sites with more wet meadow and wet meadow patches to sites with more forest and forest patches. And, PC 3 depicted a gradient of sites with greater developed area to sites with more open water. For landscape PCs 1 and 2 it appears that interior and random sites separate somewhat, with interior sites tending have a greater forest component, and random sites tending to have higher wet meadow and shallow marsh components (Figure 6). The ANOSIM indicated that landscape features did differ among "type" (rho = 0.104, P < 0.001), but this was probably because site selection was based on landscape features. The forest block size variable was not included in the PCA because it reduced fit of the results.

Landscape variance among sites within each type was least for interior sites (landscape σ^2 = 0.892), intermediate for random sites (landscape σ^2 = 0.934), and greatest for edge sites (landscape

$\sigma^2 = 1.174$). However, for the local variable dataset, variance was least for edge sites ($\sigma^2 = 0.900$), intermediate for random sites ($\sigma^2 = 0.979$), and greatest for interior sites ($\sigma^2 = 1.122$).

There was a strong effect of river (UMR, Cannon, Vermillion) on local habitat composition (ANOSIM rho = 0.525, $P < 0.001$). Cannon and Vermillion River sites differed the most (ANOSIM rho = 0.748), followed by UMR and Vermillion River sites (ANOSIM rho = 0.672, $P < 0.001$) and then UMR and Cannon River sites (ANOSIM rho = 0.431, $P < 0.001$). Many variables contributed to these differences, especially basal area, number of snags, Phalaris cover, canopy cover and ground cover (Table 8).

Invasive species

Phalaris was the most common invasive plant, encountered on 32 of 51 transects (63%). It occurred in vast blankets on nine of the 10 transects on Cannon River bottoms sites, with an average (over the four vegetation survey points per transect) cover of over 50% on all but one transect. At the 23 remaining transects where *Phalaris* occurred, its average cover ranged from 1 to 9% (n = 14 sites) to 10 to 40% (n = 9 sites). With regard to site type, 60% of interior, 70% of edge, and 53% of random transects had at least some *Phalaris*. Overall, average cover of Phalaris on transects did not differ among site types (interior average= 19.3%, 90% CI 42.22 to 80.78; edge average = 19.72%, 90% CI 45.91 to 85.35; random average = 14.34%, 90% CI 40.7 to 69.42). Of the breeding bird survey plots (single 10m radius), *Phalaris* occurred on 47% of interior, 29% of edge and 12% of random plots. Excluding Cannon River point counts, sites with some *Phalaris* cover is reduced to 31% of interior, 8% of edge, and 0% of random points.

Dodder (*Cuscuta* spp.), a parasite on wood nettle (*Laportea canadensis*), was the next most commonly encountered invasive, detected in 13 sample areas. It was never abundant when detected, but on one sample area (12 interior) it was detected at all four vegetation sample plots.

Other invasive species were not often detected along transects. Garlic mustard (*Alliaria petiolata*) was only detected on three transects [6%], but was encountered more often as we walked to transects and between sample plots along transects. Buckthorn (*Rhamnus cathartica*) was detected on five transects (10%). When present there were only a few individuals and they were in the seedling stage. Four of the five sites that had buckthorn were near Bay Point Park Marina in Red Wing. The fifth was in an interior site along the Cannon River between the Cannon River bike trail and the active railroad track. Burdock (*Arctium* spp.) was detected on two transects and spiny plumeless thistle (*Carduus acanthoides*) was found on one transects.

Objective 3. Analyze bird and vegetation data to determine habitat features associated with species presence or abundance for migrating and breeding birds in the area, including forest structure, landscape features, and presence and abundance of invasive plants.

Migration bird community

Bird assemblages (species detected and average number of detections) did not differ appreciably among the three site types. The two-dimensional plot of NMS results (Figure 7) shows lack of sorting by site type; and, because minimum stress of 0.22 was achieved in 56 of 100, iterations the general pattern of site arrangement in this plot was reasonably good. The 3-dimensioinal results had slightly lower stress (0.17). Although the ANOSIM test suggested some overall differentiation in the bird assemblage among site types (rho = 0.043, P = 0.039), no clear significant differentiation was detected in pair-wise comparisons of site types (random-edge rho = 0.050, P = 0.082; random-interior rho = 0.037, P = 0.103; interior-edge rho = 0.04, P = 0.098). Bird assemblages in interior-edge sites within a pair were more similar to each other than to sites in different pairs (rho = 0.509, P < 0.001). Thus, bird assemblages tended to be spatially autocorrelated.

Diversity measures for the bird assemblages during migration did not differ by site type overall (ANOSIM rho = 0.031, P = 0.92). The displayed pattern in the 2-dimensional NMS plot of site relations to each other is reliable because very low stress of 0.02 was reached in 96 out of 100 iterations. However, in pair-wise comparisons of site types, diversity measures at random sites differed from interior sites (rho = 0.092, P = 0.027), while edge sites did not differ from random or interior sites (rho = -0.008, P = 0.462, rho = 0.007, P = 0.321, respectively). This may due to 10 edge and random sites (four edge and six random) with lower diversity indices that grouped apart from the main group at the 80% similarity level (Figure 8). Site 9 interior is a noticeable outlier with unusually low diversity indices. For example, Shannon diversity and species richness at 9 interior were 1.77 and 2.40, respectively, but the site with the maximum values of 3.33 and 8.67 (site 7 interior) fell in the main cluster of sites at the left hand side of the 2-dimensional NMS plot.

Cerulean and Golden-winged Warblers tended to occur at sites with more “typical” bird assemblages, as evidenced by their occurrence at sites in the center of two dimensional NMS plots of sites (Figure 9 and 10). Prothonotary Warblers, however, tended to occur at sites with less typical bird assemblages (Figure 11). Although Ceruleans and Prothonotaries occurred together on three sites, sites with Ceruleans tended to have more individuals and species than average and sites with Prothonotaries tended to have fewer individuals and species than average (Figures 12 and 13).

Breeding bird community

Just as for the migration season, the 2-dimensional NMS plot (Figure 14) did not show clear structure of the breeding bird community, but once again ANOSIM hinted at a relation to site type (rho = 0.027, P = 0.116). Reliability of this 2-dimensional NMS solution is generally good because minimum stress of 0.25 was reached in 25 of 100 iterations, and 3-dimensional was slightly better (stress = 0.19). Pair-wise comparisons of bird assemblage composition revealed that random sites were different from edge (rho = 0.063, P = 0.038) and interior sites (rho = 0.059, P = 0.039), but interior and edge sites did not differ (rho = -0.041, P = 0.921). As for the migration data, the bird assemblages of sites in interior and edge pairs were spatially autocorrelated (rho =0.465, P < 0.001).

Relations among site types based on diversity measures of bird assemblages during the breeding season suggested no differences overall (ANOSIM rho = -0.024, P = 0.82). The 2-dimensional NMS plot revealed that no sites appeared to be outliers and sites flowed along a continuum from low to high diversity (Figure 15). Furthermore, the pattern displayed in this NMS result is reliable because very low stress of 0.03 was reached in 68 out of 100 iterations. Shannon diversity and species richness ranged from 3.12 and 7.85, respectively, at site 13 interior, to 2.28 to 4.28, respectively, at site 28 random.

The pattern of sites where Cerulean and Prothonotary warblers occurred in the bird assemblage NMS plots were similar to those for migration (Figures 16 and 17), where Ceruleans tended to be in sites with a typical bird assemblage and several sites with Prothonotaries were at fringe sites. However, in the NMS plot of diversity indices, sites were so similar that no statement can be made about diversity measures for sites where Cerulean and Prothonotary Warblers occurred (Figures 18 and 19). These species occurred together at only one site during the breeding .

Multivariate analyses of bird communities related to habitat features of sites

The RELATE routine in PRIMER revealed that the migration bird community was not related to either habitat data sets (landscape variables rho =0.125 and P = 0.09; local variables rho = 0.091 and P = 0.17). For the breeding community there was no relation with the landscape dataset (rho = 0.048 and P = 0.276). However there was strong evidence of a relation between the breeding bird community and the local habitat variable dataset (rho = 0.495 and P < 0.001).

The BioEnv analyses suggested individual variables or a smaller set of variables that were correlated to the bird community data. Correlations ranged from a high of 0.563 between breeding birds and select local variables, to a low of 0.329 between migration and select landscape variables (Table 9). All correlations found were significant based on 100 random permutations for each comparison (local habitat: migration P < 0.01, breeding P < 0.01; landscape habitat: migration P < 0.02, breeding P < 0.01).

Although the bird communities in the study area during migration and the breeding season did not display distinct groupings with regard to site type, there were differences in bird assemblages that associated with local habitat (LINKTREE analyses; Figures 20 and 21). The LINKTREE analyses for landscape data, however, had low initial R values (less than 0.4), indicating initial groupings that were not as strong as they were for local habitat variables. Furthermore, trees resulting from landscape data were “messy” and difficult to interpret; therefore, their results are not reported here.

For both migration and the breeding season bird data and the local habitat variables data set, all of the Vermillion River sites separated out on the first split for having very low ground cover. These sites also differed from UMR and Cannon River sites by having greater average detections of Prothonotary Warbler, and lower species abundance and diversity. Abundance of many common species — American Redstart, Blue-grey Gnatcatcher, American Goldfinch, Warbling Vireo, Yellow Warbler — was typically low on the Vermillion River sites. Also species that are typically associated with ground cover, shrubs and open canopy — Common Yellowthroat, Grey Catbird, Song Sparrow — were rare or absent. Although this first LINKTREE split was very clear cut, other splits were less so and ferreting out which species are "responsible" for successive splits was tedious and not always consistent between migration and breeding seasons.

The next LINKTREE splits (2nd and 3rd in migration, and 2nd in breeding) separated out Cannon River sites bird assemblages on the basis of having lower average basal area (migration) and greater *Phalaris* cover (migration and breeding). Birds that were more common in Cannon River sites than in UMR and Vermillion River sites during the breeding season included: American Goldfinch, Black-capped Chickadee (*Parus atricapillus*), Brown-headed Cowbird (*Molothrus ater*), Cedar Waxwing (*Bombycilla cedrorum*), Common Yellowthroat, Grey Catbird (*Dumetella carolinensis*), Indigo Bunting (P*asserina cyanea*), Red-eyed Vireo (*Vireo olivaceus*), Rose-breasted Grosbeak (*Pheucticus ludovicianus*), and Song Sparrow. Blue-winged Warblers (*Vermivora pinus*) were observed only on Cannon River sites during the breeding season. Prothonotary and Cerulean Warblers were not observed in either season and detections of American Redstart, Great Crested Flycatcher, Red-winged Blackbird (*Agelaius phoeniceus*), and Yellow-bellied Sapsucker were lower during the breeding season on Cannon River sites. During migration Cannon River sites had higher detections of Nashville (*Vermivora ruficapilla*) and Tennessee Warblers (*Vermivora peregrina*), Common Yellowthroat, House Wren, Rose-breasted Grosbeak, Song Sparrow, Willow Flycatchers (*Empidonax traillii*), and Yellow-bellied sapsuckers. Further, Blue-winged Warbler, Eastern Bluebird (*Sialia sialis*), Lincoln's (*Melospiza lincolnii*) and Chipping Sparrows (*Spizella passerina*), Mourning Dove (*Zenaida* *macroura*), and Sedge Wren (*Cistothorus platensis*) were only detected on Cannon River sites during migration. Overall diversity and abundance of birds on Cannon River sites were not distinguishable from UMR sites.

The 3rd LINKTREE split for breeding and the 4th split for migration separates out the same five sites based on having lower ground cover. After this split the trees for migration and breeding communities differ, and bird differences become harder to discern. The sites that split out based on having lower ground cover were at least partially flooded early in the season, but dried up faster than the Vermillion River sites. In migration these sites tended to have greater than average numbers of detections of many species such as Yellow-rumped Warblers and Wilson's Warblers (*Wilsonia pusilla*), American Redstarts, American Robins, American Crows (*Corvus brachyrhynchos*), Red-eyed Vireos, Great Crested Flycatchers, Mallards (*Anas platyrhynchos*), Yellow-bellied Flycatchers (*Empidonax falviventris*), and others. During migration these sites tended to have lower detections of American Goldfinch, Baltimore Oriole, Blue-gray Gnatcatcher (*Polioptila caerulea*), Red-bellied Woodpecker, Song Sparrow, Tennessee Warbler and Yellow warblers. No Prothonotary or Cerulean Warblers, Red-winged Blackbirds, or Black-capped Chickadees were detected, and 15 other species were not detected during migration. During the breeding season these sites typically had more detections than average of American Robin, Black-capped Chickadee, Cedar Waxwing, Common Grackle, Indigo Bunting, Least Flycatcher (*Empidonax minimus*), Mallard, and Prothonotary Warblers. These sites had fewer detections than average of Baltimore Oriole, Blue-gray Gnatcatcher, Brown-headed Cowbird, House Wren and Yellow-throated Vireo (*Vireo flavifrons*), and no detections of Brown Creeper (*Certhia americana*), Blue Jay (*Cyanocitta cristata*), Cerulean Warbler, Pileated Woodpecker (*Dryocopus pileatus*), and Rose-breasted Grosbeak.

Habitat analyses for individual species

For Baltimore Oriole variables of interest included site type, basal area, tree height, canopy cover, ground cover and silver maple IV. The ground cover model was the best, but the global model also had some support (Table 10). The effect of ground cover was a 4.4% increase in odds (estimate = 1.044, 95% confidence interval 1.012, 1.077) of detecting a Baltimore Oriole with each increment increase in ground cover (increments were in cover classes). That is, as ground cover increased from cover classes 0 (0% cover) to 5 (75-100% cover) there was a 22% increase in odds of detecting a Baltimore Oriole. This result may seem odd, but on the VCRB mature forests also tended to have dense wood nettle ground cover including areas where estimated canopy cover may have been lower because of canopy gaps. Baltimore Orioles may have a non-monotonic relation with canopy cover (i.e., an association with middle ranges of canopy cover) but such relations cannot be detected with logistic regression.

For Common Yellowthroat, variables of interest included site type, canopy cover, *Phalaris* cover, ground cover, and basal area. The model with only *Phalaris* cover was the best, with the other models having little or no support (Table 10). For each increment increase in *Phalaris* cover there was a 22.7% increase in odds of detecting a Common Yellowthroat (odds estimate 1.227, 95% confidence interval 1.021, 1.475).

For Yellow Warbler, variables of interest included site type, basal area, tree height, canopy cover and ground cover. The ground cover and tree height model was the best. The two models with tree height and ground cover alone also had some support (Table 10). For each increment increase in ground cover, the odds of detecting a Yellow Warbler increased 3.2% (odds estimate 1.032, 95% confidence interval 1.004, 1.061), and for each increment increase in tree height there was a 47% decrease in odds of detecting a Yellow Warbler (odds estimate 0.524, 95% confidence interval 0.303, 0.905).

Preliminary look at forest block size and SGCN

Although detection probabilities for Cerulean and Prothonotary Warblers were low, there is no question that they occurred where they were detected even though their breeding status was unknown. However, 95% confidence limits for forest block size between forest blocks where these species were detected and remaining sampled forest blocks overlapped extensively and extremely large variance caused confidence intervals to include zero (average block size, Cerulean detected =

663,182m^2, not detected = 1,465,166 [95% CI detected = 5,633,553 to -2,703,221; not detected = 1,826,224 to -499,856]; average block size, Prothonotary detected = 719,418, not detected = 792,466 [95% CI detected = 2,498,337 to -1,059,500, 95% CI not detected = 2,610,677 to -1,025,745]).

DISCUSSION

Interior and Edge Issues- Birds

The effect of edge or interior on bird communities and individual species during spring migration and the breeding season was a main interest for this study. Edge is of interest because during spring (and fall) migration, other studies have found that typically abundance and species richness are greater near edges than deeper in forests and especially more so than in homogeneous habitats (pole timber) (Rodewald and Brittingham 2002). The only community metric found to differ among site types during spring migration was the number of resident species detected per survey (greatest in interiors, least in edges associated with interiors). Per survey detections of all birds, numbers of species and detections for the other migratory guilds did not differ by site type. Although the NMS plots of the overall community did not show a clear pattern related to site type, the ANOSIM analysis suggested a pattern related to type. However, there were no significant differences in bird community composition in pair-wise comparisons between site types. Occupancy analysis of SGCN detections did not reveal a clear relation with site type for detection or occupancy probabilities. However, the floodplain forest of the UMR as a whole is an important habitat for migratory birds during spring migration. Kirsch and Heglund (in review) found that although the bird assemblages overlap, the bird assemblage in floodplain forests of the UMR differs from that found in adjacent uplands during spring migration. In their review of a 10 year dataset of point counts on the Upper Mississippi National Wildlife and Fish Refuge (Refuge), Thogmartin et al. (2009) did not find a difference between floodplain and upland bird assemblages during spring migration, although sample sizes for upland forests were small (less than 10 points on average).

For the breeding season, interior forest or patch size is of interest because it is thought that the bird community in interior forests differs from edge, and some species rely on large forests. It is important to note that the terms forest interior and area sensitivity, although related, do not mean the same things. Forest interior is that area of a forest patch that is some defined distance from an edge. Area sensitivity is a feature of bird habitat selection behavior reflected in bird presence or abundance varying directly with forest patch size. Abundance of an area sensitive bird species may or may not vary in relation to distance from edge in the forest patch, whereas abundance of a forest interior species will be greater farther from the patch edge. Defining a forest patch in riverine forest, especially the UMR floodplain forest with its many interspersed habitats and waterways, is difficult. Being able to define a forest patch in such a landscape a priori is arbitrary and depends heavily on details of aerial photo interpretation scale and details of habitat delineation available on GIS that an investigator has available. In this system a forest patch may in fact be very large but not have any "interior" because it is long and narrow. Preliminary analyses of forest "patch" size here did not reveal any relations with Cerulean or Prothonotary Warbler detection. What functions as a forest patch on the UMR in a birds' eye view also is not known. It depends on how birds respond to different edge types, and forest widths, for example (Small and Hunter 1989, Suarez et al. 1997). Because Cerulean Warblers occurred on islands in this study area, perhaps the overall abundance of forest in this system is more important for this species than "patch size" or distance from an edge.

For ease of interpretation and inference, I investigated forest interior greater than 100m from any edge. Hence interior and associated edges occurred in wider forest areas. Random sites were in any other area that was farther than 100m from an interior patch/associated edge. Bird community metrics did not differ by site type, but taken as a whole the NMS revealed a difference in the bird community between random sites and interior/edge sites. It is possible, then, that wider forests do support a slightly different bird community. However, actually testing which species are contributing to the difference is not possible without very high detection probabilities, and greater variance in sight occupancy. All the most common species with high detection probabilities occurred at virtually every site, and presence of the few species that were tested did not differ by site type. The NMS may be picking up differences in abundance rather than presence of species, but modeling for abundance and habitat type covariates using occupancy sampling to account for detection probabilities is an area that needs further theoretical development beyond the scope of this study. Cursory inspection of the bird community data suggests that some common species, not SGCN, may be “responsible” for the difference between random sites and interior/edge pairs, and that these differences may be small. DeCamps et al. (1987) found that the effect of forest “surface area” was much less important to bird community composition in floodplain forests than in terrace forests along the Garonne River in France.

Although Cerulean Warblers are thought to be forest interior and area sensitive species (Ambuel and Temple 1983, Hamel 2000), occupancy sampling analyses did not reveal a relation of detection probability or estimated occurrence clearly related to site type. Cerulean Warblers were detected on only four sites during the breeding season and it may be instructive to note that three of these sites were on what any reasonable river manager would call an island (two sites, 13I and 13E, were on the same island). These island forest “patches” ranged in size from 21.8ha to 26.6 ha, nowhere near the size thought to be necessary for successful breeding in the Vermillion/Cannon River Bottoms plan (600m wide, and greater than 700ha). The fourth site (4I) where a Cerulean was detected was in the upper Pool area of Pool 3 and a rough estimate of patch size for that location was 29.6 ha, and was embedded in a largely forested matrix. Because floodplain forest patches of the UMR are not in an upland habitat matrix, and there are many other floodplain forest patches in close proximity, it is likely that Cerulean Warblers are able to successfully nest on the VCRB, but no nesting data on Ceruleans are available for the UMR.

Prothonotary Warblers are reported to avoid forests less than 100 ha in size, and wooded borders along waterways less than 30 m wide (Kahl et al. 1985, cited in Petit 1999). However, three of the seven sites where Prothonotaries were detected during the breeding season were on islands. Because they are associated with water, it is natural to think that they may be more associated with edges than large forest blocks or interior forest. They also occurred at non-islands, in patches of forest of varying sizes and one even included an interior. It appears that although Prothonotary Warbler numbers were low, they can occur in a variety of forest landscape configurations on UMR forests.

Relations of bird species with patch size and corridor widths were discovered in upland situations (for example, Ambuel and Temple 1984, Whitcomb 1981, Freemark and Merriam 1986, Hodges and Krementz 1996). Such relations are also not necessarily well documented or documented using an appropriate demographic metric (Villard 1998). Riparian buffer width may also be related to bird abundance and diversity in some landscapes and management situations (Keller et al. 1993, Stauffer and Best 1980). However, rarity of “forest interior species” and a community dominated by forest edge and generalist species seems a common theme for linear and naturally fragmented riverine forest (Hooper 1991, Knutson et al. 1996, Wakeley and Roberts 1996, Miller et al. 1997, Saab 1999, Inman et al. 2002, Miller et al. 2004). For example, on the Wisconsin River, a major tributary of the Upper Mississippi River, the floodplain forest bird assemblage is by dominated a different set of generalist forest birds (Song Sparrow, Black-capped Chickadee, Red-eyed Vireo, and Eastern Wood-Peewee) (Miller et al. 2004). Also, on the Wisconsin River, Ovenbird (*Seiurus aurocapillus*) was the seventh most common species, but no Cerulean Warblers were detected (Miller et al. 2004). Cerulean Warblers were detected on the Vermillion Cannon River Bottoms study area in 2008, but no Ovenbirds were detected during the breeding season and there were only two detections of Ovenbirds during migration. On the Roanoke River in North Carolina, patch size and edge effects were minimal, and in this system forest vegetation type (cypress-sweat gum swamp forest versus sycamore-elm-ash levee forest) was the major determinant of species abundance and composition (Sallabanks et al. 2000). Along the UMR and in the study area floodplain forests do not differ this drastically.

Interior and Edge Issues- Habitat

The overall picture of floodplain forest as habitat in the study area is one of gradual differences, mature closed canopy with high ground cover (primarily wood nettle) changing to more open canopy with high *Phalaris* cover, unrelated to site type. Tendencies for certain tree species to be more important in certain site types are slight. One might expect different tree species, more shrubs, grasses and invasive plants in edges. If there were edge differences of this sort they were not noticeable where we sampled, which was 25 meters from an edge at edge sites and some random sites. We observed that edges tended to be “hard,” for example tree fall gaps and open water abutting mature forest. *Phalaris* was found in all site types, and if anything was slightly less frequent in random sites. That the landscape habitat analysis showed a gradient related to site type is trivial because it merely reflects the criteria that were used to set up the sampling design. The more important issue was whether birds responded to habitat differences at that scale, and they did not.

Bird Community Features

Floodplain forests of the Vermillion Cannon River Bottoms and Upper Mississippi River in Pool 3 and upper Pool 4, harbor a diverse and abundant bird community during the spring migration and the breeding season. The community is heavily dominated by five or six species, however, in both spring migration and the breeding season. During migration, Cerulean, Prothonotary, Golden-winged, and Canada Warblers and most transient neotropical and short distance migrant birds, while present, were not common. Prothonotary and Cerulean Warblers were detected at even fewer sites during the breeding season. Occupancy sampling for both Prothonotary and Cerulean Warblers suggested that detection probabilities are higher during the breeding season than migration, which makes sense because birds are defending territories by June. Lower occupancy in breeding season versus migration also is reasonable because any transients will have moved on as well. Detections of Cerulean and Prothonotary Warblers were too low to assess any habitat or site type effects on occurrence.

Cerulean Warblers may have been more common than we detected. They may not sing constantly and they typically sing from high branches (Hamel 2000), which lowers probability of detection. During vegetation surveys in June, for example, a Cerulean was heard singing on site 1 interior continuously for 10 minutes but was silent the remainder of the hour that we were present at the site. Cerulean Warblers were only formally detected on four sites, so even if site detectability was close to one the sample size would be too small for reliable estimation of habitat effects.

Although estimated detection probabilities for Prothonotary Warbler were low, this species has a loud and distinctive song. Males sing constantly throughout the breeding season but more frequently earlier in the season (Petit 1999). We casually observed a lull in Prothonotary singing in early June throughout the study area, but I cannot demonstrate it clearly with the survey data because of the small number of sites where they were detected. Song frequency is related to density of breeding males (Petit 1999). Although Prothonotaries increased greatly on the Refuge between 1994 and 2003 (Thogmartin et al. 2009), the VCRB area is further north and at the northern edge of this species' range (Petit 1999) which may contribute to the uncommonness of this species. This in turn, may have led to lower singing rate and thus lower detection probabilities. Prothonotaries are far more common in more southern UMR pools especially below the Quad Cities (Emlen et al. 1986, E. Kirsch unpubl. data).

Only 10 species in breeding season and nine species in migration season were common and widespread (average number of birds per survey ≥ 0.5 and observed frequency of occurrence on sites of ≥ 75%, See Appendices 2 and 3). It is important to note that even with three visits to each site, especially during the breeding season when most of birds are territorial and therefore less mobile and more vocal, detection probabilities for the remainder of species were not high. This is an important fact that is rarely recognized and brings any estimate of habitat features related to a species' occurrence or abundance based on few surveys at each site into question. The implications for monitoring and adaptive management are also great. Careful consideration will need to be given to survey protocols that include enough repeated survey samples, or to use of another bird population metric (e.g., nesting success) relative to the management action and the possible effect of sample size on the bird parameter of interest.

Recognizing this limitation, and assuming that detection probability of each species is relatively constant within a season, it appears that that the bird community is dominated by the same five species in both spring and summer: American Redstart, House Wren, American Robin, Yellow Warbler, and Warbling Vireo. All of these species had site detection probabilities over >97% and probability of occupancy between 86 and 100%. Thogmartin et al. (2009) also note the prevalence of American Redstart, American Robin, House Wren and Warbling Vireo in floodplain forest of the Refuge, but Yellow Warbler does not make their list of common species. All of these species are forest generalists and not adverse to edge. American Redstart is far more common in floodplain forest than upland forest during the breeding season (Knutson et al. 1997), and Warbling Vireo and Yellow Warbler are frequently associated with riparian areas (Lowther et al. 1999, Garaldi and Grant 2000, Thogmartin et al. 2009). Other common species with easily heard and recognized songs had site detection probabilities between 0.96 (Baltimore Oriole) and 0.64 (Red-bellied Woodpecker).

Habitat Features of the Study Area

Compared to forests in other UMR Pools in the Upper Mississippi River National Fish and Wildlife Refuge (Knutson and Klaas 1998, Yin et al. 1997), the study area is notable for rarity of oaks. We did not encounter any oaks, although they are present in a few small, higher elevation patches (US Army Corps of Engineers [Corps], St. Paul District Forest Inventory, unpubl. data). As in other UMR pools, cottonwoods are not incredibly common and tend to be very large. None of the sites we surveyed were dominated by cottonwood, although Corps data show a few sites where cottonwood dominates. The mature green ash and black ash component in the study area was second to silver maple in importance value. Turner et al. (2004) found on the Wisconsin River that sites with major ash components tended to be in areas that had been in forest for more than 70 years. Some black walnut were observed but rarely sampled. The average dbh of sampled silver maples was around 55 cm; however, many large over-mature silver maples were noted, and in many areas we observed that smaller silver maples that had reached the lower canopy height were dying, due to being shaded. Compared to 1992 data collected in a similar manner at sites from Pools 6-9 (Knutson and

Klaas 1998), importance values of silver maple, American elm, and hackberry were approximately the same, but importance values for the ash species, box elder, and cottonwood were more than two times higher on the Vermillion/Cannon River Bottoms study area.

Principle components analysis revealed relations among habitat features of sites that made sense even if they were not related to site type. As one would expect, basal area and canopy cover were lower where *Phalaris* cover was higher. It is thought that *Phalaris* cannot gain a foothold or persist under a closed canopy (Maurer and Zedler 2002). The number of tree species was lower where silver maple importance value was higher. Where there were large, mature silver maples, there tended not to be many other species of trees. Hackberry importance value was higher where cottonwood importance value was lower. Since both of these species are somewhat flood tolerant and typical in floodplain forests, this dichotomy may be related to forest age at a site. Since hackberry is shade tolerant it may be present on older forest sites because it can regenerate under a canopy. Since cottonwood is shade intolerant, trees must have become established in high light conditions when there was creation/scouring of new alluvium because bare soil ground is also beneficial to germination of this species.

Habitat characteristics differed among the three rivers in the study area. Cannon River sites were characterized by having greater Phalaris cover, lower basal area and canopy cover, fewer snags and shorter trees than sites along the other two rivers. Perhaps past management of the area and nutrient enhancement has contributed to these conditions. Vermillion River sites were characterized by having low ground cover, no Phalaris, and greater basal area and numbers of snags. These sites were deeply flooded throughout May and were flooded again in June for several days. It is not possible to ascertain if these sites would have been more similar to UMR sites if the spring of 2008 had not been wetter than normal, although basal area was appreciably higher than on the UMR.

The most notable invasive species in the study area was *Phalaris.* It was widespread in the Cannon River Bottoms. It was absent on Vermillion River sites although we observed some patches

Phalaris in other areas along the Vermillion. Phalaris does occur on UMR sites but it was patchily distributed. On the Cannon River but also on a few UMR sites, patches of *Phalaris* occasionally occurred in interior forest areas. Hence there is risk for infestation even in these interior areas if the canopy opens up too much. However, *Phalaris* was also noted in areas with good tree canopy cover (and the *Phalaris* was in flower so positive identification could be made), which seems to be contrary to the notion that *Phalaris* cannot survive in shady conditions (Maurer and Zedler 2002). A post hoc Pearson correlation between canopy cover and *Phalaris* cover was strong ($r^2 = -0.658$, $P < 0.0001$). While this is not good news for easily controlling risk of *Phalaris* infestation in at least the interior areas of the VCRB forest, at present the bird community in the most heavily *Phalaris* infested areas were still robust, although they did differ from areas without Phalaris (see further discussion below). Further tree loss and canopy opening must at some point cause a shift in species composition and certainly species that require little or no ground cover vegetation (Prothonotary Warbler) would not benefit (see below).

Invasive plant species, with the exception of *Phalaris*, are not overtly noticeable. Next to Phalaris, garlic mustard may be the most worrisome because it was found in many areas in small patches. Garlic mustard is notorious for spreading rapidly, and in vast forests with extensive wood nettle ground cover, detecting patches for eradication will be difficult. Buckthorn was only detected at sites near Red Wing, and individuals were seedlings/saplings. The Corps data indicate buckthorn is also present on the island across from Prescott, MN, and the island just downstream of lock and dam 3. Buckthorn can spread rapidly once mature because birds eat the fruits and can deposit propagules far from source plants. Compared to other UMR pools, some invasive species were notable by their apparent absence. Honeysuckle and black locust, for example, have heavily invaded many areas in Pool 8, but were not detected in the study area (except along the Cannon River bike trail). Even the Corps data do not list any occurrences of honeysuckle. Wild cucumber, which is a huge problem in Pools south of the Quad Cities, was rarely detected, and only small individuals were seen.

Habitat Features Related to Birds

Cannon River sites provide an example of what bird assemblages may tend towards as the canopy opens and *Phalaris* takes over the ground cover in an area. In general, during the breeding season Cannon River sites tended to have more open forest and shrub related species, and fewer American Redstarts, Great crested Flycatchers, Yellow-bellied Sapsuckers and Red-winged Blackbirds. During migration Cannon River sites hosted greater numbers of Tennessee and Nashville Warbles than remaining sites, as well as several species that were not detected elsewhere. The great diversity and abundance of birds on Cannon River sites suggests that *Phalaris* does not necessarily lead to lower species diversity or to loss of many forest bird species. The Cannon River Bottoms also hosted a nesting pair of Red-shouldered Hawk. It is of note that some Cannon River sites with good *Phalaris* cover (1.5m tall) were under an almost closed canopy (20I, 55R). The confirmed Red-shouldered Hawk detections (with behavior indicating a breeding pair) were in the vicinity of 20I, 20E, and 55R, all of which had extensive *Phalaris* cover (50-75% cover, along the transect), and moderately open (cover class 4, 51-75% cover) to closed canopy conditions (76-95% cover).

Lack of ground cover was most strongly related to differences in the bird community and primarily occurred on the Vermillion River, but lack of ground cover was also driven by flood duration. Sites on the Vermillion River had fewer bird detections and species. It is not possible to separate the effect of sites being flooded versus not having ground cover. Several other sites on the UMR had ground cover higher than that on the Vermillion but still lower than all other sites (also caused by some flooding earlier in May), and the bird community in both migration and breeding seasons was slightly different at these sites, and indicated by LINKTREE.

These community relations to habitat and among site differences are merely suggestive, however. It is important to remember that NMS revealed no clear structure and stress levels only indicate that only general patterns can be discerned in the two- and three-dimensional solutions. By and large the bird community is relatively constant across the study area, mostly consisting of the top five species with other common species mixed in with no clear overall pattern related to habitat.

It was only possible to assess habitat relations for three common species because of low detection probabilities for most species, and high estimated occupancy rates for the others. This is a disappointing result where SGCN are concerned. Informally, however, we observed Cerulean Warblers in or near mature cottonwood groves or single large cottonwoods at sites and other areas where we detected them by chance. This species typically occurs in mature forests with tall trees and an open understory (Hamel 2000). Areas with some trees having much larger diameters than surrounding trees may also be important to this species (Robbins et al. 1992). This species nests in cavities near or over water, in forests that are mature enough to provide trees with cavities and have sparse understory vegetation (Petit 1999). Although Prothonotary Warblers were detected at sites with much *Phalaris* cover and other vegetation ground cover during migration (1I, 8I,15I, and 13I), they were only found at one of these sites (13I), which had *Phalaris* and ground cover class 4 (50-75%) during the breeding season. There remaining six sites where Prothonotaries were detected during the breeding season had little ground cover, open understory, and were flooded or partially flooded well into May. During the 1993 flood on the UMR, in Pools 6 through 9, Knutson (1995) and Knutson and Klaas (1997) found that Prothonotary abundance was higher on flooded than un-flooded sites, and in general Prothonotary Warbler abundance was correlated with presence of mature open canopy forests with that had tall trees as well as numerous snags and sparse understory.

Presence of Baltimore Orioles was most strongly associated with greater ground cover rather than in a tree structure or species variable. Baltimore Orioles are adaptable but favor riparian woodland edge (Rising and Flood 1998). Perhaps in the study area this species simply avoided flooded sites that ended up having little ground cover, and other features of habitat structure were well within what this species typically will accept.

The relation of Common Yellowthroat presence with *Phalaris* cover is not unusual. Common Yellowthroats prefer thick herbaceous and shrub cover (Guzy and Ritchison 1999), and in fact, Kirsch et al. (2007) demonstrated that yellowthroats do not avoid *Phalaris* in wet meadows even when other vegetation is available. Common Yellowthroats could be found in any site type, however, including interiors that did not have *Phalaris*.

Habitat relations found for Yellow Warbler also make sense, specifically association with lower tree heights and greater ground cover. This species typically is associated with shrubby and successional woodlands, especially if they are wet (Lowther et al. 1999). Compared to other studies on the UMR during the breeding season (Kirsch in revision, Thogmartin et al. 2009) the relative abundance of Yellow Warblers is higher than in pools downriver in the Upper Mississippi National Wildlife and Fish Refuge. Tree fall gaps in the generally mature and tall forest of the study area must be numerous to support this apparent abundance of Yellow Warblers.

MANAGEMENT AND MONITORING IMPLICATIONS

Even though we expended considerable effort to survey 51 sites three times during each season, detection probabilities for many species were still low. Depending on abundance and detectablity features of each species (song frequency, loudness, etc.), there is a trade-off between number of discrete sample sites and how often sites should be visited. To increase the possibility of detecting a rare species, more sites and fewer visits is recommended, whereas for common species, fewer sites and more surveys per site is recommended (McKenzie et al. 2006). The bottom line for monitoring or estimating habitat relations based on species presence (or abundance), using counting methods (point count, transects, area counts) for birds, is that one survey is never enough to estimate detection probabilities and occupancy (McKenzie et al. 2006). Because Cerulean and Prothonotary Warblers are rare, it appears that greater than 51 sites would be needed to more accurately assess detection probability and occupancy. Once site detection rates are greater than 95%, investigating relations of species presence with habitat features becomes more feasible and results more valid. Fifty-one sites and three surveys per site were adequate for many of the common species, but most of these were so common that few sites were not occupied.

If more information about Cerulean and Prothonotary Warbler distribution in the study area is desired a more extensive survey will need to be done. Further, to estimate abundance will require high detection probabilities; hence, sites will need to be surveyed several times. It does not seem necessary to continue surveys to estimate bird community composition, even as related to habitat features, because the community is relatively homogeneous throughout the study area and in UMR floodplain forests at large (E. Kirsch in review, Thogmartin et al. 2009)

Other bird metrics can be investigated for relations to habitat features and monitored for response to habitat management. Perhaps the next step towards determining potential habitat requirements and value for birds on the study area is to look at productivity. Obviously this will be very difficult to do for Cerulean Warbler because of their low probable abundance during the breeding season, but it may be possible for Prothonotary Warblers and other species. Estimating nest success related to certain habitat features amenable to management seems a reasonable next step.

Certain management goals stated in the Vermillion/Cannon River Bottoms Management plan were thought to benefit forest interior species, particularly Cerulean Warbler and Red-shouldered Hawk. In each of the five management units the plan calls for a forest patch 700 ha in size within a 4,000 ha forest matrix composed of at least 50% forest. Within these 4000 ha forest matrix areas four patches 1,000 ha in size and at least 600 m wide are desired, with canopy cover in each forest patch averaging 70%. These recommendations seem to fit well in an area like the Lower Mississippi Alluvial Valley where vast areas of floodplain forest have largely been eliminated (Twedt and Loesch 1999, Twedt et al. 2006). Floodplain forest on the UMR, however, is contained within a relatively narrow floodplain, and the pre-lock and dam forest was naturally fragmented such that 1,000 ha "blocks" of unfragmented forest may not be feasible.

Cerulean Warblers were present during the breeding season on four locations, and forest patches in these locations ranged in size from 29.5ha to 21.8ha. Three of these locations actually were on what most river managers would call main channel islands. The last location was in a large forested habitat matrix with greater than 50% forest, but it was not far from the main channel (<270 m), and not far from a forest edge (approx. 155 m). Of course, we do not know what productivity was at these sites, and if there were Cerulean Warblers breeding in other locations, we did not sample them. For migratory songbirds, however, the level of fragmentation, a dearth of “interior” forest, and the size of forest “blocks” may not strongly influence nesting success on the floodplain, just as it doesn’t in Driftless Area upland forests that are highly fragmented (Knutson et al. 2004).

Of the two locations where Red-shouldered Hawks were observed, site 1 interior fits with the large forest patch description in the management plan. This area has mostly 90% or greater canopy cover, tall mature trees, ground cover primarily of wood nettle, but also canopy gaps and small patches of *Phalaris* wet meadow, with sloughs interspersed. Red-shouldered Hawks were present on the Cannon River Bottoms where the floodplain is more narrow, but taken along with the adjacent upland forest, this area fits descriptions of suitable habitat (Stravers 2003). Unfortunately forest block size in that area cannot be estimated similarly to the rest of the study area because the GIS coverage provided by the MN DNR (Mcbs_npc_clipped.shp) was collected and interpreted at a different scale than the USGS coverages used for Pools 3 and 4 (which included the Vermillion River, Upper Midwest Environmental Sciences Center). Also, habitat classification criteria differed from USGS definitions which became apparent when we access sites on the Cannon River.

Prothonotary Warblers occurred, with one exception, at sites that had a good deal of flooding early in the season. Several of these sites, those on the Vermillion River, also flooded in June. Maintaining and restoring mature forest with snags near waterways and at lower elevation sites is probably important for supporting and encouraging Prothonotary Warblers. Restoring such sites will be difficult because *Phalaris* is harder to control in these same site conditions. Nest boxes placed near or over water can also be used to encourage nesting by Prothonotaries, but boxes should be monitored because House Wrens compete fiercely with Prothonotaries for nest cavities, and wasps may usurp boxes as well (Walkinshaw 1941, Petit 1989, Blem and Blem 1991). Prothonotaries tend to be successful again house Wrens when the nest is over standing water. Nest boxes need to be of appropriate size to encourage Prothonotary nesting (i.e., Petit et al. 1987).

Regarding invasive species management, Phalaris poses the most obvious risk for spread and reducing forest regeneration. Because *Phalaris* was found throughout the study area and in places far from water, timber management anywhere will need to diligently control for *Phalaris*. Forest restoration efforts in canopy gaps and on the edges of forest where sites are elevated may prove fruitful for small scale success. Although the negative correlation between canopy cover and *Phalaris* cover was strong, *Phalaris* can still come to dominate the ground cover where the canopy is partially open (Cannon river Sites). Intensive *Phalaris* control measures should be planned when timber management will cause any degree of canopy opening.

Although garlic mustard is not yet widespread, without management it may quickly proliferate and become uncontrollable. Observed patches are still of a size that plant pulling crews can be effective. A monitoring program should be put in place, perhaps focusing on areas typically used by campers and along trails, as well as some random component because deer can also spread seed. This monitoring program may also be used to detect other invasives such as buckthorn, so that quick control may be possible. Regarding buckthorn, pulling the small seedlings in areas around the Bay Point Marina can probably be achieved with a small crew at this point.

I conclude with a final thought concerning adaptive management and monitoring for habitat and wildlife responses on the study area, the Vermillion Cannon River Bottoms Area. Although this area seems large, it may not be large enough to host a variety of management actions at large enough scales to discern which management actions lead to desired conservation outcomes in most common habitat situations. Moreover, time scales for monitoring will need to be on the order of decades. To avert massive die off of silver maples, several large or many small restoration efforts may need to be undertaken. Implementing a few very large projects or many smaller ones may seem risky on such a small study area. Hence, I recommend coordinated planning, based on hydro-geomorphic modeling (HGM) results (i.e., Heitmeyer 2007) and monitoring for forest adaptive management among all partner agencies on the UMR. The work of Twedt et al. (2006) and the U.S. Fish and Wildlife Service Lower Mississippi Valley Joint Venture (LMVJV) office has implemented a collaboration and a database that coordinates mapping, modeling, planning and monitoring in a large and complex floodplain landscape that has worked well to guide forest restoration and management, and to coordinate monitoring to track benefits to songbirds (LMVJV Forest Resource Conservation Working Group 2007). A similar approach should be implemented in the Upper Mississippi River floodplain.

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Figure 1. Vermillion/Cannon River Bottoms study area on Pools 3 and 4 of the Upper Mississippi River. Breeding bird survey points are depicted with blue dots.

Figure 2. Example of interior patches with interior breeding bird survey points (blue dots), associated edge survey point and a random point location on Pool 3 of the Upper Mississippi River.

Figure 3. Species accumulation plots for spring migration 2008. “Sobs” is the curve of observed species counts. Bootstrap counts are based on the proportion of samples containing a species. “UGE” is the calculated species accumulation curve based on the methods of Ugland et al. (2003).

Figure 4. Species accumulation plots for breeding season 2008. “Sobs” is the curve of observed species counts. Bootstrap counts are based on the proportion of samples containing a species. “UGE” is the calculated species accumulation curve based on the methods of Ugland et al. (2003).

Figure 5. Principle Components Analysis Axes 1 and 2 for local habitat variables collected along transects and at breeding bird points on the Vermillion/Cannon River Bottoms area of Pools 3 and 4 on the Upper Mississippi River, 2008. Variables codes are as follows, and those ending in “sqrt” were squareroot transformed: BA avg. = average basal area, snag avg. = average number of snags, treeht = average tree height, cancov = canopy cover, # sps = number of tree species in a sample. Importance values of trees were: ACNE = box elder, ACSA2 = silver maple, CEOC = hackberry, FRAXI = ash species, PODE = cottonwood, and ULAM = American elm.

Figure 6. Principle Components Analysis Axes 1 and 2 for landscape habitat variables collected within 25m of the breeding bird survey point at sites on the Vermillion/Cannon River Bottoms area of

Pools 3 and 4 on the Upper Mississippi River, 2008. All variables were square root transformed. Forest area = forsqrt, wet meadow area = wetmsqrt, open water area = opwsqrt, shallow marsh = smarshsqrt, developed area = develsqrt, area of forest divided by number of forest polygons = forpolsqrt, and area of wet meadow divided by number of wet meadow polygons = wtmpolysqrt.

Figure 7. Two dimensional plot of Nonmetric Multidimensional Scaling results for the bird community during spring migration (May) at sites on the Vermillion/Cannon River Bottoms area of Pools 3 and 4 on the Upper Mississippi River, 2008.

Figure 8. Two dimensional plot of Nonmetric Multidimensional Scaling results for diversity indices of the bird community during spring migration (May) at sites on the Vermillion/Cannon River Bottoms area of Pools 3 and 4 on the Upper Mississippi River, 2008.

Figure 9. Bubble plot of Cerulean Warbler abundance (square root transformed) at sites during migration, where sites are distributed in 2 dimensional NMS plot (Figure 6). Site symbols are: I = interior, E = edge, R = random.

Figure 10. Bubble plot of Golden-winged Warbler abundance (square root transformed) at sites during migration, where sites are distributed in 2 dimensional NMS plot (Figure 6). Site symbols are: I = interior, E = edge, R = random.

Figure 11. Bubble plot of Prothonotary Warbler abundance (square root transformed) at sites during migration, where sites are distributed in 2 dimensional NMS plot (Figure 6). Site symbols are: I = interior, E = edge, R = random.

Figure 12. Bubble plot of Cerulean Warbler abundance (square root transformed) at sites during migration, where sites are distributed in 2 dimensional NMS plot of bird community diversity indices (Figure 11).

Figure 13. Bubble plot of Prothonotary Warbler abundance (square root transformed) at sites during migration, where sites are distributed in 2 dimensional NMS plot of bird community diversity indices (Figure 11).

Figure 14. Two dimensional plot of Nonmetric Multidimensional Scaling results for the bird community during summer breeding season (June) at sites on the Vermillion/Cannon River Bottoms area of Pools 3 and 4 on the Upper Mississippi River, 2008.

Figure 15. Two dimensional plot of Nonmetric Multidimensional Scaling results for diversity indices of the bird community during breeding season (June) at sites on the Vermillion/Cannon River Bottoms area of Pools 3 and 4 on the Upper Mississippi River, 2008.

Figure 16. Bubble plot of Cerulean Warbler abundance (square root transformed) at sites during breeding season, where sites are distributed in 2 dimensional NMS plot (Figure 13). Site symbols are: I = interior, E = edge, R = random.

Figure 17. Bubble plot of Porthonotary Warbler abundance (square root transformed) at sites during breeding season, where sites are distributed in 2 dimensional NMS plot (Figure 13). Site symbols are: I = interior, E = edge, R = random.

Figure 18. Bubble plot of Cerulean Warbler abundance (square root transformed) at sites during breeding season, where sites are distributed in 2 dimensional NMS plot of bird community diversity indices during migration (Figure 17).

Figure 19. Bubble plot of Prothonotary Warbler abundance (square root transformed) at sites during breeding season, where sites are distributed in 2 dimensional NMS plot of bird community diversity indices during migration (Figure 17).

Figure 20. Results of LINKTREE analyses of local habitat variables with bird community data from migration. Only splits that were significant based on SIMPROF are presented. Prothonotary Warblers were detected at sites that are underlined, Cerulean Warblers were detected at sites with an asterisk, and Golden-winged warblers were detected at sites with a "‡" sign.

Figure 21. Results of LINKTREE analyses of local habitat variables with bird community data from the breeding season. Only splits that were significant based on SIMPROF are presented. Prothonotary Warblers were detected at sites that are underlined and Cerulean Warblers were detected at sites with an asterisk.

Table 1. Estimated (GENMOD) mean number of birds detected per survey during spring migration and breeding season in the Vermillion/Cannon River Bottoms area of the Upper Mississippi River, 2008. Neotropical and short distance migrant species included songbirds and all other terrestrial species in those migration guilds (i.e., excluding gulls, terns, shorebirds, waterbirds, and waterfowl). Differences between season were not tested because the survey methods and area surveyed differed (transects covered 2.1 times the area sampled as point counts, and typically lasted longer than point counts).

		Site type			
Season	Variable	Interior	Edge	Random	Probability
Migration	Total number birds	27.4	24.6	24.9	0.4223
	Number species	12.6	11.7	12.7	0.3827
	Neotropical migrants[a]	18.1	16.3	18.9	0.3939
	Local neotropicals	12.9	12.9	15.9	0.1816
	Neotropical transients	4.8	3.1	2.9	0.1424

	Short distance migrants	7.2	7.1	6.2	0.3962
	Residents	1.9	1.1	1.6	0.0418
Breeding	Total number birds	18.2	17.9	18.3	0.9580
	Number species	10.6	10.6	10.1	0.6120
	Neotropical migrants	9.9	9.6	9.4	0.4177
	Short distance migrants	6.1	5.3	5.4	0.4796
	Residents	1.9	1.9	3.6	0.4730

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[a] This estimate includes unknown species in genera known to be neotropical migrants, e.g., vireos, warblers; whereas estimates for local and transient neotropical migrants do not include birds only identified to genus.

Table 2. Occupancy model information and parameter estimates for SGCN on the Vermillion/Cannon River Bottoms IBA during spring migration (May) and the breeding season (June) of 2008. Only models which converged are presented. The probability that a site is occupied is denoted under column **psi^**, and the probability of detection given that the site is occupied and the bird is present is denoted under column **p^**. Where results for three **psi^** or **p^** are presented in the table the order of estimates are for edge, interior and random site types. Estimates were also derived for observer effects. Cerulean Warbler is CERW, Golden-winged Warbler is GWWA, and Prothonotary Warbler is PROW.

Season	Species	Model	AIC	wt	psi^ (90% CL)[a]	p^ (90% CL)[a]
Migratory	CERW	psi(.)p(.)	73.19	0.47	0.32 (0.11, 0.65)	0.22 (0.08, 0.49)
		psi(.)p(type)	74.14	0.29	0.41 (0.13, 0.76)	0.05 (0.01, 0.20), 0.24 (0.04, 0.70), 0.25 (0.08, 0.57)
		psi(type)p(.)	74.61	0.23	0.12 (0.02, 0.49), 0.46 (0.11, 0.85), 0.42 (0.09, 0.84)	0.22 (0.08, 0.49)
	GWWA	psi(.)p(.)	80.57		0.92 (0.00, 1.00)	0.09 (0.02, 0.34)
	PROW	psi(.)p(.)	73.63	0.44	0.29 (0.10, 0.58)	0.29 (0.08, 0.65)
		psi(.)p(type)	74.29	0.32	0.31 (0.15, 0.53)	0.13 (0.03, 0.44), 0.20 (0.05, 0.54), 0.60 (0.19, 0.90)
		psi(type)p(.)	76.48	0.11	0.19 (0.04, 0.54), 0.28 (0.07, 0.65), 0.42 (0.10, 0.83)	0.28 (0.08, 0.65)
		psi(.)p(observer)	76	0.13	0.25 (0.11, 0.46)	0.48 (0.11, 0.86), 0.35 (0.11, 0.70), 0.15 (0.02, 0.57)
Breeding	CERW	psi(.)p(.)	51.23	0.26	0.10 (0.04, 0.23)	0.37 (0.17, 0.64)
		psi(.)p(type)	49.57	0.59	0.15 (0.06, 0.33)	0.11 (0.01, 0.48), 0.69 (0.34, 0.91), 0.10 (0.01, 0.48)
		psi(type)p(.)	54.72	0.05	0.08 (0.01, 0.33), 0.15 (0.04, 0.41), 0.08 (0.01, 0.33)	0.38 (0.17, 0.64)
		psi(.)p(observer)	53.06	0.10	0.09 (0.04, 0.20)	0.65 (0.19, 0.94), 0.45 (0.17, 0.77), 0.18 (0.03, 0.59)

PROW	psi(.)p(.)	74.1	0.53	0.18 (0.09, 0.32)	0.37 (0.19, 0.60)
	psi(.)p(type)	77.71	0.09	0.17 (0.07, 0.34)	0.43 (0.01, 0.99), 0.50 (0.17, 0.82), 0.33 (0.15, 0.58)
	psi(type)p(.)	75.82	0.22	0.08 (0.01, 0.32), 0.15 (0.04, 0.41), 0.30 (0.12, 0.57)	0.38 (0.19, 0.61)
	psi(type)p(type)	77.85	0.08	0.06 (0.01, 0.27), 0.13 (0.04, 0.35), 0.45 (0.08, 0.89)	0.64 (0.16, 0.94), 0.52 (0.20, 0.82), 0.20 (0.04, 0.57)
	psi(.)p(observer)	77.99	0.08	0.17 (0.09, 0.32)	0.43 (0.15, 0.76), 0.36 (0.14, 0.65), 0.36 (0.13, 0.68)

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[a] Weighted averages when estimated by type [e.g., p^ from model psi(.)p(type) represents a weighted average of the type-specific p estimates].

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Table 3. Occupancy model information and parameter estimates for common breeding bird species on the Vermillion/Cannon River Bottoms IBA during spring migration (May) and the breeding season (June) of 2008. The probability that a site is occupied is denoted under column **psi^**, and the probability of detection given that site is occupied and the bird is present is denoted under column **p^**.

Species	psi^ (90% CL)	survey p^ (90% CL)	site p^ (90% CL)
American Goldfinch	1.00 (0.00, 1.00)	0.41 (0.344, 0.471)	0.79 (0.718, 0.852)
American Redstart	1.00 (0.00, 1.00)	0.96 (0.922, 0.978)	0.99 (0.999, 0.999)
American Robin	0.95 (0.822, 0.987)	0.69 (0.621, 0.757)	0.97 (0.946, 0.986)
Baltimore Oriole	0.77 (0.645, 0.857)	0.67 (0.604, 0.756)	0.96 (0.938, 0.985)
Common Grackle	0.48 (0.316, 0.654)	0.37 (0.245, 0.510)	0.75 (0.570, 0.882)
Common Yellowthroat	0.63 (0.498, 0.750)	0.57 (0.468, 0.660)	0.92 (0.849, 0.961)
Great Crested Flycatcher	0.97 (0.203, 0.999)	0.37 (0.279, 0.466)	0.75 (0.625, 0.848)
House Wren	0.98 (0.896, 0.997)	0.88 (0.831, 0.997)	0.99 (0.995, 0.999)
Red-bellied Woodpecker	0.98 (0.000, 1.000)	0.29 (0.207, 0.403)	0.64 (0.501, 0.787)
Song Sparrow	0.90 (0.775, 0.963)	0.62 (0.541, 0.692)	0.94 (0.903, 0.971)
Tree Swallow	1.00 (0.00, 1.00)	0.02 (0.010, 0.055)	0.06 (0.030, 0.156)
Warbling Vireo	0.91 (0.810, 0.962)	0.77 (0.705, 0.826)	0.99 (0.974, 0.995)
Yellow-bellied Sapsucker	0.78 (0.505, 0.920)	0.34 (0.240, 0.453)	0.71 (0.561, 0.836)
Yellow Warbler	0.86 (0.747, 0.925)	0.74 (0.668, 0.800)	0.98 (0.963, 0.992)

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Table 4. Average values importance values (IV, maximum value 300) and frequency of occurrence (Freq.) at sites for vegetation data collected along transects in the Vermillion/Cannon River Bottoms area of the Upper Mississippi River during June, 2008. There were 17 samples for each site type and "interior" and "edge" sites were paired. Maximum importance value possible was 300. Box elder = ACNE2, Silver maple = ACSA2, Hackberry = CEOC, Green ash = FRPE, Cottonwood = PODE3, American elm = ULAM.

					ACNE2		ACSA2		CEOC		FRPE		PODE3		ULAM	
Site type	Basal area	No. Snags	Tree height (m)	Sapling ht .(m)	IV	Freq.	IV	Freq.	IV	Freq.	IV	Freq.	IV	Freq.	IV	Freq.
Interior	13.1	5.6	12.6	4.9	17.9	0.53	152.2	1.00	5.1	0.29	42.6	0.94	16.9	0.29	45.3	0.82
Edge	13.1	5.0	12.1	5.5	33.6	0.59	152.8	0.94	15.3	0.41	45.4	0.76	16.0	0.29	26.9	0.65
Random	14.3	6.0	12.9	5.3	27.28	0.59	137.7	0.94	6.1	0.29	43.5	0.82	26.7	0.41	41.5	0.88
Study area	13.5	5.6	12.6	5.2	26.3	0.57	147.6	0.96	9.3	0.33	44.3	0.84	19.8	0.33	39.0	0.78

Table 5. Summary of average diameter at breast height (dbh) of each species and relative frequency of occurrence in for each site type from data collected along transects in the Vermillion/Cannon River Bottoms area of the Upper Mississippi River during June, 2008. Relative frequency of each species is the number of trees of each species sampled divided by 272, where that is the total number of possible trees sampled in each site type (17 sites, 4 plots per transect, 4 trees per plot).

	Percent frequency			Average diameter at breast height		
Tree species	Edge	Interior	Rand.	Edge	Interior	Rand.
Box elder	11.0	6.6	8.8	29.9	33.2	24.7
Silver maple	48.5	45.9	45.2	57.6	54.7	57.1
Hackberry	5.9	2.2	1.8	26.9	22.0	28.1
Black ash	2.9	2.9	<0.1	29.7	44.6	28.1
Green ash	29.0	14.3	16.2	28.0	35.2	28.9
Cottonwood	1.5	3.3	4.4	134.6	86.2	79.2
Black willow	<0.1	1.8	4.4	15.2	23.7	66.2
American elm	9.9	19.8	16.9	21.5	23.7	23.0

Table 6. Principle Component Analysis variable loadings for local habitat variables on the first three principle components. All tree importance values (IV) except silver maple's, *Phalaris* cover, canopy cover, and ground cover were square root transformed.

Variable	PC1	PC2	PC3
Avg. basal area	-0.436	-0.024	0.060
Avg. snags	-0.333	-0.008	-0.124
Avg. tree height	-0.361	0.056	0.179
Box elder IV	0.125	0.379	-0.234
Silver maple IV	-0.235	-0.394	-0.090
Hackberry IV	0.041	-0.282	-0.601
Ash sp. IV	0.059	-0.179	-0.263
Cottonwood IV	0.025	0.236	0.583
Black willow IV	0.320	-0.139	0.072
American elm IV	-0.130	0.401	0.248
Number tree species	0.052	0.458	-0.161
Avg. *Phalaris* cover	0.398	-0.126	0.093
Canopy cover	-0.395	0.210	-0.067
Ground cover	0.234	0.283	0.152

Table 7. Principle Component Analysis variable loadings for landscape habitat variables on the first three principle components. All variables were square root transformed.

Variable	PC1	PC2	PC3
Forest area/number forest polygons	0.032	0.485	0.046
Wet meadow area/number wet meadow polygons	-0.514	-0.400	0.087
Developed area	-0.040	-0.012	-0.826
Shallow marsh area	0.229	-0.353	-0.419
Forest area	-0.395	0.507	-0.004
Wet meadow area	-0.512	-0.387	0.134
Open water area	0.512	-0.270	0.338

Table 8. Habitat variables that contributed to differences among Upper Mississippi, Cannon, and Vermillion River sites. Values of the F statistic and probability levels are from one way ANOVA tests, all of which had two degrees of freedom.

	UMR		Cannon		Vermillion			
Variable	Mean	SE	Mean	SE	Mean	SE	F	P
Trees/ha	1,628.0	(53.9)	1,348.0	(143.4)	1,521.0	(77.6)	2.59	0.0851
Basal area	14.4	(0.55)	8.5	(1.27)	17.3	(1.12)	14.67	<0.0001
Number snags	5.7	(0.43)	3.0	(0.38)	11.0	(1.55)	15.26	<0.0001
Tree height(m)	13.0	(0.27)	10.7	(0.48)	13.4	(0.49)	9.17	0.0004
Silver maple IV	137.0	(9.70)	149.3	(18.87)	242.0	(12.09)	6.02	0.0047
Number tree species	4.4	(0.20)	4.0	(0.36)	2.8	(0.48)	3.54	0.0367
Phalaris cover [1]	4.6	(1.30)	73.7	(7.72)	0.0	(0.00)	122.70	<0.0001
Canopy cover [1]	91.2	(1.50)	68.8	(7.78)	97.5	(0.00)	12.53	<0.0001
Ground cover [1]	90.0	(2.35)	97.5	(0.00)	11.5	(3.50)	76.75	<0.0001

[1] Cover was estimated in the field with classes. Midpoints of cover classes were used in analyses.

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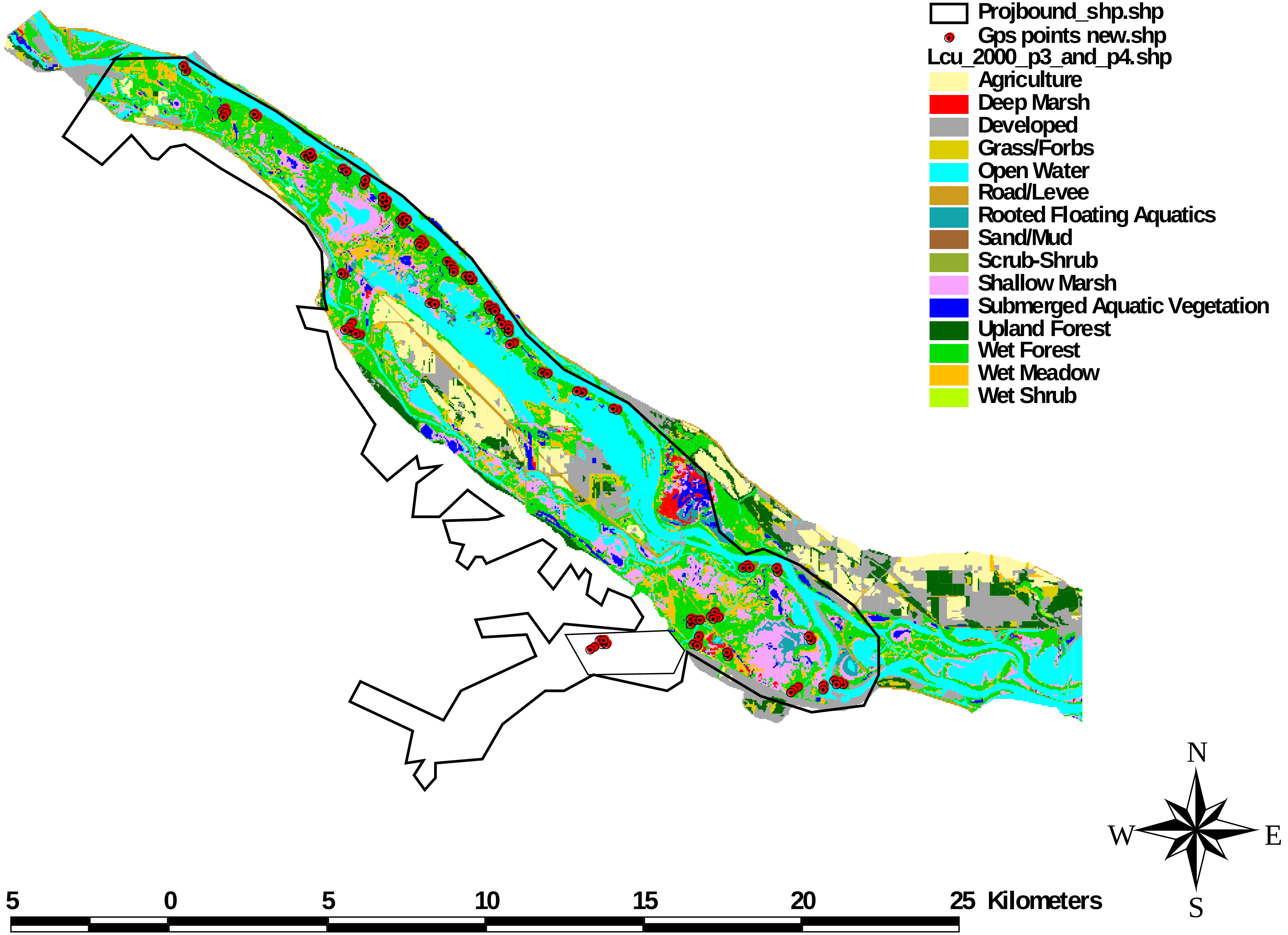
Table 9. Variables that the BioEnv analysis routine selected as being most correlated with the structure of respective bird communities. Only the variables with the maximum correlation are listed. All landscape variables were square root transformed. All correlations are significant to the 0.02 level or lower, based on 100 random permutations.

Habitat data set	Bird data set	Spearman Correlation coef.	Variables
Local	Migration	0.553	*Phalaris* cover, ground cover
Local	Breeding	0.563	Avg. snags, box elder IV, black ash IV, *Phalaris* cover, ground cover
Landscape	Migration	0.335	developed area, shallow marsh area
Landscape	Breeding	0.329	shallow marsh area

Table 10. Comparison of models of local habitat variables related to presence of Baltimore Orioles, Common Yellowthroats, and Yellow Warblers at sites during the breeding season on the Vermillion/Cannon River Bottoms Area of the UMR in 2008. Abbreviations include number of model parameters (k) and model weights (w_i).

	Baltimore Oriole			Common Yellowthroat			Yellow Warbler		
Model	k	ΔAIC	w_i	k	ΔAIC	w_i	k	ΔAIC	w_i
Global model	8	1.53	0.312	8	10.00	0.007	8	5.62	0.038
Site type	3	9.83	0.005	3	21.10	0.000	3	10.57	0.003
Basal area	2	10.30	0.004	2	15.09	0.000	2	5.87	0.034
Tree height	2	10.71	0.003	..	..	..	2	3.41	0.116
Canopy cover	2	10.28	0.004	2	12.28	0.002	2	7.16	0.012
Phalaris cover	..	..	..	2	0.00	0.991	..	..	..
Ground cover	2	0.00	0.669	2	19.58	0.000	2	3.15	0.132
Silver maple IV	2	10.73	0.003	2	20.41	0.000	2	7.04	0.019
Ground cover and tree height	..	..	..	..	..	..	3	0.00	0.639

Figure 1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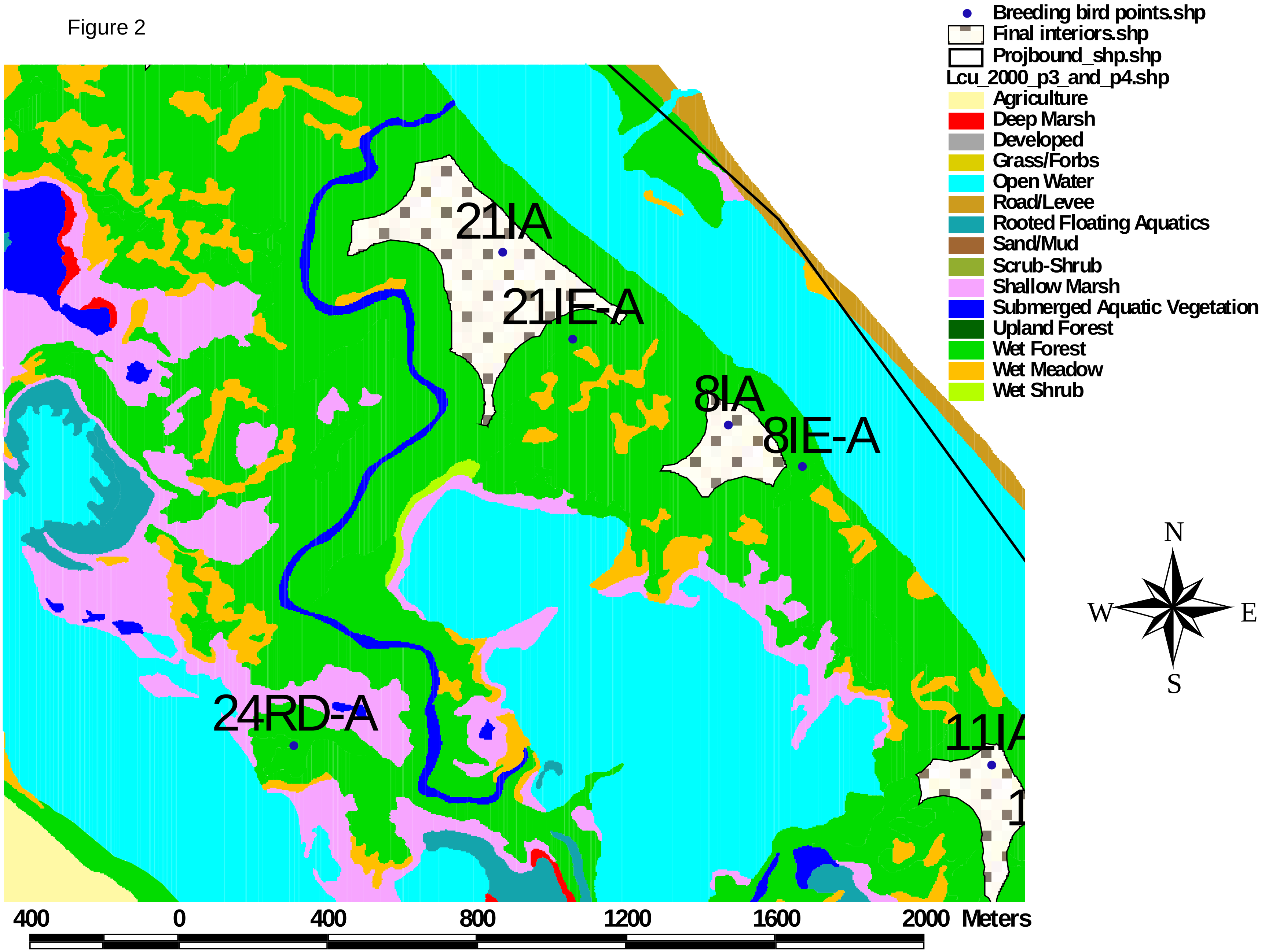
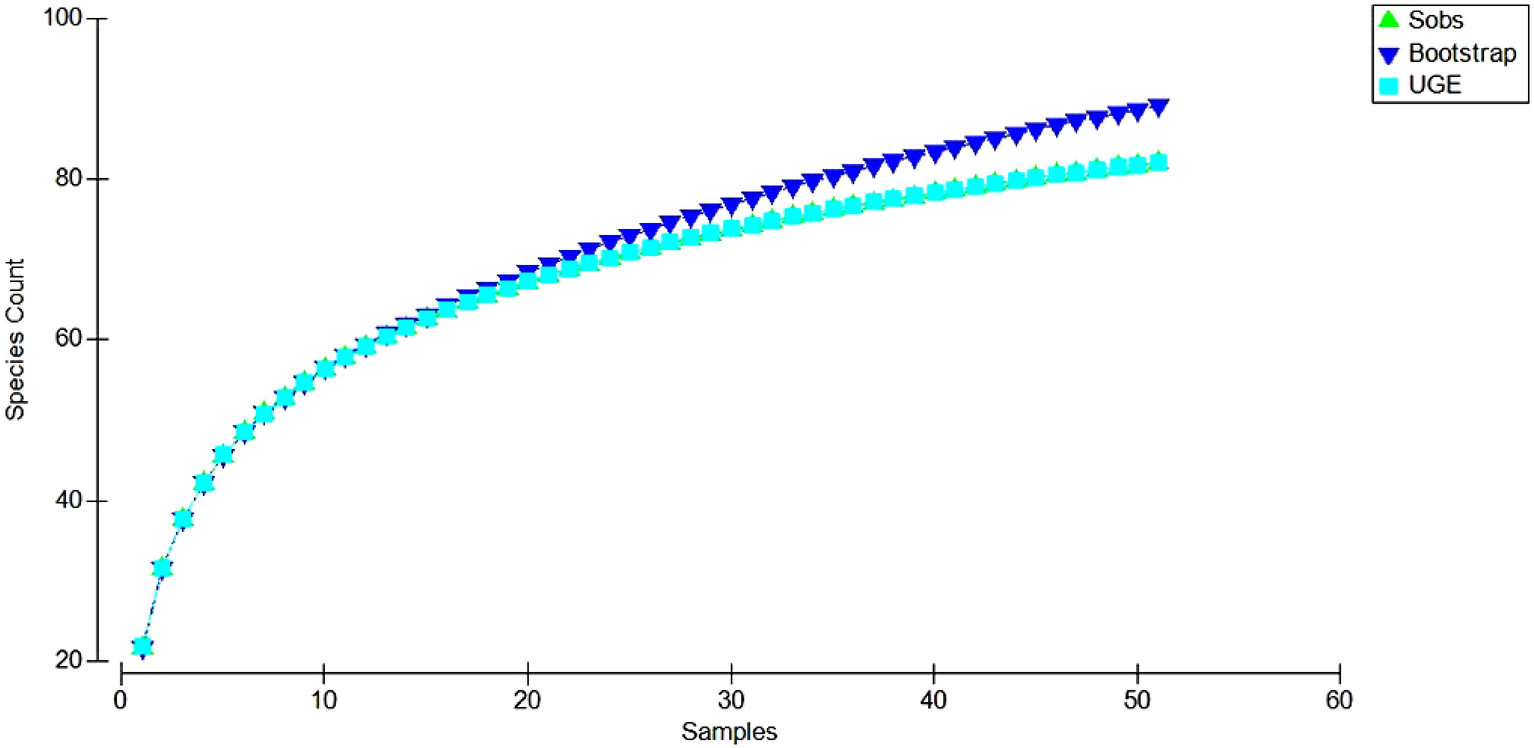
Gps points new.shp
Lcu_2000_p3_and_p4.shp
Agriculture
Deep Marsh
Developed
Grass/Forbs
Open Water
Road/Levee
Rooted Floating Aquatics
Sand/Mud
Scrub-Shrub
Shallow Marsh
Submerged Aquatic Vegetation
Upland Forest
Wet Forest
Wet Meadow
Wet Shrub
N
W
E
S
5
0
5
10
15
20
25 Kilometers

Figure 2



Breeding bird points.shp
Final interiors.shp
Projbound_shp.shp
Lcu_2000_p3_and_p4.shp
Agriculture
Deep Marsh
Developed
Grass/Forbs
Open Water
Road/Levee
Rooted Floating Aquatics
Sand/Mud
Scrub-Shrub
Shallow Marsh
Submerged Aquatic Vegetation
Upland Forest
Wet Forest
Wet Meadow
Wet Shrub
21IA
21IE-A
8IA
8IE-A
24RD-A
11I
N
W
E
S
400
0
400
800
1200
1600
2000
Meters

Figure 3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60
40
20
Species Count
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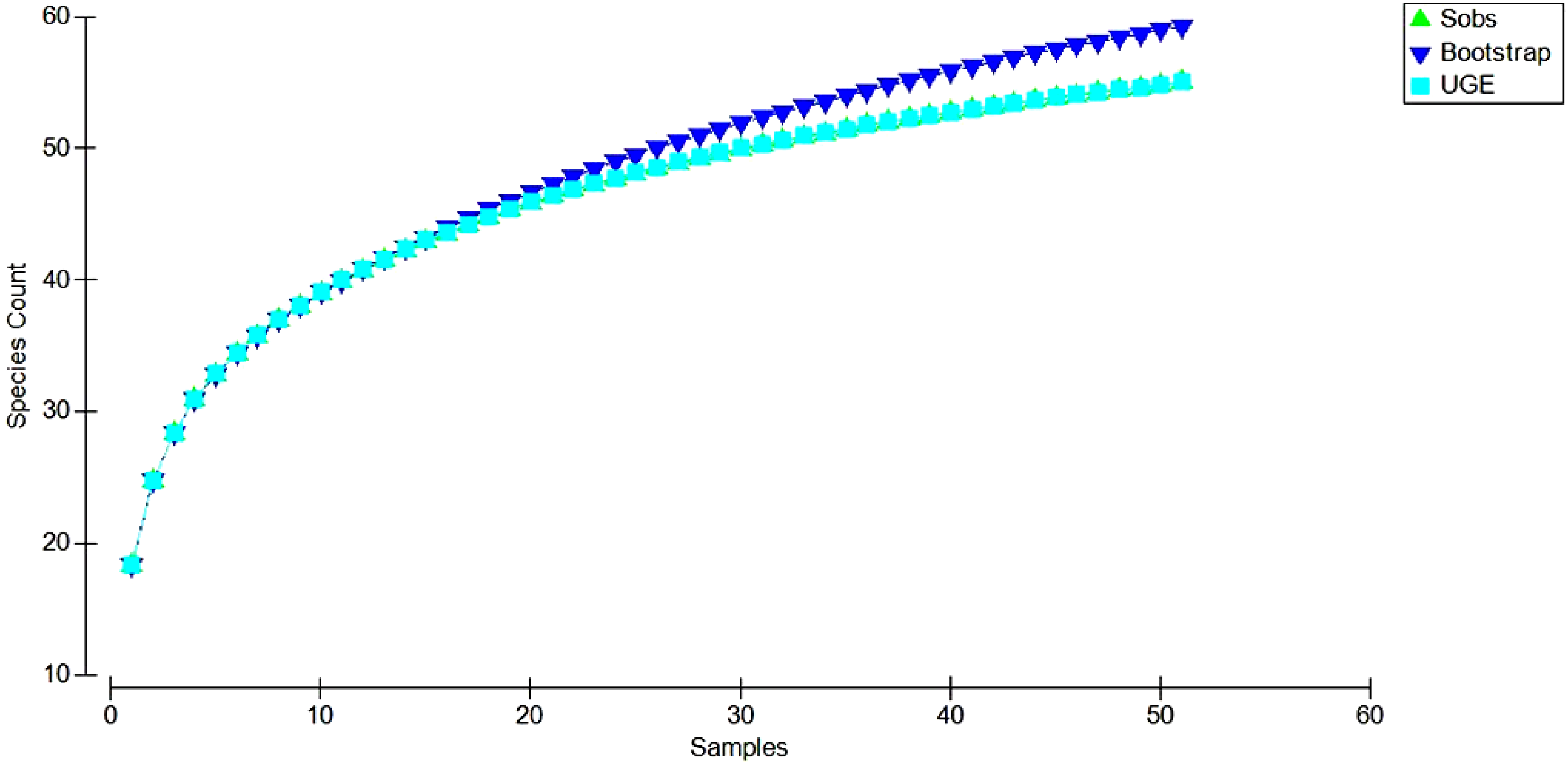
10
20
30
40
50
60
Samples
Sobs
Bootstrap
UGE

Figure 4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Bootstrap
UGE
Species Count
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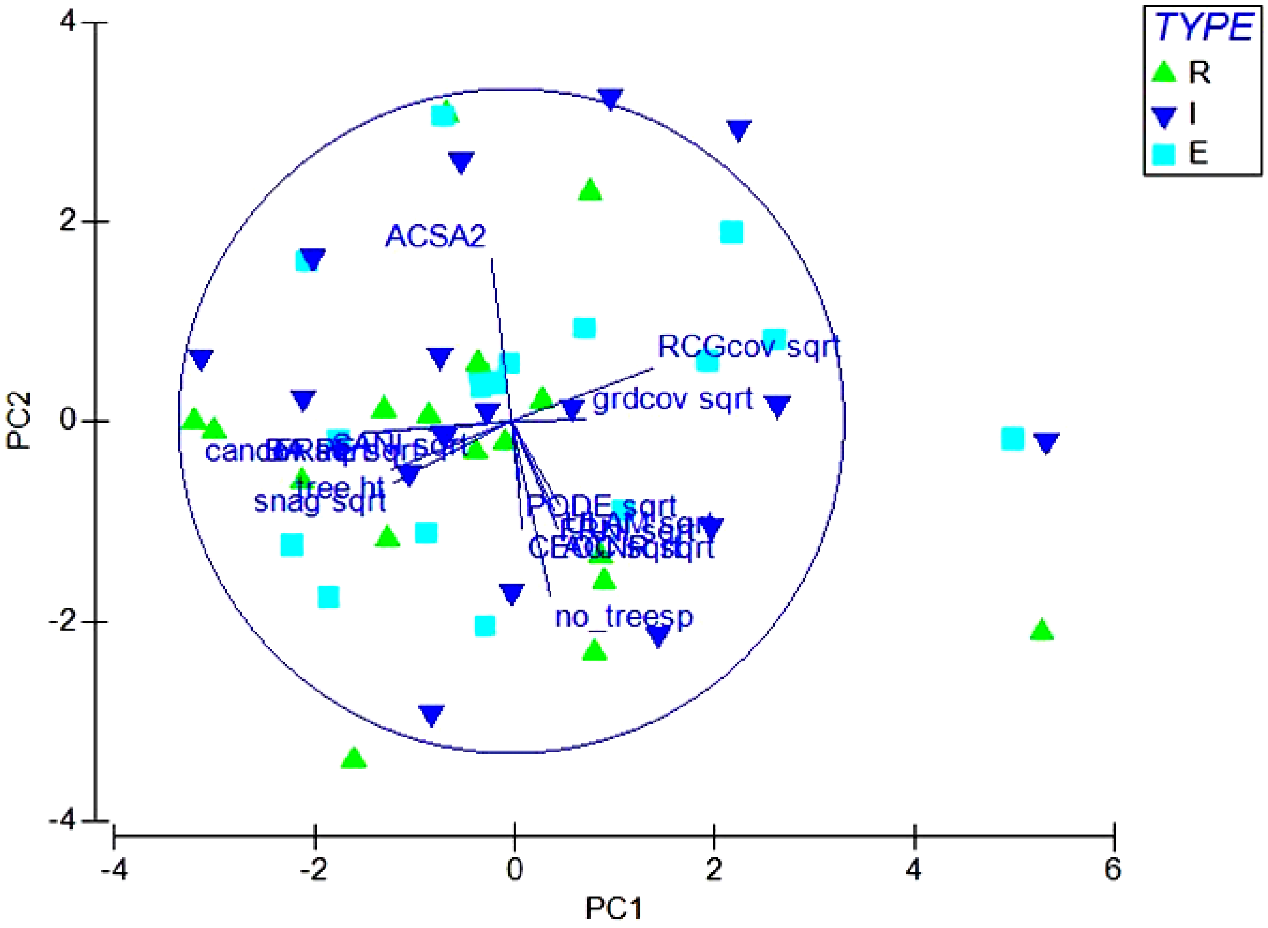
30
40
50
60
Samples

Figure 5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I
E
ACSA2
RCGcov sqrt
grdcov sqrt
SANI sqrt
tree ht
snag sqrt
PODE sqrt
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PC2
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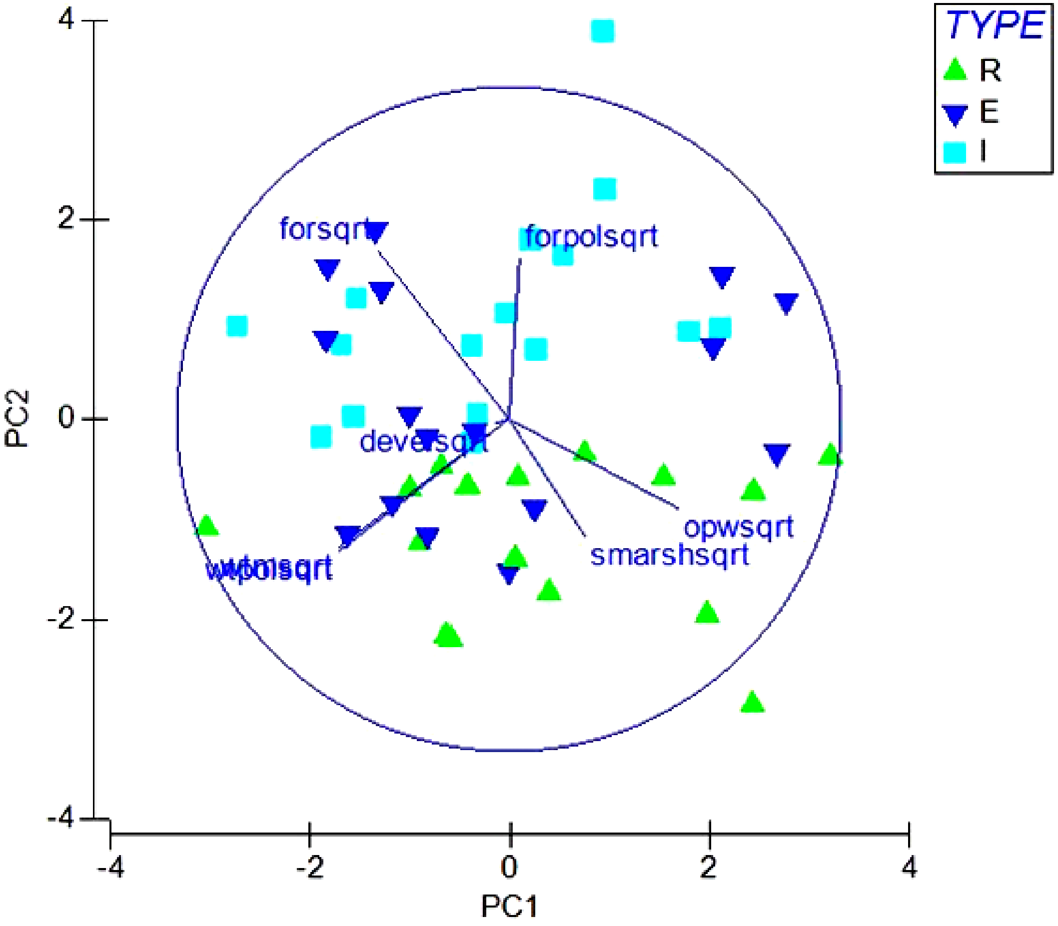
2
0
-2
-4
PC1
-4
-2
0
2
4
6

Figure 6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forpolsqrt
devsqrt
wtmsqrt
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opwsqrt
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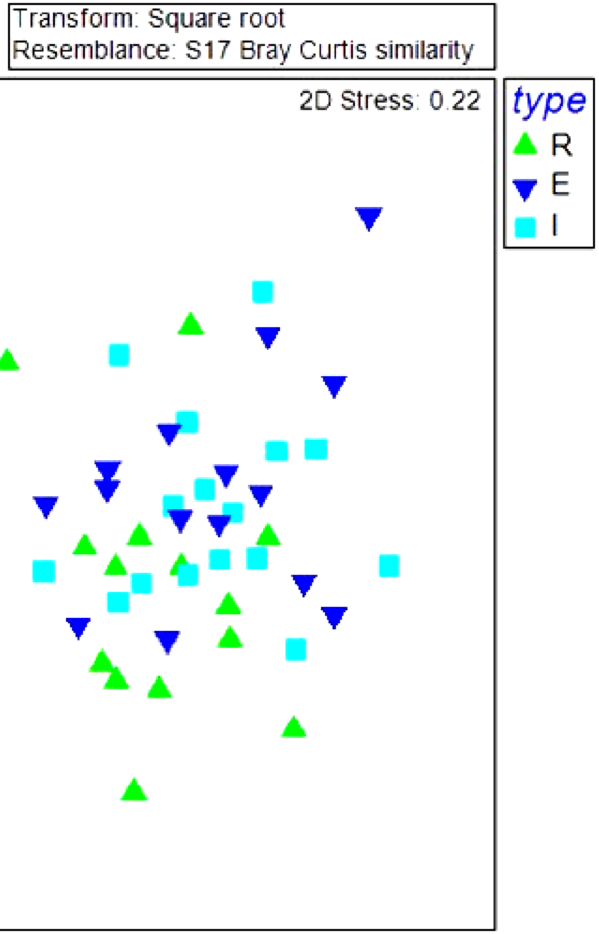
0
2
4
PC1

Figure 7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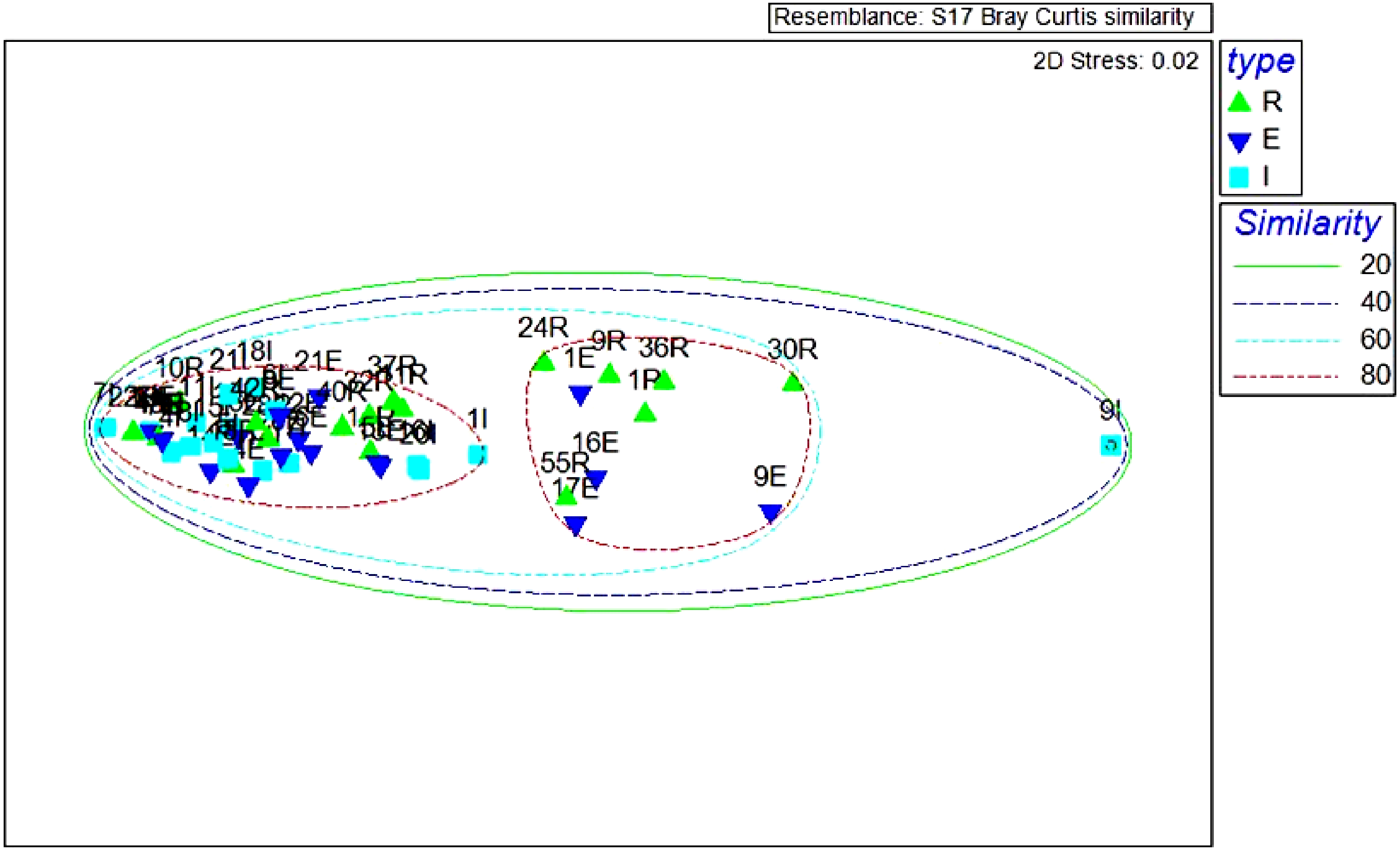
▼ E
■ I

Figure 8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▼ E
■ I
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80
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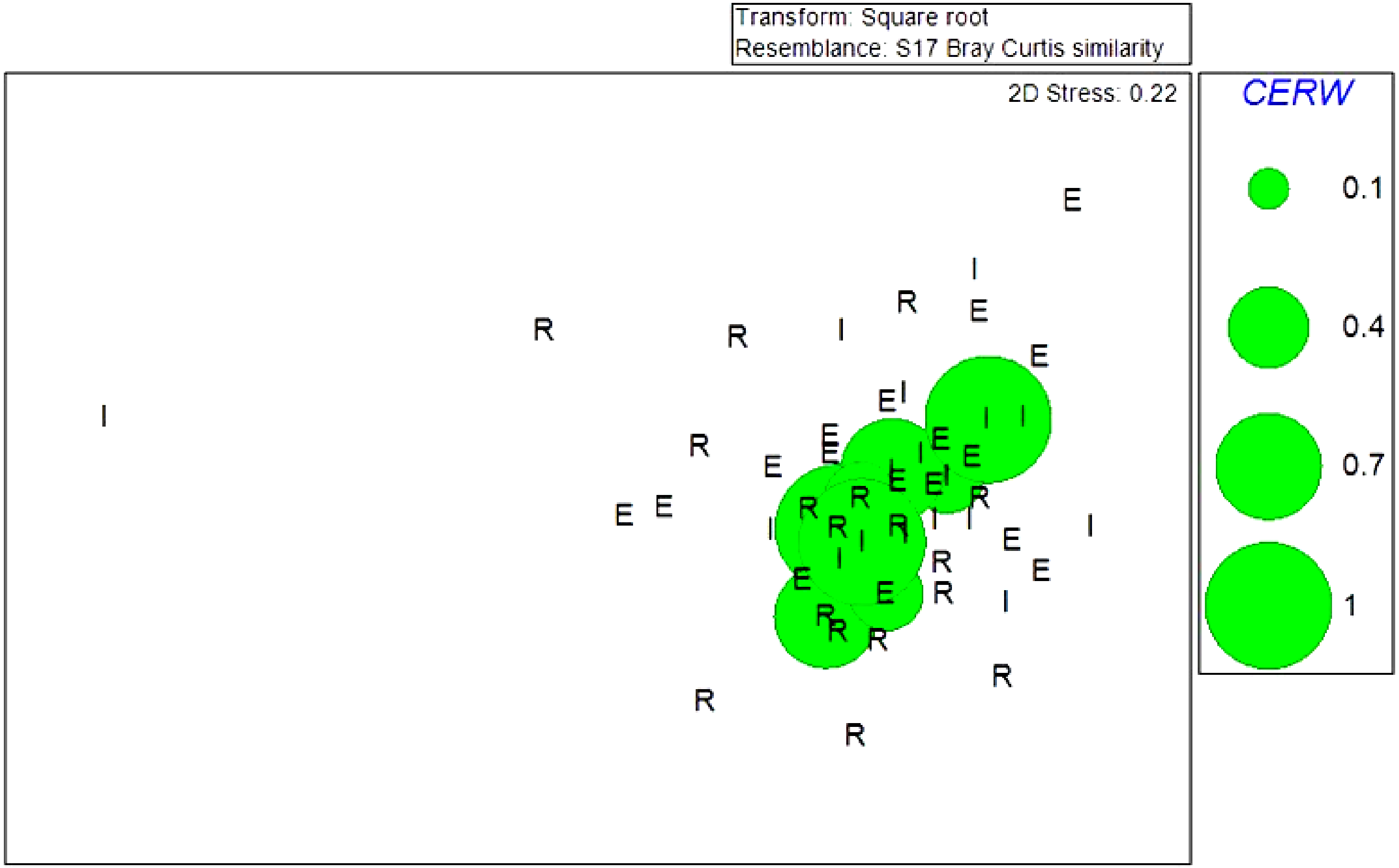
9R
1E
36R
30R
1R
16E
55R
17E
9E
9I
1I
10R
21I
18I
21E
37R
42R
40R
22R
31R
20I

Figure 9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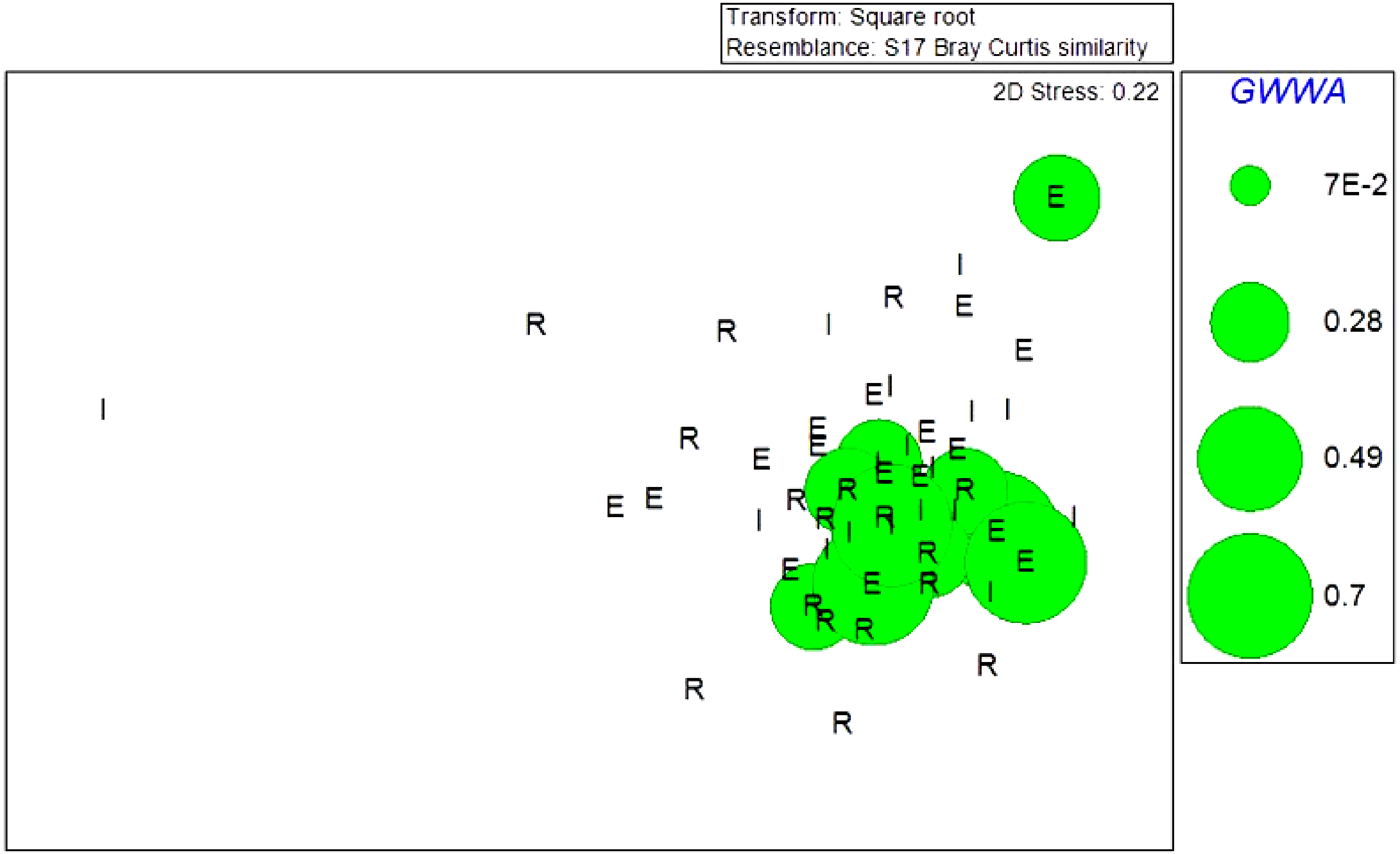
1
R
I
E

Figure 10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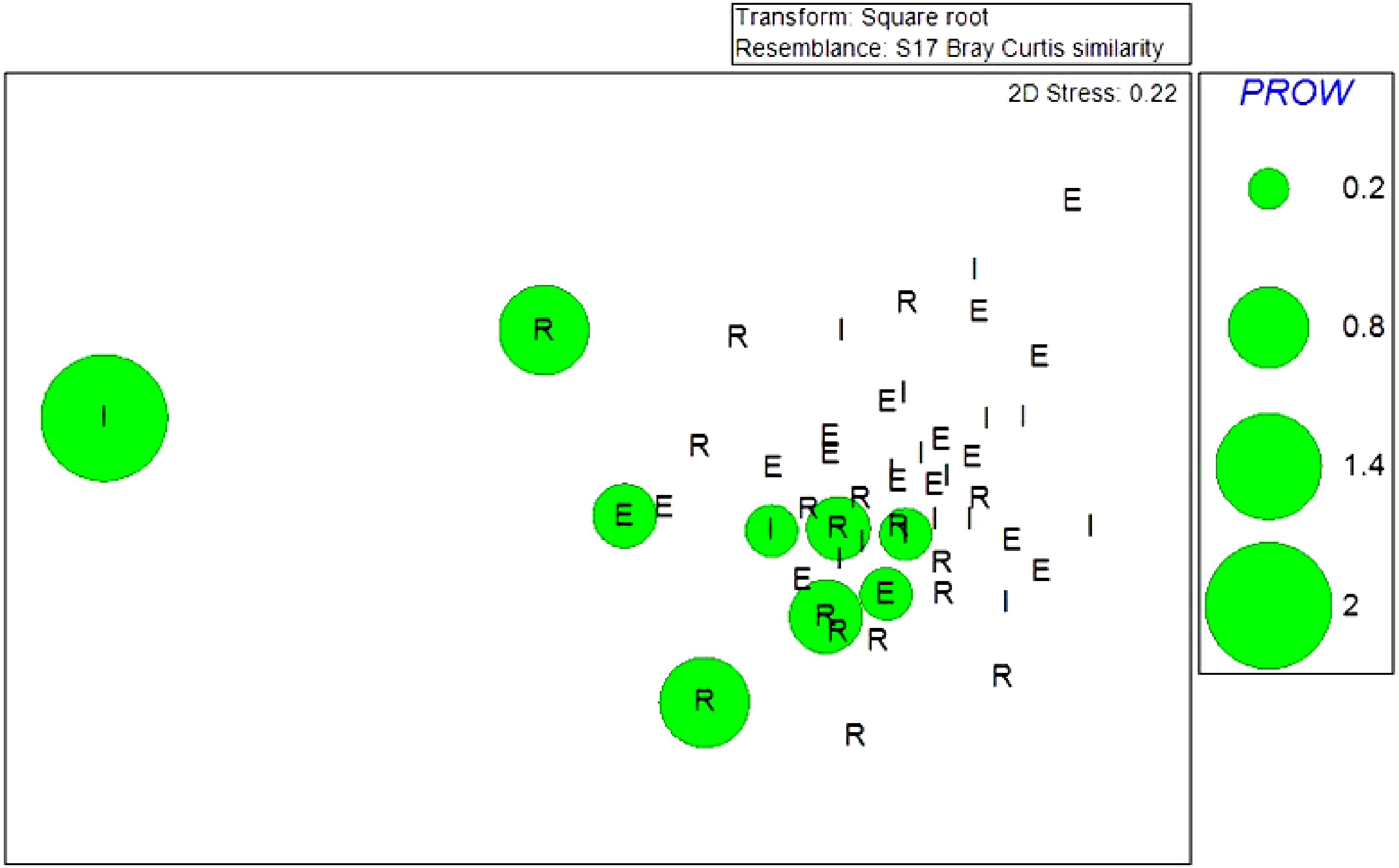
E
I
R

Figure 11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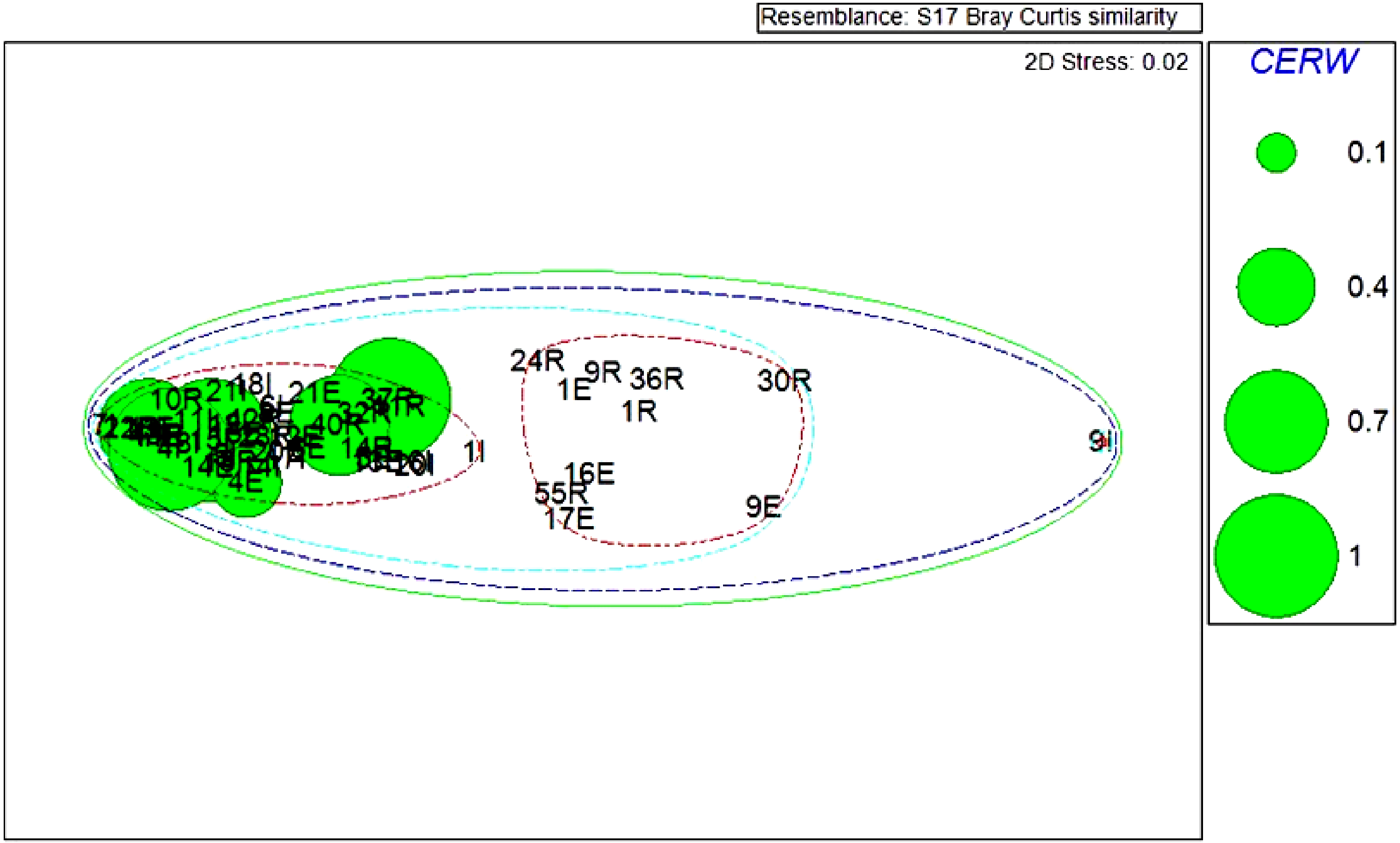
2
I
R
E

Figure 12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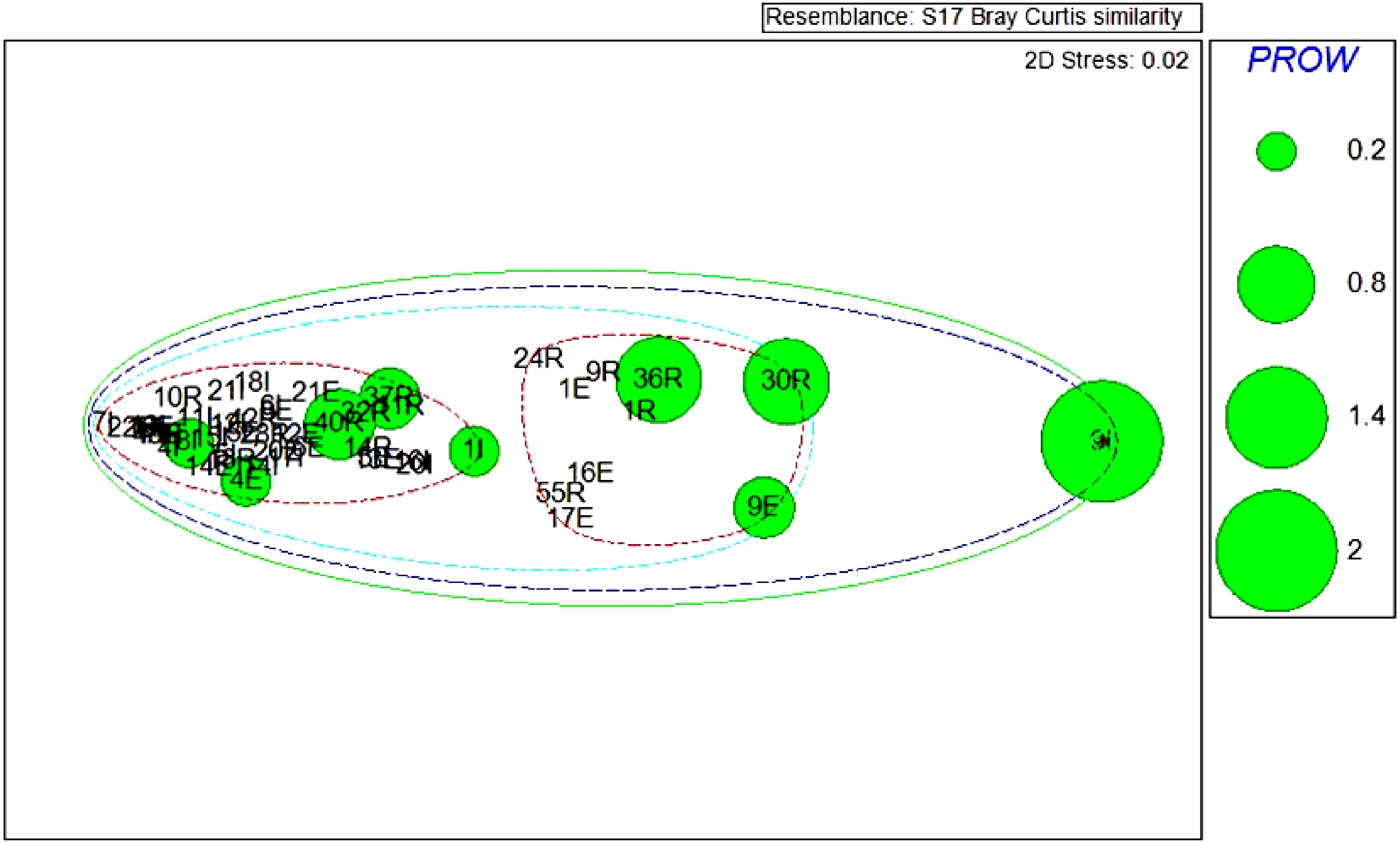
24R
1E
9R
36R
30R
1R
16E
55R
17E
9E
9I
1I
10R
21I
18I
21E
37R
32R
40R
14R
4E
14E

Figure 13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1E
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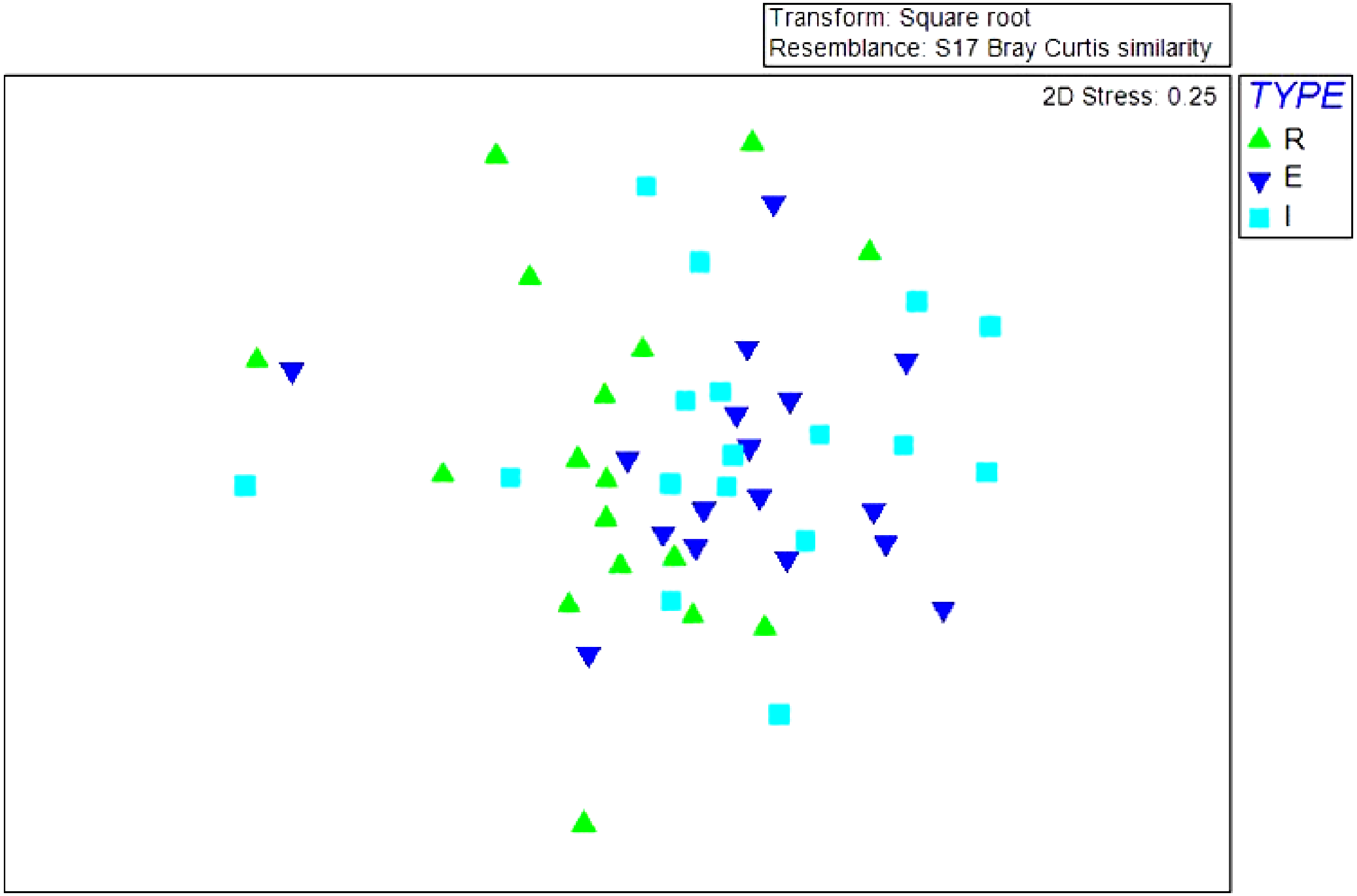
1R
30R
16E
55R
17E
9E
1J
10R
21I
18I
21E
37R
40R
22R
14R
4E
14E
20I

Figure 14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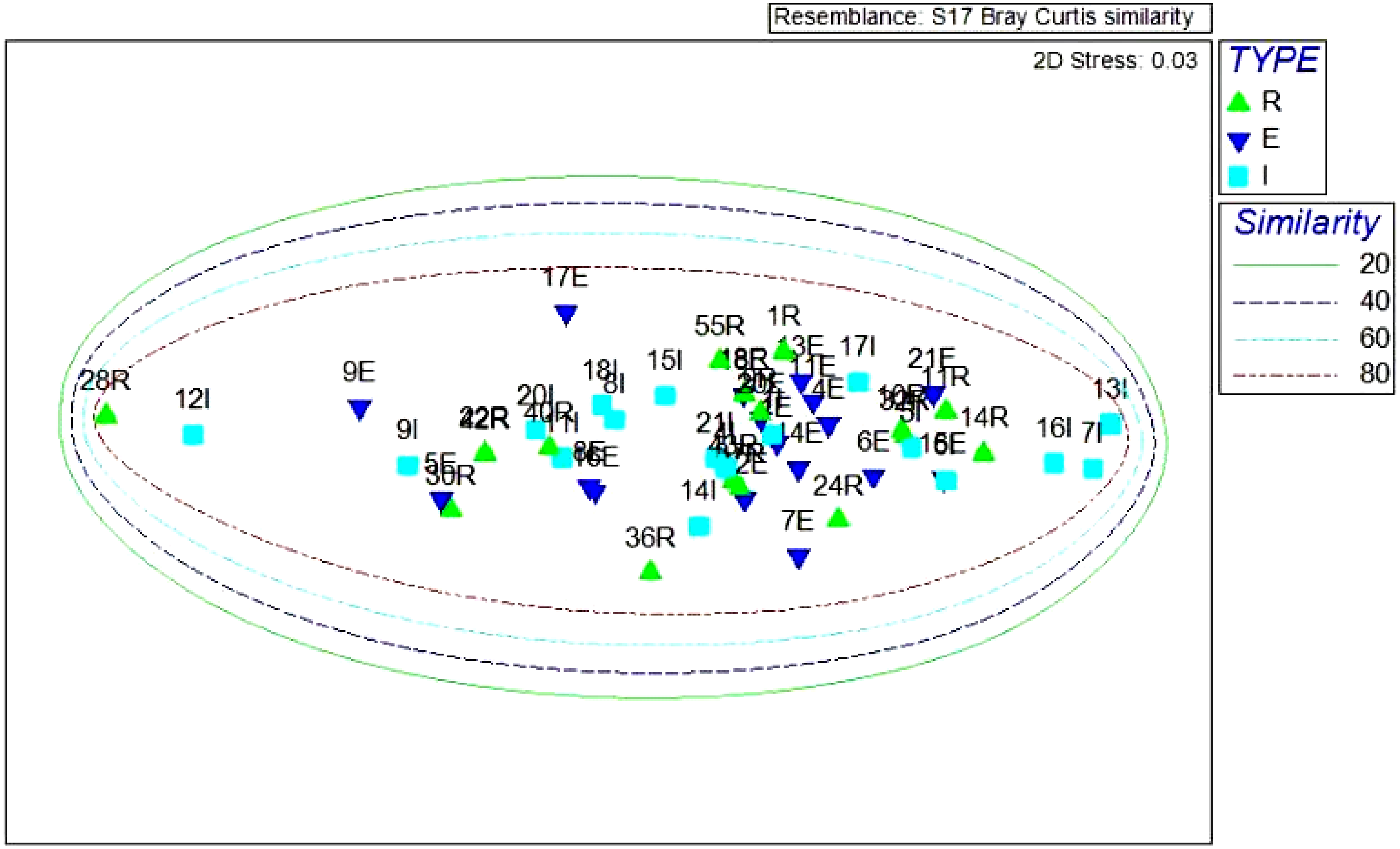
I

Figure 15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I
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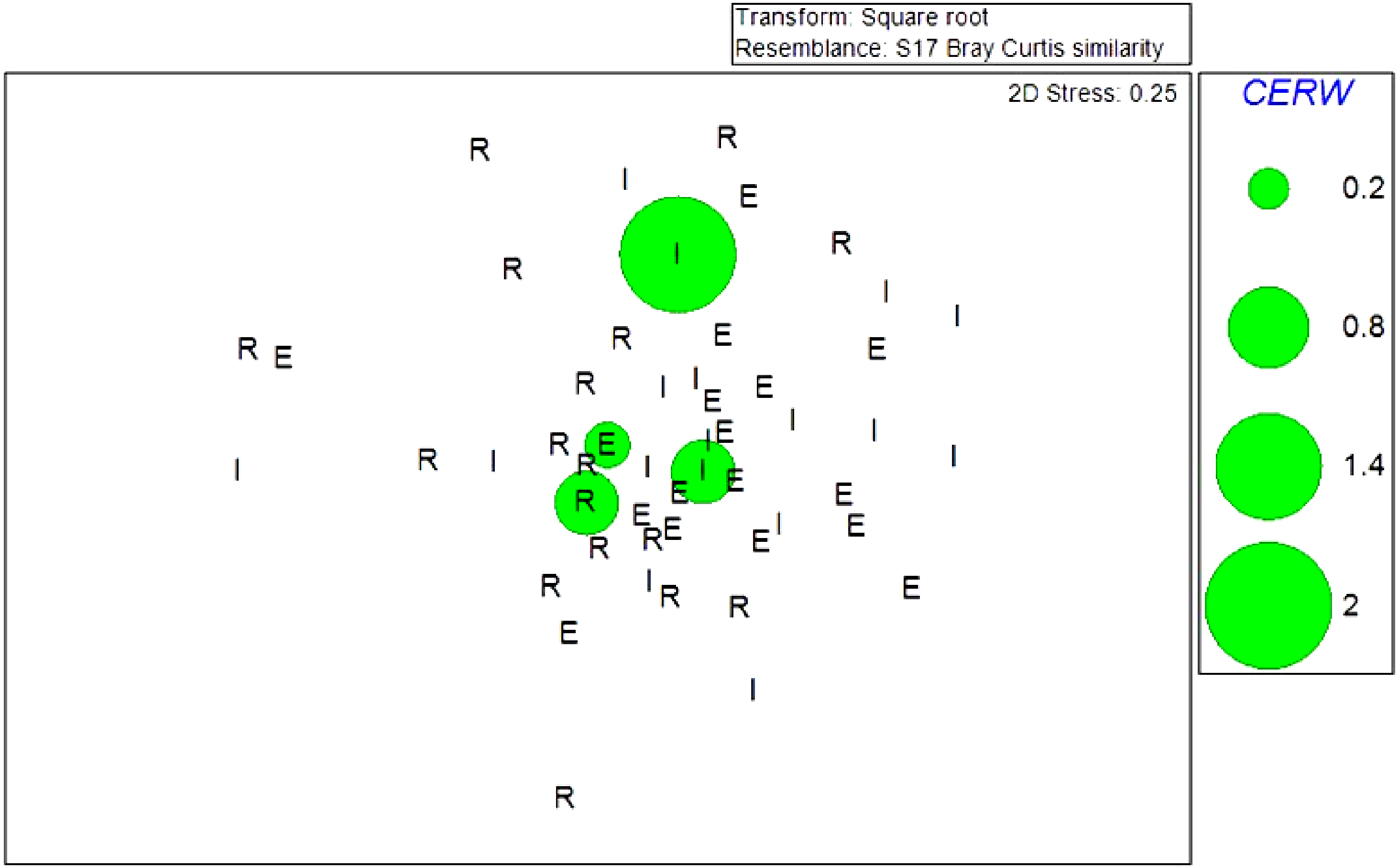
80
17E
55R
1R
13E
17I
15I
18I
8I
9E
28R
12I
20I
40R
22R
9I
11I
21E
11R
13I
14R
16I
7I
21I
4E
6E
24R
5E
30R
36R
14I
7E
2E

Figure 16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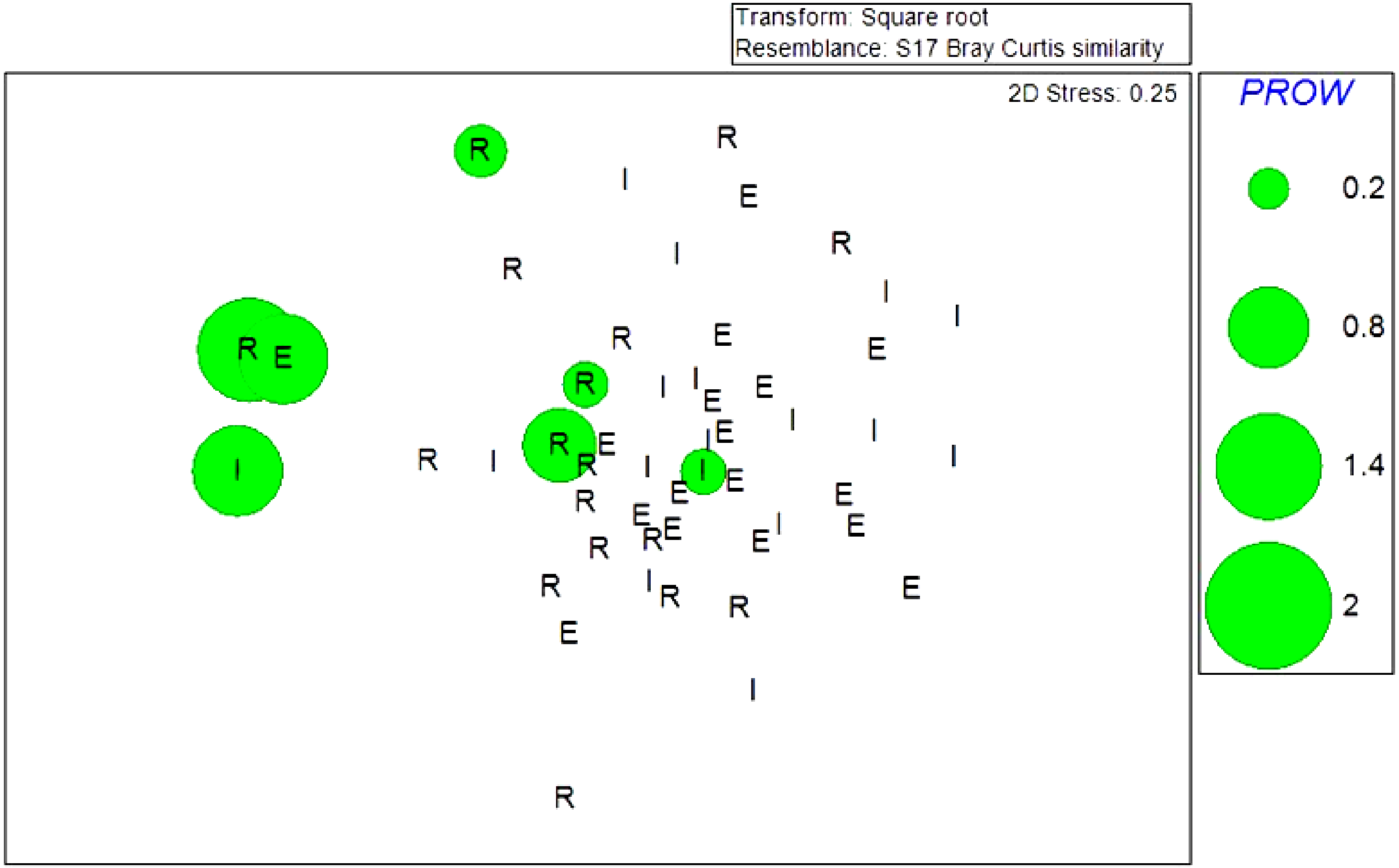
2
R
E
I

Figure 17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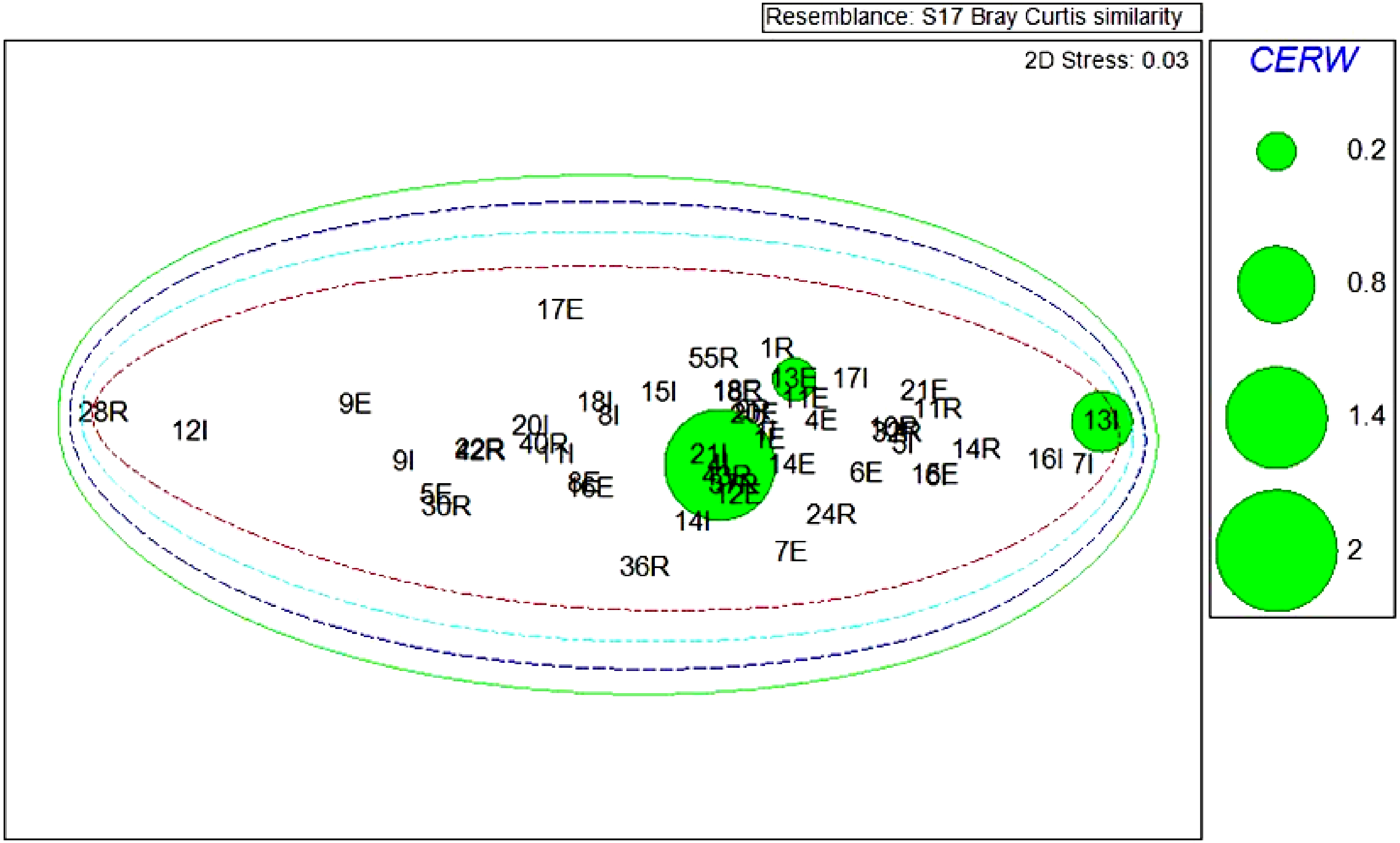
0.8
1.4
2

Figure 18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17E
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1R
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17I
21E
11R
18R
20E
11E
4E
15I
18I
8I
9E
28R
12I
20I
40R
1I
42R
9I
5E
30R
8E
16E
21I
4E
12E
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14E
6E
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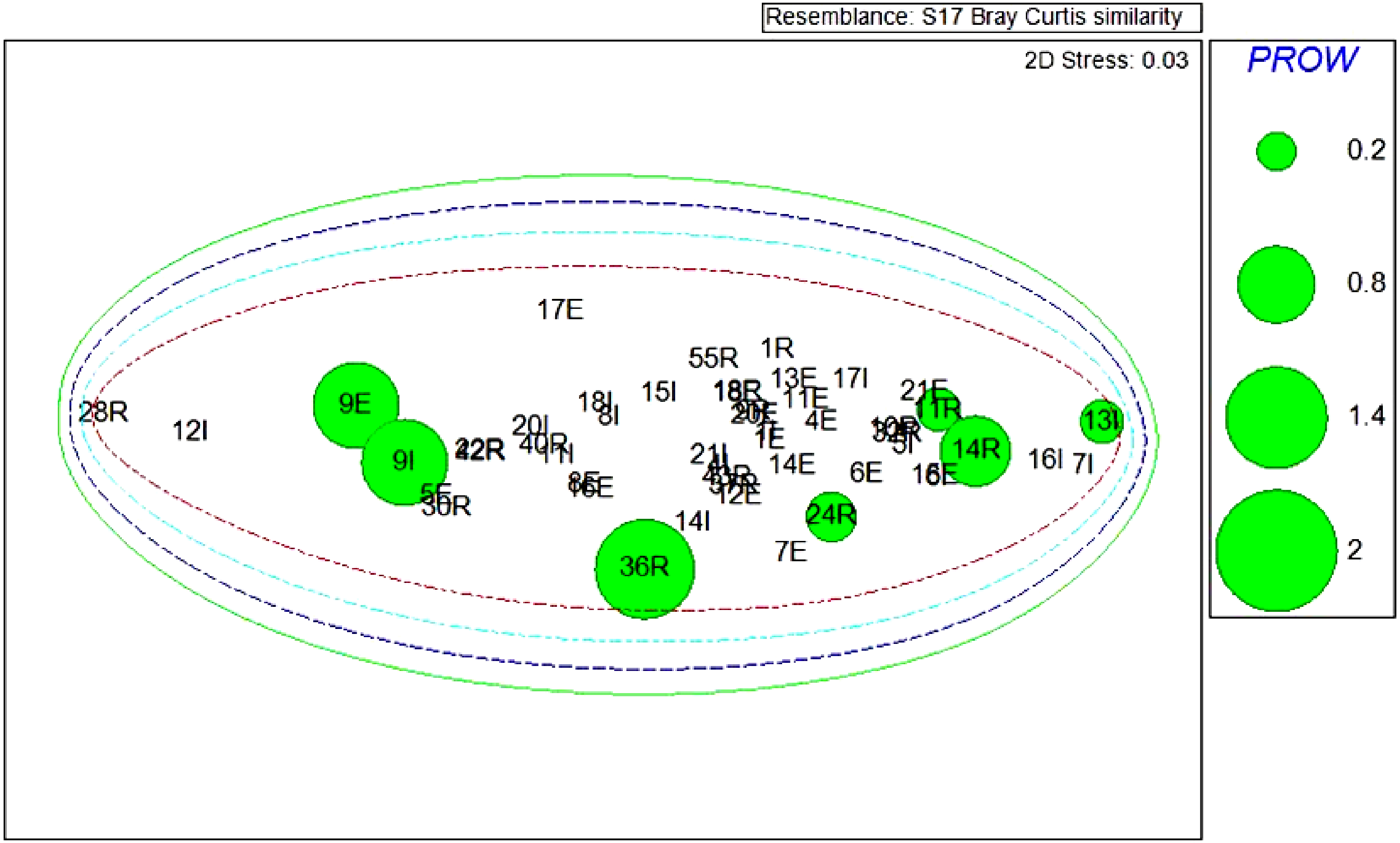
16I
7I
13I
24R
7E
36R
5I

Figure 19



Resemblance: S17 Bray Curtis similarity
2D Stress: 0.03
PROW
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0.8
1.4
2
17E
55R
1R
13E
17I
18I
8I
15I
18R
11E
21E
11R
28R
12I
9E
9I
20I
40R
42R
4E
20E
1E
13I
14R
16I
7I
5I
21I
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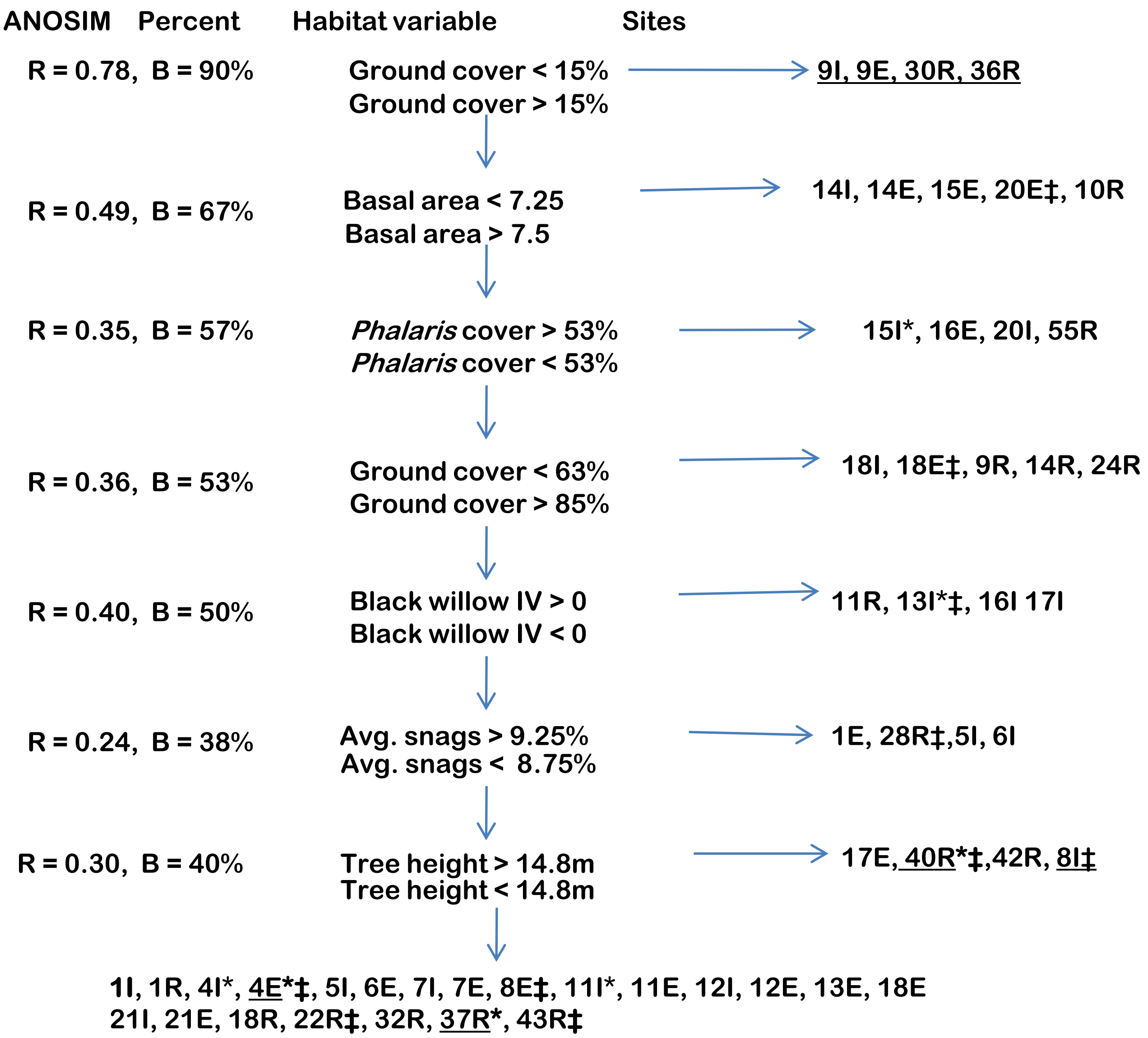
6E
16E
8E
5E
30R
12E
24R
14I
7E
36R

88

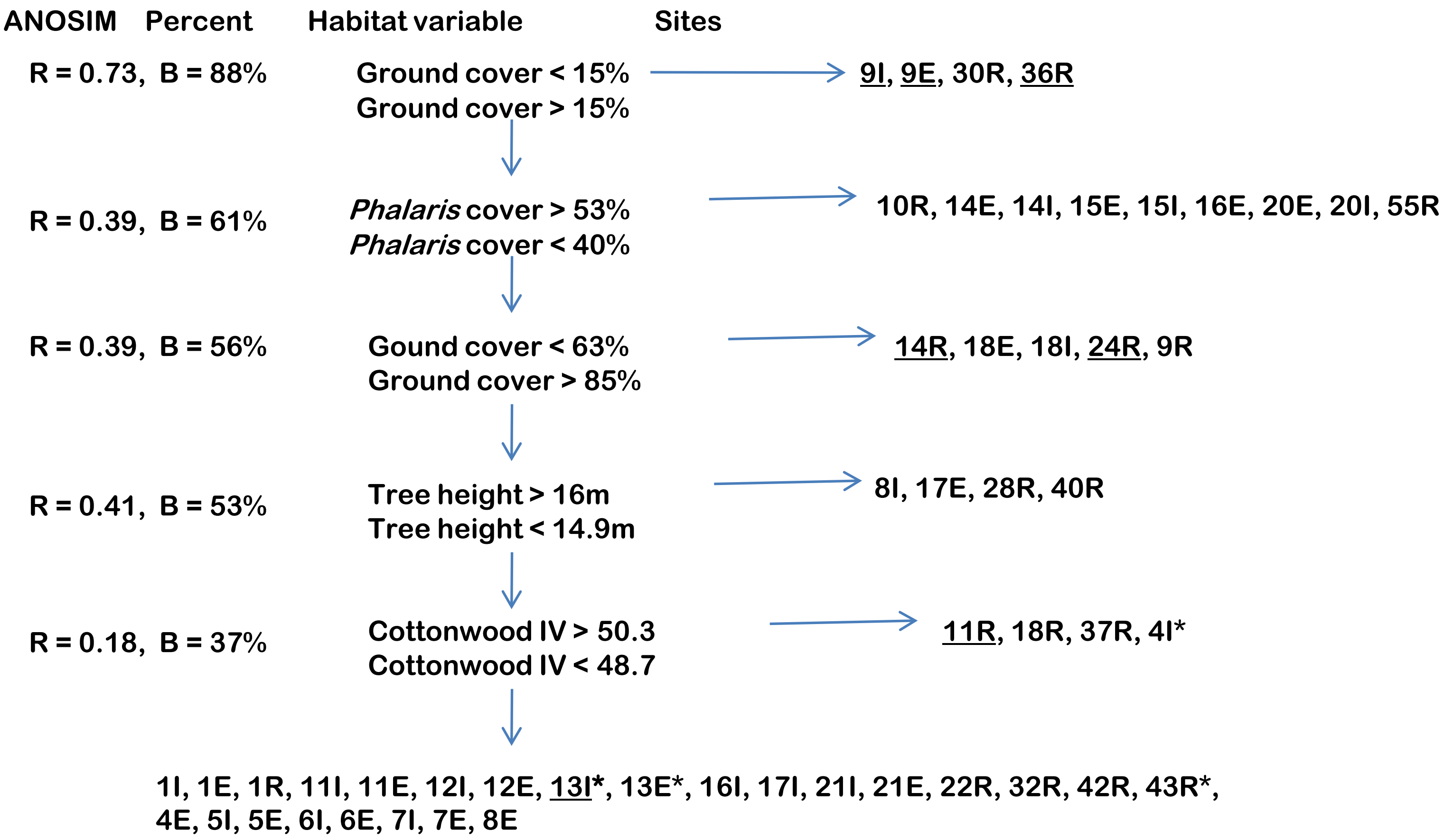
Figure 20



ANOSIM	Percent	Habitat variable	Sites
R = 0.78,	B = 90%	Ground cover < 15% Ground cover > 15%	9I, 9E, 30R, 36R
R = 0.49,	B = 67%	Basal area < 7.25 Basal area > 7.5	14I, 14E, 15E, 20E‡, 10R
R = 0.35,	B = 57%	*Phalaris* cover > 53% *Phalaris* cover < 53%	15I*, 16E, 20I, 55R
R = 0.36,	B = 53%	Ground cover < 63% Ground cover > 85%	18I, 18E‡, 9R, 14R, 24R
R = 0.40,	B = 50%	Black willow IV > 0 Black willow IV < 0	11R, 13I*‡, 16I 17I
R = 0.24,	B = 38%	Avg. snags > 9.25% Avg. snags < 8.75%	1E, 28R‡,5I, 6I
R = 0.30,	B = 40%	Tree height > 14.8m Tree height < 14.8m	17E, 40R*‡,42R, 8I‡

1I, 1R, 4I*, 4E*‡, 5I, 6E, 7I, 7E, 8E‡, 11I*, 11E, 12I, 12E, 13E, 18E
21I, 21E, 18R, 22R‡, 32R, 37R*, 43R‡

Figure 21



ANOSIM	Percent	Habitat variable	Sites
R = 0.73,	B = 88%	Ground cover < 15% Ground cover > 15%	9I, 9E, 30R, 36R
R = 0.39,	B = 61%	*Phalaris* cover > 53% *Phalaris* cover < 40%	10R, 14E, 14I, 15E, 15I, 16E, 20E, 20I, 55R
R = 0.39,	B = 56%	Gound cover < 63% Ground cover > 85%	14R, 18E, 18I, 24R, 9R
R = 0.41,	B = 53%	Tree height > 16m Tree height < 14.9m	8I, 17E, 28R, 40R
R = 0.18,	B = 37%	Cottonwood IV > 50.3 Cottonwood IV < 48.7	11R, 18R, 37R, 4I*

1I, 1E, 1R, 11I, 11E, 12I, 12E, 13I*, 13E*, 16I, 17I, 21I, 21E, 22R, 32R, 42R, 43R*,
4E, 5I, 5E, 6I, 6E, 7I, 7E, 8E

Appendix 1. Field notes for limited Red-shouldered Hawk surveys conducted during spring 2008 in the Vermillion/Cannon River Bottoms Area.

Equipment: Insignia portable CD player (Model NS-P4112); Sony portable speakers (Model SRS-M30); playback recording taken from audio CD- Stokes Field Guide to Bird Songs: Eastern Region

Method: We followed the broadcast call technique as described in Henneman et. al 2007. A 10-minute survey period began with a 20-second Great Horned Owl hoot followed by a 40-second listening period and continued with a Red-shouldered Hawk call of the same duration and listening period. The sequence length totaled 5-minutes and consisted of 3 Great Horned Owl hoots and 2 Red-shouldered Hawk calls, and was followed by a 5-minute period of passive listening. The speakers were directed towards the middle of the floodplain and no attempt was made to alter the direction of the broadcast during the survey period. Given the time constraint in procuring equipment, no attempt was made to test the decibel level of the portable speaker system.

Upon entering the Cannon River Bottoms area near Hwy 61, we marked a starting waypoint location using a Garmin GPS unit. A survey was conducted and then we walked until the receiver indicated that the successive point was at least 400 meters distant, to conduct another survey.

Results: Water levels in oxbow channels within the floodplain limited our ability to maneuver through and achieve sufficient coverage of representative Red-shouldered Hawk habitat along the Cannon River in early May 2008. The stage of the Cannon River at Welch, MN was 5.77 feet. Only two broadcast surveys were conducted at a distance of approximately 400 meters apart on 1 May, and no response from adult Red-shouldered Hawks was detected. The first survey point was along a wooded dike with overhead power lines in a clearing immediately to the east and the second survey point was at the edge of a small clearing between the North Cannon River and Collischan Road (Table 1). Although no decibel level testing was performed on the portable speaker system, it was determined that the sound level was less than optimal to broadcast sufficiently to a distance of 200 meters, or roughly the area of overlap between survey points. Weather conditions were hazy sunshine with high thin clouds, a light E-SE wind, and temperatures in the middle to upper 50's. There is no reason to suspect that weather would have been a factor influencing the intensity of the broadcast or our ability to hear a response. There was very little leaf cover in the canopy, again not likely influencing the possibility of eliciting a response.

GPS locations of Red-shouldered Hawk broadcast surveys, 1 May 2008.

Survey Point	Easting	Northing
1	0530872	4936805
2	0530478	4936697

Adult Red-shouldered Hawks were heard vocalizing at various locations in the Cannon River Valley and at one location in the floodplain along the Mississippi River throughout the months of May and June. While traversing flooded timber on 7 May an adult was calling in the vicinity of site Interior 1, and a similar observation was noted for the area on 21 May. An adult was heard calling in timber north of the railroad tracks, approximately due north of site Random 10 on 19 May. An adult was heard calling and recorded during a breeding bird survey (100 m flagging) at site Interior 20 on 10 June and another was heard in the vicinity on 27 June. An adult was heard and recorded during a breeding bird survey at site Random 55 on 4 June, though the bird was estimated to be 200 meters west of the survey area. One adult was observed performing aerial displays over Cannon River Road and a second adult was simultaneously vocalizing to the west on 8 June.

Appendix 2. Bird species detections per survey (number of birds detected/numbers of surveys) during spring migration surveys of the Vermillion/Cannon River Bottoms IBA, 2008. Codes for migratory guild (Migr. Guild) are: NTL = Neotropical migrant local breeding species, NTT = neotropical migrant transient, SDL = short distance migrant locally breeding species, SDT = short distance migrant transient, RES = resident species. Within each migratory guild bird species are arranged in the same taxonomic sequence used in bird field guides. Frequency of occurrence (Freq. occur.) was calculated as the number of sites where a species was detected at least once divided by the total number of sites (n=51).

			Site type			Freq.
Migr. Guild	Common Name	Scientific Name	Interior	Edge	Rand.	occur.
NTL	Yellow-billed cuckoo	*Coccyzus americanus*	0.00	0.04	0.05	0.06
	Ruby-throated hummingbird	*Archilochus colubris*	0.00	0.04	0.08	0.08
	Eastern wood-peewee	*Contopus virens*	0.37	0.10	0.60	0.55
	Willow flycatcher	*Empidonax traillii*	0.04	0.02	0.03	0.06
	Least flycatcher	*Empidonax minimus*	0.14	0.29	0.30	0.29
	Great crested flycatcher	*Myiarchus crinitus*	0.22	0.29	0.43	0.53
	Unknown Flycatcher		0.04	0.02	0.03	
	Tree swallow	*Tachycineta bicolor*	0.02	0.00	0.03	0.04
	Blue-gray gnatcatcher	*Polioptila caerulea*	0.84	0.80	1.03	0.18
	Wood thrush	*Hylocichla mustelina*	0.04	0.00	0.00	0.02
	Unknown thrush		0.04	0.06	0.00	
	Grey catbird	*Dumetella carolinensis*	0.31	0.45	0.18	0.37
	Yellow-throated vireo	*Vireo flavifrons*	0.20	0.20	0.25	0.51
	Warbling vireo	*Vireo gilvus*	1.20	0.96	1.63	0.86
	Red-eyed vireo	*Vireo olivaceus*	0.22	0.14	0.33	0.43
	Unknown vireo		0.04	0.04	0.00	
	Blue-winged warbler	*Vermivora pinus*	0.00	0.02	0.00	0.02
	Northern parula	*Parula americana*	0.08	0.10	0.10	0.20
	Yellow warbler	*Dendroica petechia*	1.31	1.43	1.08	0.86
	Chestnut-sided warbler	*Dendroica pensylvanica*	0.71	0.51	0.53	0.65
	Cerulean warbler	*Dendroica cerulea*	0.18	0.02	0.13	0.16
	American redstart	*Setophaga ruticilla*	6.22	5.90	7.10	0.94
	Prothonotary warbler	*Protonotaria citrea*	0.08	0.04	0.13	0.18
	Ovenbird	*Seiurus aurocapillus*	0.00	0.04	0.03	0.06
	Mourning warbler	*Oporornis philadelphia*	0.00	0.00	0.03	0.02
	Common yellowthroat	*Geothlypis trichas*	0.41	0.76	0.50	0.59
	Veery	*Catharus fuscescens*	0.04	0.02	0.00	0.06
	Unknown warbler		0.02	0.02	0.03	
	Scarlet tanager	*Piranga olivacea*	0.02	0.00	0.00	0.02
	Rose-breasted grosbeak	*Pheucticus ludovicianus*	0.24	0.24	0.13	0.35
	Indigo bunting	*Passerina cyanea*	0.12	0.08	0.03	0.14
	Baltimore oriole	*Icterus galbula*	0.69	0.37	1.05	0.78
NTT	Yellow-bellied flycatcher	*Empidonax flaviventris*	0.02	0.00	0.03	0.04
	Ruby-crowned kinglet	*Regulus calendula*	0.00	0.04	0.00	0.04
	Gray-cheeked thrush	*Catharus minimus*	0.02	0.02	0.00	0.04

	Swainson's thrush	*Catharus ustulatus*	0.02	0.02	0.05	0.06
	Golden-winged warbler	*Vermivora chrysoptera*	0.06	0.15	0.10	0.20
	Tennessee warbler	*Vermivora peregrina*	0.84	0.69	0.58	0.53
	Orange-crowned warbler	*Vermivora celata*	0.02	0.02	0.05	0.04
	Nashville warbler	*Vermivora ruficapilla*	0.59	0.60	0.18	0.43
	Magnolia warbler	*Dendroica magnolia*	0.37	0.33	0.35	0.41
	Yellow-rumped warbler	*Dendroica coronata*	1.49	0.23	0.43	0.51
	Black-throated green warbler	*Dendroica virens*	0.02	0.00	0.03	0.04
	Blackburnian warbler	*Dendroica fusca*	0.08	0.04	0.10	0.12
	Pine warbler	*Dendroica pinus*	0.00	0.02	0.00	0.02
	Bay-breasted warbler	*Dendroica castanea*	0.00	0.04	0.00	0.02
	Blackpoll warbler	*Dendroica striata*	0.02	0.08	0.05	0.12
	Black-and-white warbler	*Mniotilta varia*	0.22	0.21	0.33	0.49
	Northern waterthrush	*Seiurus noveboracensis*	0.69	0.23	0.38	0.47
	Louisiana waterthrush	*Seiurus motacilla*	0.00	0.00	0.03	0.02
	Wilson's warbler	*Wilsonia pusilla*	0.22	0.08	0.20	0.29
	Canada warbler	*Wilsonia canadensis*	0.02	0.10	0.10	0.16
SDL	Great blue heron	*Ardea herodias*	0.02	0.02	0.00	0.04
	Wood duck	*Aix sponsa*	0.14	0.13	0.05	0.20
	Hooded merganser	*Lophodytes cucullatus*	0.02	0.00	0.00	0.02
	Mallard	*Anas platyrhynchos*	0.04	0.00	0.03	0.04
	Bald eagle	*Haliaeetus leucocephalus*	0.02	0.02	0.03	0.06
	Mourning dove	*Zenaida macroura*	0.00	0.06	0.00	0.02
	Yellow-bellied sapsucker	*Sphyrapicus varius*	0.38	0.13	0.20	.033
	Northern flicker	*Colaptes auratus*	0.06	0.10	0.05	0.18
	Eastern phoebe	*Sayornis phoebe*	0.00	0.02	0.00	0.02
	House wren	*Troglodytes aedon*	2.14	2.21	1.93	1.00
	Sedge wren	*Cistothorus platensis*	0.00	0.00	0.03	0.02
	American robin	*Turdus migratorius*	1.56	1.23	1.53	0.92
	Eastern bluebird	*Sialia sialis*	0.00	0.04	0.03	0.04
	Cedar waxwing	*Bombycilla cedrorum*	0.06	0.00	0.00	0.02
	Chipping sparrow	*Spizella passerina*	0.00	0.00	0.05	0.02
	Song sparrow	*Melospiza melodia*	0.70	0.77	0.63	0.72
	Swamp sparrow	*Melospiza georgiana*	0.02	0.10	0.00	0.08
	Red-winged blackbird	*Agelaius phoeniceus*	0.04	0.19	0.05	0.12
	Common grackle	*Quiscalus quiscula*	0.00	0.02	0.08	0.04
	Brown-headed cowbird	*Molothrus ater*	1.04	1.23	0.65	0.82
	American goldfinch	*Carduelis tristis*	1.12	0.92	1.10	0.80
SDT	Lincoln's sparrow	*Melospiza lincolnii*	0.00	0.02	0.00	0.02
	White-throated sparrow	*Zonotrichia albicollis*	0.04	0.04	0.03	0.06
RES	Great horned owl	*Bubo virginianus*	0.06	0.00	0.00	0.02
	Red-bellied woodpecker	*Melanerpes carolinus*	0.41	0.13	0.33	0.43
	Downy woodpecker	*Picoides pubescens*	0.22	0.08	0.23	0.35
	Hairy woodpecker	*Picoides villosus*	0.08	0.10	0.18	0.16
	Pileated woodpecker	*Dryocopus pileatus*	0.10	0.02	0.03	0.02
	Unknown Woodpecker		0.02	0.02	0.00	
	Blue jay	*Cyanocitta cristata*	0.00	0.04	0.05	0.06
	American crow	*Corvus brachyrhynchos*	0.22	0.08	0.05	0.14
	Black-capped chickadee	*Parus atricapillus*	0.18	0.10	0.20	0.27
	White-breasted nuthatch	*Sitta carolinensis*	0.22	0.21	0.33	0.45
	Brown creeper	*Certhia americana*	0.10	0.02	0.10	0.14

Northern cardinal	*Cardinalis cardinalis*	0.16	0.23	0.10	0.29

Appendix 3. Bird species detections per survey (number of birds detected/numbers of surveys) during June breeding season surveys of the Vermillion/Cannon River Bottoms IBA, 2008. Codes for migratory guild (Migr. Guild) are: NT = Neotropical migrant species, SD = short distance migrant, RES = resident species (Transient migrants NTT and SDT were no longer present). Within each migratory guild bird species are arranged in the same taxonomic sequence used in bird field guides. Frequency of occurrence (Freq. occur.) was calculated as the number of sites where a species was detected at least once divided by the total number of sites (n=51).

			Site type			Freq.
Migr. Guild	Common Name	Scientific Name	Interior	Edge	Rand.	occur.
NTL	Black-billed cuckoo	*Coccyzus erythropthalmus*	0.00	0.02	0.00	0.02
	Yellow-billed cuckoo	*Coccyzus americanus*	0.13	0.15	0.09	0.35
	Ruby-throated hummingbird	*Archilochus colubris*	0.02	0.06	0.07	0.14
	Eastern wood-peewee	*Contopus virens*	0.60	0.67	0.48	0.90
	Least flycatcher	*Empidonax minimus*	0.00	0.04	0.05	0.06
	Great crested flycatcher	*Myiarchus crinitus*	0.45	0.59	0.43	0.72
	Unknown Flycatcher		0.00	0.02	0.07	
	Tree swallow	*Tachycineta bicolor*	0.00	0.04	0.05	0.08
	Blue-gray gnatcatcher	*Polioptila caerulea*	0.45	0.41	0.48	0.59
	Grey catbird	*Dumetella carolinensis*	0.22	0.31	0.13	0.37
	Yellow-throated vireo	*Vireo flavifrons*	0.27	0.26	0.14	0.51
	Warbling vireo	*Vireo gilvus*	1.05	0.91	1.34	0.90
	Red-eyed vireo	*Vireo olivaceus*	0.29	0.19	0.11	0.41
	Blue-winged warbler	*Vermivora pinus*	0.02	0.00	0.00	0.02
	Yellow warbler	*Dendroica petechia*	1.18	1.28	0.93	0.84
	Chestnut-sided warbler	*Dendroica pensylvanica*	0.02	0.00	0.00	0.02
	Cerulean warbler	*Dendroica cerulea*	0.13	0.02	0.04	0.08
	American redstart	*Setophaga ruticilla*	3.56	4.02	3.73	1.00
	Prothonotary warbler	*Protonotaria citrea*	0.07	0.06	0.14	0.14
	Common yellowthroat	*Geothlypis trichas*	0.69	0.63	0.34	0.59
	Scarlet tanager	*Piranga olivacea*	0.02	0.02	0.00	0.04
	Rose-breasted grosbeak	*Pheucticus ludovicianus*	0.05	0.06	0.05	0.12
	Indigo bunting	*Passerina cyanea*	0.16	0.19	0.16	0.37
	Baltimore oriole	*Icterus galbula*	0.56	0.70	0.57	0.75
NTT	Alder flycatcher	*Empidonax alnorum*	0.00	0.00	0.04	0.04
	Black-and-white warbler	*Mniotilta varia*	0.02	0.02	0.00	0.04
SDL	Canada goose	*Branta canadensis*	0.00	0.00	0.02	0.02
	Great blue heron	*Ardea herodias*	0.02	0.00	0.00	0.02
	Wood duck	*Aix sponsa*	0.02	0.13	0.16	0.08
	Hooded merganser	*Lophodytes cucullatus*	0.04	0.02	0.00	0.04
	Mallard	*Anas platyrhynchos*	0.00	0.00	0.04	0.02
	Mourning dove	*Zenaida macroura*	0.04	0.02	0.05	0.12
	Belted kingfisher	*Ceryle alcyon*	0.00	0.00	0.02	0.02
	Yellow-bellied sapsucker	*Sphyrapicus varius*	0.25	0.28	0.34	0.57
	Northern flicker	*Colaptes auratus*	0.07	0.00	0.02	0.08

	Eastern phoebe	*Sayornis phoebe*	0.02	0.00	0.00	0.02
	House wren	*Troglodytes aedon*	2.00	1.54	1.48	1.00
	Eastern bluebird	*Sialia sialis*	0.02	0.02	0.00	0.04
	American robin	*Turdus migratorius*	1.18	0.78	1.38	0.92
	Cedar waxwing	*Bombycilla cedrorum*	0.07	0.04	0.09	0.08
	Song sparrow	*Melospiza melodia*	1.02	0.89	0.54	0.86
	Red-winged blackbird	*Agelaius phoeniceus*	0.02	0.02	0.41	0.12
	Common grackle	*Quiscalus quiscula*	0.49	0.26	1.89	0.37
	Brown-headed cowbird	*Molothrus ater*	0.80	0.72	0.63	0.90
	American goldfinch	*Carduelis tristis*	0.67	1.09	0.41	0.86
RES	Cooper's hawk	*Accipiter cooperii*	0.02	0.00	0.00	0.02
	Red-bellied woodpecker	*Melanerpes carolinus*	0.20	0.30	0.55	0.65
	Downy woodpecker	*Picoides pubescens*	0.27	0.31	0.38	0.65
	Hairy woodpecker	*Picoides villosus*	0.11	0.09	0.09	0.25
	Pileated woodpecker	*Dryocopus pileatus*	0.00	0.02	0.04	0.06
	Unknown Woodpecker		0.04	0.02	0.00	
	Blue jay	*Cyanocitta cristata*	0.04	0.00	0.04	0.04
	American crow	*Corvus brachyrhynchos*	0.22	0.08	0.05	0.20
	Black-capped chickadee	*Parus atricapillus*	0.27	0.26	0.13	0.37
	White-breasted nuthatch	*Sitta carolinensis*	0.24	0.35	0.25	0.53
	Brown creeper	*Certhia americana*	0.05	0.02	0.02	0.10
	Northern cardinal	*Cardinalis cardinalis*	0.22	0.17	0.04	0.37