Abundance and Characteristics of Northern Indiana Wetlands

Robert E. Rolley
Indiana Division of Fish and Wildlife
300 W. First Street
Bloomington, Indiana 47401
AND
Jimmy F. New
Indiana Division of Fish and Wildlife
5344 S. Hupp Road
LaPorte, Indiana 46350

Introduction

Fresh water wetlands are among the most productive habitats on earth. Wetlands are essential habitat for many species of waterfowl, furbearers, nongame birds and mammals, fish, mollusks, herptiles, and plants. Other values of wetlands include timber production, flood control, water quality improvement, erosion control, and recreation (Tiner 1984).

An estimated 178,000 ha of inland wetlands are lost nationally each year, primarily due to agricultural development. Approximately 54% of the original 81,000,000 ha of wetlands in the 48 contiguous states had been drained or filled by the mid-1970's (Tiner 1984).

Information on the abundance and characteristics of wetlands is needed to guide wetland conservation efforts. This study was undertaken to provide preliminary information on wetlands in northern Indiana as part of an ongoing statewide wetland inventory.

Methods

The size and classification of wetlands were determined from wetland maps and interpreted aerial photographs, enlarged to a scale of 1:24,000, that were prepared by the National Wetlands Inventory, U.S. Fish and Wildlife Service. Color-infrared aerial photographs were taken during May and June 1981-84. Wetland maps and interpreted photo-enlargements were available for the northern third of the state. The study area was divided into two regions, the Northern Indiana Wetland Region (NIWR) and the Kankakee and Wabash River Watersheds (KWRW), based on a subjective assessment of wetland density (Figure 1).

Wetlands were classified according to Cowardin et al. (1979). The Lacustrine system includes large permanently flooded lakes, reservoirs, and smaller basins that are greater than 2 meters deep. Palustrine wetlands are small and/or shallow areas, usually dominated by hydrophytic vegetation, frequently referred to as marshes, swamps, bogs, or fens. The Riverine system includes wetlands that are contained within a channel that at least periodically contains flowing water.

Water regime modifiers describe the duration and frequency of flooding which partially influences the plant and animal communities of wetlands. Temporarily flooded wetlands have surface water for only short periods of time during the growing season and ground water is usually well below the surface. Ground water is usually at or near the surface in saturated wetlands. Seasonally flooded wetlands have surface water for extended periods early in the growing season but usually become dry by the end of the growing season. Semipermanently flooded sites have surface water throughout the growing season in most years, intermittently exposed areas have surface water in all but the driest years, and permanently flooded wetlands have surface water in all years. Intermittently flooded wetlands usually have exposed substrates but surface water may be present for

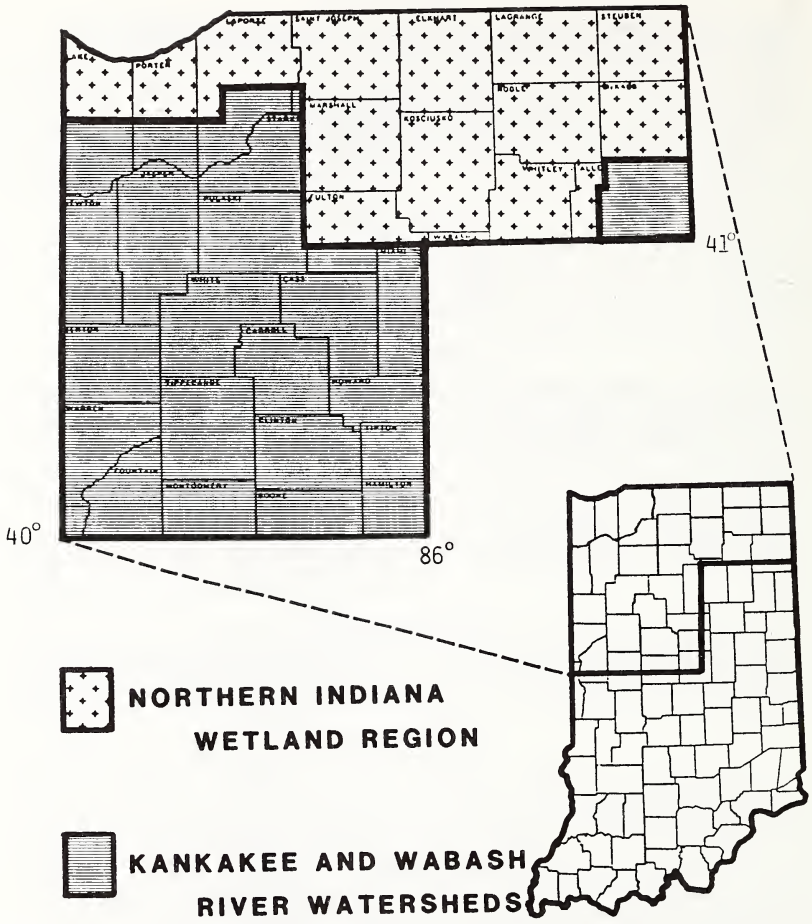

FIGURE 1. Location of northern Indiana study area.

variable periods not related to season flooding. Artificially flooded wetlands are those where the duration and timing of flooding are controlled by man with pumps, siphons, dikes, or dams.

We used a stratified random sample of sections (2.59 sq. km) to estimate the area and abundance of wetlands. The sampling scheme was modified from that described by Brewster et al. (1976) and Heitmeyer (1980). One section was randomly selected from each of 333 townships in northern Indiana. The number of wetlands in each section and their classification were recorded. The area of every wetland in the sample quadrats was measured with a Numonics digitizer. Very narrow wetlands, that were mapped with lines instead of enclosed polygons, were assumed to be 6.1 m wide for area calculations.

The mean ($\pm$ SE) number and ha of wetlands in the sample quadrats were expanded to estimate the number and ha of surface area of wetlands in each region. Chi-square tests of independence were used to examine regional differences in the distribution of wetland classifications. Regional differences in wetland size were examined with t-tests.

Wetland areas were log-transformed because size distributions differed significantly from normality ($P \leq 0.01$).

We used the terminology of Cowardin (1982) to differentiate between wetlands (areas of homogeneous hydrologic, edaphic, and biological characteristics) and wetland basin (land feature capable of holding water). A wetland basin may contain one or more wetlands.

Results

A total of 2,329 wetland basins were present within the 333 sampled quadrats. Eighty-four percent of the wetland basins were homogeneous areas containing a single wetland. The remaining 16% were heterogeneous areas with two or more wetlands per basin. These heterogeneous basins contained an average of 3.0 wetlands/basin.

Sampled sections within the NIWR contained a mean of 10.8 ± 0.7 wetland basins and 23.3 ± 2.5 ha of wetlands. Extrapolation of these estimates to the entire 11,932 km² region resulted in an estimated 49,603 ± 3,032 wetland basins that covered 107,145 ± 11,681 ha. Within the KWRW, sampled quadrats contained an average of 4.5 ± 0.3 wetland basins and 10.0 ± 1.1 ha of wetlands. These estimates expand to 35,463 ± 2,600 basins and 78,722 ± 8,812 ha of wetlands within the 20,479 km² KWRW. In the northern third of Indiana, we estimate that there were 85,066 ± 3,939 wetland basins and 185,867 ± 17,292 ha of wetlands.

Palustrine wetlands comprised 96% of the wetlands and 78% of the wetland surface area in northern Indiana (Table 1). Only 1% of the wetlands were lacustrine, but

TABLE 1. Estimated number and area (ha) of wetlands of each wetland system in northern Indiana. Standard errors of the estimates are in parentheses.

Wetland system	Northern Indiana Wetland Region	Kankakee & Wabash River Watersheds	Total
N wetlands			
Lacustrine	828	473	1,301
	(175)	(140)	(225)
Palustrine	63,666	44,487	108,152
	(3,767)	(3,272)	(4,927)
Riverine	691	2,799	3,490
	(159)	(382)	(385)
Area of wetland			
Lacustrine	21,483	13,131	34,613
	(2,542)	(1,694)	(3,473)
Palustrine	84,430	60,529	144,960
	(9,260)	(6,842)	(13,557)
Riverine	1,243	5,062	6,305
	(297)	(793)	(843)

because of their relative large area ($\bar{x}$ = 26.6 ha), lacustrine wetlands comprised 19% of the wetland surface area. Three percent of wetlands were riverine and these accounted for 3% of the wetland surface area.

The distribution of wetland systems differed slightly but significantly between the two regions ($\chi^2 = 59.7$, df = 2, $P < 0.001$). Riverine system wetlands composed 6% of wetlands in the KWRW but constituted only 1% of the wetlands in the Northern Indiana Wetland Area. Palustrine wetlands composed 93% and 98% of the wetlands in the KWRW and NIWR, respectively.

Seven wetland classes were represented in the sampled quadrats. Unconsolidated

bottom, the predominant class for both lacustrine and riverine system wetlands, formed 99% of the wetland surface area for lacustrine system wetlands and 98% for riverine system wetlands. The remaining area of lacustrine wetlands was classified as unconsolidated shore. The class streambed comprised 1% of the riverine surface area, as did the class unconsolidated shore.

The most frequent classes of palustrine wetlands were forested, emergent, and scrub-shrub wetlands (Table 2). In the entire study area, 52% of the palustrine surface area

TABLE 2. Estimated area (ha) of wetland classes in northern Indiana. Standard errors of the estimate are in parentheses.

Wetland system and class	Northern Indiana Wetland Region	Kankakee & Wabash River Watersheds	Total
Lacustrine			
Unconsolidated bottom	21,303 (2,552)	13,131 (1,694)	34,434 (3,480)
Unconsolidated shore	180 (401)	0	180 (416)
Palustrine			
Aquatic bed	388 (140)	291 (129)	679 (192)
Emergent	30,876 (3,516)	14,933 (1,858)	45,809 (4,459)
Forested	37,968 (4,279)	37,794 (4,360)	75,770 (7,209)
Scrub-shrub	10,511 (1,323)	2,948 (511)	13,460 (1,477)
Unconsolidated bottom	4,677 (683)	4,564 (702)	9,241 (1,081)
Riverine			
Streambed	0	39 (53)	39 (52)
Unconsolidated bottom	1,243 (297)	4,960 (782)	6,203 (834)
Unconsolidated shore	0	62 (67)	62 (66)

was composed of forested wetlands, 32% was emergent wetlands, and 10% was scrub-shrub wetlands.

The distribution of palustrine wetland classes was significantly different between regions ($\chi^2 = 27.2$, df = 5, $P < 0.001$). The forested class made up 62% of the palustrine wetland surface area in the KWRW, whereas it composed 45% of the surface area in the NIWR. Emergent and scrub-shrub classes comprised 37% and 12%, respectively, of the wetland surface area in the NIWR as compared to 25% and 5% in the KWRW.

The majority of the surface area of lacustrine wetlands has surface water present throughout the year in virtually all years. Eighty-seven percent of the lacustrine surface area in the sampled quadrats was classified as permanently flooded, 8% was mapped as intermittently exposed/permanently flooded, and 4% was mapped as intermittently exposed (Table 3). Water regimes seasonal, semipermanent, intermittently flooded, and artificial were combined with water regime intermittently exposed/permanent for analysis of the regional distribution of water regimes for lacustrine wetlands because of the low expected frequencies for these water regimes. There was no significant difference in the distribution of water regimes between the two regions ($\chi^2 = 4.1$, df = 2, $P = 0.13$).

TABLE 3. Estimated area (ha) of wetlands with each water regime in northern Indiana. Standard errors of the estimates are in parentheses.

Wetland system and water regime	Northern Indiana Wetland Region	Kankakee & Wabash River Watersheds	Total
Lacustrine			
Seasonal	176	0	176
	(396)		(411)
Semipermanent	34	0	34
	(175)		(182)
Intermittently	662	645	1,306
exposed	(762)	(823)	(1,107)
Permanent	17,843	12,486	30,330
	(2,677)	(1,807)	(3,587)
Intermittently	4	0	4
flooded	(62)		(64)
Artificial	99	0	99
	(297)		(308)
Intermittently	2,664	0	2,664
exposed/permanent	(1,479)		(1,561)
Palustrine			
Temporary	10,376	32,667	43,044
	(1,309)	(3,800)	(4,205)
Saturated	5,226	127	5,353
	(744)	(84)	(709)
Seasonal	44,106	19,647	63,754
	(4,936)	(2,376)	(6,107)
Semipermanent	5,817	3,002	8,819
	(810)	(518)	(1,042)
Intermittently	1,849	1,912	3,761
exposed	(352)	(382)	(550)
Permanent	1,613	1,646	3,259
	(322)	(347)	(498)
Artificial	25	0	25
	(34)		(35)
Saturated/semipermanent/	11,254	1,271	12,526
seasonal	(1,404)	(295)	(1,389)
Intermittently	186	157	343
exposed/permanent	(94)	(93)	(133)
Unknown	3,977	97	4,073
	(603)	(73)	(582)
Riverine			
Seasonal	0	62	62
		(67)	(66)
Semipermanent	0	20	20
		(38)	(37)
Permanent	1,194	4,860	6,053
	(290)	(770)	(820)
Saturated/semipermanent/	0	19	19
Seasonal		(37)	(37)
Intermittently	49	101	150
exposed/permanent	(55)	(86)	(103)

The distributions of water regimes for palustrine wetlands differed markedly between regions ($\chi^2 = 758$, dr = 9, $P < 0.001$). Over 53% of the palustrine surface area in the KWRW was classified as temporarily flooded, but only 12% of the palustrine area in the NIWR was so classified. Saturated and seasonally flooded wetlands were proportionally more common in the NIWR. Water regime could not be determined from the aerial photography for 5% of the palustrine surface area in the sampled sections of the

NIWR. Less than 1% of the palustrine area in the KWRW was mapped with a water regime of unknown. Within the entire study are, 45% of the palustrine area was seasonally flooded, 28% was temporarily flooded, 6% was semipermanently flooded, 4% was saturated, 2% was permanently flooded, and 9% was mapped as saturated/semipermanent/seasonal (Table 3).

In the northern third of Indiana, 96% of the riverine surface area was permanently flooded, and 2% was intermittently exposed/permanent. Less than 2% of the riverine area was classified with water regimes of either seasonally flooded, semipermanently flooded, or saturated/semipermanent/seasonal. Water regimes seasonal and saturated/semipermanent/seasonal were combined with water regime semipermanent in order to test distribution of regimes between regions. The distribution of water regimes for riverine wetlands did not differ significantly between the NIWR and the KWRW ($\chi^2 = 2.3$, df = 2, $P = 0.31$).

The classification of mapped wetlands indicated whether the wetland was man-made or modified by man. Lacustrine wetlands in the NIWR were predominantly non-modified natural wetlands, whereas those in the KWRW were mostly diked or impounded (Table 4). This difference was significant ($\chi^2 = 16.8$, df = 2, $P < 0.001$).

TABLE 4. Estimated area (ha) of natural wetlands and wetlands with man-made modifications in northern Indiana. Standard errors of the estimates are in parentheses.

Wetland system and modification	Northern Indiana Wetland Region	Kankakee & Wabash River Watersheds	Total
Lacustrine			
Not modified	19,440	1,589	21,029
	(2,636)	(1,253)	(3,520)
Diked/impounded	1,119	11,328	12,447
	(983)	(1,959)	(3,037)
Excavated	923	214	1,138
	(896)	(481)	(1,035)
Palustrine			
Not modified	73,479	56,165	129,645
	(8,086)	(6,366)	(12,152)
Partially drained/	8,975	1,543	10,518
ditched	(1,156)	(333)	(1,201)
Farmed	0	36	36
		(44)	(42)
Diked/impounded	380	1,090	1,470
	(138)	(269)	(300)
Excavated	1,596	1,695	3,291
	(320)	(343)	(502)
Riverine			
Not modified	353	3,872	4,225
	(151)	(658)	(645)
Excavated	890	1,190	2,080
	(247)	(316)	(417)

While over 87% of the palustrine surface area in both regions of the study area was not modified, the distributions of modifications to palustrine wetlands differed between regions ($\chi^2 = 42.8$, df = 4, $P < 0.001$). Eleven percent of the palustrine surface area in the NIWR had been partially drained or ditched but only 3% had been partially drained or ditched in the KWRW. Seventy-two percent of the surface area of riverine wetlands in the NIWR was excavated vs. 23% in the KWRW. The frequency of excavated riverine wetlands was not significantly different between regions ($\chi^2 = 1.8$, df = 1, $P = 0.17$).

Lacustrine wetlands in northern Indiana were generally large, with 53% exceeding 10.0 ha in area (Table 5). Wetlands larger than 10.0 ha comprised 94% of the lacustrine surface area. The lacustrine system did include some smaller wetlands; 28% were 5.0 ha or smaller in area. Sizes of lacustrine wetlands did not differ significantly between the two regions of the study area ($t = 0.40$, df = 34, $P = 0.69$).

TABLE 5. Estimated number and area (ha) of wetlands in northern Indiana in various size categories. Standard errors of the estimates are in parentheses.

Wetland system and size category (ha)	N wetlands	Area of wetland)
Lacustrine		
≤0.2	113 (64)	12 (108)
0.3-0.5	35 (35)	11 (102)
0.6-1.0	35 (35)	30 (170)
1.1-5.0	172 (79)	438 (647)
5.1-10.0	256 (97)	1,615 (1,228)
10.1-15.0	103 (61)	1,301 (1,109)
>15.0	586 (148)	31,196 (3,572)
Palustrine		
≤0.2	32,092 (1,720)	2,921 (463)
0.3-0.5	26,624 (1,484)	8,492 (1,011)
0.6-1.0	16,703 (1,046)	11,949 (1,336)
1.1-5.0	26,610 (1,483)	58,924 (5,664)
5.1-10.0	4,246 (431)	29,008 (2,914)
10.1-15.0	1,072 (202)	13,184 (1,451)
>15.0	802 (174)	20,480 (2,128)
Riverine		
≤0.2	424 (128)	44 (55)
0.3-0.5	577 (150)	192 (117)
0.6-1.0	1,079 (208)	760 (238)
1.1-5.0	1,139 (212)	1,630 (362)
5.1-10.0	78 (55)	616 (212)
10.1-15.0	78 (55)	912 (263)
>15.0	113 (66)	2,150 (425)

Over 67% of palustrine wetlands in both regions were 1.0 ha or smaller in size. However, most of the palustrine surface area was composed of relatively few large wetlands. Wetlands larger than 1.0 ha accounted for 84% of the palustrine surface area. Palustrine wetlands in the NIWR were slightly smaller in size than those in the KWRW ($t = 2.46$; df = 2,963; $P = 0.01$). Thirty-two percent of palustrine wetlands in the NIWR were ≤ 0.2 ha in size compared to 26% in the KWRW.

Riverine wetlands within the sampled sections rarely exceeded 5.0 ha in size. The median size of riverine wetlands in the NIWR and the KWRW was 1.0 and 0.7 ha, respectively. The size of riverine wetlands did not differ significantly between regions of the study area ($t = 0.14$, df = 87, $P = 0.89$).

Discussion

The density of wetlands in the NIWR was approximately twice as high as in the KIRW. Palustrine wetlands dominated by emergent scrub-shrub vegetation were more common in the NIWR, whereas a greater proportion of the palustrine surface area in the KWRW was characterized as forested. Palustrine wetlands in the KWRW tended to be flooded for shorter durations than those in the NIWR. Drainage rates of palustrine wetlands appear to be higher in the NIWR. The majority of lacustrine wetlands in the NIWR were natural in origin, while those in the KWRW were primarily man-made.

This examination of the abundance and characteristics of northern Indiana wetlands was designed to provide preliminary information needed to guide future wetland conservation efforts. These estimates of wetland abundance can serve as a baseline against which future wetland losses can be assessed. Such comparisons are important for evaluation of the effectiveness of wetland conservation measures. Furthermore, this information on the abundance of wetland habitats can serve as the basis for future research to quantify the abundance and distribution of wildlife species that are dependent on wetland habitats.

Acknowledgments

We greatly appreciate the efforts of the U.S. Fish and Wildlife Service in preparation of wetland maps. G. Craig assisted with wetland digitizing. C.A. Albright, R.D. Feldt, D.C. Hudak, and T.J. Moser reviewed earlier drafts of this manuscript and provided many helpful comments and suggestions.

Literature Cited

Brewster, W.G., J.M. Gates, and L.D. Flake. 1976. Breeding waterfowl populations and their distribution in South Dakota. J. Wildl. Manage. 40:50-59.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetland and deepwater habitats of the United States. U.S. Fish and Wildlife Service. FWS/OBS-79/31. 103pp.

Cowardin, L.M. 1982. Some conceptual and semantic problems in wetland classification and inventory. Wildl. Soc. Bull. 10:57-60.

Heitmeyer, M.E. 1980. Characteristics of wetland habitats and waterfowl populations in Oklahoma. M.S. thesis. Oklahoma State University, Stillwater. 263pp.

Tiner, R.W., Jr. 1984. Wetlands of the United States: current status and recent trends. U.S. Fish and Wildlife Service, National Wetlands Inventory. 59pp.