HABITAT CHARACTERISTICS OF YELLOW RAIL, UPLAND SANDPIPER, AND SHARP-TAILED SPARROW TERRITORIES

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INTRODUCTION

A major reason for the population decline of many species over the past 100 years is loss or change in habitat characteristics or complexes required by those species. However, a thorough understanding of the specific habitat requirements for many species is still lacking. Often wildlife managers or experienced naturalists recognize specific habitat components or configurations that a species needs within its breeding habitat, but quantification of these requirements, their objective determination, or a process to incorporate this information into a management framework are nearly non-existent.

We studied habitat relationships of three species that have status of special concern in Minnesota (Minnesota Department of Natural Resources 1983): the yellow rail (*Coturnicops noveboracensis*), sharp-tailed sparrow (*Ammodramus caudacutus*), and upland sandpiper (*Batramia longicauda*). Our overall goals were to: (1) identify specific habitat configurations and plant species associated with the territories of each species; (2) determine whether the vegetational methods used by Wiens and Rotenberry (e.g., Wiens 1969, Wiens and Rotenberry 1981) in grassland and shrubsteppe habitats and by ourselves in peatland habitats (e.g., Niemi et al. 1984) could be applied in prairie wetlands and grasslands; and (3) experiment with a visual method for collecting vegetation data. Our specific objectives were to: (1) locate territories of the three species; (2) sample habitat characteristics within these territories; and (3) analyze these habitat data to identify similar and different characteristics in the territories of these species.

STUDY AREAS

We studied four areas (Figure 1, Table 1): (1) Agassiz National Wildlife Refuge, Marshall County; (2) McGregor Marsh, Aitkin County; (3) Bicentennial and Blazing Star prairies, Clay County (Searle and Heitlinger 1980); and (4) Santee prairie, Mahnomen County.

METHODS

We searched the literature and contacted several naturalists (K. E. Eckert, J. C. Green, J. Mattson, T. Savaloja) to identify traditional nesting areas for the 3 species in Minnesota. We visited the study areas in early June and marked at least 4 locations per species where singing males were observed.

Because these species are of special concern in Minnesota, we chose the post-breeding season to collect vegetation data. We felt that for sensitive species, the benefits of sampling during the nesting season did not warrant potentially jeopardizing nesting success. If it is necessary to translate the data collected in early July to what the vegetation is like during initial habitat selection (May) and during nesting (May-June), then control plots in similar habitats need to be sampled from May to July. These control data could then be useful in making projections from early-July to some previous data.

We measured vegetation following methods presented by Niemi et al, (1984) (Appendix 1). Briefly the following characteristics were measured: (1) percent ground cover including any vegetation < 10 cm; (2) density and vertical distribution of graminoids (grasses and sedges) < 10 cm high; (3) density, vertical distribution, and species composition of forbs (plants > 10 cm); (4) water depth; and (5) density, vertical distribution, and species composition of phanerophytes [shrubs, forbs, or graminoids that are > 30 cm high and are present annually (Mueller-Dombois and Ellenberg 1974)]. Ten point samples were located and measured every 10 m along a randomly selected 100 m transect within four areas for each species.

We also experimented with a visual approach to habitat assessment at each territory (e.g., see Haila et al. 1980). The following habitat characteristics were estimated: (1) overall height of the vegetation (m); (2) distance of the initial observation of the individual to the nearest edge of the habitat (m); (3) size of the habitat (ha); (4) mean water depth (cm); (5) graminoid (a) density, a relative number from 0-10 with 10 being most dense, (b) height (cm), and (c) dominance, the percentage of species represented by two genera; (6) forb (a) density (0-10), (b) height (cm), and (c) dominance (%); and (7) phanerophyte (a) density (0-10), (b) height (dm), (c) dominance (%), and (d) dispersion, a relative number (0-10) with 0 being a uniform distribution and 10 representing one clump.

For both data sets we examined the mean, median, range, minimum, maximum, skewness, kurtosis (e.g. the relative peakedness or flatness of the curve defined by the distribution of the data), and the coefficient of variation for each habitat variable. Log transformations (natural) were performed to minimize skewness and kurtosis. We used principal component analysis (PCA) to explore the covariation of the habitat data for both sampling methods. We were interested in how the vegetation data could be reduced to fewer descriptive variables with minimal loss in describing bird-habitat associations. All PCA analyses were calculated with the Statistical Package for the Social Sciences and subprogram FACTOR with the PA1 method and no rotation (Nie et al. 1975).

We used stepwise discriminant function analysis (DFA) to identify differences in habitat characteristics between species territories. One DFA was calculated for all species and separate tests were calculated for each pair of species. All DFA calculations were performed using SPSS subprogram DISCRIMINANT and Wilk's lambda as the discriminating criterion (Nie et al. 1975).

RESULTS

Yellow rail and sharp-tailed sparrow habitats were located in areas 1 and 2 and upland sandpiper habitats in areas 3 and 4 (Figure 1, Table 1). In addition, we observed two endangered species (MNDNR 1983), Sprague's pipit (Anthus spragueii) and chestnut-collared longspur (Calcarius ornatus) (Table 1), but only 1 and 2 individuals respectively.

Species habitat characteristics. - The first two principal components accounted for 54% of the variation in the PCA with data for all 3 species (N = 121). PC1 was related (left to right in Figure 2) to increasing vegetation height and water depth, but decreasing densities of graminoids and forbs (Table 3). PC2 accounted for 18% of the variation in the data and was related to the number of graminoid hits in the 1-30 cm height interval, to the number of phanerophyte hits in the 31-60 cm and 61-100 cm height intervals, and to phanerophyte density. Yellow rails and sharp-tailed sparrows occurred in wet areas with higher vegetation than upland sandpipers (Table 2 and 3, Figure 2). The habitats of the sharp-tailed sparrow and yellow rail overlapped (Figure 2) according to the first two principal components. Both species occurred in areas with similar vegetation height, ground cover, and water depth relative to the upland sandpiper.

Discriminant function 1 (DF 1) was related with overall vegetation height and primarily discriminated habitats occupied by the upland sandpiper from those of the yellow rail and sharp-tailed sparrow ($P < 0.001$, Table 4). The upland sandpiper was found in areas of low vegetation (mean = 0.8 m) while the yellow rail (mean = 1.3 m) and sharp-tailed sparrow (mean = 1.2 m) in areas of high vegetation. DF 2 primarily separated the habitats occupied by the yellow rail from those of the sharp-tailed sparrow (Table 4, Figure 3). The main discriminating variable was phanerophyte density where the yellow rail was found in areas with a high density (median = 39 stems/0.0025 ha) and the sharp-tailed sparrow in areas with low densities (median = 0.1 stems/0.0025 ha). Pair-wise DFA's showed that habitats where each species was located were different from one another ($P < 0.001$) (Table 4, Figure 3).

Predominant forb species in yellow rail and sharp-tailed sparrow habitats were species common in hydric habitats (e.g., *Sparganium* spp., *Sagittaria* spp., *Caltha palustris*) and mints (Labiaceae family). In contrast, the major forbs in upland sandpiper habitats were bedstraw (*Galium* spp.), goldenrod (*Solidago* spp.) and clover (*Trifolium* spp.) (Table 5). Cattails occurred only in yellow rail territories. The predominant phanerophyte species in upland sandpiper and sharp-tailed sparrow habitats were willows (Salix spp.) (Table 5).

Although the sample size was small with the visual method, the comparative results of the PCA and DFA to the more detailed data set were striking. For example, with the PCA, the variation in species habitats can be explained with essentially the same variables as in the PCA of the detailed data set. The species centroids were distributed along PC1 and PC2 in the same relative position with both data sets (Figure 2). Similarly, the DFA of the visual data give results that agree with the more detailed method (Figure 3).

DISCUSSION

Among the ultimate goals of management for wildlife species of special concern is to (1) predict whether an area is suitable habitat for a species, or (2) identify what habitat characteristics are lacking in an area that would otherwise be satisfactory breeding habitat for a species. Here we pursued these goals by using two multivariate statistical techniques that address distinct aspects of these problems. Principal component analysis illustrates how the habitat characteristics are interrelated, (e.g., if shrub density increases then how does the density of graminoids or forbs vary with shrub density?). In contrast, discriminant function analysis identifies what territorial habitat characteristics of the three species are different. More importantly, the analysis allows us to classify a vegetation sample in regards to its probability of belonging to the territories of one of the species. Together these two statistical methods are powerful techniques to objectively elucidate the habitat requirements for bird species.

Yellow rails and sharp-tailed sparrows were found in similar kinds of habitats, but each was distinct when compared to one another. This suggests that the species probably can co-occur when the specific habitat requirements for each species are satisfied within an area. In contrast, it is unlikely that the upland sandpiper would be found in the same habitats as the yellow rail or sharp-tailed sparrow because of the differences in habitat characteristics where this species was found.

In lieu of the relatively small number of territories analyzed here, we regard these results as preliminary. How the habitat data would vary in different parts of the state or how results could vary over the season or in different years are largely unknown. However, despite the small sample sizes, these results are intuitively encouraging and larger sample sizes would furthur substantiate (1) the necessary habitat characteristics within the territories of these species and (2) to what extent can these characteristics vary within a species territory. For example, the density of phanerophytes (shrubs and mostly _Typha_) was the primary difference between the territories of the yellow rail and sharp-tailed sparrow (Table 3). It is questionable whether yellow rails use these phanerophytes, but their presence may be indicative of the overall conditions found within the species habitat. The phanerophytes are among the most visible elements within the habitats of the yellow rail and may be important from a psychological perspective in their initial habitat selection (e.g., see Lack 1933, Hilden 1964, James 1971). In contrast, phanerophyte density was low within sharp-tailed sparrow territories. A sampling of more sharp-tailed sparrow territories may reveal whether this species is intolerant of phanerophytes within its territories.

Our brief experimentation with the rapid visual approach to habitat assessment was encouraging. Comparisons with the more detailed method using the same statistical techniques revealed very similar interpretations. How sensitive this technique is to subtle differences in habitat characteristics between species and how precise it is to the collection of habitat data by different observers is unknown. However, because the method allows the rapid collection of data for one territory and allows the collection of data during the sensitive nesting period, it should receive a careful and thorough evaluation.

LITERATURE CITED

Haila, Y., O. Järvinen, and R.A. Väisänen. 1980. Habitat distribution and species associations of land bird populations on the Aland Islands, SW Finland. Ann. Zool. Fennici 17: 87-106.

Hildén, O. 1965. Habitat selection in birds. Ann. Zool. Fennici 2: 53-57.

James, F.C. 1971. Ordinations of habitat relationships among breeding birds. Wilson Bull. 83: 215-236.

Lack, D. 1933. Habitat selection in birds: with special reference to the efects of afforestation on the Breckland avifauna. J. Anim. Ecol. 2: 239-262.

Minnesota Department of Natural Resources. 1983. Plan for the management of nongame wildlife in Minnesota. MN DNR review draft. Vol. 2 - resource assessment.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. Wiley and Sons, NY.

Nie, N.H., C.H. Hull, J.G. Jenkins, K. Steinbrenner, and D.H. Brent. 1975. SPSS: Statistical package for the social sciences. McGraw-Hill, New York.

Niemi, G.J., J.M. Hanowski, J. Koukki, and A. Rajasärkkä. 1984. Inter-continental comparisons of habitat structure as related to bird distribution in peatlands of eastern Finland and northern Minnesota, USA. In C.H. Fuchsman (ed.). Proceedings of the 1983 International Peat Symposium. Bemidji, MN.

Searle, R.N. and M.E. Heitlinger. 1980. Prairies, woods and islands. A guide to the Minnesota preserves of The Nature Conservancy. The Nature Conservancy MN Chapter pub.

Wiens, J.A. 1969. An approach to the study of the ecological relationships among grassland birds. Ornithol. Monogr. 8.

Wiens, J.A. and J.T. Rotenberry. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecol. Monogr. 51: 21-41.

Table 1. Locations of species territories for the three species analyzed here, plus observation locations for two classified endangered species in Minnesota.

Species	Location
Yellow rail	Aitkin Co. NW 1/4 Sec 32 T48N R23W
	Aitkin Co. NW 1/4 Sec 5 T47N R23W
	Marshall Co. SW 1/4 Sec 21 T156N R41W
	Marshall Co. SE 1/4 Sec 20 T156N R41W
Upland sandpiper	Clay Co. NE 1/4 Sec 5 T141N R45W
	Clay Co. SE 1/4 Sec 5 T141N R45W
	Clay Co. SE 1/4 Sec 5 T141N R45W
	Mahnomen Co. SE 1/4 Sec 6 T145N R41W
Sharp-tailed sparrow	Aitkin Co. NW 1/4 Sec 32 T 48N R23W
	Aitkin Co. SW 1/4 Sec 32 T 48N R23W
	Marshall Co. SE 1/4 Sec 20 T156N R41W
	Marshall Co. SW 1/4 Sec 20 T156N R41W
Sprague's pipit	Clay Co. SW 1/4 Sec 5 T141N R45W
Chestnut-collared longspur	Clay Co. NE 1/4 Sec 5 T141N R45W
	Clay Co. NE 1/4 Sec 19 T141N R45W

Table 2. Sample size and mean (or median) for habitat variables of the three bird species.

Habitat variable		Yellow rail	Sharp-tailed sparrow	Upland sandpiper
N		41	40	40
Overall height (m)		1.3	1.2	0.8
Vegetation height (cm)		130	111	79
Ground cover (%)		15	14	35
Water depth (cm)		7.5	7.7	0
Phanerophyte height (cm)		95	45	24
Graminoid hits	0-30 cm	16	19	27
	31-60 cm	14	16	6
	61-100 cm	11	9	0
Forb hits	0-30 cm	0.5	0.4	6
	31-60 cm	0.1	0.2	0.4
	61-100 cm	0.5	0	0.1
Phanerophyte hits	0-30 cm	0.5	0	0
	31-60 cm	1.0	0	0
	61-100 cm	1.7	0	0
Graminoid density* (stems/0.0001 ha)		219	148	1321
Forb density* (stems/0.0001 ha)		9	0.1	157
Phanerophyte density* (stems/0.0025 ha)		39	0.1	0.1

*medians

Table 3. Correlation coefficients of the habitat variables with the first three principal components derived from the pooled habitat data for all three species.

Habitat variables		Principal components		
		1	2	3
Overall height		.788	.149	.144
Vegetation height		.594	.088	.108
Ground cover		-.666	.300	.300
Water depth		.765	-.113	-.389
Phanerophyte height		.599	.198	.052
Graminoid hits	1-30 cm	-.419	-.486	.519
	31-60 cm	.497	-.514	.256
	61-100 cm	.712	-.193	.126
Forb hits	0-30 cm	-.744	.366	-.241
	31-60 cm	-.616	.427	-.238
	61-100 cm	-.359	.316	-.298
Phanerophyte hits	0-30 cm	.363	.554	.337
	31-60 cm	.479	.689	.006
	61-100 cm	.491	.689	.113
Graminoid density		-.608	.079	.555
Forb density		-.706	.490	.138
Phanerophyte density		.539	.666	.205
Explained variation %		36.0	18.1	7.8
Accumulative variation %			54.1	61.9

Table 4. Standardized canonical discriminant function coefficients from the discriminant analysis (DFA) of all 3 species and each pair-wise species comparisons. Only those variables with coefficients > 0.2 were included for the respective discriminant function.

	All species		Yellow rail vs. Sharp-tailed sparrow	Yellow rail vs. Upland sandpiper	Sharp-tailed sparrow vs. Upland sandpiper
Habitat variable	DF1	DF2	DF1	DF1	DF1
Overall height	-.796	-.163	-	-	.825
Vegetation height	.441	.496	.259	.643	-.775
Ground cover	.571	.289	-	.777	-.693
Water depth	-.128	-.244	-.349	.354	.486
Graminoid hits (1-30 cm)	-	-	-	.289	.265
Graminoid hits (31-60 cm)	-.249	-.054	-	-	-
Graminoid hits (61-100 cm)	-.491	-.045	-	.663	.691
Forb hits (0-30 cm)	.339	.199	-	-.269	-.588
Forb hits (31-60 cm)	.045	-.255	-.229	-	-
Forb density	-	-	-	-	.813
Phanerophyte hits (0-30 cm)	.368	.029	-	-.410	.260
Phanerophyte height	-.315	.252	.388	.624	.464
Phanerophyte density	-.081	.843	.824	.238	-.204
Chi-square of Wilks lamda	291*	58*	46*	183*	174*
Variation explained	91	9	100	100	100

*$P < 0.001$

Table 5. Percent of forbs (A) and phanerophytes (B) within the territorial habitats of 3 species.

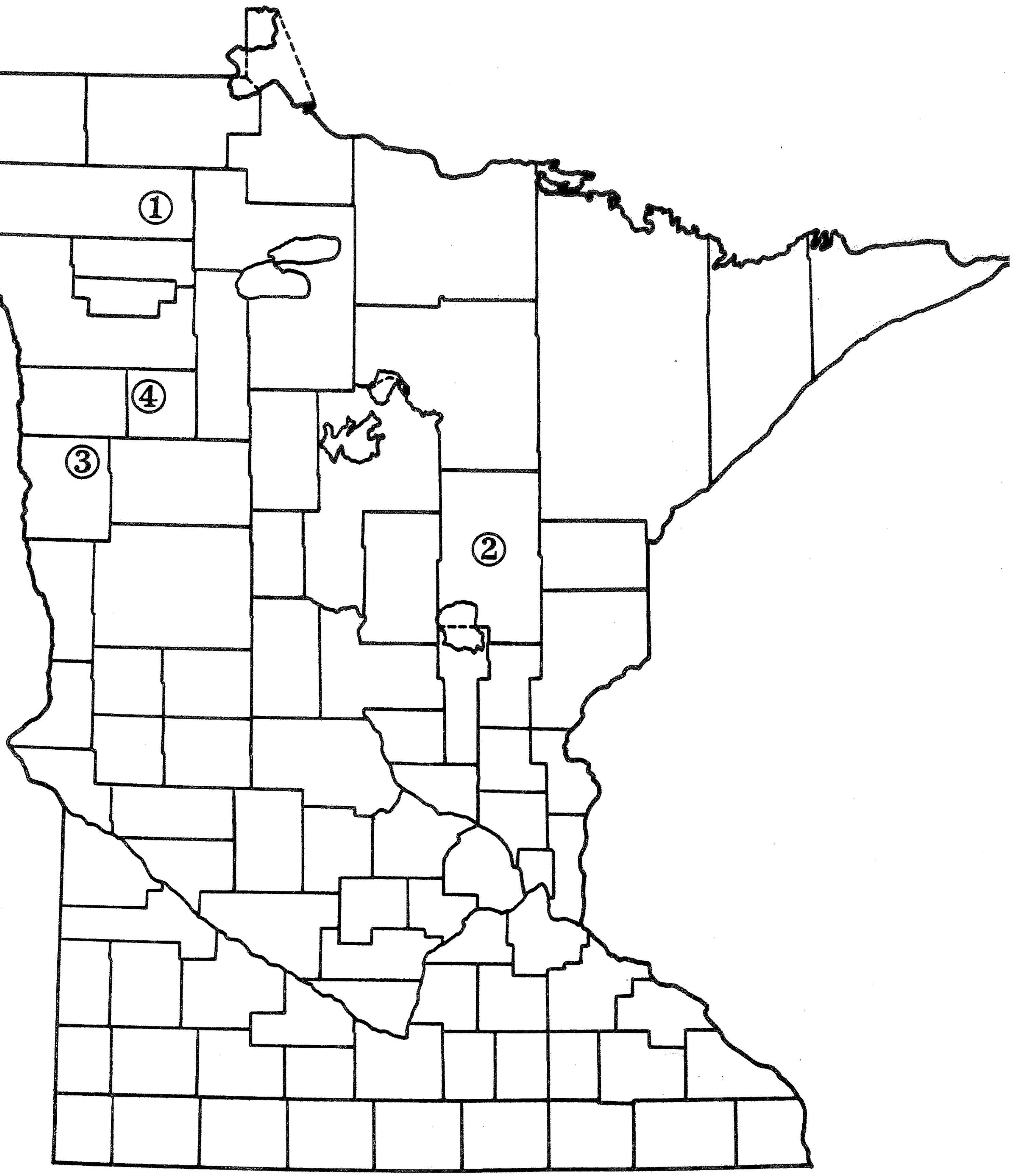
	Yellow rail	Sharp-tailed sparrow	Upland sandpiper
A. Forb species			
Sparganium spp.	-	10	-
Sagittaria spp.	11	-	-
Calla palustris	12	-	-
Smilicina spp.	-	-	1
Iris versicolor	-	1	-
Caltha palustris	2	-	-
Anemone spp.	-	-	1
Thalictrum spp.	-	-	1
Fragaria spp.	-	-	1
Potentilla palustris	-	1	-
Leguminosae Family	-	-	4
Trifolium spp.	-	1	22
Oxalis spp.	-	-	1
Umbelliferae Family	19	5	-
Zizea aurea	-	-	1
Lysmachia thyrsiflora	11	-	-
Polemoniacea Family	-	-	1
Labiacea Family	35	76	1
Galium spp.	6	1	28
Compositae Family	-	-	6
Solidago spp.	4	-	31
Cirsium spp.	-	5	1
B. Phanerophyte species			
Typha latifolia	74	-	-
Phragmites communis	-	6	-
Salix spp.	26	79	100
Populus tremuloides	-	15	-

FIGURE LEGEND

Figure 1. Location of four study areas in Minnesota.

Figure 2. Distribution of three bird species (YRAIL = yellow rail, USAND = upland sandpiper, and SHTSP = sharp-tailed sparrow) with the first two principal components for the detailed vegetation data (A) and the visual data (B).

Figure 3. Relationships of habitat structure between three bird species (YRAIL = yellow rail, USAND = upland sandpiper, SHTSP = sharp-tailed sparrow) according to the first two discriminant functions of all vegetation variables for the detailed vegetation data (A) and the visual data (B).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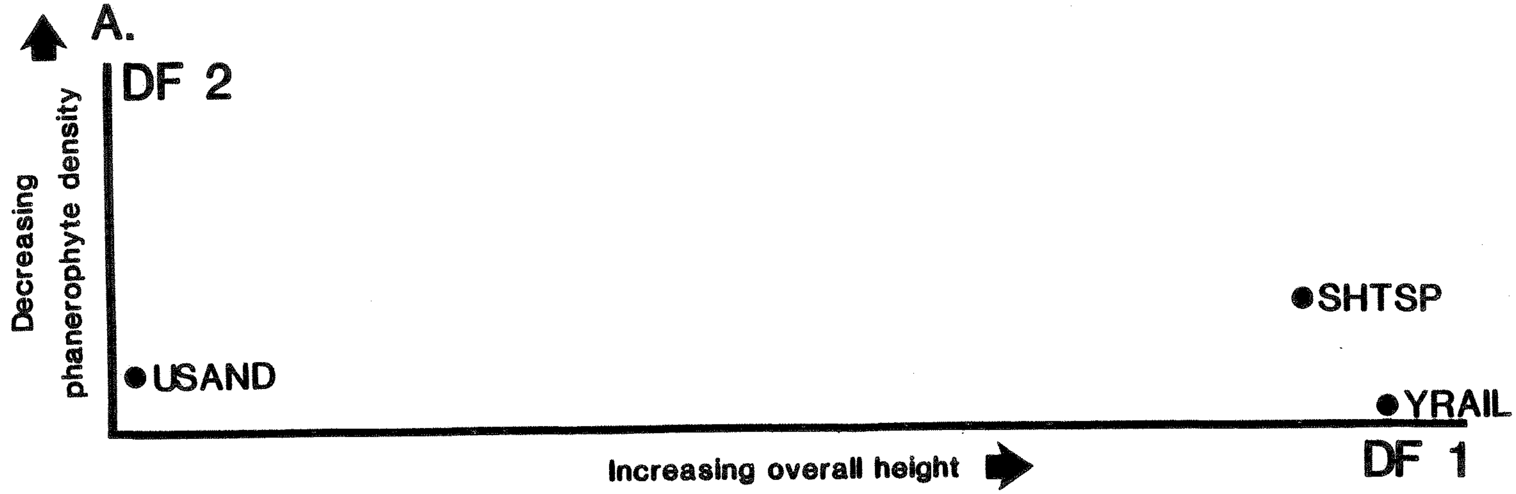
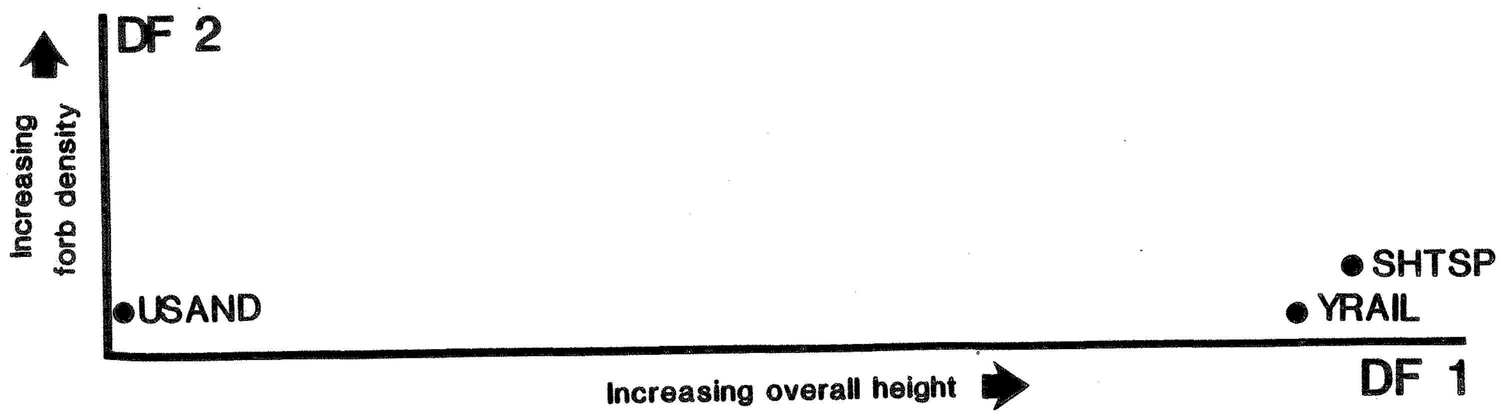
A.

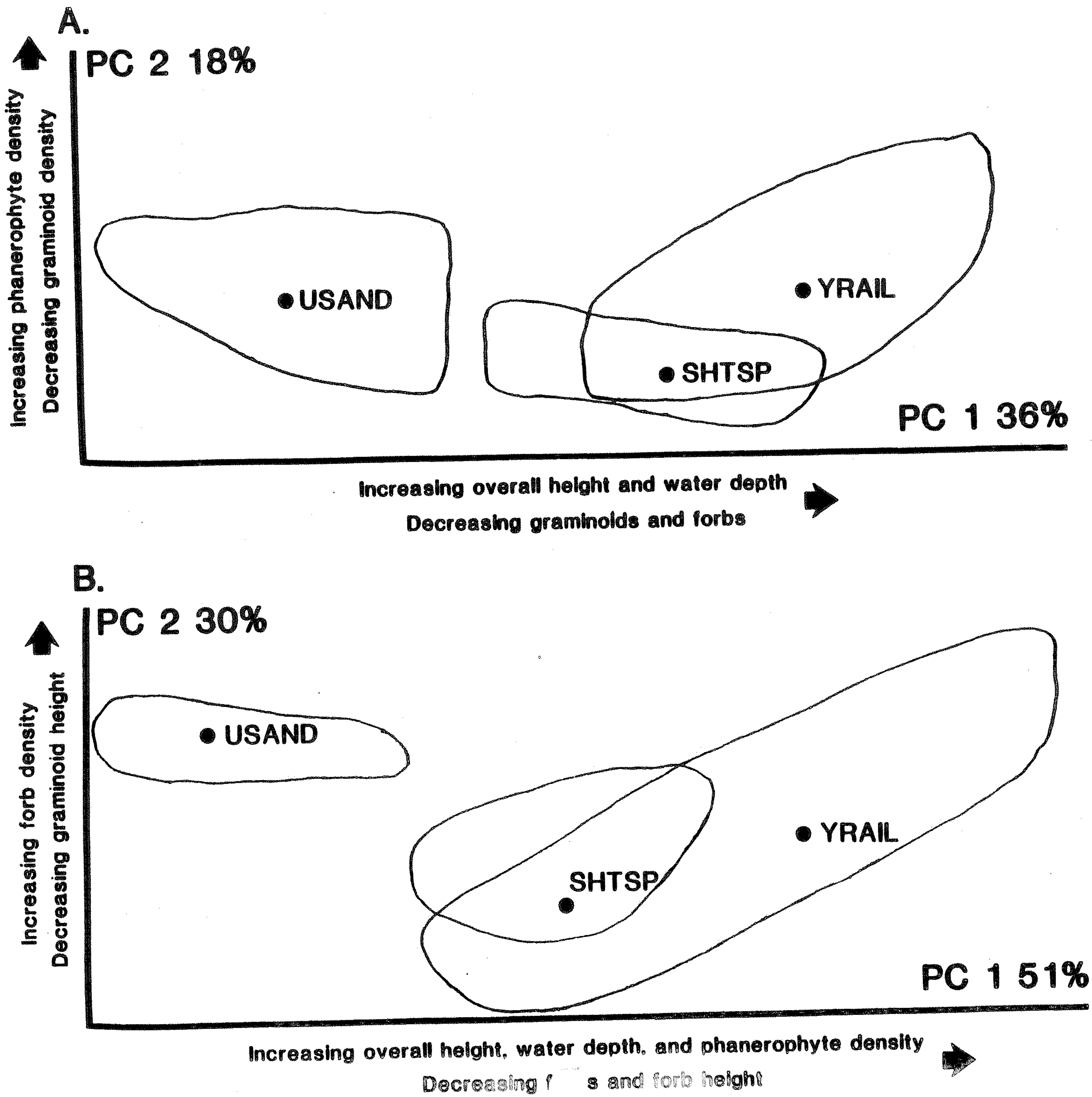


DF 2
Decreasing phanerophyte density
USAND
SHTSP
YRAIL
Increasing overall height
DF 1

B.



DF 2
Increasing forb density
USAND
SHTSP
YRAIL
Increasing overall height
DF 1


A.
PC 2 18%
Increasing phanerophyte density
Decreasing graminoid density
USAND
YRAIL
SHTSP
PC 1 36%
Increasing overall height and water depth
Decreasing graminoids and forbs
B.
PC 2 30%
Increasing forb density
Decreasing graminoid height
USAND
YRAIL
SHTSP
PC 1 51%
Increasing overall height, water depth, and phanerophyte density
Decreasing f s and forb height