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Characterization of Wetlands in the Conservation Reserve Enhancement Program in Illinois

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ABSTRACT

Farm Bill programs have been valuable tools for the restoration of wetland habitat on private lands in recent decades. Over 14,000 ha have been enrolled in the Conservation Reserve Enhancement Program's (CREP) wetland practices in Illinois alone. However, the amounts and types of wetland habitat resulting from these restorations efforts are not well documented. We surveyed a random sample of 33 CREP wetlands throughout central Illinois in 2004 and 2005 to determine the floristic, physical, hydrological, and spatial characteristics of sites representative of CREP in the Illinois River Basin. Twenty-eight of thirty-three (85%) sites achieved some degree of functional hydrology, but the area of wetland established on most of those (61%) was small (< 1 ha). Twenty-four percent of the total area enrolled in our sample qualified as wetland habitat. Among all functional sites, seasonal water regimes were the most prevalent. Many of our wetland study sites were overly dominated by upland cover. The wetland cover that was present was dominated by emergent habitat (91%), followed by forested (9%), and scrub-shrub (<1%) habitat. The mean floristic quality was relatively low among sites and varied little, with a mean C value across all sites of 4.06 ± 0.54 (mean ± SD). Neither hydrology nor wetland isolation had significant effects on floristic quality among sampled sites. We believe more time is needed for these wetlands to mature before spatial and hydrologic conditions begin to strongly affect floristic quality. However, we maintain that hydrologic management is vital for sustaining the hydroperiods necessary for establishment of wetland plant communities in restored CREP wetlands.

INTRODUCTION

Wetlands provide valuable environmental and ecological services. However, less than 10% of the presettlement wetland acreage in Illinois that once supported these services now remains (Suloway and Hubbell 1994). Conservation programs administered by the United States Department of Agriculture over the last three decades have provided a major tool for the restoration of former wetland habitat on private lands (Natl. Res. Counc. 1992). By coupling conservation initiatives with landowner incentives, CREP has been able to achieve large-scale restoration of natural areas on private lands to stabilize soil, improve water quality, and support wildlife (Allen 2005). Some 14,000 ha have been enrolled in wetland conservation practices throughout the Illinois River Basin since the program's inception in 1998 (State of Illinois 2004). While the objectives of CREP include improvements in both environmental conditions and wildlife habitat, most of the assessment of CREP, in Illinois and nationwide has been limited to soil, nutrient, and water quality variables (Lamont 2005; Wanhong et al. 2005; Demissie et al. 2001).

With tracts scattered throughout the Illinois River Basin, it is difficult for the administrating agencies to effectively describe and monitor all of the habitat being produced through these restorations. The characteristics of the habitat enrolled are only recorded according to arbitrary conservation practices (CP) rather than actual habitat restored (Allen 2005). Wetland habitat can develop as a product of any CP, including the planting of grass cover (CP 1 and 2) and hardwoods (CP 3), and the establishment of filter strips and buffers (CP 13, 21, 22, 30), but explicit wetland practices (CP 9, 23, and 31) are the typical avenues for intentional restoration of wetland habitat. CP 9 and 31 are lesser-used practices associated with shallow water areas for wildlife and bottomland hardwoods respectively. CP 23 is the most common of the three encompassing the general practices of wetland restoration, including emergent marshes and wet meadows (Allen 2005). Even though there are many different CPs to facilitate various restoration goals, the type of physical and floristic conditions produced within a single CP, such as CP 23, can vary greatly.

Wetlands that are successfully restored through programs such as CREP are largely defined by the dominant vegetative community that colonizes the site following hydrologic restoration (LaGrange and Dinsmore 1989, Sewell and Higgins 1991, Galatowitsch and van der Valk 1996, Brown 1999, Reaves and Croteau-Hartman 1994). The response of vegetation to hydrologic restoration varies according to basin size and morphology, local drainage patterns, and landscape context (Rossiter and Crawford 1986; Galatowitsch and van der Valk 1993, 1996, 1996*b*; Bedford 1999). Assessment of the vegetative community restored in CREP wetlands is an essential first step in the evaluation of the program's overall contribution to potential wildlife habitat.

Brown and Phillips (2004) conducted the first and only floristic survey of 100 representative CREP tracts in central Illinois in 2003. The floristic quality of these wetlands was found to be moderate to low compared to regional standards (Brown and Phillips 2004). Indices of habitat quality were positively correlated with area, but were not related to the other independent variables of age and connectivity (Brown and Phillips 2004). We revisited Brown and Phillips (2004) study sites to further characterize each unique wetland according to spatial, floral, and physical characteristics of macro- and microhabitats.

METHODS

Study Area

A random number generator was used in 2003 by Brown and Phillips (2004) to select 100 CREP wetland and riparian contracts from 1,213 contracts included in the Illinois Department of Natural Resources' Conservation Practices Tracking System in 2003. Each contract represented an individual enrollment in CREP, and described the legal and financial agreement between the USDA and the landowner. These contracts also described the conservation practice being applied to the particular tract, which had physical geographic boundaries, but may not have coincided with natural boundaries. The sampled database included contracts from Sangamon, Christian, Schuyler, Fulton, and Knox Counties. In 2004 we revisited the sample of 100 wetland and riparian contracts from the Brown and Phillips (2004) study to determine the number of discrete CP 23 wetlands within their 100 contracts. We identified 33 wetland restoration sites that constituted independent and entire CP 23 wetlands. This sample is small relative to the total number of sites across the watershed, but we believe it is representative of all the sites in the region. The 33 wetlands were palustrine habitats ranging in age from 3-6 years, with a history of either row crop production or pasturing prior to restoration. Sites were dispersed throughout the watersheds of the Illinois, LaMoine, Spoon, and Sangamon Rivers (Figure 1), and fell within the Western Forest-Prairie, Illinois River Bottomlands, and Grand Prairie natural divisions.

Floristic Data Collection

The flora of all 33 CREP wetlands were surveyed in the summer of 2003 using standard transect sampling techniques (Brown and Phillips 2004). Weighted indices such as the Floristic Quality Index (FQI) and its component the Mean Coefficient of Conservatism (mean C; Taft et al. 1997; Swink and Wilhelm 1979, 1994) have been found to be reliable indicators of wetland plant community integrity (Lopez and Fennessy 2002). A coefficient of conservatism is an integer ranging from 0 to 10 assigned a priori to each taxon in a regional flora that estimates the fidelity of a species to natural areas (Taft et al. 1997; Swink and Wilhelm 1979, 1994). Species with very low tolerances to disturbance and high fidelity to habitat integrity are assigned a coefficient near 10, while non-native and ruderal species that tolerate almost any disturbance and can be found in almost any type of habitat are assigned 0 or low values (Taft et al. 1997). To compare floristic quality across sites, we used the plant species list from each site to determine a mean C value for each wetland. Mean C is less strongly correlated with sampling date or area than FQI and provides a more robust indicator of relative site conservation value (Rooney and Rogers 2002; Lopez and Fennessy 2002; Matthews 2005). Each wetland also was surveyed in 2004 and 2005 to visually estimate areal coverage of herbaceous vegetation.

Habitat Data Collection

We visited each of the 33 sites weekly during the growing seasons of 2004 and 2005 to monitor fluctuations in hydrology and determine duration of inundation as an indicator of wetland status and hydrology modifier class (NRCS 1997; Cowardin et al. 1979). Semi-permanent wetlands were identified as those having surface water throughout the growing season in most years. Seasonal wetlands were those having surface water for extended periods in the growing season but not at the end of the growing season, and temporary wetlands were those with surface water for only brief periods during the growing season (Cowardin et al. 1979). We also recorded the degree of hydrologic manipulation present in each wetland. A wetland was given a hydrologic manipulation score of 1 if no initial or ongoing physical manipulations of the hydrology were detected, 2 if it was hydrologically engineered at the time of construction by some form of an excavated basin, a dozier valve, stoplog, berm, or levee, or 3 if ongoing management of water depth was detected. We tested the hypothesis that floristic quality of wetland vegetation at a site was related to hydrology by regressing mean C against our hydrologic manipulation scores.

Using National Agriculture Imagery Program color-infrared digital orthoimagery (USDA 2004), we delineated wetland boundaries based on hydrologic indicators and the relative presence of hydrophytic vegetation (Reed 1988). We classified these areas as emergent, scrub-shrub, or forested habitat as defined by Cowardin et al. (1979). Emergent wetlands were characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. Scrub-shrub wetlands included areas dominated by woody vegetation less than 6 m tall. Forested wetlands were characterized by woody vegetation ≥ 6 m tall (Cowardin et al. 1979).

Due to their previous use for intensive agriculture, our study areas were largely void of wetland flora prior to hydrologic restoration. Colonization by hydrophytes is dependent not only on germination of the dormant seed bank but also on wind, water, and animal-borne seed dispersal (Galatowitsch and van der Valk 1993). We tested the hypothesis that floristic quality at a site was influenced by the isolation of a site from potential seed sources by regressing mean C against the area of aquatic habitat within a 3-km buffer around the perimeter of each wetland (Fairbairn and Dinsmore 2001). We used National Wetlands Inventory data in ArcGIS 9.0 (United States Fish and Wildlife Service 1996; ESRI 2004) to quantify the areas of aquatic habitat within the buffers, and square-root transformed areal data to achieve a normal distribution.

RESULTS

CREP tracts ranged in size from 1.9 to 149.0 ha, with a median of 19.7 ha. Twenty-eight of the 33 tracts (85%) had functional hydrological regimes ranging from temporary to semi-permanent (Cowardin et al. 1979; Table 1). The remaining 5 sites did not support enough water to meet wetland hydrologic criteria. The area of actual wetland ranged from 0.01 to 122.80 ha with a median of 0.9 ha (Table 1). Twenty-four percent of the total area across all sites qualified as wetland habitat. Twenty-five of the 28 functional wetlands (89%) were < 5 ha in size, and 17 (68%) of those 25 were < 1 ha in size.

Temporary wetlands accounted for 21.5% of total wetland area. Seasonal wetlands were the most prevalent, covering 57% of wetland area. Semi-permanent wetlands accounted for the remaining area (21.5%; Table 1). Only 2 of the 28 functional wetlands were actively managed for water depth throughout the year by opening and closing water structures to fill and drain the wetland according to season and river stage (Table 1). Thirteen of the 28 were hydrologically engineered at the time of construction, for a total of 15 out of 28 functional wetlands that were modified in one form or another, which is higher than the estimated percentage of modified wetlands statewide (27%; Suloway and Hubbell 1994). The remaining 13 sites lacked any hydrologic engineering or construction (Table 1).

CREP regulations call for a maximum ratio of 6:1 upland to wetland area for CP 23 wetland practices, yet 24 of the 33 (72%) sampled sites exceeded this maximum. Several other sites included little or no buffer within the contract boundaries, which resulted in 76% of the total area across all of the sampled sites being classified as upland buffer (Table 2). The remaining area was dominated by emergent vegetation association (22%), followed by forested (2.2%), and scrub-shrub (<0.1%; Table 2). Of the total functional wetland area, emergent vegetation associations constituted 90.6%, forested, 9.2%, and scrub-shrub, 0.2%. This distribution of wetland habitat differs from statewide coverage, which is comprised of 62% forested cover, 16 % emergent, and 4% scrub-shrub (Suloway and Hubbell 1994). The areal coverage of hydrophytic vegetation within functional wetlands ranged 0% to 100%, with a mean of 46 ± 34% (mean ± SD; Table 1).

Total species richness of CP 23 wetlands ranged from 11 to 41 with a mean of 26 ± 7 species (mean ± SD). Mean C values ranged from 3.45 to 4.79 with a mean of 4.06 ± 0.54 and FQI values ranged from 11.76 to 30.92 with a mean of 20.80 ± 4.50 (Table 1). The relationship between mean C values of hydrophytic vegetation and the level of hydrologic manipulation among all sites was not significant ($R^2 = 0.002$, P=0.80). The amount of aquatic habitat within a 3 km buffer around the wetland ranged from 27 to 1719 ha with a mean of 328 ± 438 ha (Table 1). Although there was a trend toward greater values of mean C with increasing area of wetland surrounding a site, the amount of variation explained by the relationship was small (R^2=0.08, P=0.18).

DISCUSSION

Producing functional wetlands through the restoration of disturbed agricultural areas is a challenging task (Perrow and Davy 2002). Most of the CP23 projects we surveyed contained at least some functional wetland habitat, but the areal extent of these wetlands was small. A few sites supported extensive wetland complexes, but 54% of wetlands were <1 ha in size. Although these small wetlands can play an important role in reducing isolation among patches of wetland habitat (Gibbs 1993; Semlitsch and Bodie 1998), they typically support lower abundance and species richness of wildlife (Fairbairn and Dinsmore 2001). Overall, only 24% of the total area across our sample of 33 sites qualified as wetland habitat. Thus, although 14,000 ha have been enrolled in CREP CP 23 contracts in Illinois, the actual area of wetland restored may be closer to 3,360 ha if our study sites are representative.

The ratio of upland to wetland area in most CREP sites within our sample was well above the program's maximum ratio of 6:1 upland to wetland habitat. Wetland buffers and native grass cover are worthy and necessary restoration components that provide important filtering functions and valuable habitat for many fauna. However, many of the CP23 tracts we surveyed already had upland cover adjacent to them and were sufficiently buffered without relegating a majority of the CP23 tract to additional buffer. Furthermore, many other areas within the eligible enrollment region historically supported prairie habitat and as such possess conditions better-suited for restoring quality upland habitat. The low proportion of wetland coverage on CREP tracts reflects in part the difficulty of wetland restoration in a highly variable hydrologic setting (Galatowitsch and van der Valk 1996), but we believe improvements could be made by focusing more on the intended goal of wetland habitat and implementing the necessary measures to support a more extensive and sustainable hydrology.

An active effort to engineer a sustainable hydrology should be included in most restoration projects. Wetlands can and do naturally form solely from the cessation of crop production in drained floodplains, but many of these wetlands lack the hydrologic persistence necessary to support a viable wetland community. While temporary, ephemeral habitat is essential for many wildlife species (Swanson et al. 1974), it inevitably occurs in the periphery of seasonal and semi-permanent sites that also support water into the growing season. The use of excavation and water retention structures in small restoration projects provides greater potential for sustaining longer hydroperiods which can support the growth of emergent and aquatic wetland plants as well as a plethora of wildlife that require wetland habitat (Ehrenberger 2003). All of the hydrologically engineered sites that we sampled supported functional water regimes, while all of the sites that lacked a functional hydrology were passive restorations without any intentional hydrologic engineering. The level of hydrologic manipulation in our sample did not have a statistically significant effect on mean C values. Similarly, we did not detect a relationship between isolation and mean C. Most of CREP wetland plant assemblages were dominated by common generalist species leading to low variation in mean C among sites. This suggests that either a longer time will be needed for plants with high conservation values to successfully colonize suitable sites, or that high quality species will require active management. We believe that the inundation supported through hydrologic engineering may have an increasing effect on the recruitment of wetland plants as these CREP wetlands mature past their first few years of existence.

The targeting of specific habitat within CREP is limited by the first-come-first-served enrollment system, but even within this context, we believe that the areal extent of wetland habitat restored could be improved by placing wetlands on sites better suited for hydrologic restoration and by actively engineering these sites with simple hydrologic structures. While funds for extensive management are limited, managers and landowners could do more to utilize the resources allocated for initial restoration costs, such as implementation cost-shares and practice incentive payments. As the demand for enrollment among landowners grows, so should the standards for effective implementation of the CREP's restoration goals.

As we work to protect and restore more functional wetland habitat, there is a need to maximize and sustain the benefits of enrollments by better tracking the progression of restoration. CREP wetlands will invariably change with time through degradation from exotic species, sedimentation, and nutrient loading and/or enhancement brought by colonization of native species and development of hydric soils. Continued monitoring of the physical and floral characteristics of this habitat is necessary to understand, protect, and maximize the ecological investment these easements represent.

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Figure 1. CP23 CREP wetland study sites, Illinois River Basin, Illinois, USA. Black areas not representative of the size of the tracts, but enlarged for visibility.

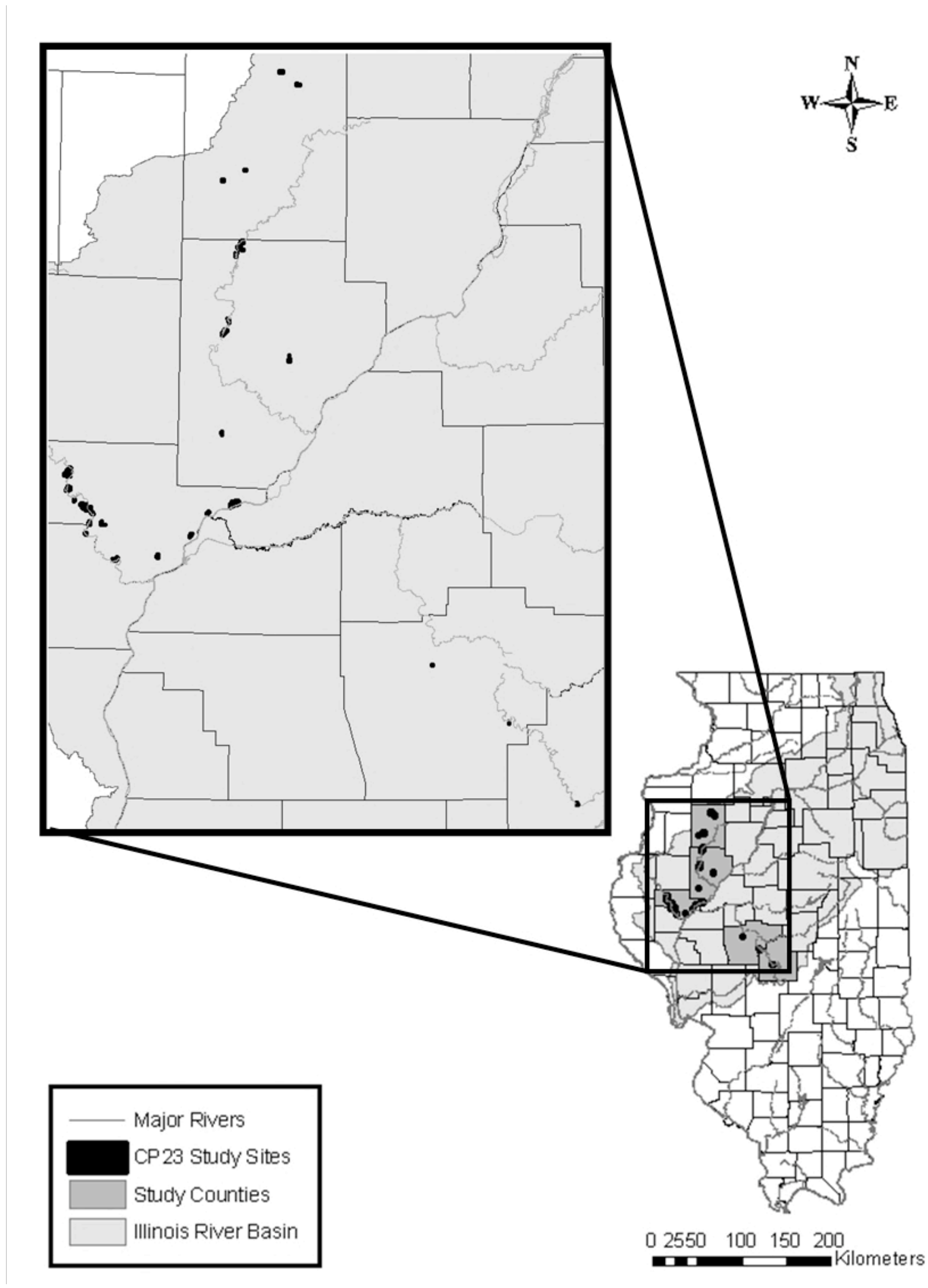

Table 1. Habitat characteristics of central Illinois CP23 CREP wetland study sites, 2005. HYDRO=the water regime modifier. Semi-permanent wetlands have surface water throughout the growing season in most years, seasonal wetlands have surface water for extended periods in growing season but not at the end of the growing season, and temporary wetlands have surface water for only brief periods during the growing season (Cowardin et al. 1979). ENG=the level of hydrologic engineering. ISOL=wetland isolation, estimated by the amount of aquatic habitat (ha) within a 3 km buffer around the perimeter of each wetland (Fairbairn and Dinsmore 2001). TRACT=the area (ha) of the enrolled contract tract. WETLAND=the area (ha) of the delineated wetland. HABITAT=the wetland class (Cowardin et al. 1979). C=the mean C value (Swink and Wilhelm 1994; Taft et al. 1997). VEG= percent areal coverage of wetland vegetation.

SITE	COUNTY	WTRSHD	HYDRO	ENG	ISOL	TRACT	WETLAND	HABITAT	C	VEG
1	Schuyler	Illinois	Semi-perm	3	1502	149	122.80	emergent	4.3	10
2	Schuyler	Illinois	Seasonal	2	1356	11	11.10	forested	3.7	90
3	Schuyler	Illinois	Seasonal	1	1720	22	1.86	forested	3.9	100
4	Schuyler	LaMoine	Temp	1	172	47	0.13	forested	3.9	100
5	Schuyler	LaMoine	Temp	1	137	8	0.21	scrub-shrub	4.0	100
6	Schuyler	LaMoine	Seasonal	1	165	20	0.50	emergent	3.9	10
7	Schuyler	LaMoine	Seasonal	2	168	44	12.27	emergent	3.9	40
8	Schuyler	LaMoine	Semi-perm	2	132	17	16.44	emergent	4.3	40
9	Schuyler	LaMoine	Seasonal	1	196	21	8.19	forested	3.5	80
10	Schuyler	LaMoine	Semi-perm	2	218	17	4.97	emergent	4.3	50
11	Schuyler	LaMoine	Temp	1	324	82	15.79	emergent	3.9	30
12	Schuyler	LaMoine	Seasonal	1	419	6	0.21	emergent	4.5	90
13	Schuyler	LaMoine	Temp	1	461	40	0.09	emergent	4.2	100
14	Schuyler	LaMoine	Semi-perm	3	240	106	26.57	emergent	3.9	50
15	Schuyler	LaMoine	Semi-perm	2	243	36	12.36	emergent	4.2	20
16	Fulton	Spoon	Seasonal	2	78	6	0.24	scrub-shrub	4.1	20
17	Fulton	Spoon	Seasonal	2	158	29	0.94	emergent	4.1	20
18	Fulton	Spoon	Temp	1	118	35	0.01	emergent	4.1	0
19	Fulton	Spoon	Temp	1	128	8	0.01	emergent	4.2	0
20	Fulton	Spoon	Seasonal	1	206	58	0.66	emergent	4.1	10
21	Fulton	Spoon	Seasonal	1	152	30	0.01	emergent	4.2	0
22	Knox	Spoon	Seasonal	2	95	14	0.57	emergent	3.7	40
23	Knox	Spoon	Seasonal	2	34	10	0.89	emergent	4.3	30
24	Knox	Spoon	Seasonal	2	27	32	3.23	emergent	3.6	50
25	Knox	Spoon	Semi-perm	2	62	24	0.71	emergent	3.8	40
26	Sangamon	Sangamon	Seasonal	2	101	2	0.84	emergent	4.5	30
27	Sangamon	Sangamon	Seasonal	2	251	8	0.96	emergent	3.9	40
28	Christian	Sangamon	Seasonal	1	312	6	0.04	emergent	4.8	90

Table 2: Distribution of dominant vegetation associations among 33 CP23 CREP wetland sites in the Illinois River watershed (Cowardin et al. 1979).

Dominant vegetation association	pooled area (ha)	% area
upland	718.6	75.6
emergent	209.6	22.1
scrub-shrub	0.5	<0.1
forested	21.3	2.2
total	950	100