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Changes in the Vegetation and Wildlife Use of a Small Prairie Wetland Following a Drought[1]

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Several transect methods were used to study marsh vegetation resulting from drought-induced mud flats of a 1.7-ha wetland in northwestern Iowa. All three methods produced comparable results, but point-count and interval transects were most rapid and reflected submergent and floating as well as emergent plants. Most wet meadow plants were eliminated in about three years, whereas shallow marsh and deep marsh species survived until muskrats eliminated all emergent plants. Both vegetation and wildlife responses were typical of shallow prairie wetlands of the region.
INDEX DESCRIPTORS: Wetlands; Vegetation; Wildlife.

Understanding the dynamics of wetland vegetation in relation to water levels is important in understanding wildlife use, plant strategies for establishment and reproduction, plant-water relationships, and in practical uses such as marsh restoration and wildlife management. Partly to gain detailed information on selected wetlands in relation to wildlife use and partly to evaluate several common methods of quickly assessing marsh vegetation, this study was established in 1968 when the study wetland, like numerous other potholes in northwestern Iowa, was dry. Vegetation and wildlife populations were recorded through 1974 after several years of normal water levels.

Specific objectives were to: 1) document changes in vegetation from the mud flat germination phase to the open-water stage, examining changes in species composition and life form, 2) evaluate the relative value of several common methods used for rapid assessment of vegetation, and 3) relate vegetative changes to wildlife use.

We are indebted to several student assistants who sampled or helped to sample transects during 1968 to 1974, particularly Steven Byers, Loren Bates, Robert Howard, William Eldridge, Jan Eldridge, and the late Robert Bergman. Field work on this project was conducted under the Iowa Conservation Commission Pittman-Robertson Research Projects W-105R and W-113R, Iowa Agriculture and Home Economics Experiment Station Project 1969, and analysis was done under Project 17-88 of the Minnesota Agricultural Experiment Station. Alan Afton and Frank Martin of the University of Minnesota assisted in the statistical analysis.

STUDY AREAS AND METHODS

A single Class IV wetland (Stewart and Kantrud 1971), number A6, was selected in Dewey's Pasture Wildlife Management Area near Ruthven, Iowa. The wetland was about 1.7 ha (4.2 acres), in the shape of a dumbbell, and connected at high water level by a narrow channel to an adjacent and larger wetland. Surrounding uplands were rolling and dominated by bluegrass as described by numerous authors (see Weller 1979).

Water level data were recorded annually during late May or early June as an index to general water conditions on the area, and in some years, seasonal records were maintained to measure water loss during the summer.

An index to bird use was determined by repeated nest searches for overwater nests of nonpasserines. Records of muskrat activity are available from photographs taken annually.

Gross cover maps were made annually after the peak of growth, and photos were taken from the same point annually. Detailed vegetative data were gathered along three transects selected randomly from 60 east-west lines established at uniform intervals. Transects 1 and 3 were in the northern and larger lobe; transect 2 was in the southern, smaller segment. Transects crossed the marsh, connecting the outer edges of the shallow marsh zone. On each transect, data were recorded in three ways: a *point-count* at each 1-foot interval along a metal tape recorded presence or absence of all plant life forms by species; *intercepts* of plant species and numbers of individual emergent plants in contact with both sides of each foot of the tape; and *interval*, the presence or absence of a species along each 1-foot interval. The intercept represents a count of emergent plants by species and, therefore, provides some index to density but was not useful for submergent or floating plants. The other two methods show presence or absence in the sampling units and a gross measure of abundance. All provide an index to species richness. Statistical tests were Analysis of Variance (ANOVA) and Chi-square.

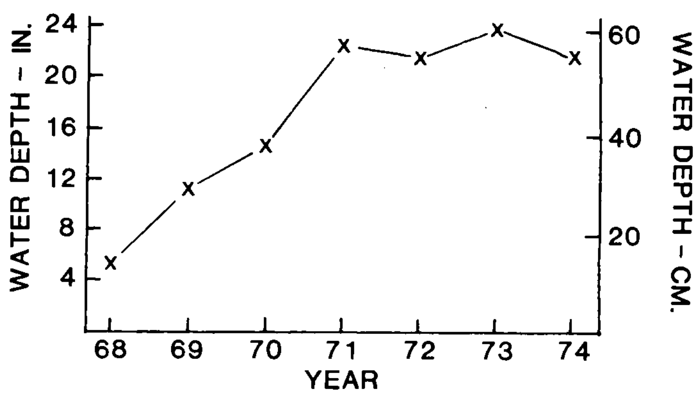

Fig. 1 **Water level changes on pothole number A6 from 1968-1974, based on levels in late May or early June.**

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Table 1. Counts of plants sampled by transect, transect method, and year. I^1 = totals stems intercepting both sides of sampling tape; I^2 = number of 1-foot intervals with species present; P.C. = point-count at 1-foot intervals. Plants are ordered by growth form, by time of germination, and by relative abundance. Transects varied in length as follows: T1 = 230'; T2 = 110'; T3 = 241'.

		1968			1969			1970			1971			1972			1973			1974		
		T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
EMERGENT SPECIES																						
Cattail *Typha* spp.	I^1	439	216	297	52	77	10	25	21	14	5	26	0	0	0	0	0	0	0	2	0	2
	I^2	59	79	61	40	53	7	22	18	13	4	19	0	0	0	0	0	0	0	2	0	0
	P.C.	19	17	11	13	15	3	5	3	1	0	4	0	0	0	0	0	0	0	0	0	1
Arum-leaved Arrowhead *Sagittaria cuneata*	I^1	124	87	105	92	3	139	50	9	98	62	2	115	21	6	32	0	1	4	0	0	1
	I^2	74	56	64	92	3	139	49	2	81	51	2	79	18	6	26	0	1	3	0	0	2
	P.C.	9	5	10	4	3	0	9	0	23	7	0	15	5	0	4	0	0	0	0	2	0
Soft-stemmed Bulrush *Scirpus validus*	I^1	109	193	61	38	149	77	0	5	4	0	7	1	0	0	0	0	1	0	0	0	0
	I^2	43	49	35	20	64	40	0	5	3	0	4	1	0	0	0	0	1	0	0	0	0
	P.C.	1	8	4	6	21	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Large Burreed *Sparganium eurycarpum*	I^1	64	19	37	26	0	10	20	3	8	15	0	1	0	0	0	0	0	0	0	0	0
	I^2	49	13	22	18	0	8	19	3	7	14	0	1	0	0	0	0	0	0	0	0	0
	P.C.	2	2	0	7	0	1	2	0	1	1	0	1	0	0	0	0	0	0	0	0	0
Spike-rush *Eleocharis palustris*	I^1	55	123	10	0	0	0	0	0	105	7	7	86	0	0	0	0	0	0	0	0	0
	I^2	16	22	6	0	0	0	0	0	34	3	2	30	1	0	0	0	0	0	0	0	0
	P.C.	0	3	1	0	0	0	0	0	5	1	0	2	0	0	0	0	0	0	0	0	0
Lake Sedge *Carex lacustrus*	I^1	34	24	2	12	2	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I^2	12	20	2	11	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P.C.	1	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Bulrush *Scirpus fluviatilis*	I^1	20	0	18	12	5	12	5	3	4	3	1	1	0	0	0	0	0	0	0	0	0
	I^2	8	0	14	11	4	8	3	3	3	3	1	1	0	0	0	0	0	0	0	0	0
	P.C.	2	0	1	2	0	4	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Water Plaintain *Alisma subcordatum*	I^1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I^2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P.C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hard-stemmed Bulrush *Scirpus acutus*	I^1	0	0	2	35	43	0	59	40	81	23	39	18	0	2	2	0	0	0	0	0	0
	I^2	0	0	1	20	17	0	36	28	38	12	20	10	0	2	2	0	0	0	0	0	0
	P.C.	0	0	1	7	6	0	4	3	8	1	1	0	0	0	1	0	0	0	0	0	0
Smartweed *Polygonum* spp.	I^1	0	0	0	2	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0
	I^2	0	0	0	2	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0
	P.C.	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
SUBMERGENT SPECIES																						
Water Buttercup *Rannunculus* spp.	I^1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I^2	172	15	135	223	25	241	48	10	116	11	5	6	0	0	0	0	0	0	0	0	0
	P.C.	42	8	22	17	9	241	36	2	49	2	0	1	0	0	0	0	0	0	0	0	0
Greater Bladderwort *Utricularia vulgaris*	I^1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I^2	0	0	0	0	16	135	178	88	207	144	72	136	77	96	69	2	14	0	0	0	0
	P.C.	0	0	0	0	13	68	99	35	134	87	45	87	28	82	32	0	3	0	0	0	0
Water Milfoil *Myriophyllum spicatum*	I^1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I^2	0	0	0	0	0	0	5	0	1	84	0	35	199	23	163	29	19	14	0	0	0
	P.C.	0	0	0	0	0	0	3	0	0	42	0	8	150	6	125	2	6	1	0	0	0
Sago Pondweed *Potamogenton pectinatus*	I^1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I^2	0	0	0	0	0	0	3	0	12	78	2	111	2	0	0	0	0	2	2	35	2
	P.C.	0	0	0	0	0	0	2	0	4	65	0	98	0	0	0	0	0	2	1	17	1

Table 1 continued (2).

		1968			1969			1970			1971			1972			1973			1974		
		T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
SUBMERGENT SPECIES (cont'd)																						
Coontail																						
Certatophyllum demersum	I[1]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I[2]	0	0	0	0	0	0	0	0	0	21	0	11	49	1	77	61	20	188	60	8	87
	P.C.	0	0	0	0	0	0	0	0	0	2	0	6	12	0	33	20	5	40	29	5	29
Leafy Pondweed																						
Potamogenton foliosus	I[1]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I[2]	0	0	0	0	0	0	0	0	0	0	0	0	49	8	114	48	54	24	2	6	6
	P.C.	0	0	0	0	0	0	0	0	0	0	0	0	11	1	84	16	39	8	1	2	1
FLOATING SPECIES																						
Slender Riccia																						
Riccia fluitans	I[1]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I[2]	0	0	0	0	0	0	2	10	3	0	74	6	18	36	8	0	0	0	0	0	0
	P.C.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Ivy-leaved Duckweed																						
Lemna trisculca	I[1]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I[2]	0	0	0	0	0	0	1	9	0	0	21	4	18	23	17	5	31	45	27	25	15
	P.C.	0	0	0	0	0	0	0	1	0	0	2	0	0	2	1	0	4	0	7	10	4
Lesser Duckweed																						
Lemna minor	I[1]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I[2]	0	0	0	0	0	0	0	0	0	0	30	3	3	29	0	0	0	0	0	0	0
	P.C.	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Algae																						
Filamentous algae	I[1]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I[2]	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	150	35	217	13	26	13
	P.C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	92	22	191	6	13	6
Purple-fringed Riccia																						
Ricciocarpus natans	I[1]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	I[2]	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	0	0	0	0
	P.C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dotted Wolfia																						
Wolfia punctata	I[1]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	I[2]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	6	0	0	0
	P.C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

RESULTS

Water Levels

Year-to-year water level changes in late May or early June are shown in Figure 1 and reflect a change from a wet mud condition in August of 1968 with a few small pools of less than 2 cm to a fully flooded but shallow condition in the spring of 1969. In 1970 the water level started at full pool in May but was nearly dry by early August. The area was at full-pool level from the spring of 1971 until August of 1974, when the level declined drastically during the summer until the area again was open sheetwater.

Seasonal variation in depth was measured in 1970, 1971, 1972, and 1974. Water-level declines from late May or early June until early August varied from a minimum of 5 cm in 1972 to 48 cm in 1974. Water loss varied with rainfall, winds, and vegetation.

Vegetation: General Patterns

Because of a previous pattern of high water level and muskrat consumption of dominant emergents, pothole A6 was generally open but dry in midsummer of 1968. The only remaining vegetation was in small residual stands of cattail (*Typha latifolia*). In 1969, sparse vegetation resulted from germination on the mud flats in 1968 and covered about 50% of the area. By 1970, only one-fourth of the area was open water, consisting of two pools. Thereafter, opening progressed from 40% (1971), to 80% (1972), 90% (1973), and 95% (1974). The drastic decline in emergent vegetation between 1971 and 1972 was a product of muskrat eat-out. Muskrat density was about nine lodges per hectare in 1972.

The general vegetative pattern was typical of most studies reported previously: residual cattail tolerated the drought; germination resulted in a diversity of species that survived until high water and muskrats eliminated them after about four years (see Weller and Spatcher 1965, Weller and Fredrickson 1974).

Vegetation: Transect Data

The three transects reflect the general changes recorded on cover maps: high density of seedlings in 1968, reduced but stable plant densities for 1969-1971, and reduced density of emergents after 1971. Data from all transects are shown by method and year in Table 1.

Plant species richness reached a peak in 1971, three years after the natural drawdown, but establishment was earlier for emergents than for submergents or floating plants (Table 2). Emergents reached their peak in species richness immediately after flooding, remained constant until 1971, and declined drastically by 1972. Emergent plants were eliminated in the following order: water plaintain, spikerush, soft-stemmed bulrush, river bulrush, and lake sedge (Table 3).

Table 2. Plant species richness recorded on transects by year and life form.

	All Species	Emergents	Submergents	Floating
1968	10	9	1	0
1969	10	8	2	0
1970	17	9	4	4
1971	19	8	6	5
1972	13	3	5	5
1973	10	1	6	3
1974	7	2	3	2

Table 3. Plant species recorded on transects, arranged by growth form, colonization time, and realtive abundance.

	1968	1969	1970	1971	1972	1973	1974
Emergents							
Cattail	X	X	X	X	—	—	X
Arum-leaved Arrowhead	X	X	X	X	X	X	X
Soft-stemmed Bulrush	X	X	X	X	—	—	—
Large Burreed	X	X	X	X	—	—	—
Spike-rush	X	—	X	X	X	—	—
Lake Sedge	X	X	X	—	—	—	—
River Bulrush	X	X	X	X	—	—	—
Hard-stemmed Bulrush	X	X	X	X	X	—	—
Water Plaintain	X	—	—	—	—	—	—
Smartweed	—	X	X	X	—	—	—
Submergents							
Water Buttercup	X	X	X	X	—	—	—
Greater Bladderwort	—	X	X	X	X	X	—
Water Milfoil	—	—	X	X	X	X	—
Sago Pondweed	—	—	X	X	—	X	X
Muskgrass	—	—	—	X	X	X	—
Coontail	—	—	—	X	X	X	X
Leafy Pondweed	—	—	—	—	X	X	X
Floating							
Slender Riccia	—	—	X	X	X	—	—
Ivy-leaved Duckweed	—	—	X	X	X	X	X
Lesser Duckweed	—	—	X	X	X	—	—
Purple-fringed Riccia	—	—	X	X	X	—	—
Algae	—	—	—	X	—	X	X
Dotted Wolfia	—	—	—	—	X	X	—

Both submergents and free-floating plants peaked in 1971 and were reduced only by shallow water again in 1974. Except for water buttercup which germinated on the mud flats, submergents developed with continuous inundation. Bladderwort appeared in 1969, followed by water milfoil, chara, and sago. The last submergent species to establish after four years was leafy pondweed. It is more difficult to assess the pattern for free-floating plants because they are not present significantly on mud flats and may be blown free at the openmarsh stage. *Riccia* and *Ricciocarpus* were best represented at midstage or hemimarsh when protected by emergents, and *Wolfia* appeared late in the cycle.

Table 4. Summary of ANOVAs for differences between years based on presence in 1-foot intervals on transects 1 to 3.

Plant	F-Value	Prob. Level
Cattail	76.270	$p<.01$
Arum-leaved Arrowhead	18.530	$p<.01$
Soft-stemmed Bulrush	8.377	$p<.01$
Large Burreed	73.630	$p<.01$
Spike-rush	2.568	$p<.05$
Lake Sedge	14.360	$p<.01$
River Bulrush	19.010	$p<.01$
Water Plaintain	4.000	$p<.01$
Hard-stemmed Bulrush	25.750	$p<.01$
Smartweed	47.200	$p<.01$
Water Buttercup	13.690	$p<.01$
Greater Bladderwort	134.300	$p<.01$
Water Milfoil	267.600	$p<.01$
Sago Pondweed	71.500	$p<.01$
Muskgrass	88.270	$p<.01$
Coontail	11.280	$p<.01$
Leafy Pondweed	160.600	$p<.01$
Slender Riccia	1.267	$p>.05$
Ivy-leaved Duckweed	7.257	$p<.01$
Lesser Duckweed	1.081	$p>.05$
Algae	338.700	$p<.01$
Purple-fringed Riccia	1.000	$p>.05$
Dotted Wolfia	0.9972	$p>.05$
Totals		
Floating	7.025	$p<.01$
Submergents	54.940	$p<.01$
Emergents	30.130	$p<.01$

[1]Species not recorded on transects

Occurrences of plants by years are shown in Table 3 based on data pooled from all methods and transects. Twenty-four species or taxa were recorded. ANOVAs showed differences between years in all but four cases of floating plants which were affected by wind drift (Table 4). Chi-square tests uniformly demonstrated significant differences between years for all species except *Polygonum* spp., for which data were sparse, and these data are, therefore, not shown.

Evaluation of Vegetation Sampling Methods

Although the intercept system provided the largest sample size and reflected the gradual change from one plant community to another, it was the most time-consuming system and showed no obvious differences between data from the other methods. Both the point-count and interval methods were used to sample the transects with the assumption that chances are in favor of striking the same species and reflecting their relative distribution and abundance. The intercept method was not suitable for quick assessment of small floating plants or submergents, and both point-count and interval were best for all species where density data were not essential.

Effects on Wildlife

Muskrats (*Ondatra zibethicus*) were absent in 1968, although deteriorated lodges remained from 1967. Muskrats invaded early in 1969, and lodges were conspicuous in 1971. By 1972, about 16 lodges were in evidence, and the area had been significantly denuded. Lodges were scarce in 1973, and only two remained in 1974.

Table 5. Nests of birds that nested overwater on Dewey's Pasture pothole A6, 1968-1974.

Year	American Coot (*Fulica americana*)	Pied-billed Grebe (*Podilymbus podiceps*)	Black Tern (*Childonias niger*)	Ruddy Duck (*Oxyura jamaicensis*)	Least Bittern (*Ixobrychus exilis*)	Nest Totals	Species Richness
1968	0	0	0	0	0	0	0
1969	3	0	0	0	0	3	1
1970	2	1	7	0	0	10	3
1971	1	2	0	1	1	7	4
1972	2	1	0	0	0	3	2
1973	3	1	0	0	0	4	2
1974	0	1	0	0	0	1	1

Nests of birds that use overwater sites were recorded annually and are shown in Table 5. There was an immediate response to flooding, but the vegetation was too sparse for anything but late-nesting coots in 1969. Three species nested in 1970 with a total of 10 nests, and 4 species had 7 nests in 1971. By 1972 and 1973, vegetation again was sparse, and only coots and grebes nested. One grebe even nested in 1974 when there were only a few small clumps of vegetation.

As a part of a related study, aquatic invertebrates were sampled in this wetland during 1971 and 1972 (Voigts 1976). Invertebrate abundance was generally greatest in beds of submerged vegetation interspersed with emergent vegetation.

DISCUSSION

Vegetative change and waterbird response after a drought in 1968 was typical of the dynamics of larger areas where such observational data have been recorded (Weller and Spatcher 1965) or where experimental water manipulations have been conducted (Weller and Fredrickson 1974). These data demonstrate the responsiveness of emergent plants to suitable germination sites, the slower establishment of submergent plants such as sago pondweed, and the rapid response of coots and grebes to newly flooded vegetation. Also evident is the pattern of muskrat invasion and the subsequent elimination of vegetation and the waterbirds that use such vegetation for nest sites.

These data on species richness and numbers of nests generally agree with the pattern experienced in the entire Dewey's Pasture Wildlife Management Area (Weller 1979) but with smaller numbers of species involved. Although the response time of this pattern differed little from that of larger wetlands, and this 2-ha unit had many fewer bird species, the greatest bird species richness and density occurred in 1970 and 1971 when plant species richness was greatest. Similar data for areas of various sizes should provide necessary inputs for modeling water fluctuations, vegetative dynamics, and wildlife response to such wetland habitats.

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