Biological Inventory of a Multi-Purpose Flood Control Impoundment in Northwest Minnesota and Potentials for Nongame and Game Bird Management

W. Daniel Svedarsky
Principal Investigator

Northwest Agricultural
Experiment Station
University of Minnesota
Crookston, Minnesota

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BIOLOGICAL INVENTORY OF A MULTI-PURPOSE FLOOD CONTROL IMPOUNDMENT IN NORTHWEST MINNESOTA AND POTENTIALS FOR NONGAME AND GAME BIRD MANAGEMENT

Final Report on the cooperative agreements between
The Soil Conservation Service (U.S.D.A.),
The Red Lake Watershed District,
The Nongame Program of The Minnesota Department of Natural Resources
and
The University of Minnesota,
Northwest Agricultural Experiment Station, Crookston

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Prepared by
W. Daniel Svedarsky, Principal Investigator
Northwest Agricultural Experiment Station
University of Minnesota, Crookston

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INTRODUCTION

In 1988, a multi-purpose flood control project known as the "BR-6 Impoundment" was completed in Polk County, Minnesota. The project contained upland habitats, a restored marsh, and a flood storage impoundment, designed to reduce flooding in the Burnham Creek Watershed while providing benefits for wetland and prairie wildlife. It was a cooperative project of the Soil Conservation Service, Red Lake Watershed District, West Polk County Soil and Water Conservation District, and the Minnesota Department of Natural Resources. Often, multi-purpose flood control projects are proposed to provide wildlife benefits but few base-line data have been collected in the early stages of such projects to document these wildlife values and serve as a reference to evaluate further changes.

Specific objectives of this study were as follows:

1) To conduct a base-line biological and water quality inventory of a multi-use impoundment in northwest Minnesota.

2) To evaluate use of the impoundment by migratory species, particularly shorebirds and waterfowl, and to suggest means of maintaining and possibly increasing this use.

3) To develop a long-term management plan based on this study and a literature review which will enhance habitat for resident and migratory wildlife.

4) To recommend ways in which public use can be integrated into a management plan without compromising flood control and wildlife management values.

A study of this sort is largely descriptive rather than experimental. Efforts were made to describe, as thoroughly as possible, the physical and biological characteristics of the project area, now known as the Burnham Creek Wildlife Management Area, during the field seasons of 1990 and 1991. These data will aid future comparative studies of vegetation, water quality and quantity, breeding and migratory bird use, and nesting success. The study should provide some quidelines useful in the design of other multi-purpose projects, although what works well in one site may not have the same results in another area. The discussion of likely biological changes and management considerations contained in this report is based on 2 field seasons of data collection, 23 years of field observations in northwest Minnesota by the principal investigator, interviews with agency personnel with similar field experience, and a review of appropriate literature. As such, it is a progress report and subject to refinements as observations continue and wetland management is better understood.

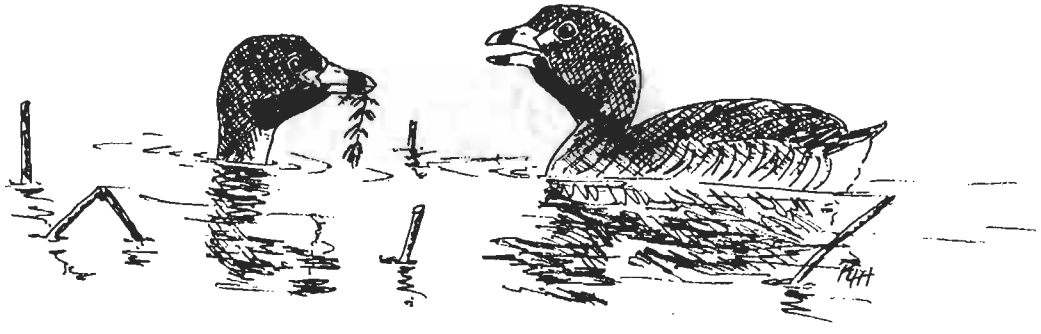
An effort was made to make the report useful to a broad readership and the use of technical jargon and theoretical concepts has been minimized. Common names of plants and animals are used throughout but scientific names are indicated the first time an organism is referred to in the text. English units of measurement have been used instead of, or in addition to, metric units when it was believed to add to readability, particularly in regard to water depth measurements. Metric units were used in presenting data from biological sampling procedures which are usually carried out by specialists.

The study was funded by the Soil Conservation Service, Red Lake Watershed District, and the Nongame Program of the Minnesota Department of Natural

Resources in conjunction with the Northwest Agricultural Experiment Station of the University of Minnesota, Crookston. Considerable in-kind support and field assistance was provided by the Section of Wildlife, Minnesota Department of Natural Resources, and coordinated by Terry Wolfe and Ross Hier of the Crookston field office. The Minnesota Chapter of The Nature Conservancy consented to the establishment of cattail monitoring plots on the adjacent Pembina Trail Preserve which will serve as a valuable future reference.

Appreciation is expressed to the following individuals who made helpful comments on a draft copy of the study proposal: Larry Pollard, Soil Conservation Service; David Anderson, James Mattsson and George Swanson of the U.S. Fish and Wildlife Service; Leigh Fredrickson, University of Missouri; Terry Wolfe, Ross Hier and Steve Maxson, Minnesota Department of Natural Resources; Francesca Cuthbert, University of Minnesota, St. Paul; and Richard Crawford, University of North Dakota. The following individuals assisted with collecting field data and/or many hours of sorting invertebrates in the laboratory: Ross Hier, Keith Johnson, David Delehanty, Kim Vesey, Kevin Munn, Kelly Wolfe, Max Grivno, Vance Lanning, Tom Feiro, Jay Huseby and Terry Wolfe. Special thanks to Ross Hier who contributed the art work for the report, coordinated the invertebrate phase of the study and reviewed the final report. Del Wright of Media Resources, University of Minnesota, Crookston prepared figures and assisted with the photo section of the report. Bobby Holder of the Northwest Experiment Station provided helpful comments on water quality aspects of the study and analized water samples. Lowell Enerson, Executive Director, Red Lake Watershed District was particularly helpful in promoting agency cooperation and support and the importance of wildlife benefits in flood control projects.

The support and encouragement of Experiment Station Superintendent Larry Smith throughout the study and preparation of this report is gratefully acknowledged and much appreciated. Thanks too, to Experiment Station secretary, Jan Solheim who patiently typed many "cut and paste" drafts of the report.



STUDY AREA

The 435-acre (175 hectare) study area is located 15 miles (24 km) southeast of Crookston, mostly in Sections 2 and 11 of Onstad Township, T-148, R-45W. The tract is situated in a complex of beach ridges formed along the margin of Glacial Lake Agassiz. These ridges trend mostly north-south and are quite sandy at their crests with finer textured soils in depressional areas. The eastern edge of the study area lies near the crest of a beach ridge known as the Tintah ridge complex. The land slopes to the west with the western boundary of the study area about 30 ft (9.1 m) lower than the eastern edge. A lower beach ridge runs through the site and separates the restored 62-acre (25 ha) bulrush marsh from the constructed 74-acre (30 ha) flood storage pool. The interior road generally follows the crest of this ridge (Fig. 1).

Soils present on the site can be inferred from the detailed inventory conducted on the Pembina Trail Preserve adjacent to the north (Minn. D.N.R. 1979). The Lohnes-Syrene-Hangaard Association is typically found on or adjacent to glacial lake beach ridges and has generally well-drained, coarse-textured soils with neutral reaction. The remainder of the site is covered by the Roliss-Kittson-Viking association which is more poorly drained, generally higher in organic matter and slightly more alkaline in reaction. Beach ridges tend to have seep areas along their westward slopes in this region of Minnesota. An organic soil zone occurs near the base of the large ridge near the Wildlife Pool (WP) margin and supports a unique plant community known as a fen. Fens are peaty areas saturated with ground water discharge that is generally alkaline in reaction.

The original vegetation of the general area was tallgrass prairie dominated by big bluestem (Andropogon gerardii), little bluestem (Andropogon scoparius), Indiangrass (Sorghastrum nutans) and switchgrass (Panicum virgatum) in better drained sites; prairie cordgrass (Spartina pectinata), bluejoint reedgrass (Calamagrostis canadensis) and sedges (Carex spp.) in low areas; and shallow marshes dominated by bulrush (Scirpus spp.), cattail (Typha spp.), reed (Phargmites communis) and whitetop (Scolochloa festucacea). Shrub willows (Salix spp.) and trembling aspen (Populus tremuloides) were present on the original prairie landscape but recurrent fires reduced their prominence. Fire suppression in the early 1900's resulted in the enlargement of aspen clones and growth of shrub willows. The immediate area to the north and east of the study area (within 3 miles or 4.8 km) was mostly in pastureland in 1970 with over half being native vegetation. Most of the well-drained beach ridge sites had been cultivated in the past but had reverted to grass and forb grasslands. Conversion of the grasslands and wetlands to intensive row crop farming commenced in the early 1970's and presently almost all private land is being intensively farmed for sunflowers, small grain, and corn. All of the area within the study area boundary has been disturbed except the Aspen/Brush Fen, 2 small native prairie tracts at the northeast and southeast corners, and a major protion of the WP except the area disturbed by the construction of the old drainage ditch (Fig. 1). Specific information on the wetland vegetation of the study area is presented in the VEGETATION section of this report but general upland vegetation is as follows:

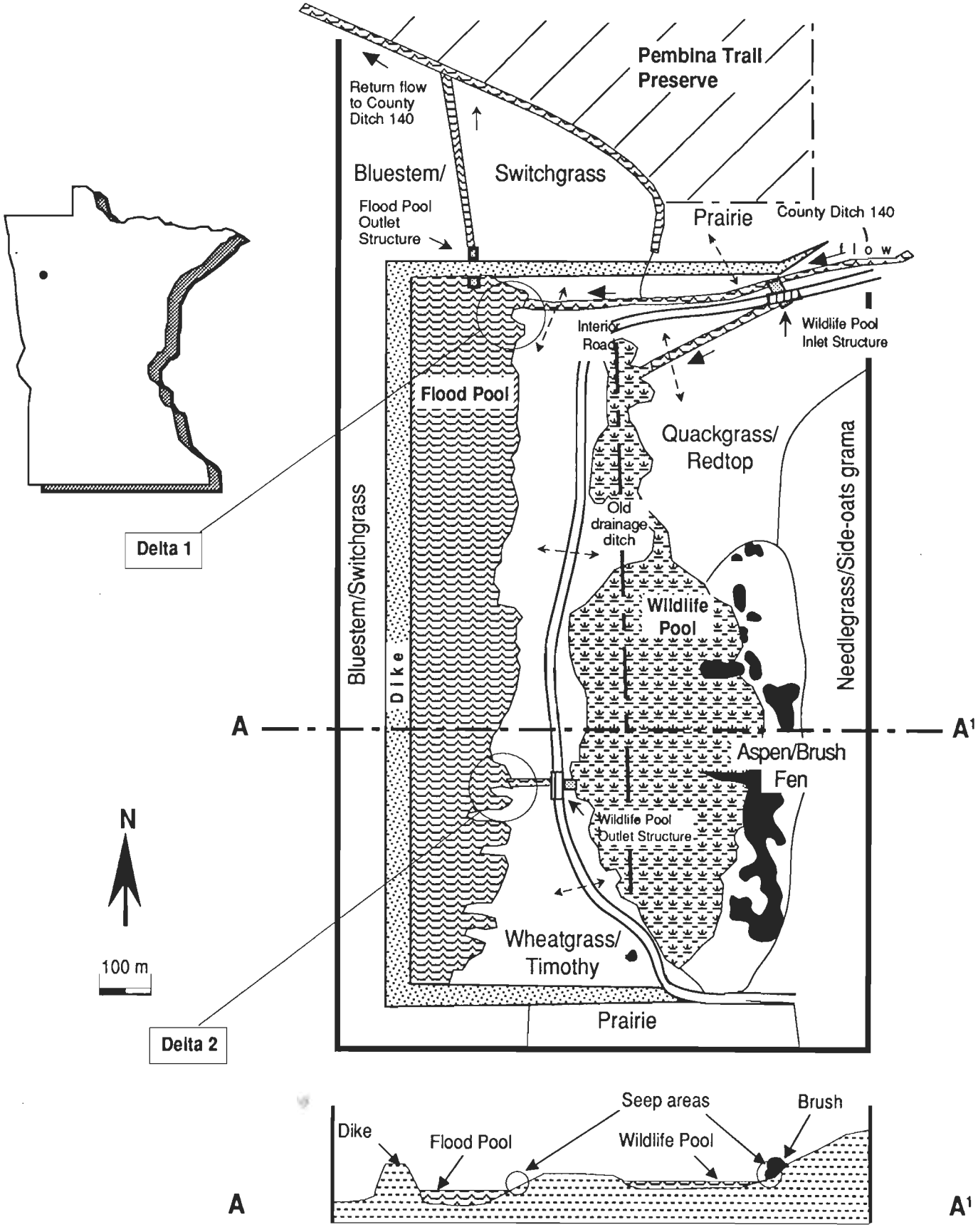


Fig. 1. Burnham Creek Wildlife Management Area. Polk County, Minnesota.

1. Prairie (16.1 A or 6.5 ha) - Dominated by big bluestem (Andropogon gerardii), Indian grass (Sorghastrum nutans), switchgrass (Panicum virgatum) and other native prairie species of grasses, forbs, and shrubs.

2. Aspen/Brush Fen (27.4 A or 11.1 ha) - A hummocky, seep area along a ridge dominated by native species: sedges, reed-grass (Calamagrostis spp.) willows (Salix spp.), trembling aspen (Populus tremuloides) and other native forbs and grasses. About 50% open and 50% trees and shrubs.

3. Wheatgrass/Timothy (75.6 A or 30.6 ha) - A lower ridge site planted in 1988 and currently dominated by wheatgrasses (Agropyron intermedium, A. smithii, A. repens), timothy (Phleum pratense), bluegrass (Poa spp.), sweet clover (Melilotus spp.), with seep areas dominated by reed canary grass (Phalaris arundinacea), bulrush and sedges.

4. Bluestem/Switchgrass (71.2 A or 28.8 ha) - A lower site planted with native species in 1988 and dominated by big bluestem, switchgrass, Indian grass, and redtop (Agrostis stolonifera), with intermixed weedy forbs.

5. Quackgrass/Redtop (42.3 A or 17.1 ha) - A lower site, planted with native grass species in 1988 but mostly dominated by quackgrass, redtop, Canada thistle (Cirsium arvense), sow-thistle (Sonchus uliginosus), and sweet clover. Contained up to 2 in. (5 cm) of standing water in the spring and after heavy rains.

6. Needlegrass/Side-oats grama (31.9 A or 12.9 ha) - A dry, ridge site planted in 1988 and dominated by green needlegrass (Stipa viridula), side-oats grama (Bouteloua curtipendula), bluegrass, hoary alyssum (Berteroa incana), and sage (Artemesia spp.).

7. Dike (22.2 A or 9.0 ha) - A rather steep, sloping site planted in 1988 and dominated by wheatgrasses, switchgrass, and side-oats grama.

The study area is positioned among a cluster of state Wildlife Management Areas and Nature Conservancy tracts (Fig. 2) which enhances its habitat values. The primary water source for the project enters the northeast corner through County Ditch 140 which has a drainage area of about 8.1 square miles or 21.0 km^2 (S.C.S. 1982). About 75% of the drainage area is presently cultivated for corn and small grain production.

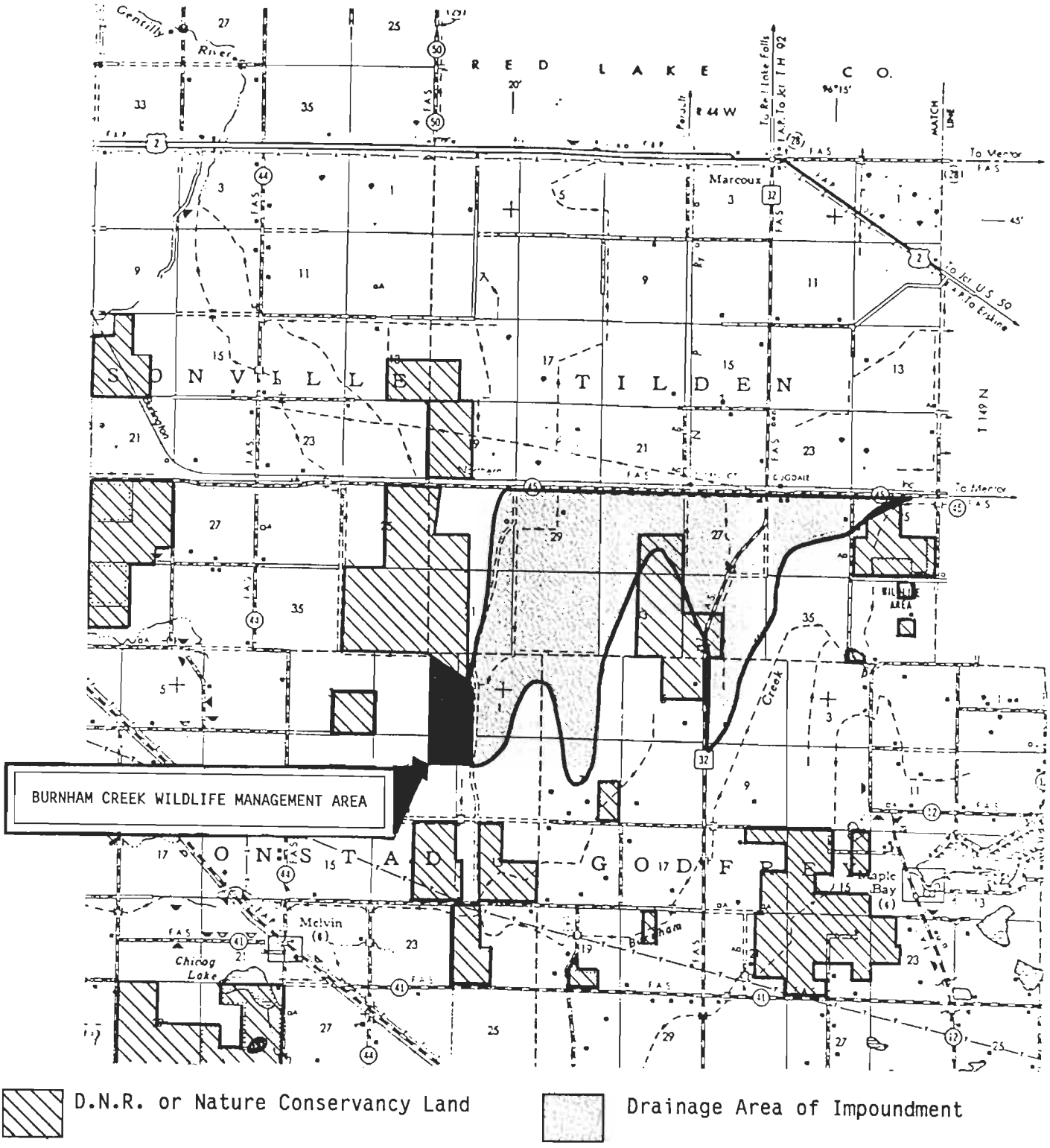


Fig. 2. Location of Burnham Creek Wildlife Management Area in relation to other wildlife lands and drainage area of impoundment.

HYDROLOGY

Water quantity and quality play a major role in the functioning of a wetland system such as the Burnham Creek Wildlife Management Area. Swanson and Duebbert (1989) emphasize that hydrologic factors not only dictate wetland hydroperiods and chemical characteristics but also the "availability of key food items (plant and animal), overwater nesting cover, sites for pair isolation, escape cover, and suitable water quality" (for drinking).

Past geologic events determined present topographic conditions which affect surface water flow. Surficial geologic deposits affect subsurface water flow and the chemical characteristics of both surface runoff and ground water discharge. Regional precipitation patterns determine how much water can potentially move through a system. Man-influenced hydrologic factors in this system include land use within the 8.1 square mile watershed as it affects surface drainage, soil erosion, pesticide and nutrient inputs; and control of water levels in the Wildlife Pool (WP). The hydrologic flow pattern for both pools is illustrated in Fig. 3. Surface runoff to both pools comes primarily from County Ditch 140 with a minor amount from the local watersheds located mostly within the project area boundary. No water was released from the WP during 1990 and 1991 so it functioned like a closed-system wetland which, long-term, would tend to accumulate more salts than a flow-through wetland like the Flood Pool (FP). According to Kantrud, et al. (1989a) "atomspheric water tends to be low in dissolved salts, runoff tends to be intermediate, and ground water, depending on the characteristics of the substrate, tends to be high."

METHODS

Water quantity measurements included twice-weekly recording of WP and FP levels and recording precipitation at the study area during the 1991 field season. WP levels were recorded as depth in inches above the substrate at the southeast corner of the WP Outlet Structure. The substrate was 2.63 feet down from the top of the concrete box structure. The FP level was measured on the FP Outlet Structure gauge which was also the approximate depth over the concrete slab near the exit opening. In 1991, a rain gauge was installed near the WP Outlet Structure and weekly precipitation totals were recorded from late April through September. Yearly precipitation data were obtained from the Northwest Agricultural Experiment Station of the University of Minnesota located at Crookston.

The following water quality parameters were recorded: pH, total alkalinity, total hardness, conductivity, total dissolved solids, nitrate, and phosphate. Bi-weekly water samples were collected in sterile plastic bags, then immediately frozen until analysis. Samples were collected at the metal weir structure on County Ditch 140, near the Wildlife Pool Outlet Control Structure, and near the Flood Pool Outlet Control Structure. An Orion 407-A pH meter was used to measure pH. A Lachet Auto-Analizer System was used to measure nitrate, phosphate, and total alkalinity. A Hach conductivity bridge was used to measure total dissolved solids and conductivity. A Hach field kit was used to measure total hardness. A Secchi disk was used to measure turbidity in the FP.

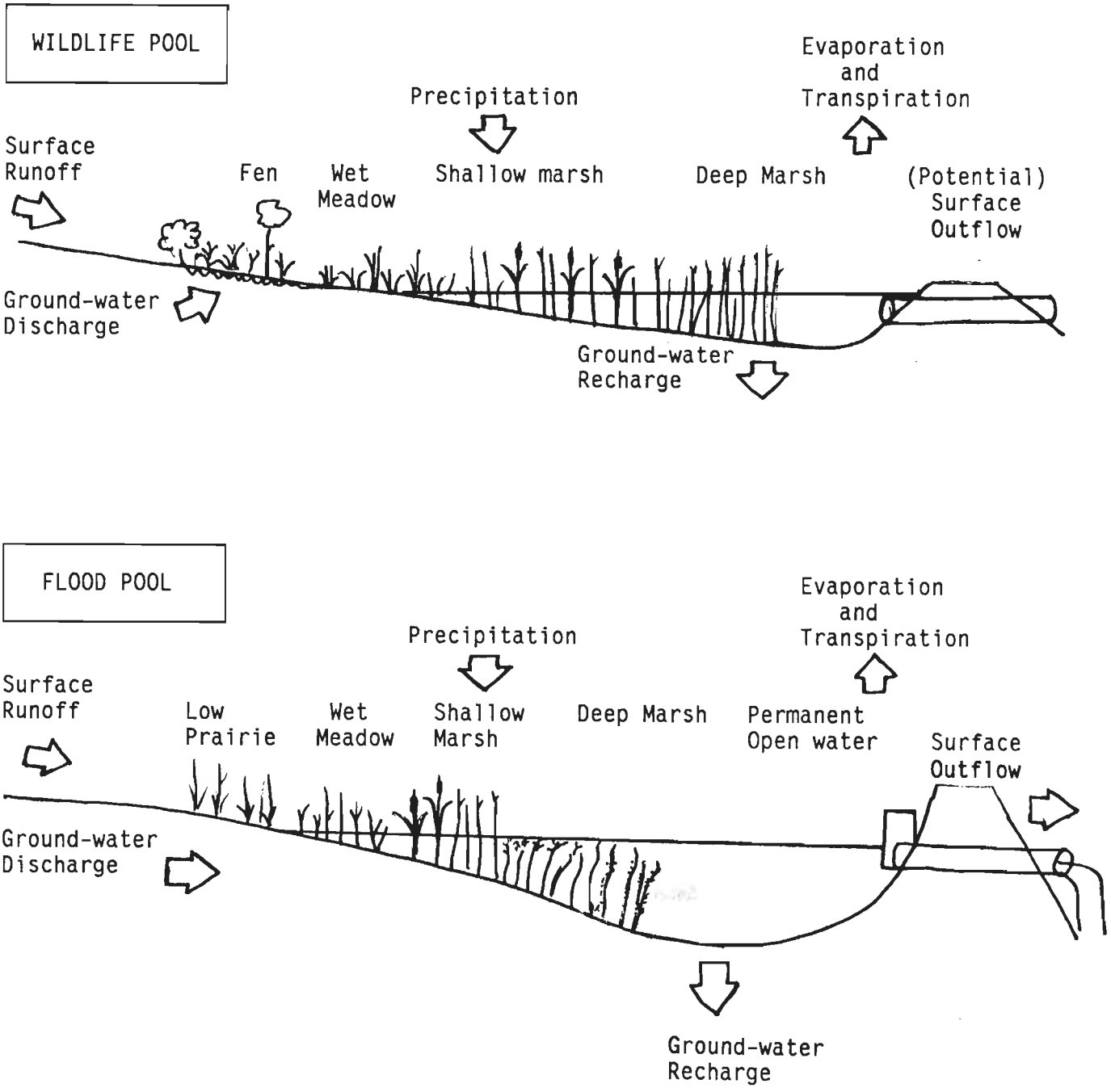


Fig. 3. Schematic cross-section of Burnham Creek Wildlife Management Area illustrating flow pattern of a closed-system (Wildlife Pool) and a flow-through (Flood Pool) wetland (modified from Kantrud, et al. 1989a).

Quantity

Pool levels were quite low at the beginning of the 1990 field season as a result of low precipitation during the preceding year. The Wildlife Pool (Fig. 4) was essentially dry except for the old drainage ditch and 2-3 in. depths in about 10% of the pool. The WP Inlet Structure was plugged with sediment and ice until 22 April. The snowmelt peak flow had passed by that date but there was sufficient flow to gradually raise WP levels 5 in. by 23 May. Over 3 in. of precipitation occurred on 1-2 June with another 2.5 in. by 22 June at which time the WP level had risen to 2.1 ft. (Fig. 4). The inlet structure was closed on 22 June and levels continued to fall until the WP was mostly dry again by 29 August. Water loss was due to a combination of evaporation, transpiration and seepage through the ridge separating the WP from the FP.

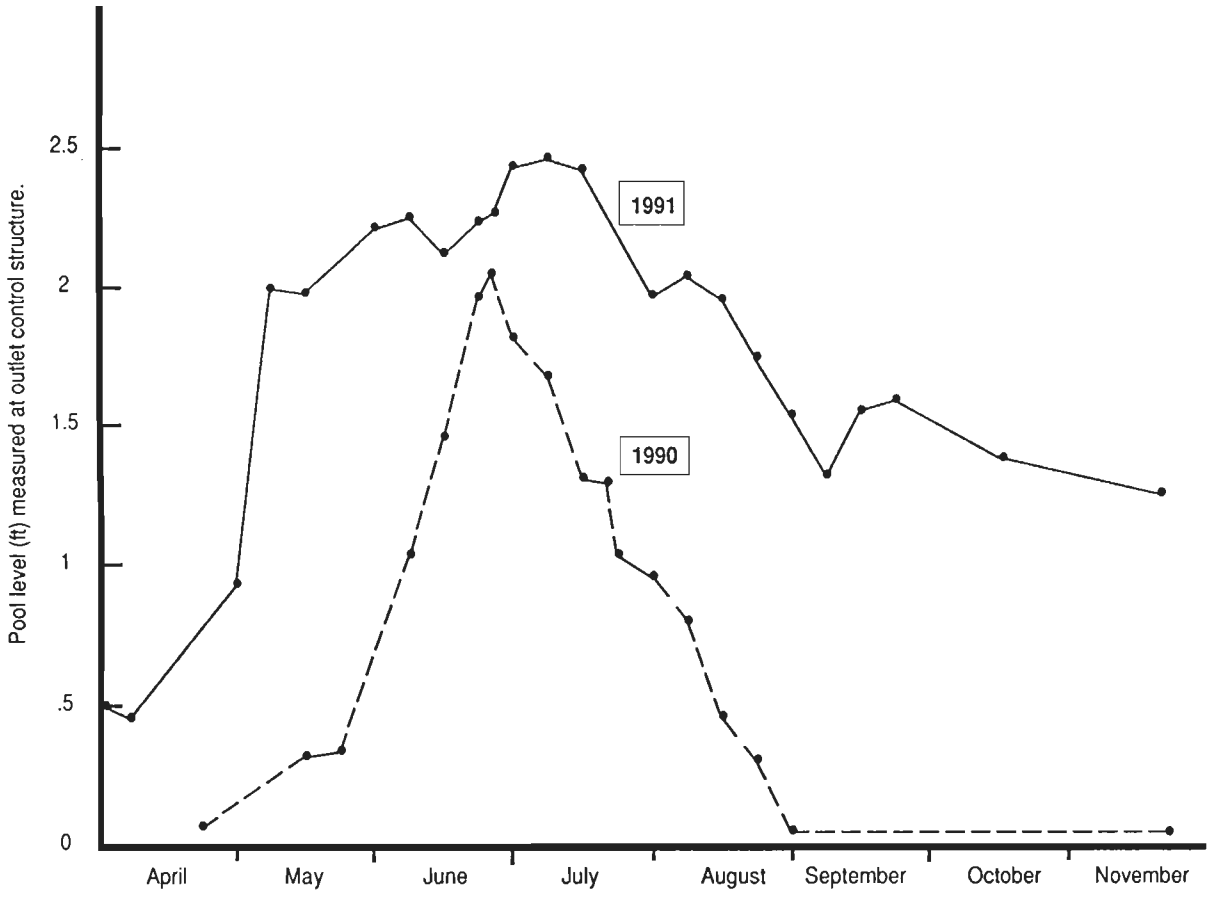


Fig. 4. Seasonal changes in Wildlife Pool levels at the Burnham Creek Wildlife Management Area, 1990 and 1991.

FP levels were generally low in 1990 and fluctuated less than 1 ft. throughout the summer due to the low precipitation (Fig. 5). Precipitation totals at Crookston from March through August in 1990 were 13.70 in. (Table 1), somewhat lower than the long-term average amount for this period of 14.55 in. (Severson 1982). From September 1990 to 31 March 1991 a total of 3.76 in. of precipitation occurred compared to the long-term average of 6.96 in. This resulted in low, early pool levels but the WP Inlet Structure was functional early enough to shunt spring melt water into the WP. This, combined with April and May precipitation, resulted in 2 ft. of water in the WP about 1½ months earlier than in 1990 (Fig. 4). The WP Inlet Structure was closed on 8 May 1991 when the level was 2 ft. but it continued to rise until mid-July due to direct precipitation and local runoff inputs. Also, cooler water temperatures along the eastern edge of the WP suggested significant inflow of seepage discharged below the ridge.

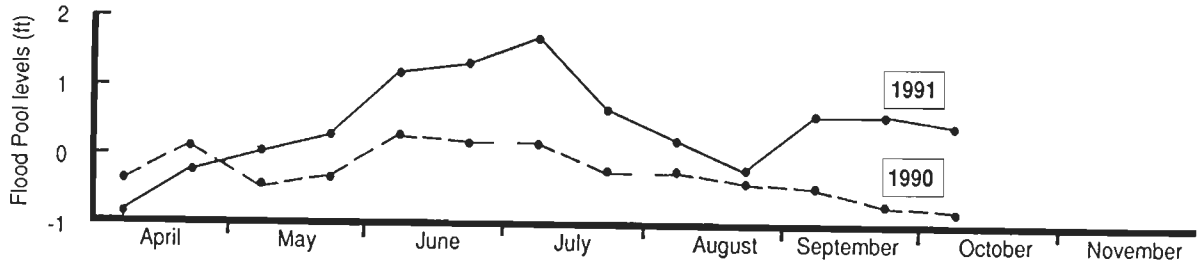


Fig. 5. Flood Pool levels at the Burnham Creek Wildlife Management Area, 1990 and 1991.

FP levels were about 1 ft. higher throughout the summer of 1991 than 1990 due to greater amounts of precipitation (Fig. 5). Precipitation totals at Crookston from March through August in 1991 were 15.26 in. compared to 13.70 in 1990 (Table 1). The study area rain gauge showed 19.45 in. of precipitation from late April through August, more than 4 in. than that recorded at Crookston (Table 1). In comparing precipitation between sites for the total period the rain gauge was monitored, the study area received 24.05 compared to 17.14 in. at Crookston or 6.9 in. more precipitation in a distance of only 15 miles. Thus, weather data from the Crookston monitoring station may not be sufficiently comparable to the study site to rely on solely in planning for water level manipulation at the WP. Regular site inspections during critical periods of overwater nesting activity are necessary.

Table 1. Weekly precipitation totals (inches) at Northwest Experiment Station (1990 and 1991) and Burnham Creek Wildlife Management Area (1991).

Month	Week	1990	1991 NWES	1991 BCWMA
January	1	0.05	0.07	
	2	0.07	0.08	
	3	0.02	0.11	
	4	0.11	0.04	
February	1	0.00	0.00	
	2	0.00	0.46	
	3	0.16	0.28	
	4	0.15	0.36	
March	1	Trace	Trace	
	2	0.60	Trace	
	3	0.89	0.02	
	4	0.47	0.14	
April	1	0.00	Trace	
	2	0.06	1.01	
	3	0.07	0.21	
	4	1.62	2.07	1.63
May	1	0.00	1.32	3.00
	2	0.14	0.18	0.00
	3	0.46	0.35	0.00
	4	0.11	1.70	4.00
June	1	3.34	0.00	1.81
	2	0.46	2.33	1.22
	3	1.80	0.76	0.50
	4	0.19	1.45	2.25
July	1	0.10	0.98	2.50
	2	0.00	0.20	0.37
	3	0.38	1.60	0.80
	4	0.00	0.00	0.24
August	1	0.38	0.59	1.13
	2	1.23	0.00	0.00
	3	0.39	0.27	0.00
	4	1.01	0.08	0.00
September	1	0.23	0.49	0.35
	2	0.00	1.14	2.75
	3	0.64	1.54	1.00
	4	0.04	0.11	0.50
October	1	0.00	Trace	
	2	0.07	0.28	
	3	0.42	0.05	
	4	0.04	1.27	
November	1	0.00	0.49	
	2	0.00	0.11	
	3	0.00	0.16	
	4	0.07	0.10	
December	1	0.00	0.21	
	2	0.03	0.19	
	3	0.41	0.08	
	4	0.25	0.00	
Total:		16.49	22.79	24.05

Water Quality Parameters

A general water quality profile of the primary inflow (County Ditch 140), WP, and the FP for 1990 is presented in Table 2. Parameters vary on a seasonal basis as they are affected by the inflow of snow melt water, precipitation, ground water, and concentration effects of evapotranspiration. Measures of total alkalinity, total hardness, and specific conductance tended to increase during the 1990 field season. Swanson et al. (1988) found specific conductance to increase during the ice-free season from 500 to 2000 uS/cm in a North Dakota wetland and also noted the wide yearly variation that can occur with higher conductance in a dry year and less in a wet year due to concentration effects.

Of the various parameters measured (Table 2), specific conductance is probably used most as a predictor of a wetland's value for wildlife in the Northern Great Plains. The specific conductance values observed in both pools from 500-600 uS/cm would be at the upper end of Stewart and Kantrud's (1971) "fresh" water plant community and the lower end of the "slightly brackish" community. Because of the variability of single measures of specific conductance, Stewart and Kantrud emphasize the importance of using plant associations as indicators of salinity and used this as a basis for their wetland classification system.

Measures of pH (around 8.9) in this study indicated conditions which were more alkaline than the "slightly alkaline" (pH around 7.8) water of Agassiz National Wildlife Refuge, a managed wetland complex located about 70 miles north of this study area (Vorland and Weller 1981). Our values, however, were comparable to the median value of 9.0 recorded by Swanson et al. (1988) in 178 prairie lakes in central North Dakota.

Total alkalinity values indicate a high buffering capacity comparable to values observed at the Agassiz Refuge (Vorland and Weller 1981). Total hardness values in excess of 180 mg/l (ppm) indicate very hard water which was also indicated by calcium carbonate (marl) encrustations on submergent vegetation.

Nitrate levels in the WP and all except the 31 March value of the FP were comparable to the low levels recorded at the Agassiz Refuge (Vorland and Weller 1981). FP nitrate levels of 1.63 mg/l were recorded on 31 March when ice was in early stages of break-up and there was limited opportunity for inflow water from County Ditch 140 to mix with FP water. At that time, nitrate levels of 2.29 mg/l were recorded in County Ditch 140 and were the highest recorded for the season. Kadlec (1979) indicated that large concentrations of waterfowl could make significant nitrogen contributions to a wetland system, and the fecal accumulation on the ice and shoreline were substantial in this study but migration peaks were after 31 March. The higher nitrate levels in County Ditch 140 are probably due to the agricultural land use of the watershed.

Phosphate levels were generally low in all samples and were similar to values recorded at the Agassiz Refuge (Vorland and Weller 1981).

Secchi disk readings of 4 ft. were representative of the FP during the summer of 1990. These were reduced to around 3 ft. in 1991 due to greater amounts of precipitation and suspended material in inflow waters of County Ditch 140.

Table 2. Selected water quality parameters at 3 sample sites at Burnham Creek Wildlife Management Area in 1990.

	County Ditch 140							Wildlife Pool			Flood Pool					
Parameter	Mar 8	Mar 31	Apr 22	May 25	Jun 28	Jul 6	Jul 23	Mar 31	Jul 6	Jul 23	Mar 31	Apr 22	May 25	Jun 28	Jul 6	Jul 23
pH	9.2	9.0	8.6	8.6	8.8	9.0	8.3	9.0	9.0	8.4	9.4	9.2	9.4	9.0	8.9	8.8
Total alkalinity (mg/l)	58	84	176	170	266	218	282	130	234	269	90	212	129	196	204	234
Total hardness (mg/l as $CaCO_3$)	100	140	240	320	320	260	340	260	320	360	140	240	240	280	260	260
Conductivity (uS/cm)	255	318	482	624	619	540	700	520	567	669	292	531	538	556	538	580
Total dissolved solids (mg/l)	171	212	322	415	414	359	468	345	381	445	189	351	357	361	361	388
Nitrate (mg/l)	1.08	2.29	1.33	0.64	0.24	0.32	1.88	0.06	0.03	0.03	1.63	0.16	0.03	0.04	0.04	0.03
Phosphate (mg/l)	0.22	0.12	0.10	0.00	0.25	0.14	0.04	0.11	0.15	0.01	0.10	0.01	0.03	0.11	0.10	0.12

VEGETATION

The primary emphasis in this study was aquatic vegetation in the Wildlife and Flood Pools, the planted habitats of the dry ridge along the east edge of the study area (Needlegrass/Side-oats grama) and the ridge separating the 2 pools (Wheatgrass/Timothy). It is anticipated that these habitats will change the most through time in response to plant succession, prescribed burn management and/or fluctuating water levels.

METHODS

The vegetation in both pools was qualitatively described at selected sites using an aerial photograph in conjunction with field reconnaissance. Quantitative data were collected along 6 east-west transects through the FP and along 1 north-south transect through the WP. Transects were permanently marked at both ends with steel fence posts with the transect origin post marked with a number which also served as a photo point marker. Percent cover was estimated in square meter plots placed to the right of the transect line at 10-m intervals except along transect 7 in the WP where a 20-m interval was used. A 10-m length of nylon cord was attached to 2 metal rods which were used to sight a straight course between the 2 end posts. Plot sites were approached carefully so as not to cloud the water before a floating, wooden square meter frame was positioned and cover estimates could be made. In water over 1-m deep the frame was grasped at 2 corners then used as a scraper to collect submergent vegetation that was approximately contained in the plot.

Visual obstruction readings (VOR) using a Robel pole (Robel et al. 1970) were taken on transects located in 2 habitats: the dry ridge site (Transect 10), and the lower ridge between pools (Transect 9). Fifty sampling points were taken at 10-m intervals along these transects.

Photographs were taken 10 m due east of photo points 1-6 and 10 m due south of photo points 7-10 with the numbered post centered in the photograph (Appendix 3).

To evaluate the invasion of the WP by cattails, 5 circular plots were established in bulrush-dominated areas and 5 in sedge/grass-dominated areas. Additionally, 5 control plots were established in a comparable bulrush marsh on the Pembina Trail Preserve, adjacent to the study area on the north. A metal fence post was driven in the center of the plot and identified with a numbered, rubber livestock ear tag. Corresponding numbers were also permanently stamped on the metal posts. A 5-m string was attached to a circle of plastic pipe, slipped over the post then used to describe a 5-m radius circular plot within which all cattail stems were counted. Ten water depths were measured within a 2.5 m radius of the post and the average stem height was visually estimated. Cattail stem height was the height above water plus the water depth. Photographs were taken 5 m due south of the center post to provide a visual record (Appendix 4).

Voucher plant specimens were collected and deposited in the University of Minnesota, Crookston herbarium. Plant names follow Gleason and Cronquist (1963) with taxonomic revisions from Ownbey and Morley (1991) and common names from Stewart and Kantrud (1972) and Reed (1986).

RESULTS AND DISCUSSION

The general vegetation of the pools is depicted in Figure 6 and the accompanying description. Due to drought conditions, levels in both pools were quite low in mid-August of 1990 when vegetation data were collected. This facilitated sampling along FP transects crossing water >4 ft deep.

The development of a vigorous submergent plant community in the FP in only 3 growing seasons was noteworthy. About 50% of the FP contained water less than 3 ft. in mid-August of 1990 and those areas were generally covered (75%) with submergent vegetation. Grassleaf pondweed was particularly abundant followed by sago pondweed, and leafy pondweed (Table 3). Muskgrass was quite common in depths less than 12 in. while grassleaf and sago pondweed were most common in the 12-24 in. depth zone. Water plantain, softstem bulrush, duck potato, and cattail seedlings were quite common along the shallow, littoral zone of the FP and are expected to increase unless flooded out. Woody species, especially sandbar and peach-leafed willow and eastern cottonwood, are quite common along the FP shoreline. To reference complete transect data, see Appendixes 5-10.

Table 3. Frequency of occurrence (FOO) and mean percent cover (PC) of aquatic plants measured on Flood Pool transects by depth zones, 29 and 30 August 1990.

	Depth zone (in.)							
Species	0-12 (N=31)[1]		12.1-24 (N=30)		24.1-36 (N=5)		>36 (N=6)	
	FOO	PC	FOO	PC	FOO	PC	FOO	PC
	%							
Muskgrass (*Chara* spp.)	58.0	19.1	10.0	0.3				
Grassleaf pondweed (*Potamogeton pusillus*)	54.8	36.5	70.0	52.7	80.0	83.0	66.7	2.5
Sago pondweed (*P. pectinatus*)	19.4	5.0	30.0	13.1				
Leafy pondweed (*P. foliosus*)	6.5	0.3	16.7	4.5	20.0	1.0	33.3	0.7
Water plantain (*Alisma triviale*)	29.0	1.1	6.7	0.07				
Softstem bulrush (*Scirpus validus*)	16.1	0.3						
Duck potato (*Sagittaria latifolia*)	6.5	0.1	3.3	0.03				
Cattail (*Typha* spp.)	22.6	0.3						
Common water milfoil (*Myriophyllum sibiricum*)			3.3	0.03				

[1] Number of meter square plots occurring within depth zone.

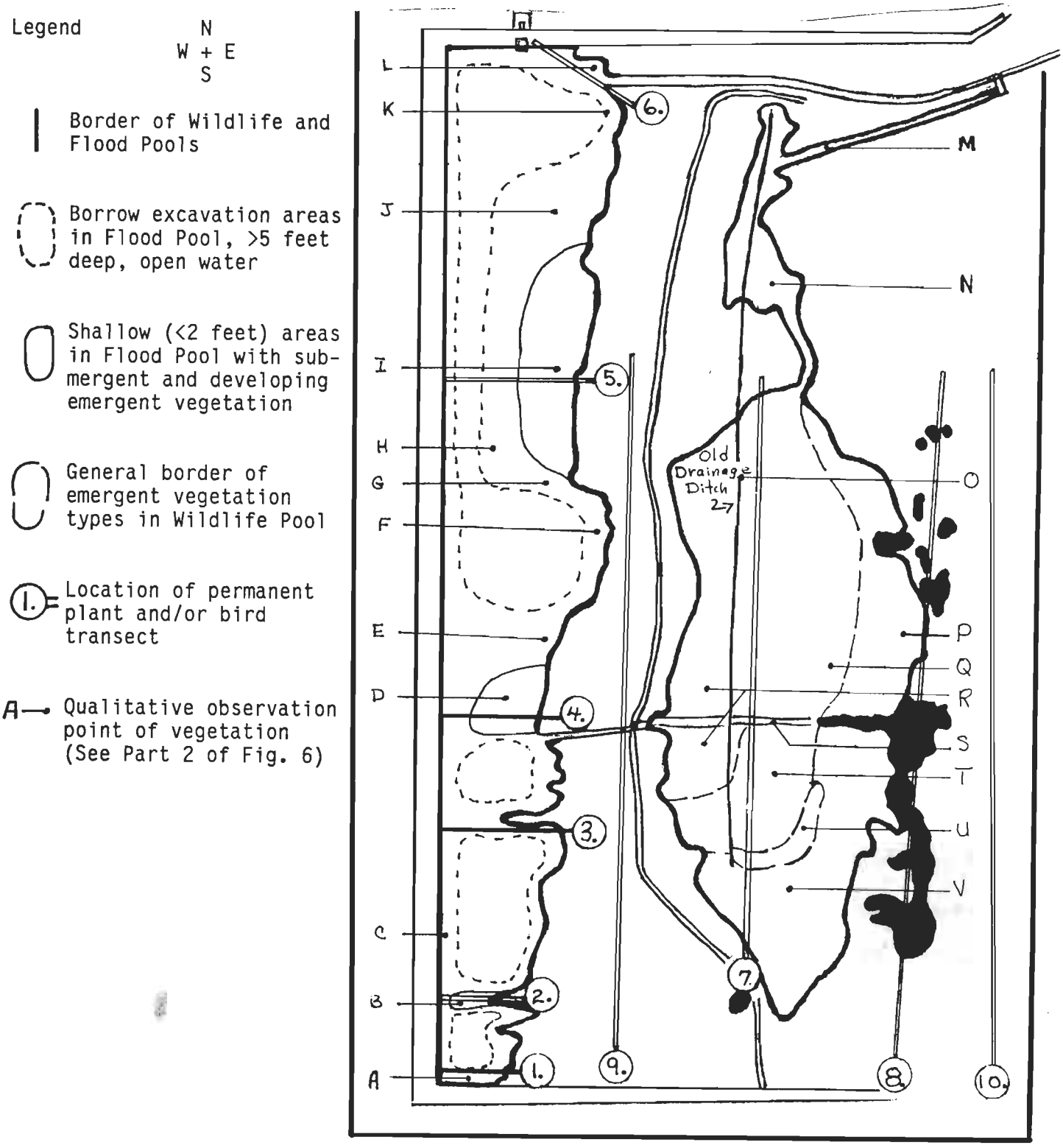


Figure 6. General distribution of aquatic vegetation in Wildlife and Flood Pools and location of permanent transects, Burnham Creek Wildlife Management Area, August 1990. Part 1 of 2.

Part 2 of Figure 6.

Habitat descriptions at selected locations in Flood and Wildlife Pools:

A. Plant cover 20%. Mostly grassleaf pondweed (Potamogeton pusillus) (85%) with leafy pondweed (P. foliosus) (10%) and scattered plants of duck potato (Sagittaria latifolia) and water plantain (Alisma triviale), some growing to depths of 2.5 ft.

B. A gravelly point with less than 6 in. of water. Cattail (Typha spp.) (80%) and softstem bulrush (Scripus validus) (20%) seedlings becoming established at density of 3 plants/m^2.

C. Edge of dike and pool where a strip of peach-leaved (Salix amygdaloides) and sandbar willow (S. exigua) and Eastern cottonwood (Populus deltoides) seedlings occurred at the water's edge along with scattered softstem bulrush plants, then water plantain and duck potato out to a depth of 2.5 ft. where grassleaf pondweed began.

D. Plant cover 75%. Mostly grassleaf pondweed growing in 8-10 in. of water in an area where the topsoil was apparently undisturbed. Residual stems and rhizomes of quackgrass and scattered cattail seedlings occurred as well.

E. Gravelly shoreline area covered mostly (50%) with muskgrass (Chara spp.).

F. Plant cover 5%. Scattered plants of sago and grassleaf pondweed, water plantain and duck potato out to depths of 3 ft.

G. Plant cover 20%. Mostly grassleaf pondweed (80%) with sago pondweed, duck potato and water plantain growing out to depths of 3 ft.

H. Plant cover 90% in water less than 2 ft. deep then reduced to 30% plant cover from 2 to 3.5 ft. depths. Mostly grassleaf pondweed (85%) and sago pondweed (15%). Flatstem pondweed (P. zosteriformis) found in water from 3.5 to 5 ft. deep.

I. Plant cover around 95% in water less than 2 ft. deep. Dense mat of mostly (90%) grassleaf pondweed about 8 in. thick with some sago pondweed.

J. Plant cover 30%. Sago pondweed (40%), grassleaf pondweed (30%), water plantain (10%) and leafy pondweed (10%). Some muskgrass beneath pondweeds.

K. Plant cover less than 5% along the edge of a rather sharp drop-off into deeper water. Mostly duck potato and water plantain out to 3 ft. depth with scattered muskgrass on the bottom.

L. Delta area where main inlet channel comes into Flood Pool. A productive zone due to the inflow of nutrient rich cropland drainage water. Plant cover over 95% in water generally less than 1 ft. deep and dominated by a thick mat of muskgrass (85%) and water plantain (10%). Plant cover 50% in 1-3 ft. deep zone and dominated by sago pondweed (80%), grassleaf pondweed (10%) water plantain (5%) and duck potato (5%).

Part 3 of Figure 6.

M. Wildlife Pool inlet channel, about 3 ft. deep with a rather uniform and dense strip of cattail in the center, bordered by 4-ft. strip of open water along its length.

N. About 40% emergent plant cover; principally cattail (90%) and softstem bulrush (10%). Fringe areas of this portion of the Wildlife Pool dominated by quackgrass, redtop, bluegrass and various native species. Periodically containing up to 6 in. of water.

O. Old drainage ditch, generally around 4 ft. deep. Little emergent vegetation and about 50% coverage by submergent species; principally bladderwort (Utricularia vulgaris), water smartweed (Polygonum amphibium), and grassleaf pondweed. Spoil mounds from ditch colonized by native prairie species; asters (Aster spp.), grass-leaved goldenrod (Euthamia gramineus), rough-leaved sunflower (Helianthus maxmilliani), mints, big bluestem, bluegrass, and sow-thistle. Some cottonwood seedlings present as well.

P. Fringe zone containing 0 to 3 ft. of water and 90% emergent plant cover dominated by fine-leaved sedges (60%); principally, water sedge (Carex aquatilus), beaked sedge (C. rostrata), slender sedge (C. lasiocarpa), and Buxbaum's sedge (C. buxbaumii), reed-grass, cord grass (Spartina pectinata), and rushes (Eleocharis spp.) intermixed.

Q. More than 95% coverage by emergent vegetation; principally, hardstem bulrush (Scirpus acutus) (90%), and scattered plants of cattail (5%). "Understory" submergent community dominated by bladderwort (80%); water smartweed; sago, grassleaf and variable-leafed pondweeds; muskgrass; and an aquatic moss (Drepanocladus sp.).

R. About 50% cover of emergent vegetation west of the old drainage ditch; principally hardstem bulrush (40%) in deeper water and cattail (40%) and reed (Phragmites communis) (10%) in shallower water. Understory submergent community similar to area Q except a rather lush growth of Cladophora alga developed in late mid-August.

S. Old township roadway with a gravelly base covered by up to 1 ft. of water in mid-summer. Eastern portion supported trembling aspen trees, most of which have been killed by recent higher water levels. Redosier dogwood (Cornus stolonifera) and willow shrubs are also common. The westerly portion of the roadway dominated by a solid stand of reed.

T. About 90% emergent vegetation cover; whitetop (Scolochloa festucacea) (40%), cattail (20%), hardstem bulrush (20%) reed (10%) and sedges (10%). Understory submergent community similar to area Q.

U. Over 95% emergent vegetation cover; mostly of reed (90%) and cattail (10%).

V. About 95% emergent vegetation dominated by whitetop and sedges (70%), softstem bulrush (10%), cattail (10%), and water smartweed (2%). Scattered willows (8%) in shallow water.

The dense growth of submergent vegetation along the east portion of the FP appeared to be attractive habitat for amphipods, minnows, and small leopard frogs which, in turn, attracted wetland birds. Fruit production on water plantain and pondweeds, especially sago, was noted to be quite high in portions of the FP and was attractive to ducks commonly observed feeding there.

The WP is a restored natural marsh which was mostly drained but never cultivated so the original vegetation was largely intact. However, restored water levels are perhaps 12-15 in. deeper than pre-drainage levels. This is inferred by the flooding out of 8-9 in. diameter aspen trees on the old roadbed and the zone of emergent sedges along the east edge of the WP which appeared to be thinning out in response to higher water levels. The WP is dominated by emergent vegetation covering about 80% of the pool surface. Hardstem bulrush is dominant followed by cattail, reed, and whitetop. Bladderwort was very common in the WP but absent from the FP.

Both narrowleaf (Typha angustifolia) and broadleaf (Typha latifolia) cattail are present in the study area as well as the hybrid (T. x glauca). Cattails appeared to be expanding in dominance in the WP as a result of fine-leaved sedges (Carex spp.) and whitetop being flooded out by higher water levels. Furthermore, a decrease in salinity due to the inflow of fresh water from County Ditch 140 would also tend to promote cattail expansion at the expense of hardstem bulrush and whitetop (George Swanson, pers. comm.). Data were collected in cattail monitoring plots on the WP and the Pembina Trail Preserve (Table 4) and will be useful to evaluate possible long-term changes in plant composition at the 2 sites.

Table 4. Cattail monitoring plot data for Burnham Creek Wildlife Management Area (BCWMA) and Pembina Trail Preserve, mid-August 1991.

Plot number	Water depth (in.)	Stem height (ft.)	Stem number[1]
Wildlife Pool (BCWMA), 14 August			
11	20.9	3.1	75
12	11.1	3.6	116
13	20.9	3.7	77
14	18.9	5.4	394
15	16.1	4.4	38
16	20.9	5.0	372
17	16.9	4.7	212
18	18.9	5.2	76
19	20.1	4.7	194
20	22.8	5.2	93
Pembina Trail Preserve, 20 August			
21	2.0	4.3	195
22	3.9	4.7	297
23	2.0	4.8	216
24	2.0	3.3	481
25	2.0	4.3	203

[1] Total cattail stems in 10-m diameter, circular plot.

A considerable number of softstem bulrush seedlings were noted along the shoreline of the FP and the edge of the WP where fluctuating water levels drowned out water-intolerant vegetation. Millar (1976) noted that softstem bulrush is more indicative of unstable conditions (e.g. widely fluctuating water levels) whereas hardstem bulrush usually indicates relatively stable, semi-permanent water conditions. The 2 species were observed to reflect those conditions in this study.

Presently, a rather diverse flora characterizes the WP due to a variety of depths and the transition to a fen community along much of its easterly edge. Kantrud et al. (1989b) noted that the flora of a wetland is a function of its water regime, salinity, and disturbance by man. A variety of man-influenced factors have affected the bulrush marsh of the WP over the last 80 years. Probably in the 1920's, the east-west township road was constructed which bisected the marsh and affected the water regime by causing greater water depths to occur north of the road than those south of the road. This likely explains the predominance of the more water-tolerant hardstem bulrush north of the old roadway and whitetop, reed, cattail and sedges to the south. Also, the original depth of the marsh may have been lowered somewhat by the township road ditches draining to the west. The marsh was later drained by the north-south ditch which cut through the roadway and drained to the north. This dewatered phase lasted 5 years. Presently the following factors are having varying influences upon the marsh vegetation: 1) the restoration of water to a wetland which had been drained for a period, 2) the addition of greater depths of water than the existing vegetation had adjusted to, and 3) a change in inflow water quality. In addition to direct precipitation, local runoff and ground water discharge, the marsh now receives substantial inputs of cropland runoff water which would be fresh and contain more nutrients than previous input sources.

The flora of the WP will likely change due to the preceding factors. Plant species composition and percent cover were measured in 43 square-meter plots taken along Transect 7 running north-south through much of the WP (Appendix 11). These data will provide a useful reference in evaluating future changes in the vegetation. Another factor which could alter at least the cover of some plant species is muskrats which are currently not present but will likely thrive when they eventually immigrate to the site.

Density characteristics of 2 planted upland habitats were measured at 50 sample stations each with a Robel pole to determine VOR. The VOR reading for the ridge between pools (Transect 9) was 5.36 $\pm$ 1.51 decimeters for cover dominated by wheatgrass, quackgrass, and timothy. The VOR for the ridge site along the east edge of the study area (Transect 10) was 2.37 $\pm$ 0.57 decimeters for cover dominated by green needlegrass and side-oats grama. Readings were taken on 7 August 1990 and were reduced by the dry conditions of 1990, especially on the eastern ridge site. A listing of plant species for which voucher specimens were collected is contained in Appendix 12.

INVERTEBRATES

Our goal was to obtain a basic inventory of the aquatic invertebrates present in both pools. Further, it was of interest to determine what invertebrates were present during the waterfowl nesting season when females require a high protein diet for egg production, and also during the brood-rearing season when ducklings require a diet high in protein as well.

METHODS

Sampling was conducted in late May (nesting period) and mid-July (brood period) at stations randomly selected within habitat types from a gridded map of the pools. These stations were used both sample periods in both years. In 1990, habitat types sampled in the WP included: the old drainage ditch, bulrush, bulrush-sedge interface, whitetop, and reed. Some bulrush stations sampled in 1990 had become invaded by cattail in 1991, creating a somewhat different habitat type. Water depths also varied in the WP and ranged from 6 in. to 36 in. in 1990, a dry year, and from 6 in. to 55 in. (old drainage ditch) in 1991, a wet year. Water levels did not fluctuate as much in the FP and samples were taken from 6 in. to 60 in. both years. Initially, FP sample sites were open water with little vegetation but greater amounts of submergent vegetation were present during the last 3 sample periods (July in 1990 and May and July in 1991).

Three sampling methods were used. A net sweep was taken at 15 stations within each pool. Activity traps consisting of 1 gallon glass jars with clear plastic funnels were suspended mid-way in the water column (usually about 12 in. below the surface) or placed on the bottom in water <16 in. deep for a 24-hr period at 7 sampling stations in each pool. Seven core samples were taken at these stations using a 2.76 in. diameter stoppered tube adapted from Swanson (1978). Samples were fixed with 10% formalin in the field and classified in the lab (Pennak 1953).

RESULTS AND DISCUSSION

Some qualitative differences are apparent between pools and sampling periods (Table 5). Sweep net and activity trap data show the WP to be more diverse than the FP with regard to invertebrate fauna in both years. In comparing sampling periods within years (May vs. July), diversity decreased slightly in the WP while increasing slightly in the FP. During the first sampling period in 1990, the most notable differences between pools was the better representation of Diptera and Coleoptera in the WP (Table 5). Water fleas (Daphnia spp.) and fingernail clams (Sphaeriidae) were found in the WP but not in the FP whereas scuds (Hyallela spp.), mayflies (Ephemeroptera), and caddisflies (Trichoptera) were found only in the FP. Overall, midges (Chironomidae) were the most abundant invertebrate sampled in both pools. However, water fleas were captured in slightly higher numbers than midges in the WP. It should be noted, however, that equipment used was not ideal for sampling small invertebrates such as water fleas. The July sampling period was generally characterized by decreasing quantities of most suborders and families (Table 5). Mayflies colonized the WP but caddisflies were still found only in the FP. The most notable change was within the snails (Gastropoda). Pond and orb snails increased greatly in the WP whereas orb and pouch snails showed large increases in the FP.

Table 5. Combined sweep net and activity trap samples for the Wildlife and Flood Pools per sample date, Burnham Creek Wildlife Management Area, 1990 and 1991.

	Wildlife Pool				Flood Pool			
	1990		1991		1990		1991	
Taxon group	May	July	May	July	May	July	May	July
INSECTA								
Diptera (flies)								
Anthomyiidae (anthomyiid flies)	-	-	9	-	-	-	-	-
Chironomidae (midges)	2,191	542	280	1,047	762	79	10	38
Chaoborinae (phantom midges)	1	-	-	-	-	-	-	-
Culicinae (mosquitoes)	7	-	-	-	-	2	-	-
Ceratopogonidae (biting midges)	14	-	33	-	-	-	-	-
Stratiomyiidae (soldier flies)	-	-	6	3	-	-	-	1
Tabanidae (horseflies)	1	1	5	-	-	-	-	-
Tipulidae (crane flies)	-	-	1	-	-	-	-	-
Unknown fly (adult)	1	-	-	-	-	-	-	-
Unknown pupae	1	-	-	-	-	-	-	-
Ephemeroptera (mayflies)	-	10	1	2	108	6	-	3
Trichoptera (caddis flies)	-	-	13	9	92	115	44	151
Odonata								
Anisoptera (dragonflies)	3	32	70	22	-	1	-	-
Zygoptera (damselflies)	57	24	86	11	5	1	4	4
Hemiptera (true bugs)								
Belostomatidae (water bug)	-	2	-	2	-	-	-	-
Corixidae (water boatmen)	27	15	5	25	137	125	24	1693
Gerridae (water striders)	3	-	-	-	-	-	-	-
Nepidae (water scorpions)	-	1	-	1	-	-	-	-
Notonectidae (backswimmers)	18	8	2	6	-	3	2	3
Hebridae (velvet water bugs)	-	-	1	-	-	-	-	-
Coleoptera (beetles)								
Circulionidae (weevils)	1	-	-	-	-	-	-	-
Chrysomelidae (leaf beetles)	-	-	7	14	-	-	4	3
Dytiscidae (diving beetles)	116	4	68	-	3	-	-	2
Elmidae (riffle beetles)	-	-	1	-	-	-	-	-
Gyrinidae (whirligig beetles)	2	-	-	-	-	-	-	-
Haliplidae (crawl. water beetles)	11	31	42	4	-	3	2	2
Hydrophilidae (scavenger beetles)	1	13	2	3	-	2	-	-
Collembola (springtails)	-	-	3	-	-	-	-	-

Table 5. Continued.

Taxon group	Wildlife Pool 1990 May	Wildlife Pool 1990 July	Wildlife Pool 1991 May	Wildlife Pool 1991 July	Flood Pool 1990 May	Flood Pool 1990 July	Flood Pool 1991 May	Flood Pool 1991 July
CRUSTACEA								
Cladocera								
Daphnia spp. (water fleas)	2,522	136	498	-	-	-	-	-
Notostraca (tadpole shrimps)	-	-	-	1	-	-	-	-
Amphipoda								
Hyallela spp. (scuds)	-	-	-	-	110	549	1	3
Copepoda	-	1	-	-	-	-	-	-
MOLLUSCA								
Pelecypoda	-	-	-	-	-	-	-	-
Sphaeriidae (fingernail clams)	24	27	31	10	-	-	-	-
Gastropoda								
Lymnaeidae (pond snails)	52	1,059	1,698	850	-	-	22	200
Physidae (pouch snails)	-	50	32	3	13	174	5	1
Planorbidae (orb snails)	196	705	419	672	2	175	80	474
ARACHNIDA								
Hydracarina (water mites)	6	-	1	-	1	3	6	37
Unknown arachnid	-	-	4	-	-	-	3	-
ANNELIDA								
Hirudinea (leeches)	1	2	-	-	1	3	-	1
NEMATODA (round worms)	-	-	12	3	-	-	1	-
UNKNOWN EGGS/CASES	77	12	22	28	5	12	3	38
VERTEBRATA								
Amphibians								
Rana pipiens tadpole (leopard frog)	2	-	47	1	-	1	3	-
Ambystoma tigrinum larval stage (tiger salamander)	-	1	16	-	-	-	-	-
Bufo sp. tadpole (toad)	-	-	2	-	-	-	-	-
Fishes								
Pimephales promelas (fathead minnow)	-	139	1	2	220	473	323	202
Rhinichthys atratulus (blacknose dace)	-	-	-	-	-	1	-	-
Etheostoma nigrum (Johnny darter)	-	1	-	-	-	2	1	10
Eucalia inconstans (brook stickleback)	-	19	3	7	-	42	32	64

In 1991, diversity was up slightly in both pools when compared to 1990. Sampling indicated midges were still fairly abundant in the WP but had decreased substantially in the FP. Caddisflies were observed in WP samples for the first time. Dragonflies and damselflies (Odonata) were better represented in the WP than in the FP. The emergent vegetation of the WP may be more attractive to odonates as it probably contributes to higher success during emergence and subsequent metamorphosis. Samples indicated water boatmen (Corixidae) populations were high in the FP during the final sampling period. Water fleas were observed in much lower numbers which may reflect the type of equipment used and/or some changes in habitat conditions (e.g. cooler water temperatures). Compared to 1990, scud numbers greatly decreased in the FP in 1991. Again, none were observed in the WP. A notable change from 1990 to 1991 occurred within the snails. Pond snails and orb snails became more abundant in both pools. In 1990, pond snails were not observed in the FP.

Although vertebrates were not intentionally sampled, many were represented in sweep net and activity trap samples (Table 5). Four species of fish; fathead minnows (Pimephales promelas), blacknose dace (Rhinichthys atratulus), Johnny darters (Etheostoma nigrum), and brook sticklebacks (Eucalia inconstans) were found. All 4 were found in the FP and all but the dace were represented in samples from the WP. Fathead minnows were the most abundant species and increased from the first to second sampling periods in both pools in 1990. Samples from 1991 indicated they were less abundant in the WP although they may have been more dispersed with the higher water levels. Their populations remained high in the FP but decreased after the first sampling period in 1991. During July sampling in 1991, numerous dead fatheads were observed in the FP.

Invertebrates in core samples from both pools in both years were generally not very diverse or abundant (Table 6). However, seed diversity and abundance tended to be greater in 1991 compared to 1990. Sedge (Carex spp.) seeds were most abundant in 1990 samples whereas bulrush (Scirpus spp.) seeds were in 1991. Pondweed (Potamogeton spp.) seeds were absent in 1990, but were well represented in 1991, perhaps reflecting a prolific seed year in 1990 due to relative low and stable water levels in the FP. Interestingly, wildcelery (Vallisineria americana) is known only from the seeds collected in core samples as the plants themselves have not been collected in either pool.

The relationship of the invertebrate community to birds, particularly waterfowl, merits some discussion. The importance of animal foods, such as aquatic insects, mollusks, and crustaceans to nesting ducks has been documented by numerous researchers (e.g. Rogers and Korschgen 1966; Krapu 1974, 1979; Swanson et al. 1979, 1986; Swanson and Duebbert 1989; Ankney and Afton 1988). Krapu (1979) found female dabbling ducks on diets low in animal foods had reduced clutch and egg size. Similarly, Swanson et al. (1986) while working on captive mallards, showed that diets reduced in animal foods led to lower clutch size, fewer renesting attempts along with increased renesting intervals. These studies have stressed the need for protein uptake as the major reason most breeding female ducks (particularly dabbling ducks) consume large amounts of invertebrates. Recently, several studies (Ankney and Afton 1988, Afton and Ankney 1991) have pointed out the importance of lipid reserves to laying waterfowl and their relationship to invertebrate consumption and protein uptake. These papers are mainly concerned with nutrient reserves and clutch size theory but show that the physiological needs of waterfowl at this time in the annual cycle are complex. Breeding ducks are influenced by these physiological needs

Table 6. Core samples from the Wildlife and Flood Pools, Burnham Creek Wildlife Management Area, 1990 and 1991.

Taxon group	Wildlife Pool				Flood Pool			
	1990		1991		1990		1991	
	May	July	May	July	May	July	May	July
INSECTA								
Diptera (flies)								
Chironomidae (midges)	70	41	1	15	29	38	6	69
Chaoborinae (phantom midges)	1	-	-	-	-	-	-	-
Culicinae (mosquitoes)	1	-	-	-	-	-	-	-
Tabanidae (horse flies)	-	-	-	-	-	-	-	1
Hemiptera (true bugs)								
Corixidae (water boatmen)	1	-	-	-	-	-	-	-
Ephemeroptera (mayflies)	-	-	-	-	6	2	-	2
Trichoptera (caddis flies)	-	-	-	-	1	2	2	-
Coleoptera (beetles)								
Dytiscidae (diving beetles)	2	-	-	-	-	-	-	-
Chrysomelidae (leaf beetles)	-	-	-	2	-	-	-	1
CRUSTACEA								
Cladocera								
Daphnia spp. (water fleas)	108	6	-	-	-	-	-	-
Amphipoda								
Hyalella spp. (scuds)	-	-	-	-	3	9	-	-
MOLLUSCA								
Gastropoda								
Lymnaeidae (pond snails)	-	15	1	1	-	-	-	-
Physidae (pouch snails)	-	2	-	-	-	4	-	-
Planorbidae (orb snails)	7	26	-	3	-	5	-	-
ANNELIDA								
Unknown Annelid	-	1	-	-	-	-	-	-
NEMATODA	-	1	7	-	-	-	-	2
Seeds								
Scirpus spp. (bulrushes)	280	-	414	360	14	-	382	372
Carex spp. (sedges)	39	350	222	235	292	246	55	51
Potamogeton spp. (pondweeds)	-	-	60	46	-	-	8	107
Poaceae (grasses)	-	1	27	11	-	1	27	3
Vallisineria americana (wildcelery)	-	-	9	19	-	-	3	4
Unknown Compositae	-	-	-	-	-	-	-	1

and environmental factors which affect their food sources. Variables such as water chemistry, seasonal water levels, and climatic conditions influence invertebrate populations (Swanson and Duebbert 1989). Sampling from this study was not intended to measure a wide array of variables but should provide some insight into the availability of invertebrate foods to breeding and migrant waterfowl.

Invertebrate sampling (Table 5) found substantial numbers of various animal foods such as snails, midges, caddisflies, and mayflies, determined to be important for hens and ducklings in other studies (Chura 1961, Bartonek and Hickey 1969, Street 1977, Swanson 1985). From field observations it appears many hens with broods use the WP from hatch to the time ducklings reach the Ic - IIa (13-25 days) class (Gollop and Marshall 1954). This may be related to the abundance of midges in the WP compared to the FP. Street (1977) found ducklings less than 13 days old relied heavily on midges. These insects can be very abundant and are accessible to ducklings while emerging from larval stages on the water's surface. This food source coupled with the dense, emergent cover probably creates ideal habitat conditions for new broods. Many hens seemed to move older broods to the FP as evidenced by their sudden appearance there during weekly observations (nest dragging information provided insight into the general number of broods expected to be seen on the study area). Kantrud (1986) found waterfowl broods preferred semi-open to open emergent marshes in North Dakota. Although overall WP invertebrate samples were more diverse, the FP invertebrate diversity increased from May to July in both seasons. Also, one must assume that hens lead broods to areas of high food availability with considerations to duckling security. Although the FP contains fewer emergents than the WP, it has dense beds of submergent plants (see section on VEGETATION). Past studies have found positive relationships between numbers of aquatic invertebrates and submergent plant communities (Voigts 1976, Armstrong and Nudds 1985). Many of the FP submergent beds are composed of Potamogeton spp. which are indicative of good water quality (Swanson and Duebbert 1989). Of several communities sampled, Berg (1949) found Potamogeton beds supported a large, diverse assemblage of insects. Voigts (1976) concluded that invertebrate abundance increases as submergents replace emergents. However, the maximum number of invertebrates were found in a submergent marsh interspersed with emergents. From this, one would expect the FP to improve as a brood marsh as it ages and more emergents become established in shallow water areas.

Invertebrate foods used by breeding birds have also been shown to be important for various migrant birds such as Lesser Scaup (Aythya affinis) at Thief Lake WMA, a major Scaup stopover in northwest Minnesota (Afton, et al. 1991). We found that the Burnham Creek WMA is becoming a significant spring and fall stopover for Lesser Scaup and that certain invertebrate groups (e.g. gastropods) are similar in abundance to those at Thief Lake.

The diversity of aquatic habitats which comprise the WP-FP complex have created good breeding and stopover habitat for various bird species. By having 2 pools with differing characteristics (i.e. WP is dominated by emergents and FP is dominated by submergent plant communities) breeding ducks have a wide variety of habitats to use. This may reduce variation in conditions which can impact invertebrate populations, thus improving breeding success for many species dependent on abundant animal foods.

BIRDS

METHODS

Three methods were used to study birds in this project; a general census throughout the field season, breeding bird transects, and nest searching. A general bird census was usually done each time the study area was visited. A total of 79 census visits were carried out in 1990 and 72 in 1991. At least 2 and commonly 3 census visits were made weekly with at least 60% occurring in the morning.

Census visits began in early March and continued until wetlands completely froze over; late November in 1990 and late October in 1991. A census was mostly done from a vehicle and commenced at the south end of the interior road (Fig. 1). We slowly drove north observing both pools and the upland ridge between pools. Good visibility of the FP with a spotting scope was possible near the WP Outlet Structure, particularly during mornings with the rising sun behind us. Observations of bird species, their approximate number, location, and behavior were recorded on a data sheet/habitat map (Appendix 13). The interior road was driven to the north, then east between the two inlet channels to the beginning of the dike road then along the north, west and south edges of the FP to the south end of the interior road. Wetland birds were emphasized more than upland birds in the study and a more complete survey was made of the FP than the WP. The visibility of the FP was better due to limited shoreline vegetation and the census route being atop the dike. The dense emergent vegetation of the WP limited bird observations to the periphery and viewing down the old drainage ditch from the north end (Fig. 1). Smaller shorebirds were frequently identified by walking to the edge of the FP (particularly the Delta-2 area) and observing at close range.

Two methods were used for nest searching. Upland habitats were searched using a cable-chain drag (Higgins et al. 1969) pulled by 2 all-terrain vehicles. Upland habitats were searched 3 times in 1990 (22, 23 May; 14, 15 June; and 10, 11 July); and twice in 1991 (29, 30 May and 25, 26 June). Wetland habitats were searched by 2-3 personnel wading abreast on 4, 7, 10 June; 22, 26, 28 June; and 9, 12 July in 1990, and on 31 May, 2, 3 June; 27 June; and 9, 12 July in 1991. After flushing laying or incubating birds, flags were placed 10 m from nests and locations plotted on a field map. Structural characteristics of nest sites were measured at the time of discovery by placing a Robel pole in the nest and averaging 100% VOR measures taken from 4 directions. The dominant vegetation at nest sites was qualitatively determined. Nests were checked weekly to determine hatching success or to monitor fledgings.

Breeding bird transects were run along permanently marked north-south transects (numbers 7, 8, 9, 10), established in 4 somewhat distinct habitat types (Fig. 6). Methodology followed Mikol (1980) in which all birds were censused 25 meters either side of a compass line approximately 1000 meters long, except Transect 7 which was approximately 800 m in length. Transects constituted a plot of 50,000 m^2 or 5 hectares and were marked by a numbered steel fence post at the south end and another post at the north end. Transects were run 4 and 26 June in 1990 and 29 May, 16 and 21 June in 1991.

RESULTS AND DISCUSSION

The study area is quite diverse in habitats represented and is strategically located along waterfowl and shorebird migration corridors (Fig. 7). This

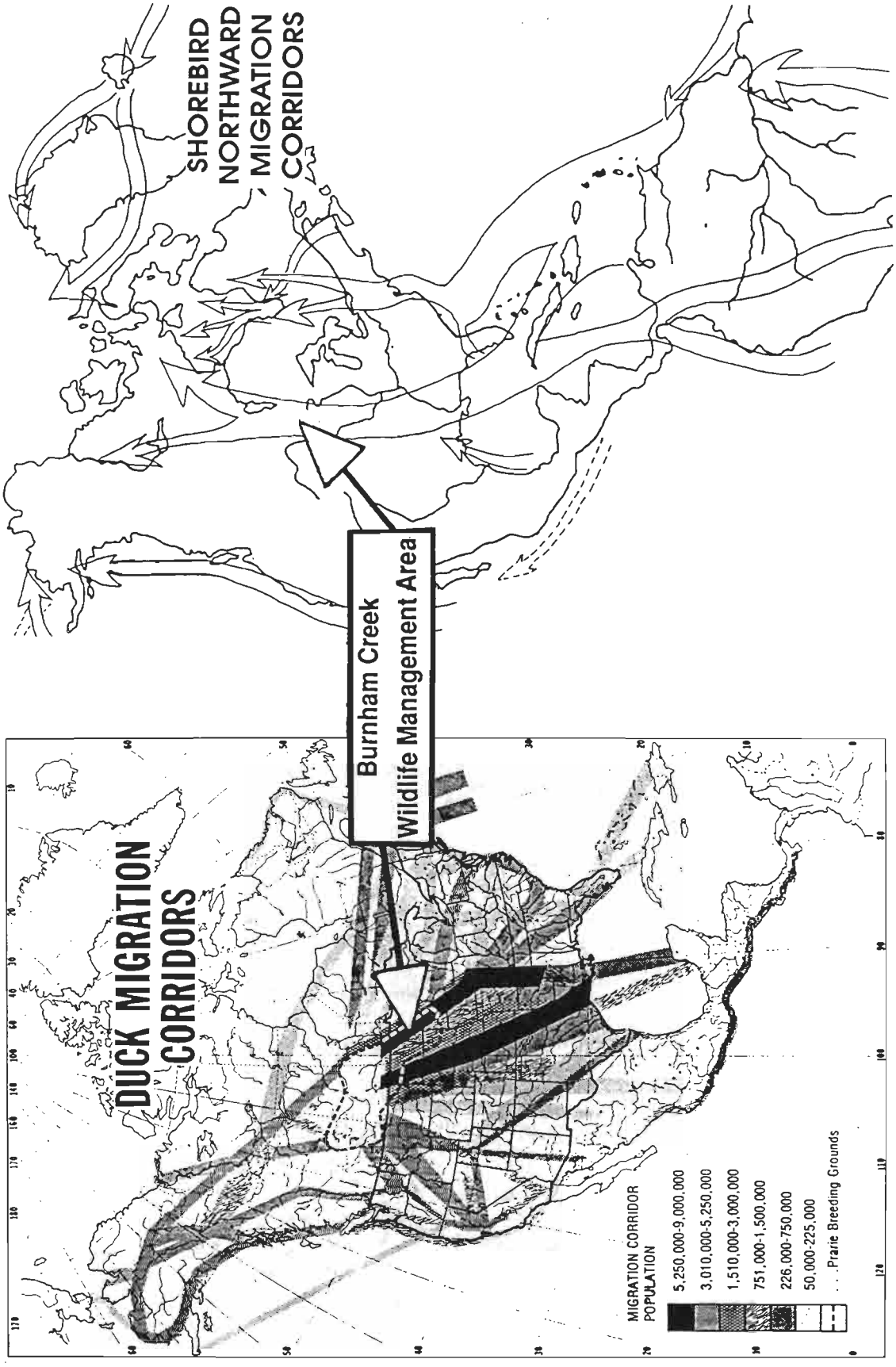


Fig. 7. Location of Burnham Creek Wildlife Management Area with respect to waterfowl (from Bellrose 1976) and shorebird (from Morrison 1984) migration corridors.

explains sighting a minimum of 137 bird species during 2 field seasons and the nesting of at least 60 species. The following 6 "special concern" (Coffin and Pfannmuller 1988) species were documented to nest on the study area: American Bittern, Greater Prairie-Chicken, Sandhill Crane, Upland Sandpiper, Wilson's Phalarope, and Sharp-tailed Sparrow. Black Terns also bred on the study area and are currently being considered as a candidate for "special concern" status. Sightings were made of 2 additional "special concern" species (American White Pelican and Marbled Godwit), 1 "threatened" species (Bald Eagle) and the federally "endangered" Whooping Crane.

Use by migratory birds

Individual species accounts are contained in Appendix 14 which note early and late dates for migrant species, including some which nested on the study area.

Certain migrants, particularly waterfowl and Sandhill Cranes, tended to build up in numbers during spring and fall. Canada Geese arrived in mid-March with peak numbers of 2500-3000 birds in early April and 1000-3000 birds in late October. Mallards had a spring peak in mid-April (6000 in 1990 and 2400 in 1991), a molt migration peak of about 650 males in mid-June, and a fall peak of 4-5,000 birds in late October. The general area is a traditional staging area for Sandhill Cranes which began arriving in early April and peaked around 5,000 birds in mid-April and around 5,000 birds in mid-October. On 21 October 1990 a Whooping Crane was observed with about 5,000 Sandhill Cranes as they flew into the FP to night roost. The Whooping Crane was observed in the general area until at least 28 October.

The large, open water expanse of the FP and adjacent cropland were attractive to waterfowl and Sandhill Cranes. Also, the study area has refuge status from 1 September through the end of the duck season which also enhances its attractiveness to fall migrants and locally produced waterfowl.

Shorebird peaks occurred around mid-May and mid-August (Fig. 8) but varied between species. Greater Yellowlegs and Killdeer were generally the first and last shorebirds to be observed. Over 90% of the shorebird observations occurred along the eastern edge of the FP, particularly the Delta-2 area where the channel from the WP joins the FP (Fig. 1). The eastern edge was characterized by a gradually sloping, sand-gravel shoreline with little emergent vegetation, particularly in the southern half. An expanse of undisturbed topsoil covered by 0-30 cm of water was located just north of the Delta-2 area and was an attractive feeding area by shorebirds with longer legs and phalaropes. A distinctive peak in summer-fall shorebird migration was not observed in 1991 as in 1990 and may have been due to generally higher FP levels reducing the amount of foraging habitat available (Fig. 8). Also, the greater summer precipitation in 1991 and the resulting increase of standing water in other sites may have reduced the attractiveness of the FP. Shorebirds were observed feeding in nearby cropland pools in 1991 which were not present in 1990.

The attractiveness of an abundant shorebird food resource was illustrated in 1990 when on 22 August a moose was found floating dead off a sandy spit along the east edge of the Flood Pool. One week later the carcass had been reduced to a mass of maggots, bones, and skin. Maggots floated and were blown to the nearby spit where they attempted to burrow into the sand. From 29-31 August, the following shorebirds were observed on the spit and eagerly fed on the

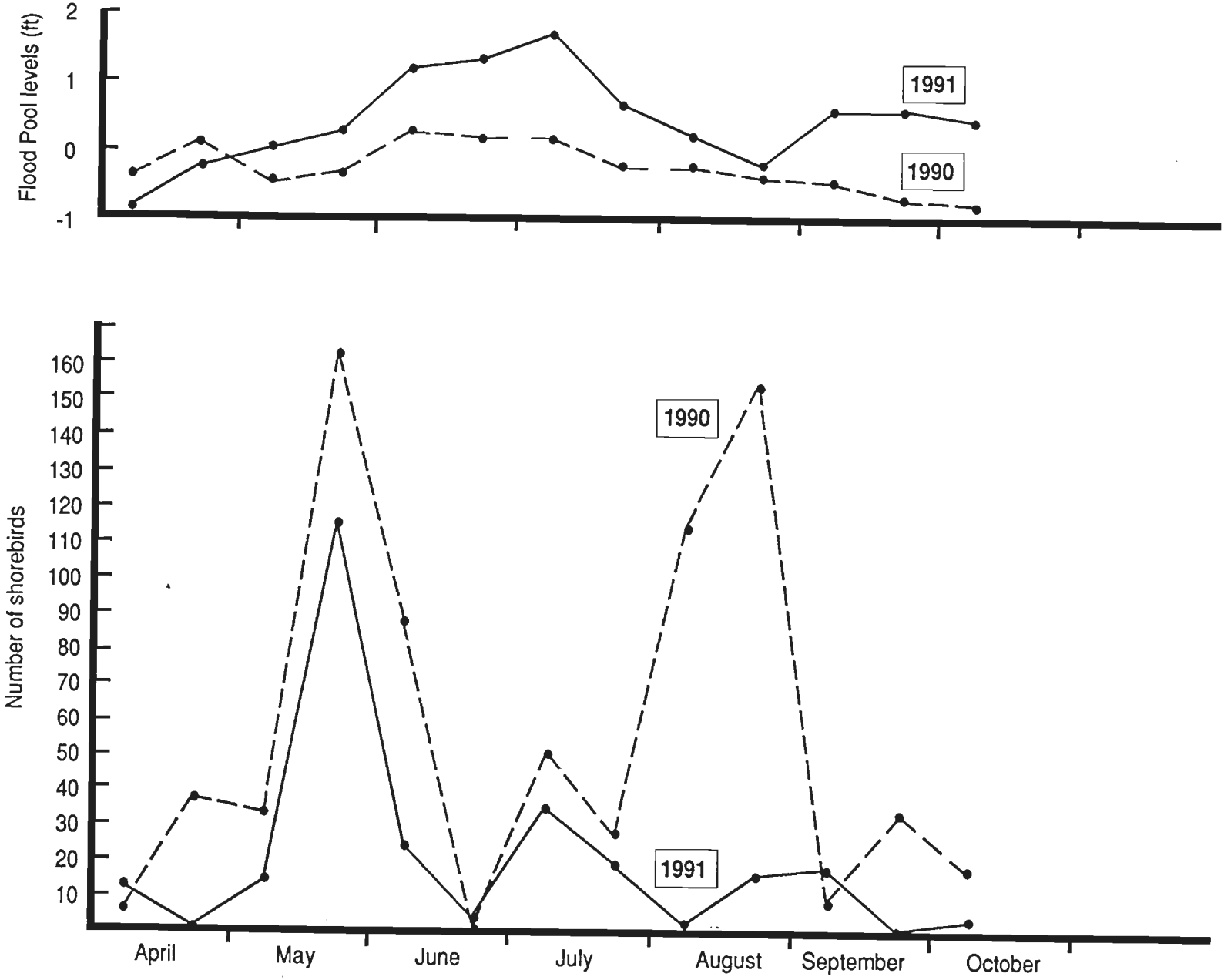


Fig. 8. Seasonal shorebird numbers and Flood Pool levels at the Burnham Creek Wildlife Management Area, 1990 and 1991.

Does not include killdeer, upland sandpiper, and woodcock. Flood Pool levels measured at outlet structure gauge.

maggots as they washed ashore: Killdeer, Semipalmated Plover, Semipalmated Sandpiper, Least Sandpiper, Spotted Sandpiper, Baird's Sandpiper, Pectoral Sandpiper, Short-billed Dowitcher, Greater Yellowlegs and Lesser Yellowlegs. The shorebirds were so intent on feeding that they allowed observers to approach within 8 m. During 1 observation period, approximately 5 maggots per meter of shoreline were washing ashore every 10 minutes along a 15 m portion of shoreline downwind of the moose. Generally 10-20 shorebirds were feeding in a flock containing 5-6 species when observations were made over the 3-day period.

Use by breeding birds

A minimum of 60 bird species bred on the study area as evidenced by locating a nest, young, adults carrying food or territorial advertisement by adults. The Aspen/Brush Fen habitat had the greatest structural diversity which was reflected in 38 species recorded during breeding bird transects followed by the Wheatgrass/Timothy habitat with 14, and the Wildlife Pool and Needlegrass/Side-oats grama habitats with 12 each (Appendices 15-18). Some species recorded on breeding bird transects did not breed in that habitat but were foraging there or simply flying over. Table 7 summarizes breeding birds using all habitat types of the study area as determined by breeding bird transects, cable-dragging, and incidental observations. The most abundant breeding species was the Yellow-headed Blackbird which nested in the bulrush marsh portion of the WP.

Water conditions were quite different between years. In 1990, the WP had low water until heavy rains in late May and early June caused a rapid rise. Water levels peaked in late June, then steadily fell the remainder of the season (Fig. 4). In contrast, 1991 was marked by early high water levels which were maintained throughout the season. Low water in 1990 apparently delayed nesting and reduced the number of nests initiated for some species. Black Terns and Blue-winged Teal nested about 2 weeks later in 1990 compared to 1991 and also established more nests in the wetter year of 1991; 10 versus 26 nests for Black Terns, and 5 versus 22 nests for Blue-winged Teal (Appendixes 19 and 20). Ruddy ducks, Canvasbacks, and American Coots also initiated more nests in 1991 than 1990. Rising water levels after nests had become established caused the loss of about 95% of the first nests of Yellow-headed Blackbirds in 1990 and 6 of 7 Ruddy Duck nests in 1991. At least one Sora and Mallard nest were known to be flooded out in 1990. Interestingly, only 1 Sora nest was found in 1991 compared to 8 in 1990. The fine-leaved sedge habitats around the periphery of the WP appeared to have been partially flooded out in 1991 and this may partially explain fewer Sora nest observations. Also, wetter conditions in 1991 may have made other habitats more desirable for Sora nesting which were not thoroughly searched.

The nest fate of selected species was evaluated during both years. In general, more overwater nests hatched than upland nests in 1990 when 10 of 31 (32%) overwater nests hatched compared to only 1 of 12 (8%) upland nests (Tables 8 and 9). In 1991, about 34 of 94 (36.2%) overwater nests hatched compared to 20 of 33 (60.6%) upland nests. Nest loss was due mainly to rising water and mink predation for overwater nests and to red fox, striped skunk, and raccoon predation for upland nests. An active mink den was present in the WP in 1991 (perhaps in 1990 as well) which accounted for the loss of adult birds, eggs, and young. A striking difference in success of upland nests was noted between years with Mayfield success of 0.6% observed in 1990 compared to 37.5% in 1991. This dramatic difference in nesting success may have been due to increased coyote activity around the study area relative to red fox. In the course of field work

Table 7. Breeding birds and nesting habitat associations, Burnham Creek Wildlife Management Area, 1990 and 1991.

Species	Habitat type							
	Aspen/ Brush-Fen	Wheat-grass/ Timothy	Wild-life Pool	Needlegrass/ Side-Oats Grama	Quack-grass/ Redtop	Prairie	Flood Pool edge	Bluestem/ Switch-grass
Pied-billed grebe			X					
*American bittern		X			X			
Least bittern			X					
Mallard	X	X	X					
Northern pintail (nest site unknown)								
Blue-winged teal		X		X	X			X
Northern shoveler				X				
Canvasback			X					
Ruddy duck			X					
Northern harrier	X							
*Greater prairie-chicken					X			
Virginia rail			X					
Sora	X		X					
American coot			X					
*Sandhill crane			X					
Killdeer							X	
Spotted sandpiper							X	
*Upland sandpiper						X		
Common snipe	X							
*Wilson's phalarope		X						
Black tern			X					
Mourning dove	X							
Black-billed cuckoo	X							
Yellow-bellied sapsucker	X							
Northern flicker	X							
Eastern wood-pewee	X							
Willow flycatcher	X							
Least flycatcher	X							
Great crested flycatcher	X							
Eastern kingbird	X							
Tree swallow	X							
Blue jay	X							
House wren	X							
Sedge wren	X	X			X			
Marsh wren		X	X					
Veery	X							
American robin	X							
Gray catbird	X							
Brown thrasher	X							
European starling	X							
Warbling vireo	X							
Yellow warbler	X							
Common yellowthroat	X	X						

Table 7. Continued.

Species	Habitat type: Aspen/ Brush Fen	Wheat-grass/ Timothy	Wild-life Pool	Needlegrass/ Side-Oats Grama	Quack-grass/ Redtop	Prairie	Flood Pool edge	Bluestem/ Switch-grass
Clay-colored sparrow	X							
Vesper sparrow				X				
Savannah sparrow		X						
Grasshopper sparrow				X				
LeConte's sparrow		X			X			
*Sharp-tailed sparrow		X						
Song sparrow	X							
Swamp sparrow	X							
Bobolink		X		X				X
Red-winged blackbird	X	X	X		X		X	
Western meadowlark		X		X			X	
Yellow-headed blackbird			X					
Brewer's blackbird								X
Common grackle	X							
Brown-headed cowbird	X	X	X					
Northern oriole	X							
American goldfinch	X	X						

*Classified as "special concern" species in Minnesota.

Table 8. Overwater nesting by selected species at the Burnham Creek Wildlife Management Area, 1990 and 1991.

Species	1990		1991	
	No. found	Successful	No. found	Successful
Mallard	1	0	0	0
Canvasback	1	0	6	4
Ruddy duck	0	0	7	0
American coot	6	2	47	22[1]
Least bittern	1	0	0	0
Pied-billed grebe	3	1	7	3
Virginia rail	1	1	0	0
Sora	8	4	1	?
Black tern	10	2 (?)	26	5
Total	31	10	94	34
Apparent success	32.2%		36.2%	

[1] Minimum number as not all nests were relocated or checked for status.

Table 9. Upland nesting by selected species at the Burnham Creek Wildlife Management Area, 1990 and 1991.

Species	1990		1991	
	No. found	Successful	No. found	Successful
Mallard	3	0	2	2
Blue-winged teal	5	0	23	14
Northern shoveler	0	0	1	0
American bittern	3	1	4	3
Northern farrier	1	0	0	0
Greater prairie-chicken	0	0	1	0
Total	12	1	31	19
Apparent success	8.3%		61.3%	
Mayfield success[1]	0.6%		37.5%	

[1] Excluding American bittern due to asynchronous hatching resulting from commencement of incubation during egg laying.

in 1990, 2 red foxes and 1 coyote were sighted compared to 1 red fox and 6 coyote sightings in 1991. The number of coyote sightings in or within 1.6 km of the study area and a report of coyote pup "yipping" in the vicinity suggested a den was in the area in 1991. Coyotes are known to displace red fox (Sargeant et al. 1987) and increased rates of nesting success of ground nesting birds are currently being observed in areas where coyotes have become common. Coyotes are not as dense as red foxes since a coyote family occupies 5 x as much space and they tend to concentrate on larger prey. Also, a considerable number (80+) of rock piles were buried adjacent to the study area in the fall of 1990 and these were known to serve as den sites for red fox, raccoon, and striped skunk.

Most upland nests were located inside of the dike (Fig. 9), however, the area outside of the dike was burned 9 April 1991 and residual cover was not available there for early nesters in 1991. Also, the easterly edge of the study area was not used by larger ground nesting species either year. Cover on this site was light due to the droughty, sandy soil and also the low precipitation in 1990. Some cover preferences of certain species were noted (Appendixes 19 and 20). American Bitterns nested in the tallest and densest cover (VOR=4.7 $\pm$ 1.26 decimeters), followed by Mallard (3.6 $\pm$ 1.12 dm), Blue-winged Teal (3.0 $\pm$ 0.68 dm), and Wilson's Phalarope (1.1 $\pm$ 0.79 dm). Blue-winged Teal nest placement suggested a preference to nest close to edges as 21 of 28 nests were placed within 15 m of a road, dike, or edge of a wetland, ditch, or abrupt habitat change (Fig. 9).

While burning decreased the suitability of nesting conditions for some early nesting species it apparently created favorable conditions for Brewer's Blackbirds. The only nests of this species found during the study were located on 3 June 1991 when the regrowth following the spring burn was about 25 cm. Three nests were loosely grouped north of the dike and a lone nest was west of the dike. A Wilson's Phalarope nest was also found in regrowth cover about 20 cm in height. Two Greater Prairie-Chicken broods were flushed in the burn regrowth while cable-dragging the northwest corner of the study area on 26 June 1991 along with 8 white-tailed jackrabbit young from 2 litters. Migrant Lesser Golden Plovers and Black-bellied Plovers were both observed in short, burn regrowth areas.

Waterfowl broods and habitat use

All 10 waterfowl nests discovered in 1990 failed to hatch, however, a Mallard brood of 11 was observed in the FP on 11 July. On 17 July a Mallard brood of 1 and another of 11 (presumably the one observed on 11 July) were observed in the WP. We concluded that these 2 broods were the only waterfowl broods present in 1990. Based on nest checks and brood observations, the following minimum number of broods were hatched per species in 1991: Blue-wing Teal (14), Mallard (2), Northern Shoveler (1), Northern Pintail (1), and Canvasback (4). A surprising amount of brood use occurred in the FP; not only along the developing emergent vegetation fringe around the edge but in open water areas as well. For example, on 2 August 1991, at least 6 Blue-winged Teal and 3 Canvasback broods were in the FP. A vigorous growth of submergent vegetation in shallower portions of the FP provided seeds and vegetative matter (especially Potamogeton spp.), and habitat for invertebrates and small minnows. Although viewing opportunities were limited by heavy cover in the WP, there appeared to be abundant brood food resources there as well.

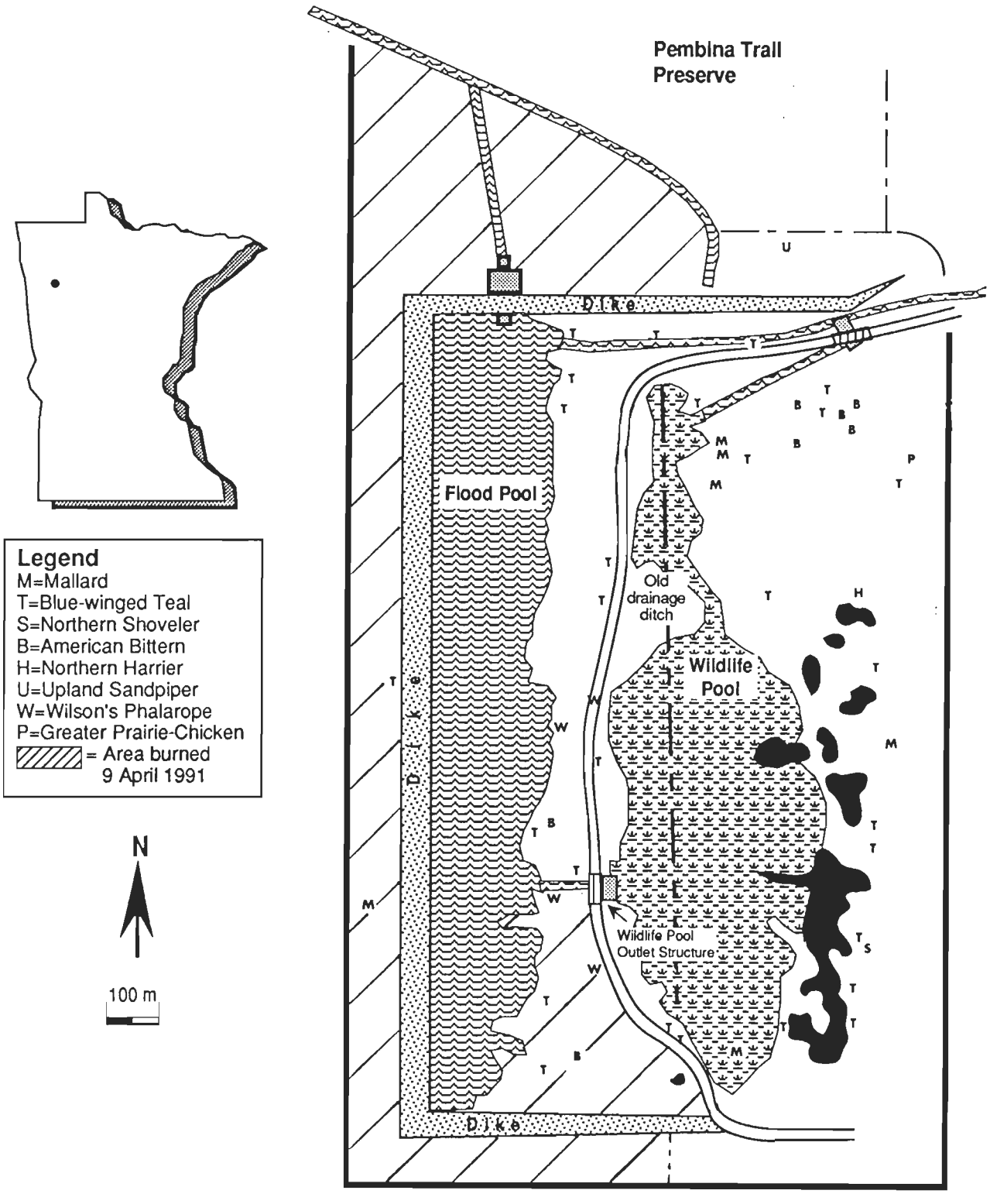


Fig. 9. Upland nest locations of selected species at Burnham Creek Wildlife Management Area in 1990 and 1991.

Important bird habitat areas

In the course of 2 field seasons of observation, there were specific parts of the study area which appeared to be favored for certain activities of bird species and are as follows:

1. Flood Pool The relatively large open water expanse of the FP with bare shoreline areas together with adjacent cropland feeding areas were attractive to migrant waterfowl and Sandhill Cranes. Shallow (0-0.5 m) water areas, particularly those with topsoil remaining, were especially attractive feeding areas for puddle ducks and shorebirds because of submergent plant foods and animal foods associated with this substrate. Flooded topsoil areas provided invertebrates for probe-feeding shorebirds. The easterly half of the FP received about 90% of the total bird use because of the greater proportion of shallow water and probably the openness which afforded better predator detection. The shoreline dropped off rather abruptly along the western pool edge near the dike. The FP contained deeper areas in the northern half where borrow materials had been extracted for dike construction. These provided overwintering conditions for minnows which provided an attractive food resource for mergansers, Double-crested Cormorants, grebes, Common Loons, terns, gulls, and herons. A shallow area located about 500 m south of the FP Outlet Structure along the east shore was the preferred roost site for Sandhill Cranes as well as a favored feeding area for puddle ducks. The two delta areas (Delta-1 and Delta-2 in Fig. 1) were attractive feeding areas for puddle ducks and shorebirds. The Delta-2 site was especially attractive as a feeding and loafing site and a mixed species group of 50+ birds was common in this area. South of Delta-2 were 4 sand-gravel spits which extended 30-50 m into the FP when water levels were low. These were favored loafing sites of waterfowl, and Black Terns (especially newly-fledged young), and were attractive shorebird feeding areas. Killdeer nested on these bare areas as well.

2. Wildlife Pool The emergent vegetation of cattails, bulrushes, and reed provided habitat for overwater nesting species, particularly Canvasback, Ruddy Duck, Least Bittern, American Coot, Yellow-headed Blackbird and Pied-billed Grebes. The portion of the WP which seemed to be an especially attractive nesting area for these species was an area of dense hardstem bulrush east of the old north-south drainage ditch and north of the old east-west road which bisected the WP. Along the periphery of the WP was a zone of fine-leaved grasses and sedges intermixed with willow shrubs containing water generally less than 0.3 m deep. This was the favored nesting area for Black Tern and Sora in 1990. This vegetation type appeared to be more open in 1991 perhaps due to higher water. Whitetop, in particular, appeared to be quite reduced in density in 1991 compared to 1990. Production of frogs in the WP was high, especially for leopard frogs, which had an estimated mature tadpole density of 8 per square meter on 10 July 1990. This food resource was probably important to Great Blue Herons, Least Bitterns, and American Bitterns, the latter species establishing at least 3 nests both years.

3. Upland habitats Based on this study, those upland habitats inside of the dike and adjacent to the pools were favored nesting areas. An area of low, Quackgrass/Redtop habitat northeast of the Wildlife Pool (Fig. 1) seemed especially preferred with 14 nests found in about 12 ha. Several bird species bred in the Aspen/Brush Fen because of the structural diversity of the habitat.

MAMMALS

A systematic census of mammals was not carried out on the study area, except for a scent post survey route which was established on site. However, it was felt that a general narrative on mammal occurrence would add to the completeness of this report. Mammals can greatly influence a nature appreciation visit by the general public. They can also influence marsh vegetation (e.g. muskrats and beaver) and predaceous species can impact nesting and brood success of birds.

Moose (Alces alces)

The study area is strategically positioned between the Pembina Trail Preserve to the north and the Burnham and Trail Wildlife Management Areas to the south and provides travel cover between (Fig. 2). A well-used trail runs through the Aspen/Brush Fen along the east edge of the study area and moose were commonly observed in that habitat during the field seasons. Moose were also commonly observed feeding in the corn fields adjacent to the study area. A young bull moose died of unknown causes and was found floating in the Flood Pool on 22 August 1990. Perhaps fever conditions prompted it to attempt to cool off in the water where it died. As discussed in the BIRDS section, this addition of biomass to the food chain stimulated a great amount of feeding by shorebirds on the maggots washing ashore on a sandy spit.

White-tailed Deer (Odocoileus virginianus)

Deer, like moose, were commonly observed on the study area and used the trail through the Aspen/Brush Fen as travel cover. They also used the study area as fawning cover as at least 2 and perhaps 3 fawns were discovered while cable-dragging on 26 June 1991.

Coyote (Canis latrans)

Coyotes have become more common in the general area in recent years. While conducting prairie chicken censuses during the 1970's it was a rare occurrence to see a coyote in the course of 10-15 census mornings. Now it is common to make 4-5 sightings during a spring census season. Coyotes apparently became more common during the course of the study. In 1990, 1 incidental observation was made in the course of field work compared to 6 in 1991. This could partially explain the apparent nesting success for upland, ground nesters increasing from 8.3% in 1990 to 61.3% in 1991.

Red Fox (Vulpes vulpes)

Foxes were observed occasionally on the study area as well as their tracks. They were believed responsible for the loss of some nests both years due to the absence of eggs in a destroyed nest. No dens were observed nearby but over 80 large rock piles were present in the field to the west during 1990 and would have offered ideal denning conditions.

Raccoon (Procyon lotor)

Raccoons were common on the study area as evidenced by sightings, droppings and tracks. Corn was planted next to the study area both years and droppings

commonly contained corn residue. Also, the abundance of leopard frogs on the study area was felt to be an attractant to raccoons. Some duck nests were destroyed by raccoons, particularly those close to wetland edges used by raccoons.

Badger (Taxidea taxus)

Digging activity observed on the sandy ridge along the east edge of the study area. Badger are probably not very common on this area at this time.

Beaver (Castor canadensis)

A single, young individual was observed along the old drainage ditch in the WP on 9 July 1991. It was observed sporatically for a few days. No cutting of aspen or willows along the east edge of the WP was observed.

Muskrat (Onadatra zibethica)

No muskrat sightings or sign was observed during the study even though the area appeared to be excellent muskrat habitat. Apparently the series of dry years has reduced regional populations to the extent that immigrants have been scarce.

Otter (Lutra canadensis)

One record. On 3 July 1991 fresh otter tracks were observed and photographed in the soft mud along the east edge of the Flood Pool.

Striped Skunk (Mephites mephites)

Very common on the study area and believed responsible for a number of nest destructions. Used rock piles in adjacent private cropland to the west as den sites. Over 80 of these rock piles were buried in late fall of 1990 and the equipment operator indicated that "many" of them contained skunks.

Mink (Mustela vison)

Mink were common on the study area and probably had a den both years but one was found in 1991. It was located in 3 spoil piles along the old drainage ditch near the north end of the bulrush marsh portion of the WP. Table 10 summarizes the items identified from prey remains and scats located above ground near den burrows during the 1st week of July.

This was an impressive variety and quantity of prey and does not include prey remains left underground, undiscovered near the den, or consumed away from the den near the kill site. Several of the ducks were females and were probably preyed upon while nesting.

Weasels

Probably the least (Mustela rixosa), short-tailed (M. erminea), and long-tailed (M. frenata) weasels all occur in the area but only the long-tailed was observed on 3 July 1991.

Plains Pocket Gopher (Geomys bursarius)

Common throughout study area on well-drained areas and moved into lower areas during the dry conditions of 1990.

Table 10. Number of prey items found at a mink den, Burnham Creek Wildlife Management Area, July 1991.

Adults		Eggs	
American coot	6, possibly 7	Blue-winged teal	3
Ruddy duck	4	Sora	2
Blue-winged teal	2	American coot	1
Pied-billed grebe	2	Ruddy duck	1
Mallard	2		7
	16		
Young		**Other**	
<1 week old American coot	3	Tiger salamander	2
American coot chick (upper mandibles in scats)	8	Pocket gopher	1
3-week-old Northern pintail	1	Leopard frog	5
<3-week-old dabbler ducklings (probably Mallard or Blue-winged teal)	4		
Yellow-headed blackbirds	2		
	18		

Franklin's Ground Squirrel (*Citellus franklinii*)

Fairly common, especially along the ridge separating the pools where heavy vegetation was present. The removal of 1-2 eggs from some clutches was attributed to Franklin's ground squirrels.

Thirteen-Lined Ground Squirrel (*Citellus tridecemlineatus*)

Fairly common on well-drained portions of the study area with cover less than 30 cm. They are known to prey on eggs and may have been responsible for the loss of some eggs in this study.

Predator Scent Post Survey

In 1990, a 2.7-mile (4.32 km) census route was set up on the study area as part of the state-wide program coordinated by Bill Berg, Minnesota Department of Natural Resources, Grand Rapids. Ten stations of sifted soil with a scented disc were spaced at 0.3 mile intervals along this route and left overnight. The disc is particularly attractive to mammals and stations were checked for tracks to obtain a general index as to the species and general abundance of carnivorous mammmals present. The following route was established: starting at the southeast corner of the study area then north on the boundary road to the northeast corner then west on the dike road around to the junction of the interior road at the south end then north on the interior road until 10 scent stations had been established. Table 11 summarizes mammal sign observed.

Table 11. Mammal sign recorded at 10 scent stations, Burnham Creek Wildlife Managment Area, 1990 and 1991.

	Date	
Species	14 September 1990	4 September 1991
Red fox	2	2
Striped skunk	2	1
Raccoon	1	0
Mink	2	0
Coyote	0	1

Statewide trends in the "transition zone" for 4 of the above species as of 1990 were: red fox - increasing, raccoon - increasing, coyote - recent decrease but still higher than most of 1980's, and striped skunk - increasing (Bill Berg, pers. comm.).

REPTILES AND AMPHIBIANS

The plains garter snake (Thamnophis radix hydeni) was the only reptile observed during the study. The following amphibians were identified: swamp tree frog (Pseudacris triseriata maculata), American toad (Bufo americana), leopard frog (Rana pipiens), wood frog (Rana sylvatica) and tiger salmander (Ambystoma tigrinum). American toads were very common on the study area and leopard frogs were abundant. Both reproduced in the WP and while running a vegetation transect through the WP on 6 July 1990, nearly mature leopard frog tadpoles were estimated at 8 per square meter in more open areas. The WP satisfied most of the following criteria of Hine et al. (1981) for an ideal breeding pond for leopard frogs: 1) be within 1.6 km of a hibernaculum or wetland for winter hibernation (likely the FP in this case), 2) have a spring depth of 1.5 m or more to promote appropriate open water/cover ratio, 3) littoral vegetation around at least 2/3 of the pond circumference for egg mass attachment and escape cover, 4) gradual sloping bottom to promote emergent vegetation, 5) open water to allow appropriate warming, 6) surrounding land appropriate summer habitat for adults and juveniles, and 7) water present most of the time but drys up periodically to eliminate fish predation possibility. The WP was very low in 1990 until late May and early June which apparently created ideal reproduction conditions for leopard frogs which completed their development by mid-July and began moving to more upland areas. Another reference to their abundance in 1990 was about 1 frog per 25 m was inadvertently killed by driving once through the interior road on 29 August. By early September the WP was essentially dry except the old drainage ditch and presumably frogs moved to the FP for hibernation. Apparently, hibernating conditions were adequate in the winter of 1990-91 because leopard frogs were plentiful in May of 1991 and were readily available as a food source to birds (particularly bitterns and herons) and mammals.

MAJOR FINDINGS

1. The 435-acre Burnham Creek Wildlife Management Area (BCWMA) is a diverse project area due to the variation of soil and hydrologic conditions present, the restoration of a relatively natural marsh, the creation of a flood storage pool, and the seed mixtures used in establishing cover on upland sites. Of particular ecological interest are 2 small native prairie remanents and a calcareous fen community.

2. The primary water supply (County Ditch 140) drains an approximate 8.1 square mile watershed of which about 75% is intensively farmed. The potential for inputs of sediment, fertilizer, and pesticides to the Flood Pool and Wildlife Pool is present. In this study, suspended sediment after heavy rains was high, nitrogen and phosphorus levels in runoff water were not excessive, and pesticides were not measured.

3. Specific conductance measures of 500-600 u^S/cm place these pools in the "fresh" to "slightly brackish" classification. Measures of pH (around 8.5) indicated alkaline conditions and total hardness values in excess of 180 mg/l indicated very hard water.

4. Water levels were lower in both pools in 1990 than 1991 due to reduced precipitation and the blocked Wildlife Pool Inlet Structure early in 1990. Low spring water levels in 1990 delayed nesting by overwater nesting birds and excessive summer rises caused the loss of some nests.

5. The vegetation of the restored marsh (Wildlife Pool) was comprised mainly of native species typical of natural wetlands of the Northern Great Plains (cattails, softstem and hardstem bulrush, whitetop, sedges, reed, and bladderwort). The extent of submergent vegetation establishment in the created wetland (Flood Pool) was extensive with over half of the pool area occupied by plants, particularly grassleaf, leafy, and sago pondweed. Sago pondweed is a particularly important food species for waterfowl.

6. Cattail invasion of the Wildlife Pool appeared to be increasing, especially around marsh edges where plants with limited water tolerance were flooded out creating a bare surface. Such areas provide sites for cattails to spread by seeds and vegetatively by rhizomes. Higher than historic water levels and a decrease in salinity will likely change the composition of the Wildlife Pool vegetation. Permanent monitoring plots were established to measure possible changes in cattail density.

7. Woody plants, especially cottonwood and willows, are becoming established along the edge of the Flood Pool and parts of upland habitats which pose management concerns. If these species are not controlled, they will favor forest and edge wildlife species at the expense of prairie species. Also, the development of Flood Pool shoreline vegetation (woody and herbaceous species) can be expected to affect the use of these areas as sites for loafing, feeding and/or roosting by aquatic birds.

8. Diverse and relatively abundant invertebrate populations were found in the Wildlife and Flood Pools. Midges were the most abundant type found in each with water fleas and fingernail clams found only in the Wildlife Pool and scuds and mayflies found only in the Flood Pool. Many of the invertebrate groups recorded are important waterfowl foods. Four types of minnows and abundant tadpoles (toads and leopard frogs) also added considerably to the aquatic food base. The vegetation of both pools served as important habitat to invertebrate populations as well as to minnows and tadpoles.

9. A minimum of 137 bird species was observed during the study with at least 60 breeding species including the following state "special concern" species: American Bittern, Greater Prairie-Chicken, Sandhill Crane, Upland Sandpiper, Wilson's Phalarope, and Sharp-tailed Sparrow. The Black Tern, a "special concern" candidate species also bred on the study area both years. The federally "threatened" Bald Eagle and "endangered" Whooping Crane were also observed.

10. The Flood Pool was an important stop-over area for migratory species, particularly waterfowl, Sandhill Cranes, and shorebirds. The study area is located along a major migratory flight path and the food resources of the adjacent cropland stubble enhances the value of the area. Up to 5,000 Sandhill Cranes and as many waterfowl were common in the spring as well as the fall.

11. Two delta areas and 6 bare, sand/gravel spits along the edge of the Flood Pool were especially attractive feeding and/or loafing areas for aquatic birds. Bare shoreline areas with wide zones of shallow water (0-8 inches) over flooded topsoil were preferred shorebird feeding areas.

12. Of 60 species recorded to breed in the study area, 38 species bred in the diverse, brushy fen community along the eastern edge of the Wildlife Pool. Overall, the Yellow-headed Blackbird was the most abundant breeding species in the study area, followed closely by Red-winged Blackbirds. Blue-winged Teal were the most common upland nesting waterfowl species and Canvasbacks were the most common overwater nester. American Coots were particularly abundant in 1991, a year of higher, early water levels in the Wildlife Pool.

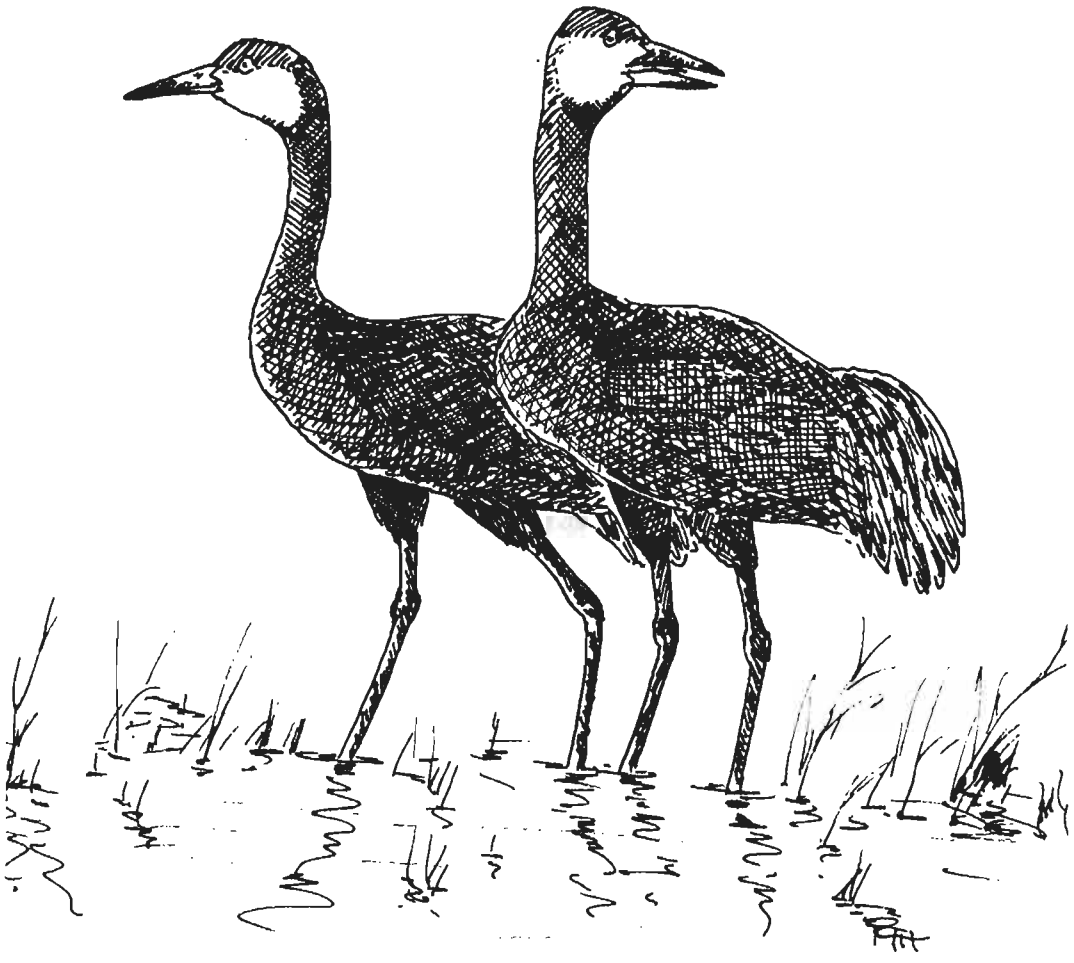
13. Nest losses were primarily due to predation, rising water levels, and strong storms. Red fox, skunks, and raccoons were important predators of upland nests in 1990 with only 1 of 12 (8%) reference nests hatching. In 1991, 19 of 31 (61%) reference nests hatched which was at least partially attributed to coyotes becoming more common in the area and presumably reducing other mammalian predators. The presence of nearby mammalian predator denning sites (i.e. rock piles) was believed to be a factor in predator abundance. In 1991, a family of mink destroyed several nests and killed adult and young waterfowl and coots. Rising water during the peak of Yellow-headed Blackbird nesting in 1990 destroyed 95% of their first nests with at least 1 Sora and Mallard nest flooded as well. A strong storm in 1991 was believed to have destroyed 60% of the Black Tern nests built on floating vegetation.

14. Bird species differed with regard to nesting cover preferences. American Bitterns preferred the tallest and densest cover followed by Mallards, Blue-winged Teal, Wilson's Phalaropes, then Killdeer, which require bare ground.

15. Only 2 waterfowl broods were recorded in 1990 compared to a minimum of 22 in 1991. Differences in nest predation as well as nesting efforts were responsible for this dramatic difference. A surprising amount of brood use occurred along the zone of emergent vegetation and the beds of submergent vegetation along the edge of the Flood Pool.

16. American Bitterns were a noteworthy nesting species with a total of 7 nests possibly producing 14 young during 2 nesting seasons. This species has apparently been declining 4% per year in the North Central States since 1966. An abundance of leopard frogs was believed to have contributed to the strong breeding effort by American Bitterns in this study area.

17. The close proximity of the Wildlife Pool, Flood Pool and associated upland habitats was believed to have substantially complemented the individual habitat values of each. Specific sites within habitats were favored for certain wildlife activities such as nesting, feeding, and loafing.



MANAGEMENT CONSIDERATIONS

The wildlife values of the Burnham Creek Wildlife Management Area (BCWMA) are varied depending on the species concerned and the portion of the area considered. Resident species of low mobility such as leopard frogs or 13-lined ground squirrels use one or more portions of the area year-round. Migrant species like Tundra Swans use the Flood Pool for resting and feeding on tubers and also feed in adjacent fields for a 2-3 week period in the spring and briefly in the fall. Migrant shorebirds might make a single feeding stop at the edge of the Flood Pool. The following management discussion attempts to identify the major wildlife values of different habitats of the BCWMA based on 2 years of observation, discuss general management practices, and propose possible application of these practices at the BCWMA. Birds have been emphasized as the focus for management. Finally, public use options are discussed considering the recreational potentials of the area.

Wildlife and Flood Pools

Although there is considerable overlap in the following categories, the primary wildlife habitat functions of the Wildlife Pool are as follows: foraging - migrant and breeding waterfowl and other wetland birds; over-water nesting - waterfowl, Black Terns, American Coots, grebes, rails, and passerine birds; the water as a breeding site - toads, leopard frogs, minnows, invertebrates; brood - waterfowl and other wetland birds; and loafing - Wood Ducks near the wooded edge. Habitat values of the Flood Pool include: foraging - migrant and breeding waterfowl, gulls, shorebirds, terns, grebes, Double-crested cormorants; over-water nesting - limited to blackbirds and Marsh Wrens along the fringe zone of emergent vegetation; the water as a breeding site - minnows and invertebrates; brood - waterfowl, coots, and grebes; loafing - migrant and breeding waterfowl, gulls, cormorants, shorebirds, terns; roosting - waterfowl, cranes, shorebirds; staging - migrant waterfowl and cranes, molt migration mallards and Canada geese; winter hibernation - presumably for leopard frogs since the Wildlife Pool is shallow and spring frog populations are quite high, suggesting local hibernation (Merrell 1977).

A. Water level manipulation. The major management tool available for the Wildlife Pool, and to a lesser extent for the Flood Pool, is water level manipulation. An inlet and outlet control structure is present on the Wildlife Pool and it may be possible to adapt the Flood Pool Outlet Structure to allow some water level control.

   1. Vegetation control (cover management). Raise levels to flood out certain plant species (cattails and woody species) and promote their replacement by more desirable species or create more open water for a more desirable mix of open water/emergent vegetation; usually 50:50 (Weller 1981). The response of vegetation to lowered water levels or drawdown will depend upon the drawdown date, seed availability and soil type with considerable variation from one site to another.

      Early drawdown (May and June) tends to result in greater shoot densities of emergent species (bulrush, cattails) compared to late summer (July and August) which favors annual species (Merendino and Smith 1991, Harris and Marshall 1963).

Of particular interest in this study was the growth and spread of cattail, especially in the Wildlife Pool. Since cattails are prolific seed producers, one must assume that there is an abundance of seeds in most wetland situations which will germinate optimally in mudflat or shallow water conditions (Linde et al. 1976). Furthermore, cattails may expand rapidly by rhizomes where competing vegetation is weakened by flooding. This has occurred along the north and west edges of the Wildlife Pool and in interior areas where whitetop and sedges were apparently flooded out. An increase in the substrate temperature surrounding cattail rhizomes due to a decrease in shading is key to enhancing this growth (Linde et al. 1976). In interior areas of the Wildlife Pool where hardstem bulrush is well established, it should maintain itself due to its high water tolerance and stem density. A variety of water-tolerant sedges are present along the east edge of the Wildlife Pool and should persist although the emergent (bulrush, cattail, reed) - sedge transition zone would be expected to move eastward toward the fen as plant species sort themselves out in a higher water level regime than previously existed. Present water levels are probably 12 in. higher than those of the recent past as inferred from water levels at the base of flooded-out trembling aspen trees along the old roadway in the Wildlife Pool.

Both broad-leaved, narrow-leaved, and hybrid cattails are present on the BCWMA. Twelve to 15 in. of flooding were required to reduce broad-leaved cattail at Agassiz National Wildlife Refuge with an excess of 2.5 ft. required to reduce narrow-leaved and hybrid cattail (Harris and Marshall 1963). Little cattail control can be effected in the Wildlife Pool by raising water levels given the design of the outlet structure. In fact, higher water levels would likely stimulate the vegetative expansion of cattail near fringe areas. If one assumes that the existing distribution of cattail will persist, then a strategy of limiting its spread could be adopted by maintaining existing, non-cattail vegetation by lower water levels.

Possible actions:

a. Although the Wildlife Pool is probably 80% emergent cover and 20% open water (as opposed to the recommended 50:50 ratio), raising water levels to the limit of the structure would doubtfully be sufficient to flood out hardstem bulrush and narrow-leaved and hybrid cattails to create more open water. Instead, cattail would likely replace fine-leaved emergents (whitetop and sedges) used as nesting habitat by Soras and Black Terns (at least during 1 year). Maintaining Wildlife Pool levels at an outlet depth of 20 in. (12 in. down from the top of structure) should maintain most of the fine-leaved emergent community and not unduly promote the expansion of cattails. When this level is present at the outlet structure the following water levels are present in the plant zones of the Wildlife Pool: hardstem bulrush (24-36 in.), whitetop - deep water sedges (10-20 in.), shallow water sedges (0-15 in.), cattail - reed (0-30 in.), and softstem bulrush (0-10 in.).

   Perhaps muskrats will contribute toward the desirable 50:50 cover ratio when they become common. At least 1 was sighted in late spring of 1992.

b. Emergent vegetation and woody species are developing rapidly along some portions of the Flood Pool shoreline. While more shoreline cover will encourage nesting and brood use by some species, it will reduce habitat for species such as shorebirds and cranes which prefer openness. Flood storage functions of the Flood Pool, perhaps preclude very much purposful manipulation of water levels, but at least 2 feet of additional water could be held in the Flood Pool by installing a simple stop-log adaptation to the outlet structure. This should be sufficient to flood out some shoreline vegetation but disking to control succession in shorebird management has been used effectively in Missouri (Rundle and Fredrickson 1981) and could be useful here. A gradual drawdown commencing in mid-July should provide shorebird foraging habitat during the summer/fall migration period. These higher mid-summer levels could, however, negatively impact submergent vegetation of the Flood Pool due to increased wave action and associated turbidity.

2. Vegetation control (food management). Summer drawdowns can increase production of natural waterfowl foods (millets, smartweed, dock, rice cutgrass, pigweed) or provide mudflat areas for artificial seeding of waterfowl food plants (Linde 1969). Partial summer drawdown can increase seed production of pondweeds, particularly sago pondweed (Harris and Marshall 1963, Keith 1961).

   Possible actions:

   Effects of water levels on plant foods were not noted in the Wildlife Pool probably due to the shading effect of emergent vegetation on submergents. However, when Flood Pool levels were quite low in 1990 due to dry conditions, an abundant pondweed seed crop, especially sago, was noted. Thus, lowered summer Flood Pool levels should stimulate submergent foods. Without water level control, increased submergent growth in the Flood Pool would likely be best during dry years and poor during wet years.

3. Invertebrate production (as a food resource for waterfowl and other aquatic birds). Invertebrate populations tend to be high the first 2 years after flooding due to enhanced nutrient release from the decay of pre-flood vegetation (Whitman 1976). Also, invertebrate numbers and diversity have been found to be higher with a mix of open water and emergent vegetation which can be achieved through water level manipulation (Voights 1976).

   Possible actions:

   No specific management action is suggested due to the lack of data in this study adequate to clearly relate invertebrate productivity to associated environmental influences, such as water level manipulation.

4. Increasing the availability of animal foods. Water levels can be regulated to increase the availability of invertebrates (those living in the bottom substrate as well as those free swimming) to aquatic birds, depending upon their feeding zone. For example, Killdeer feed on the

surface of bare shorelines, godwits probe in saturated muds, Least Sandpipers feed at the shoreline, Pectoral Sandpipers feed in 0 to 3 in. of water, Greater Yellowlegs in 4 to 10 in., etc. Even with water level management capability, depth variation within a unit is important to provide the proper habitat for a wide range of species (Hands et al. 1991, Colwell and Oring 1988).

Possible actions:

Assuming that water levels were raised on the Flood Pool by the installation of a control structure, gradual dewatering to coincide with summer/fall shorebird migration should enhance food availability. Flood Pool levels are generally too high for purposeful shorebird management during the spring/summer migration due to spring runoff.

5. Stabilized levels during overwater nesting period. Two-thirds of the annual precipitation in northwest Minnesota occurs during May, June, and July which creates the potential for considerable "bounce" and flooding of overwater nests. Stable or slowly declining summer water levels would safeguard overwater nests.

   Possible actions:

   Inlet and outlet control structures on the Wildlife Pool allow the regulation of water level bounce during all except the most severe storms. The allowable bounce for overwater nesting Black Terns and Pied-billed Grebes would likely be the smallest at around 2 in., whereas Yellow-headed Blackbirds could tolerate 10-12 in. Minimizing the bounce from June through mid-July should safeguard most overwater nests. Adding a stop log adaptation to the gate valve outlet structure of the Wildlife Pool should facilitate better bounce control since field workers can only check levels periodically and the gate valve has to be manually adjusted.

6. Animal management. Muskrat and carp are probably the 2 animal species of most concern regarding water level management. Carp may greatly reduce desirable wildlife plant growth due to turbidity resulting from their feeding. Lowered water levels in winter cause freeze-out of carp and muskrat. Conversely, higher overwinter water levels result in population carryover, and can be used as a valuable tool in vegetation control.

   Possible actions:

   Carp are not present in the study area but 4 species of minnows are and could have some impact on the invertebrate food base although minnows serve as a food source to grebes, loons, terns, cormorants, bitterns, and herons. Higher winter water levels in the Wildlife Pool should promote overwintering and population increase of muskrats which could increase the proportion of open water by their feeding activities.

Effects of water level manipulations are varied as illustrated by the previous discussion but a common recommendation is to carry out a drawdown every 5 to 7 years (Harris and Marshall 1963, Whitman 1976). This goal could be adopted for the BCWMA but appropriately modified depending on moisture conditions for a

given year. For example, 1990 was a dry year resulting in a late summer "drawdown" condition, so a planned drawdown would not be scheduled until 1995 if another dry year did not occur in the interim.

B. Other methods of pool vegetation management. In order to achieve a more desirable mix of open water to emergent plant cover, other methods might be considered such as fall or early winter burning or cutting. Cutting cattail shoots and leaves followed by a rise in water levels can be an effective control as it deprives rhizomes of oxygen which is transported down through dead aerial tissue (Linde 1969). Winter cutting of emergents using a tractor and rotary mower could be an effective management technique which could be researched in this study area.

C. Structures associated with pools. A variety of structures have been used in wetland management including: nesting cones and boxes, large round bales for loafing and nesting, culverts positioned upright and filled with earth for nesting, loafing/nesting rafts, and large loafing rocks.

Possible actions:

1. Six nesting cones have been installed on site but have not been used for nesting in 3 seasons. They are used as display perches by blackbirds.

2. Nest boxes for Wood Ducks, Hooded Mergansers and/or American Kestrels could be placed along the wooded edge of the Wildlife Pool. With appropriate predator guards, the Wood Duck population would be expected to build since they are present each year but nest sites are absent.

3. Large, round hay bales could be placed in both pools and would possibly attract pioneering, breeding pairs of Canada Geese.

4. Black Terns have responded to floating, wooden frame nesting structures elsewhere and might benefit from them at this site. Small, square bales could also be evaluated for this purpose by sinking them so that only 1 in. protruded above water.

5. Loafing/nesting rafts have been successfully used in deeper wetland sites and could be installed in the Flood Pool. Since their maintenance is fairly labor intensive they are not recommended here.

6. Rocks along the eastern shoreline of the Flood Pool are presently used as loafing sites by cormorants, gulls, terns, waterfowl and shorebirds. There is an abundant supply of rocks in piles along the eastern edge of the BCWMA and more could be placed along the Flood Pool edge.

D. Other wetland development possibilities to complement pools. The brood values of the Wildlife and Flood Pools appear underutilized. There are some opportunities to develop satellite wetlands to augment breeding pair or courtship habitat and possibly increase waterfowl production at the BCWMA.

1. An approximate 1/3-mile portion of County Ditch 140 is no longer used at the north edge of the BCWMA. A series of pools could be developed with combination rock and earthen dams of about 3-ft. height. Rocks are available on site and earth could be placed on the upstream side of dams although there would be minimal water flow.

2. A similar alteration could be made in the 1/4-mile outlet channel of the Flood Pool to allow more pooling of water and breeding pair and/or brood use. Again, rocks are readily available and could be transported with a front-end loader. Even with 2-3 ft. of pooled water in the outlet channel, the dimensions of the channel should adequately accommodate the restricted flow of the Flood Pool Outlet Structure.

Upland and Moist Grasslands

Grassland habitats present on site provide nesting sites for a variety of wetland birds which depend heavily on pool habitats (dabbler ducks, American Bitterns, Wilson's Phalarope, Common Snipe). They also provide foraging habitat for blackbirds and frogs which breed in the pools, particularly the Wildlife Pool. A number of passerine birds (Bobolink, grassland sparrows, Common Yellowthroat, Western Meadowlark, etc.) nest and forage almost exclusively in the grasslands and birds such as Lesser Golden and Black-bellied Plovers used burned grassland for foraging stops during migration. Insects, mammals, reptiles, and amphibians also use grassland habitats as they serve as predator or prey in the overall habitat system.

A. Nesting and foraging cover management. Cover required by grassland birds will vary as to height and density. Dabbler ducks, American Bitterns and Northern Harrier require relatively tall and dense cover which also tends to be an effective deterrent to mammalian predators. Wilson's Phalaropes prefer thin cover after a burn or where growing conditions restrict plant growth. Residual cover from the previous growing season is important for those species which initiate nests early before the current year's growth begins.

Possible actions:

1. Rotational burning. A 4-year burning rotation is generally recommended for grasslands in the Northern Great Plains in which 1/4 of the grassland acreage of a unit would be burned each year. This would assure the availability of short cover in newly-burned areas each spring for those species requiring it for nesting and/or foraging. Timing of prescribed burns is generally dependent upon whether the vegetation grows during the cool or warm season. The cover planted in-between the pools is predominantly cool season species comprised of bluegrasses, wheatgrasses and timothy and should be burned in early spring before regrowth commences. The ridge site along the eastern portion of the BCWMA was also planted to cool season green needlegrass and side-oats grama and would benefit by early spring burning. Growth could be reduced in a dry spring however due to removal of the mulch layer and the subsequent moisture loss from this dry site. The areas outside of the dike were planted to predominantly warm season species of big bluestem, Indian grass, and switchgrass which would be stimulated by burning later in the spring when cool season species had commenced growth. Generally this would be in early to mid-May in northwest Minnesota.

   The stimulation of native vegetation (both planted and remnant areas) will not only enhance habitat values for animals but also add to the aesthetic values of the area for the general public. A variety of prairie wildflowers are present in remnant areas and would be expected to move in to planted areas over time.

B. Woody plant management. Secondary succession of woody shrub and tree species has commenced and will progress rapidly in some areas. Cottonwood and willows are the primary species becoming established in grassland as they have wind-borne seeds and grow well in full sunlight. Trembling aspen can be expected to spread more gradually into the grassland along the edge of the Aspen/Brush Fen. While a scattering of shrubs and trees can add to the diversity of the grassland plants and animals, they have the potential to shift the species mix toward more edge and forest species and away from grassland or prairie species. Trees can serve as hunting perches for birds of prey which could deter use by some grassland or wetland birds. The presence of woody vegetation may also hamper future nest-searching activities using a cable-drag.

Possible actions:

1. Rotational burning. Burning conducted as previously described should top-kill woody plants but may not permanently kill or seriously weaken woody species unless conducted at a time when carbohydrate root reserves are at minimal levels. Generally this occurs when leaves have just fully expanded.

2. Cutting. Cutting at full leaf expansion should maximize injury but stump sprouting will probably still occur and treating freshly cut stumps with an herbicide may be necessary to kill individual plants. Girdling may be effective for larger woody plants.

C. Weed control. The 2 species of primary concern in the grasslands on site are Canada thistle and leafy spurge (Euphorbia esula). Canada thistle is often effectively controlled by prescribed burning to maintain vigorous grassland communities or a combination of burning and broad-leafed herbicide application. Herbicides (Tordon) are presently the only practical means of controlling leafy spurge in the Northern Great Plains and 2 small occurrences on-site are being controlled in this manner at present.

Aspen/Brush Fen

The most ecologically unique community at the BCWMA is the seepage fen which has become dominated by woody species, particularly trembling aspen, pussy willow (Salix discolor), and prairie willow (S. humilis). This community would have been more open in presettlement times due to recurrent fires and with woody species comprised mainly of bog birch (Betula pumila), hoary willow (Salix candida) and shrubby cinquefoil (Potentilla fruiticosa). These species are still present but confined to more open areas. If woody plant succession is allowed to proceed, many unique fen species like grass of Parnassus (Parnassia palustris), Kalm's lobelia (Campanula kalmii), and fringed gentian (Gentianopsis procera) will become rare on site. The brushy nature of the site does, however, add considerably to the bird species diversity of the area as well as serving as moose habitat. It is common to observe moose here which are an interest feature.

Possible actions:

1. Complete fire suppression. No burning management would result in continued development of an aspen-dominated forest eventually replaced

with shade-tolerant green ash (Fraxinus pennsylvanica) and box elder (Acer negundo). In time, this would probably replace all of the fen community except in wetter areas.

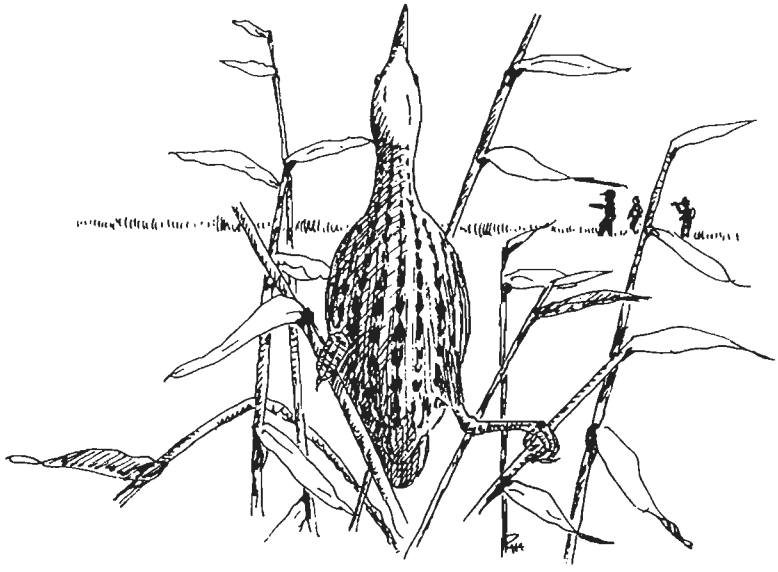
2. Rotational burning. Periodic burning on a 4-year rotation would maintain some open areas but due to the wide-spread coverage of trembling aspen there would be a dense sucker shoot growth following burns. A period of annual or biennial burning would probably be necessary in order to reduce the dominance of woody species in this site, perhaps accompanied by summer cutting or girdling in mid-June when carbohydrate root reserves are low. A compromise might be to identify the highest quality (botanically speaking) parts of the fen and intensively control woody species there in order to maintain the fen as an interest feature. Other areas dominated by woody species could be managed as such to add to bird diversity and moose habitat.

Public Use

Due to the diversity of the BCWMA, the presence of relatively large wetlands in an area where they are lacking, and its location in a major bird migration corridor, it has significant public use potentials. The spring and fall concentrations of waterfowl and cranes are becoming well known and are viewed by several individuals and birding groups. The entire area is a sanctuary from 1 September until the end of the duck season which serves to hold large numbers of waterfowl in the area. Field shooting of waterfowl, particularly geese, is becoming common on the adjacent private land to the south and west.

Natural history study could be better facilitated by the development of a brochure with a bird list and location of interest points. These could be made available in a dispenser on site near a marked parking lot. A nature trail could be established on the area along with a permanent observation blind. Probably the best location for an observation blind would be at the Delta-2 location along the east shore of the Flood Pool.

Educational groups from the University of Minnesota, Crookston use the area for field trips and individual study projects. Also, the summer field ornithology class from the Itasca Biological Station of the University of Minnesota makes an annual trip to the site in July.



DESIGN CONSIDERATIONS

In designing a multi-purpose project like the Burnham Creek Impoundment, a number of engineering and biological factors have to be considered and adapted to the site. Environmental factors such as precipitation, runoff estimates, geological conditions, as well as plant and animal populations all have a bearing on project design and how successful it will be in meeting stated objectives. In many instances, the response of wildlife to developed habitats can be anticipated based on similar developments, however, each site has some unique features which influence wildlife effects that become evident only after a project is completed. This section will discuss project design features which seem to have worked well from a wildlife standpoint and those which might have been modified or added. The basis for this discussion is the 2-year study and the intent is that this information will benefit the design of future multi-purpose impoundment projects.

Things Which Have Worked Well:

1. Upland habitats adjacent to pools provide essential nesting and foraging habitats for aquatic as well as terrestrial birds. Cover planting mixtures were appropriate and are aesthetically pleasing and functional as nesting cover and foraging habitat.

2. The presence of the Flood Pool close to the Wildlife Pool enhances the wildlife value of each.

3. The large expanse of open water in the Flood Pool makes it attractive as a resting area for migratory birds.

4. Gradual sloping shorelines of the Flood Pool provide excellent foraging and loafing habitat for a variety of breeding and migrating aquatic birds, especially where fertile topsoil was flooded.

5. Fluctuating water levels of the Flood Pool provide good shorebird foraging areas although on an unpredictable schedule depending on precipitation patterns.

6. The sand/gravel spits with scattered rocks extending into the Flood Pool provide attractive loafing and/or foraging sites for waterfowl, shorebirds, terns, gulls, and cormorants.

7. The presence of deeper water areas of the Flood Pool provide overwintering habitat for minnows serving as forage for mergansers, grebes, terns, Common Loons, Double-crested Cormorants, herons, and egrets.

8. The positioning of the Flood Pool inflow channel close to the Outlet Structure probably reduces the turbidity of the Flood Pool more than if the inflow were at one end and the outflow at the other end. Turbidity is a critical factor affecting the productivity of submergent vegetation.

Possible Design Improvements:

1. Rock piles left along the western edge of the project area serve as mammalian predator denning sites and could have been buried, spread out along the Flood Pool edge as loafing sites, used to construct "sunken islands" at intervals in the Flood Pool to reduce wave action, or used to construct low dams for pools in the blocked off portion of County Ditch 140.

2. Elongate sunken islands constructed perpindicular to the long axis of the Flood Pool would have promoted the growth of patches of emergent and submergent vegetation. This would have provided interspersed brood cover and also reduced wave action and its attendant erosion and increased turbidity.

3. By lowering the Flood Pool Outlet Structure and equipping the outlet with a control structure, there would have been additional management capabilities to raise levels to control shoreline woody vegetation and expose mudflats during shorebird migration.

4. The existence of the old township roadway could have been used as a base for forming 2 cells in the Wildlife Pool to allow more flexibility in water level management for different species.

5. The spoil piles from the drainage ditch used to drain the bulrush marsh served as sites for mink dens and the growth of woody vegetation. Both are undesirable for maximum waterfowl production. The spoil could have been used to fill the ditch and create a more natural appearing marsh. The deeper water of the ditch probably serves as a mink overwintering site.

6. Another option for the restoration of the bulrush marsh would have been a simple restoration; divert no additional water into the marsh, just fill in the ditch and let the wetland function as a natural marsh, going through wet and dry cycles without water level manipulation. It appears that a portion of the restored wetland is destined to become a cattail monotype due to increased water levels and possibly the inflow of fresh, nutrient-enriched water.

7. To facilitate bird-watching opportunities, strategically positioned observation mounds could have been constructed.

EPILOGUE

To a visitor, the Burnham Creek Wildlife Management Area could seem like a wildlife bonanza, particularly in the spring and fall when thousands of migrating waterfowl and cranes are present. The area also has significant potential as wildlife production or breeding habitat as this study has documented. However, Cowardin and Goforth (1985) caution, "we also need to know if we see increased use patterns at impoundments because we are helping increase population levels or because we are simply attracting animals from other areas." A related question is how the wildlife use at this project area compares with the former wetland and prairie complex in the watershed which was destroyed and contributed to the flooding conditions which helped justify the construction of the impoundment. Except for field feeding in cropland stubble, wildlife use has become concentrated in the project area; creating a greater potential for disease outbreak and also increasing the prey base of ground-nesting birds for mammalian predators. Nests which are concentrated in "habitat islands" are generally more likely to be destroyed than those more dispersed over the landscape.

A significant wildlife development such as the Burnham Creek Wildlife Management Area has to be viewed in a regional and historical perspective in order to properly assess its present values. A diverse prairie landscape has been largely converted to intensive crop production in the watershed but this project has been an important effort to regain some of the lost wildlife resource values.

APPENDIXES

Appendix 1. Wildlife Pool levels of the Burnham Creek Wildlife Management Area measured at the outlet structure, 1990 and 1991.[1]

1990		1991	
Date	Level (ft.)	Date	Level (ft.)
19 April	0.00	3 April	0.50
22 April	0.00	13 April	0.42
25 April	0.17	1 May	0.92
16 May	0.33	10 May	2.00
23 May	0.42	16 May	1.96
25 May	0.38	30 May	2.18
4 June	1.08	9 June	2.21
15 June	1.42	13 June	2.13
20 June	1.92	18 June	2.21
22 June	2.04	21 June	2.29
28 June	1.88	24 June	2.21
2 July	1.67	26 June	2.25
6 July	1.50	1 July	2.38
13 July	1.29	8 July	2.46
16 July	1.25	14 July	2.38
23 July	1.04	2 August	1.97
27 July	0.96	6 August	2.05
3 August	0.79	8 August	2.04
14 August	0.46	13 August	1.93
22 August	0.23	20 August	1.73
29 August	0.00	29 August	1.53
13 September	0.00	4 September	1.35
25 September	0.00	11 September	1.54
16 October	0.00	16 September	1.58
29 October	0.00	22 September	1.58
24 November	0.00	18 October	1.33

[1] Measured at the southeast corner of the concrete box structure. Measurements are water depths over the substrate which, during 1990 and 1991, was 2.63 ft down from the top of the concrete.

Appendix 2. Flood Pool levels of the Burnham Creek Wildlife Management Area measured at outlet structure gauge, 1990 and 1991.

1990		1991	
Date	Level (ft.)	Date	Level (ft.)
8 March	-0.25	19 March	-0.88
31 March	-0.25	13 April	-0.80
4 April	-0.21	10 May	0.04
25 April	0.08	16 May	0.08
2 May	0.08	21 May	0.33
16 May	-0.42	30 May	0.56
25 May	-0.24	9 June	0.66
4 June	0.03	12 June	1.16
14 June	0.05	13 June	0.86
22 June	0.10	16 June	0.96
2 July	0.20	24 June	0.71
6 July	0.20	1 July	1.66
23 July	-0.13	3 July	1.66
3 August	-0.21	7 July	1.71
14 August	-0.25	8 July	1.66
22 August	-0.33	14 July	0.66
13 September	-0.42	15 July	0.64
25 September	-0.50	19 July	0.40
2 October	-0.58	22 July	0.33
29 October	-0.67	28 July	-0.06
24 November	-0.75	2 August	0.00
		6 August	0.04
		8 August	0.08
		13 August	-0.04
		20 August	-0.08
		29 August	-0.10
		4 September	-0.10
		11 September	0.60
		16 September	0.60
		31 October	0.40

Appendix 3. Photographs of transect photo points and general aspects at the Burnham Creek Wildlife Management Area. Photographs taken 10 meters away from photo posts.

Figure 3-1. Flood Pool Transect No. 1, looking west. 21 August 1991.

Figure 3-2. Flood Pool Transect No. 2, looking west. 21 August 1991.

Figure 3-3. Flood Pool Transect No. 3, looking west. 21 August 1991.

Figure 3-4. Flood Pool Transect No. 4, looking west. 21 August 1991.

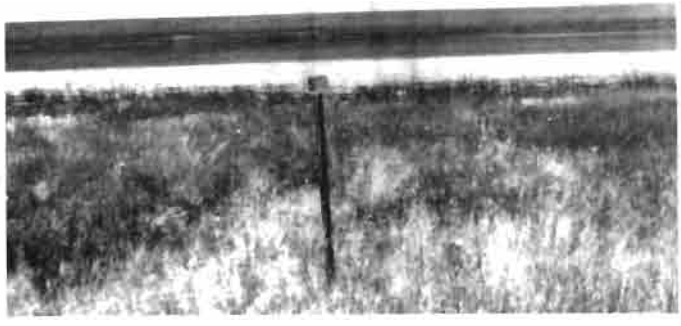


Figure 3-5. Flood Pool Transect No. 5, looking west. 29 August 1990.

Figure 3-6. Flood Pool Transect No. 6, looking west. 21 August 1991.

Appendix 3. Continued.

Figure 3-7. Wildlife Pool Transect No. 7, looking north. 21 August 1991.

Figure 3-8. Aspen/Brush Fen Transect No. 8, looking north. 21 August 1991.

Figure 3-9. Wheatgrass/Timothy Transect No. 9, looking north. 21 August 1991.

Figure 3-10. Needlegrass/Side-oats grama Transect No. 10, looking north. 21 August 1991.

Figure 3-11. Looking east across Flood Pool near Transect No. 2. 21 August 1991.

Figure 3-12. Looking north along west edge of Flood Pool. Note softstem bulrush and water plantain in water and willows along shoreline. 1 August 1990.

Appendix 3. Continued.

Figure 3-13. Plant sampling frame along edge of Flood Pool. 29 August 1990.

Figure 3-16. Collecting cattail monitoring plot data in Wildlife Pool where whitetop was flooded out. 13 August 1991.

Figure 3-14. Sampling submergent vegetation along Flood Pool Transect No. 4. 29 August 1990.

Figure 3-17. Looking south at old drainage ditch from the north end of Wildlife Pool. 8 March 1990.

Figure 3-15. Sampling invertebrates in the Flood Pool. 30 May 1990.

Figure 3-18. Soil erosion in cropland of the BCWMA watershed. 26 June 1991.

Figure 3-19. Field worker examining the site of a Ruddy Duck nest in Wildlife Pool. 1 July 1991.

Figure 3-20. Ruddy Duck nest made of green hardstem bulrush and cattail. 1 July 1991.

Figure 3-21. Field worker pointing to Black Tern nest along east edge of Wildlife Pool. 22 June 1990.

Figure 3-22. Black Tern nest made of flooded-out whitetop. 22 June 1990.

Figure 3-23. Sora nest made from fine-leaved sedges along east edge of Wildlife Pool. Note entry ramp. 22 June 1990.

Figure 3-24. Canvasback nest made of bulrush and located in dense bulrush in Wildlife Pool. 22 June 1990.

Figure 3-25. Field feeding Sandhill Cranes near BCWMA. Arrow points to Whooping Crane. 23 October 1990. (Photo by David Lambeth)

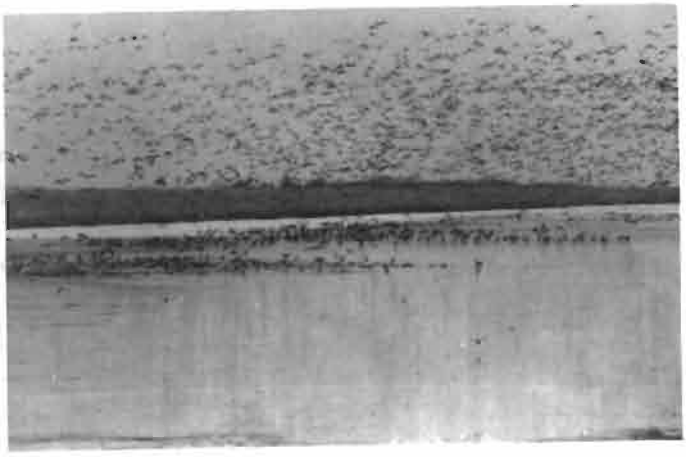


Figure 3-26. Fall concentration of waterfowl on Flood Pool. Mostly Mallards and Canada Geese. 31 October 1991.

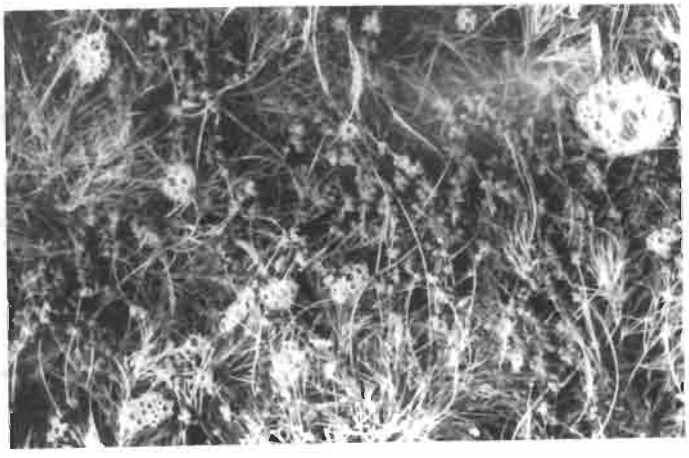


Figure 3-27. Lush growth of sago pondweed in Flood Pool. 22 August 1990.

Figure 3-28. Concentration of leopard frogs near Flood Pool Outlet Structure. 22 August 1990.

Figure 3-29. Adult American Bittern guarding young at nest site. 26 July 1990.

Figure 3-30. Young American Bitterns. 24 June 1991.
Appendix 3. Continued.

Appendix 3. Continued.

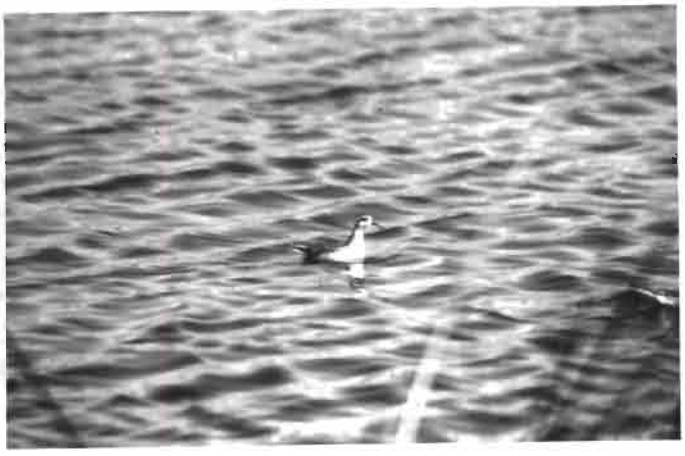


Figure 3-31. Red-necked Phalarope along edge of Flood Pool. 4 September 1991.

Figure 3-32. Pectoral and Least Sandpipers along edge of Flood Pool. 29 August 1990.

Figure 3-33. Greater Yellowlegs feeding in Delta 1 area of Flood Pool. 3 August 1990.

Figure 3-34. A mixed flock of Baird's and Pectoral Sandpipers and a Short-billed Dowitcher along edge of Flood Pool. 29 August 1990.

Figure 3-35. Aerial view of Burnham Creek Wildlife Management Area facing north. 19 July 1990.

Appendix 4. Photo points of cattail monitoring plots at the Burnham Creek Wildlife Management Area. Photographs taken 5 meters due south of photo posts.

Figure 4-1. Cattail monitoring plot No. 11 in Wildlife Pool facing north. Flooded-out whitetop site. 13 August 1991.

Figure 4-2. Cattail monitoring plot No. 12 in Wildlife Pool facing north.

Figure 4-3. Cattail monitoring plot No. 13 in Wildlife Pool facing north. 13 August 1991.

Figure 4-4. Cattail monitoring plot No. 14 in Wildlife Pool. 13 August 1991.

Figure 4-5. Cattail monitoring plot No. 15 in Wildlife Pool facing north. 13 August 1991.

Figure 4-6. Cattail monitoring plot No. 16 in Wildlife Pool facing north. 13 August 1991.

Figure 4-7. Cattail monitoring plot No. 17 in Wildlife Pool facing north. 13 August 1991.

Figure 4-8. Cattail monitoring plot No. 18 in Wildlife Pool facing north. 13 August 1991.

Figure 4-9. Cattail monitoring plot No. 19, bulrush marsh on Pembina Trail Preserve facing north. 20 August 1991.

Figure 4-10. Cattail monitoring plot No. 20, bulrush marsh on Pembina Trail Preserve facing north. 20 August 1991.

Figure 4-11. Cattail monitoring plot No. 21, bulrush marsh on Pembina Trail Preserve facing north. 20 August 1991.

Figure 4-12. Cattail monitoring plot No. 22, bulrush marsh on Pembina Trail Preserve facing north. 20

Figure 4-13. Cattail monitoring plot No. 23, bulrush marsh on Pembina Trail Preserve facing north. 20 August 1991.

Figure 4-14. Cattail monitoring plot No. 24, bulrush marsh on Pembina Trail Preserve facing north. 20 August 1991.

Figure 4-15. Cattail monitoring plot No. 25, bulrush marsh on Pembina Trail Preserve facing north. 20 August 1991.

Appendix 5. Water depths and percent plant cover along Flood Pool Transect No. 1, 29 August 1990.

Species	Plot number										
	1	2	3	4	5	6	7	8	9	10	11
	Water depth (in.)										
	0	2	8	13	15	16	16.5	20.5	18.5	28	28
Agropyron repens (Quackgrass)	50										
Agrostis stolonifera (Redtop)	5										
Plantago eriopoda (Alkali plantain)	1										
Salix exigua (Sandbar willow)	1										
S. amygdaloides (Peach-leafed willow)	1										
Taraxacum officinale (Dandelion)	3										
Juncus sp. (Rush)	1										
Typha sp. (Cattail)		1									
Scirpus validus (Softstem bulrush)		3									
Chara sp. (Muskgrass)		10	88								
Potamogeton pectinatus (Sago pondweed)			10		35			2			
P. pusillus (Grassleaf pondweed)				100		5				70	70
P foliosus (Leafy pondweed)						15					
Alisma triviale (Water plantain)			2								
Myriophyllum sibiricum (Common water milfoil)						1					

Appendix 6. Water depths and percent plant cover along Flood Pool Transect No. 2, 29 August 1990.

Species	Plot number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	Water depth (in.)												
	0	0	0	0	0	0	0	0	.5	0	0	0	0
Hordem jubatum (Foxtail barley)	1	3	6	1	5	3							
Panicum capillare (Witchgrass)	2		2	2	30	3							
Ambrosia artemesiifolia (Common ragweed)		15											
Sonchus uliginosus (Smooth sow-thistle)		3			2								
Echinochloa crusgalli (Barnyard grass)		1		1	1	7							
Euphorbia serpyllifolia (Thyme-leaved spurge)		1	1			5							
Salsola kali (Russian thistle)			1										
Agropyron repens (Quackgrass)			1										
Sisymbrium loeselii			1										
Aster ericoides (Many-flowered aster)					1								
Chenopodium glaucum (Pale goosefoot)						2							
Polygonum lapathifolium (Willow smartweed)						1							
Populus deltoides (Eastern cottonwood)						1							
Artemesia biennis (Biennial wormwood)						1							
Scirpus validus (Softstem bulrush)							1	3	2	1		3	
Typha spp. (Cattail)							1	1	1	2	1	1	
Eleocharis tenuis (Slender spikerush)								1	1				
Potamogeton pectinatus (Sago pondweed)										15	7	40	6
Chara spp. (Muskgrass)										1			3
Alisma triviale (Water plantain)													1

Appendix 7. Water depths and percent plant cover along Flood Pool Transect No. 3, 30 August 1990.

Species	Plot number																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Water depth (in.)																				
	0	0	1	9	13	12	12.5	8.5	5.5	6	0	0	4.5	14.5	19	19	39	18.5	17	17.5	7
Agropyron repens (Quackgrass)	7																				
Panicum capillare (Witchgrass)	5	10																			
Lycopus americanus (Cutleaf water-horehound)	1																				
Hordeum jubatum (Foxtail barley)		5																			
Helianthus rigidus (Stiff sunflower)		2																			
Artemesia biennis (Biennial wormwood)		1																			
Sonchus uliginosus (Smooth sow-thistle)		1																			
Chara spp. (Muskgrass)			7	10				1	2	2			1								
Potamogeton pectinatus (Sago pondweed)			25	20	90					10								50			50
P. pusillus (Grassleaf pondweed)			35	5		10								80	95	80	10		100		5
P. foliosus (Leafy pondweed)				5	5	5								5				20		90	
Typha spp. (Cattail)			1								1										
Alisma triviale (Water plantain)				1	1																
Scripus validus (Softstem bulrush)											1										
Eleocharis acicularis (Needle spikerush)												5									

Appendix 8. Water depths and percent plant cover along Flood Pool Transect No. 4, 30 August 1990.

Species	Plot number																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Water depth (in.)																	
	0	0	0	1	3	8.5	10	9.5	9	8.5	10.5	13.5	14.5	17	23	28	28	16
Sonchus uliginosus (Smooth sow-thistle)	2																	
Agropyron repens (Quackgrass)	10	10																
Poa pratensis (Kentucky bluegrass)	10																	
P. compressa (Canada bluegrass)	4																	
Agrostis stolonifera (Redtop)	3																	
Echinochloa crusgalli (Barnyard grass)		3																
Alisma triviale (Water plantain)		2																
Circium arvense (Canada thistle)		1	1															
Hordeum jubatum (Foxtail barley)		3																
Artemesia biennis (Biennial wormwood)		2																
Panicum capillare (Witchgrass)		3	1															
Polygonum lapathifolium (Willow smartweed)		1																
Salix exigua (Sandbar willow)		1																
Typha spp. (Cattail)			2															
Scripus validus (Softstem bulrush)			1															
Chara spp. (Muskgrass)			5	3	2	1	1		3									2
Potamogeton pusillus (Grassleaf pondweed				50	70	99	99	100	95	100	100	100	1	95	100	95	97	60
P. pectinatus (Sago pondweed)													99					10

Appendix 9. Water depths and percent plant cover along Flood Pool Transect No. 5, 30 August 1990.

Species	Plot number																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Water depth (in.)																						
	0	0	0	1	2	8	11	13.5	17.5	21.5	24	19	20	19	20.5	22	30	40	40	50	48	48	23
Agrostis stolonifera (Redtop)	1	3																					
Poa pratensis (Kentucky bluegrass)	1																						
P. compressa (Canada bluegrass)	10	2																					
Hordeum jubatum (Foxtail barley)	3																						
Panicum capillare (Witchgrass)	25	5	4																				
Agropyron repens (Quackgrass)	3	40	2																				
Artemesia biennis (Biennial wormwood)	1		5																				
Populus deltoides (Eastern cottonwood)	1																						
Sonchus uliginosus (Smooth sow-thistle)		1	3																				
Juncus spp. (Rush)		1																					
Circium arvense (Canada thistle)		1																					
Melilotus spp. (Sweet clover)		1																					
Bidens cernua (Nodding beggarticks)			1																				
Typha spp. (Cattail)			1	2																			
Chenopodium glaucum (Pale goosefoot)			1																				
C. rubrum (Red goosefoot)			1																				

Appendix 9. Continued.

	Plot number																					
	Water depth (in.)																					
	0	0	0	1	2	8	11	13.5	17.5	21.5	24	19	20	19	20.5	22	30	40	40	50	48	48	23
Polygonum lapathifolium (Willow smartweed)			1																				
Scirpus validus (Softstem bulrush)			2	1																			
Potamogeton pusillus (Grassleaf pondweed)				60	100	100	99	100	100	100	100	70	100	20	60	95				1	2	1	20
P. pectinatus (Sago pondweed)												30											70
P. foliosus (Leafy pondweed)																5	1	1	3				
Chara spp. (Muskgrass)														5									
Sagittaria latifolia (Duck potato)											1												
Alisma triviale (Water plantain)							1																

Appendix 10. Water depths and percent plant cover along Flood Pool Transect No. 6, 30 August 1990.

Species	Plot number																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Water depth (in.)																
	0	0	4	9.5	6	0	0	0	2	4	.5	0	0	0	0	1	0
Phleum pratense (Timothy)	30																
Hordeum jubatum (Foxtail barley)	1																
Poa pratensis (Kentucky bluegrass)	3																
Agropyron repens (Quackgrass)		25															
Agrostis stolonifera (Redtop)	5																
Scirpus validus (Softstem bulrush)		2	1				2					1	1	3			
Bidens cernua (Nodding beggarticks)		3															
Juncus spp. (Rush)		3															
Chara spp. (Muskgrass)			92						90	95	89			5		94	
Potamogeton pusillus (Grassleaf pondweed)			5											30			
P. pectinatus (Sago pondweed)				96													
Eleocharis acicularis (Needle spikerush)						10											
Alisma triviale (Water plantain)		4	1		1		25	45	10	5	10	30	25	5	20	3	
Sagittaria latifolia (Duck potato)							5				1		1		1	2	
Typha spp. (Cattail)		2	1									2		1	3	1	2
Scirpus atrovirens (Green bulrush)																	10

Appendix 11. Water depths and percent plant cover along Wildlife Pool Transect No. 7, 31 August 1990.

Species	Plot number																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Water depth (in.)																					
	0	0	0	0	0	0	0	0	0	0	0	0	.5	.5	.5	.5	1	1.5	1.5	1	1	2
Typha spp. (Cattail)	5	1	1		15	1		5	5													1
Calamagrostis spp. (Reedgrass)	15	20	3		2	5																
Potamogeton gramineus (Variableleaf pondweed)			5																			
Apocynum sibiricum (Indian hemp)			2																			
Aster junciformis (Rush aster)			1																			
Scirpus validus (Softstem bulrush)			10	5																		
Scirpus acutus (Hardstem bulrush)												5							5	7	30	15
Scolochloa festucacea (Whitetop)				5			20	5	5	50	15	8	20		20	20	40	30	7			
Carex atherodes (Awned sedge)							5															
C. buxbaumii (Buxbaum's sedge)						3								2	1	1						
C. lasiocarpa (Slender sedge)								2					2	2		2				5	5	
C. rostrata (Beaked sedge)				3						5												
Polygonum amphibium (Water smartweed)				1				1	1				1	1								
Drepanocladus spp. (Aquatic moss)								85	30	10												
Juncus balticus (Baltic rush)				2	5	5		2	3													
Phargmites communis (Reed)											5	6	5		4				10	7		
Chara spp. (Muskgrass)																						20
Utricularia vulgaris (Bladderwort)																						10
Juncus spp. (Rush)																						

Appendix 11. Continued.

Species	Plot number																				
	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
	Water depth (in.)																				
	2	1	1	1	0	0	.5	.5	1	.5	.5	1	1	1	.5	1	1	1	1	1	.5
Typha spp. (Cattail)					5	20	5	7													
Calamagrostis spp. (Reedgrass)																					
Potamogeton gromineus (Variableleaf pondweed)																					
Apocynum sibiricum (Indian hemp)																					
Aster junciformis (Rush aster)																					
Scirpus validus (Softstem bulrush)																					
Scirpus acutus (Hardstem bulrush)	30	30	25	15	5		6	6	35	30	35	40	40	35	25	35	40	40	40	30	20
Scolochloa festucacea (Whitetop)																					10
Carex atherodes (Awned sedge)																					
C. buxbaumii (Buxbaum's sedge)																		1		1	
C. lasiocarpa (Slender sedge)	1	2	2	5	2		5	1	6	2	10	5	5	7	8	8	12	12	15	10	
C. rostrata (Beaked sedge)																					
Polygonum amphibium (Water smartweed)	1			1							2		2				1	1			
Drepanocladus spp. (Aquatic moss)				10		70		1	5			20	20	46	38						
Juncus balticus (Baltic rush)																					
Phargmites communis (Reed)																					
Chara spp. (Muskgrass)	10	20	50			10	20	66		10											
Utricularia vulgaris (Bladderwort)	15	10		20				4	54	20	20	10	10	10	5	30	20	10	15	5	15
Juncus spp. (Rush)					10			15													

Appendix 12. Partial plant list for Burnham Creek Wildlife Management Area with emphasis on aquatic plants.

Scientific names follow Ownbey and Morley (1991) and plants are represented by specimens deposited in herbarium of University of Minnesota, Crookston. Common names follow Stewart and Kantrud (1972) and Reed (1986).

ALISMACEAE Water-Plantain Family
Sagittaria latifolia Willd. Duck-potato. Edge of Wildlife Pool (WP).
Alisma triviale Pursh. Water plantain. Edge of Flood Pool (FP).

AMARATHACEAE Amaranth Family
Amaranthus retroflexus L. Pigweed. West edge of WP.

APIACEAE Parsley Family
Zizia aurea (L.) Koch. Golden Alexander. Edge of FP.
Cicuta maculata L. Water hemlock. Edge of FP.

APOCYNACEAE Dogbane Family
Apocynum sibiricum Jacq. Indian hemp. Edge of FP.

ASCLEPIADACEAE Milkweed Family
Asclepias incarnata L. Swamp-milkweed. Low area by FP.

ASTERACEAE Sunflower Family
Rudbeckia hirta L. Black-eyed Susan. Edge of FP.
Erigeron philadelphicus L. Daisy fleabane. Edge of FP.
Aster borealis (T. & G.) Prov. Rush aster. Edge of WP/Fen.
Aster unbellatus Mill. Flat-topped white aster. Fen.
Sonchus uliginosus Bieb. Smooth sow-thistle. Edge of FP.
Bidens frondosa L. Beggar-ticks. East edge of FP.
Euthamia graminifolia (L.) Nutt. Grass-leafed goldenrod. Fen.
Aster novae-angliae L. New England aster. Edge of WP.
Bidens cernua L. Sticktight. Edge of FP.
Lactuca pulchella (Pursh) D.C. Blue lettuce. Edge of FP.
Achillea millefolium L. Common yarrow. Edge of FP.
Artemesia biennis Willd. Biennial wormwood. Edge of FP.

BRASSICACEAE Mustard Family
Berteroa incana (L.) DC. Hoary alyssum. Dry ridge, east edge of BCWMA.

CAMPANULACEAE Bluebell Family
Lobelia kalmii L. Kalm's lobelia. Fen.

CERATOPHYLLACEAE Hornwort Family
Ceratophyllum demersum L. Coontail. WP.

CHENOPODIACEAE Goosefoot Family
Chenopodium glaucum L. Oak-leaved goosefoot. East edge of FP.
C. rubrum L. Red goosefoot. East edge of FP.

CYPERACEAE Sedge Family
Eriophorum augustifolium Honck. Cottongrass. East edge of WP.

Appendix 12. Continued.

CYPERACEAE Sedge Family
Scirpus atrovirens Willd. Green bulrush. Along county ditch 140 and FP deltas.
S. validus Vahl. Softstem bulrush. Edge of FP and WP.
S. acutus Bigel Hardstem bulrush. WP.
S. torreyi Olney. Torrey's three-square Edge of FP.
Eleocharis acicularis (L.) R. & S. Needle spikerush. Edge of FP.
Eleocharis macrostachya Britt. [palustris (L.) R. & S.] Creeping spikerush. Edge of WP.
Eleocharis elliptica Kunth. [tenuis (Willd.) Schult.] Slender spikerush. South edge of FP.
Carex atherodes Spreng. Awned or slough sedge. South end of WP.
Carex rostrata Stokes. Beaked sedge. South end of WP.
Carex buxbaumii Wahlenb. Buxbaum's sedge. South & east edge of WP.
Carex virudula Michx. Greensedge. Fen.
Carex aquatilis Wahlenb. Water sedge. Up to 1 m water in WP.
C. sartwellii Dewey. Sartwell's sedge. Edge of WP.
C. lasiocarpa Ehrh. Slender sedge. East edge of WP, up to 1 m of water.

EQUISETACEAE Horestail Family
Equisetum fluviatile L. Water horsetail. Fen

FABACEAE Legume Family
Trifolium pratense L. Red clover. Edge of FP.

HALORAGACEAE Water-Milfoil Family
Myriophyllum sibiricum Komarov. [M. exalbescens Fern.] Water milfoil. FP.

IRIDACEAE Iris Family
Sisyrinchium mucronatum Michx. Blue-eyed grass. Edge of FP.

JUNCACEAE Rush Family
Juncus torreyi Cov. Torrey's rush. Edge of pools.
Juncus dudleyi Wieg. Dudley's rush. Edge of pools.
Juncus balticus Willd. Baltic rush. Edge of pools.
Juncus nodosus L. Jointed rush. East edge of FP.

JUNCAGINACEAE Arrow-Grass Family
Triglochin maritima L. Arrowgrass. Edge of WP.

LAMIACEAE Mint Family
Lycopus americanus Mulh. Cutleaf water-horehound. Moist edges of pools.
Mentha arvensis L. Wild mint. Moist edges of pools.
Stachys palustris Marsh hedgenettle. Edge of pools.
Prunella vulgaris L. Selfheal. Edge of FP.

LENTIBULARIACEAE Bladderwort Family
Utricularia vulgaris L. Bladderwort. Wildlife Pool.

LILIACEAE Lily Family
Allium stellatum Ker. Wild onion. Ridge between pools.

Appendix 12. Continued.

NAJADACEAE Naiad Family
Najas flexilis (Willd.) Rostk. & Schmidt Bushy pondweed. Flood Pool.

ONAGRACEAE Evening Primrose Family
Epilobium leptophyllum Raf. Narrow-leaved willow herb. Edge of WP.

PLANTAGINACEAE Plantain Family
Plantago eriopoda Torr. Alkali plantain. Low area by FP.

POACEAE Grass Family
Poa compressa L. Canada bluegrass. Low areas throughout.
Scolochloa festucacea (Willd.) Link Whitetop. Southerly portion of WP.
Deschampsia caespitosa (L.) Beauv. Tufted hair grass. Edge of pools.
Muhlenbergia richardsonis (Trin.) Rydb. Mat muhly. Fen.
Leerzia oryzoides (L.) Swartz Rice-cut grass. Along county ditch 140.
Echinochloa crusgalli (L.) Beauv. Barnyard grass. Edge of FP.
Spartina pectinata Link. Cord grass. Edge of WP.
Calamagrostis inexpansa Gray. Northern reedgrass. Edge of WP.
C. neglecta (Ehrh.) Gaertn. Slimstem reedgrass. Edge of WP.
C. canadenesis (Michx.) Beauv. Bluejoint. Edge of WP.

POLYGONACEAE Buckwheat Family
Rumex maritimus L. Golden dock. Edge of WP near control structure.
R. orbicalatus Gray Great water dock. Edge of FP.
Polygonum amphibium L. Water smartweed. Wildlife Pool.
Polygonum lapathifolium L. Willow smartweed. Edge of pools.
P. aviculare L. Knotweed. East edge of FP.
P. pensylvanicum L. Pinkweed. East Edge of FP.

POTAMOGETONACEAE Pondweed Family
Potamogeton gramineus L. Variable leaf pondweed. Wildlife Pool.
P. pectinatus L. Sago pondweed. Both pools.
P. pusillus L. Grassleaf pondweed. Both pools.
P. zosteriformis Fern. Flat-stem pondweed. Deeper water of FP.
P. filiformis Pers. Fine-leaved pondweed. Flood Pool.
P. natans L. Floating pondweed. S. end of FP.
P. foliosus Raf. Leafy pondweed. S. end of FP.
P. richardsonii (Benn.) Rydb. Richardson's pondweed. Flood Pool.

PRIMULACEAE Primrose Family
Lysimachia quadriflora Sims. Whorled loosestrife. Edge of FP.

RANUNCULACEAE Buttercup Family
Ranunculus sceleratus L. Cursed or blister crowfoot. Edge of FP.
Thalictrum dasycarpum Fisch. & Lall. Tall meadowrue. East edge of FP.

ROSACEAE Rose Family
Potentilla norvegica L. Rough cinquefoil. Dry ridge, east edge of BCWMA.
Potentilla fruticosa L. Shrubby cinquefoil. Fen.

Appendix 12. Continued.

SALICACEAE Willow Family
Salix exigua Nutt. [S. interior Rowlee] Sandbar willow. Edge of FP.
S. amygdaloides Anderss. Peach-leaved willow. Edge of FP.

SAXIFRAGACEAE Saxifrage Family
Parnassia palustris L. Grass of Parnassus. Fen.

SPARGANIACEAE Bur-Reed Family
Sparganium eurycarpum Engelm. Giant bur-reed. Edge of FP.

ZANNICHELLIACEAE Horned Pondweed Family
Zannichellia palustris L. Horned pondweed. Wildlife Pool.

Appendix 13. Data sheet for bird observations at Burnham Creek Wildlife Management Area.

General weather conditions:_____ Date:_____ Time:_____

_____ Temp:_____ Wind:_____

_____ Field Workers:_____

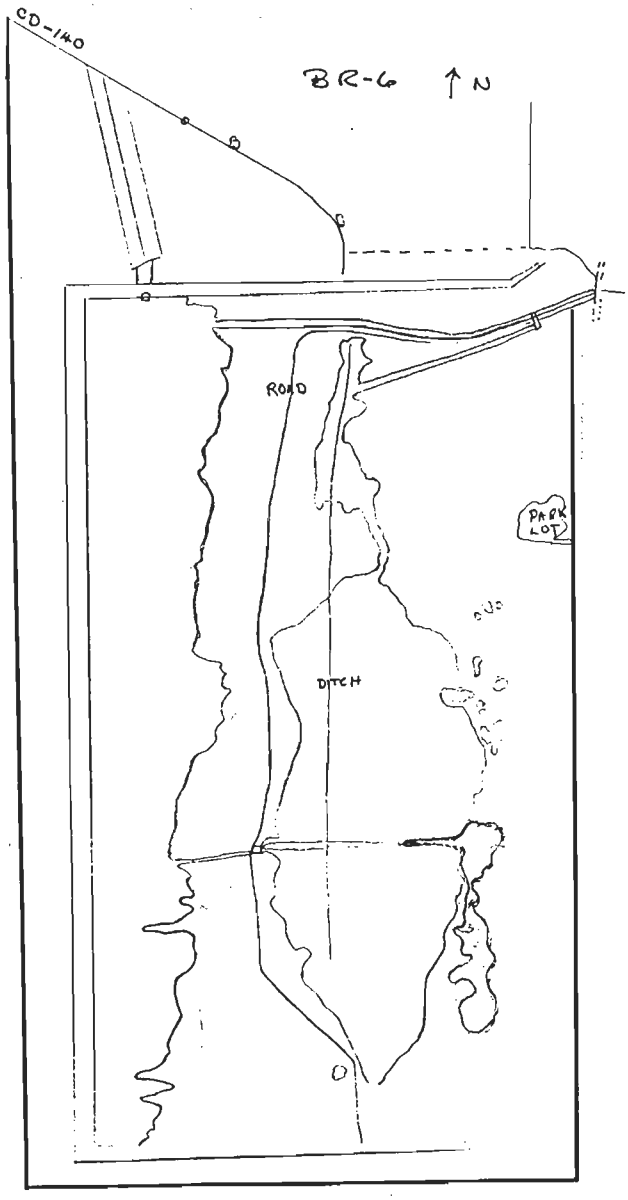
BIRD SPECIES, NUMBERS, AND LOCATION

Storage Pool

Level:_____

Wildlife Pool

Level:_____



Appendix 14. Bird species accounts, Burnham Creek Wildlife Management Area, 1990 and 1991.

The following section summarizes observations for individual bird species observed on or very near the study area from March through November of 1990 and 1991. Spring and fall occurrences of non-nesting migratory species are bracketed by "extreme" dates with "peaks" noted if any were suggested. Early and late "extreme" dates are noted for summer resident species. Species for which good evidence (territorial advertisement, carrying food, presence of nest, observation of flightless young) was obtained indicating nesting are marked with *. For those species observed very infrequently (<8 occasions), specific dates and numbers are indicated. Species which live year-round in the area are identified as "resident."

Common Loon (Gavia immer)
Three records: Single birds on 22 April and 23 July in 1990 and 28 July in 1991. North end of Flood Pool (FP), apparently feeding on minnows in deeper water.

Western Grebe (Aechmophorus occidentalis)
Two records: 22 June (5) in 1990 and on 10 July (1) in 1991. Observed swimming and diving in the north half of the FP.

Red-necked Grebe (Podiceps grisegena)
Single birds was observed on 16 and 25 May 1990. In 1991, 1 was observed on 24 June, 5 on 8 July, 2 on 9 July, 4 on 10 July and 2 on 15 July. All birds were adults and were foraging in the northern half of the FP.

Horned Grebe (Podiceps auritus)
None observed in 1990 but 3 on 1 May and 2 on 16 September during 1991; all in the northern half of the FP.

Eared Grebe (Podiceps nigricollis)
Suspected to have nested in a whitetop area of the Wildlife Pool (WP) in 1989. In 1990, 2 were observed on 1 and 2 May, 4 on 10 May, 5 on 23 May, 2 on 7 June and 3 on 22 June; all in the FP. In 1991, a pair was seen on 28 May, and 3, 16, and 26 June; all in the FP. Although adults were observed during the nesting season both years we didn't observe nests or young.

*Pied-billed Grebe (Podilymbus podiceps)
Extremes: 22 April - 15 October in 1990 and 1 May - 11 September in 1991. Three nests were located in 1990 and at least 7 nests were present in 1991. The mean clutch size in 1991 for 7 nests was 7.9 with a range of 5-12. The earliest clutch initiation date was 24 May 1991. Probably 3 of the 7 nests contained at least 1 hatched egg with a minimum of 4 young fledged in 1991. Nests were in cattail, bulrush, and whitetop areas of the WP but foraging was commonly observed in the northern half of the FP.

American White Pelican (Pelecanus erythrorhynchos)
Two records: A flock of 57 were resting off a sandy spit in the south portion of the FP on 3 August 1990 and 11 were resting in the Delta 2 area of the FP on 16 May 1991.

Double-crested Cormorant (Phalacrocorax auritus)
Extremes: 25 April - 25 September in 1990 and 1 May - 18 October in 1991. A total of 220 birds were observed on 23 days in 1990 compared to 55 birds on 12 days in 1991. The number of census visits was similar each year suggesting a decrease in birds using the area between years. A total of 20 or more birds were observed on each of 5 days in 1990. Birds were usually foraging in or resting along a bare shoreline of the FP but a few observations were made in the old drainage ditch of the WP.

Great Egret (Casmerodius albus)
Nine records: 20 April (1) and 23 May (1) in 1990. 6 August (1), 20 August (6), 21 August (2), 4 September (1), 16 September (2), 2 October (1) and 7 October (1) in 1991. Birds were generally feeding along the east edge of the FP, particularly the Delta 1 area.

Snowy Egret (Leucophoyx thula)
One record: 2 birds were observed in the extreme southeast corner of the FP on 1 August 1990, foraging in 15-20 cm water.

Great Blue Heron (Heron herodias)
Extremes: 3 April - 15 October in 1990. 9 June - 7 October in 1991.
Peaks: 1 August (5) and 13 September (6) in 1990. 2 August (5) and 7 September (5) in 1991. Birds were observed around all edges of the FP and also foraged along the WP edge and Inlet and Outlet Channels.

Black-crowned Night Heron (Nycticorax nycticorax)
Two records: Lone bird flying over WP on 4 June 1990 and a lone bird flushed from the WP Inlet Channel on 28 May 1991.

*American Bittern (Botaurus lentiginosus)
Extremes: 16 May - 30 August in 1990. 16 May - 11 September in 1991. Birds were generally observed along the east edge of the FP and the edge of the WP, particularly in the northern portion. It was believed the high leopard frog population was a definite benefit to American Bitterns. Three nests were located in 1990 and 4 in 1991; all but 1 in upland sites. Four of the 7 nests hatched and a total of 14 young could have fledged during the 2 years.

*Least Bittern (Ixobrychus exilis)
Due to their secretive nature, it is unknown when birds arrived on the study area but a nest with 5 eggs was observed in the center of the bulrush portion of the WP on 22 June 1990. The nest was positioned in dense hardstem bulrush about .3 m above water .6 m deep. By 2 July it had been partially destroyed and abandoned. An adult was heard vocalizing at the north end of the bulrush marsh on 26 June 1990. An adult was flushed from the channel leading from the WP Outlet Structure to the FP on 28 June 1991 during cable-dragging. On 1 July 1991 an adult was flushed from the center of the bulrush marsh near the nest site of 1990.

Tundra Swan (Cygnus columbianus)
Extremes: 31 March - 2 May and 1 fall observation, 17 November in 1990. 1 April - 24 April and 18 October - 31 October in 1991.
Peaks: 8 April (200) and 17 November (17) in 1990. 6 April (100) and 23

October (50) in 1991. A lone swan, possibly a Trumpeter Swan, was observed on 25 May and 14 and 20 June 1990. Another lone swan was observed once on 21 May 1991. Swans were observed only in the FP and commonly when it was partially ice covered. They typically fed in nearby corn stubble fields and on tubers in the FP.

Canada Goose (Branta canadensis)
Extremes: 12 March - 14 June and 13 September - 7 November in 1990. 19 March - 18 June and 4 September - 31 October in 1991.
Peaks: 13 April (2500) and 8 October (680) in 1990. 6 April (3000) and 31 October (3500) in 1991. Generally the main migration had moved through by mid-April but 15-20 birds were observed occasionally until mid-June. The FP and its bare, gravelly east shoreline were used for resting but birds would feed on nearby harvested corn and small grain fields during the day. Occasionally smaller groups (<10) would fly from the WP but no nesting attempts were documented. A collared (white numbers on red collar) bird was observed on 2 April 1991 which had been marked 20 July 1990 as an adult female near Churchill, Manitoba. On 31 October 1991, at least 5 birds were observed with orange collars and white numbers but it was not possible to read the numbers. On 25 March 1992, 3 collared geese were observed resting with a flock just west of the dike in a corn field with standing water. The following data were obtained from the U.S. Fish and Wildlife Service: Number 60RY was marked as an adult female near Hudson's Bay Manitoba on 23 July 1990 and was also sighted at the Swan Lake National Wildlife Refuge in northwest Missouri. Number 27H7 was marked as an adult female near the Cape of Churchill, Manitoba on 20 July 1991. Number P4A8 was banded at Swan Lake National Wildlife Refuge on 17 October 1991 and later observed 4 times there. The study area is on the migratory route of the "Eastern Prairie Population" of Canada Geese which breed near Hudson's Bay, Manitoba and winter primarily at the Swan Lake National Wildlife Refuge in northwest Missouri (Fig. 10).

Greater White-fronted Goose (Anser albifrons)
Four records: 2-3 birds were observed with Canada Geese from 31 March to 6 April 1990 in the FP.

Snow Goose (Chen caerulescens)
Extremes: 13 April - 31 May and 17 September - 23 October in 1990. Only 1 observed in the spring of 1991 (20 May) but 800-1000 during 23-31 October.
Peaks: 19 and 30 April (250) and 23 October (150) in 1990. 23 October (1000) 1991. Snow geese used the FP for resting and nearby grain fields for feeding.

*Mallard (Anas platyrhynchos)
Extremes: 30 March - 24 November in 1990 and 24 March - 31 October in 1991.
Peaks: 6 April (6,000), 20 June (molt migration of 700, mostly males), and 21 October (4,000) in 1990. 20 April (2,400), 9 June (600), and 18 October (5,000) in 1991. Four nests were discovered in 1990. Of these, 2 were destroyed by predators, 1 abandoned during egg-laying and one abandoned due to high water. Two broods were hatched from undiscovered nests in 1990 and likely fledged 1 and 8 ducklings. Two successful nests were found in 1991 and at least 3 broods were observed on the FP on 23 June 1991. One female was with an adult-size young, another with 11, 4/5 grown young and the other with 6, 1/3 grown young.

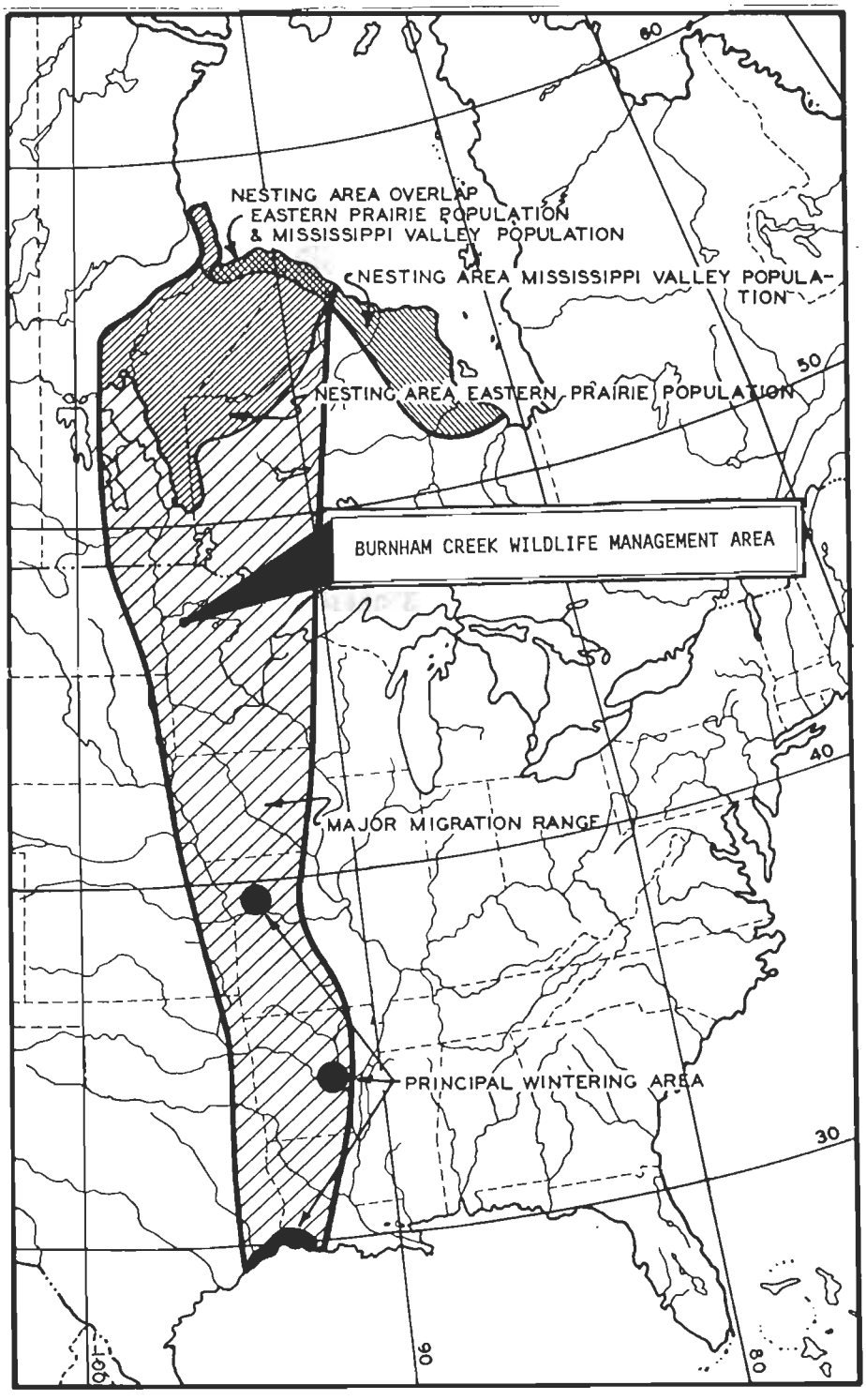


Fig. 10. Location of Burnham Creek Wildlife Management Area with respect to the migratory route of the Eastern Prairie Population of Canada geese. (Adapted from Vaught and Kirsch 1966).

American Black Duck (Anas rubripes)
One record: 1 observed on 17 September 1990 in the FP.

*Northern Pintail (Anas acuta)
Extremes: 31 March - 31 May and 14 August - 17 September in 1990. 3 April - 10 May and 7 - 23 October in 1991.
Peaks: 6 April (500) and 13 September (50) in 1990. 13 May (250) and 23 October (100) in 1991. Although pairs were observed both years, no nests or broods were observed. However, on 27 June 1991 a ¼ adult-size duckling was found at an active mink den near the old drainage ditch at the northwest corner of the WP indicating successful nesting. Most sightings were made in the FP but adults fed in nearby grain fields.

Gadwall (Anas strepera)
Seven records: 13 April (2), 29 May (1) and 24 September (1) in 1990. 20 April (50), 10 May (2), 26 June (2) and 19 July (5) in 1991. All observations were made in the FP.

American Wigeon (Anas americana)
Extremes: 4 April - 16 October in 1990 and 2 April - 22 September in 1991.
Peaks: 22 April (40) and 13 September (75) in 1990. 13 April (500) and 22 September (10) in 1991. Most (90%) observations were made in the FP with the remainder made in the WP.

*Northern Shoveler (Spatula clypeata)
Extremes: 9 April - 30 August in 1990. 13 April - 23 October in 1991.
Peaks: 22 April (30) in 1990 and 13 April (100) in 1991. Nesting was not documented in 1990 although a nest was found in 1991 which was later depredated. On 22 July 1991 a brood of 1 approximately 10-day-old duckling was observed. Shovelers were observed in the WP much more than the FP.

*Blue-winged Teal (Anas discors)
Extremes: 8 April - 16 October in 1990. 3 April - 7 September 1991.
Peaks: 30 April (50) and 29 August (310) in 1990. 4 April (250) and 7 September (100) in 1991. Five nests were located in 1990 but all were unsuccessful. No broods from undiscovered nests were observed in 1990. In 1991, 23 nests were found with 14 of these successfully hatching. Broods used the WP as well as the emergent vegetation edge of the FP.

Green-winged Teal (Anas crecca)
Extremes: 31 March - 12 May and 13 September - 16 October in 1990. 3 April - 14 May and 21 August - 23 October in 1991.
Peaks: 19 April (100) and 17 September (121) in 1990. 5 April (200) and 2 September (125) in 1991. From 2-10 adults were observed occasionally during the summer of both years. Most observations were made in the FP and commonly in the company of Blue-winged Teal.

Wood Duck (Aix sponsa)
Extremes: 19 April - 13 September in 1990. 20 May - 8 August 1991.
Generally wood ducks were observed in small numbers (<10) with a high count of 30 on 21 May 1991. Observations were made along the east edge of the FP or

along the brushy east edge of the WP. No cavities suitable for nesting or nest boxes were present on the study area.

Redhead (Aythya americana)
Eight records: 8 April (2), 19 April (2), and 20 April (5) in 1990. 3 April (35), 5 April (50), 28 May (10), 9 July (1), and 31 October (100) in 1991. All observations were in the FP.

*Canvasback (Aythya valisineria)
Extremes: 8 April - 16 October in 1990. 3 April - 22 September in 1991.
Peaks: 13 April (20) and 15 October (21) in 1990. 3 April (10) in 1991.

In 1990, a single nest was found in a dense bulrush area of the WP. It was destroyed near hatching time, probably by a mink. In 1991, an estimated 8 canvasback females nested on the study area. Six nests were located during the study and 2 females with broods were seen for which no nest was located. The 6 known nests all occurred in approximately 1 m of water within bulrush or cattail stands in the WP. Five of the 6 nest platforms consisted primarily of bulrush. The other nest was constructed primarily of cattail. Based on hatch dates, clutches were initiated from 6 May through 21 June. Clutch size ranged from 6 to 9 eggs with a mean of 7.3 (s.d.=1.21). One 6-egg clutch contained a probable parasitic egg. An infertile sixth egg appeared in the nest at least 7 days after a clutch size of 5 had been reached.

Four of these nests hatched and adult females with appropriately aged ducklings were subsequently seen in the FP. A fifth female was killed on the nest platform during hatch. Four of 6 eggs were starred on 16 June. On 24 June the nest platform contained remains of an adult female, 2 intact eggs (including a rotten, parasitic egg) and hatch-like shell fragments of 3 eggs. In the sixth nest, remains of 3 Yellow-headed Blackbird chicks were found among the Canvasback eggs, probably the remains of a mink kill. The nest failed apparently due to abandonment by the female. However, we do not know if the female abandoned the nest before or after this disturbance.

Four females with broods at ages consistent with known hatches were observed in the FP on several dates. Assuming that we correctly associated broods with known nests and that broods remained together, we were able to observe duckling survivorship. A female hatched 8 of 9 eggs on 6 June. On 15 July the brood consisted of 3 ducklings and remained at 3 through 1 August when regular observations ended. A second female hatched 8 eggs on approximately 10 June and had a brood of 6 on 19 July. The brood consisted of 4 ducklings on 23 July and remained at 4 through 1 August. A third female hatched 7 of 8 eggs on 12 June, had 5 ducklings on 23 July, and 4 on 29 July. A fourth female hatched 7 eggs on 19 July, had 7 ducklings on 22 July, and 5 on 29 July and 1 August. The overall mean number of ducklings lost per day was .11 (s.d.=0.63). However, the rate of loss was not linear, with very young ducklings disappearing at a greater rate than older ducklings.

Two female Canvasbacks with broods that did not correlate with any known nests were seen once each during the study period. A female with a brood of 12 small ducklings was seen on 19 July in the FP. On 23 July, a female with a single duckling nearly adult-sized was seen. The fate of these broods is unknown.

Ring-necked Duck (Aythya collaris)
Extremes: 8 April - 30 April and 25 September - 16 October in 1990. 26 March - 9 May and 22 September - 2 October in 1991.
Peaks: 9 and 19 April (50) and 16 October (50) in 1990. 3 April (95) in 1991. All observations made in FP.

"Scaup"
Probably >90% of the scaup observed were Lesser Scaup (Aythya affinis), however, Greater Scaup (Aythya marila) were also observed. They are grouped due to the difficulty of positive identification under low light and/or long distance viewing.
Extremes: 30 March - 12 May and 15 October - 7 November in 1990. 26 March - 21 May and 23 October - 31 October in 1991.
Peaks: 13 April (250) and 16 October (200) in 1990. 5 April (1,500) and 31 October (100) in 1991. All observations made in FP.

Common Goldeneye (Bucephala clangula)
Four records: 13 April (5) and 19 April (2) in 1990. 26 March (4) and 2 April (10) in 1991. All observations made in FP.

Bufflehead (Bucephala albeola)
Extremes: 31 March - 16 May in 1990 with no fall observations. 2 April - 16 May and 18 - 31 October in 1991.
Peaks: Four or less birds were observed per count in 1990 but 50 were observed on 20 April and 20 on 31 October in 1991. All observations made in FP.

*Ruddy Duck (Oxyura jamaicensis)
Extremes: 25 April - 24 September in 1990. 1 May - 22 July in 1991. No more than 13 were observed on any count (27 April 1990) in the FP but more were likely present in the WP where nesting occurred. No nests or broods were observed in 1990 although a nest remnant from an earlier year was found. Seven nests were located in 1991 when nests were initiated from 3 June to as late as 21 July. Nests were located in dense residual bulrush stands and were constructed of bulrush over water that was .75 m deep. Four completed clutches contained 11, 11, 10, and 9 eggs ($\bar{x}$=10.3). Six nests were depredated or flooded with the remaining nest depredated during hatching. The breast skin and feathers of a duckling, 2 intact eggs, and shell fragments of 6 or 7 eggs were in the nest and it is unknown if any ducklings survived. No broods were observed.

Common Merganser (Mergus merganser)
Extremes: 31 March - 31 May in 1990. 26 March - 16 May in 1991. No fall observations.
Peaks: 8 April 1990 (100) and 13 May 1991 (100). Generally around 15 birds observed in the southern half of the FP either foraging or resting along the east edge.

Hooded Merganser (Lophodytes cucullatus)
Six records: 13 April (2), 28 June (1), and 15 October (4) in 1990. 13 June (1), 16 September (1) and 23 October (3) in 1991. All observations made in the FP.

Turkey Vulture (Cathartes aura)
One record: 28 May 1991. A single bird was observed soaring over the north end of the study area.

Cooper's Hawk (Accipiter cooperii)
One record: 4 September 1991. Bird observed near north end of FP.

*Northern Harrier (Circus cyaneus)
Extremes: 30 March - 25 September 1990. 26 March - 11 September 1991. From 1-4 Harriers were observed sporatically on census days during 1990. A nest was discovered during egg laying on 13 June 1990 when it contained 4 eggs. On 20 June it contained 6 eggs but had been depredated by 6 July. Generally fewer harriers were observed in 1991 but 6 were recorded on 11 September 1991. While nest searching the WP in 1990, we found the remains of a Harrier nest from a previous year covered by 0.3 m of water. The fate of this nest could not be determined.

Red-tailed Hawk (Buteo jamaicensis)
Regularly observed soaring over the study area from late March through the field season during both years.

Swainson's Hawk (Buteo swainsoni)
Regularly observed during the 1991 field season 1 km south of the study area and likely hunted the study area.

Bald Eagle (Haliaeetus leucocephalus)
Three records: An adult flew over the study area heading south on 13 September 1990. An immature was observed feeding on a dead bird on 29 October 1990. On 31 October 1991 an immature was perched in a dead aspen along the east edge of the study area, when approximately 8,000 waterfowl were present on the FP.

Prairie Falcon (Falco mexicanus)
One record: 16 May 1991. Observed sitting on a large rock pile at the south-west corner of the study area.

American Kestrel (Falco sparverius)
First observed on 27 March in 1990 and 26 March in 1991, then observed sporatically throughout the field season. Suitable nesting cavities or nest boxes were not available on the study area.

Ring-necked Pheasant (Phasianus colchicus)
One record: 19 March 1990.

*Gray Partridge (Perdix perdix)
Resident. Observed most commonly around the edge of the study area particularly in March and April before adjacent crops were planted and provided cover. Three pairs were flushed along the east edge of the study area while cable-dragging on 29 May 1991. No nests were found but they probably nested on or near the study area.

*Greater Prairie-Chicken (Tympanuchus cupido pinnatus)
Resident. A booming ground with 6 males was located 300 m east of the southeast corner of the study area in 1990 and a ground with 16 males was located 200 m west of the northwest corner of the study area in 1991. A 2- to 3-day old brood was found on the east-west dike along the south edge of the FP on 15 June 1990 while cable-dragging. On 29 May 1991 a nest with 7 eggs was found 200 m south of the WP Inlet Structure in quackgrass/smooth brome cover. It was likely depredated by a fox. On 26 June 1991, 2, 30-day-old broods were flushed in a native grass planting along the northwest edge of the study area. The cover had been burned on 9 April 1991 and contained a vigorous mixture of legumes and grass, open at ground level, and with abundant insects; the ingredients of good prairie-chicken brood habitat. Other incidental prairie chicken flushes were mostly along the edges of the study area; never in the interior portion.

*Virginia Rail (Rallus limicola)
The precise arrival date is unknown but a nest was found along the edge of the WP on 22 June 1990 in a dense stand of hardstem bulrush, cattail, and sedge. The nest was positioned 25 cm above water which was 27 cm deep and contained 9 eggs on 28 June. An adult was on the nest on 2 July but was not disturbed. The nest was empty on 6 July when an adult was calling nearby, suggesting that young were present. No nests were found in 1991 but adults were heard from early June to mid-July. Seven adults were flushed from seep areas containing 2-10 cm of water during cable-dragging on 25-26 June 1991. Rails (Virgina and Sora) were not observed in these areas in 1990 when conditions were dryer and little standing water was present.

*Sora (Porzana carolina)
Four Soras were observed on 16 May 1991 and probably arrived on the study area around mid-May both years. Eight nests were found in 1990 with at least 4 of them successfully producing young. Only 1 nest was found in 1991. The mean completed clutch size for 8 nests was 10.8 with a range of 8-13. The approximate date when egg laying commenced was 6 June. Nests were typically located 30 cm above water about 25 cm deep and 5-10 m in from the east edge of the WP. Nests were usually constructed of fine-leaved sedges which were also used to form a ramp leading down to the water and somewhat of an over-topping dome partially concealing the nest. One nest was located in cattails and constructed of cattail leaves. It is unknown why only 1 nest was found in 1991 compared to 8 in 1990. However, water levels were higher in 1991 and much of the fine-leaved vegetation, apparently preferred for nesting habitat in 1990, had been flooded out. Ten Soras were flushed from upland seep areas with 2-10 cm of water while cable-dragging on 26 June 1991 but no nests were found. It is possible that nesting was undetected in some of these upland sites or that birds nested in dense cattail borders of the pools in 1991.

*American Coot (Fulica americana)
Extremes: 25 April - 15 October in 1990 and 11 April - 31 October 1991. Egg laying commenced around mid-June in 1990 and 5 completed clutches contained a mean of 11 eggs (range 10-12). Nests were established in bulrush and cattail stands where water depths were about 0.5-1 m deep. Most nests were located in the WP, but 2 nests were located in the WP Inlet Channel in 1991. A total of 6 nests were found in 1990 and 47 in 1991. Higher water levels occurred earlier in 1991 and likely increased nesting. Apparent nest success was 33.3%

in 1990 and at least 46.8% in 1991 but not all nests were relocated. In 1991, mink were known to prey on coot eggs and chicks as 26 upper mandibles from coot chicks along with shell fragments were found in mink scats.

Whooping Crane (Grus americana)
On 21 October 1990 a single bird was observed in the company of about 5,000 Sandhill Cranes as they flew into the FP to roost. It stayed with the Sandhill Cranes as they fed in surrounding fields, returning to the FP to roost. It was last observed on 28 October. Apparently the same bird had been sighted on 11 October 1990 near the Agassiz National Wildlife Refuge located 100 km to the north.

*Sandhill Crane (Grus canadensis)
Extremes: 4 April - 7 November in 1990. 26 March - 31 October in 1991. Peaks: 13 April (4,000) and 21 October (5,000) in 1990. 14 April (5,000) and 7 September (1,700) in 1991. The general area around the study area has been a traditional fall and spring crane staging area for at least 20 years. There are few roads and dwellings, and large stubble fields provide waste grain (particularly corn) for feeding. The construction of the impoundment provided an attractive roosting site, particularly in the fall of 1990. Birds favored a 0.3 m deep area along the east edge of the northerly portion of the FP for roosting. In the fall of 1991, birds had apparently shifted roosting activities to the Dugdale Wildlife Management located 3 km to the east. Nesting was recorded during the late 1970's and 1980's in the bulrush marsh located 1 km to the north on the Pembina Trail Preserve. On 21 May 1991, 2 adults and 1 young (less than 1 week, probably 1-3 days old) were observed in the southerly portion of the bulrush marsh of the WP. They were moving to the south. A few hours later 2 adults and 2 young were observed 1 km south of the earlier observation and were likely the same birds; assuming that 1 young was missed earlier. A crane-like nest pile was later found about 100 m from the WP sighting. It is likely that 2 young were produced on the study area in 1991.

Black-bellied Plover (Pluvialis squatarola)
Two records: 16 May and 22 May, 1991. On 16 May, 8 birds were with Lesser Golden Plovers in planted native grassland in the north portion of the study area, north of the dike. On 22 May, 3 birds were along the east edge of the FP in moist grassland. Both areas had been burned 9 April 1991.

Lesser Golden-Plover (Pluvialis dominica)
Four records: 23 May (3), 29 May (3), and 31 May (15) in 1990 and 16 May (40) in 1991. Sightings in 1990 were along the east edge of the FP, and in 1991 they were feeding in a spring-burned, planted grassland with Black-bellied Plovers.

Semipalmated Plover (Charadrius semipalmatus)
Seven records: 13 April (5), 19 April (1), 26 April (1), 27 April (5), 23 May (1) and 30 August (1) in 1990 and 22 May (1) in 1991. All sightings were along the open, east shoreline of the FP.

*Killdeer (Charadrius vociferus)
Extremes: 31 March - 1 October 1990. 19 March - 1 October 1991. Killdeer were relatively common throughout the summer along the open gravelly eastern edge of the FP. Probably 3-5 pairs nested there each year. In 1991, a nest scrape was found in the former construction parking lot along the northeast edge of the study area.

Greater Yellowlegs (Tringa melanoleucas)
Extremes: 20 April - 16 May and 2 July - 15 October in 1990. 4 April - 22 May and 18 June - 18 October in 1991.
Peaks: 10 May (6) and 14 August (40) in 1990 and 14 April (3) and 29 August (6) in 1991. Birds typically foraged in water 5-15 cm along all edges of the FP but mostly in the delta areas along the east edge. One bird was observed to feed on a small minnow.

Lesser Yellowlegs (Tringa flavipes)
Extremes: 20 April - 2 May and 2 July - 15 October in 1990. 5 April - 1 May and 20 August - 4 September in 1991.
Peaks: 20 April (5) and 30 August (13) in 1990 and 5 April (3) and 29 August (5) in 1991. Usually feeding in the company of Greater Yellowlegs in water less than 6 cm along the east edge of the FP.

Solitary Sandpiper (Tringa solitaria)
One record: Five were observed feeding in the Delta-1 area at the north end of the FP on 22 August 1991.

Willet (Catoptrophorus semipalmatus)
Five records: 25 April (1) in 1990 and 16 May (1), 22 May (2), 29 May (1) and 5 June (1) in 1991. Generally observed feeding in the Delta-2 area of the FP and often in the company of Marbled Godwits. A Willet actively scolded an observer near the Delta-2 area on 5 June 1991 but no nest was found.

*Spotted Sandpiper (Actitus macularia)
Extremes: 4 June - 31 August in 1990 and 1 May - 20 August in 1991.
Peaks: 1 August (7) in 1990 and 1 May (8) in 1991. All observations made along the bare shoreline of the FP particularly the southern portion. A 3/4 adult-size chick was photographed along the water side of the south, east-west dike on 1 August 1990.

Upland Sandpiper (Bartramia longicauda)
Extremes: 25 April - 11 July in 1990. Generally observed in shorter cover areas around the periphery of the study area. A young brood was observed on 11 July 1990 during the cable-dragging of a strip of native prairie in the northwest corner of the study area. A nest was discovered in this area on 30 May 1991. One infertile egg remained on 18 June and 3 eggs were presumed to have hatched. On 27 June 1991 an adult with a 1-week-old chick was observed 3.2 km southwest of the study area along a township road.

Marbled Godwit (Limnosa fedoa)
Extremes: 13 April - 11 July, 1990 and 16 May - 16 June 1991.
Peaks: 23 May (5), 4 and 7 June (5) in 1990, and 29 June (14) in 1991. Birds were usually observed feeding in the Delta 2 area of the FP, in water less than 6 cm deep. They also fed and rested on the adjacent shoreline where the vegetation was <10 cm and the topsoil was saturated.

Hudsonian Godwit (Limosa haemastica)
One record: 23 May 1990.
Observed along east edge of FP with Marbled Godwits.

Ruddy Turnstone (Arenaria interpres)
Single record: 28 May 1991. A lone bird flew out of the FP.

Semipalmated Sandpiper (Calidris pusilla)
Four records: 29 August (6), 30 August (6), and 31 August (5) in 1990 and 5 June (15) in 1991. All observations along the open sandy shoreline of the east edge of the FP.

Least Sandpiper (Calidris minutilla)
Extremes: 21 May (only 1 spring observation) and 10 July - 31 August 1990.
Peak ?: A total of 30 were observed spread out along the east edge of the FP in on 10 July 1990. High water in the Flood Pool in 1991 reduced shallow water areas preferred by shorebirds but standing water areas in adjacent cropland was used. A flock of 20 was observed in an adjacent corn field on the west of the study area 15 July 1991. On 23 July 1991 a lone bird was observed along the east edge of the FP.

White-rumped Sandpiper (Calidris fuscicollis)
Two records: 4 June (15) in 1990 and 5 June (1) in 1991.
Both observations along east edge of FP just south of Delta 2 area.

Baird's Sandpiper (Calidris bairdii)
Two records: 30 August (12) and 31 August (10) in 1990.
Observations were made along sandy shoreline of the east edge of FP where birds were feeding on maggots washing ashore from a dead moose.

"Peep Sandpipers"
Species identification uncertain but probably Least, Semipalmated, Baird's and/or White-rumped Sandpipers.
Birds observed on 2 May (8), 16 May (3), 7 June (6) and 7 August (10) in 1990 feeding and/or flying along sandy shoreline of east edge of FP.

Pectoral Sandpiper (Calidris melanotos)
Four records: 29 August (6), 30 August (6) and 31 August (5) in 1990 and 4 September (1) in 1991.
Observations in 1990 were associated with feeding on maggots from a dead moose along the east shoreline of FP. Observation in 1991 near Delta-2.

Dunlin (Calidris alpina)
Five records: 20 May (8), 21 May (6), 23 May (1), 31 May (8) and 4 June (15) of 1990. All observations along the sandy eastern edge of the FP.

Stilt Sandpiper (Calidris himantopus)
Three records: 27 July (1) and 3 August (2) in 1990. 4 September (7) in 1991. All observations near Delta 2 along east edge of FP in 8-10 cm deep water.

Long-billed Dowitcher (Limnodromus scolopaceus)
Three records: 20 May (1) and 21 May (1) in 1990 and 22 May (1) in 1991.
Observed feeding in 2-6 cm water along east edge of FP in southern portion.

"Fall Dowitchers"
Either long-billed or short-billed but lumped here due to the difficulty in distinguished birds in basic plumage.
Three records: 2 July (4) and 10 July (12) in 1990 and 15 July (15) in 1991.
Birds in 1990 were along eastern edge of FP and 1991 birds were feeding in a flooded corn field along the west edge of the study area.

*Common Snipe (Gallinago gallinago)
Extremes: 9 April - 17 September in 1990 and 16 May - 23 July in 1991.
Snipe were primarily observed along the edges of the Wildlife Pool with 1-3 cm of standing water, particularly in the northerly portion. Aerial courtship displays by 2-3 males were common both years through early June. After July birds were occasionally flushed along the east edge of the FP with 17 flushed on 23 July 1991. These were probably birds moving in from other areas rather than on-site reproduction.

American Woodcock (Scolopax minor)
One record: 1 May 1990
While only one sighting was recorded, this species is probably present on a regular basis along the brushy fen area on the east edge of the WP. They have been reported to breed on the Pembina Trail Preserve to the north and are common in the fall on the Burnham Wildlife Management Area located 1.2 km south of the study area.

*Wilson's Phalarope (Phalaropus tricolor)
Extremes: 16 May - 25 July in 1990 and 16 May - 8 July in 1991.
Maximum numbers of adults were noted on 31 May (20) and 7 June (20) in 1990 and 22 May (5) in 1991. Most feeding observations were near the Delta-2 portion of the FP. All nests were within 100 m of the channel leading from the WP Outlet Structure to the FP.

Table 12. Wilson's phalarope nesting data, Burnham Creek Wildlife Management Area, 1990 and 1991.

Initiation date	Habitat	Nest fate
16 May 1990	5 cm grassy cover in between tracks of interior road	Depredated. Skunk?
11 June 1990	18 cm grassy cover in seep area	Probably hatched
6 June 1990	5 cm grassy cover near seep area	Depredated.
27 May 1991	17 cm smooth brome regrowth following 8 April burn	Depredated.

A male was flushed while cable-dragging on 15 June 1991 from an area of brome regrowth that was typical nesting habitat. Although the behavior of the male suggested the presence of a nest, none was ever found. On 8 July 1991 an adult male was performing chick-guarding behavior near the Delta-2 area suggesting an additional, and successful, nest which we had not found.

Red-necked Phalarope (Phalaropus lobatus)
Two records: One (female) on 28 May and 2 on 11 September 1991. Both observations near the Delta-2 area of FP.

Herring Gull (Larus argentatus)
Two records: 31 March and 29 May in 1990.
Observed along east edge of FP near Delta-2.

Ring-billed Gull (Larus delawarensis)
Extremes: 8 April - 7 November in 1990 and 3 April - 4 September in 1991. A maximum of 28 was observed on 10 June 1990 and 25 on 3 June 1991. More were observed in 1990 with a total of 170 observed on 26 days compared to 60 observed on 6 days in 1991.

Franklin's Gull (Larus pipixcan)
Extremes: 13 April - 21 May in 1990 and 1 May - 4 September in 1991.
In 1990, 60 birds were observed on 9 days and 82 on 4 days in 1991. Birds observed either flying over or resting on the bare eastern shoreline of the FP.

Bonaparte's Gull (Larus philadelphia)
Two records: 1 May (6) and 16 May (10) in 1991.
Birds observed along eastern edge of FP.

Caspian Tern (Sterna caspia)
Two records: 25 July (10) in 1990 and 16 May (5) in 1991.
Observed resting along east edge of FP.

Common Tern (Sterna hirundo)
A lone bird observed on 22 April then 2-12 birds seen on 6 days from 10 June - 25 July in 1990. Three records in 1991; 18 June (6), 24 June (1) and 3 July (1). Birds foraged in the FP and rested along the bare shoreline of the east edge.

Forster's Tern (Sterna forsteri)
Two records: 7 July (2) and 8 July (16) in 1991
Birds foraged in the FP and rested on bare shoreline along the east edge.

*Black Tern (Childonias niger)
Extremes: 16 May - 7 August in 1990 and 16 May - 7 August in 1991.
Nesting occurred in the eastern portion of the WP where there was an equal proportion of open water and emergent vegetation. Ten nests were found in 1990 and 26 in 1991. Early WP water levels were considerably lower in 1990 compared to 1991 and nesting was delayed about 3 weeks until late May rains resulted in 0.3-0.6 m water levels in the nesting area. Nesting success was low in 1990 but 3-4 young were produced. In 1991, 40 breeding adults produced at least 7 young even after a strong storm was believed to have destroyed 60% of the active nests. Although adults nested only in the WP, they fed regularly on minnows in the FP and took young there after fledging. Young rested on exposed rocks and bare shorelines in the southern portion of the FP, along the east edge.

*Mourning Dove (Zenaidura macroura)
Doves became common on the study area in early May and were present as a nesting species in the aspen woods along the east edge of the study area. A minimum of 2 nests were present in 1991.

*Black-billed Cuckoo (Coccyzus erythropthalmus)
Summer resident of the aspen woods. Adult observed carrying food on 7 July 1991.

Great Horned Owl (Bubo virginianus)
Resident. Adults were observed throughout the study area both years but most sightings were in the aspen woods. Occasionally owls would perch on nest baskets placed in the WP. Nesting on site was not documented.

Belted Kingfisher (Ceryle alcyon)
Birds were first observed on 22 April in 1990 and 4 April in 1991. One to 2 birds were observed sporatically throughout the summer, particularly when water was flowing out of the FP Outlet Structure. A single bird typically would perch on the top of the large culvert and watch for minnows in the plunge pool below.

*Northern Flicker (Coloptes auratus)
First observed on 20 April 1990 and present in the aspen woods throughout both summers. Likely bred in fire-killed, larger aspen trees but no nests were found.

*Yellow-bellied Sapsucker (Sphyrapicus varius)
Observed in the aspen forest during breeding bird survey in 1990 and probably bred.

*Willow Flycatcher (Empidonax traillii)
Fairly common in the shrubby willows along the Aspen/Brush Fen. Apparently arrived later in 1990 as no birds were heard or seen on the 4 June census but 5 birds were calling on 26 June. In contrast, 5 were calling on 29 May in 1991.

*Least Flycatcher (Empidonax minimus)
Common in the aspen woods portion of the Aspen/Brush Fen.

Eastern Wood-Pewee (Contopus virens)
One record: A bird was heard singing in the aspen woods of the Aspen/Brush Fen on 16 June 1991.

*Eastern Kingbird (Tyrannus tyrannus)
First observed on 21 May 1990 and 10 May in 1991. A common summer resident. Nested along the Aspen/Brush Fen but foraged in the adjacent Needlegrass/Side-oats Grama, WP, and Quackgrass/Redtop habitats. Two nests were located in 1991, both in branches of willows overhanging the east edge of the WP.

Western Kingbird (Trannus verticalis)
One record: 21 May 1990 along Aspen/Brush Fen.

*Great Crested Flycatcher (Myiarchus crinitus)
One heard in the aspen woods in 1990, but not recorded in 1991.

Horned Lark (Eremophila alpestris)
Common along the field road and cropland along the east edge of the study area.

*Tree Swallow (Tachycineta bicolor)
First observed on the study area on 15 March 1990 and probably 4-5 pairs produced young in cavities of fire-killed aspen tress along the Aspen/Brush Fen. Less than 20 were present on the site until late July when migrant birds arrived. Peak numbers were recorded on the following dates: 23 July (400), 27 July (300) and 3 August (100) in 1990 and 28 July (400) in 1991.

Barn Swallow (Hirundo rustica)
A few birds were observed sporatically over the summer both years but a migrant group of 70 was observed on 29 August and 50 on 4 September in 1991. This group was with a mixed flock of swallows which foraged near the FP Outlet Structure.

Cliff Swallow (Petrochelidon pyrrhonota)
Three records: Two birds were observed near the FP Outlet Structure on 28 May 1991 and, in both years, about 100 birds were with a mixed flock of swallows near the structure during the last week of July and the 1st week of August.

Bank Swallow (Riparia riparia)
Two records: A mixed group of swallows frequented the FP Outlet Structure in late July and early August in both years. On 27 August 1990, the group contained 300 Bank Swallows and 100 on 7 September.

Blue Jay (Cyanocitta cristata)
Occurred sporatically in the aspen woods of the Aspen/Brush Fen.

Black-billed Magpie (Pica pica)
Relatively common, year-round resident in the general area but observed only in the fall and winter on the study area.

American Crow (Corvus brachyrhynchos)
Small migrant flocks were noted in early March both years and individuals were observed sporatically through the summer but no evidence of breeding on the study area was noted.

Black-capped Chickadee (Parus atricapillus)
Resident. Observed only during March and April in the Aspen/Brush Fen.

*House Wren (Troglodytes aedon)
Summer resident of the Aspen/Brush Fen and at least 1 pair nested in woodpecker cavities in the fire-killed aspen trees both years.

*Marsh Wren (Cistothorus palustris)
A common breeding species in the bulrush marsh, especially in more dense cattails, bulrushes, and reed. Also bred in a seep area northeast of Delta-2, dominated by reed canary grass and timothy. A minimum of 20 pairs bred on the study area both years.

*Sedge Wren (Cistothorus platensis)
Early date of 10 May in 1991. A common summer resident of the thick grassy areas located mainly along the grassy ridge between pools and more open areas along the Aspen/Brush Fen. At least 20 pairs bred on the study area both years, generally in wetter areas.

*Veery (Catharus fuscescens)
Present in the aspen woods both years and probably bred in 1990 but no more than 1 pair.

*American Robin (Turdus migratorius)
Present in the aspen woods both years in small numbers and at least 1 pair bred in 1990.

*Gray Catbird (Dumetella carolinensis)
Present in the brushy aspen woods both years and 2 pairs probably bred.

*Brown Thrasher (Toxostoma rufum)
Observed both years in the brushy aspen woods and 1 pair probably bred.

*European Starling (Sturnus vulgaris)
Observed in 1991 in the aspen woods and at least 1 pair probably bred in cavities of fire-killed aspen trees.

*Warbling Vireo (Vireo gilvus)
Present both years in the taller aspen along the Aspen/Brush Fen and 1-2 pairs probably bred.

*Yellow Warbler (Dendroica petechia)
A common summer resident of the Aspen/Brush Fen with at least 8 breeding pairs each year.

*Common Yellowthroat (Geothlpis trichas)
A common summer resident of primarily the Aspen/Brush Fen but also occurred in seep areas along the grassy ridge separating the pools, particularly in rank cover. Probably 10 breeding pairs on the study area both years.

American Tree Sparrow (Spizella arborea)
A common early migrant present on the study area from mid-March to mid-May.

*Clay-colored Sparrow (Spizella pallida)
A common summer resident of the Aspen/Brush Fen, particularly along shrub/grassy edges. Probably 10-15 breeding pairs were present on the study area both years.

*Vesper Sparrow (Pooecetes gramineus)
Fairly common along roadways in the study area particularly the boundary road along the east edge. Arrived on the study area around the last week in April. On 12 June 1991, a nest with 4 eggs was found on the north dike about 80 m east of the FP Outlet Structure.

*Savannah Sparrow (Passerculus sandwichensis)
Common summer resident in dryer grassland portions of the study area, particularly the Wheatgrass/Timothy habitat between pools and the Needlegrass/Side-oats Grama habitat along the east portion of the study area.

*Grasshopper Sparrow (Ammodramas savannarum)
One or 2 males singing in dryer grassland sites in the southeast portion of the study area on 29 and 30 May 1991. Probably breeding and occurring in other grassland areas in the northwest and westerly portions of the study area as well.

*Le Conte's Sparrow (Ammospiza leconteii)
Generally occurred in moist grassland sites with relatively thick cover. Singing males were common in the Quackgrass/Redtop grassland just north of the WP. At least 10 breeding pairs present.

*Sharp-tailed Sparrow (Ammodramus caudacuta)
A summer resident of moist grasslands on the study area. Found mostly in tall (>1 m) cover of the Wheatgrass/Timothy habitat between pools and occasionally along the east edge of the WP in sedge/shrub habitat. At least 10 pairs bred.

*Song Sparrow (Melospiza melodia)
Common along the Aspen/Brush Fen with probably 8-10 pairs breeding.

*Swamp Sparrow (Melospiza georgiana)
Observed infrequently along the edge of the WP and the Aspen/Brush Fen. On 5 June 1991, a male was singing just north of the WP Control Structure in rank sweet clover along the edge of the interior road. Probably 1-2 pairs bred on the study area each year.

*Bobolink (Dolichonyx oryzivorus)
Arrived on the study area around mid-May and was a common summer resident of grassland areas with taller cover. Occurred in the Wheatgrass/Timothy, Needlegrass/Side-oats Grama, Quackgrass/Redtop, and Bluestem/Switchgrass habitats. A minimum of 25-30 breeding pairs present each year.

*Red-winged Blackbird (Agelaius phoeniceus)
In 1990, a flock of about 100 was first observed on 31 March and on 24 March in 1991. Common nesting species in emergent vegetation around Wildlife and Flood Pools. Several nests were placed in willow shrubs along the east edge of the WP. Seep areas supporting bulrushes, timothy, and reed canary grass along the west slope of the Wheatgrass/Timothy habitat were attractive nesting habitat as well. Red-winged Blackbirds arrived earlier than Yellow-headed Blackbirds and were apparently displaced by them from the interior portion of the WP. Those redwings nesting in interior portions of the WP were generally south of the flooded-out old township road which ran east and west through the WP Outlet Structure. Yellow-headed Blackbirds were generally absent from this area. Water depths were shallower there and cattails and reed were more dominant as opposed to the area north of the roadway which was deeper and dominated by hardstem bulrush.

*Yellow-headed Blackbird (Xanthocephalus xanthocephalus)
First observed on 25 April in 1990 and 1 May in 1991. This species was the most abundant breeding bird on the study area. Nesting was mainly in the bulrush marsh portion of the WP, generally north of the old township road described above. Most of the first nesting attempts failed in 1990 due to rising water in the WP. Many flooded-out nests were observed while running the breeding bird transect on 26 June 1990. Several males were present but not actively advertising territories. Renesting occurred but it's extent compared to the number of initial nests was unknown. Renests observed on 26 June contained about 2 eggs in nests made entirely of dead material, primarily bulrush. High water had innundated much of the dead vegetation, and the floating stems used for renest construction were quite waterlogged. Consequently the weight of these new nests caused some to bend down close to the water and were likely swamped and abandoned.

On 21 May 1991 an estimated 250 adult males were displaying and vocalizing in the bulrush marsh. Nests at various stages of completion were present but no eggs were observed in several nests checked. On 7 June 1991 a breeding bird census was taken along the transect line traversing the core Yellow-headed Blackbird breeding area. Eggs were hatching by 10 June and by 24 June nests with 1 to 4 eggs, newly hatched chicks, and nearly fledged chicks were present. A strong storm on 25 June 1991 blew over many nests and caused some mortality. By 8 July most young were flying, however, some nests still contained nestlings. By 15 July 1991, no nests contained eggs, and one nestling and a few newly flying fledglings were observed. Most young of the year birds were strong flyers at this point and had joined adults in large feeding flocks of 60-100 which used the Wheatgrass/Timothy habitat between pools and the Needlegrass/Side-oats Grama grassland along the easterly portion of the study area.

*Western Meadowlark (Sturnella neglecta)
Early dates of 27 March in 1990 and 24 March in 1991. Observed in low numbers throughout the field season, preferring generally well-drained grassland sites with shorter cover. Males used shrubs and aspen trees along the Aspen/Brush Fen as singing perches but foraging, and presumably nesting, occurred in grassland areas.

*Brewer's Blackbird (Euphagus cyanocephalus)
Early arrival dates were not closely monitored but 4 nests were found on 3 June 1991 while cable-dragging. The cover was planted warm-season native grasses which had been burned 9 April 1991. Three nests were separated by about 50 m forming somewhat of a group located just north of the FP. Other nests were likely present in the general area but undiscovered. The 4 nests contained the following: 3 host eggs and 3 Brown-headed Cowbird eggs; 2 host eggs and 2 cowbird eggs; 3 blackbird young; and 6 blackbird eggs. The regrowth cover was about 0.3 m tall at the time and quite open with no litter due to the burn. Nests were usually associated with a clump of alfalfa or thistle.

*Common Grackle (Quiscalus quiscula)
A small number of grackles were regularly observed during both field seasons in or near the aspen woods along the east edge of the WP. Breeding probably occurred.

*Brown-headed Cowbird (Molothrus ater)
The arrival date of cowbirds was not clearly noted but they were abundant by late May. They were generally associated with tree and shrub habitats, at least for perching, but they parasitized 2 Brewer's Blackbird nests which were at some distance (>100 m) from woody vegetation. At least 40 adults were present on the study area most of both seasons.

Orchard Oriole (Icterus spurius)
One record: An immature male was observed flying east over the WP on 21 May 1991. Orchard Orioles are generally uncommon in the general area with about 1 sighted for every 100 Northern Orioles.

*Northern Oriole (Icterus galbula)
A common summer resident of the Aspen/Brush Fen. Probably 3-5 breeding pairs present. On 7 July 1991 an adult male accompanied by a food-begging fledgling was observed foraging along the east edge of the aspen woods.

*American Goldfinch (Carduelis tritis)
A flock of at least 25 were present on the study area on 21 May 1991. These were probably migrants. A male was observed collecting downy pappus from cattails in early June of 1991 suggesting that nesting was underway. Probably 10 breeding pairs were present on the study area. Nesting probably occurred in areas with woody vegetation but birds foraged in most habitats of the study area.

Appendix 15. Breeding bird data for Transect 7 - Wildlife Pool habitat, 1990 and 1991.[1]

	Number per census date			
	1990			1991
Species	4 June	26 June	$\bar{x}$	7 June
Yellow-headed blackbird	47	50	49.5	92
Black tern	1	6	3.5	34
Red-winged blackbird	4	3	3.5	
Marsh wren	2	3	2.5	
*Tree swallow	3		1.5	
*Marbled godwit				2
Sandhill crane	2		1.0	
Common yellowthroat	2		1.0	
*Bobolink				1
Savannah sparrow				1
Sora	1		0.5	
*Cliff swallow	1		0.5	

1 50 x 1000 meter transect or 5 hectares.

* Observed during survey but did not breed in habitat type.

Appendix 16. Breeding bird data for Transect 8 Aspen/Brush Fen habitat, 1990 and 1991.[1]

	Number per census date						
	1990			1991			
Species	4 June	26 June	$\bar{x}$	29 May	16 June	21 June	$\bar{x}$
Brown-headed cowbird	11	14	12.5	6	9	13	9.3
Red-winged blackbird	10	6	8.0	9	13	9	10.3
Clay-colored sparrow	9	10	9.5	8	8	4	6.7
Common yellowthroat	11	6	8.5	7	5	3	5.0
Yellow warbler	7	10	8.5		6	6	4.0
Song sparrow	5	4	4.5	5	9	5	6.3
Mourning dove	5	5	5.0	5	5	4	4.7
Least flycatcher	1	6	3.5	7	4	2	4.3
Eastern kingbird	9	4	6.5	1	1	3	1.7
Willow flycatcher		5	2.5	5	3	4	4.0
American goldfinch	5	1	3.0	1	4	3	2.7
Northern oriole	1	1	1.0	3	5	2	3.3
Sedge wren	7	1	4.0		1	1	0.7
Western meadowlark	1	2	1.5	3	3	1	2.3
House wren	1	1	1.0	4	1	2	2.3
Gray catbird	1	2	1.5		1	3	1.3
Black-billed cuckoo		2	1.0	3		1	1.3
Common grackle	2	3	2.5		1		0.3
Robin	3		1.5			3	1.0
Warbling vireo		3	1.5		1	1	0.7
Yellow-headed blackbird				3	1	1	
Veery	1	2	1.5	1			0.3
Tree sparrow	2		1.0	1		2	1.0
Blue jay	3		1.5				
Swamp sparrow	1	2	1.5				
Northern flicker		1	0.5	1	1		0.7
Brown thrasher	1		0.5		1		0.3
Great-crested flycatcher	1	1	1.0				
European starling					1	1	
Sharp-tailed sparrow	1		0.5				
Yellow-bellied sapsucker		1	0.5				
Virginia rail		1	0.5				
Sora		1	0.5				
*Great horned owl					1		
Eastern wood pewee					1		
Bobolink				1			
Grasshopper sparrow				1			
Vesper sparrow						1	

[1] 50 x 1000 meter transect or 5 hectares.

* Observed during survey but did not breed in habitat type.

Appendix 17. Breeding bird data for Transect 9 - Wheatgrass/Timothy habitat, 1990 and 1991.[1]

Species	Number per census date						
	1990			1991			
	7 June	28 June	$\bar{x}$	5 June	16 June	21 June	$\bar{x}$
Red-winged blackbird	14	13	13.5	7	8	2	5.7
Bobolink	13	2	7.5	6	4	1	3.7
Sedge wren	8	11	9.5		5	2	2.3
American goldfinch		19	9.5	1	2		1.0
Marsh wren		5	2.5	4		4	1.3
Savannah sparrow	7	2	4.5		2	2	1.3
Brown-headed cowbird	3	2	2.5		2		0.7
LeConte's sparrow	1	4	2.5				
*Black tern					4		1.3
Sharp-tailed sparrow	1	1	1.0			1	0.3
Western meadowlark	1	1	1.0	1			0.3
Common yellowthroat	1		0.5		1	1	0.7
Killdeer	2		1.0				
Wilson's phalarope	1		0.5				
*Yellow-headed blackbird		60[2]	30.0		2		0.7

1 50 x 1000 meter transect or 5 hectares.

2 Concentration of feeding birds which nested in Wildlife Pool.

* Observed during survey but did not breed in habitat type.

Appendix 18. Breeding bird data for Transect 10 - Needlegrass/Side-oats grama habitat, 1990 and 1991.[1]

	Number per census date						
	1990			1991			
Species	10 June	26 June	$\bar{x}$	30 May	16 June	21 June	$\bar{x}$
Savannah sparrow	2	1	1.5	2	2	1	1.7
Brown-headed cowbird				8	2		3.3
Vesper sparrow	2		1.0	2		1	1.0
Clay-colored sparrow				5	1		2.0
Western meadowlark		1	0.5	1	2	1	1.3
*American goldfinch					5		1.7
Bobolink				1		1	0.7
*Eastern kingbird		1	0.5				
Sedge wren		1	0.5				
Mourning dove	1		0.5				
Grasshopper sparrow				1			0.3
*Yellow-headed blackbird						60[2]	20.0

1 50 x 1000 meter transect or 5 hectares.

2 Feeding flock from Wildlife Pool.

* Observed during survey but did not breed in habitat type.

Appendix 19. Summary of nest data at Burnham Creek Wildlife Management Area, 1990.

No.	Species	Date found	Approx. initiation date	Completed clutch size	Vegetation	VOR[1]	Site	Nest fate
1	Mallard	21 May	15 May		Quackgrass	2.0	Moist lowland	Depredated. Fox?
3	Mallard	14 June	13 June		Alfalfa/Sweet clover	4.8	Moist lowland	Deserted renest with 1 egg.
4	Mallard	14 June	10 June	9	Thistle/Smooth brome	4.6	Moist lowland	Depredated. Raccoon?
18	Mallard	22 June	10 June		Willow shrub	2.5	Hummock in marsh	Abandoned, probably due to high water.
6	Blue-winged teal	14 June	4 June	11	Foxtail barley/Redtop	3.0	Moist lowland	Hen killed off nest? Abandoned?
7	Blue-winged teal	15 June	7 June	9	Quackgrass	3.9	Upland	Depredated. Fox?
8	Blue-winged teal	15 June	5 June	10	Quackgrass	3.5	Upland	Depredated. Fox?
10	Blue-winged teal	15 June	8 June	9	Timothy	1.6	Moist upland	Depredated. Raccoon.
30	Blue-winged teal	10 July	22 June	9	Redtop	3.6	Moist upland	Depredated. Skunk or raccoon.
16	Canvasback	22 June	17 June	5	Bulrush		Over water	Depredated. Mink.
14	American coot	22 June	1 June	11	Bulrush		Over water	Successful.
19	American coot	26 June	19 June		Bulrush		Over water	Depredated.
24	American coot	21 June	19 June		Bulrush		Over water	Depredated.
25	American coot	22 June	14 June	12	Bulrush		Over water	Unknown, may have hatched.
26	American coot	22 June	16 June		Bulrush		Over water	Depredated.
34	American coot	12 July	16 June	11	Bulrush		Over water	Successful.
27	Pied-billed grebe	28 June	26 June		Bulrush/Cattail		Floating mat	Abandoned.
32	Pied-billed grebe	9 July			Bulrush/Cattail		Floating mat	Unknown.
35	Pied-billed grebe	12 July		8	Bulrush/Cattail		Floating mat	Unknown, may have hatched.
13	Sora	22 June	16 June	13	Cattail		15 cm above water	Depredated. Mink.
15	Sora	22 June	12 June	10	Bulrush		18 cm above water	Successful.
20	Sora	26 June	9 June		Bulrush		30 cm above water	Successful.
21	Sora	26 June	15 June	10	Sedge		30 cm above water	Successful.
22	Sora	26 June	12 June	11	Sedge		25 cm above water	Successful.
31	Sora	9 July			Willow		20 cm above water	Flooded.
31a	Sora	9 July		11				Unknown.
23	Virginia rail	22 June	6 June	9	Bulrush/Cattail		25 cm above water	Successful.
17	Least bittern	22 June	18 June	5	Bulrush		30 cm above water	Abandoned. Eggs out of nest.
9	American bittern	15 June		4	Quackgrass	6.9	Upland	Depredated. Fox?
28	American bittern	10 July	19 June	4	Quackgrass/Redtop	5.5	Moist lowland	Successful.
29	American bittern	10 July		3	Quackgrass/Redtop	5.3	Moist lowland	Depredated. Skunk?
5	Northern harrier	13 June	9 June	6	Smoothbrome/Quackgrass	5.4	Upland	Depredated.
2	Wilson's phalarope	20 May	15 May	4	Wheatgrass (in roadway)	0.4	Upland	Depredated. Skunk?
11	Wilson's phalarope	15 June	1 June		Timothy	1.9	Moist lowland	Successful.
12	Wilson's phalarope	10 June		4		0.4	Moist lowland	Depredated. Bird.

1 VOR = Visual Obstruction Reading, height in decimeters where there is 100% visual obstruction of a Robel density pole viewed from 4 cardinal directions. Measured only at upland nest sites.

Appendix 20. Summary of nest data at Burnham Creek Wildlife Management Area, 1991.

No.	Species	Date found	Approx. initiation date	Completed clutch size	Vegetation	VOR[1]	Site	Nest fate
36	Blue-winged teal	29 May	7 May	11	Quackgrass/Smooth brome	3.8	Upland	Successful
39	Blue-winged teal	29 May	17 May	10	Quackgrass/Smooth brome	3.5	Upland	Depredated. Skunk? (researchers broke 3 eggs when found)
40	Blue-winged teal	29 May	16 May	10	Quackgrass/Smooth brome	3.8	Upland	Successful
41	Blue-winged teal	29 May	8 May	11	Quackgrass/Smooth brome	2.9	Upland	Depredated. Ground squirrel
42	Blue-winged teal	30 May	16 May	13	Quackgrass/Smooth brome	3.1	Upland	Hen killed on nest. Mink?
43	Blue-winged teal	30 May	26 May	8	Quackgrass/Smooth brome	3.0	Upland	Depredated. Ground squirrel
44	Blue-winged teal	30 May	21 May	10	Quackgrass	3.6	Upland	Successful
45	Blue-winged teal	30 May	17 May	12	Timothy/Switchgrass	4.0	Moist lowland	Successful
46	Blue-winged teal	30 May	21 May	11	Timothy/Switchgrass	2.3	Moist lowland	Successful
47	Blue-winged teal	30 May	8 May	10	Switchgrass/Smooth brome	2.0	Moist lowland	Depredated. Raccoon?
49	Blue-winged teal	30 May	10 May	11	Redtop/Bluegrass	2.3	Moist upland	Depredated. Raccoon?
50	Blue-winged teal	30 May	14 May	11	Quackgrass	3.3	Upland	Depredated. Skunk
51	Blue-winged teal	30 May	24 May	11	Quackgrass/Switchgrass	2.3	Upland	Depredated. Raccoon?
52	Blue-winged teal	30 May	17 May	11	Bluegrass/Quackgrass	1.6	Moist lowland	Successful.
53	Blue-winged teal	30 May	11 May	11	Quackgrass/Bluegrass	2.5	Moist lowland	Depredated. Raccoon.
57	Blue-winged teal	30 May	20 May	11	Quackgrass/Switchgrass	2.8	Moist lowland	Successful
140	Blue-winged teal	31 May	30 May	12	Sedge	2.5	Moist lowland	Successful
60	Blue-winged teal	25 June	15 June	7	Smooth brome/Needlegrass	2.8	Upland	Successful, although 2 eggs eaten
61	Blue-winged teal	25 June	28 May	11	Smooth brome	3.8	Upland	Successful
62	Blue-winged teal	25 June	1 June	10	Quackgrass	2.4	Upland	Successful
63	Blue-winged teal	25 June	27 May	8	Quackgrass	3.0	Moist upland	Successful
65	Blue-winged teal	25 June	25 May	10	Bluegrass/Goldenrod	2.6	Moist lowland	Successful
66	Blue-winged teal	25 June	26 May	11	Quackgrass	3.4	Moist lowland	Successful
38	Northern shoveler	29 May	22 May	10	Quackgrass/Smooth brome	3.0	Upland	Depredated. Skunk?
55	Mallard	30 May	25 May	9	Switchgrass/Redtop	3.9	Moist lowland	Successful
93	Mallard	3 June	17 May	8	Quackgrass	3.5	Upland	Successful
60a	Canvasback	31 May	19 May	5	Bulrush		Over water	Depredated; hen killed during hatch
71	Canvasback	3 June	12 May	9	Bulrush		Over water	Successful

1 VOR = Visual Obstruction Reading, height in decimeters where there is 100% visual obstruction of a Robel density pole viewed from 4 cardinal directions. Measured only at upland nest sites.

Appendix 20. Continued.

No.	Species	Date found	Approx. initiation date	Completed clutch size	Vegetation	VOR[1]	Site	Nest fate
83	Canvasback	3 June	12 May	8	Bulrush		Over water	Successful. One chick dead at nest.
101	Canvasback	3 June	11 May	8	Bulrush		Over water	Probably successful.
131	Canvasback	10 June	31 May	6	Bulrush		Over water	Abandoned.
141	Canvasback	26 June	20 May	7	Bulrush		Over water	Successful.
138	Ruddy duck	24 June	15 June	11	Bulrush		Over water	Depredated. Mammal.
142	Ruddy duck	26 June	16 June	10	Bulrush		Over water	Flooded out.
144	Ruddy duck	27 June	24 June	6	Bulrush		Over water	Depredated.
145	Ruddy duck	27 June	2 June	9	Bulrush		Over water	Depredated.
147	Ruddy duck	1 July	22 June	11	Bulrush		Over water	Flooded.
148	Ruddy duck	22 July	16 July	2	Bulrush		Over water	Flooded.
149	Ruddy duck	22 July	20 July	?	Bulrush		Over water	Depredated when found.
61a	American coot	31 May	27 May	10	Cattail			Successful.
62a	American coot	31 May	20 May	12	Cattail/Bulrush			Unknown.
63a	American coot	31 May	29 May	9	Cattail/Dogwood			Successful.
64a	American coot	31 May	23 May	11	Cattail/Bulrush			Probably successful.
65a	American coot	31 May	23 May	13	Reed			Unknown.
66a	American coot	31 May	25 May	8	Willow			Unknown.
67	American coot	31 May	20 May	11	Bulrush			Probably successful.
69	American coot	3 June	27 May	8	Bulrush			Unknown.
70	American coot	3 June	25 May	10	Bulrush			Unknown.
73	American coot	3 June	3 June	7	Bulrush			Successful.
81	American coot	3 June	30 May	7	Bulrush			Unknown.
82	American coot	3 June	28 May	12	Bulrush			Unknown.
89	American coot	3 June	3 June	?	Cattail			Unknown.
94	American coot	3 June	29 May	7	Quackgrass/Cattail/Bulrush			Successful.
96	American coot	3 June	21 May	13	Cattail			Successful.
97	American coot	3 June	21 May	13	Cattail			Probably successful.
98	American coot	3 June	1 June	?	Cattail			Probable depredation.
99	American coot	3 June	26 May	9	Cattail/Willow			Unknown.
100	American coot	3 June	28 May	7	Quackgrass/Cattail			Probably flooded.
102	American coot	3 June	25 May	10	Quackgrass/Bulrush			Probably flooded.

1 VOR = Visual Obstruction Reading, height in decimeters where there is 100% visual obstruction of a Robel density pole viewed from 4 cardinal directions. Measured only at upland nest sites.

Appendix 20. Continued.

No.	Species	Date found	Approx. initiation date	Completed clutch size	Vegetation	VOR[1]	Site	Nest fate
103	American coot	3 June	27 May	8	Cattail/Grass			Successful.
104	American coot	3 June	29 May	?	Cattail			Successful.
105	American coot	3 June	28 May	7	Cattail			Unknown.
106	American coot	3 June	28 May	7	Cattail			Unknown.
107	American coot	4 June	25 May	11	Cattail			Probably successful.
108	American coot	4 June	29 May	8	Cattail			Flooded.
109	American coot	4 June	30 May	6	Whitetop/Bulrush			Successful.
110	American coot	4 June	21 May	12	Reed			Successful.
111	American coot	4 June	29 May	7	Reed/Cattail			Successful.
113	American coot	4 June	28 May	8	Reed/Bulrush			Unknown.
114	American coot	4 June	3 June	?	Whitetop/Reed			Probable depredation.
115	American coot	4 June	26 May	10	Bulrush/Reed			Successful.
116	American coot	4 June	23 May	13	Reed/Bulrush			Successful.
117	American coot	4 June	29 May	7	Bulrush			Unknown.
118	American coot	4 June	25 May	11	Bulrush/Cattail			Successful.
119	American coot	4 June	21 May	8	Bulrush			Successful.
120	American coot	4 June	30 May	8	Whitetop/Bulrush			Failed (predator or flood).
121	American coot	4 June	25 May	11	Bulrush/Whitetop			Unknown.
122	American coot	4 June	24 May	12	Bullrush/Cattail			Unknown.
124	American coot	4 June	21 May	12	Cattail/Bulrush			Successful.
125	American coot	6 June	4 June	?	Sedge/Willow			Unknown.
126	American coot	6 June	6 June	?	Bulrush/Juncus spp.			Unknown.
127	American coot	7 June	6 June	?	Bulrush			Depredated.
137	American coot	24 June	22 June	7	Willow			Successful.
139	American coot	25 June	19 June	6	Cattail			Unknown.
143	American coot	26 June	23 June		Bulrush			Successful.
146	American coot	27 June	22 June	4	Bulrush			Probably successful.
77	Pied-billed grebe	3 June	30 May	5	Bulrush			Depredated (bird-like).
88	Pied-billed grebe	3 June	28 May	8	Bulrush			Unknown.
95	Pied-billed grebe	3 June	31 May	7	Cattail			Unknown.
112	Pied-billed grebe	4 June	1 June	8	Whitetop/Bulrush			Successful.
123	Pied-billed grebe	4 June	27 May	12	Bulrush			Probably successful.
128	Pied-billed grebe	7 June	2 June	7	Bulrush/Cattail/Whitetop			Unknown.
148	Pied-billed grebe	13 June	22 May	9	Bulrush/Cattail			Successful.

[1] VOR = Visual Obstruction Reading, height in decimeters where there is 100% visual obstruction of a Robel density pole viewed from 4 cardinal directions. Measured only at upland nest sites.

Appendix 20. Continued.

No.	Species	Date found	Approx. initiation date	Completed clutch size	Vegetation	VOR[1]	Site	Nest fate
37	Greater prairie-chicken	29 May			Quackgrass/Smooth brome	4.9	Upland	Destroyed. Fox or coyote?
48	American bittern	30 May	29 May	6	Timothy/Reed canary	4.3	Wet lowland	Successful.
56	American bittern	30 May	27 May	5	Switchgrass/Quackgrass	3.5	Moist lowland	Successful.
58	American bittern	30 May	26 May	4	Sweetclover/Smooth brome	3.8	Moist lowland	Depredated.
64	American bittern	25 June	4 June	6	Quackgrass/Sweet clover	3.6	Upland	Successful.
67	Sora	21 June	?	12	Sedge/Grass		On hummock in marsh	Unknown.
59	Wilson's phalarope	31 May	?	4	Spring-burned brome	1.6	Upland	Depredated.
54	Upland sandpiper	30 May	25 May	4	Bluestem prairie	0.8	Upland	Successful.

1 VOR = Visual Obstruction Reading, height in decimeters where there is 100% visual obstruction of a Robel density pole viewed from 4 cardinal directions. Measured only at upland nest sites.

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