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FLORISTIC QUALITY ASSESSMENT OF ONE NATURAL AND THREE RESTORED WETLAND COMPLEXES IN NORTH DAKOTA, USA

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Abstract: Floristic quality assessment is potentially an important tool for conservation efforts in the northern Great Plains of North America, but it has received little rigorous evaluation. Floristic quality assessments rely on coefficients assigned to each plant species of a region's flora based on the conservatism of each species relative to others in the region. These ''coefficients of conservatism'' (C values) are assigned by a panel of experts familiar with a region's flora. The floristic quality assessment method has faced some criticism due to the subjective nature of these assignments. To evaluate the effect of this subjectivity on floristic quality assessments, we performed separate evaluations of the native plant communities in a natural wetland complex and three restored wetland complexes. In our first assessment, we used C values assigned ''subjectively'' by the Northern Great Plains Floristic Quality Assessment Panel. We then performed an independent assessment using the observed distributions of species among a group of wetlands that ranged from highly disturbed to largely undisturbed (data-generated C values). Using the panel-assigned C values, mean C values ($\bar{C}$) of the restored wetlands rarely exceeded 3.4 and never exceeded 3.9, with the highest values occurring in the oldest restored complex; all but two wetlands in the natural wetland complex had a $\bar{C}$ greater than 3.9. Floristic quality indices (FQI) for the restored wetlands rarely exceeded 22 and usually reached maximums closer to 19, with higher values occurring again in the oldest restored complex; only two wetlands in the natural complex had an FQI less than 22. We observed that 95% confidence limits for species richness and percent natives overlapped greatly among wetland complexes, whereas confidence limits for both $\bar{C}$ and FQI overlapped little. $\bar{C}$ and FQI values were consistently greater when we used the data-generated C values than when we used the panel-assigned C values; nonetheless, conclusions reached based on these two independent assessment techniques were virtually identical. Our results are consistent with the opinion that coefficients assigned subjectively by expert botanists familiar with a region's flora provide adequate information to perform accurate floristic quality assessments.

Key Words: conservatism, floristic quality assessment, Great Plains, hydrophytes, monitoring, prairie pothole region, species richness, wetland plants, wetland restoration

INTRODUCTION

Swink and Wilhelm (1979, 1994) developed and later refined a system for assessing the quality of native plant communities in the Chicago, Illinois region of the United States. Their system, floristic quality assessment, was based on the concept that plant species display varying degrees of tolerance to disturbance, as well as varying degrees of fidelity to specific habitat integrity. They termed this tolerance and fidelity ''species conservatism'' and assigned each native plant species in the Chicago region a coefficient of 0 to 10 based on its conservatism relative to other native species in the region. A very conservative species (i.e., one with very low tolerances to disturbance and high fidelity to habitat integrity) was assigned a coefficient of 10, while a species that tolerates almost any disturbance and can be found in almost any habitat type was assigned a coefficient of 0. Species with conservatisms falling between the two extremes were assigned appropriate coefficients ranging between 0 and 10 based on the professional judgment of botanists familiar with the region's flora. Subsequently, coefficients of conservatism were assigned to plant species of Michigan, Missouri, the remainder of Illinois, northern Ohio, and most recently North Dakota, South Dakota, and their adjacent grasslands (Ladd 1993, Andreas and Lichvar 1995, Herman et al. 1997, Taft et al. 1997, Northern Great Plains Floristic Quality Assessment Panel 2001).

Given the assumption that the floristic quality of an area is directly related to its richness in conservative species (Wilhelm and Ladd 1988), the assigned coefficient of conservatism (C) values, together with a list of native plant species present in an area, can be used to evaluate the floristic quality of that area (Swink and Wilhelm 1994). A mean C ($\bar{C}$) can be calculated by

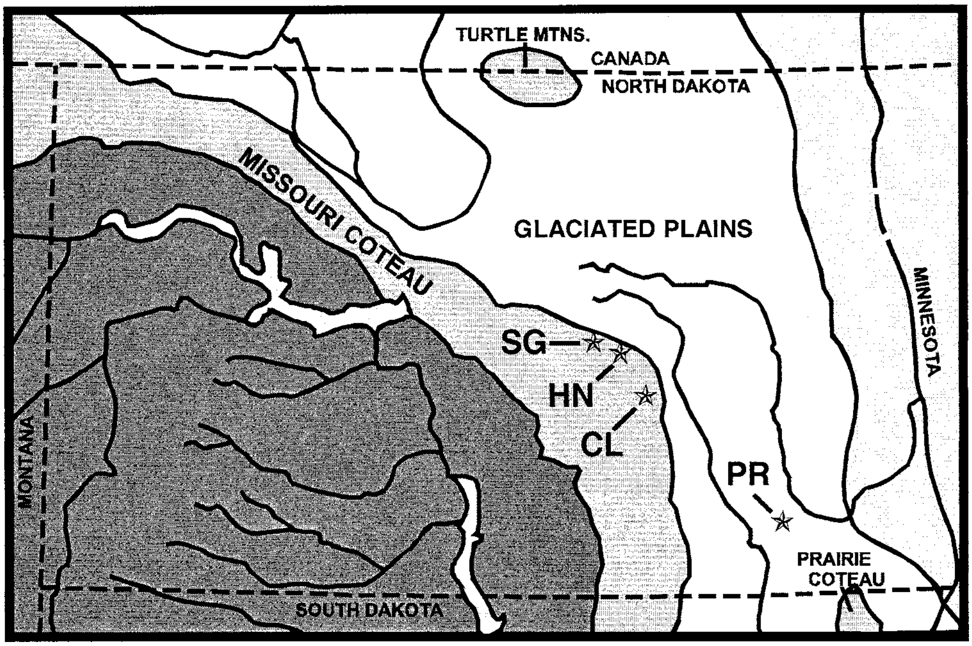

Figure 1. Location of Hawk's Nest Wildlife Development Area (HN), Sweet Grass Wildlife Development Area (SG), Pilgrim's Rest Wildlife Development Area (PR), and the Cottonwood Lake Study Area (CL) in the prairie pothole region of North Dakota.

summing the C values for each native species present in the survey and dividing the summation by the total number of native species present (N). Thus, $\bar{C}$ represents the average conservatism of the native plant community. If habitat quality of an area has degraded, the first plants lost from the plant community will be conservative species (i.e., those with the highest C values). $\bar{C}$ decreases as conservative species are replaced by less conservative species (i.e., those with lower C values), non-native weeds, or no plants at all. A floristic quality index (FQI) can also be calculated. FQI is a weighted species richness estimate that uses a square root transformation of N to incorporate species richness into the index (Swink and Wilhelm 1994, Taft et al. 1997). It is possible for two plant communities, one with 2 species and one with 20 species, to have the same $\bar{C}$, but the FQI for the community with 20 species would be much higher. Introduced species are not used in the calculations of either $\bar{C}$ or FQI, but their impact is measured indirectly to the extent that their occurrence is related to a diminishment in the number of conservative, native species present (Swink and Wilhelm 1994).

A common criticism of floristic quality assessment is that the C values are assigned subjectively by a relatively small group of individuals. This concern persists even though the subjectivity comes from a group of experts intimately familiar with the region's flora that assigns C values before floristic quality is evaluated. In our study, we used the C values assigned by the Northern Great Plains Floristic Quality Assessment Panel (2001) to assess the quality of plant communities of one natural and three restored wetland complexes in North Dakota. C values assigned by the panel reflect the panel members' opinions of the conservatism of each species throughout North and South Dakota, excluding the Black Hills. In addition, we performed a second independent assessment using a more objective approach in which we derived C values from data collected from 204 wetlands randomly distributed throughout the prairie pothole region of the United States (Gleason and Euliss, unpublished data; see http://www.npwrc.usgs.gov/wetlands). We then compared the results obtained using both the ''subjectively'' assigned and ''objectively'' estimated sets of C values.

STUDY AREA

The landscape of North Dakota is largely the result of glaciation (Figure 1). When the last glaciers retreated from the region approximately 12,000 years ago, they left behind a landscape dotted with numerous depressional wetlands caused by the uneven deposition of sediments, the scouring action of glaciers, and the melting of buried ice blocks. Due to the geologically young nature of the landscape and the resulting lack of integrated drainage systems, wetlands in the prairie pothole region of North Dakota are typically not connected by overland water flows; however, they are connected to and are greatly influenced by ground-water flow paths (Winter and Rosenberry 1995). The unique hydrology and climate of this region have a profound influence on the hydroperiod, water chemistry, and ultimately the biotic communities that inhabit these prairie wetlands (Kantrud et al. 1989, Euliss et al. 1999). Stewart and Kantrud (1971) developed a wetland classification system based on these differences in plant communities resulting from various hydrologic regimes and water chemistries (i.e., salinities), and Kantrud et al. (1989) provide lists of plant species associated with the different water regimes and salinity levels of prairie wetlands.

In addition to hydrologic regime and salinity, disturbance by man has had great influence on plant species composition of prairie wetlands (Kantrud et al. 1989). Cultivation of wetland basins commonly occurs in short hydroperiod wetlands and even in long hydroperiod wetlands during drought years. Farmers also regularly cultivate the outer zones of many wetlands with greater water permanence. These operations can temporarily eliminate most plants in these areas and, if repeated regularly, do not allow the original native plant communities to reestablish themselves (Kantrud and Newton 1996). Further, cultivation of wetland catchments has increased sedimentation rates of prairie wetlands (Gleason and Euliss 1998). Kantrud and Newton (1996) noted silt accumulations that virtually eliminated the plant communities of the wet meadow zone in several of their study wetlands in cultivated watersheds.

In order to shorten the hydroperiod and thus increase to amount of time when wetlands are dry and can be farmed, many prairie wetlands have been drained either with open ditches or tiles. Approximately 50% of the estimated original 8 million ha of wetlands in North Dakota no longer remain (Dahl 1990). In response to increased awareness of wetland functions and values, numerous prairie wetlands have been restored in efforts to reverse the impacts of wetland drainage. However, Galatowitsch and van der Valk (1996) found that while deep marsh and submersed plant species appeared to be comparable, the number of wet meadow and sedge meadow species was lower in restored wetlands than in natural wetlands. Additionally, restored wetlands may be shallower than their natural analogues due to increased sedimentation during the time period when the wetlands were drained and farmed. This loss of wetland volume in restored wetlands may influence hydrologic regimes and water chemistry that ultimately determine plant species composition (Gleason 2001).

In July and August, 1995, we sampled the plant communities of wetlands within one natural wetland complex, the Cottonwood Lake Study Area (16 wetlands sampled), and three restored wetland complexes, Hawk's Nest Wildlife Development Area (14 wetlands sampled), Sweet Grass Wildlife Development Area (11 wetlands sampled), and Pilgrim's Rest Wildlife Development Area (12 wetlands sampled). These wetland complexes are hereafter referred to as Cottonwood Lake, Hawk's Nest, Sweet Grass, and Pilgrim's Rest. Cottonwood Lake (Section 19, T142N, R66W, Stutsman county, ND), Hawk's Nest (Section 10, T144N, R68W, Stutsman county, ND), and Sweet Grass (Section 34, T145N, R70W, Wells county, ND) are situated along the eastern portion of the Missouri Coteau in North Dakota, whereas Pilgrim's Rest (Section 34, T134N, R95W, LaMoure county, ND) is situated in the Glaciated Plains of North Dakota (Figure 1). Wetlands within the three restored wetland complexes were restored by the U.S. Bureau of Reclamation in 1987, 1990, and 1993, respectively. Thus, the restored wetlands in the complexes were eight, five, and two years old when sampled in 1995. The upland areas of all three restored complexes were reseeded to grassland cover during restoration; however, no supplemental plantings of native wetland species occurred in any of the three restored wetland complexes. The natural wetland complex evaluated, Cottonwood Lake (see http://www.npwrc.usgs.gov/clsa), is an undrained complex that has been used for long-term studies since 1967. Information on wetland hydrology, water chemistry, and biota (e.g., Winter and Carr 1980, Hanson and Swanson 1987, LaBaugh et al. 1987, Nelson and Butler 1987, Poiani and Johnson 1988, and Swanson 1990) provided reference data to facilitate comparisons with the three restored wetland complexes (Horner and Raedeke 1989, D'Avanzo 1990).

METHODS

We developed lists of plant species identified during July and August, 1995 in wetlands at Cottonwood Lake, Hawk's Nest, Sweet Grass, and Pilgrim's Rest (Table 1). Sample wetlands from each complex were selected based on their similarity in size and hydroperiod to wetlands at Cottonwood Lake; wetlands thus selected spanned the hydrologic continuum from ground-water recharge to ground-water discharge within each wetland complex evaluated. For each wetland sampled, we established five transects radiating from the wetland's center into the upland along randomly selected compass bearings. Along each transect, we randomly located a 0.25 m^2 plot within each wetland vegetation zone described by Stewart and Kantrud (1971), excluding the low-prairie zone. After we identified and recorded species within plots, we searched the remainder of each wetland for additional species and, if they occurred, added them to our species list for each wetland. Even though only native,

Table 1. Number of wetlands in which plant species occurred in the Cottonwood Lake (CL), Hawk's Nest (HN), Sweetgrass (SG), and Pilgrim's Rest (PR) wetland complexes, 1995. Cottonwood Lake (16 wetlands sampled) is a natural wetland complex, whereas Hawk's Nest (14 wetlands sampled), Sweetgrass (11 wetlands sampled), and Pilgrim's Rest (12 wetlands sampled) were restored in 1987, 1990, and 1993, respectively. C Panel = coefficient of conservatism provided by the Northern Great Plains Floristic Quality Assessment Panel (2001) and C Data = coefficient of conservatism generated from data collected from 204 prairie wetlands (Gleason and Euliss, unpublished data). Non-native species are identified with a single asterisk (*). A double asterisk (**) identifies species that did not occur in Gleason and Euliss' data set. Scientific names and authors follow USDA, NRCS (2001).

Species	C Panel	C Data	Number of Wetlands			
			CL	HN	SG	PR
Achillea millefolium L.	3	5	14	0	0	0
Agropyron cristatum (L.) Gaertn.	*	*	2	0	2	2
Alisma subcordatum Raf.	2	**	4	13	11	11
Allium stellatum Nutt. ex Ker-Gawl.	7	9	12	0	0	0
Alopecurus aequalis Sobol.	2	2	0	1	1	0
Ambrosia psilostachya DC.	2	1	11	10	8	10
Amorpha canescens Pursh	9	5	10	0	0	0
Andropogon gerardii Vitman	5	5	11	1	0	6
Anemone canadensis L.	4	5	16	8	2	0
Anemone cylindrica Gray	7	**	3	0	0	0
Apocynum cannabinum L.	4	5	10	7	1	1
Argentina anserina (L.) Rydb.	2	5	6	2	2	0
Artemisia absinthium L.	*	*	6	14	11	3
Artemisia frigida Willd.	4	10	10	0	0	0
Artemisia ludoviciana Nutt.	3	5	15	0	0	0
Asclepias ovalifolia Dcne.	9	5	13	1	3	2
Asclepias speciosa Torr.	4	5	5	6	3	7
Asclepias verticillata L.	3	10	0	1	0	0
Astragalus agrestis Dougl. ex G. Don	6	**	9	0	0	0
Bacopa rotundifolia (Michx.) Wettst.	3	2	0	0	1	3
Beckmannia syzigachne (Steud.) Fern.	1	3	0	11	11	6
Biden cernua L.	3	**	0	13	10	7
Bidens vulgata Greene	1	**	1	9	4	8
Bolboschoenus fluviatilis (Torr.) Sojak	2	3	1	10	6	8
Bouteloua curtipendula (Michx.) Torr.	5	5	4	5	0	3
Bromus inermis Leyss.	*	*	6	14	11	10
Bromus japonicus Thunb. ex Murr.	*	*	0	0	1	9
Bromus tectorum L.	*	*	0	0	0	2
Calamagrostis stricta (Timm) Koel.	5	6	1	0	0	0
Calylophus serrulatus (Nutt.) Raven	7	**	3	5	1	0
Calystegia sepium (L.) R. Br.	0	**	0	2	2	5
Campanula rotundifolia L.	7	**	8	1	0	0
Carex atherodes Spreng.	4	5	16	12	10	5
Carex pellita Muhl ex Willd.	4	5	1	0	0	0
Carex vulpinoidea Michx.	2	3	1	3	5	8
Ceratophyllum demersum L.	4	5	2	1	0	1
Chenopodium album L.	*	*	1	1	1	0
Cicuta maculata L.	4	5	10	7	6	2
Cirsium arvense (L.) Scop.	*	*	16	14	11	12
Cirsium vulgare (Savi.) Ten.	*	*	14	0	0	3
Convolvulus arvensis L.	*	*	1	6	6	6
Conyza canadensis (L.) Cronq.	0	1	0	2	4	11
Crataegus chrysocarpa Ashe	6	10	7	0	0	0
Dactylis glomerata L.	*	*	0	2	7	1
Dalea purpurea Vent.	8	9	8	0	0	0
Echinacea angustifolia DC.	7	**	5	0	0	0
Echinochloa crus-galli (L.) Beauv.	*	*	0	8	10	12
Echinochloa muricata (Beauv.) Fern.	0	**	1	0	0	2
Eleocharis acicularis (L.) Roemer & J. A. Schultes	3	2	0	2	8	9

Table 1. Continued.

Species	C Panel	C Data	Number of Wetlands			
			CL	HN	SG	PR
Eleocharis compressa Sullivant	8	3	9	0	0	0
Eleocharis palustris (L.) Roemer & J. A. Schultes	4	3	9	11	10	10
Elymus canadensis L.	3	1	5	1	1	1
Elymus repens (L.) Gould	*	*	14	14	9	11
Epilobium ciliatum Raf.	3	3	5	8	10	9
Equisetum arvense L.	4	5	0	0	0	1
Equisetum hyemale L.	3	5	5	3	0	1
Erigeron philadelphicus L.	2	1	1	2	1	4
Euphorbia esula L.	*	*	0	5	0	0
Fragaria virginiana Duchesne	4	5	1	0	0	0
Galium boreale L.	4	6	15	0	0	0
Gentiana andrewsii Griseb.	10	**	3	0	0	0
Glyceria grandis S. Wats.	4	**	0	4	4	1
Glyceria striata (Lam.) A. S. Hitchc.	6	1	2	5	0	0
Glycyrrhiza lepidota Pursh	2	5	16	10	2	3
Grindelia squarrosa (Pursh) Dunal	1	5	3	0	1	0
Helenium autumnale L.	4	**	0	2	0	0
Helianthus maximiliani Schrad.	5	5	16	7	3	0
Helianthus pauciflorus Nutt.	8	5	15	4	3	1
Hesperostipa spartea (Trin.) Barkworth	8	10	0	0	0	1
Hippuris vulgaris L.	5	10	0	1	0	0
Hordeum jubatum L.	0	1	6	11	11	12
Iva xanthifolia Nutt.	0	4	0	7	8	4
Juncus balticus Willd.	5	5	11	6	1	5
Juncus tenuis Willd.	4	**	0	0	0	1
Juncus torreyi Coville	2	3	7	7	5	8
Koeleria macrantha (Ledeb.) J. A. Schultes	7	**	0	1	2	1
Lactuca serriola L.	*	*	1	8	9	8
Lactuca tatarica (L.) C. A. Mey.	1	5	16	6	2	1
Lappula occidentalis (S. Wats.) Greene	2	**	16	1	2	6
Lemna trisulca L.	2	5	15	13	6	8
Lemna turionifera Landolt	1	4	15	14	10	9
Liatris ligulistylus (A. Nels.) K. Schum.	10	10	11	0	0	0
Liatris punctata Hook.	7	10	5	0	0	0
Lithospermum canescens (Michx.) Lehm.	7	10	3	0	0	0
Lobelia spicata Lam.	6	2	0	2	0	2
Lycopus americanus Muhl. ex W. Bart.	4	3	2	7	2	1
Lycopus asper Greene	4	5	7	12	10	3
Lysimachia ciliata L.	6	5	0	0	3	4
Malva neglecta Wallr.	*	*	0	0	2	0
Medicago sativa L.	*	*	7	11	11	11
Melilotus officinalis (L.) Lam.	*	*	14	12	11	12
Mentha arvensis L.	3	3	5	12	7	7
Myriophyllum spicatum L.	*	*	0	5	3	2
Nepeta cataria L.	*	*	2	0	0	0
Oligoneuron rigidum (L.) Small	4	5	16	5	9	5
Panicum capillare L.	0	2	1	0	0	0
Panicum virgatum L.	5	4	16	13	7	8
Parthenocissus quinquefolia (L.) Planch.	2	**	1	0	0	0
Pascopyrum smithii (Rydb.) A. Löve	4	1	0	0	4	8
Pediomelum argophyllum (Pursh) J. Grimes	4	5	10	0	0	0
Phalaris arundinacea L.	0	4	13	7	9	7
Phleum pratense L.	*	*	7	0	0	0
Phragmites australis (Cav.) Trin. ex Steud.	0	4	1	2	1	0
Physalis virginiana P. Mill.	4	3	4	1	0	0

Table 1. Continued.

Species	C Panel	C Data	Number of Wetlands			
			CL	HN	SG	PR
Plantago major L.	*	*	4	0	8	5
Poa palustris L.	4	5	5	1	1	0
Poa pratensis L.	*	*	16	9	9	4
Polygonum amphibium L.	3	4	15	14	9	11
Polygonum convolvulus L.	*	*	1	7	4	4
Polygonum lapathifolium L.	1	1	0	1	0	4
Populus deltoides Bartr. ex Marsh.	3	1	3	0	0	3
Potamogeton foliosus Raf.	2	**	0	5	2	3
Potamogeton richardsonii (Benn.) Rydb.	4	6	0	3	1	0
Potentilla norvegica L.	0	1	0	0	2	6
Prenanthes racemosa Michx.	10	**	2	0	0	0
Ranunculus cymbalaria Pursh	3	4	2	6	3	2
Ranunculus gmelinii DC.	8	2	1	9	8	2
Ranunculus longirostris Godr.	3	3	0	1	1	4
Ratibida columnifera (Nutt.) Woot. & Standl.	3	2	4	0	0	0
Ribes americanum P. Mill.	7	9	4	0	0	0
Rosa arkansana Porter	3	5	11	0	0	2
Rudbeckia hirta L.	5	4	13	8	0	0
Rumex crispus L.	*	*	10	13	11	13
Sagittaria cuneata Sheldon	6	2	1	9	5	4
Schoenoplectus acutus (Muhl. ex Bigelow) A. & D. Löve	5	5	8	6	8	2
Schoenoplectus tabernaemontani (K. C. Gmel.) Palla	3	3	3	8	6	6
Scirpus atrovirens Willd.	5	10	0	3	0	0
Scolochloa festucacea (Willd.) Link	6	4	11	4	3	0
Setaria viridis (L.) Beauv.	*	*	1	14	9	12
Silene latifolia Poir.	*	*	0	1	0	0
Sinapis arvensis L.	*	*	0	7	9	4
Solidago canadensis L.	1	5	15	5	0	6
Solidago gigantea Ait.	4	5	16	5	2	2
Sonchus arvensis L.	*	*	16	14	11	12
Spartina pectinata Bose ex Link	5	5	16	5	2	0
Spiraea alba Du Roi	7	10	13	10	10	4
Stuckenia pectinatus (L.) Boerner	0	3	0	1	2	2
Symphoricarpos occidentalis Hook.	3	5	16	0	1	0
Symphyotrichum ericoides (L.) Nesom	2	5	0	0	1	0
Symphyotrichum lanceolatum (L.) Nesom	3	1	16	12	11	9
Taraxacum officinale G. H. Weber ex Wiggers	*	*	0	0	0	2
Thinopyrum intermedium (Host) Barkworth & D. R. Dewey	*	*	8	10	11	11
Thinopyrum ponticum (Podp.) Z. W. Liu & R. C. Wang	*	*	0	6	11	9
Thlaspi arvense L.	*	*	1	4	2	3
Toxicodendron rydbergii (Small ex Rydb.) Greene	3	**	5	0	0	0
Tragopogon dubius Scop.	*	*	7	13	4	6
Trifolium hybridum L.	*	*	0	0	0	1
Typha angustifolia L.	*	*	3	5	8	8
Typha latifolia L.	2	3	4	14	8	6
Typha × *glauca* Godr. (pro sp.)	*	3	5	6	9	6
Urtica dioica L.	0	4	6	11	3	0
Utricularia macrorhiza Le Conte	2	5	12	10	7	4
Verbena hastata L.	5	1	1	3	0	0
Vicia americana Muhl. ex Willd.	6	5	2	0	0	0
Xanthium strumarium L.	0	3	0	12	11	7
Zizia aptera (Gray) Fern.	8	4	6	0	0	0

wetland species were subsequently used in our calculations of floristic quality, all plants occurring within wetlands were identified to species for estimation of species richness and percent natives. From the species lists for each wetland, we assessed the quality of their native plant communities by calculating $\bar{C}$ and FQI using two sets of independently derived C values. We also calculated species richness and percent natives for each wetland.

Panel-Assigned C values

We calculated $\bar{C}$ and FQI for each wetland sampled using C values provided by the Northern Great Plains Floristic Quality Assessment Panel (2001). FQI was calculated as

$$FQI = \bar{C}\sqrt{N}$$

where N was the total number of native species present in a wetland. As is common practice, introduced species were not used in the calculations of either $\bar{C}$ or FQI (Swink and Wilhelm 1994). We then calculated a mean $\bar{C}$ and FQI for each of the four wetland complexes and established 95% confidence limits (Snedecor and Cochran 1980) for our estimates.

Species Richness

Even though only native plant species were included in our calculations of $\bar{C}$ and FQI, we calculated species richness for each wetland both including and excluding non-native species. We then calculated average species richness estimates and the percentage of native species for each wetland complex and established 95% confidence limits around our estimates.

Data-Generated C Values

We also estimated $\bar{C}$ and FQI for each wetland using data-generated C values. Gleason and Euliss (unpublished data) sampled the plant communities of 204 wetlands during the summer of 1997 as part of a larger effort to evaluate restored wetlands in the prairie pothole region of the United States (see http://www.npwrc.usgs.gov/wetland). The data-generated C values used in our study were derived from data from these 204 wetlands. The 204 wetlands Gleason and Euliss sampled included natural wetlands within native prairie (n = 46), natural wetlands within planted grass (n = 43), restored wetlands greater than five years old (n = 46), restored wetlands one to five years old (n = 31), and drained wetlands (n = 38). These sampled wetlands covered a range of disturbances from relatively undisturbed native prairie wetlands to greatly disturbed drained wetlands. All wetlands, except the native prairie wetlands, were situated on U.S. Department of Agriculture Conservation Reserve Program land or similar planted grasslands; the native prairie wetlands were located within natural grasslands. To sample plant communities of the 204 wetlands, Gleason and Euliss used methods modified from Kantrud and Newton (1996). They sampled wetland vegetation along four equally spaced transects radiating from each wetland's center. In each vegetative assemblage bisected by a transect, they centered a 1-m^2 plot in the middle of the assemblage and identified and recorded each plant species occurring within the plot. While walking between plots, they noted other plant species not occurring in the plots and added them to the species list. For the effort described here, we merged the species lists from all 204 wetlands to obtain a single list of plant species occurring in the sampled wetlands (Table 2).

We assigned C values to each native species occurring in the 204 wetlands using the following criteria. If a plant species only occurred in the native prairie wetlands sampled, it was considered to be very conservative and was assigned a C value of 10. If a species occurred in the native prairie wetlands and also in the planted grass wetlands, it was assigned a C value of 8 or 9 depending on whether it occurred more often in the native prairie or the planted grass wetlands. If a species occurred only in the planted grass wetlands, it was assigned a C value of 7. We assigned a C value of 6 to those species that occurred in native prairie, planted grass, and only the oldest restored wetlands sampled. Species that occurred in recently restored wetlands and drained wetlands were considered to be the least conservative and were assigned C values ranging from 0 to 5 depending upon which wetland type they occurred in most frequently (Table 3).

RESULTS

Of the 244 native plant species identified in the wetlands sampled by Gleason and Euliss (Table 2), 34 species were found only in the native prairie wetlands (i.e., C = 10). An additional 23 species were found in both native prairie and planted grass wetlands, or only in planted grass wetlands but not in any of the restored wetlands sampled (i.e., C = 7, 8, or 9). The remainder of the plant species occurred in a variety of combinations that included occurrence in both restored and/or drained wetlands. The largest number of species (62) occurred in restored and drained wetlands but had their greatest frequency in native prairie wetlands (i.e., C = 5). The data-generated C values are presented in Table 2 with the panel-assigned C values for comparison.

Clearly, the C values generated from Gleason and

Table 2. Data generated coefficients of conservatism for 244 native plant species encountered by Gleason and Euliss (unpublished data) in their 1997 sampling of 204 prairie wetlands distributed throughout the prairie pothole region of the United States. Numbers in parentheses are coefficients assigned by the Northern Great Plains Floristic Quality Assessment Panel (2001). Scientific names and authors follow USDA, NRCS 2001.

Coefficient	Species
10 (*)	*Acorus calamus* L.
10 (4)	*Amorpha fruticosa* L.
10 (4)	*Artemisia frigida* Willd.
10 (3)	*Asclepias verticillata* L.
10 (10)	*Azolla mexicana* Schlecht. & Cham. ex K. Presl
10 (10)	*Carex buxbaumii* Wahlenb.
10 (5)	*Carex praegracilis* W. Boott
10 (5)	*Carex sartwellii* Dewey
10 (0)	*Chamaesyce glyptosperma* (Engelm.) Small
10 (6)	*Crataegus chrysocarpa* Ashe
10 (8)	*Dalea candida* Mich. ex Willd.
10 (5)	*Elaeagnus commutata* Bernh. ex Rydb.
10 (0)	*Ellisia nyctelea* (L.) L.
10 (6)	*Euthamia graminifolia* (L.) Nutt.
10 (6)	*Hesperostipa comata* (Trin. & Rupr.) Barkworth
10 (8)	*Hesperostipa spartea* (Trin.) Barkworth
10 (10)	*Hierochloe odorata* (L.) Beauv.
10 (5)	*Hippuris vulgaris* L.
10 (1)	*Juncus bufonius* L.
10 (9)	*Lathyrus palustris* L.
10 (10)	*Liatris ligulistylus* (A. Nels.) K. Schum.
10 (7)	*Liatris punctata* Hook.
10 (8)	*Liatris pycnostachya* Michx.
10 (8)	*Lilium philadelphicum* L.
10 (7)	*Lithospermum canescens* (Michx.) Lehm.
10 (5)	*Monarda fistulosa* L.
10 (4)	*Muhlenbergia racemosa* (Michx.) B.S.P.
10 (7)	*Oxalis violacea* L.
10 (4)	*Rhus glabra* L.
10 (3)	*Salix nigra* Marsh.
10 (6)	*Schizachyrium scoparium* (Michx.) Nash
10 (5)	*Scirpus atrovirens* Willd.
10 (7)	*Spiraea alba* Du Roi
10 (8)	*Symphyotrichum novae-angliae* (L.) Nesom
9 (7)	*Allium stellatum* Nutt. ex Ker-Gawl.
9 (5)	*Astragalus canadensis* L.
9 (8)	*Dalea purpurea* Vent.
9 (8)	*Hypoxis hirsuta* (L.) Coville
9 (6)	*Potamogeton gramineus* L.
9 (7)	*Ribes americanum* P. Mill.
9 (7)	*Thalictrum dasycarpum* Fisch. Ave-Lall.
8 (8)	*Carex bebbii* Olney ex Fern.
8 (6)	*Dichanthelium oligosanthes* (J. A. Schultes) Gould
8 (2)	*Senecio congestus* (R. Br.) DC.
8 (5)	*Solidago missouriensis* Nutt.
8 (3)	*Spirodela polyrhiza* (L.) Schleiden
8 (5)	*Triglochin maritimum* L.
8 (8)	*Zigadenus elegans* Pursh
7 (1)	*Agrostis hyemalis* (Walt) B.S.P.

Table 2. Continued.

Coefficient	Species
7 (10)	*Carex interior* Bailey
7 (8)	*Carex utriculata* Boott
7 (2)	*Cyperus erythrorhizos* Muhl.
7 (2)	*Eleocharis obtusa* (Willd.) J.A. Schultes
7 (5)	*Scorphularia lanceolata* Pursh
7 (10)	*Sisyrinchium campestre* Bickn.
7 (7)	*Sphenopholis obtusata* (Michx.) Scribn.
7 (0)	*Veronica peregrina* L.
6 (8)	*Allium canadense* L.
6 (5)	*Calamagrostis stricta* (Timm) Koel.
6 (4)	*Carex brevior* (Dewey) Mackenzie
6 (2)	*Distichlis spicata* (L.) Greene
6 (4)	*Galium boreale* L.
6 (4)	*Potamogeton richardsonii* (Benn.) Rydb.
6 (3)	*Teucrium canadense* L.
6 (6)	*Thalictrum venulosum* Trel.
6 (7)	*Tradescantia bracteata* Small ex Britt.
5 (3)	*Achillea millefolium* L.
5 (9)	*Amorpha canescens* Pursh
5 (5)	*Andropogon gerardii* Vitman
5 (4)	*Anemone canadensis* L.
5 (4)	*Apocynum cannabinum* L.
5 (2)	*Argentina anserina* (L.) Rydb.
5 (3)	*Artemisia ludoviciana* Nutt.
5 (9)	*Asclepias ovalifolia* Dcne.
5 (4)	*Asclepias speciosa* Torr.
5 (3)	*Boltonia asteroids* (L.) L'Her.
5 (5)	*Bouteloua curtipendula* (Michx.) Torr.
5 (5)	*Calamagrostis canadensis* (Michx.) Beauv.
5 (10)	*Carex aquatilis* Wahlenb.
5 (4)	*Carex atherodes* Spreng.
5 (4)	*Carex pellita* Muhl. ex Willd.
5 (4)	*Ceratophyllum demersum* L.
5 (4)	*Cicuta maculata* L.
5 (5)	*Cornus sericea* L.
5 (4)	*Equisetum arvense* L.
5 (3)	*Equisetum hyemale* L.
5 (3)	*Equisetum laevigatum* A. Braun
5 (4)	*Fragaria virginiana* Duchesne
5 (8)	*Galium trifidum* L.
5 (2)	*Glycyrrhiza lepidota* Pursh
5 (1)	*Grindelia squarrosa* (Pursh) Dunal
5 (5)	*Helianthus maximiliani* Schrad.
5 (8)	*Helianthus nuttallii* Torr. & Gray
5 (8)	*Helianthus pauciflorus* Nutt.
5 (5)	*Juncus balticus* Willd.
5 (1)	*Lactuca tatarica* (L.) C. A. Mey.
5 (2)	*Lemna trisulca* L.
5 (*)	*Lotus unifoliolatus* (Hook.) Benth.
5 (4)	*Lycopus asper* Greene
5 (6)	*Lysimachia ciliata* L.
5 (7)	*Lysimachia thyrsiflora* L.
5 (10)	*Muhlenbergia richardsonis* (Trin.) Rydb.
5 (5)	*Nassella viridula* (Trin.) Barkworth
5 (4)	*Oligoneuron rigidum* (L.) Small

Table 2. Continued.

Coefficient	Species
5 (4)	*Pediomelum argophyllum* (Pursh) J. Grimes
5 (4)	*Poa palustris* L.
5 (7)	*Potamogeton zosteriformis* Fern.
5 (8)	*Potentilla arguta* Pursh
5 (7)	*Ranunculus flabellaris* Raf.
5 (3)	*Rosa arkansana* Porter
5 (8)	*Rosa blanda* Ait.
5 (5)	*Rosa woodsi* Lindl.
5 (5)	*Schoenoplectus acutus* (Muhl. ex Bigelow) A. & D. Löve
5 (3)	*Sium suave* Walt.
5 (1)	*Solidago canadensis* L.
5 (4)	*Solidago gigantea* Ait.
5 (6)	*Solidago mollis* Bartl.
5 (5)	*Spartina pectinata* Bosc ex Link
5 (3)	*Stachys palustris* L.
5 (3)	*Symphoricarpos occidentalis* Hook.
5 (2)	*Symphyotrichum ericoides* (L.) Nesom
5 (4)	*Symphyotrichum falcatus* (Lindl.) Nesom
5 (2)	*Utricularia macrorhiza* Le Conte
5 (10)	*Vallisneria americana* Michx.
5 (3)	*Vernonia fasciculata* Michx.
5 (6)	*Vicia americana* Muhl. ex Willd.
5 (2)	*Viola sororia* Willd.
5 (8)	*Zizia aurea* (L.) W. D. J. Koch
4 (2)	*Calystegia macounii* (Greene) Brummitt
4 (5)	*Cirsium flodmanii* (Rydb.) Arthur
4 (9)	*Eupatorium maculatum* L.
4 (0)	*Iva xanthifolia* Nutt.
4 (1)	*Lemna turionifera* Landolt
4 (2)	*Muhlenbergia asperifolia* (Nees & Meyen ex Trin.) Parodi
4 (5)	*Panicum virgatum* L.
4 (0)	*Phalaris arundinacea* L.
4 (0)	*Phragmites australis* (Cav.) Trin. ex Steud.
4(3)	*Polygonum amphibium* L.
4 (0)	*Polygonum pensylvanicum* L.
4 (3)	*Ranunculus cymbalaria* Pursh
4 (5)	*Rudbeckia hirta* L.
4 (6)	*Sagittaria latifolia* Willd.
4 (4)	*Schoenoplectus maritimus* (L.) Lye
4 (5)	*Scirpus pallidus* (Britt.) Fern.
4 (6)	*Scolochloa festucacea* (Willd.) Link
4 (0)	*Urtica dioica* L.
4 (8)	*Zizia aptera* (Gray) Fern.
3 (1)	*Agrotis scabra* Willd.
3 (2)	*Alisma gramineum* Lej.
3 (0)	*Ambrosia artemisiifolia* L.
3 (5)	*Asclepias incarnata* L.
3 (1)	*Beckmannia syzigachne* (Steud.) Fern.
3 (1)	*Bidens frondosa* L.
3 (2)	*Bolboschoenus fluviatilis* (Torr.) Sojak
3 (7)	*Carex alopecoidea* Tuckerman
3 (7)	*Carex sychnocephala* Carey
3 (2)	*Carex vulpinoidea* Michx.

Table 2. Continued.

Coefficient	Species
3 (2)	*Chenopodium rubrum* L.
3 (3)	*Coreopsis tinctoria* Nutt.
3 (8)	*Eleocharis compressa* Sullivant
3 (4)	*Eleocharis palustris* (L.) Roemer & J. A. Schultes
3 (3)	*Epilobium ciliatum* Raf.
3 (6)	*Epilobium leptophyllum* Raf.
3 (5)	*Fraxinus pennsylvanica* Marsh.
3 (*)	*Iris versicolor* L.
3 (2)	*Juncus torreyi* Coville
3 (0)	*Leptochloa fusca* (L.) Kunth
3 (4)	*Lycopus americanus* Muhl. ex W. Bart.
3 (2)	*Lygodesmia juncea* (Pursh) D. Don ex Hook.
3 (3)	*Mentha arvensis* L.
3 (3)	*Parietaria pensylvanica* Muhl. ex Willd.
3 (4)	*Physalis virginiana* P. Mill.
3 (4)	*Potamogeton nodosus* Poir.
3 (2)	*Potamogeton pusillus* L.
3 (4)	*Puccinellia nuttalliana* (J. A. Schultes) A. S. Hitchc.
3 (3)	*Ranunculus longirostris* Godr.
3 (2)	*Rorippa palustris* (L.) Bess.
3 (7)	*Rumex aquaticus* L.
3 (1)	*Rumex maritimus* L.
3 (3)	*Salix exigua* Nutt.
3 (8)	*Schoenoplectus heterochaetus* (Chase) Sojak
3 (4)	*Schoenoplectus pungens* (Vahl) Palla
3 (3)	*Schoenoplectus tabernaemontani* (K.C. Gmel.) Palla
3 (4)	*Sparganium eurycarpum* Engelm. ex Gray
3 (0)	*Stuckenia pectinatus* (L.) Boerner
3 (8)	*Symphyotrichum ciliatum* (Ledeb.) Nesom
3 (2)	*Typha latifolia* L.
3 (*)	*Typha* × *glauca* Godr. (pro sp.)
3 (8)	*Viola nuttallii* Pursh
3 (0)	*Xanthium strumarium* L.
2 (2)	*Alopecurus aequalis* Sobol.
2 (3)	*Bacopa rotundifolia* (Michx.) Wettst.
2 (10)	*Carex hallii* Olney
2 (0)	*Chamaesyce maculata* (L.) Small
2 (8)	*Crepis runcinata* (James) Torr. & Gray
2 (2)	*Cyperus odoratus* L.
2 (3)	*Eleocharis acicularis* (L.) Roemer & J. A. Schultes
2 (5)	*Heliopsis helianthoides* (L.) Sweet
2 (7)	*Juncus alpinoarticulatus* Chaix
2 (6)	*Lobelia spicata* Lam.
2 (0)	*Panicum capillare* L.
2 (10)	*Pedicularis canadensis* L.
2 (8)	*Poa secunda* J. Presl
2 (3)	*Polygonum ramosissimum* Michx.
2 (10)	*Potamogeton natans* L.
2 (8)	*Ranunculus gmelinii* DC.
2 (4)	*Ranunculus macounii* Britt.
2 (4)	*Ranunculus pensylvanicus* L. f.
2 (3)	*Ratibida columnifera* (Nutt.) Woot. & Standl.
2 (6)	*Sagittaria cuneata* Sheldon
2 (3)	*Salix amygdaloides* Anderss.

Table 2. Continued.

Coefficient	Species
2 (*)	*Veronica anagallis-aquatica* L.
1 (2)	*Ambrosia psilostachya* DC.
1 (4)	*Artemisia dracunculus* L.
1 (0)	*Asclepias syriaca* L.
1 (2)	*Atriplex subspicata* (Nutt.) Rydb.
1 (6)	*Carex granularis* Muhl. ex Willd.
1 (0)	*Conyza canadensis* (L.) Cronq.
1 (3)	*Elymus canadensis* L.
1 (2)	*Erigeron philadelphicus* L.
1 (3)	*Erigeron strigosus* Muhl. ex Willd.
1 (6)	*Glyceria striata* (Lam.) A. S. Hitchc.
1 (2)	*Hedeoma hispida* Pursh
1 (0)	*Helianthus annuus* L.
1 (0)	*Helianthus petiolaris* Nutt.
1 (0)	*Hordeum jubatum* L.
1 (5)	*Juncus interior* Wieg.
1 (2)	*Leersia oryzoides* (L.) Sw.
1 (5)	*Lysimachia hybrida* Michx.
1 (5)	*Packera pseudaureus* (Rydb.) W. A. Weber & A. Löve
1 (4)	*Pascopyrum smithii* (Rydb.) A. Löve
1 (0)	*Polygonum erectum* L.
1 (1)	*Polygonum lapathifolium* L.
1 (3)	*Populus deltoides* Bartr. ex Marsh.
1 (4)	*Populus tremuloides* Michx.
1 (0)	*Potentilla norvegica* L.
1 (9)	*Potentilla pensylvanica* L.
1 (1)	*Rumex salicifolius* Weinm.
1 (3)	*Symphyotrichum lanceolatum* (L.) Nesom
1 (5)	*Verbena hastata* L.
0 (2)	*Cyperus acuminatus* Torr. & Hook. ex Torr.
0 (0)	*Lepidium densiflorum* Schrad.
0 (9)	*Rumex orbiculatus* Gray
0 (6)	*Sorghastrum nutans* (L.) Nash

Euliss's unpublished data and the resulting $\bar{C}$ and FQI values have a different distribution and a higher mean value ($\bar{C}$ data-generated = 4.8) than the coefficients assigned by the Northern Great Plains Floristic Quality Assessment Panel ($\bar{C}$ panel-assigned = 4.2). However, the relative $\bar{C}$ and FQI values for our four wetland complexes were almost identical using the two independent assessment techniques (Tables 4 and 5). We found that restored wetlands in the younger complexes (Sweet Grass and Pilgrim's Rest) had lower $\bar{C}$ and FQI statistics than restored wetlands in Hawk's Nest and wetlands in the natural complex (Cottonwood Lake) had the highest $\bar{C}$ and FQI values using either set of C values (Tables 4 and 5). The only overlap of 95% confidence limits for $\bar{C}$ values occurred between the two youngest restored complexes (Table 4). There was no overlap of 95% confidence limits for FQI between Cottonwood Lake and any of the restored wetland complexes, and the pattern of overlap that occurred between Hawk's Nest and Sweet Grass and between Sweet Grass and Pilgrim's Rest was identical using either set of C values (Table 5).

For individual wetlands, $\bar{C}$ and FQI calculated using data-generated C values were also consistently greater

Table 3. Criteria used to assign coefficients of conservatism (C values) to native plant species from native prairie wetlands (P), natural wetlands in planted grasslands (N), restored wetlands greater than 5 years old (G), restored wetlands less than 5 years old (L), and drained wetlands (D) in the prairie pothole region of North America. Number in parentheses is the number of species assigned that value.

C Value	Criteria
10 (34)	Only occurred in P
9 (7)	Occurred in both P and N, but not in G, L, or D; $P > N$
8 (7)	Occurred in both P and N, but not in G, L, or D; $P < N$
7 (8)	Only occurred in N
6 (9)	Occurred in P and/or N, and G; P or $N > G$
5 (62)	Other combinations but greatest occurrence in P
4 (20)	Other combinations but greatest occurrence in N
3 (43)	Other combinations but greatest occurrence in G
2 (23)	Other combinations but greatest occurrence in L
1 (29)	Other combinations but greatest occurrence in D
0 (4)	Only occurred in D

Table 4. Average coefficient of conservatism ($\bar{C}$) with 95% upper and lower confidence limits for wetlands in the Cottonwood Lake, Hawk's Nest, Sweetgrass, and Pilgrim's Rest wetland complexes, 1995. Cottonwood Lake is a natural wetland complex whereas Hawk's Nest, Sweetgrass, and Pilgrim's Rest were restored in 1987, 1990, and 1993, respectively. $\bar{C}$s were calculated using coefficients provided by the Northern Great Plains Floristic Quality Assessment Panel (Panel-Assigned) and coefficients generated from data collected from 204 prairie wetlands (Data-Generated). Means followed by the same letter have overlapping 95% confidence limits.

Coefficients Complex	n	Lower 95% Conf. Limit	Mean $\bar{C}$	Upper 95% Conf. Limit
Panel-Assigned				
Cottonwood Lake	16	4.0	4.2 a	4.4
Hawk's Nest	14	3.1	3.3 b	3.4
Sweetgrass	11	2.9	3.0 bc	3.2
Pilgrim's Rest	12	2.5	2.7 c	3.0
Data-Generated				
Cottonwood Lake	16	4.7	4.9 a	5.0
Hawk's Nest	14	3.7	3.8 b	3.9
Sweetgrass	11	3.2	3.4 c	3.5
Pilgrim's Rest	12	2.8	3.0 c	3.3

Table 5. Average floristic quality index (FQI) with 95% upper and lower confidence limits for wetlands in the Cottonwood Lake, Hawk's Nest, Sweetgrass, and Pilgrim's Rest wetland complexes, 1995. Cottonwood Lake is a natural wetland complex whereas Hawk's Nest, Sweetgrass, and Pilgrim's Rest were restored in 1987, 1990, and 1993, respectively. FQIs were calculated using coefficients provided by the Northern Great Plains Floristic quality Assessment Panel (Panel-Assigned) and coefficients generated from data collected from 204 prairie wetlands (Data-Generated). Means followed by the same letter have overlapping 95% confidence limits.

Coefficients Complex	n	Lower 95% Conf. Limit	Mean FQI	Upper 95% Conf. Limit
Panel-Assigned				
Cottonwood Lake	16	25.5	27.9 a	30.3
Hawk's Nest	14	17.1	18.8 b	20.5
Sweetgrass	11	14.9	16.6 bc	18.3
Pilgrim's Rest	12	11.7	14.1 c	16.6
Data-Generated				
Cottonwood Lake	16	28.9	30.8 a	32.7
Hawk's Nest	14	19.3	21.1 b	22.9
Sweetgrass	11	16.4	18.1 bc	19.9
Pilgrim's Rest	12	12.5	15.0 c	17.5

than those calculated using panel assigned C values. Using the data-generated C values, $\bar{C}$ for individual wetlands ranged from 2.4 at Pilgrim's Rest to 5.3 at Cottonwood Lake. $\bar{C}$ values of the restored wetlands rarely exceeded 3.9 (n = 4), and no wetlands in any of the three restored complexes had a $\bar{C}$ greater than 4.2. All of the Cottonwood Lake wetlands had $\bar{C}$ values greater than 4.2. Using panel-assigned C values, $\bar{C}$ for individual wetlands ranged from 2.1 at Pilgrim's Rest to 4.7 at Cottonwood Lake. $\bar{C}$ values of the restored wetlands rarely exceeded 3.4 (n = 4), and no wetlands in any of the three restored complexes had a $\bar{C}$ greater than 3.9. All but two of the Cottonwood Lake wetlands had $\bar{C}$ values greater than 3.9. Floristic quality indices for individual wetlands were also greater when calculated using data-generated C values than when calculated using panel-assigned C values. Using data-generated values, FQIs for individual wetlands ranged from 8.4 at Pilgrim's Rest to 35.6 at Cottonwood Lake. Floristic quality indices for restored wetlands rarely exceeded 26 (n = 2), and only two wetlands at Cottonwood Lake had an FQI less than 26. Using panel-assigned C values, FQIs of individual wetlands ranged from 8.3 at Pilgrim's Rest to 33.8 at Cottonwood Lake. Floristic quality indices for restored wetlands rarely exceeded 22 (n = 2), and only two wetlands at Cottonwood Lake had FQIs less than 22.

Table 6. Average species richness (number of species per wetland) estimates and percentage of native species, with 95% upper and lower confidence limits for wetlands in the Cottonwood Lake, Hawk's Nest, Sweetgrass, and Pilgrim's Rest wetland complexes, 1995. Cottonwood Lake is a natural wetland complex whereas Hawk's Nest, Sweetgrass, and Pilgrim's Rest were restored in 1987, 1990, and 1993, respectively. Means followed by the same letter have overlapping 95% confidence limits.

Complex	n	Lower 95% Conf. Limit	Mean	Upper 95% Conf. Limit
Including Non-Natives				
Cottonwood Lake	16	50.7	55.7 a	60.7
Hawk's Nest	14	45.6	50.9 ab	56.3
Sweetgrass	11	45.6	50.3 ab	54.9
Pilgrim's Rest	12	38.2	44.4 b	50.6
Excluding Non-Natives				
Cottonwood Lake	16	39.5	44.4 a	49.3
Hawk's Nest	14	29.3	33.8 b	38.2
Sweetgrass	11	26.2	30.3 b	34.3
Pilgrim's Rest	12	21.3	27.1 b	32.8
Percent Natives				
Cottonwood Lake	16	68.9	71.4 a	73.9
Hawk's Nest	14	57.0	60.1 b	63.1
Sweetgrass	11	54.4	57.3 b	60.2
Pilgrim's Rest	12	49.1	54.5 b	59.9

Mean species richness values also increased with increased age of the complexes and were greatest in wetlands of the natural wetland complex (Table 6). However, 95% confidence intervals of species richness overlapped in all cases except between Cottonwood Lake (the natural complex) and Pilgrim's Rest (the youngest restored complex). When non-natives are excluded from the species richness estimates, confidence intervals for Cottonwood Lake no longer overlap with the restored complexes. However, 95% confidence intervals for all three restored complexes still overlap greatly. The percentage of native species showed similar overlap of 95% confidence intervals.

DISCUSSION

Our findings closely parallel those of Swink and Wilhelm (1994) despite the geographic and climatic differences between the prairie pothole region and the Chicago region. Swink and Wilhelm found that $\bar{C}$ values for restored wetlands in the Chicago region tended to reach maximums between 3.0 and 3.7 after approximately five years, with FQIs ranging from 25 to 35. Restored wetlands within the wetland complexes we studied had $\bar{C}$ values ranging from 2.1 to 3.8, with the highest $\bar{C}$ values occurring in wetlands of the oldest complex (Hawk's Nest). Wetlands at the natural complex, Cottonwood Lake, had the highest $\bar{C}$ values (3.4 to 4.7) of any of the four complexes studied. Floristic quality index values for the restored wetlands in our study were generally lower than those found for restored wetlands by Swink and Wilhelm (1994); however, they followed the same trend, with FQI values increasing as wetlands increased in age and peaking at about 21 in the oldest restored complex we evaluated.

Species richness may provide a distorted picture of the floristic quality of specific sites. Several of our restored wetlands had species richness values meeting or exceeding values for wetlands at Cottonwood Lake. Based on richness alone, it would be easy to conclude that the restored wetlands had floristic quality equal to or exceeding that of the natural wetlands at Cottonwood Lake. However, by applying C values and calculating $\bar{C}$ and FQI values for each wetland, we found that although species richness was similar among wetlands, many of the species present in restored wetlands were relatively low quality, ''opportunistic'' species, and as expected, the natural area had the greatest floristic quality with more conservative species than any of the three restored complexes we examined. Additionally, 95% confidence limits overlapped greatly among complexes when considering species richness (Table 6). However, confidence limits for both $\bar{C}$ and FQI overlapped little among the natural and restored complexes (Tables 4 and 5), clearly showing that Cottonwood Lake supported plant communities of greater floristic quality than any of the restored complexes. A trend in increasing floristic quality as restored wetlands age is also clearly evident in the $\bar{C}$ and FQI values. This trend is suggested but obscured in the species richness values due to overlapping confidence limits among all three restored complexes.

The historic land-use and current management strategies at Cottonwood Lake have not been optimal to promote the preservation of conservative species. Only three species at Cottonwood Lake had a panel–assigned C value of 10 (Table 1). Although none of the wetlands at Cottonwood Lake have been drained, approximately 18% of the upland areas surrounding the wetlands had been tilled and planted to agricultural crops prior to acquisition by the U.S. Fish and Wildlife Service in 1963. This disturbance of the uplands and the resulting alteration of the wetlands through sediment and chemical inputs (Martin and Hartman 1986, Grue et al. 1989, Gleason and Euliss 1998) may have adversely affected some conservative species. Since 1963, management of the site by the U.S. Fish and Wildlife Service has been directed by long-term studies of wetland hydrology, water chemistry, and wetland biota. These studies have limited the extent to which fire, grazing, and other management tools could be used to promote the preservation of conservative species that evolved under natural regimes of periodic burning and grazing. Even given the less than optimal conditions at Cottonwood Lake, its wetlands still had greater floristic quality (i.e., supported more conservative species) than wetlands of the restored complexes we evaluated. In fact, there were 15 species with panel-assigned C values greater than 5 that occurred at Cottonwood Lake but did not occur in any of the 3 restored complexes (Table 1).

$\bar{C}$ values of restored wetlands in the complexes we studied rarely exceeded 3.4 and usually reached maximums closer to 3.3 in the oldest restored complex; respective FQI values rarely exceeded 22 and usually reached maximums closer to 19. Not a single species with a panel-assigned C value of 10 occurred in any of the restored complexes. Additionally, we found that wetlands with $\bar{C}$ values greater than 3.8 or FQI values greater than 25 had plant communities of a quality that was not duplicated in any of the restored complexes we studied. The floristic quality assessment method developed and refined by Swink and Wilhelm (1979, 1994) provides a means by which these high quality wetlands can be identified. In addition to evaluating restoration efforts and identifying areas of high floristic quality, floristic quality assessment can be used to facilitate comparisons of plant communities among different sites, to monitor areas for changes in floristic quality over time, and to evaluate the response of plant communities to management treatments.

The rules we used to derive data-generated C values (Table 3) for plant species data collected by Gleason and Euliss (unpublished data) produced greater C values with a different distribution than those subjectively assigned by the Northern Great Plains Floristic Quality Assessment Panel (Table 1). The five disturbance classes we chose may not have adequately spanned the entire disturbance gradient. Four of the five classes had tilled soils surrounding the wetlands. Thus, a plant occurring in a natural wetland that had the uplands tilled and replanted to grasses could have received a coefficient as high as 9. Using the criteria established by the panel (Northern Great Plains Floristic Quality Assessment Panel 2001) the same species would likely receive a C value of 4 or less. Using the panel's criteria, coefficients of 5 or more were reserved for species that almost always occur in natural areas but with varying degrees of degredation; we only had a single class for native prairie wetlands and gave all plants that only occurred there the maximum C value of 10. Even though the $\bar{C}$s and FQIs we obtained using the C values generated from data were consistently greater than those obtained using the coefficients assigned subjectively, the conclusions reached based on the independent evaluations were virtually identical. The similarity of the two evaluations supports the argument that C values assigned subjectively by expert botanists familiar with a region's flora provide adequate information to perform accurate floristic quality assessments.

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