

**AVIAN USE OF BEAVER-CREATED WETLANDS IN  
NORTHERN WISCONSIN**

by

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## **Abstract**

### **Waterfowl use of beaver-created wetlands**

Waterfowl use of wetlands before and after beaver dam removal was compared to determine affect of wetland drainage on waterfowl. We observed waterfowl from blinds on 15 randomly selected beaver-created wetlands in northern Wisconsin in 1990 and 1991 for 786 hours. Thirty additional wetlands were selected at random for waterfowl surveys to compare to the waterfowl use on study wetlands. Vegetation was sampled, interspersion of emergent vegetation was determined, and wetland area and age determined to relate waterfowl use and wetland variables. Results indicate waterfowl use decreases in the year following dam removal. Comparison of walking waterfowl surveys to observations from blinds indicated walking surveys underestimated waterfowl use by a factor of 17.7. Area of open water was the only variable that accounted for a significant portion of the variable associated with waterfowl use index means. We found 0.51 broods (3.24 ducklings)/ha of beaver-created wetland in northern Wisconsin which fell within a range of results found in other regions. Recommendations are made to manage beaver at higher population levels where economic damage is minimal, and to increase habitat area for breeding waterfowl, broods, and molting flocks of waterfowl.

### **Avian use of beaver-created wetlands**

We conducted avian censuses on 14 randomly selected beaver-created wetlands in northern Wisconsin to determine species richness and composition to test hypothesis that inherent edge of wetlands would attract a high diversity of

avian species including nest parasitizers. We observed 87 species between April and August 1991. No brown-headed cowbirds were observed in 1991, although they occurred on 1 wetland in 1990. Recommendations are made for future study of the net affect on avian species using beaver-created wetlands.

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## INTRODUCTION

This thesis presents the results of data collected from April to August in 1990 and 1991, in Forest County, Wisconsin. The thesis is divided into 2 independent manuscripts that will be submitted for publication. Each manuscript is written in the style that the target journal requires. The "Waterfowl use of beaver-created wetlands in northern Wisconsin" will be submitted to the Wildlife Society Bulletin. The "Avian use of beaver-created wetlands in northern Wisconsin" will be submitted to the Wilson Bulletin.

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RH: WATERFOWL USE OF BEAVER-CREATED WETLANDS - Smith and Nauman

WATERFOWL USE OF BEAVER-CREATED WETLANDS IN NORTHERN WISCONSIN

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## INTRODUCTION

Beavers (Castor canadensis) make a positive contribution to the development of waterfowl habitat (Beard 1953, Nevers 1968, Kirby 1973, Nummi 1989). By limiting the flow of water, an associated wetland develops and stores water and nutrients vital to wildlife (Rutherford 1964, Naiman 1988, Wilde et al. 1950). The impounded water eventually kills the riparian vegetation, opening the canopy to water and light tolerant shrub and emergent vegetation (Wilde et al. 1950). The new vegetational structure and diversity offers more habitat to waterfowl and other wetland dependant species (Hair et al. 1978, Smith 1992).

Beaver populations in Wisconsin are increasing statewide (Wisconsin Department of Natural Resources 1990) which has raised public concern over the economically detrimental effects of beaver-created wetlands, such as road and timber damage and trout stream degradation. In 1990 the Wisconsin Department of Natural Resources implemented a beaver management plan that focused on beaver population reduction in the northern portion of the state where beaver populations are highest and where conflicts between resource user groups were concentrated (Wisconsin Department of Natural Resources 1990).

Because 56% of the nation's original wetlands have been converted for development and agriculture (Dahl 1990, U.S. Fish and Wildlife Service 1990a) and waterfowl populations have dropped concurrently (U.S. Fish and Wildlife Service 1990b), the North American Waterfowl Management Plan (NAWMP)

was passed to protect and manage wetlands against loss and degradation (U.S. Fish and Wildlife Service 1986). However in Wisconsin, where nearly 50% of the original wetlands have been lost (Dahl 1990), beaver-created wetlands are being drained without mitigation.

In order to meet the goals of the NAWMP, Wisconsin was divided into regions based on their ability to produce waterfowl. High and low stratum signified high and low waterfowl production, respectively. But beaver-created wetlands were not included in the wetland censuses (Wisconsin Department of Natural Resources 1989).

As a result of the Wisconsin Beaver Management Plan, the greatest amount of beaver-created wetland loss is occurring in the Northern Low Stratum (NLO) waterfowl production area because these wetlands were presumed to provide little value to waterfowl (Wisconsin Department of Natural Resources 1989).

In several northeastern states, research indicates that beaver-created wetlands provide high quality waterfowl and brood habitat (Stanton 1965, Nevers 1968, Brown and Parsons 1979). In addition, high beaver populations are encouraged because of their addition to the wetland surface area for waterfowl production.

Our objectives were to: Determine the waterfowl use of beaver-created wetlands in northeastern Wisconsin, determine if dam removal decreased waterfowl use of wetlands, correlate wetland variables to waterfowl use and compare results of 2 waterfowl census techniques.

## STUDY AREA AND METHODS

We conducted field work from April-August 1990 and 1991 within T.36N, R.16E and T.34N, R.14E in the Laona District of the Nicolet National Forest (Nicolet) in Forest County, Wisconsin. Topography of the Nicolet is largely due to multiple periods of glaciation resulting in a variety of soil types, eskers, moraine, kettle lakes, poor drainage in low areas and many streams. Timber production and recreation are the main land uses on the Laona district.

The Laona district has a high beaver population (Wisconsin Department of Natural Resources 1990) which has been censused for 4 years and colony locations have been digitized in a Geographic Index System (GIS) database. An extended trapping season has occurred in the Laona District, with additional beaver removal on all trout streams and in areas of other resource conflict for the last 4 years.

Beaver-created wetlands selected for this study were located from maps of beaver colonies based on aerial censuses. The selection of wetlands for study was based on their accessibility ( $\leq 2$  km from a road), size ( $\leq 16.2$  ha), distance from lakes and human disturbance ( $>1$  km), and an elevated vantage point which offered a complete view of the flight space above the pond and 75% of the wetland surface. From wetlands meeting these criteria, 10 were selected at random in 1990. An additional 4 were selected at random in 1991. After the selection process, blinds were constructed 6-12 m high in trees at the margin of the wetlands where they offered the best view of open water and emergent cover and resulted in minimal disturbance to the wetland. A waterfowl use

index was created using the number of minutes waterfowl used a wetland divided by the observation period length (e.g. lone male mallard 60 min./180 min or 0.33 of observation period). Waterfowl use was recorded by species and grouping class (e.g. pair, lone male, lone female, brood, flock). Each wetland was observed from the blind  $\geq 1$  time/8 da during the 3 h after sunrise or before sunset.

Three wetlands were selected at random for dam removal (experimental wetlands) after the first year of study to determine the response of waterfowl to wetland drainage. One wetland, drained in 1989, was selected as a pilot to determine if objectives would be met by the design. Dams were removed with ammonium nitrate explosives immediately following ice break-up. Waterfowl use index values for ponds with dams (control wetlands) and ponds after dam removal were compared by using a 2-sample  $\bar{I}$ -test.

Vegetation was analyzed to determine species composition, canopy coverage, and frequency of occurrence of vegetation species at the wetland edge and within the wetland by (Daubenmire 1959). Vegetation plots were established at random distances along transects radiating out in the 4 cardinal directions from a prominent landmark in the wetland. Aquatic and submergent vegetation was sampled from a canoe along predetermined transects at randomly determined intervals. Results of sampling were used to determine if linear relationships existed between waterfowl use and vegetation composition.

The area of wetlands was determined from aerial photographs and topographic maps or ground surveys by using a compass and range finder

where applicable. Several studies have indicated the importance of brood cover to waterfowl use of wetlands (Stanton 1965, Ball 1973, Hepp and Hair 1976). Therefore slide transparencies were taken in late June from a plane to determine the ratio of open water to emergent cover (Kirby 1973). Slide transparencies were then projected onto a grid and water and emergent cover were calculated by the number of entire and partial squares they covered on the grid.

Aerial photographs were reviewed to determine relative ages of wetlands based on presence or absence of the wetland on each aerial photograph series. Photographs were available from the Nicolet National Forest dating from 1938 to 1986. Determination that there was beaver influence on the stream was based on the presence of a wetland or disturbance in riparian vegetation.

Thirty additional wetlands were selected at random in 1991 to be censused by using techniques described by Knudsen (1962) to be compared with surveys from blinds and other waterfowl survey studies. These wetlands were censused 19 June - 25 July by observing from 1 location for 1 h, and then walking the perimeter of the pond. Waterfowl and brood use/wetland was quantified to extrapolate to known active beaver colony data, thereby estimating possible total waterfowl and brood use of beaver-created wetlands in the Nicolet.

## RESULTS

Waterfowl observations (3 h periods) were made 97 (mean = 8.8/wetland)

times in 1990, and 165 (mean = 11/wetland) times in 1991 totaling 786 h (Table 1).

A 2-sample  $T$ -test indicated waterfowl use decreased ( $P < 0.05$ ) after draining all of the experimental wetlands ( $n = 3$ ). Brood density declined from 7 to 2 broods after dams were removed. Waterfowl use also decreased ( $P < 0.05$ ) on 3 of 7 control wetlands (Table 1).

A Satterthwaite (1946) approximate  $F$  test of waterfowl use index means in a nested, Multivariate Analysis of Variance indicated no differences ( $P = 0.08158$  in 1990 and  $P = 0.75242$  in 1991) between groupings of waterfowl: lone male, lone female, pairs, broods and flocks, and no differences ( $P = 0.07904$  in 1990 and  $P = 0.44$  in 1991) between wetlands. But differences ( $P = 0.01829$  in 1990 and  $P = 0.00000$  in 1991) occurred between species: mallard (Anas platyrhynchos), wood duck (Aix sponsa), hooded merganser (Lophodytes cucullatus), common merganser (Mergus merganser), ring-necked duck (Aythya collaris) blue-winged teal (Anas discors), and pied-billed grebe (Podilymbus podiceps). All groupings and species index values in 1991 were then pooled to increase degrees of freedom, to determine if differences existed between wetlands. Student Neuman Keuls ranges test identified all wetlands differed ( $P < 0.05$ ) from at least 1 wetland.

Linear regression of mean waterfowl use in 1990 against wetland area, age, area of open water, and interspersion of emergent vegetation indicated waterfowl use accounted for insignificant (Adjusted  $R^2 = 0.1252$ ,  $df = 6$ ,  $F = 1.358$ ,  $P = 0.3507$ ) proportions of the variability of these characteristics. Area of

Table 1. Number of waterfowl observations, mean waterfowl use,  $\bar{E}$  values, degrees of freedom, and  $\underline{P}$  values on beaver-created wetlands in the Nicolet National Forest, Forest County, Wisconsin, 1991.

Wetland <sup>a</sup>	N of observations made		Mean waterfowl use index		$\bar{E}$ value & degrees of freedom <sup>b</sup>
	1990	1991	1990	1991	
I-A	11	12	0.8966	0.8319	$\bar{E} = 1.87; 139,158 \text{ df}; \underline{P} = 0.029$
II-A	12	8	0.4243	0.5306	$\bar{E} = 1.17; 16,34 \text{ df}; \underline{P} = 0.295$
IV-A	9	12	0.7868	0.2616	$\bar{E} = 1.30; 10,15 \text{ df}; \underline{P} = 0.0046$
VI-A	10	11	0.5614	0.6446	$\bar{E} = 1.17; 30,19 \text{ df}; \underline{P} = 0.4586$
VIII-A	7	11	0.6428	0.7381	$\bar{E} = 1.29; 12,23 \text{ df}; \underline{P} = 0.4315$
IX-A	6	11	0.9058	0.7253	$\bar{E} = 1.57; 23,22 \text{ df}; \underline{P} = 0.0095$
XI-A	0	9	nd <sup>c</sup>	0.971	nd <sup>c</sup>
XII-A	0	10	nd <sup>c</sup>	0.8343	nd <sup>c</sup>
XIII-A	0	10	nd <sup>c</sup>	0.962	nd <sup>c</sup>
XIV-A	0	12	nd <sup>c</sup>	0.5629	nd <sup>c</sup>
XV-A	8	15	0.9257	0.9186	$\bar{E} = 3.15; 90,29 \text{ df}; \underline{P} = 0.8727$
III-B	10	13	0.8414	0.5592	$\bar{E} = 3.29; 17,44 \text{ df}; \underline{P} = 0.0034$
V-B	11	13	0.976	0.1676	$\bar{E} = 5.34; 17,160 \text{ df}; \underline{P} = 0.0000$
X-B	6	11	0.8444	0.529	$\bar{E} = 2.15; 66,29 \text{ df}; \underline{P} = 0.0048$
VII-C	7	7	0.3875	0	
total	63.00	121.00			
mean	5.73	11.00			
std	4.84	1.84			

<sup>a</sup> A = indicates control wetlands, B = experimental wetlands (dam removed in 1991), C = pi wetland (dam removed in 1989)

<sup>b</sup> values generated from 2-sample T-Test.

<sup>c</sup> nd = no data available

open water was the only independent variable entered into the equation using waterfowl use index means in 1991 ( $df = 13$ ,  $F = 7.497$ ,  $P = 0.0169$ ). Adjusted  $R^2$  for the equation = 0.31698. Spearman Rank indicated use and area (coefficient = 0.7714), and size and area (coefficient = 0.6816) were correlated; and use and size were slightly correlated (coefficient = 0.6297).

Brood use and clutch size of broods on control wetlands increased from 18 broods (3.4 ducklings/brood) in 1990 to 23 broods (6.1 ducklings/brood) in 1991, respectively (Table 2). Brood use of wetlands increased from 0.42/ha in 1990 to 0.53/ha in 1991. Duckling use increased from 1.44 ducklings/ha in 1990 to 3.24 ducklings/ha in 1991. The area of wetlands in the sample was 44.17 ha in 1990 and 58.95 ha in 1991 (Table 2).

Clutch sizes increased from 3.4-6.1 ducklings/brood in 1990 and 1991, respectively. Number of ducklings on all wetlands increased from 62 in 1990 to 140 in 1991. Species composition of broods was dissimilar between 1990 and 1991 (Fig. 1).

Waterfowl surveys from walking census of 30 additional wetlands indicated waterfowl use of 11 and brood use of 4 wetlands. Extrapolating these figures to the 398 beaver colonies in the Nicolet in 1991 (US For. Ser. unpubl. report), there were 51.7 broods in 1991. By comparison, instantaneous counts from surveys from blinds on study wetlands resulted in 2.3 broods/wetland (14 ducklings/wetland) or 915.4 broods (5584 ducklings) in the Nicolet. Waterfowl surveys from walking census results on beaver-created wetlands underestimated the instantaneous census from blinds by a factor of 17.7 (0.13

Table 2. Wetland area, waterfowl broods, and number of ducklings observed on beaver-created wetlands in the Nicolet National Forest, Forest County, Wisconsin.

Wetland (hectares)	Area	1990		1991			
		N broods	N broods per ha	N broods	N ducklings	N broods per ha	N ducklings per ha
IA	11.6	3	0.3	5	30	0.4	2.6
IIA	9.7	2	0.2	0	0	0.0	0.0
XVA	11.1	1	0.1	6	34	0.5	3.1
IVA	1.9	2	1.1	0	0	0.0	0.0
ViA	0.8	1	1.2	2	14	2.4	16.7
VIIIA	1.5	1	0.7	0	0	0.0	0.0
IXA	1.5	1	0.7	1	1	0.7	0.7
XIA	1.7	nd	nd	3	22	1.8	13.2
XIIA	2.8	nd	nd	5	30	1.8	10.7
XIIIA	9.6	nd	nd	0	0	0.0	0.0
XIVA	0.7	nd	nd	1	9	1.4	12.2
VIIC	0.7	0	0.0	0	0	0.0	0.0
XB	1.1	0	0.0	1	6	0.9	5.6
VB	3.3	4	1.2	0	0	0.0	0.0
IIIB	1.1	3	2.7	1	2	0.9	1.8
total-B	5.4			2	8	0.4	1.5
total-A	43.2	18	0.4	23	140	0.5	3.2

A = experiment wetlands (dams removed in 1991), B= control wetlands, C = pilot wet (dam removed in 1989)

not included in brood/ha figures because dam broke in June 1990.

nd = no data

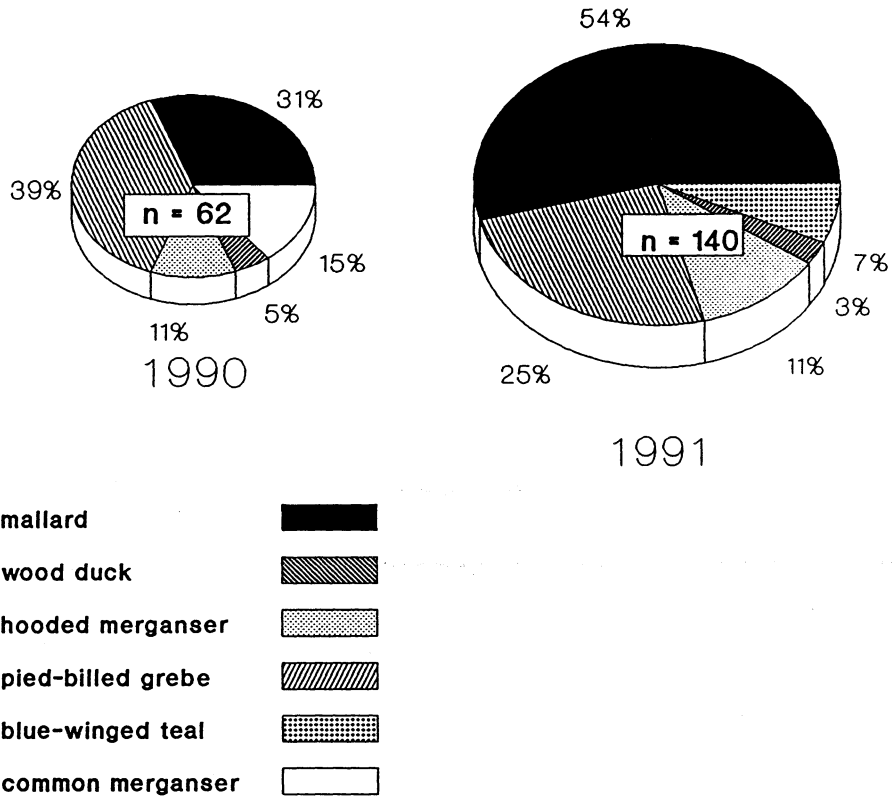


Fig. 1. Species composition of ducklings on beaver-created wetlands in 1990 and 1991 in the Nicolet National Forest, Forest County, Wisconsin.

broods/wetland vs. 2.3 broods/wetland).

The most commonly occurring floating and submergent aquatic genuses included duckweed (Spirodella, Lemna, and Wolffia) 73% occurrence, pondweed (Potamogeton) 64% occurrence, milfoil (Myriophyllum) 45% occurrence, and bladderwort (Utricularia) 36% occurrence. The most commonly occurring genuses of vegetation at the margins of the wetlands were sedge (Carex) 93% occurrence, raspberry (Rubus) 60% occurrence, and redtop (Calamagrostis) 47% occurrence. Emergent vegetation cover ranged from 34-81% of the wetland surface.

Aerial photographs revealed 6 of wetlands were  $\geq 53$  years old, 3 were 28 years old, 3 were 19 years old, and 3 were 9-12 years old. Throughout their history, all wetlands had periodic drawdowns which were visible on the aerial photographic series (Table 3).

## DISCUSSION

Two of the 3 control wetlands that decreased significantly from 1990 to 1991 had variable water levels in early 1991. Beaver trappers frequently pull down the dam to elicit beaver activity thereby dropping the water level in the impoundment. These drawdowns decrease the available water to waterfowl as indicated by our results.

The Satterthwaite (1946) approximation of a MANOVA was used because species and grouping classes of waterfowl were not equally represented on each wetland, thereby causing imbalance to the design. We found molting wood duck drakes concentrated on wetlands regardless of pond size but no

Table 3. Relative ages and history of drawdowns on beaver-created wetlands in the Nicolet National Forest, Forest County, Wisconsin, 1991.

Wetland	Estimated age	Aerial photograph series								
		1991	1990	1986	1982	1979	1972	1963	1951	1938
I-A	>53 yrs	a	a	a	e	e	d	g	d	c
II-A	>53 yrs	e	b	e	c	c	e	a	c	a
IV-A	12 yrs	c	b	a	e	f				
VI-A	28 yrs	b	a	a	d	d	e	f		
VIII-A	9 yrs	a	a	e	o					
IX-A	19 yrs	a	a	e	e	a	f			
XI-A	53 yrs	a	a	a	a	e	e	g	a	f
XII-A	12 yrs	b	a	a	e	f				
XIII-A	28 yrs	a	a	a	a	a	a	f		
XIV-A	19yrs	a	a	a	a	o				
XV-A	>53 yrs	a	a	a	c	d	e	g	d	a
III-B	>53 yrs	b	a	a	c	c	d	a	a	g
V-B	>53 yrs	e	a	a	c	e	e		a	g
X-B	19 yrs	e	a	a	c	a	f			
VII-C	28 yrs	e	e	a	a	e	a	f		

A = indicates experimental wetland (dam removed in 1989), B indicates control wetland, C = indicates pilot wetland (dam removed in 1989).

a = indicates wetland present, b = indicates dam broke in given year, c = indicates partial drawdown, d = indicates dam located further upstream, e = indicates complete drawdown, f = indicates air photo precedes impoundment, g = indicates no air photo available

mallard drakes were seen on any beaver-created wetland after 20 June.

Wetlands selected by molting wood ducks ranged 1.7 -11.66 ha and emergent cover range 20%-45% of the surface area. Patterson (1976) found that fledged and adult ducks showed a strong selection for fertile hard water and medium-hard water wetlands. He concluded that wetland fertility is the most important factor in habitat selection by fledged ducks.

Knudsen (1962) found that 28% of the beaver-created wetlands he observed ( $n = 313$ ) in Wisconsin produced duck broods. His data were collected 1950-1958, when waterfowl populations were near their known peak (U.S. Fish and Wildlife Service 1991). Our waterfowl censuses were conducted when populations were at almost 1/2 this peak (U.S. Fish and Wildlife Service 1991). The difference between our results of 13% brood use of wetlands and Knudsen's (1962), are proportionate to the population differences between the years of study.

Results of this study fall within the ranges of brood use in other investigations of beaver-created wetlands. Brown and Parsons (1979) found 0.25 broods/ha and 1.36 ducklings/ha in New York. Beard (1953) found 4.2 to 11.4 ducklings/ha in Michigan, and Renouf (1972) found 0.25 to 1.85 broods/ha in New Brunswick, Canada. Kirby (1973) found 1.85 broods/ha in Minnesota, but thought broods also used other bodies of water during their development. In 1991, we found 0.53 broods/ha and 3.24 ducklings/ha on control wetlands. We therefore conclude that brood use of beaver-created wetlands in northern Wisconsin falls within the range of the studies listed above.

Species composition of broods in our study was similar to all other studies mentioned above.

Kirby (1973) found that habitat variables were not correlated with waterfowl use of beaver-created wetlands. In our study, area of open water was the only variable correlated to waterfowl use. A larger sample size with fixed independent variables might provide more information on these characteristics.

### **MANAGEMENT IMPLICATIONS**

The importance of individual wetlands to waterfowl in this study is not known but we can assume that the removal of water from the wetlands disperses a substantial percentage of the waterfowl, based on our results in this region. Removing beaver-created wetlands will decrease the availability and diversity of habitat for pairing, brooding, and molting waterfowl in the summer which may decrease local populations as well. Collins (1972) concluded that there was a direct relationship between an increase in beaver colonies and an increase in waterfowl numbers from 1951-1971 in southern Ontario. Parsons and Brown (1978) found that a 5 yr beaver trapping season closure resulted in an increase from 76 to 1,269 km<sup>2</sup> of wetland surface area in New York.

A beaver management program which focuses on wetland production for waterfowl habitat is not problem-free. The cost of servicing nuisance complaints must be compared to the cost of creating and maintaining constructed impoundments. However, Ermer (1984) projected the costs and benefits of maintaining beaver at high densities over a 50 year period in New York. Net benefits, in terms of habitat, recreation, and pelts was nearly \$4,000,000 when

beavers filled 36% of the available colony sites. Benefits increased with an increasing beaver density.

A beaver management plan should emphasize the highest possible beaver population without causing unrealistic economic damage. Watersheds should be identified by their ability to produce trout, and other cold water resources, or be managed for beaver and wetland dependant species.

In Wisconsin, many trout streams have been degraded substantially by beaver since their designation was made. We suggest reclassification of streams in order to focus limited funding resources to productive trout streams. Wilde et al. (1950) found that streams impounded for long periods of time took decades to return to productive trout habitat. Therefore, in cold water priority watersheds, beaver and dam removal should be maximized, and timber cuts and other land uses should discourage beaver colonization. Watersheds with a wetland priority status should be managed for a high beaver population which would maximize wetland surface area.

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RH: AVIAN USE OF BEAVER-CREATED WETLAND HABITAT- Smith and Nauman

AVIAN USE OF BEAVER-CREATED WETLANDS IN NORTHERN WISCONSIN

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Key Words : birds, beaver, diversity, island biogeography, wetlands, Wisconsin,

## INTRODUCTION

Beavers (Castor canadensis) make a positive contribution to the development of waterfowl habitat (Beard 1953, Nummi 1989, Smith 1992) and to many species of wildlife including endangered species such as American bald eagles (Haliaeetus leucocephalis) and ospreys (Pandion haliaetus) (Knudsen 1962). However, little information is available on the contribution of beaver-created wetlands to non-game birds.

By limiting the flow of water, an associated wetland develops and stores water and nutrients vital to wildlife (Rutherford 1964, Naiman 1988, Wilde et al. 1950). Resulting habitat is beneficial to some wildlife and detrimental to others (Knudsen 1962, Avery 1988). The impounded water kills much of the riparian vegetation and opens the canopy to edge species.

Breeding bird species richness and density are high near forest edges, particularly at shrubby margins of fields, openings, and stream-forest ecotones (Gates and Gysel 1978, Gates and Giffen 1991).

Beaver populations in Wisconsin are increasing statewide (Wisconsin Department of Natural Resources 1990), which has raised public concern over the economically detrimental effects of beaver-created wetlands, such as, trout stream degradation and damage to roads, timber, and private property. In 1990, the Wisconsin Department of Natural Resources implemented a beaver management plan that focused on beaver population reduction in the northern portion of the state where beaver populations were highest and conflicts between resource user groups were concentrated (Wisconsin Department of

Natural Resources 1990).

In Wisconsin, where 46% of the original wetlands have been converted to other uses (Dahl 1990), an aggressive beaver and beaver-created wetland removal program exists in the northeastern part of the state to benefit trout. The extended beaver trapping season and trapping subsidy will likely decrease the surface area of wetlands in the northeastern part of the state. In New York, Parsons and Brown (1978) found that a 5-yr trapping season closure increased the surface area of wetlands from 764 to 1,269 km<sup>2</sup>.

Hair et al. (1978) found a higher Shannon Weaver index at beaver-created wetlands than any other habitat they investigated. Beaver-created wetlands had 103% more migrants and a higher number of individuals than terrestrial study sites. Medin and Clary (1990) found bird densities in beaver wetlands to be 3 times that of adjacent riparian habitat. The only avian species negatively affected by beaver-created wetlands were high canopy seed eaters, foliage gleaners, and insectivores (Hair et al. 1978).

### **STUDY AREA AND METHODS**

We conducted field work for a concurrent waterfowl project April-August 1990 and 1991 within T.36N, R.15E and T.34N, R.16E in the Laona District of the Nicolet National Forest (Nicolet) in Forest County, Wisconsin. Avian species richness data were collected in the 2nd field season. Topography of the Nicolet is largely due to multiple periods of glaciation resulting in a variety of soil types, eskers, moraine, kettle lakes, poor drainage in low areas and many streams. Timber production and recreation are the main land uses in the Laona district.

Beaver-created wetlands selected for study were located on beaver colony maps based on aerial censuses. Selection of wetlands for study was based on their accessibility (< 2 km from road), size ( $\leq 16.2$  ha), proximity to lakes ( $\geq 1$  km) and human disturbance (timber operation, human dwelling, etc.), and an elevated vantage point which offered a complete view of the flight space above the pond and 75% of the wetland surface. From the list of wetlands meeting these criteria, 14 were selected at random for study. After the selection process, blinds were constructed 6-12 m high in trees at the margin of the wetlands offering the best view of open water, emergent cover, and wetland edge and minimal disturbance to the wetland.

Birds were censused in conjunction with a waterfowl project. They were identified from the blind visually with 7x24 binoculars or a 60x scope and by song. Only birds which used the wetland and edge for perching, feeding, hunting, nesting or singing were included in the census. Birds identified by song but not sight were heard within the wetland margin, determined by estimating the direction and distance to the singing bird. Birds heard or observed in adjacent habitat were not included in the census. Each wetland was observed  $\geq 1$  time/8 da during the 3 h after sunrise or before sunset from the blind.

Vegetation was analyzed to determine species composition, relative canopy coverage, relative frequency of occurrence, and importance value of species occurring at the wetland edge, and within the wetland (Daubenmire 1959). Vegetation plots were established at random distances along transects

radiating out in 4 cardinal directions from a prominent landmark in the wetland. Aquatic and submergent vegetation was sampled from a canoe along predetermined transects at random intervals.

Area of wetlands was determined from aerial photographs and topographic maps, or ground surveys with compass and range finder where applicable. Slide transparencies were taken in late June from a plane to determine the ratio of open water to emergent cover and the distribution of dominant vegetation types. Aerial photographs were reviewed to determine relative ages of wetlands based on presence or absence of the wetland on each aerial photograph series. Photographs were available from 1938-1986 for the Nicolet National Forest.

## RESULTS

### Avian species

Observations were made 165 ( $\bar{x}$  = 11/wetland) times in 1991 totaling 495h. We observed 87 species from blinds. Two additional species were observed on wetlands outside of the observation period. Six species of birds occurred on 100% of the study wetlands (Table 1) and are common to wetland habitat (Robbins 1991). Species that occurred on >85% of the wetlands included generalists like the American robin (Turdus migratorius), high canopy, deciduous forest dwellers like the rose-breasted grosbeak (Pheucticus ludovicianus), and shrub/wetland dwellers like the common yellowthroat (Geothlypis trichas) (Robbins 1991).

Black-billed cuckoos (Coccyzus erythrophthalmus) occurred on 93% of

Table 1. Frequency of occurrence, relative frequency of occurrence, and percent occurrence of avian species heard or seen within wetland or wetland-forest ecotone in 1991, Nicolet National Forest, Forest County, Wisconsin.

Species	Frequency occurrence	Relative	
		frequency occurrence	Percent occurrence
Cedar waxwing ( <i>Bombycilla cedrorum</i> )	14	0.0307	1.0000
Common grackle ( <i>Quiscalus major</i> )	14	0.0307	1.0000
Great blue heron ( <i>Ardea herodias</i> )	14	0.0307	1.0000
Eastern kingbird ( <i>Tyrannus tyrannus</i> )	14	0.0307	1.0000
Red-winged blackbird ( <i>Agelaius phoeniceus</i> )	14	0.0307	1.0000
Tree swallow ( <i>Tachycineta bicolor</i> )	14	0.0307	1.0000
Black-billed cuckoo ( <i>Coccyzus erythrophthalmus</i> )	13	0.0285	0.9286
Common yellowthroat ( <i>Geothlypis trichas</i> )	13	0.0285	0.9286
Mallard ( <i>Anas platyrhynchos</i> )	13	0.0285	0.9286
Rose-breasted grosbeak ( <i>Pheucticus ludovicianus</i> )	13	0.0285	0.9286
American robin ( <i>Turdus migratorius</i> )	12	0.0263	0.8571
Chestnut-sided warbler ( <i>Dendroica pensylvanica</i> )	12	0.0263	0.8571
Song sparrow ( <i>Melospiza melodia</i> )	12	0.0263	0.8571
Wood duck ( <i>Aix sponsa</i> )	12	0.0263	0.8571
Northern flicker ( <i>Colaptes auratus</i> )	11	0.0241	0.7857
Purple finch ( <i>Carpodacus purpureus</i> )	11	0.0241	0.7857
Great crested flycatcher ( <i>Myiarchus crinitus</i> )	10	0.0219	0.7143
Northern oriole ( <i>Icterus galbula</i> )	10	0.0219	0.7143
White-throated sparrow ( <i>Zonotrichia leucophrys</i> )	10	0.0219	0.7143
Hooded merganser ( <i>Lophodytes cucullatus</i> )	9	0.0197	0.6429
Belted kingfisher ( <i>Ceryle alcyon</i> )	9	0.0197	0.6429
Swamp sparrow ( <i>Melospiza georgiana</i> )	9	0.0197	0.6429
Blue-winged teal ( <i>Anas discors</i> )	8	0.0175	0.5714
Golden-winged warbler ( <i>Vermivora chrysoptera</i> )	8	0.0175	0.5714
Hairy woodpecker ( <i>Picoides villosus</i> )	8	0.0175	0.5714
Least flycatcher ( <i>Empidonax vireescens</i> )	8	0.0175	0.5714
American goldfinch ( <i>Carduelis tristis</i> )	7	0.0154	0.5000
American bittern ( <i>Botaurus lentiginosus</i> )	7	0.0154	0.5000
Black-capped chickadee ( <i>Parus atricapillus</i> )	7	0.0154	0.5000
Black and white warbler ( <i>Mniotilta varia</i> )	6	0.0132	0.4286
Blue jay ( <i>Cyanocitta cristata</i> )	6	0.0132	0.4286
Common nighthawk ( <i>Chordeiles minor</i> )	6	0.0132	0.4286
Downy woodpecker ( <i>Picoides pubescens</i> )	6	0.0132	0.4286
Yellow warbler ( <i>Dendroica petechia</i> )	6	0.0132	0.4286
Yellow-rumped warbler ( <i>Dendroica coronata</i> )	6	0.0132	0.4286
Bald eagle ( <i>Haliaeetus leucocephalus</i> )	4	0.0088	0.2857
Common merganser ( <i>Mergus merganser</i> )	4	0.0088	0.2857
Killdeer ( <i>Charadrius vociferus</i> )	4	0.0088	0.2857
Pileated woodpecker ( <i>Dryocopus pileatus</i> )	4	0.0088	0.2857
Red-eyed vireo ( <i>Vireo olivaceus</i> )	4	0.0088	0.2857
Sora ( <i>Porzana carolina</i> )	4	0.0088	0.2857
Spotted sandpiper ( <i>Actitis macularia</i> )	4	0.0088	0.2857
European starling ( <i>Sturnus vulgaris</i> )	4	0.0088	0.2857

Table 1 cont.

Species	Frequency occurrence	Relative frequency occurrence	Percent occurrence
Canada goose ( <i>Branta canadensis</i> )	3	0.0066	0.2143
Indigo bunting ( <i>Passerina cyanea</i> )	3	0.0066	0.2143
Grey catbird ( <i>Dumetella carolinensis</i> )	3	0.0066	0.2143
Pied-billed grebe ( <i>Podilymbus podiceps</i> )	3	0.0066	0.2143
Ring-necked duck ( <i>Aythya collaris</i> )	3	0.0066	0.2143
Sedge wren ( <i>Cistothorus platensis</i> )	3	0.0066	0.2143
Sharp-shinned hawk ( <i>Accipiter striatus</i> )	3	0.0066	0.2143
Common snipe ( <i>Gallinago gallinago</i> )	3	0.0066	0.2143
Virginia rail ( <i>Rallus limicola</i> )	3	0.0066	0.2143
American woodcock ( <i>Scolopax minor</i> )	2	0.0044	0.1429
Barn swallow ( <i>Hirundo rustica</i> )	2	0.0044	0.1429
Grey jay ( <i>perisoreus canadensis</i> )	2	0.0044	0.1429
Chipping sparrow ( <i>Spizella passerina</i> )	2	0.0044	0.1429
Eastern phoebe ( <i>Sayornis phoebe</i> )	2	0.0044	0.1429
Evening grosbeak ( <i>Coccothraustes vespertinus</i> )	2	0.0044	0.1429
Ruby-throated hummingbird ( <i>Archilochus coubris</i> )	2	0.0044	0.1429
Osprey ( <i>Pandion haliaetus</i> )	2	0.0044	0.1429
Palm warbler ( <i>Dendroica palmarum</i> )	2	0.0044	0.1429
Red-breasted nuthatch ( <i>Sitta canadensis</i> )	2	0.0044	0.1429
American tree sparrow ( <i>Spizella arborea</i> )	1	0.0022	0.0714
Black tern ( <i>Chlidonias niger</i> )	1	0.0022	0.0714
Blackburnian warbler ( <i>Dendroica fusca</i> )	1	0.0022	0.0714
Brown creeper ( <i>Certhia americana</i> )	1	0.0022	0.0714
Canada warbler ( <i>Wilsonia canadensis</i> )	1	0.0022	0.0714
Cooper's hawk ( <i>Accipiter cooperii</i> )	1	0.0022	0.0714
Eastern bluebird ( <i>Sialia sialis</i> )	1	0.0022	0.0714
Field sparrow ( <i>Spizella pusilla</i> )	1	0.0022	0.0714
Golden-crowned kinglet ( <i>Regulus satrapa</i> )	1	0.0022	0.0714
Greater yellowlegs ( <i>Tringa melanoleuca</i> )	1	0.0022	0.0714
Green-backed heron ( <i>Butorides striatus</i> )	1	0.0022	0.0714
Green-winged teal ( <i>Anas crecca</i> )	1	0.0022	0.0714
Winter wren ( <i>Troglodytes troglodytes</i> )	1	0.0022	0.0714
Magnolia warbler ( <i>Dendroica magnolia</i> )	1	0.0022	0.0714
Mourning dove ( <i>Zenaida macroura</i> )	1	0.0022	0.0714
Nashville warbler ( <i>Vermivora ruficapilla</i> )	1	0.0022	0.0714
Common raven ( <i>Corvus corax</i> )	1	0.0022	0.0714
Northern waterthrush ( <i>Seiurus motacilla</i> )	1	0.0022	0.0714
Red-shouldered hawk ( <i>Buteo lineatus</i> )	1	0.0022	0.0714
Sandhill crane ( <i>Grus canadensis</i> )	1	0.0022	0.0714
Scarlet tanager ( <i>Piranga olivacea</i> )	1	0.0022	0.0714
Solitary sandpiper ( <i>Tringa solitaria</i> )	1	0.0022	0.0714
Tennessee warbler ( <i>Vermivora peregrina</i> )	1	0.0022	0.0714
Warbling vireo ( <i>Vireo gilvus</i> )	1	0.0022	0.0714
White-crowned sparrow ( <i>Zonotrichia leucophrys</i> )	1	0.0022	0.0714

the wetlands and nested on most of them. Nests were easily located 1.5-4 m high in Balsam fir (Abies balsamea) or spruce (Picea spp.) trees.

Many snag excavators and a few bark gleaners were attracted to the snags including: northern flickers (Colaptes auratus), pileated woodpeckers (Dryocopus pileatus), and brown creepers (Certhia americana) (Table 1). Cavity nesters were attracted to the excavated snags killed by beaver-impounded water. Wood ducks (Aix sponsa), tree swallows (Tachycineta bicolor), hooded mergansers (Lophodytes cucullatus), European starlings (Sturnus vulgaris), and black-capped chickadees (Parus atricapillus) were observed entering or exiting cavities on wetlands.

In 1990, brown-headed cowbirds (Molothrus ater) occurred on a 11.1 ha study wetland. The wetland was 9.6 and 12.9 km from the nearest agricultural and residential area, respectively, where other brown-headed cowbirds were observed in 1990 and 1991. Brown-headed cowbirds were not observed in 1991 on any of the 14 study wetlands or 30 additional wetlands observed for waterfowl broods.

Avian species richness was plotted against wetland size (Fig. 1) and age (Fig. 2), but no relationships exist. Wetlands were then pooled into 4 vegetational groups to determine if mean avian species richness of the vegetational groups delineated relationships. No relationships existed in this grouping either (Fig. 3).

### Vegetation

The most commonly occurring floating and submergent aquatic

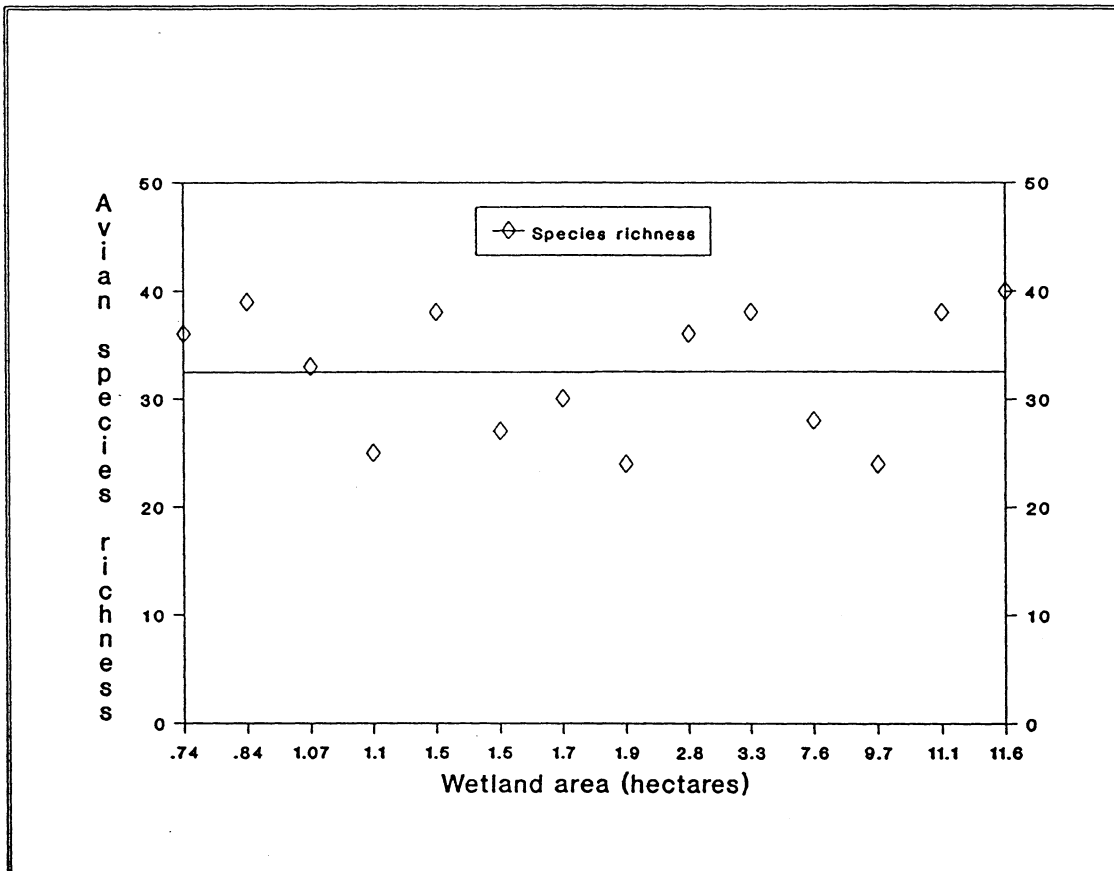


Fig. 1. Avian species richness relationship to beaver-created wetland size, Nicolet National Forest, Forest County, Wisconsin, 1991.

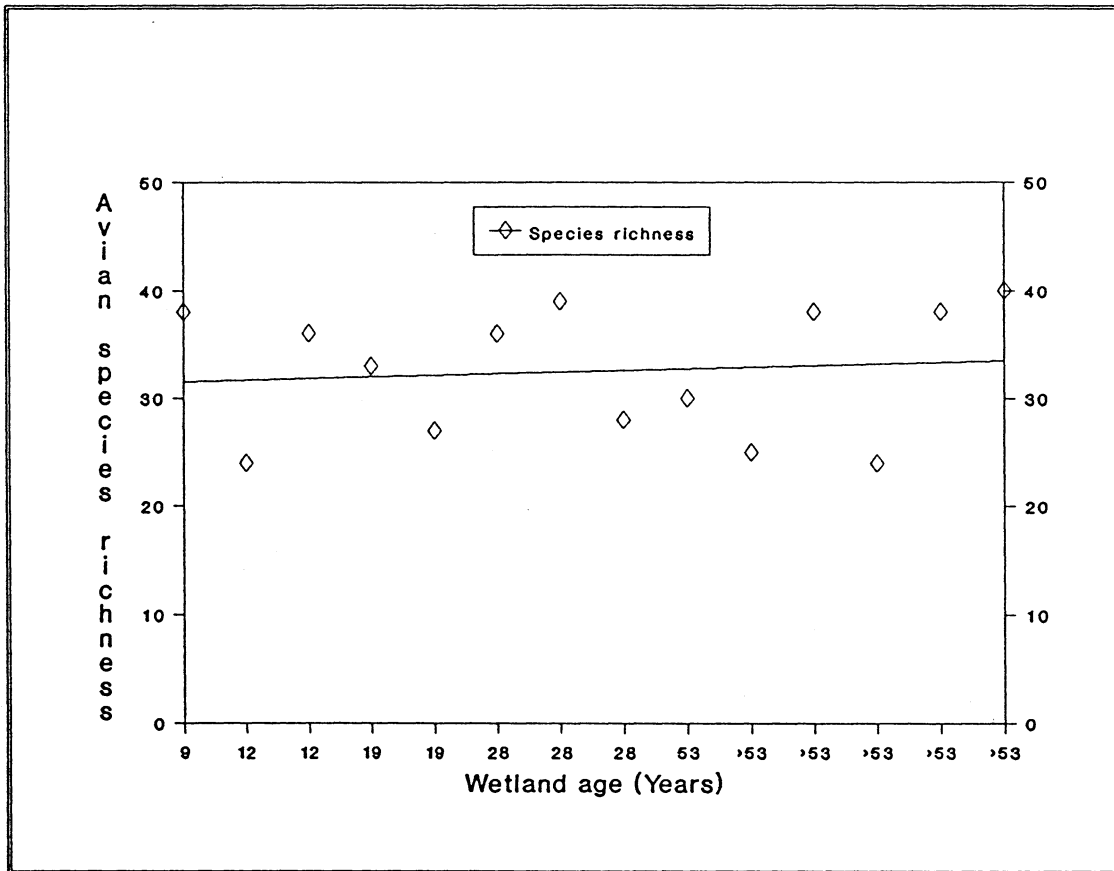


Fig. 2. Avian species richness relationship to beaver-created wetland age, Nicolet National Forest, Forest County, Wisconsin, 1991.

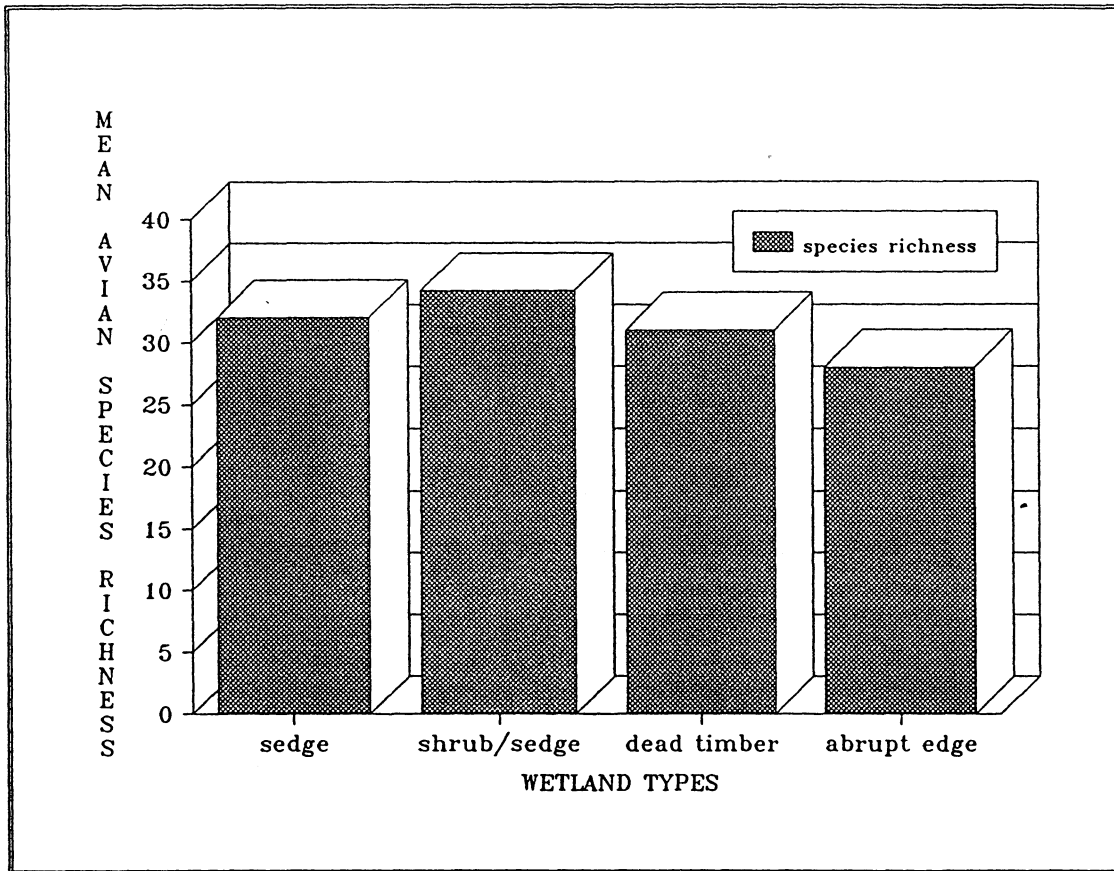


Fig. 3. Avian species richness relationship to beaver-created wetlands grouped by general successional stage. Nicolet National Forest, Forest County, Wisconsin, 1991.

genuses included duckweed, (Spirodella, Lemna, Wolffia) 73% occurrence, pondweed, (Potamogeton) 64% occurrence, milfoil, (Myriophyllum) 45% occurrence), and bladderwort, (Utricularia) 36% occurrence. The most commonly occurring genuses at the margins of the wetlands were, sedge, (Carex) 64% occurrence, raspberry, (Rubus) 60% occurrence and redbud, (Calamagrostis) 47% occurrence. Emergent vegetation ranged from 34-81% of open water coverage.

#### Additional observations

A wild turkey (Meleagris gallopavo) was flushed off the ground beneath a white spruce (Abies glauca) when we entered the wetland to analyze vegetation. It was never again observed on that or any other wetland and was the only sighting in 2 years of wetland observations and upland exploration in the study area.

During a waterfowl survey by canoe, a black-backed woodpecker (Picoides arcticus) nest was discovered in the middle of an old beaver impoundment. The nest was located about 40 m from the stream channel 5 m high in a dead tamarack (Picea amphibia).

## DISCUSSION

### Wetland islands

Island habitats interest wildlife scientists (MacClintock et al. 1977, Temple 1990) because they typify the patterns of abundance and species diversity in limited habitat. Beaver-created wetlands in northern Wisconsin are like islands because they typically are separated by dissimilar habitat.

### Species richness and wetland size

The equilibrium theory of island biogeography (MacArthur and Wilson 1967) states that the number of species and species abundance on an island represent a balance between ingress and egress. The larger the island, the greater the ingress and the lower the egress rates. Wetlands in this study ranged 0.74-11.66 ha but showed no relationship to species diversity. The concurrent waterfowl project prevented us from collecting species abundance data and therefore statistically determining trends .

Small sample size ( $n = 14$ ) might have influenced the relationship between wetland age and avian species richness or there might not be a relationship between the 2 variables.

### Contributions of wetlands to edge and forest fragmentation

Beaver-created wetlands are similar to clearcuts in the northern forest because they open the canopy and fragment the forest. Wetland margins are aquatic-upland ecotones with greater structural and vegetational diversity than in either adjacent habitat (Hair et al. 1978). Breeding bird species richness and density are generally high in these areas (Gates and Giffen 1991, Gates and Gysel 1978, Leopold 1933), but net production is suspect. Robbins (1988), Brittingham and Temple (1983), and Gates and Gysel (1978) expressed concern over the neotropical migrants attracted to the diversity in the ecotone habitat. Brood parasitism by brown-headed cowbirds and predation increase where 2 habitat types join. Although brown-headed cowbirds were seen on only 1 wetland in 2 yrs of study, potential exists for their colonization of the

wetland edge.

### **MANAGEMENT RECOMMENDATIONS**

Beaver-created wetlands are rich in avian, vegetational, and structural diversity. Wetland succession creates many microhabitats potentially available to breeding birds (Hair et al. 1978). The results of this study indicate the richness of breeding birds. However, beaver-created wetlands fragment forests and open the canopy to edge species. What is not clear is the net affect of beaver-created wetlands on neotropical migrants, residents, and short-distance migrants in the wetlands. Potential exists for brown-headed cowbird colonization of the wetlands. Although there was no relationship between area of wetland and species richness there might be relationships between wetland size and species abundance. There might also be a negative affect on the forest interior avian species adjacent to the wetlands.

The Wisconsin Beaver Management Plan currently focuses on beaver population reduction and results in wetland reduction in the northeastern part of the state. These wetlands are rich in avian species, but some are viewed as a nuisance because they cause economic damage. Further study of these wetlands and constructed impoundments in the northern forest is needed to determine the net affects on neotropical migrants, residents and short distance migrants.

### **ACKNOWLEDGEMENTS**

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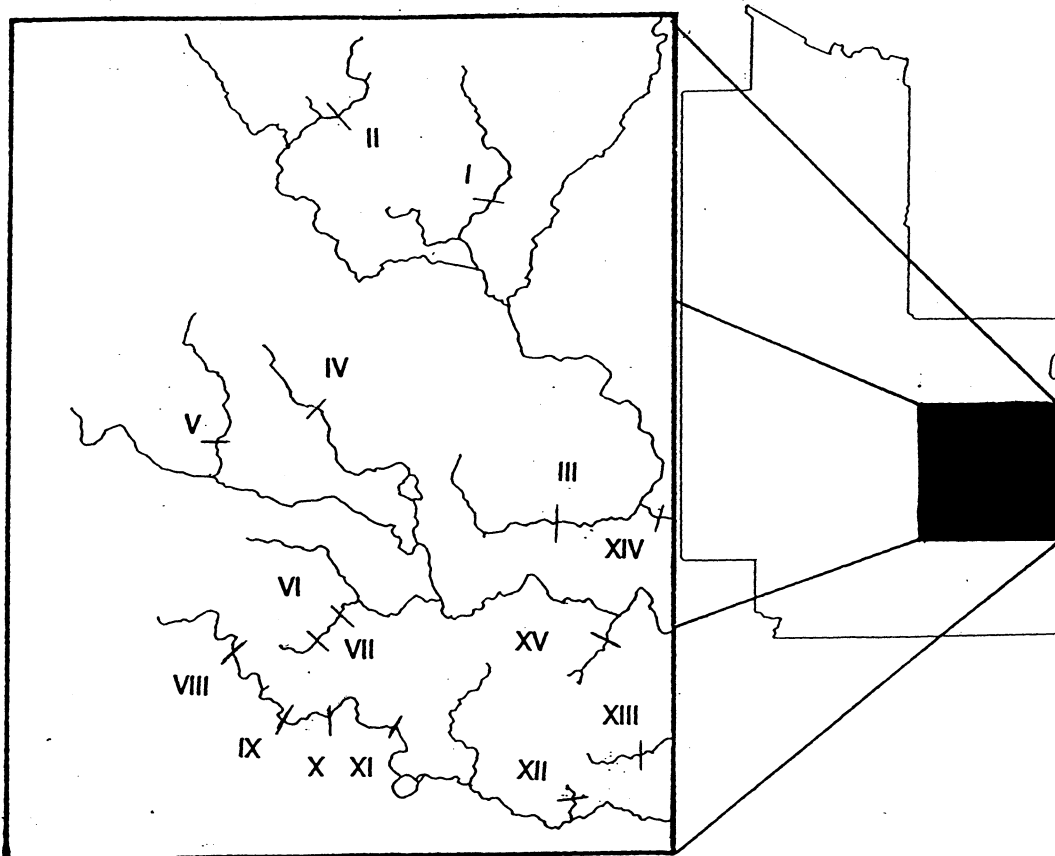
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Appendix A. Study area map showing locations of beaver-created wetlands in the Nicolet National Forest, Forest County, Wisconsin, 1991.



- I lower beaver pond on East branch of Rock Creek, Forest County, WI
- II lower beaver pond on upper Catwillow Creek, Forest County, WI
- III Halleys Creek beaver pond, Section 23, T. 34N, R.16E.
- IV upper beaver pond on Shabodock Creek, Forest County, WI
- V lower beaver pond on Stoney Creek, Forest County, WI
- VI upper beaver pond on Mexico Creek, Forest County, WI
- VII lower beaver pond on Mexico Creek, Forest County, WI
- VIII upper beaver pond on Otter Creek, Forest County, WI
- IX upper beaver pond on unnamed creek, Section 8, T.34N, R.16E, WI
- X lower beaver pond on unnamed creek, Section 8, T.34N, R.16E, WI
- XI upper beaver pond on unnamed creek, Section 9, T.34N, R.16E, WI
- XII upper beaver pond on unnamed creek, Section 14 T.34N, R.16E, WI
- XIII middle beaver pond on Newmann Creek, Forest County, WI
- XIV beaver pond on unnamed creek, Section 13, T.34N, R.16E, WI
- XV upper beaver pond on unnamed creek, Section 35, T.35N, R.16E, WI

Appendix B. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within upper beaver-created wetland on Mexico Creek, Sect. 36, T.35N, R.15E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Open water	0.6028	0.3871	0.4949
Algae ( <u>Alga</u> spp.)	0.1904	0.2581	0.2242
Flat-stem pondweed ( <u>Potamogeton zosteriformis</u> )	0.0526	0.1613	0.1069
White-stem pondweed ( <u>Potamogeton praelongus</u> )	0.0804	0.1290	0.1047
Stonewort ( <u>Chara</u> sp.)	0.0773	0.0645	0.0709

Appendix C. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of upper beaver-created wetland on Mexico Creek, Sect. 36, T.35N, R.15E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Sedge ( <u>Carex</u> spp.)	0.2329	0.1221	0.1775
Open	0.1364	0.1069	0.1216
Swamp thistle ( <u>Cirsium muticum</u> )	0.0797	0.0687	0.0742
Raspberry ( <u>Rubus</u> spp.)	0.0724	0.0534	0.0629
Grass ( <u>Graminae</u> spp.)	0.0462	0.0687	0.0574
Reed canary grass ( <u>Phalaris arundinaceae</u> )	0.0504	0.0611	0.0557
Prickly gooseberry ( <u>Ribes cynosbati</u> )	0.0640	0.0382	0.0511
Sphagnum moss ( <u>Sphagnum</u> spp.)	0.0178	0.0534	0.0356
Spotted jewelweed ( <u>Impatiens capensis</u> )	0.0100	0.0687	0.0344
Meadowsweet ( <u>Spirea</u> sp.)	0.0304	0.0382	0.0343
Horsetail ( <u>Equisetum</u> sp.)	0.0388	0.0229	0.0309
Bunchberry ( <u>Cornus canadensis</u> )	0.0294	0.0305	0.0300
Cleavers ( <u>Galium aparine</u> )	0.0105	0.0382	0.0243
Marsh marigold ( <u>Caltha</u> spp)	0.0168	0.0153	0.0160
Red-osier dogwood ( <u>Cornus stolonifera</u> )	0.0084	0.0229	0.0156
Wild mint ( <u>Mentha arvensis</u> )	0.0126	0.0153	0.0139
Manna grass ( <u>Glyceria</u> spp.)	0.0126	0.0153	0.0139
Chokecherry ( <u>Prunus virginiana</u> )	0.0126	0.0153	0.0139
Moss ( <u>Philonotis</u> spp.)	0.0031	0.0229	0.0130
Waxy meadow rue ( <u>Thalictrum revolutum</u> )	0.0073	0.0153	0.0113
Tall meadow rue ( <u>Thalictrum polygamum</u> )	0.0021	0.0153	0.0087
Wood strawberry ( <u>Fragaria vesca</u> )	0.0063	0.0076	0.0070
Wild strawberry ( <u>Fragaria virginiana</u> )	0.0063	0.0076	0.0070
Stinging nettle ( <u>Urtica dioica</u> )	0.0063	0.0076	0.0070
Great Saint Johnswort ( <u>Eupatorium perfoliatum</u> )	0.0063	0.0076	0.0070
Dock ( <u>Rumex</u> spp.)	0.0063	0.0076	0.0070
Aster ( <u>Aster</u> spp.)	0.0063	0.0076	0.0070
Violet ( <u>Viola</u> spp.)	0.0010	0.0076	0.0043
Smartweed ( <u>Polygonum</u> spp.)	0.0010	0.0076	0.0043
Plantain ( <u>Plantago</u> spp.)	0.0010	0.0076	0.0043
Marsh skullcap ( <u>Scutellaria epilobifolia</u> )	0.0010	0.0076	0.0043

Appendix D. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within upper beaver-created wetland on an unnamed creek, Sect. 35, T.35N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Open water	0.3596	0.2105	0.2850
Flat-stem pondweed ( <i>Potamogeton zosteriformis</i> )	0.1930	0.1754	0.1842
Stonewort ( <i>Chara</i> sp.)	0.1610	0.1579	0.1595
Bladderwort ( <i>Utricularia</i> spp.)	0.1039	0.2105	0.1572
Coontail ( <i>Ceratophyllum</i> spp.)	0.0721	0.1053	0.0887
Yellow water lily ( <i>Nuphar</i> sp.)	0.0424	0.0351	0.0388
Algae ( <i>Alga</i> spp.)	0.0180	0.0526	0.0353
Floating-leaf pondweed ( <i>Potamogeton natans</i> )	0.0446	0.0175	0.0311
Water milfoil ( <i>Myriophyllum</i> spp.)	0.0064	0.0175	0.0120
Big duckweed ( <i>Spirodela polyrhiza</i> )	0.0011	0.0175	0.0093

Appendix E. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of upper beaver-created wetland on an unnamed creek, Sect. 35, T.35N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative coverage	Relative frequency	Importance value
Sedge ( <u>Carex</u> spp.)	0.2849	0.7083	0.4966
Open	0.3110	0.5417	0.4263
Reed meadow grass ( <u>Glyceria grandis</u> )	0.0953	0.2917	0.1935
Meadowsweet ( <u>Spiraea</u> spp.)	0.0715	0.2917	0.1816
Water parsnip ( <u>Sium suave</u> )	0.0420	0.1667	0.1043
Wild mint ( <u>Mentha arvensis</u> )	0.0375	0.1667	0.1021
Grass ( <u>Graminae</u> spp.)	0.0409	0.1250	0.0829
Sphagnum moss ( <u>Sphagnum</u> spp.)	0.0250	0.1250	0.0750
Raspberry ( <u>Rubus</u> spp.)	0.0148	0.1250	0.0699
Bluejoint ( <u>Calamagrostis</u> spp.)	0.0148	0.1250	0.0699
Blue flag iris ( <u>Iris versicolor</u> )	0.0148	0.1250	0.0699
Water hemlock ( <u>Cicuta maculata</u> )	0.0079	0.0833	0.0456
Goldenrod ( <u>Solidago</u> spp.)	0.0068	0.0833	0.0451
Rush ( <u>Juncus</u> spp.)	0.0023	0.0833	0.0428
Arrowhead ( <u>Sagittaria</u> spp.)	0.0023	0.0833	0.0428
Spotted jewelweed ( <u>Impatiens capensis</u> )	0.0023	0.0833	0.0428
Canada anemone ( <u>Anemone canadensis</u> )	0.0023	0.0833	0.0428
Sarsaparilla ( <u>Aralia nudicaulis</u> )	0.0068	0.0417	0.0242
Bulrush ( <u>Scirpus cyperinus</u> )	0.0068	0.0417	0.0242
Manna grass ( <u>Glyceria</u> spp.)	0.0068	0.0417	0.0242
Silky dogwood ( <u>Cornus amomum</u> )	0.0011	0.0417	0.0214
Large-leaved aster ( <u>Aster macrophyllus</u> )	0.0011	0.0417	0.0214
Marsh bedstraw ( <u>Galium palustre</u> )	0.0011	0.0417	0.0214

Appendix F. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within upper beaver-created wetland on an unnamed creek, NE 1/4, SW 1/4, Sect. 13, T.35N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Stonewort ( <u>Chara</u> sp.)	0.8168	0.5333	0.6750
Algae ( <u>Algae</u> spp.)	0.1082	0.2000	0.1541
Open Water	0.0209	0.0667	0.0438
Waterweed ( <u>Elodea canadensis</u> )	0.0105	0.0333	0.0219
Water buttercup ( <u>Ranunculus</u> sp.)	0.0105	0.0333	0.0219
Pondweed ( <u>Potamogeton richardsonii</u> )	0.0105	0.0333	0.0219
Floating-leaf pondweed ( <u>Potamogeton natans</u> )	0.0105	0.0333	0.0219
Water smartweed ( <u>Polygonum amphibium</u> )	0.0105	0.0333	0.0219
Sago pondweed ( <u>Potamogeton pectinatus</u> )	0.0017	0.0333	0.0175

Appendix G. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of upper beaver-created wetland on an unnamed creek, NE 1/4, SW 1/4, Sect. 13, T.35N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative coverage	Relative frequency	Importance value
Sedge ( <u>Carex</u> spp.)	0.2329	0.1221	0.1775
open	0.1364	0.1069	0.1216
Swamp thistle ( <u>Cirsium muticum</u> )	0.0797	0.0687	0.0742
Raspberry ( <u>Rubus</u> spp.)	0.0724	0.0534	0.0629
Grass ( <u>Graminae</u> spp.)	0.0462	0.0687	0.0574
Reed canary grass ( <u>Phalaris arundinaceae</u> )	0.0504	0.0611	0.0557
Prickly gooseberry ( <u>Ribes cynosbati</u> )	0.0640	0.0382	0.0511
Sphagnum moss ( <u>Sphagnum</u> spp.)	0.0178	0.0534	0.0356
Spotted jewelweed ( <u>Impatiens capensis</u> )	0.0100	0.0687	0.0344
Meadowsweet ( <u>Spirea</u> sp.)	0.0304	0.0382	0.0343
Horsetail ( <u>Equisetum</u> sp.)	0.0388	0.0229	0.0309
Bunchberry ( <u>Cornus canadensis</u> )	0.0294	0.0305	0.0300
Cleavers ( <u>Galium aparine</u> )	0.0105	0.0382	0.0243
Marsh marigold ( <u>Caltha</u> spp)	0.0168	0.0153	0.0160
Red-osier dogwood ( <u>Cornus stolonifera</u> )	0.0084	0.0229	0.0156
Wild mint ( <u>Mentha arvensis</u> )	0.0126	0.0153	0.0139
Manna grass ( <u>Glyceria</u> spp.)	0.0126	0.0153	0.0139
Chokecherry ( <u>Prunus virginiana</u> )	0.0126	0.0153	0.0139
Moss ( <u>Philonotis</u> spp.)	0.0031	0.0229	0.0130
Waxy meadow rue ( <u>Thalictrum revolutum</u> )	0.0073	0.0153	0.0113
Tall meadow rue ( <u>Thalictrum polygamum</u> )	0.0021	0.0153	0.0087
Wood strawberry ( <u>Fragaria vesca</u> )	0.0063	0.0076	0.0070
Wild strawberry ( <u>Fragaria virginiana</u> )	0.0063	0.0076	0.0070
Stinging nettle ( <u>Urtica dioica</u> )	0.0063	0.0076	0.0070
Great Saint Johnswort ( <u>Eupatorium perfoliatum</u> )	0.0063	0.0076	0.0070
Dock ( <u>Rumex</u> spp.)	0.0063	0.0076	0.0070
Aster ( <u>Aster</u> spp.)	0.0063	0.0076	0.0070
Violet ( <u>Viola</u> spp.)	0.0010	0.0076	0.0043
Smartweed ( <u>Polygonum</u> spp.)	0.0010	0.0076	0.0043
Plantain ( <u>Plantago</u> spp.)	0.0010	0.0076	0.0043
Marsh skullcap ( <u>Scutellaria epilobifolia</u> )	0.0010	0.0076	0.0043

Appendix H. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within middle beaver-created wetland on Shabodock Creek, SE 1/4, Sect. 2, T.35N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Big duckweed ( <u>Spirodela polyrhiza</u> )	0.6011	0.3256	0.4633
Open water	0.2057	0.1163	0.1610
Watermeal ( <u>Wolffia</u> sp.)	0.0179	0.2326	0.1252
Water milfoil ( <u>Myriophyllum</u> spp.)	0.0555	0.1395	0.0975
Lesser duckweed ( <u>Lemna minor</u> )	0.0358	0.1395	0.0877
Leafy pondweed ( <u>Potamogeton foliosus</u> )	0.0805	0.0000	0.0403
Thallose liverwort ( <u>Riccia fluitans</u> )	0.0036	0.0465	0.0250

Appendix I. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of middle beaver-created wetland on Shabodock Creek, SE 1/4, Sect. 2, T.35N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative coverage	Relative frequency	Importance value
Spotted jewelweed ( <u>Impatiens capensis</u> )	0.3314	0.2133	0.2724
Open	0.1749	0.1733	0.1741
Sedge ( <u>Carex</u> spp.)	0.1404	0.1867	0.1635
Spotted jewelweed ( <u>Impatiens capensis</u> )	0.1059	0.0800	0.0929
Raspberry ( <u>Rubus</u> spp.)	0.0598	0.0533	0.0566
Goldenrod ( <u>Solidago</u> spp.)	0.0391	0.0667	0.0529
Sphagnum moss ( <u>Sphagnum</u> moss)	0.0334	0.0667	0.0500
Wood strawberry ( <u>Fragaria vesca</u> )	0.0288	0.0133	0.0211
Marsh fern ( <u>Thelypteris palustris</u> )	0.0173	0.0133	0.0153
Sarsaparilla ( <u>Aralia nudicaulis</u> )	0.0173	0.0133	0.0153
Stinging nettle ( <u>Urtica dioica</u> )	0.0069	0.0133	0.0101
Spike rush ( <u>Eleocharis</u> spp.)	0.0069	0.0133	0.0101
Rough bedstraw ( <u>Galium asprellum</u> )	0.0069	0.0133	0.0101
Bluejoint ( <u>Calamagrostis</u> spp.)	0.0069	0.0133	0.0101
Bog rosemary ( <u>Andromeda glaucophylla</u> )	0.0069	0.0133	0.0101
Marsh thistle ( <u>Cirsium muticum</u> )	0.0069	0.0133	0.0101
Manna grass ( <u>Glyceria</u> spp.)	0.0069	0.0133	0.0101
Violet ( <u>Viola</u> spp.)	0.0012	0.0133	0.0072
Arrow-leaved tearthumb ( <u>Polygonum sagittatum</u> )	0.0012	0.0133	0.0072
Buckwheat ( <u>Fagopyrum sagittatum</u> )	0.0012	0.0133	0.0072

Appendix J. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within middle beaver-created wetland on Newman Creek, SE 1/4, Sect. 11, T.34N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Spatterdock ( <u>Nuphar</u> sp.)	0.3532	0.2245	0.2889
Floating-leaf pondweed ( <u>Potamogeton natans</u> )	0.2388	0.2449	0.2419
Open water	0.2206	0.1837	0.2021
Water milfoil ( <u>Myriophyllum</u> spp.)	0.0580	0.1224	0.0902
Algae ( <u>Algae</u> spp.)	0.0448	0.0612	0.0530
Pondweed ( <u>Potamogeton robinsii</u> )	0.0249	0.0204	0.0226
Bladderwort ( <u>Utricularia</u> spp.)	0.0249	0.0204	0.0226
Flat-stem pondweed ( <u>Potamogeton zosteriformis</u> )	0.0100	0.0204	0.0152
Bur reed ( <u>Sparganium</u> spp.)	0.0100	0.0204	0.0152
Water smartweed ( <u>Polygonum amphibium</u> )	0.0100	0.0204	0.0152
Big duckweed ( <u>Spirodela polyrhiza</u> )	0.0017	0.0204	0.0110
Lesser duckweed ( <u>Lemna minor</u> )	0.0017	0.0204	0.0110
White-stem pondweed ( <u>Potamogeton praelongus</u> )	0.0017	0.0204	0.0110

Appendix K. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of middle beaver-created wetland on Newman Creek, SE 1/4, Sect. 11, T.34N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative coverage	relative frequency	Importance value
Open	0.2144	0.1698	0.1921
Sedge ( <u>Carex</u> spp.)	0.1674	0.0849	0.1262
Sphagnum moss ( <u>Sphagnum</u> spp.)	0.0911	0.0755	0.0833
Bunchberry ( <u>Cornus canadensis</u> )	0.1067	0.0566	0.0817
Raspberry ( <u>Rubus</u> spp.)	0.0589	0.0660	0.0625
Grass ( <u>Graminae</u> spp.)	0.0340	0.0755	0.0548
Spotted jewelweed ( <u>Impatiens capensis</u> )	0.0423	0.0660	0.0542
Balsam fir ( <u>Abies balsamiae</u> )	0.0442	0.0472	0.0457
Speckled alder ( <u>Alnus incana</u> )	0.0681	0.0189	0.0435
Large-leaved aster ( <u>Aster macrophyllus</u> )	0.0221	0.0377	0.0299
Golden saxifrage ( <u>Chrysosplenium americanum</u> )	0.0166	0.0377	0.0271
Rough bedstraw ( <u>Galium aparine</u> )	0.0258	0.0283	0.0270
Canada mayflower ( <u>Maianthemum canadense</u> )	0.0129	0.0377	0.0253
Manna grass ( <u>Glyceria</u> spp.)	0.0285	0.0189	0.0237
Moss ( <u>Philonotis</u> spp.)	0.0074	0.0283	0.0178
Sarsaparilla ( <u>Aralia nudicaulis</u> )	0.0147	0.0189	0.0168
Great saint Johnswort ( <u>Hypericum perforatum</u> )	0.0110	0.0189	0.0150
Marsh fern ( <u>Thelypteris palustris</u> )	0.0064	0.0189	0.0127
Strawberry ( <u>Fragaria virginiana</u> )	0.0064	0.0189	0.0127
Lady fern ( <u>Athyrium filix-femina</u> )	0.0018	0.0189	0.0104
Violet ( <u>Viola</u> spp.)	0.0055	0.0094	0.0075
Alder ( <u>Alnus</u> spp.)	0.0055	0.0094	0.0075
Yellow clintonia ( <u>Clintonia borealis</u> )	0.0055	0.0094	0.0075
Rough gooseberry ( <u>Ribes cynosbati</u> )	0.0009	0.0094	0.0052
Honey suckle ( <u>Lonicera</u> spp.)	0.0009	0.0094	0.0052
Common wood sorrel ( <u>Oxalis montana</u> )	0.0009	0.0094	0.0052

Appendix L. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within beaver-created wetland on an unnamed creek, NE 1/4, Sect. 8, T.34N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Open water	0.3523	0.1778	0.2650
Lesser duckweed ( <u>Lemna minor</u> )	0.1981	0.1778	0.1879
Water milfoil ( <u>Myriophyllum</u> spp.)	0.1088	0.2000	0.1544
Leafy pondweed ( <u>Potamogeton foliosus</u> )	0.0779	0.2000	0.1390
Algae ( <u>Alga</u> spp.)	0.2451	0.0000	0.1226
Big duckweed ( <u>Spirodela polyrrhiza</u> )	0.0114	0.1556	0.0835
Watermeal ( <u>Wolffia</u> sp.)	0.0065	0.0889	0.0477

Appendix M. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of beaver-created wetland on an unnamed creek, NE 1/4, Sect. 8, T.34N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative coverage	relative frequency	Importance value
Bluejoint ( <u>Calamagrostis</u> spp.)	0.3027	0.2754	0.2890
Sedge ( <u>Carex</u> spp.)	0.3204	0.2464	0.2834
Bullrush ( <u>Scirpus cyperinus</u> )	0.1253	0.1159	0.1206
Open	0.0632	0.1159	0.0896
Raspberry ( <u>Rubus</u> spp.)	0.0809	0.0870	0.0839
Meadowsweet ( <u>Spirea</u> spp.)	0.0443	0.0290	0.0367
Horsetail ( <u>Equisetum</u> spp.)	0.0233	0.0290	0.0261
Marsh thistle ( <u>Cirsium muticum</u> )	0.0078	0.0290	0.0184
Stinging nettle ( <u>Urtica dioica</u> )	0.0078	0.0290	0.0184
Canary reed grass ( <u>Phalaris arundinaceae</u> )	0.0166	0.0145	0.0156
Soft rush ( <u>Juncus effusus</u> )	0.0067	0.0145	0.0106
Buttercup ( <u>Ranunculus</u> spp.)	0.0011	0.0145	0.0078

Appendix N. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within lower beaver-created wetland on East Branch of Rock Creek, SW 1/4, Sect. 21, T.36N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Coontail ( <u>Ceratophyllum</u> spp.)	0.4374	0.1964	0.3169
Lesser duckweed ( <u>Lemna minor</u> )	0.1993	0.2857	0.2425
Open water	0.2363	0.1786	0.2075
Big duckweed ( <u>Spirodela polyrhiza</u> )	0.0459	0.1964	0.1211
Thallose liverwort ( <u>Riccia fluitans</u> )	0.0159	0.0893	0.0526
Pondweed ( <u>Potamogeton</u> sp.)	0.0370	0.0179	0.0274
Arrowhead ( <u>Sagittaria</u> sp.)	0.0265	0.0179	0.0222
Bladderwort ( <u>Utricularia</u> spp.)	0.0018	0.0179	0.0098

Appendix O. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of lower beaver-created wetland on East Branch of Rock Creek, SW 1/4, Sect. 21, T.36N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative coverage	Relative frequency	Importance value
Sedge ( <u>Carex</u> spp.)	0.3778	0.2674	0.3226
Open	0.1210	0.1395	0.1303
Raspberry ( <u>Rubus</u> spp.)	0.0782	0.0814	0.0798
Grass ( <u>Graminae</u> spp.)	0.0892	0.0698	0.0795
Goldenrod ( <u>Solidago</u> spp.)	0.0342	0.0465	0.0404
Bluejoint ( <u>Calamagrostis</u> spp.)	0.0452	0.0349	0.0401
Sphagnum moss ( <u>Sphagnum</u> spp.)	0.0440	0.0349	0.0394
Wood strawberry ( <u>Fragaria fescua</u> )	0.0183	0.0581	0.0382
Yellow clintonia ( <u>Clintonia borealis</u> )	0.0330	0.0349	0.0339
Moss ( <u>Philonotis</u> spp.)	0.0159	0.0349	0.0254
Lesser duckweed ( <u>Lemna minor</u> )	0.0257	0.0233	0.0245
Bloodroot ( <u>Sanguinaria canadensis</u> )	0.0147	0.0233	0.0190
Lady fern ( <u>Athyrium filix-femina</u> )	0.0183	0.0116	0.0150
Balsam fir ( <u>Abies balsamea</u> )	0.0183	0.0116	0.0150
Balsam poplar ( <u>Populus balsamifera</u> )	0.0183	0.0116	0.0150
Speckled alder ( <u>Alnus incana</u> )	0.0183	0.0116	0.0150
Trembling aspen ( <u>Populus tremuloides</u> )	0.0024	0.0233	0.0129
Meadowsweet ( <u>Spiraea</u> spp.)	0.0073	0.0116	0.0095
Sensitive fern ( <u>Onoclea sensibilis</u> )	0.0073	0.0116	0.0095
Sarsaparilla ( <u>Aralia nudicaulis</u> )	0.0073	0.0116	0.0095
Red maple ( <u>Acer rubrum</u> )	0.0012	0.0116	0.0064
Bunchberry ( <u>Cornus canadensis</u> )	0.0012	0.0116	0.0064
Rough bedstraw ( <u>Galium asprellum</u> )	0.0012	0.0116	0.0064
Hispid buttercup ( <u>Ranunculus hispidus</u> )	0.0012	0.0116	0.0064

Appendix P. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within beaver-created wetland on Otter Creek, SW 1/4, SW 1/4 Sect. 27, T.35N, R.15E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Open water	0.5957	0.2564	0.4261
Water milfoil ( <i>Myriophyllum</i> spp.)	0.1766	0.1795	0.1780
Pondweed ( <i>Potamogeton</i> spp.)	0.1007	0.1026	0.1016
Lesser duckweed ( <i>Lemna minor</i> )	0.0198	0.1795	0.0996
Star duckweed ( <i>Lemna trisulca</i> )	0.0314	0.1282	0.0798
Algae ( <i>Algae</i> spp.)	0.0446	0.0513	0.0479
Pondweed ( <i>Potamogeton robinsii</i> )	0.0198	0.0513	0.0355
Bladderwort ( <i>Utricularia</i> spp.)	0.0116	0.0513	0.0314

Appendix Q. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of upper beaver-created wetland on Otter Creek, SW 1/4, SW 1/4 Sect. 27, T.35N, R.15E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Relative importance value
Sedge ( <i>Carex</i> spp.)	0.1632	0.1043	0.1337
Spotted jewelweed ( <i>Impatiens capensis</i> )	0.1083	0.1130	0.1107
Open	0.0858	0.0870	0.0864
Sphagnum moss ( <i>Sphagnum</i> spp.)	0.0675	0.0870	0.0772
Cutgrass ( <i>Leersia</i> sp.)	0.1238	0.0261	0.0749
Bluejoint ( <i>Calamagrostis</i> sp.)	0.0605	0.0522	0.0563
Large-leaved aster ( <i>Aster macrophyllus</i> )	0.0309	0.0609	0.0459
spike rush ( <i>Eleocharis</i> sp.)	0.0520	0.0348	0.0434
Sugar maple ( <i>Acer saccharum</i> )	0.0338	0.0435	0.0386
Lady fern ( <i>Athyrium filix-femina</i> )	0.0506	0.0261	0.0384
Violet ( <i>Viola</i> spp.)	0.0281	0.0435	0.0358
Reed canary grass ( <i>Phalaris arundinaceae</i> )	0.0323	0.0348	0.0336
Horsetail ( <i>Equisetum</i> spp.)	0.0309	0.0261	0.0285
Canada anemone ( <i>Anemone canadensis</i> )	0.0183	0.0261	0.0222
Yellow clintonia ( <i>Clintonia borealis</i> )	0.0183	0.0261	0.0222
Bracken fern ( <i>Pteridium aquilinum</i> )	0.0352	0.0087	0.0219
Balsam fir ( <i>Abies balsamea</i> )	0.0056	0.0348	0.0202
Rough bedstraw ( <i>Galium asprellum</i> )	0.0056	0.0348	0.0202
Common cattail ( <i>Typha latifolia</i> )	0.0169	0.0174	0.0171
Wood strawberry ( <i>Fragaria vesca</i> )	0.0028	0.0174	0.0101
Cleavers ( <i>Galium aparine</i> )	0.0028	0.0174	0.0101
Black ash ( <i>Fraxinus nigra</i> )	0.0084	0.0087	0.0086
Sarsaparilla ( <i>Aralia nudicaulis</i> )	0.0084	0.0087	0.0086
Water parsnip ( <i>Sium suave</i> )	0.0014	0.0087	0.0051
Star flower ( <i>Trientalis borealis</i> )	0.0014	0.0087	0.0051
Speckled alder ( <i>Alnus incana</i> )	0.0014	0.0087	0.0051
Common dandelion ( <i>Taraxacum officinale</i> )	0.0014	0.0087	0.0051
Raspberry ( <i>Rubus</i> sp.)	0.0014	0.0087	0.0051
Moss ( <i>Philonotis</i> spp.)	0.0014	0.0087	0.0051

Appendix R. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within upper beaver-created wetland on an unnamed creek, NW 1/4, Sect. 9, T.34N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Open water	0.3523	0.1778	0.2650
Lesser duckweed ( <u>Lemna minor</u> )	0.1981	0.1778	0.1879
Water milfoil ( <u>Myriophyllum</u> spp.)	0.1088	0.2000	0.1544
Leafy pondweed ( <u>Potamogeton foliosus</u> )	0.0779	0.2000	0.1390
Algae ( <u>Algae</u> spp.)	0.2451	0.0000	0.1226
Big duckweed ( <u>Spirodela polyrhiza</u> )	0.0114	0.1556	0.0835
Watermeal ( <u>Wolffia</u> sp.)	0.0065	0.0889	0.0477

Appendix S. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of upper beaver-created wetland on an unnamed creek, NW 1/4, Sect. 9, T.34N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative coverage	Relative frequency	Importance value
Bullrush ( <u>Scirpus cyperinus</u> )	0.3097	0.1918	0.2507
Bluejoint ( <u>Calamagrostis</u> spp.)	0.0921	0.0959	0.0940
Bunchberry ( <u>Cornus canadensis</u> )	0.0921	0.0548	0.0735
Open	0.0650	0.0685	0.0667
Sedge ( <u>Carex</u> spp.)	0.0785	0.0548	0.0667
Stinging nettle ( <u>Urtica dioica</u> )	0.0589	0.0685	0.0637
Soft rush ( <u>Juncus effusus</u> )	0.0453	0.0685	0.0569
Horsetail ( <u>Equisetum</u> spp.)	0.0302	0.0685	0.0494
Meadowsweet ( <u>Spirea</u> spp.)	0.0604	0.0274	0.0439
Raspberry ( <u>Rubus</u> spp.)	0.0287	0.0548	0.0417
Wild strawberry ( <u>Fragaria virginiana</u> )	0.0287	0.0548	0.0417
Marsh skullcap ( <u>Scutellaria epilobilifolia</u> )	0.0211	0.0548	0.0380
Sensitive fern ( <u>Onoclea sensibilis</u> )	0.0272	0.0411	0.0341
Lady fern ( <u>Athyrium filix-femina</u> )	0.0317	0.0274	0.0296
Speckled alder ( <u>Alnus incana</u> )	0.0181	0.0274	0.0228
Large-leaved aster ( <u>Aster macrophyllus</u> )	0.0091	0.0137	0.0114
Lesser duckweed ( <u>Lemna minor</u> )	0.0015	0.0137	0.0076
Swamp buttercup ( <u>Ranunculus septentrionalis</u> )	0.0015	0.0137	0.0076

Appendix T. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within beaver-created wetland on Halleys Creek, NW 1/4, Sect. 23, T.35N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Coontail ( <u>Ceratophyllum</u> spp.)	0.4374	0.1964	0.3169
Lesser duckweed ( <u>Lemna minor</u> )	0.1993	0.2857	0.2425
Open water	0.2363	0.1786	0.2075
Big duckweed ( <u>Spirodella polyrhiza</u> )	0.0459	0.1964	0.1211
Thallose liverwort ( <u>Riccia fluitans</u> )	0.0159	0.0893	0.0526
Pondweed ( <u>Potamogeton</u> spp.)	0.0370	0.0179	0.0274
Arrowhead ( <u>Sagittaria</u> spp.)	0.0265	0.0179	0.0222
Bladderwort ( <u>Utricularia</u> spp.)	0.0018	0.0179	0.0098

Appendix U. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of beaver-created wetland on Halleys Creek, NW 1/4, Sect. 23, T.35N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Open	0.3074	0.2468	0.2771
Sedge ( <u>Carex</u> spp.)	0.3074	0.1169	0.2121
Raspberry ( <u>Rubus</u> spp.)	0.0597	0.0909	0.0753
Sphagnum moss ( <u>Sphagnum</u> spp.)	0.0506	0.0649	0.0578
Goldenrod ( <u>Solidago</u> spp.)	0.0649	0.0260	0.0454
Lady fern ( <u>Athyrium filix-femina</u> )	0.0350	0.0390	0.0370
Large-leaved Aster ( <u>Aster macrophyllus</u> )	0.0402	0.0260	0.0331
Grass ( <u>Graminae</u> spp.)	0.0233	0.0390	0.0312
Bluejoint ( <u>Calamagrostis</u> spp.)	0.0272	0.0260	0.0266
Tall meadow rue ( <u>Thalictrum polygamum</u> )	0.0039	0.0390	0.0214
Reed canary grass ( <u>Phalaris arundinaceae</u> )	0.0156	0.0260	0.0208
Stinging nettle ( <u>Urtica dioica</u> )	0.0091	0.0260	0.0175
Horsetail ( <u>Equisetum</u> spp.)	0.0026	0.0260	0.0143
Moss ( <u>Philonotis</u> spp.)	0.0026	0.0260	0.0143
Bracken fern ( <u>Pteridium aquilinum</u> )	0.0078	0.0130	0.0104
Marsh thistle ( <u>Cirsium muticum</u> )	0.0078	0.0130	0.0104
Lily-of-the-valley ( <u>Convallaria majalis</u> )	0.0078	0.0130	0.0104
Speckled alder ( <u>Alnus incana</u> )	0.0078	0.0130	0.0104
Buttercup ( <u>Ranunculus</u> spp.)	0.0078	0.0130	0.0104
Common Chokecherry ( <u>prunus virginiana</u> )	0.0013	0.0130	0.0071
Sarsaparilla ( <u>Aralia nudicaulis</u> )	0.0013	0.0130	0.0071
Yarrow ( <u>Achillea millefolium</u> )	0.0013	0.0130	0.0071
Waxy meadow rue ( <u>Thalictrum revolutum</u> )	0.0013	0.0130	0.0071
Partridgeberry ( <u>Mitchella repens</u> )	0.0013	0.0130	0.0071
Aster ( <u>Aster</u> spp.)	0.0013	0.0130	0.0071
Meadow foxtail ( <u>Alopecurus</u> spp.)	0.0013	0.0130	0.0071
Marsh bedstraw ( <u>Galium palustre</u> )	0.0013	0.0130	0.0071
Trembling aspen ( <u>Populus tremuloides</u> )	0.0013	0.0130	0.0071

Appendix V. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within beaver-created wetland on an unnamed creek, SE 1/4, NW 1/4, Sect. 9, T.24N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Lesser duckweed ( <u>Lemna minor</u> )	0.3672	0.3095	0.3384
Big duckweed ( <u>Spirodela polyrhiza</u> )	0.0833	0.2857	0.1845
Bladderwort ( <u>Utricularia</u> spp.)	0.2969	0.0476	0.1722
Water milfoil ( <u>Myriophyllum</u> spp.)	0.1354	0.1190	0.1272
Water smartweed ( <u>Polygonum amphibium</u> )	0.0313	0.0476	0.0394
Algae ( <u>Algae</u> spp.)	0.0313	0.0476	0.0394
Leafy pondweed ( <u>Potamogeton foliosus</u> )	0.0182	0.0476	0.0329
Sedge ( <u>Carex</u> spp.)	0.0156	0.0238	0.0197
Open water	0.0156	0.0238	0.0197
Thallose liverwort ( <u>Riccia fluitans</u> )	0.0026	0.0238	0.0132
Meadowsweet ( <u>Spirea</u> spp.)	0.0026	0.0238	0.0132

Appendix W. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of beaver-created wetland on an unnamed creek, SE 1/4, NW 1/4, Sect. 9, T.24N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative coverage	Relative frequency	Importance value
Raspberry ( <u>Rubus</u> spp.)	0.1959	0.1034	0.1497
Bluejoint ( <u>Calamagrostis</u> spp.)	0.1472	0.0920	0.1196
Speckled alder ( <u>Alnus incana</u> )	0.1277	0.0575	0.0926
Sedge ( <u>Carex</u> spp.)	0.0779	0.0805	0.0792
Open	0.0547	0.0690	0.0619
Horsetail ( <u>Equisetum</u> spp)	0.0523	0.0575	0.0549
Wild sarsaparilla ( <u>Aralia nudicaulis</u> )	0.0414	0.0575	0.0494
Grass ( <u>Graminea</u> spp.)	0.0292	0.0575	0.0433
Bunchberry ( <u>Cornus canadense</u> )	0.0389	0.0460	0.0425
Balsam poplar ( <u>Populus balsamifera</u> )	0.0450	0.0230	0.0340
Large-leaved aster ( <u>Aster macrophyllus</u> )	0.0170	0.0460	0.0315
Joe-pye weed ( <u>Eupatorium dubium</u> )	0.0365	0.0230	0.0297
White spruce ( <u>Picea glauca</u> )	0.0255	0.0230	0.0243
Bracken fern ( <u>Pteridium aquilinum</u> )	0.0255	0.0230	0.0243
Willow ( <u>Salix</u> spp.)	0.0097	0.0345	0.0221
Cleavers ( <u>Galium aparine</u> )	0.0097	0.0345	0.0221
Blueberry ( <u>Vaccinium</u> spp.)	0.0195	0.0230	0.0212
Water speedwell ( <u>Veronica anagallis</u> )	0.0036	0.0345	0.0191
Wood strawberry ( <u>Fragaria vesca</u> )	0.0073	0.0115	0.0094
Swamp buttercup ( <u>Ranunculus septentrionalis</u> )	0.0073	0.0115	0.0094
Large-flowered trillium ( <u>Trillium grandiflorum</u> )	0.0073	0.0115	0.0094
Honeysuckle ( <u>Lonicera</u> spp.)	0.0073	0.0115	0.0094
Chokecherry ( <u>Prunus virginiana</u> )	0.0073	0.0115	0.0094
Swamp fly honeysuckle ( <u>Lonicera oblongifolia</u> )	0.0012	0.0115	0.0064
Orange hawkweed ( <u>Hieracium aurantiacum</u> )	0.0012	0.0115	0.0064
Marsh skullcap ( <u>Scutellaria epilobifolia</u> )	0.0012	0.0115	0.0064
Canada mayflower ( <u>Maiathemum canadense</u> )	0.0012	0.0115	0.0064
Bloodroot ( <u>Sanguinaria canadensis</u> )	0.0012	0.0115	0.0064

Appendix X. Relative canopy coverage, frequency of occurrence and importance value of aquatic vegetation within upper beaver-created wetland on an unnamed creek, NW 1/4, Sect. 14, T.34N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative canopy coverage	Relative frequency of occurrence	Importance value
Water milfoil ( <u>Myriophyllum</u> spp.)	0.4072	0.2407	0.3240
Open water	0.3763	0.0370	0.2067
Lesser duckweed ( <u>Lemna minor</u> )	0.0258	0.2778	0.1518
Big duckweed ( <u>Spirodela polyrhiza</u> )	0.0168	0.1481	0.0825
Algae ( <u>Algae</u> spp.)	0.0786	0.0741	0.0763
Thallose liverwort ( <u>Riccia fluitans</u> )	0.0064	0.0926	0.0495
Leafy pondweed ( <u>Potamogeton foliosus</u> )	0.0387	0.0370	0.0378
Sedge ( <u>Carex</u> spp.)	0.0193	0.0185	0.0189
Bur reed ( <u>Sparganium</u> sp.)	0.0077	0.0185	0.0131
Bluejoint ( <u>Calamagrostis</u> spp.)	0.0077	0.0185	0.0131
Water arum ( <u>Calla palustris</u> )	0.0077	0.0185	0.0131
Floating-leaf pondweed ( <u>Potamogeton natans</u> )	0.0077	0.0185	0.0131

Appendix Y. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of upper beaver-created wetland on an unnamed creek, NW 1/4, Sect. 14, T.34N, R.16E, Forest County, Wisconsin, 1991.

Species	Relative coverage	Relative frequency	Importance value
Open	0.0970	0.0648	0.0809
Bracken fern ( <u>Pteridium aquilinum</u> )	0.0970	0.0526	0.0748
Grass ( <u>graminea</u> spp.)	0.0675	0.0607	0.0641
Raspberry ( <u>Rubus</u> spp.)	0.0455	0.0486	0.0470
Honeysuckle ( <u>Lonicera</u> spp.)	0.0720	0.0040	0.0380
Large-leaved aster ( <u>Aster macrophyllus</u> )	0.0280	0.0324	0.0302
Moss ( <u>Philonotis</u> spp.)	0.0210	0.0324	0.0267
Willow ( <u>Salix</u> spp.)	0.0220	0.0202	0.0211
Sedge ( <u>Carex</u> spp.)	0.0230	0.0121	0.0176
Bunchberry ( <u>Cornus canadense</u> )	0.0145	0.0202	0.0174
Yellow clintonia ( <u>Clintonia borealis</u> )	0.0100	0.0202	0.0151
Quaking aspen ( <u>Populus tremuloides</u> )	0.0065	0.0121	0.0093
Wood strawberry ( <u>Fragaria vesca</u> )	0.0040	0.0121	0.0081
Lady fern ( <u>Athyrium filix-femina</u> )	0.0035	0.0081	0.0058
Chokecherry ( <u>Prunus virginiana</u> )	0.0030	0.0040	0.0035
Orange hawkweed ( <u>Hieracium aurantiacum</u> )	0.0030	0.0040	0.0035
Blueberry ( <u>Vaccinium</u> spp.)	0.0005	0.0040	0.0023
Swamp buttercup ( <u>Ranunculus septentrionalis</u> )	0.0005	0.0040	0.0023
Balsam fir ( <u>Abies balsamea</u> )	0.0005	0.0040	0.0023

Appendix Z. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of lower beaver-created wetland on Mexico Creek, NE 1/4, T.35N, R.15E, Forest County, Wisconsin, 1991.

Species	Relative coverage	Relative frequency	Importance value
Sedge ( <u>Carex</u> spp.)	0.4438	0.2388	0.3413
Open	0.0807	0.1194	0.1000
Goldenrod ( <u>Solidago</u> spp.)	0.0908	0.0896	0.0902
Manna grass ( <u>Glyceria</u> spp.)	0.0605	0.0597	0.0601
Bullrush ( <u>Scirpus cyperinus</u> )	0.0519	0.0448	0.0483
Horsetail ( <u>Equisetum</u> spp.)	0.0144	0.0746	0.0445
Grass ( <u>Graminae</u> spp.)	0.0576	0.0299	0.0437
Marsh skullcap ( <u>Scutellaria epilobifolia</u> )	0.0187	0.0448	0.0318
Rough bedstraw ( <u>Galium asprellum</u> )	0.0115	0.0448	0.0282
Bluejoint ( <u>Calamagrostis</u> spp.)	0.0101	0.0299	0.0200
Honeysuckle ( <u>Lonicera</u> spp.)	0.0216	0.0149	0.0183
Bracken fern ( <u>Pteridium aquilinum</u> )	0.0216	0.0149	0.0183
Speckled alder ( <u>Alnus incana</u> )	0.0216	0.0149	0.0183
Swamp candles ( <u>Lysimachia terrestris</u> )	0.0216	0.0149	0.0183
Arrowhead ( <u>Sagittaria latifolia</u> )	0.0086	0.0149	0.0118
Willow ( <u>Salix</u> spp.)	0.0086	0.0149	0.0118
Wood strawberry ( <u>Fragaria vesca</u> )	0.0086	0.0149	0.0118
Soft rush ( <u>Juncus effusus</u> )	0.0086	0.0149	0.0118
Interrupted fern ( <u>Osmunda claytonia</u> )	0.0086	0.0149	0.0118
Raspberry ( <u>Rubus</u> spp.)	0.0086	0.0149	0.0118
Spotted jewelweed ( <u>Impatiens capensis</u> )	0.0086	0.0149	0.0118
Large-leaved aster ( <u>Aster macrophyllus</u> )	0.0086	0.0149	0.0118
Agrimony ( <u>Agrimony gryposepala</u> )	0.0014	0.0149	0.0082
Water parsnip ( <u>Sium suave</u> )	0.0014	0.0149	0.0082
Wild strawberry ( <u>Fragaria virginiana</u> )	0.0014	0.0149	0.0082

Appendix AA. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of lower beaver-created wetland on Stoney Creek, SW 1/4, SE 1/4, Sect. 10, T.35N, R.15E, Forest County, Wisconsin, 1991.

Species	Relative coverage	relative frequency	Importance value
Open	0.2905	0.3750	0.3328
Bluejoint ( <u>Calamagrostis</u> spp.)	0.0251	0.5833	0.3042
Sedge ( <u>Carex</u> spp.)	0.3324	0.1667	0.2495
Meadowsweet ( <u>Spirea</u> spp.)	0.0698	0.2083	0.1391
Raspberry ( <u>Rubus</u> spp.)	0.0391	0.1667	0.1029
Joe-pye weed ( <u>Eupatorium dubium</u> )	0.0251	0.1667	0.0959
Water arum ( <u>Calla palustris</u> )	0.0503	0.1250	0.0876
Willow ( <u>Salix</u> spp.)	0.0838	0.0417	0.0627
Blue flag iris ( <u>Iris versicolor</u> )	0.0335	0.0833	0.0584
Joe-pye weed ( <u>Eupatorium dubium</u> )	0.0503	0.0417	0.0460

Appendix AB. Relative canopy coverage, frequency of occurrence and importance value of vegetation at the edge of beaver-created wetland on Catwillow Creek, SE 1/4, Sect. 12, T.36N, R.15E, Forest County, Wisconsin, 1991.

specie	Relative coverage	Relative frequency	Importance value
Open	0.5609	0.4364	0.4986
Sedge ( <u>Carex</u> spp.)	0.2719	0.3273	0.2996
Bluejoint ( <u>Calamagrostis</u> spp.)	0.1504	0.2000	0.1752
Water smartweed ( <u>Polygonum punctatum</u> )	0.0084	0.0182	0.0133
Meadowsweet ( <u>Spirea</u> spp.)	0.0084	0.0182	0.0133