VEGETATION OF BLUFF SPRINGS SAND PONDS

FINAL REPORT

ILLINOIS WILDLIFE PRESERVATION FUND SMALL PROJECT

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INTRODUCTION

Much of pre-settlement Illinois was covered by wet prairie, though large-scale drainage projects initiated over a century ago have removed 85% of the wetlands (Herget 1978, Suloway and Hubbell 1994, McClain 1997, Prince 1997). Given the topography, soils and meteorology of the region, and based on historical accounts of settlers (Prince 1997), a large, but unquantified, proportion of prairie wetlands were probably temporary ponds. Today, very few natural temporary ponds exist, and those that remain are more spatially isolated than the dense clusters of ponds that likely existed prior to settlement (Winsor 1987, Prince 1997), and are primarily relegated to soils that are relatively unsuitable for intensive agriculture.

Given the above, Bluff Springs Sand Ponds (BSSP) is an exceptional site. The privately-owned property is in Cass County, IL (NE1/4 Sec 34 T18N R11W), within the Illinois River Sand Areas Division. The site contains 14 temporary ponds with varying hydroperiods and interconnections, depending on pond location, annual precipitation, and morphometry. Four of the 14 ponds are isolated from all other ponds by topography: 10 ponds are formed in shallow depressions within generally-level terrain. Those 10 ponds are isolated in drier years (e.g., 1997), while in wetter years (e.g., 1998), the 10 ponds may be more appropriately described as slightly deeper areas within a shallow swamp. However, slight elevation differences within the site form complex patterns of flooding and hydroperiod among the ponds. Most ponds dry completely by mid-summer, though one pond can have a hydroperiod > 1 year, given sufficient precipitation (D. Jenkins, personal observations).

The ponds are isolated from other surface waters by an encircling dune of Bloomfield fine sand, and ponds are located on either Bloomfield or Orio sandy loam soils within the dune, depending on location (Calsyn, Black and Witt, 1989). The sand dunes of the region were blown out of the Illinois River valley after retreat of Woodfordian glaciers circa 10-12,000 years ago, and according to Willman and Frye (1970), "the dunes were formed soon after the sand was exposed to wind action, and most of them have long been stabilized in their present positions." Assuming that this statement describes the BSSP site, the present configuration of temporary wetlands has probably existed for a long time.

Little detail can been determined about the vegetation history of the site prior to 1950. The property was used for cattle grazing until the 1950's (K. Fiedler, pers. communication). River birch (*Betula nigra*) was present during that period, but the vegetation was likely more open, given the grazing pressure, use of birch trees for construction of corn cribs, and the irises that were once common on the site (K. Fiedler, pers. communication). Since the 1950s, the site was permitted to undergo successional change to the forest that now dominates.

The complex effects of topography, soil type, interannual variation in precipitation, and interspecific interactions yields a mosaic of vegetation patterns within the site. As part of an ongoing study of the ponds, we collected vegetation data in and surrounding the ponds. Uhlarik et al. (1990) studied the site in 1988, as part of a comparison of river birch stands, and quantified 5 tree species within the site: *Betula nigra*, *Acer saccharinum*, *Ulmus americana*, *Sassafras albidum*, and *Prunus serotina*. They found the stand to be dominated by *B. nigra* in terms of density, basal area, and importance value, but found no *B. nigra* seedlings or saplings, suggesting eventual successional replacement of *B. nigra* by *A. saccharinum* and *U. americana*.

The purpose of our study was to further evaluate the vegetation in the BSSP, specifically to:

(A) extend the study by Uhlarik et al. (1990) to include species not previously reported within the site; (B) compare vegetation within ponds to vegetation in surrounding areas of varying hydric status; and (C) compare our results on size classes to those collected a decade earlier by Uhlarik et al. (1990).

METHODS AND MATERIALS

Samples consisted of 57 circular plots with 5 m radius (0.4477 ha total area sampled). A 5-meter radius was selected as approximating the radius of the smallest pond: a larger plot would sample vegetation outside of the pond, and confound pattern detection, while a smaller plot was considered likely to under-represent vegetation. Plots were placed in the approximate center of ponds, and generally at 4 additional plots beyond the boundaries of the pond (e.g., North, South, East, West). In some cases (e.g., a pond near the forest edge), an additional plot was omitted. General locations of plots were intentional, but precise locations were determined by a blind throw of a marker in the intended direction. All live trees > 1.5 m height and within a 5 m radius of the stake were identified, counted, and measured for diameter at breast height (DBH). In addition, all shrubs within the 5 m radius were enumerated.

Much of the forest was flooded during 1998. Some plots were within flooded areas, while others were near the high water line, and others were above high water. Plots were classified for hydric status, as follows: Center = at pond center; Flooded = inundated, all of plot below high water line; Line = plot transected by high water line; and Dry = all of plot above high water line. Data were analyzed for all plots and for hydric classes as described below.

Densities (stems/ha), relative densities (RD), basal areas (m^2/ha), relative coverage (RC), and importance value (IV = RD + RC) were calculated for tree species as described by Uhlarik et al. (1990). The preceding values were calculated for three hierarchical sets of data: (A) tree species (all size classes combined, all plots), for an overall analysis; (B) tree species (all size classes combined, by hydric class); and (C) tree species by size classes: seedlings < 2.5 cm DBH; saplings 2.5 - 10.0 cm DBH; and trees: >10.0 cm DBH. The same size classes were used by Uhlarik et al. (1990). We also analyzed shrub densities among hydric classes: Uhlarik et al. (1990) did not report shrub data.

RESULTS

A total of 57 plots were quantified, including 1,182 trees and 576 shrubs. Seventeen tree species and 7 shrub species were identified (Table 1). Three tree species dominated the forest: *A. saccharinum, B. nigra,* and *U. rubra* (Figure 1). All other species were relatively minor in importance, and include upland species that were primarily restricted to drier plots. *A. saccharinum* dominated overall (all plots, all size classes combined) density, followed by *U. rubra*, and *B. nigra. However, B. nigra* dominated overall basal area, followed by *A. saccharinum* and *U. rubra* (Figure 1). The fewer *B. nigra* trees are substantially larger than the more numerous *A. saccharinum* and *U. rubra*.

A gradient in tree composition corresponded to the hydric class gradient (Figure 2). The three dominant tree species (*A. saccharinum, B. nigra,* and *U. rubra*) were the only species recorded in pond centers, and strongly dominated flooded forest areas. *Betula nigra* density was similarly low in pond centers and flooded forest (297 and 376 stems/ha, respectively), increased strongly at high water line (932 stems/ha), and decreased again slightly at drier plots (550 stems/ha; Figure 2). The transition for *A. saccharinum* density from ponds and flooded forest (1909 and 1568 stems/ha, respectively) across high water line (466 stems/ha) to drier plots (409 stems/ha) was important to forest composition, as was the rapid increase in density of other trees (especially *Quercus* sp.) near and above high water line (Figure 2).

A hydric gradient in tree basal area also existed, though of a different pattern among species (Figure 2). Basal area of *A. saccharinum* was nearly constant among pond centers, flooded forest, and high water line plots, despite the decrease in density. *Betula nigra* and *U. rubra* basal areas were greatest at high water line (Figure 2). Also, other, upland species (*Quercus* sp., *Cornus drummondi*, etc.) were less important in basal area as in density at dry plots, showing that most of those trees were relatively small.

Size distributions of dominant trees in the 4 hydric classes reveals reasons for the differing gradient patterns of density and basal area. *A. saccharinum* in pond centers, flooded forest, and dry plots were generally small in size, but larger trees tended to be located at high water line (Figure 3), thus compensating for lower density in basal area estimates. Unlike the distributions for *A. saccharinum* and *U. rubra*, few small *Betula nigra* trees were present, and trees tended to be larger in all hydric classes (Figure 3). This tendency was especially strong at high water line, causing a greater basal area estimate there (Figure 2). *Ulmus rubra* was consistently small in size across all hydric classes (Figure 3).

Shrubs were over 3X more dense at high water line than in other hydric classes, and species generally had more narrow distributions across hydric classes than the dominant tree species

(Figure 4). *Cephalanthus occidentalis* dominated pond centers and flooded forest floor, but did so at relatively low density, and was negligible at and above high water line. High water line was generally indicated by the presence of abundant *Rubus* and *Rosa multiflora* (typically distributed just above high water); these 2 shrubs also dominated at dry sites, although at much lower density (Figure 4).

Changes in vegetation between 1988 and 1998 are presented in Table 2. All species (except *B. nigra*) exhibited a decrease in seedling density between 1988 and 1998. Ulmus rubra seedlings remained relatively numerous but experienced an 88% decrease in density (Table 2). The detection of *B. nigra* seedlings is an effect of differences in sampling design (see Discussion below): *B. nigra* seedling density may be considered equivalent, and very low, in 1988 and 1998. Also showing declines in sapling density were *Sassafras albidum* and *Prunus serotina.*

Despite declines in seedling density, species exhibited varying trends in sapling density (Table 2). *Betula nigra* saplings remained sparse, while *A. saccharinum* sapling density decreased by 60%, and *U. rubra* sapling density increased by 85%. Clearly, saplings of these species respond differently to conditions in the site. We should note that *A. saccharinum* continues to be important in sapling composition, despite the decrease in sapling density since 1988 (Table 2). We observed saplings of *Sassafras albidum* and *Prunus serotina* (none observed in 1988), but at less density than *B. nigra.*

Betula nigra continues to dominate trees (> 10.0 cm DBH) in both density and size. However, the dominance of *B. nigra* over *A. saccharinum* and *U. rubra* trees has been reduced by a loss of *B. nigra* and increases of *A. saccharinum* and *U. rubra.* The trend in tree composition reflects the continued poor recruitment of *B. nigra*, while *A. saccharinum* and *U.*

rubra have continued seedling and sapling production. Also, *A. saccharinum* surpassed *B. nigra* in average DBH during the 10 years between studies, indicating greater growth rates and/or less mortality of mature *A. saccharinum* trees. Finally, a few *Sassafras albidum* and *Prunus serotina* trees were recorded (unlike in 1988).

DISCUSSION

The forested wetland of Bluff Springs Sand Ponds is relatively simple in composition, being heavily dominated by three tree species and one shrub: other species are mostly restricted to high water line or drier sites. The vegetation is arrayed in a gradient across hydric classes, and so serves as an indicator of the location of ponds and high water line within the forest.

Vegetation reflected the longer hydroperiod of pond centers (compared to flooded forest) by having greater densities of button bush (*C. occidentalis*), and lower *U. rubra* density. Moving from flooded areas to high water line was clearly indicated by reduced silver maple (*A. saccharinum*) density, greater density and size of river birch (*B. nigra*), the presence of small upland tree species (e.g., *Quercus* sp.), and the profusion of blackberry (*Rubus* sp.) and multiflora rose (*Rosa multiflora*).

Any comparison of results between studies must be sensitive to the effect that different methods (and goals) may have on outcomes. Our study purposefully sampled areas excluded by Uhlarik et al. (1990) as being beyond the *B. nigra* stand (what they considered an edge effect) because we were interested in the distribution of species within the forest, relative to highest observed water line. In addition, our plots were located in and around ponds, while Uhlarik et al.

(1990) sampled the entire forest. Finally, sampled areas differed between studies. Uhlarik et al. (1990) used 25 m^2 quadrats to collect tree data, with two circular plots located randomly within each quadrat to collect seedling (0.0001 ha) and sapling (0.01 ha) data. Uhlarik et al. (1990) used an unstated number of multiple quadrats to "completely survey the entire forest, leaving at least a 10 m buffer strip around the perimeter to eliminate edge effects." Given that Uhlarik et al. (1990) estimated the BSSP site to be about 1.5 ha, and that a 10 m buffer size would correspond to 0.448 ha, they would have sampled $\leq$ 1.05 ha for trees, or about 17 quadrats. Corresponding areas sampled for seedlings and saplings would be about 0.0017 and 0.17 ha, respectively. By comparison, our method surveyed seedlings, saplings and trees in fifty-seven 0.00785 ha plots (total area sampled = 0.4477 ha).

Therefore, we sampled trees in < ½ the total area sampled by Uhlarik et al. (1990), but we sampled over 260-fold more area for seedlings, and 2.63 times more area for saplings. Given differences in sampling methods, it is not surprising that we detected seedlings and/or saplings of *B. nigra*, *S. albidum*, and *P. serotina* while Uhlarik et al. (1990) did not: we sampled more widely for those size classes. Consequently, minor increases between 1988 and 1998 in seedling and sapling density should not be interpreted as indicating important changes. However, substantial declines over the decade are important, given the greater sample size in 1998. Likewise, the fact that tree density changes between 1988 - 1998 were not consistently up or down across the dominant species suggests that study design differences did not consistently bias tree results.

The marked dominance of *A. saccharinum, B. nigra,* and *U. rubra* is due to the pond-focused approach we used in sampling, and the consequent emphasis on vegetation in and near those ponds that can withstand hydric conditions. However, our pond-based focus is consistent with the focus of Uhlarik et al. (1990) on the river birch stand. At the same time, our study purposely included species outside the "river birch stand" studied by Uhlarik et al. (1990), because we wished to characterize the vegetation distribution within the forest.

The "river birch stand" of 1988 (Uhlarik et al. 1990) continues its successional transition toward a forest dominated by silver maple and slippery elm. *Betula nigra* remained recruitment-limited in 1998; trees are slowly dying off without replacement, and surviving trees have grown modestly. *Acer saccharinum* is establishing itself as the dominant tree by virtue of its strong recruitment and survival in this forested wetland: its seedlings and saplings have declined in density during the decade, but continue to recruit more vigorously than most other species, and *Acer saccharinum* trees are larger and more dense than 10 years prior to our study. *Ulmus rubra* recruitment was far better in 1988 than in 1998, but the large seedling density of 1988 has translated to current dominance in the saplings and likely future importance in the canopy. However, *U. rubra* does not appear capable of sustained high recruitment in the site, and *U. rubra* trees have grown only slightly compared to *A. saccharinum*, indicating that the rising importance of *U. rubra* will likely be brief.

In another ten years, the "river birch stand" will be better described as a "silver maple stand." The forest of 1998 may be nearly described that way, especially if one is to consider seedlings and saplings. The hydric gradient observed in our study will likely persist, even after river birch (*B. nigra*) are largely replaced by silver maple (*A. saccharinum*) and slippery elm (*U. rubra*). River birch are especially dominant at high water line, and it is likely that the transition from flooded forest to high water line will be indicated in the future by a shift from *A. saccharinum* to *U. rubra* dominance. Assuming that this shift in canopy species does not severely affect shrubs, *Rubus* sp.

and *Rosa multiflora* will likely continue to denote high water line, and pond centers will continue to be indicated by high *C. occidentalis* density.

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Table 1. Species list for Bluff Springs Sand Ponds, 1998.

Trees	Shrubs
Acer saccharinum	*Cephalanthus occidentalis*
Betula nigra	*Corylus americana*
Carya cordiformis	*Forsythia sp.*
Carya illinoensis	*Lonicera*
Carya ovata	*Ribes sp.*
Carya texana	*Rosa multiflora*
Cornus drummondi	*Rubus sp.*
Cornus florida	
Diospyros virginiana	
Prunus serotina	
Quercus alba	
Quercus imbricaria	
Quercus velutina	
Robinia pseudoacacia	
Salix alba	
Sassafras albidus	
Ulmus rubra *	

* Identified as *Ulmus americana* by Uhlarik et al. (1990). We identified trees as *Ulmus rubra* based on Mohlenbrock (1990), and considered the two equivalent for comparisons of 1988 and 1998 data.

Table 2. Comparison of decadal changes in dominant vegetation of Bluff Springs Sand Ponds. 1988 data are from Table 1 of Uhlarik et al. (1990), and 1998 data are from this study.

	Seedlings Density (#/ha)		Saplings Density (#/ha)		Trees Density (#/ha)		Total Density (#/ha)		Trees Basal Area (m2/ha)		Trees I.V.		Trees Avg. Dia. (cm)	
Species	1988	1998	1988	1998	1988	1998	1988	1998	1988	1998	1988	1998	1988	1998
Betula nigra	0	9	0	64	461	391	461	465	17.8	22.0	160.4	105.4	20.7	24.4
Acer saccharinum	750	493	869	348	143	225	1762	1067	2.8	15.8	36.7	68.3	14.5	25.4
Ulmus rubra	1438	177	219	406	12	118	1669	701	0.2	2.3	2.9	21.1	13.0	14.7
Sassafras albidum	188	39	0	38	0	2	188	79	0	0.0	0	0.4	0	11.4
Prunus serotina	63	18	0	7	0	5	63	30	0	0.1	0	0.8	0	16.3

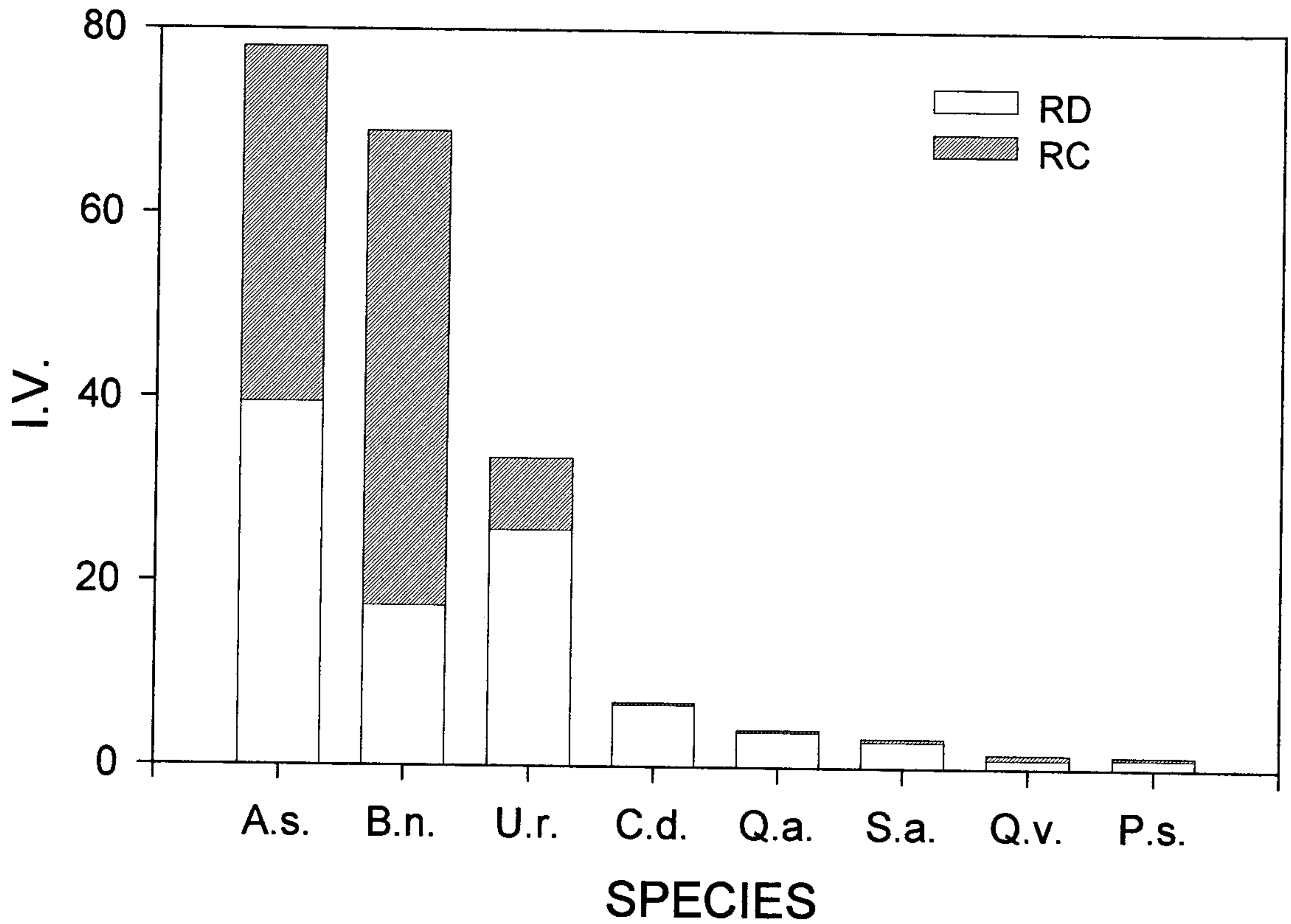
LIST OF FIGURE CAPTIONS

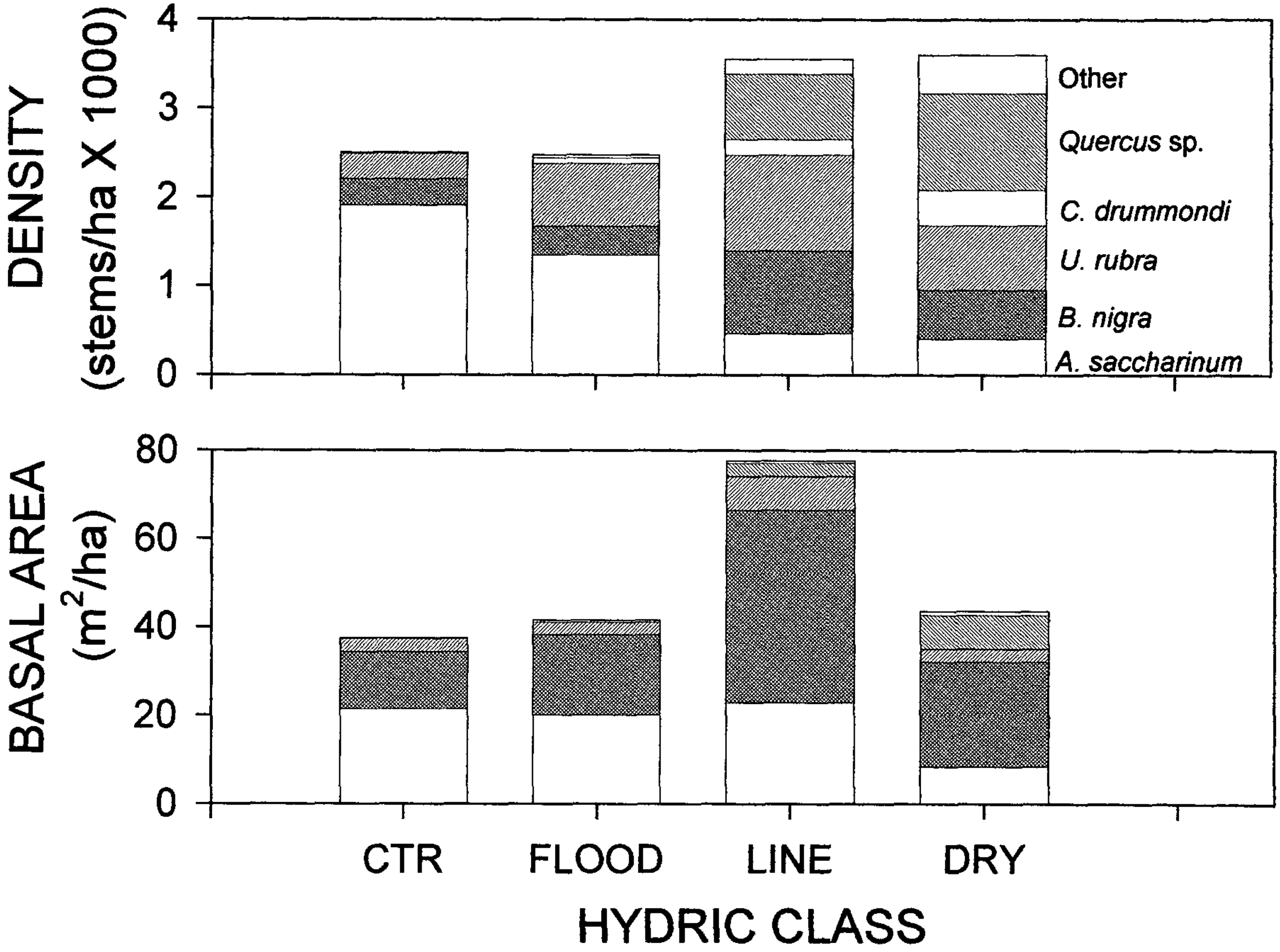
Figure 1. Overall Importance Values (I.V.) for dominant tree species. Data shown include seedling, sapling and tree size classes for all plots in the study area. RD = Relative Density, RC = Relative Coverage, and I.V. = RD + RC, per Uhlarik et al. (1990). A.s. = *Acer saccharinum*; B.n. = *Betula nigra*; U.r. = *Ulmus rubra*; C.d. = *Cornus drummondi*; Q.a. = *Quercus alba*; S.a. = *Sassafras albidum*; Q.v. = *Quercus velutina*; and P.s. = *Prunus serotina*.

Figure 2. Density and basal area of dominant tree species, across the hydric gradient. Taxonomic labels are in the same order in both graphs (*C. drummondi* had negligible basal area, and so appears missing in the bottom graph).

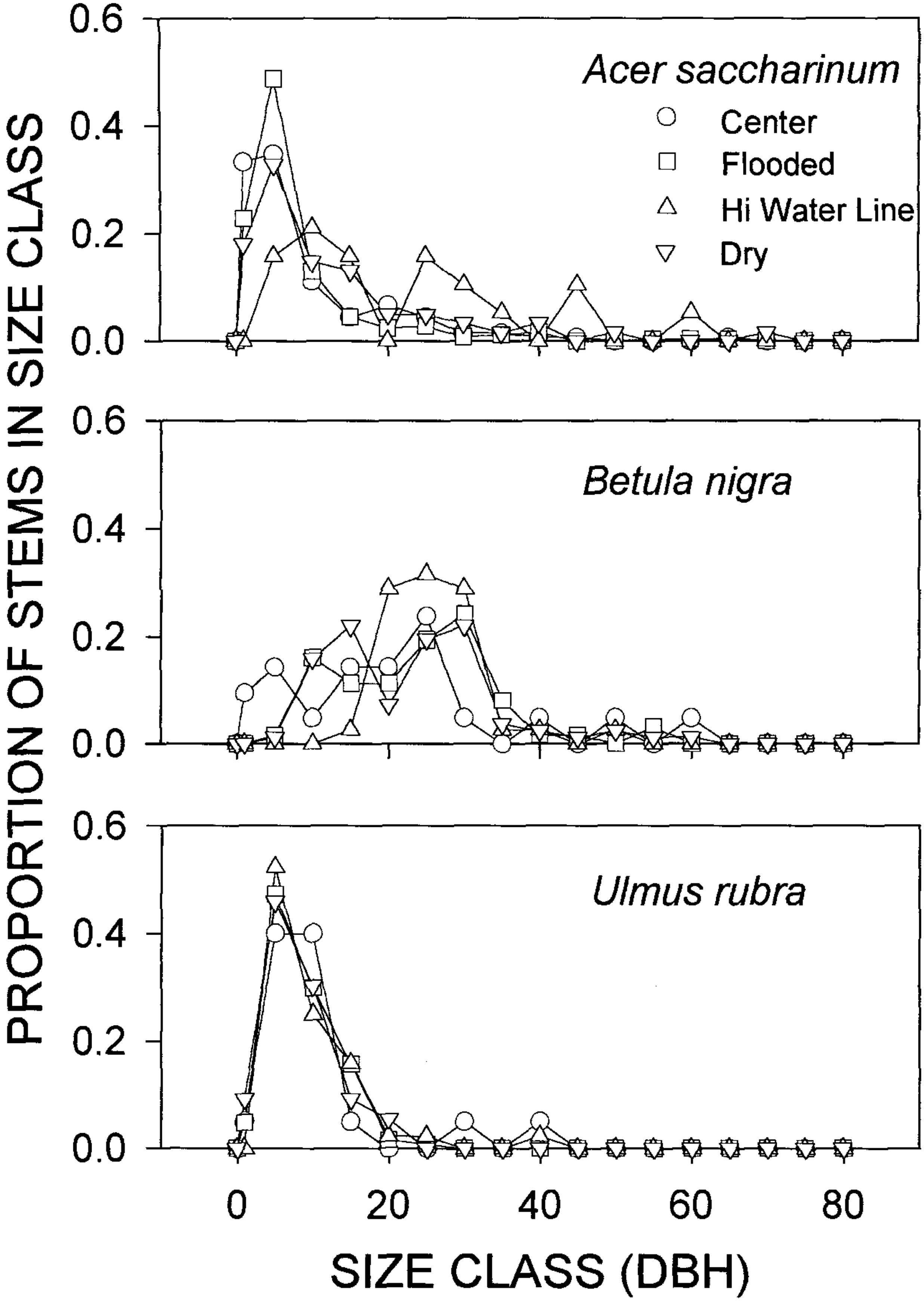
Figure 3. Size distributions of the three most dominant tree species, among hydric classes. Symbols shown for *A. saccharinum* hydric classes apply to *B. nigra* and *U. rubra* as well. Trivial occurrences of trees > 80 cm DBH were omitted for better presentation of distributions: the largest tree recorded was a 105 cm DBH *B. nigra*.

Figure 4. Shrub densities across the hydric gradient.

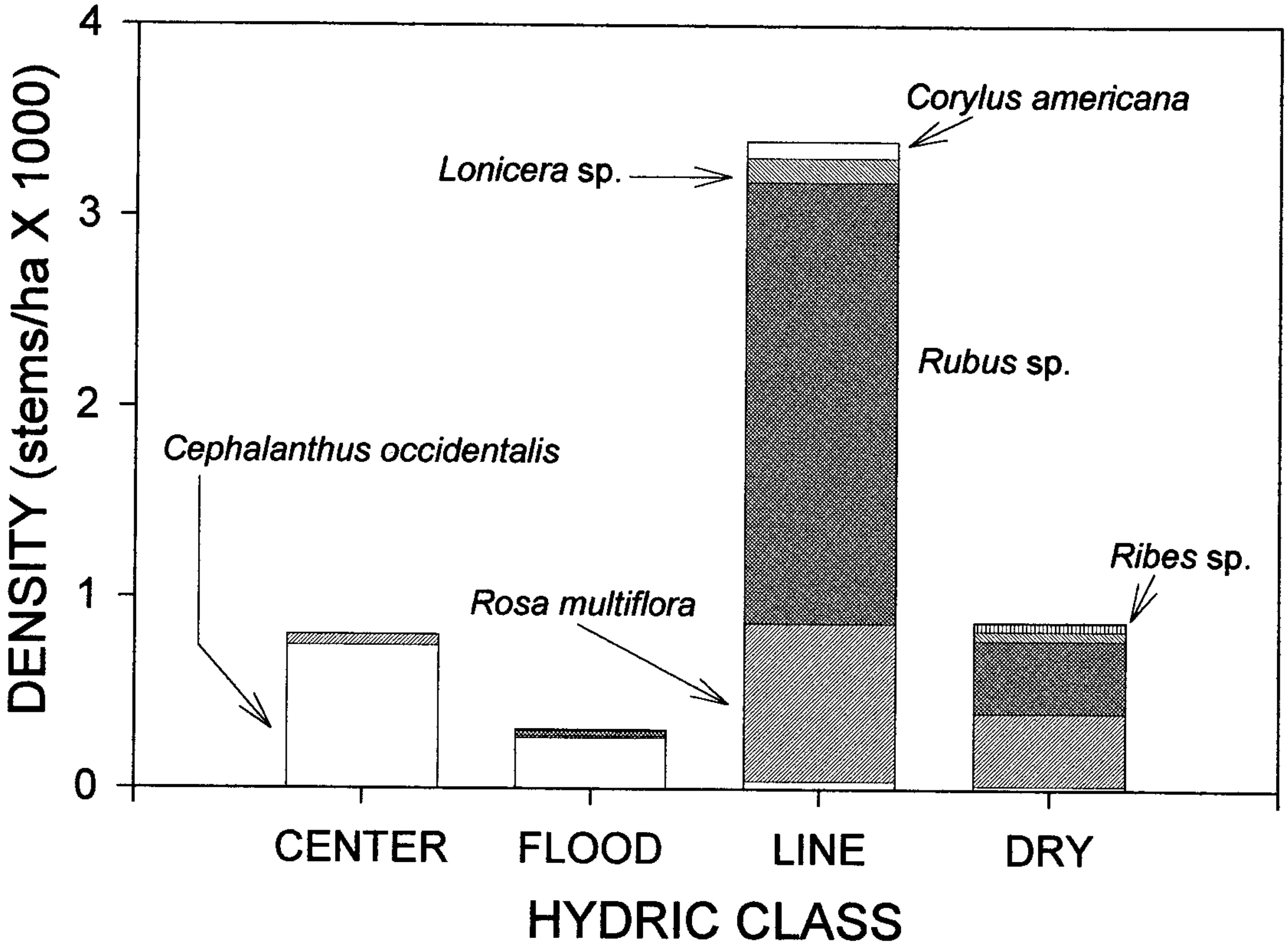

80
60
40
20
0
I.V.
RD
RC
A.s.
B.n.
U.r.
C.d.
Q.a.
S.a.
Q.v.
P.s.
SPECIES



DENSITY (stems/ha X 1000)
0
1
2
3
4
Other
Quercus sp.
C. drummondi
U. rubra
B. nigra
A. saccharinum
BASAL AREA (m2/ha)
0
20
40
60
80
CTR
FLOOD
LINE
DRY
HYDRIC CLASS



Acer saccharinum
Center
Flooded
Hi Water Line
Dry
Betula nigra
Ulmus rubra
PROPORTION OF STEMS IN SIZE CLASS
0.0
0.2
0.4
0.6
0
20
40
60
80
SIZE CLASS (DBH)


DENSITY (stems/ha X 1000)
0
1
2
3
4
Cephalanthus occidentalis
Rosa multiflora
Lonicera sp.
Corylus americana
Rubus sp.
Ribes sp.
CENTER
FLOOD
LINE
DRY
HYDRIC CLASS