SPECIAL STUDIES

CRANE SURVEYS

Introduction

The Water and Power Resouces Service is investigating crane migration in certain parts of North Dakota (see USBR 1979). One portion of this study is a monitoring program designed to: (1) determine whether whooping cranes roost in certain areas of concern identified by the Fish and Wildlife Service, and (2) determine the significance of Lake Williams as a roost site for sandhill cranes in relation to other wetlands between Lake Audubon and Mercer in eastern McLean County. The monitoring program covers six migration periods, from the fall of 1978 through the spring of 1981. This report presents the results of the crane surveys completed in the spring and fall of 1979.

Methods

Spring

A combination of aerial and ground surveys were used to monitor crane migration on the two principle study areas, Audubon-Mercer and Sheyenne Lake as described in the USBR (1979). After a preliminary flight on April 2, 1979, regular aerial surveys of both study areas began as soon as snow conditions allowed acceptable observations on April 9, and continued until May 17. Flights were scheduled for six mornings each week, but adverse weather limited the total number of complete surveys to 23. Two observers looked for whooping cranes and estimated numbers of roosting sandhill cranes following techniques used in 1978 (USBR 1979). Surveys began ½ hour before sunrise, and both study areas were surveyed during the same flight.

One observer conducted ground surveys of accessible wetlands in the Audubon-Mercer Area in the early morning and evening 5 days each week, from April 14 through May 10. Another ground monitor surveyed the

Sheyenne Lake Area six mornings each week, from May 1 through May 17. Whenever road conditions permitted, observers collected information on the location and numbers of sandhill cranes following the same methods used in 1978 (USBR 1979).

Fall

Regular fall surveys began September 4 and continued through November 10. Aerial surveys of the two study areas were made concurrently, beginning ½ hour before sunrise. The Audubon-Mercer Area was searched six mornings per week and the Sheyenne Lake Area five mornings per week. The starting point of each survey of the Audubon-Mercer Area alternated daily between Turtle Lake and Brush Lake. The estimated number and location of roosting cranes was recorded along with weather conditions and the route flown.

Ground monitors provided additional coverage of the Audubon-Mercer Area 7 days per week. Lake Audubon was monitored six mornings per week, and evening ground routes alternated daily from Lake Audubon to Lake Williams. Routes and techniques of data collection followed those used the previous year (USBR 1979).

Results and Discussion

Whooping Cranes

Spring.--No whooping cranes were observed on either study area during the spring. In North Dakota, a total of five confirmed sightings were recorded between April 16 and 20, in Williams, Ward, Divide, and McLean Counties. The sighting nearest to the Audubon-Mercer study area occurred April 16-18, 5.6 km (3.5 mi) southwest of Riverdale and 19.5 km (12 mi) southwest of the Audubon National Wildlife Refuge. Four adults were observed loafing and feeding in a wheat stubble field adjacent to the Missouri River.

Fall.--At 6:05 p.m. on September 24, 1979, two adult whooping cranes were observed on the Audubon-Mercer study area, 4 km (2.5 mi) northeast of the town of Turtle Lake. The birds were feeding with sandhill cranes in a stubble field 38 m (125 ft) southwest of a Type IV wetland and 0.8 km (0.5 mi) north of the northwest bay of Lake Williams. The cranes flew out of sight to the southwest shortly after they were sighted by WPRS personnel, and were not observed during subsequent aerial and ground surveys of the study area. The location of the whooping cranes and the surrounding land use is shown in Figure 20.

No whooping cranes were observed on the Sheyenne Lake Area. Only two other confirmed whooping crane sightings were made in North Dakota during fall migration, both in Burke County. Two adults stayed in the Beaver Lake Area southwest of Lignite, North Dakota, from October 15 until at least October 30. The other sighting, of three whooping cranes in flight over Portal, North Dakota, occurred October 22.

Further information on the use of the two study areas by whooping cranes will be collected during the spring and fall migrations of 1980 and the spring migration of 1981. In addition, Dr. Stanley Temple of the University of Wisconsin is analyzing the entire GDU to determine how much potential whooping crane habitat exists in the area. Until this information has been compiled, no conclusions can be reached regarding critical habitat for whooping cranes within the two study areas.

Sandhill Cranes

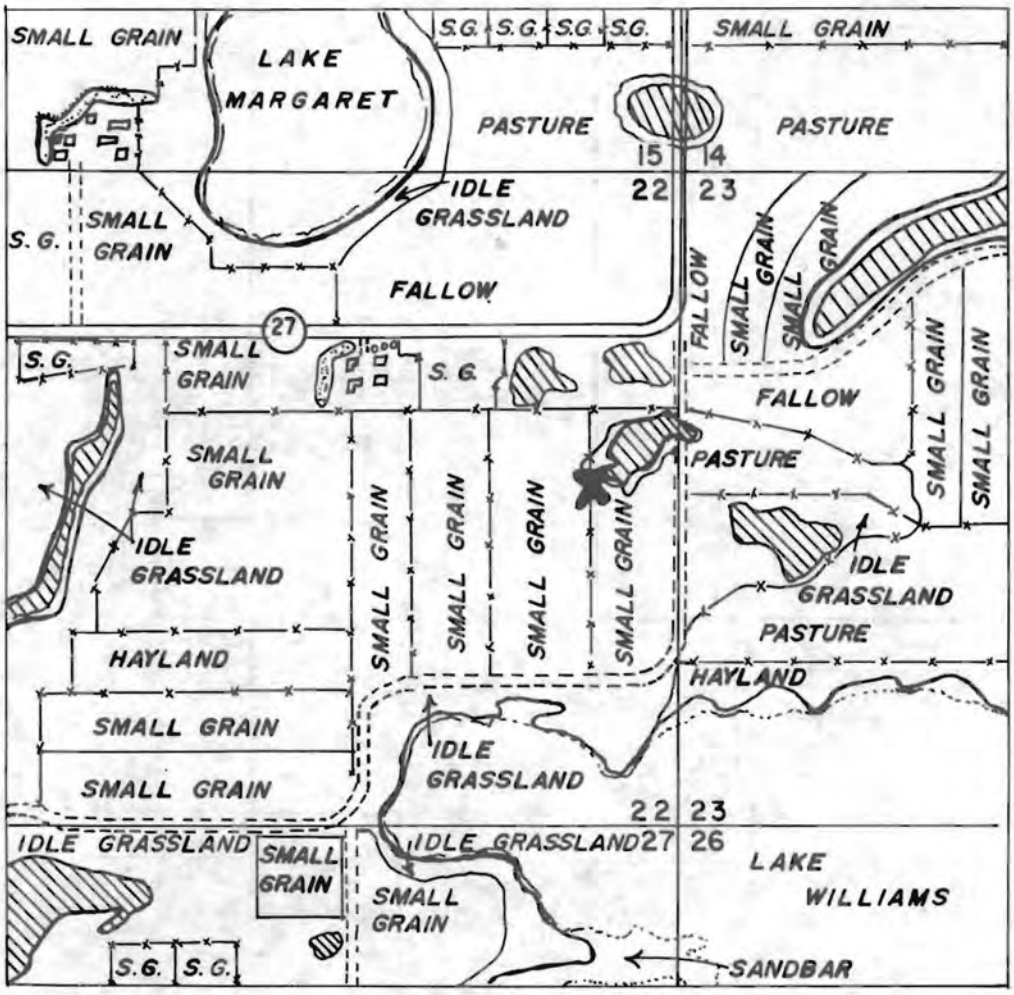
Spring.--No sandhill cranes were observed on the Sheyenne Lake Area during spring migration. On the Audubon-Mercer Area, the sandhill cranes did not stage large numbers as they did during the fall in 1978. Sandhill cranes were observed at 26 locations during 14 of 23 completed surveys of the Audubon-Mercer study area. They were first observed on April 9 and were still present during the final crane survey on May 17. The maximum flock size observed roosting on the study area was 280, though larger numbers (up to 600) were observed flying over the area. A daily maximum of 645 sandhill cranes was recorded April 21.

Roosting patterns of sandhill cranes on the Audubon-Mercer Area during the spring differed markedly from patterns observed during the fall in 1978. No cranes were observed roosting in any of the wetlands used by cranes in 1978. Instead, the cranes were associated with Type I wetlands and agricultural lands in the western half of the study area (Figure 21).

Sandhill cranes used stubble fields 51 percent of the time, fallow fields 21 percent, Type I wetlands 18 percent, and marshes 3 percent of the time. Only cranes standing in shallow water were recorded as using Type I wetlands, although there commonly were flooded areas near cranes in stubble or fallow fields which may have been used as roost sites. It was often difficult to determine whether the cranes were roosting, loafing, or feeding when observed in stubble or fallow fields.

Fall.--Fall migration in 1979 was similar to the fall migration of 1978. Sandhill cranes roosted in 35 wetlands in the Audubon-Mercer Area between August 27 and November 10. Daily estimated totals of cranes using the area are presented in Figure 22. The number of cranes using the area peaked at 21,350 on October 5 and, after a brief decline, increased again to 21,100 cranes on October 11. Northwest winds from 25 to 30 mph on October 6 probably contributed to the observed decline in numbers between October 5 and 11.

The percent of total crane-days was calculated for each of the 35 wetlands used by cranes to determine their relative importance to the birds as roost sites (USBR 1979). Thirteen wetlands individually contributed 0.5 percent or more of the crane-use of the area and collectively included 99 percent of the total use. These 13 wetlands are listed in order of descending overall importance in Table 49. The study period was analyzed in biweekly segments to detect shifts in relative importance of the wetlands as the season progressed. The maximum number of cranes observed on each wetland and the observation date is included.



EXPLANATION

SECTION LINES
WHOOPING CRANES LOCALE
TREE ROW
BUILDINGS OR HOUSES
FENCE LINE
PAVED ROAD
LAKE SHORELINE
OPEN WATER WETLAND
ALKALI COVERED MUD OR GRAVEL FLAT
GRAVEL ROAD

FIGURE 20

LAND USE SURROUNDING LOCATION OF WHOOPING CRANES

T.147N., R.80W.

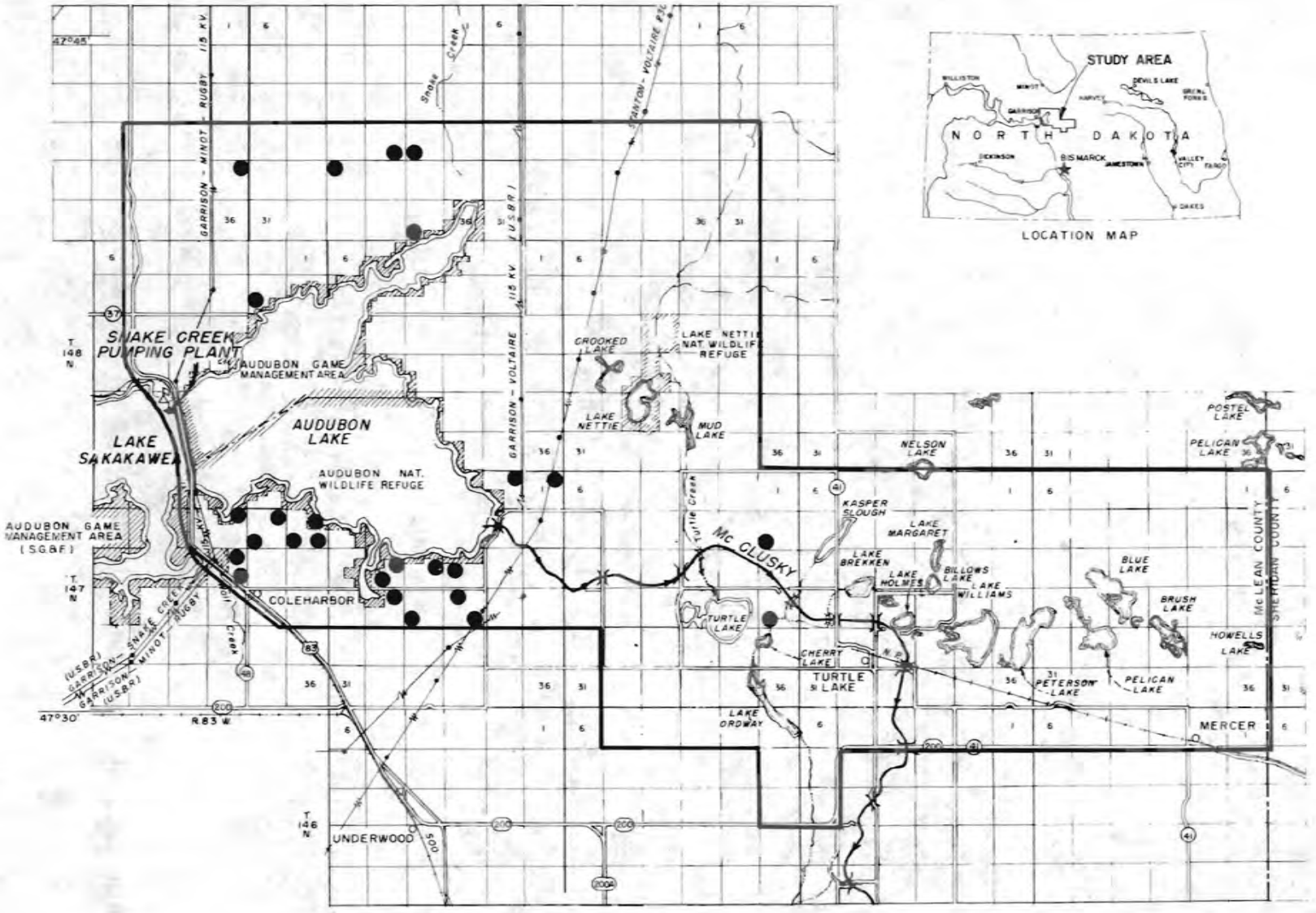


FIGURE 21

LOCATION OF SANDHILL CRANES
ON THE AUDUBON—MERCER STUDY AREA
SPRING 1979

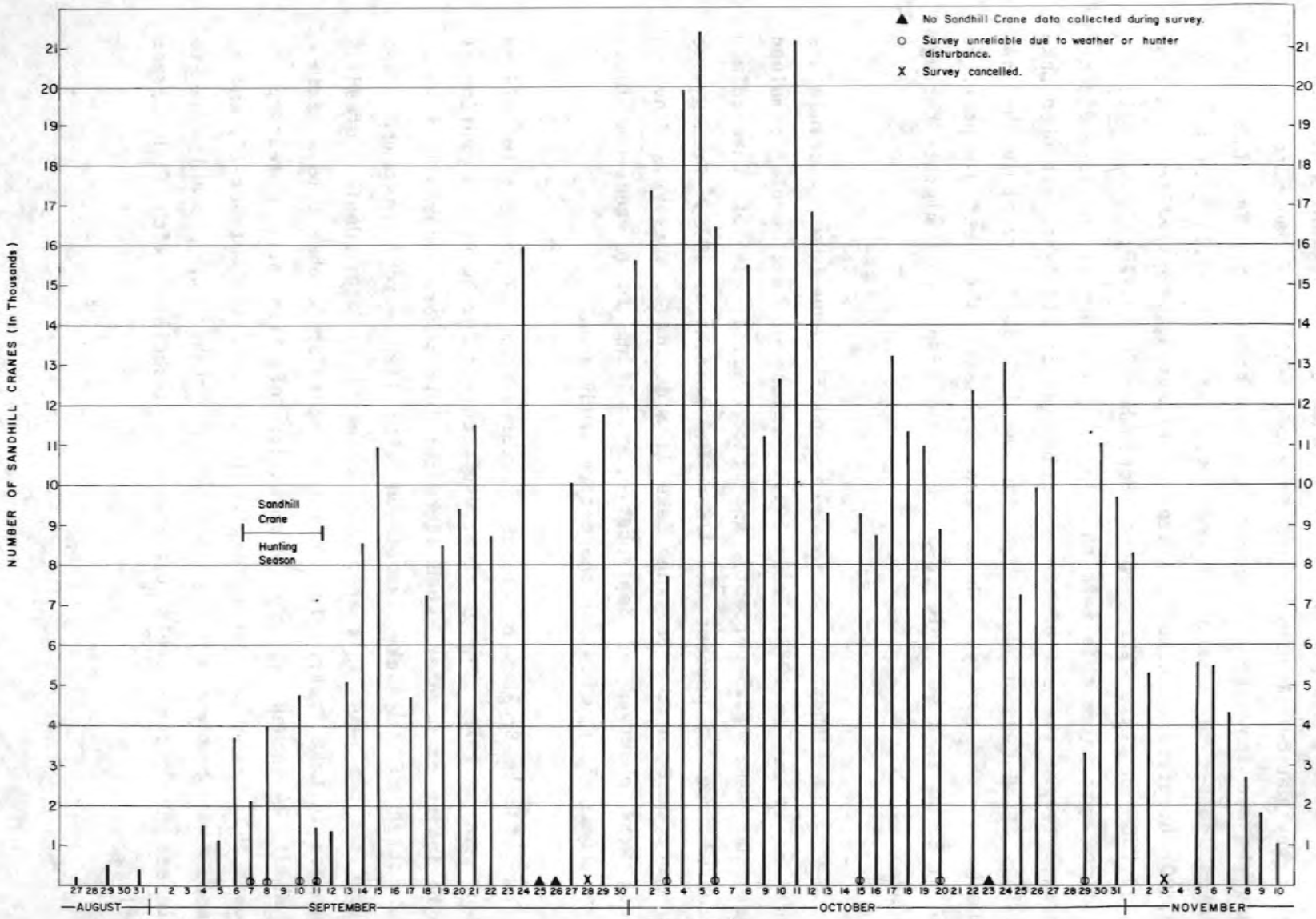


FIGURE 22

NUMBER OF SANDHILL CRANES ROOSTING

ON THE AUDUBON—MERCER AREA, McLEAN CO.

FALL 1979

Over 70 percent of all crane-use in the area occurred on Lake Williams, compared to 47.3 percent during the same period in 1978 (Table 49). The lake was used by 100 percent of the cranes at the beginning and end of the survey period (August 27 and November 7-10), and had more than 10 times the use shown by the second most important site, Spot Lake. The greatest number of cranes observed roosting on a wetland at one time (15,800) occurred on Lake Williams on October 5, compared to a maximum of 11,700 on Lake Williams on September 30, 1978. Lake Williams contained more water this fall than last. Crane-use of the lake did not decrease toward the end of the migration (as it did last year when Lake Williams dried considerably), but increased to 83.8 percent in the last 2 weeks of the survey. These data emphasize the need to preserve Lake Williams as a valuable resource to the cranes that migrate through the area.

The use of Lake Audubon, Lake Holmes, and Sheyenne Lake by cranes was minor, as it was in 1978 (Table 50). The use of Lake Audubon remained about the same (2.3 percent) and the overall use of Lake Holmes decreased from 1.6 percent in 1978 to 0.9 percent in 1979. Cranes were seen only once on the Sheyenne Lake Area during 45 surveys. Nineteen cranes were observed on September 6, resulting in a crane-use index (crane-days) of only 0.4 for the entire study area.

The use of Lake Brekken by cranes increased from 2.7 percent in 1978 to 5.9 percent in 1979. The greatest use occurred during peak migration at the beginning of October, when the water levels were abnormally low due to drainage of the lake associated with fish screen testing. Fish screen testing was initiated on October 1. Water depths steadily increased in Lake Brekken from about 6 inches on October 1 to a maximum of about 24 inches at the termination of fish screen testing on October 19. Crane use decreased substantially after October 13, and no cranes were observed on the lake after October 22, probably due to increases in water levels of the lake associated with fish screen testing.

Table 49

USE OF AUDUBON-MERCER STUDY AREA BY MIGRATING SANDHILL CRANES - FALL 1979[1/]

Areas	Aug 27 - Sept 15		Sept 16 - Sept 29		Sept 30 - Oct 13		Oct 14 - Oct 27		Oct. 28 - Nov. 10		Entire Period		Maximum No. of Cranes Seen In One Observation	
	Crane-days	% Total	Crane-days	% Total	Crane-days	% Total	Crane-days	% Total	Crane-days	% Total	Crane-days	% Total	Number	Date
Lake Williams	2,144.7(10)	63.5	7,102.7(11)	69.0	11,207.1(12)	67.9	7,861.3(12)	70.4	4,695.0(12)	83.8	6,749.8(57)	70.5	15,800	10/5
Spot Lake	316.1(9)	9.4	775.6(8)	7.5	1,030.0(11)	6.2	691.1(9)	6.2	71.5(10)	1.3	581.2(47)	6.1	2,550	10/12
Lake Brekken	73.3(9)	2.2	405.0(8)	3.9	2,057.5(10)	12.5	159.4(9)	1.4	-0-(10)	-0-	563.3(46)	5.9	4,000	10/4
Creek Lake	96.5(9)	2.9	411.3(9)	4.0	1,025.0(10)	6.2	802.8(9)	7.2	367.5(10)	6.6	547.3(47)	5.7	1,800	10/13
Pelican Lake	309.7(9)	9.2	745.6(8)	7.2	595.0(11)	3.6	362.6(9)	3.2	124.7(10)	2.2	421.5(47)	4.4	1,225	9/19
Lake Audubon	4.1(9)	0.1	170.8(13)	1.7	103.7(13)	0.6	595.2(13)	5.3	173.6(13)	3.1	223.4(61)	2.3	1,325	10/20
Crotch Lake	185.6(9)	5.5	221.9(8)	2.2	40.5(11)	0.2	72.2(9)	0.6	32.5(10)	0.6	103.5(47)	1.1	550	9/29
Martha's Slough	-0-(9)	-0-	15.3(9)	0.1	161.7(11)	1.0	216.6(10)	1.9	48.0(10)	0.9	93.1(49)	1.0	775	10/11
Lake Holmes	19.6(9)	0.6	79.6(8)	0.8	65.0(10)	0.4	185.6(9)	1.7	74.5(10)	1.3	84.3(46)	0.9	425	10/24
Lake Peterson	71.7(9)	2.1	129.4(8)	1.3	104.1(11)	0.6	14.4(9)	0.1	12.0(10)	0.2	65.4(47)	0.7	475	10/1
Turtle Lake	16.7(9)	0.5	25.0(8)	0.2	37.5(10)	0.2	142.2(9)	1.3	-0-(10)	-0-	43.6(46)	0.5	400	10/24
Lake Ordway	59.3(9)	1.8	36.3(8)	0.4	79.9(10)	0.5	68.9(9)	0.6	-0-(10)	-0-	48.8(46)	0.5	500	9/14
Elbow Lake	80.6(9)	2.4	171.9(8)	1.7	2.9(11)	TR	2.2(9)	TR	-0-(10)	-0-	45.8(47)	0.5	325	9/21
TOTAL	3,377.9	100.2	10,294.4	100.0	16,509.9	99.9	11,174.5	99.9	5,599.3	100.0	9,571.0	100.1		

1/Sample size is shown in parentheses. Unreliable estimates due to weather or hunter disturbance were eliminated from the analysis.

Table 50

RELATIVE SANDHILL CRANE USE OF SELECTED WETLANDS WITHIN GDU - FALL 1978 AND 1979

	1978		1979	
	Crane-days	Percent Total	Crane-days	Percent Total
Lake Williams	4,932.0(64)*	47.3	6,749.8(57)	70.5
Lake Brekken	281.0(26)	2.7	563.3(46)	5.9
Lake Holmes	169.0(26)	1.6	84.3(46)	0.9
Lake Audubon	230.0(40)	2.2	223.4(61)	2.3
Sheyenne Lake Area	1.5(19)	TR	0.4(45)	TR

*Sample size is shown in parentheses.

Prairie Grouse

Last year's studies (1978) documented the presence of greater prairie chickens and sharp-tailed grouse in the area (USBR 1979). In 1979, efforts were increased to determine the relative abundance and distribution of these prairie grouse.

Photo No. 1, Male Prairie Chicken, Oakes Study Area,
WPRS photo by R. Schmidt.

Methods

Listening stops described in the Biological Investigations Techniques Manual (unpublished 1979) were started on March 28 and continued through April. The booming grounds discovered were periodically visited to count displaying males into late May.

Results and Discussion

Figure 23 shows the location of good and marginal listening stops and known active booming grounds. A listening stop was considered good if: (1) the wind was less than 13 kph (8 mph), (2) the morning was precipitation free, and (3) there were no disrupting factors such as operating farm machinery, geese calling, leaves rustling, etc. Under good listening conditions, any booming grouse within 2.4 km (1.5 mi) should have been heard. A stop was considered marginal if the listening conditions were less than good, but not bad enough to cancel the route altogether. Marginal stops should have detected any displaying grouse within 0.8 km (0.5 mi).

Five active booming grounds were found. Two of the five booming grounds were active in the spring of 1978, and one booming ground apparently shifted about 0.8 km (0.5 mi) north of the 1978 location. The remaining two grounds were not detected in 1978; one may represent a pioneering ground, as it was occupied only by a single male (and occasionally a female). All booming grounds were in pastures associated with the sandhill ridge that runs between the East Oakes and the West Oakes irrigation areas.

Twenty-five male prairie chickens were counted on the five booming grounds, which, with a usual 1:1 ratio of males to females (Kirsch 1956), indicates a minimum population of 50 prairie chickens in the area distributed along the sandhill ridge between the East and West Oakes Areas. Few sharp-tailed grouse were observed. One male occupied a territory regularly on a prairie chicken booming ground, and only four others were seen in the area during the study.

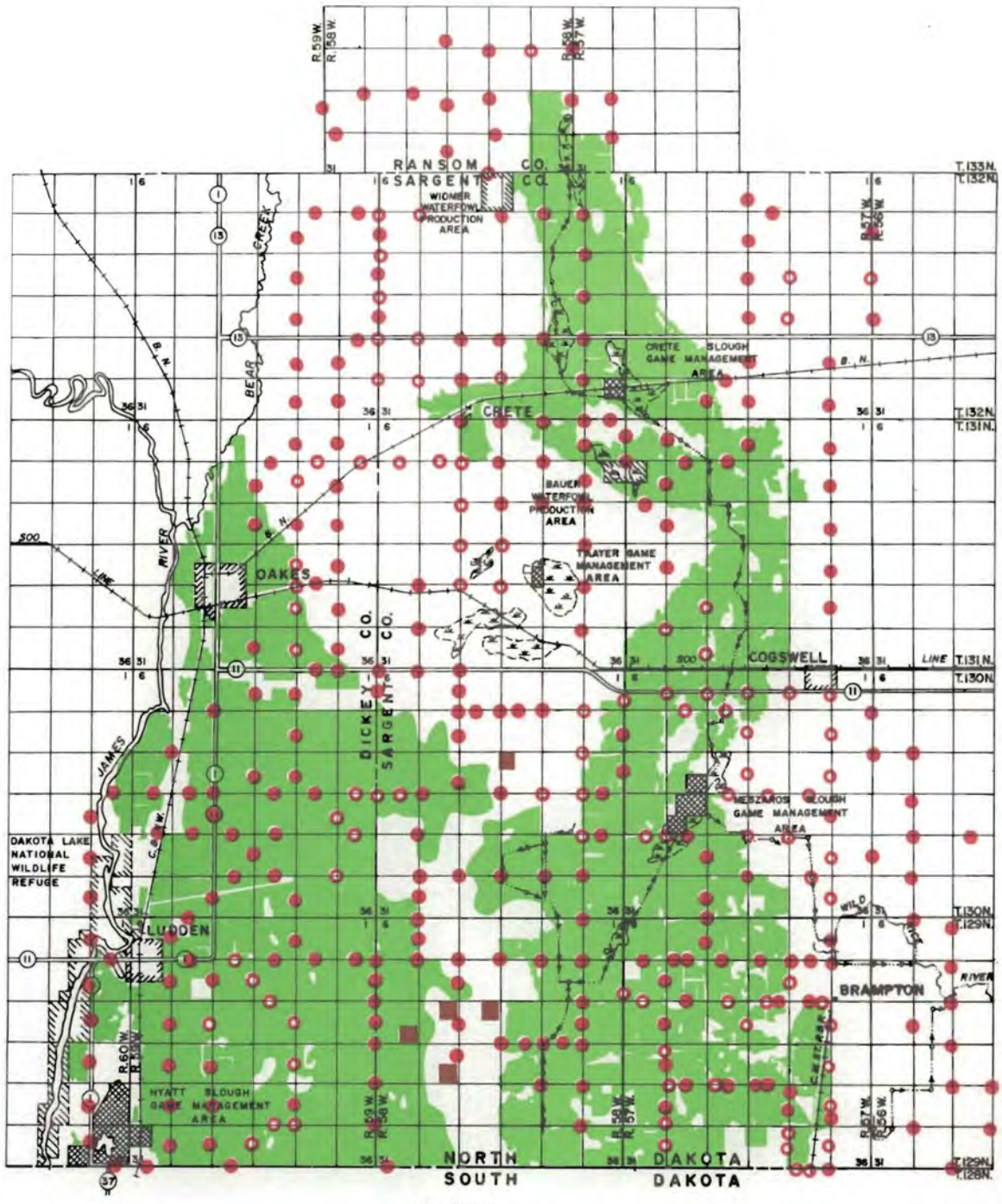


FIGURE 23

EXPLANATION

- GOOD LISTENING STOP
- MARGINAL LISTENING STOP
- 1979 BOOMING GROUND
- ARABLE LAND
- EXISTING DRAIN

OAKES STUDY AREA
1979 PRAIRIE CHICKEN OBSERVATIONS

In 1979, two sharp-tailed grouse/prairie chicken hybrids were observed (Photo No. 2) on a booming ground where a single male sharp-tailed grouse has been observed the past 2 years. This is the first recorded incidence of hybridization in this area (L. Trip, NDGF Biologist, pers. comm.), but hybrids have occurred in other parts of the State. These two hybrids were phenotypically strong in prairie chicken characteristics, which suggests the possibility of second and third generation hybrids. Sparling (1979) suggests where the number of one species is particularly low, mixed species display grounds may develop and hybrids may occur.

Photo No. 2, Sharp-tail/prairie chicken hybrid (note the speckling on the belly, and the relatively short pinnae). WPRS photo by R. Schmidt.

Four of the five booming grounds were located in nonarable land, while the fifth (T. 129 N., R. 58 W.) is located on arable (WPRS classification) land. It is not anticipated that the four booming grounds will be directly impacted by GDU development; however, the fifth ground located on the arable land would be adversely impacted or eliminated. Irrigation of land adjacent to the four booming grounds on nonarable land may enhance grouse winter food supplies (Mohler 1963), but the wetland drainage associated with irrigation will remove some of the cattail cover occasionally used by grouse during severe winters.

Kraft Slough

Introduction

Kraft Slough is a prominent 340-ha (840-acre) marsh in southeastern North Dakota that is being considered for an irrigation water storage site associated with GDU. This semipermanent wetland, containing over 3 km^2 (1½ mi^2) of marsh, is located in Sargent County 13 km (8 mi) east of the town of Oakes, North Dakota (Figure 24). Kraft Slough has been identified as one of 111 natural areas in the State, and is noted for its Franklin's gull colony (Kantrud 1973) and has received special recognition for its high canvasback production. Other studies have indicated a high avian productivity and diversity (Krapu and Duebbert 1974).

This year's studies were designed to: (1) follow up on previous Franklin's gull studies, (2) determine how Kraft's Slough avian production compared to other semipermanent marshes in the area, with emphasis on over-water nesting species, and (3) identify what special characteristics account for any differences in productivity between the different wetlands. This information should provide better understanding of potential impacts to wildlife and will aid in identifying measures necessary to adequately mitigate for wildlife losses.

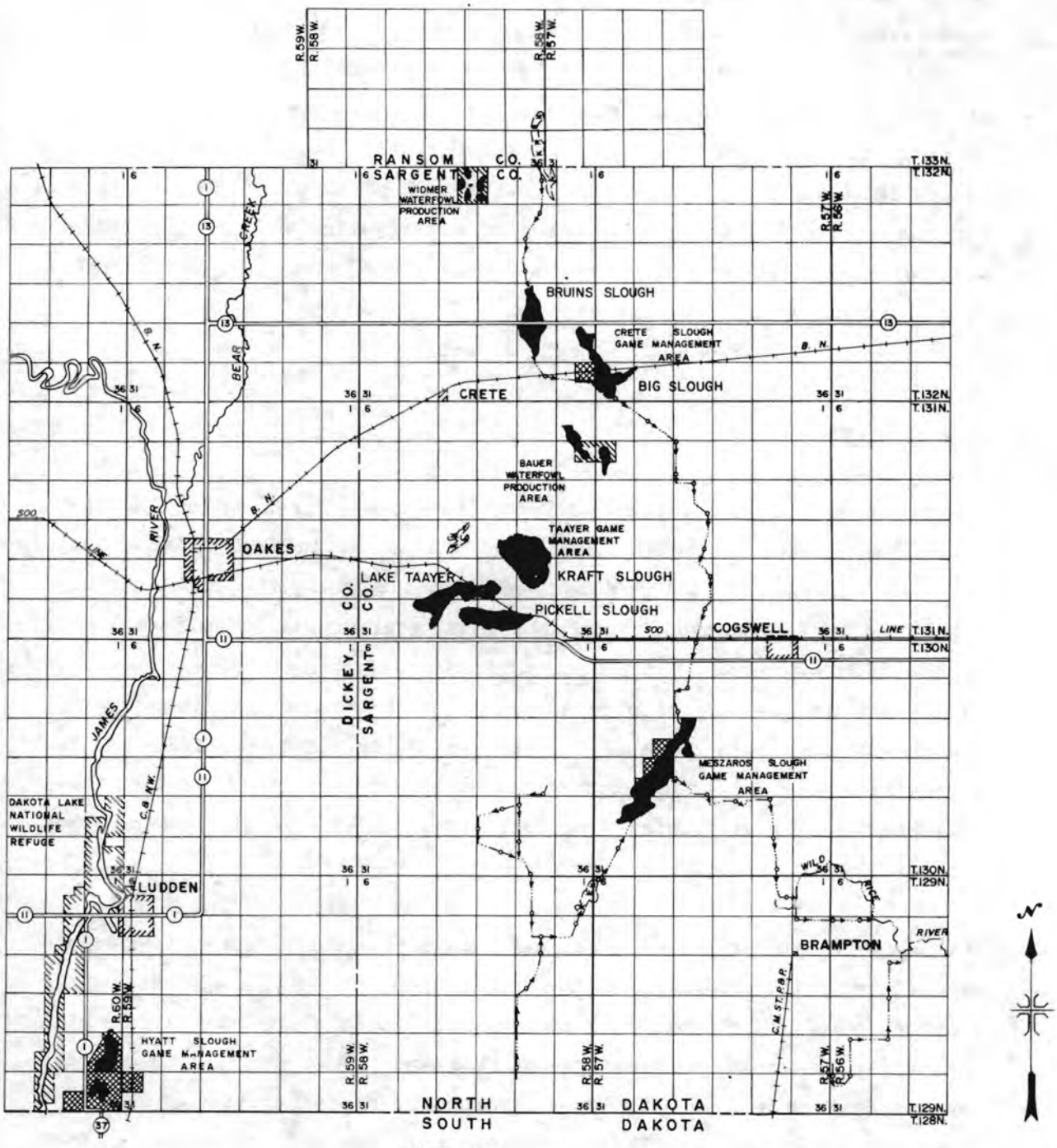


FIGURE 24

EXPLANATION

WETLAND

EXISTING DRAIN

OAKES STUDY AREA

Methods

The major semipermanent wetlands studies were (in decreasing order of wetland acreage): Big Slough (includes Crete GMA), Meszaros Slough, Kraft Slough, Lake Taayer (also locally known as Elmer's Slough), Bruns Slough, Hyatt Slough (north pool only), Pickell Slough, Widmer WPA, and Bauer WPA (east and west) (Figure 24). These wetlands were aerially photographed using color infrared film on June 29, 1979. The wetlands were covermapped from the photographs and spot-ground truthed. In areas where the emergent vegetation had not grown too tall, actual counts of over-water nests were possible using a stereoscopic light table. This proved particularly useful in counting nests of colonial nesting species.

Waterfowl were counted throughout the spring and summer by using spotting scopes to survey open water areas. Open-water counts were supplemented by canoe and beatout (foot) surveys in emergent cover. Personnel consisted of two biologists so complete coverage of these large wetland tracts (some were over 5 km^2 or 2 mi^2) was not possible.

Colonial nesting species received special attention due to the potential adverse impacts which would result from development. Colonial nesting species studied include Franklin's gulls, black-crowned night herons, and eared grebes. Colony sites were mapped and nest counts made where possible. Banding studies initiated in 1978 were continued on Franklin's gulls, and a sample of black-crowned night herons was also banded.

The habitat used for nesting by Franklin's gulls was examined at Kraft Slough and at other colony locations in both North Dakota and South Dakota, (Mud Lake and Sand Lake, both part of Sand Lake NWR in South Dakota; and Long Lake and J. Clark Salyer Refuges in North Dakota). While it was not possible to count all birds present on each wetland, enough time was spent in each area to obtain nesting and feeding species diversity data and relative abundance of most over-water nesting species. The patchy configuration of Widmer WPA encouraged waterfowl to

continually move from pond to pond making our counts unreliable. Therefore, after determining that there was no colonial nesting at Widmer WPA, it was not studied further.

Water samples were collected from each slough for later lab analysis, and each slough was also checked using a multiparameter probe. Parameters measured included dissolved oxygen, pH, and specific conductance. Benthos and invertebrate samples were collected and sent to the Denver E&R Center for analysis.

Other records that proved useful to this study include Geological Survey data and WPRS geology maps and tables. Soil Conservation Service aerial photographs were used to compare historical emergent patterns in Kraft Slough through drought and normal cycles from 1937 to 1979.

Results and Discussion

The results of this study show that wetlands are widely varied ecosystems, and certain combinations of variables result in substantial differences in wildlife use.

Table 51 lists several habitat parameters for each slough studied. Kraft Slough is not the largest or the smallest wetland studied, and as shown in Table 51, no particular variable sets the slough apart. The size of its open water central opening falls within the midrange of the others. Several of the sloughs have comparable emergent vegetation to open water ratios, and the dominant emergent (cattails) does not distinguish Kraft Slough from the other marshes. The emergent pattern of Kraft Slough is significantly different from the other sloughs studied.

Kraft Slough had the greatest species diversity of all wetlands studied (Table 52). With the unusual exception of snow geese summering at both Hyatt and Meszaros Sloughs, all other species observed at any other wetland were also represented at Kraft Slough. Kraft Slough also had the greatest breeding species diversity. Comparison of actual numbers of birds using the areas is difficult because of differences in

Table 51

1979 OAKES AREA WETLAND HABITAT COMPARISON

Wetland	Marsh Basin[1/]	Open Water[1/]	Emergent[2/] To Open	Dominant Emergent	Emergent Pattern	General Comments
Big Slough	629.93	198.55	2.17	Cattail	Large, dense patches	Bisected by railroad and drainage ditch, fluctuating water level,
Meszaros Slough	466.84	94.44	3.94	Cattail	Predominant dense mat	Old drainage ditch, last marsh to green up.
Kraft Slough	339.47	78.05	3.34	Cattail	Good interspersion, wide pattern	No surface outlet, spring fed.
Bruns Slough	332.69	50.10	5.64	Cattail	Dense, new growth	Bisected by highway and drainage ditch.
Lake Taayer	279.93	150.60	0.85	Phragmities, cattails	Narrow peripheral ring	Alkaline, shallow and mostly open water.
Hyatt Slough	204.71	52.34	2.91	Cattail, alkali bulrush	Dense new growth	Primary water source is James River, shallow.
Pickell Slough	162.92	60.55	1.69	Phragmities, cattail, alkali bulrush	A few scattered pools	Eastern third with no standing water most of the year, shallowest studied.
Widmer WPA	103.57	48.04	1.15	Cattail	Dense residual	Not a single basin, but a group of small wetlands.
Bauer WPA (west)	80.85	0.00	0.00	Cattail, phragmities	Dense residual	Late green up date. No emergent free areas.
Bauer WPA (east)	44.61	24.27	0.83	Cattail	Thin peripheral ring	Drowned out cattails, was very dense last year.

1/Hectares
2/Emergent vegetation to open water ratio.

Table 52

1979 BREEDING SEASON MARSH BIRD OBSERVATIONS BY WETLAND

Wetland Bird Species	Largest wetland.....to smallest								
	Big Slough	Meszaros Slough	Kraft Slough	Bruns Slough	Lake Taayer	Hyatt Slough	Pickell Slough	Bauer WPA west	Bauer WPA east
Horned Grebe	bu	bu	Bu	bu					
Eared Grebe	Ba	Ba	Ba	bc	Bc	bu	bu		bc
Western Grebe			bc	Uu	bc	bu			
Pied-billed Grebe	Bc	Bc	Bc	Ba		Bc	bu	Bc	Bc
White Pelican			Fc	Fc	Fc	Fc			Fu
Great Blue Heron		Fu	Fu	Fu					
Green Heron			Ur					Ur	Ur
Cattle Egret			Bu						
Black-crowned Night Heron	Bc	Bu	Ba	Fc	Fc	Fc	Fc	Fc	Fc
American Bittern	Bc	bc	bc	Bc		bu	bu	bc	bu
White-faced Ibis			Br						
Canada Goose	bc		bc	Bc	Fc	Bc	Fu		
Snow Goose		Uu				Uu			
Mallard	Ba	ba	ba	Bc	ba	bc	Ba	ba	bc
Black Duck			Uu						
Gadwall	bu	bc	ba	Ba	bc	Ba	bc	bc	bc
Pintail	Bc	bc	Ba	bc	bc	bc	ba	bc	bc
Green-winged Teal		bu	bc	bu			bu	bu	bu
Blue-winged Teal	Bc	Ba	ba	Bc	bc	Bc	bc	ba	Bc
American Wigeon			bc			bu	bu		
Northern Shoveler	bc	bc	ba	Bc	bc	Bc	bc		bc
Wood Duck	Uu	Uu	Uc		Uc		Uu	Uc	Bu
Redhead	Ba	Ba	Ba	Bc	bc	Bc	Ba	bc	Uu
Ring-necked Duck	Uu	Uu	Uc	Uc	Uu		Uu		Uu
Canvasback	Bc	Bc	bc	bc	bc	Bc	Bc		Bu
Lesser Scaup	Uu	Uu	Uc	Uu	Uc	Bc	Uc		Uu
Ruddy Duck	Bc	Ba	Ba	Ba	bc	Ba	bc		bc
Marsh Hawk	bc	bc	bc	bc				bc	
Sora	bc	bc	bc	bc	bc	?	bc	?	
Virginia Rail		bc	bc	bc	bc		bc		
American Coot	Ba	Ba	Ba	Ba	bc	Ba	Ba	Ba	Ba
Common Snipe		bu	bu				bu		
Franklin's Gull	Fc	Fc	Ba	Fc	Fc	Fc	Fc		Fc
Black Tern	Bc	Bc	Fc	ba		Fc		Ba	Fc
Long-billed Marsh Wren	Bc	Ba	Ba	bc	Bc	bc	bc	bc	
Yellow-headed Blackbird	Ba	Bc	Ba	Bc	Bc	Bc	bc	?	bu

Breeding Status

B = breeding, eggs, or dependent young
b = breeding suspected (territorial)
F = feeding or loafing
U = Breeding status undetermined

Population Status

a = abundant, numerous
c = common for that species
u = uncommon, not often seen
r = rare, seldom detected

observability of species (egrets are easier to count than rails) and the height and density of emergent vegetation. Despite this, more birds nested and fed in Kraft Slough than in any other wetland studied. Kraft Slough had nearly 10,000 Franklin's gull nests, more than any other species, except blackbirds, on any marsh studied. Kraft Slough had more black-crowned night heron nests than any other wetland. Big Slough, twice the size of Kraft Slough, with the next largest colony, had serveral hundred fewer nests.

Dabbling ducks were well represented in most sloughs, and the mud bar loafing sites at Kraft Slough were often used by molting ducks. Redheads and ruddy ducks were abundant at Kraft Slough, but canvasbacks were more numerous on several other sloughs. Coot production was high in all sloughs.

Bird Observations of Note

Franklin's gulls.--arrived at Kraft Slough in record numbers this year. Also, more birds nested at Long Lake NWR, and breeding sites undetected in 1978 were found at Mud Lake and Sand Lake of Sand Lake NWR in northeastern South Dakota. In all cases, no gull nests were found closer to the shore than 100 m (330 ft) and most of the floating nests were over 1,000 m (3,300 ft) from the closest upland (Figure 25). The other wetlands studies in the Oakes Area had very little emergent vegetation 100 m (330 ft) from the nearest shore. The linear-shaped wetlands, although larger than Kraft Slough, either had very little emergent vegetation past 100 m (330 ft) from the shore or were less than 200-m (660-ft) wide. This points out the importance of relatively large size in combination with a generally round shape and sufficiently wide emergent buffer zone.

Relatively little historical information is available on numbers of Franklin's gulls at Kraft Slough. Gulls have been known to nest there for some time, but no population estimates were reported in the literature until 1974 when 400 pairs were estimated (Krapu and Duebbert 1974). In 1977, the marsh was mostly dry and no gulls nested there, but in 1978, the water level increased, and Franklin's gulls

FIGURE 25

KRAFT SLOUGH

scale 1:12000

reoccupied the same area of the marsh where they were observed in 1974 in similar numbers. In 1979, the nest count increased to nearly 10,000 nests, and the area of the slough that was occupied by the gulls expanded from a 100 m by 200 m (330 ft by 650 ft) area on the east side to fully occupying the entire east, north, and northwest cattails within 100 m (330 ft) of the central opening (Figure 25).

Some conclusions can be made despite the limited information on the Kraft Slough gull population. It appears that the gull colony is not a single cohesive unit that depends on the slough year after year. In dry years, the Franklin's gulls migrate back to the slough, and if no suitable nesting habitat is available may move to other areas where they may or may not nest. The extreme variation in the nesting population indicates that the colony is not a single unit, but rather a mingling of nesters from year to year. Also, 1978 marked birds were observed in the greatly expanded 1979 colony. This observation indicates that the 1979 colony was not a totally new colony, as at least some birds from the previous year were back. The 10-fold expansion is greater than could be attained through recruitment from successful nests. Franklin's gulls usually begin to breed the second year after hatching. In 1977, there was no nesting at all by gulls at Kraft Slough, so in 1979 there would be no recruitment of new nesters reared at Kraft Slough.

These observations indicate that Kraft Slough is an important part of the habitat of the region-wide gull population. Further observations of banded and marked birds will be necessary to define Kraft Slough's influence on Franklin's gulls.

Close examination of the 1:12,000 color infrared photographs of Kraft Slough revealed a new method for colonial water bird census. Franklin's gull nests showed up as distinct white dots among the emergent vegetation images. This allowed good nest counts to be made of the colony with very little colony disturbance. This discovery suggests a technique for more accurate counts of colonial nesting birds, particularly the difficult to count over-water nesting

ones. Good counts were possible in areas where the cattail cover was only in an early green-up stage. Tall cattails cover the nests, so it is important to obtain photos early in the summer. Also images were best near the center of each photo. For best results, one should be sure to have adequate photo overlap.

Observations were made at the end of July of about 20 young gulls that looked mature enough to fly, but when approached would awkwardly flop in an attempt to fly. Closer examination revealed substantial wing bone deformities; some had fused wrist joints that prohibited extending the wing, while others had abnormally curved humerus bones that prohibited flight. These observations suggest possible pesticide-influenced deformities.

White faced ibis.--were observed in 1974 at Kraft Slough exhibiting territorial behavior (Krapu and Duebbert 1974). No nests or young were found, so no confirmed nesting record was established for North Dakota. In 1978, no ibis were detected at Kraft Slough, but a breeding record was established for North Dakota at Long Lake NWR (Serr 1978). In 1979, a pair nested at Kraft Slough. The nest was successful, and three of the four fledglings were banded. The birds have recently been documented nesting just south of Kraft Slough at Sand Lake NWR in South Dakota (Serr 1978). This year, refuge personnel estimated 20 ibis were produced there (Schultz, refuge biological technician, pers. comm.). Indications suggest that these are not accidental records, but a definite expansion trend.

Cattle egret.--found nesting at Kraft Slough in 1978 established the third nesting location in North Dakota and the first for the southeast part of the State. Cattle egrets were seen in the area a few years ago by local farmers, but previous nesting had not been established. The single egret nest in the black-crowned night heron colony produced three young which were all banded prior to fledging. Sand Lake NWR, to the south of Kraft Slough, has also recently experienced a substantial cattle egret increase.

Wood duck.--had been reported at Kraft Slough earlier (Krapu and Duebbert 1974). In 1979, 47 wood ducks were counted, many of which spent all summer and molted in the area. Kraft Slough has very few trees and wood ducks might nest in the area if nesting cavity sites were available. The WPRS is planning to erect several of the YCC built wood duck houses at Kraft Slough, and it is likely that they will be occupied the first year. Providing cavity nesting sites should further enhance the wildlife production of the area.

The investigations that have been conducted reveal that Kraft Slough differs from other wetlands in the study area. It appears far more productive for certain species than any other in the 1,000-km^2 (400-mi^2) Oakes study area.

The current reservoir design for Taayer Reservoir involves adding more than 6 m (20 ft) of water to Kraft Slough. This would completely drown out all existing emergent vegetation. A new ring of cattails may form around the high waterline of the new reservoir, but the widely fluctuating reservoir water levels would leave the emergents high and dry early in the season. This would make them unsuitable for over-water nesters. Developing Taayer would adversely impact all of the over-water nesters now using Kraft Slough.

Inundation of Kraft Slough to form Taayer Reservoir would destroy the ecosystem now occurring there. Replacement of Kraft Slough would be difficult if not impossible, as several factors which make the slough unique are still unknown. Among the factors which have been identified include its rather large size combined with a generally round shape; a wide emergent buffer zone; a shallow (1.5-m or 4.9-ft) central opening approaching 25 percent of the wetland; stable water level in most years; good water quality; lacy interspersion of emergents and open pools of water; and an early green-up time. These characteristics, at a minimum, would have to be present to replace Kraft Slough, and the causes for some of these factors are unknown.

Wetlands with more open water than emergent vegetation received comparatively little use by feeding waterbirds. Central openings of marshes that had an emergent vegetation to open water ratio of 3:1 heavily used by feeding waterfowl on most calm mornings. For example, on a calm morning on either Kraft Slough or Hyatt Slough, one could observe a general and complete distribution of birds with broods over the entire open water area. Sloughs with a greater proportion of open water had large portions of open water free of feeding ducks on similar calm mornings.

Kraft Slough is a ground water, rather than a surface runoff dependent marsh. The water level in Kraft Slough was not subject to the same wide fluctuation that disrupted other wetland nesting. Many canvasback and redhead nests were observed flooded out by rising water levels in the marshes (Meszaros and Big Sloughs) connected by a drainage ditch. In just the opposite situation, some wetlands were left without much standing water by midsummer (Pickell Slough). While Kraft Slough has no surface water outlets, its water quality indicates that it must be percolating water out through its bottom, or the basin would have become highly saline over a period of years.

Of major significance to the wildlife production of Kraft Slough is the interspersion pattern of its emergent community. The emergent cattail growth is not a dense residual mat, but resembles a maze. The cattails are broken up by many small scattered pools with many interconnecting channels. This lacy interspersion pattern, more than any other factor, makes nesting habitat available to over-water nesters in Kraft Slough and particularly for diving species such as eared grebes, ruddy ducks, redheads, and canvasbacks. The factors that are responsible for keeping channels open in the Kraft emergent community are not understood.

Various possibilities for the formation of the pockets and channels occurring in Kraft Slough were examined but rejected. Water depth does not account for the patterns as cattails were observed growing at varying depths from the shore to the central opening, and the open pools and channels were not deeper in most instances then where cattails could

be found. Also, historical data derived from aerial photos indicates the pools and channels shift in position. This shifting precludes the possibility that scattered soil type variation causes the pattern.

Historically, muskrats have used Kraft Slough, though none have been present for the past 3 years. As many as 419 lodges were present on Kraft Slough in 1968, but the numbers declined due to disease (Elmer Lindseth, local trapper, pers. comm.) to a total of 7 lodges by 1974 (Krapu and Duebbert 1974), and by 1977 when the studies were initiated, no muskrats were observed. The vegetation still displays the lacy pattern which shifted from 1974 to 1979, in spite of the fact that the water level dropped in 1977 and exposed the emergent openings to cattail seeding. There has been high muskrat use of the other wetlands studied, yet these wetlands do not exhibit the lacy pattern of emergents. Therefore, it is unlikely that muskrats are responsible for keeping the emergents interspersed.

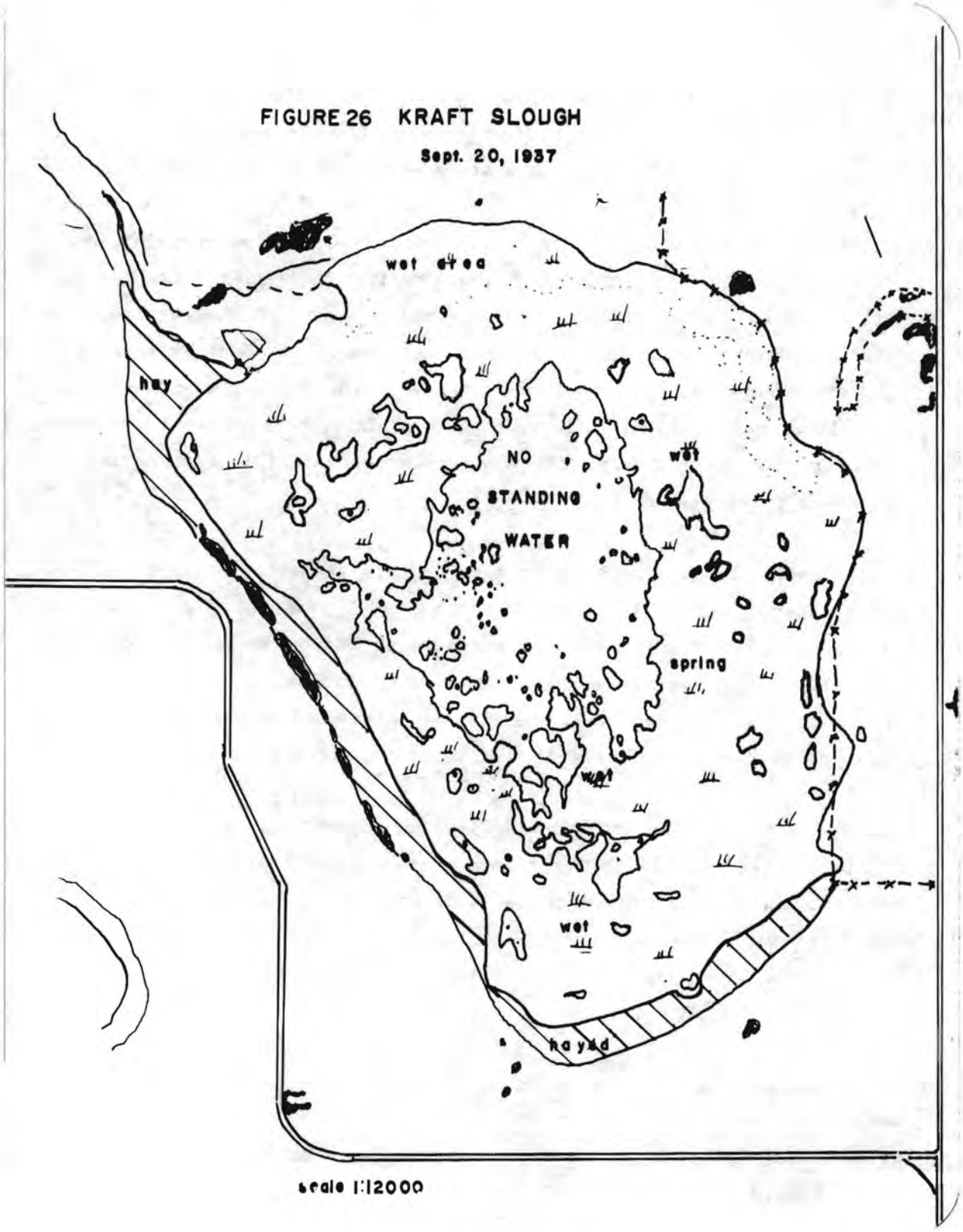
Historically, Kraft Slough shows a remarkable stability. Examination of aerial photos from 1937, 1960, 1968, and 1979 (Figures 26, 27, 28, and 29) shows quite similar vegetation patterns which are not the case for several of the surrounding sloughs and marshes. The ground-water influence and perhaps the underlying Spiritwood Aquifer (Armstrong, USGS, pers. comm.) can explain the relative stability of Kraft Slough.

Kraft Slough had one of the earliest green-up times of the wetlands studied. Meszaros Slough was over a month later in greening-up than the other marshes. The causes of the wide difference in green-up times was not determined, but many over-water nesters arrived while ice was still on the central pools. The earlier the green up time, the better protective cover for nests and broods.

Kraft Slough is in a relatively undisturbed state compared to other wetlands studied. Bruns Slough is divided by State Highway 13. Big Slough and Lake Taayer are bisected by railroad tracks. A major powerline crosses Meszaros Slough and was responsible for waterfowl

FIGURE 26 KRAFT SLOUGH

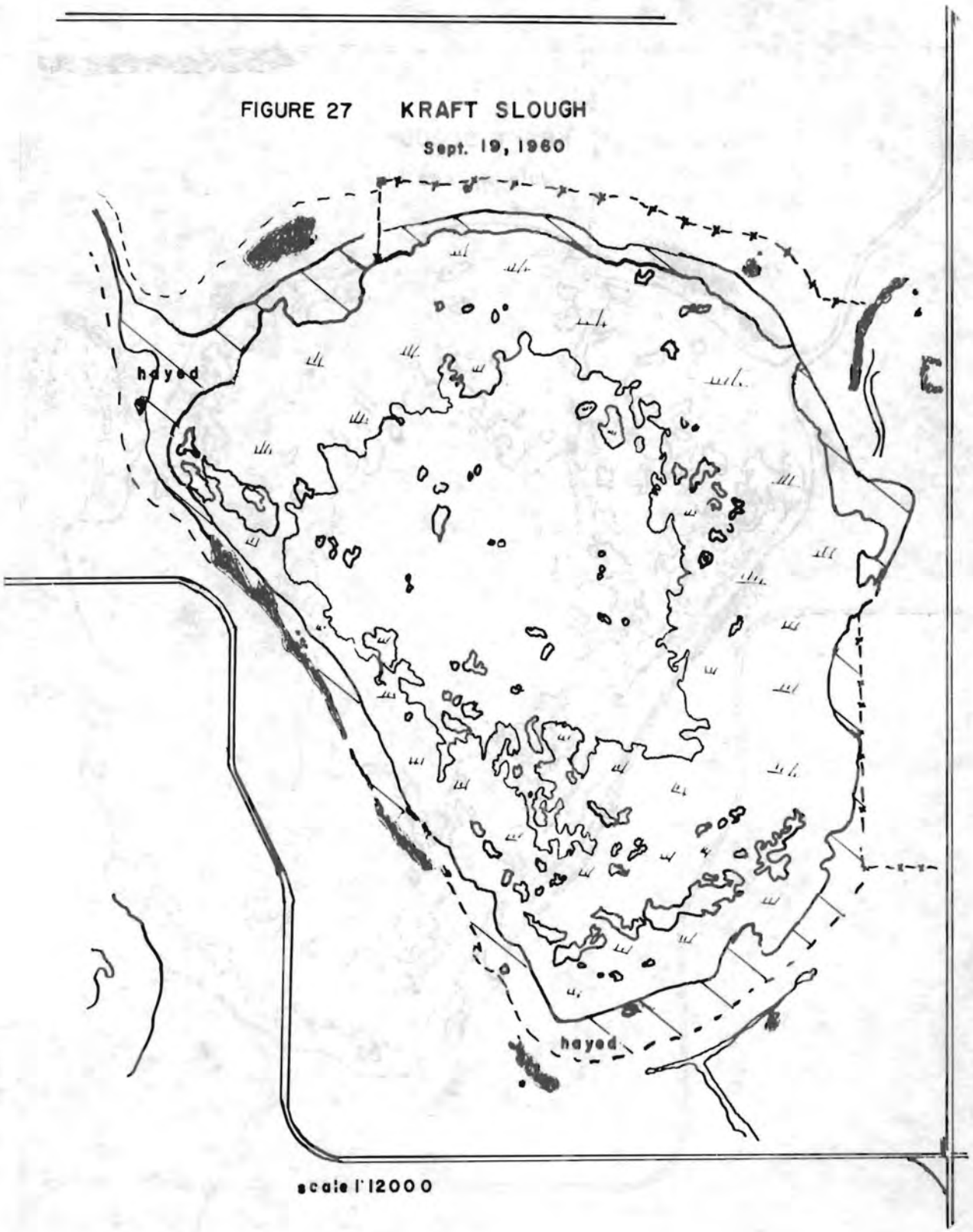
Sept. 20, 1937



scale 1:12000

FIGURE 27 KRAFT SLOUGH

Sept. 19, 1960



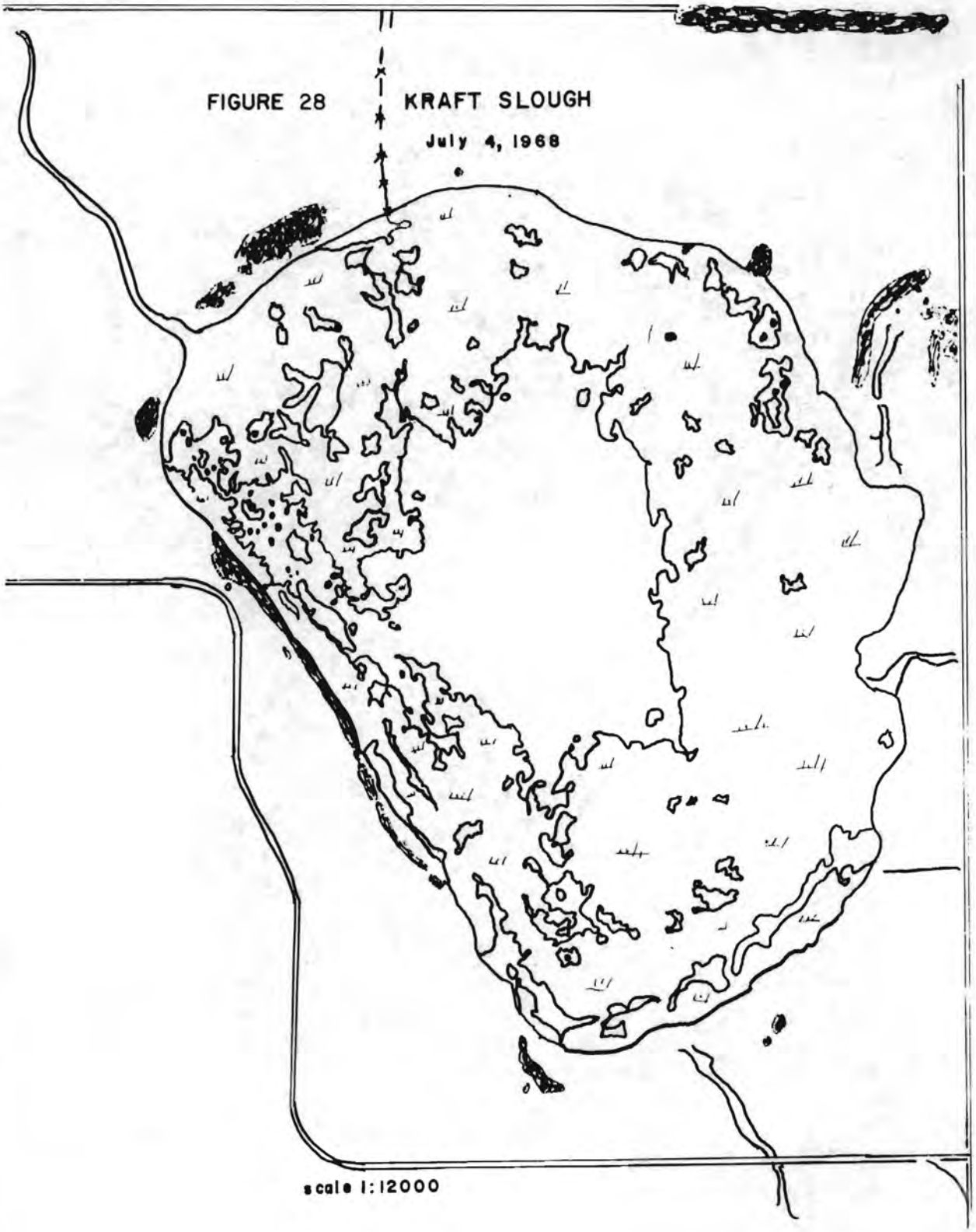
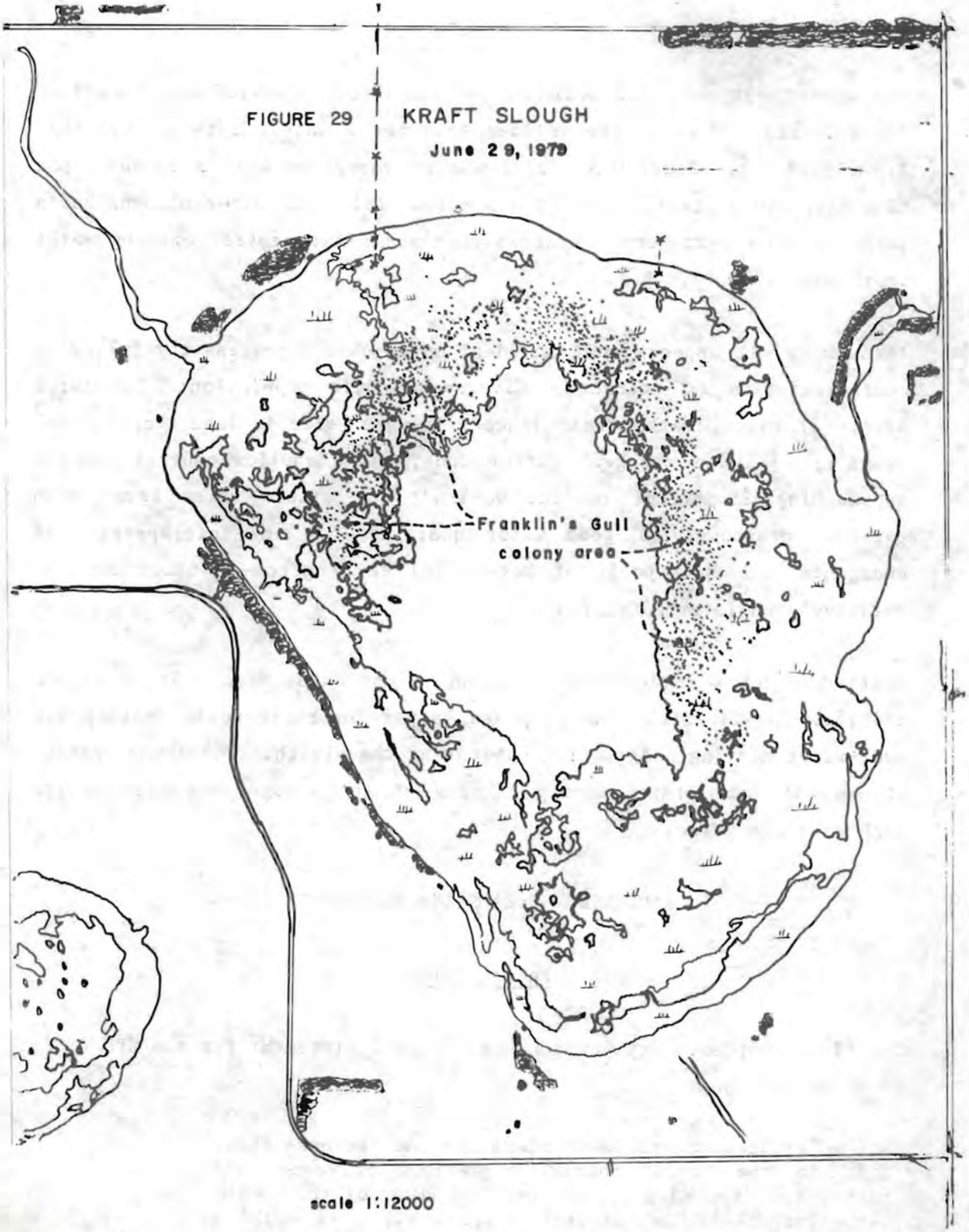


FIGURE 28
KRAFT SLOUGH
July 4, 1968
scale 1:12000

FIGURE 29 KRAFT SLOUGH

June 29, 1979



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mortality. Bruns, Big, and Meszaros Sloughs are all interconected by a drainage ditch.

The water depths of all wetlands in all places measured was less than 2 m (6.6 ft). Most of the wetland area had a water depth of less than 1.0 m (3.3 ft). Bauer WPA (east) was an exception with a rather rapid bank slope to a stable depth of 1.5 m (4.9 ft). All other sloughs had a large shallow periphery. Kraft Slough's maximum central opening water depth was 1.5 m (4.9 ft).

In summary, it appears that an ideal marsh should possess the following characteristics to attract a diverse wildlife population: (1) large size; (2) round, rather than linear, if marsh size is less than 1.6 km^2 (1 mi^2); (3) wide emergent buffer zone; (4) a shallow central opening approaching 25 percent of the wetland; (5) stable water level with periodic drawdown; (6) good water quality; (7) lacy interspersion of emergents and open pools of water; (8) early green-up time; and (9) relatively undisturbed state.

Kraft Slough is an important wetland in the Oakes Area. It is stable and rich in wildlife. The proposed Taayer Reservoir would destroy the over-water nesting and feeding habitat at the slough. The documentation of several rare State nesting records at the slough demonstrates its high wildlife value.

RECEIVING STREAMS INVESTIGATIONS

Introduction

The Final Supplementary Environmental Impact Statement for the GDU (FSES 79-7) states that:

> "Project waters would stabilize and increase flows in the James, Souris, Wintering, Sheyenne, and Wild Rice Rivers, and the Red River of the North. Increased fish habitat would result, as would a reduction of the incident of fish kills due to more oxygen and/or less seasonal drought. Present regular periods of low- and no-flow conditions would be alleviated. Increased and stabilized

> flows would also result in a change in the aquatic ecosystems. Increased flows would have a scouring effect in some reaches, and deposits of fine silty material may be reduced in size, thus increasing the diversity of substrates and aquatic invertebrates. This material would settle and gradually build up where the current slows in pools and vegetated reaches."

A major effect of increased fish habitat in the receiving streams would be to allow certain fish to expand their range. The International Garrison Diversion Study Board (IGDSB) recognized that increased fish habitat and movement could enable several fish species to move through the GDU from the Missouri River System to the Hudson Bay drainage and potentially impact the commercial fisheries in Canada as much as 75 percent. Of the species of special concern identified by the IGDSB, the gizzard shad is found in the lower James River (IGDSB 1976).

Investigations were initiated on the James River above Jamestown and the Sheyenne River near New Rockford in 1979. The James River will be the first major stream to be affected by the GDU in the Missouri River basin, and the Sheyenne River will be one of the first rivers in the Hudson Bay drainage to be affected by the GDU with the proposed development in the New Rockford and Warwick-McVille Areas.

The initial work in the receiving streams was centered on developing aquatic habitat evaluation techniques suitable for use on prairie streams such as the James and Sheyenne Rivers. Several such techniques have been developed primarily for use in cold-water, mountain-type systems, but are not entirely applicable to streams in North Dakota. Preliminary analysis identified several parameters which could be used in combination to determine the quality of prairie stream habitat. These included: bottom profile, velocity, substrate, water width, bank characteristics (including stability, composition, cover, and profile), aquatic vegetation, overall cover provided by shading from bank and aquatic vegetation, water surface height in relation to a fixed feature, benthic invertebrate communities, water quality, and photographic documentation of site appearances. When enough information is obtained

on a prairie stream to characterize various stream reaches, then accurate estimates of the suitability of the stream for various fish species can be made using life history data and fish collections. Other influences such as obstructions to fish movement, other fish species in competition, etc., may preclude the actual presence of a particular fish species.

Additionally, accurate records of these parameters can be used to document physical changes occurring to the receiving streams due to the GDU development and allow for modification of the operating plans to minimize impacts.

Following is a brief description of the James and Sheyenne Rivers followed by a general description of the actual methods used to measure the aquatic parameters.

James River Description

The James River originates in south-central Wells County near Fessenden, North Dakota. It flows east, then south through North Dakota and South Dakota to its confluence with the Missouri River near Yankton, South Dakota. In the upper reaches, the river forms a series of unconsolidated marshes and sloughs without any defined stream channel. River flows are variable and, in some years, cease by August. March through May are the normal high-flow periods; however, 1979 was exceptional with high flows continuing into August due to heavier than normal snowpack and rainfall. Total dissolved solids (TDS) as low as 200 mg/l have been recorded at peak flows of 11 m^3/s (400 ft^3/s), and TDS as high as 700 mg/l have been recorded during low-flow periods. The pH has ranged from 7.6 to 8.8, and the river is characterized as slightly alkaline.

Sheyenne River Description

The Sheyenne River originates in northwestern Sheridan County near Krueger Lake, North Dakota, and flows eastward to its confluence with

the Red River near Fargo, North Dakota. The upper sections of the river, as with the James River, have intermittent flows and a poorly defined stream channel. TDS ranges from about 200 mg/1 to 2,000 mg/1 with an average of 600 mg/1 recorded near Harwood. USGS records from 1975 to 1978 indicate a pH range from 6.9 to 8.6.

Methods

Thirty-two habitat sites were selected on the James River, and four were selected on the Sheyenne River. The average river distance between sites was 8 km (5 mi). Sites were located to avoid bias due to man-made influences such as bank stabilization and road crossings.

Each habitat site was 150 m (492 ft) in length and was crossed by a minimum of 5 transects, 30 m (98 ft) apart (Figure 30). Each transect was placed at right angles to the stream flow and was permanently marked with steel stakes driven into the ground. If a unique feature of the site was not crossed by a transect (i.e., the only high-quality pool in the site), then that feature was crossed by an additional transect.

The following measurements were made at each transect:

1. Depth: A minimum of 15 equally spaced depth measurements were made along each transect. The interval between depth measurements was determined by the water width at each transect. Depth was recorded between established intervals where the bottom topography changed radically.

2. Substrate: The substrate that occurred at each position where depth was measured was documented. The substrate was examined by hand and classified using the following criteria:

Boulders	over 30 cm (12 in) in diameter
Large rubble	15-30 cm (6-12 in) in diameter
Small rubble	7-15 cm (3-6 in) in diameter
Coarse gravel	3-7 cm (1-3 in) in diameter
Fine gravel	0.3-3 cm (0.1-1 in) in diameter
Sand	0.3 cm (0.1 in) in diameter

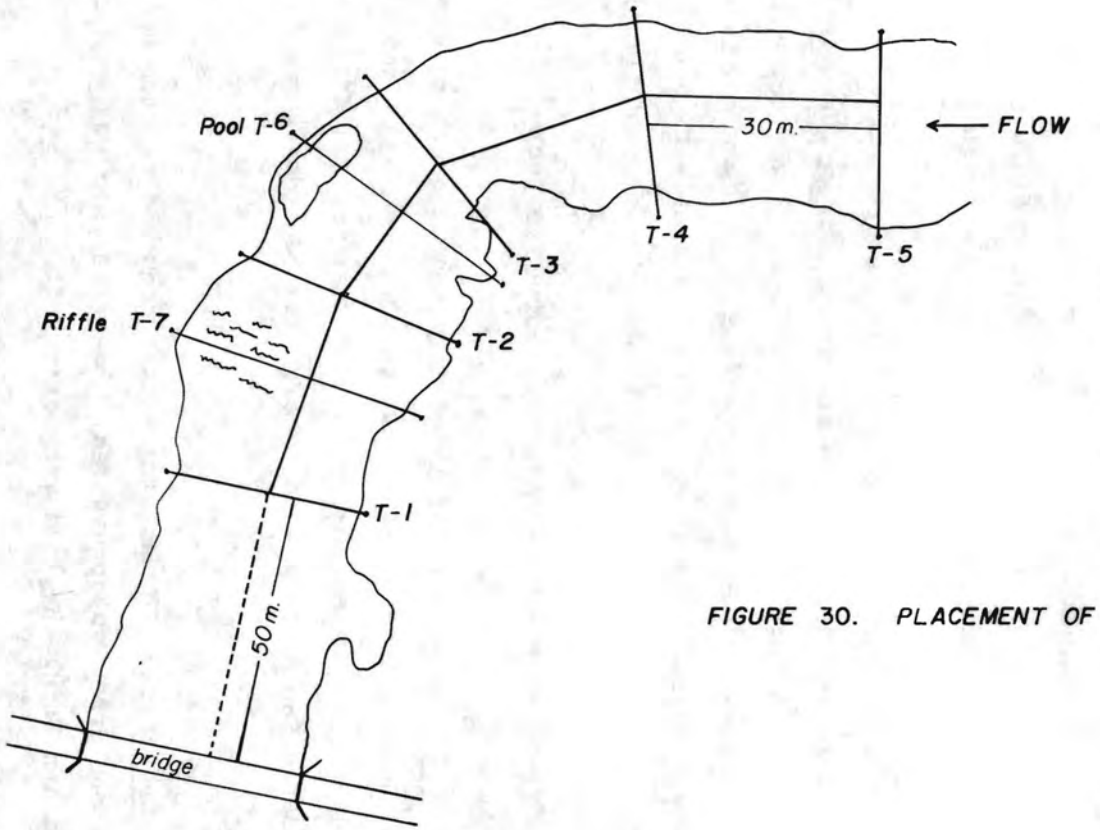


FIGURE 30. PLACEMENT OF TRANSECTS

Silt	very fine organic material mixed with clay and sand particles
Muck	decomposed organic materials

3. Total water width: Water width was measured at each transect. When a channel separation occurred, width measurements were recorded separately for each channel.

4. Bank profile: Horizontal and vertical measurements were made from water level to the high water mark or to the top of the obvious stream channel when the high water mark was more than 50 m (164 ft) from the water surface (Figure 31).

5. Bank cover: Bank cover with respect to cover over the water provided by shade was evaluated 15 m (49 ft) above and below each transect on both banks. The criteria was applied, if at any time during the day, the water surface was shaded by the bank vegetation. The prominent bank cover species were recorded.

6. Bank stability: The bank stability was evaluated 15 m (49 ft) above and below each transect on both banks. The bank stability was rated totally stable, greater than 50 percent stable, less than 50 percent stable, or totally unstable using the following criteria:

a. Totally stable: No evidence of bank damage, ungulate use, bank erosion, or sloughing. Rooted vegetation adding to stability.

b. Greater than 50 percent stable: Some erosion and sloughing present, but recovery present seasonally. Rooted vegetation adding to stability.

c. Less than 50 percent stable: Erosion and sloughing very evident, no recovery evident under most circumstances.

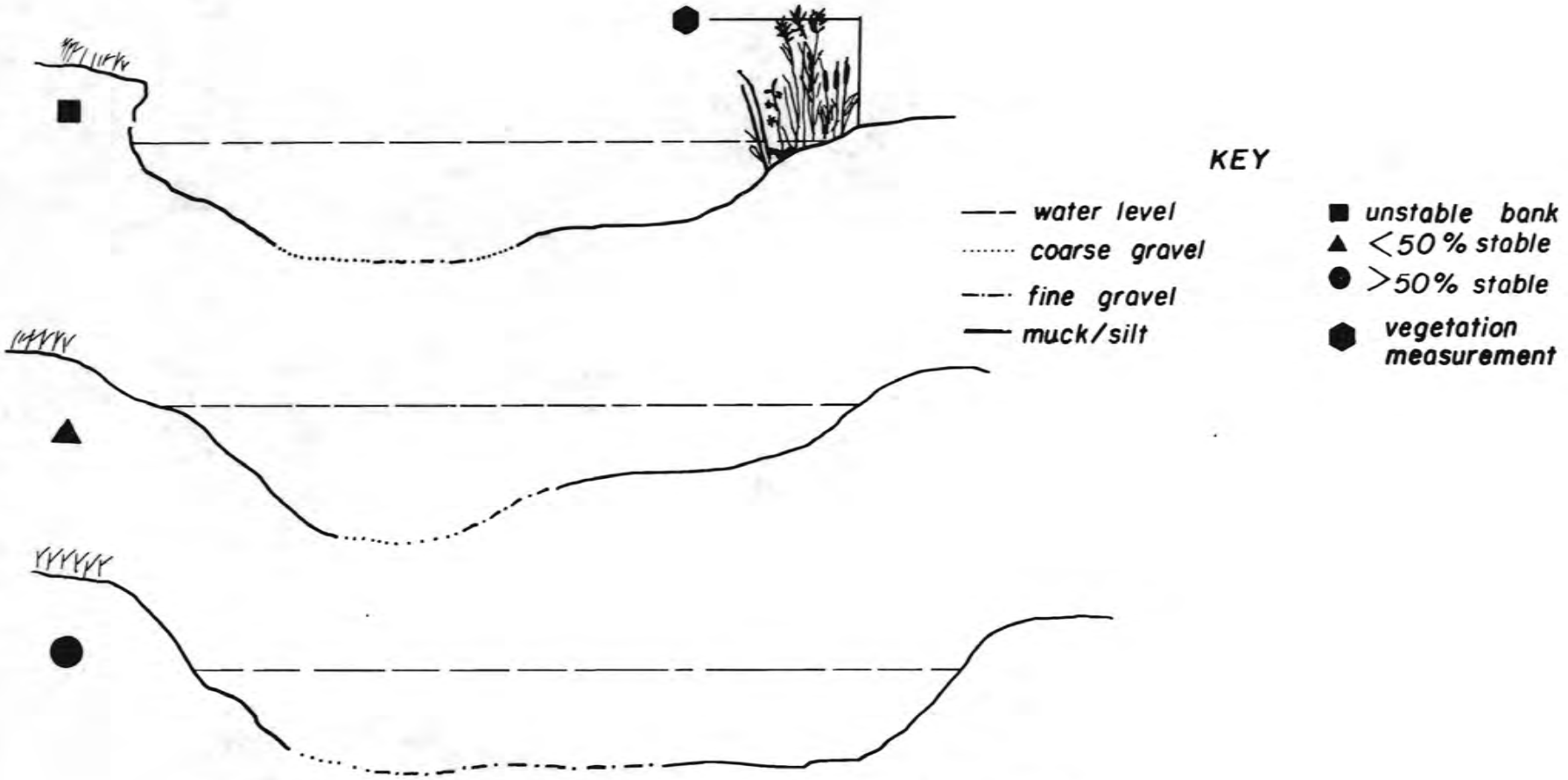


FIGURE 31 STREAMBED AND BANK PROFILE ANALYSIS

d. Totally unstable: Severe erosion and sloughing present and erosion constant.

7. Bank composition: Bank composition was recorded 15 m (49 ft) upstream and downstream of each transect. Bank composition was classified as loam, gravel, sand, clay, organic material, or as a combination of these.

8. Aquatic vegetaton: Linear measurements of the aquatic vegetation by species, both submergent and emergent, were made along each transect line.

9. Velocity: Three velocity measurements were made at each transect (one at the deepest point and one midway between the deepest point and each bank).

10. Pool-riffle ratio: The linear width of pools and riffles falling along the transect was recorded.

11. Pool quality: The quality of each pool encountered along each transect was subjectively determined using the following criteria:

a. High quality: At least 1 m (3 ft) deep, three times longer than wide, at least 50 percent cover due to shading, overhang, or submergent and emergent vegetation.

b. Medium quality: Greater than 30 cm (1 ft) deep, 10 to 50 percent cover, twice as long as wide.

c. Low quality: Less than 30-cm (1-ft) deep, 0 to 10 percent cover, less than twice as long as wide.

The following measurements were taken at each 150-m (492-ft) site surveyed:

1. Water surface: The height of the water surface from some permanent structure near the site was recorded.

2. Invertebrates: Duplicate benthic samples were taken at points within the site (i.e., duplicate samples from pool areas, riffle areas, etc.).

3. Water chemistry: Point readings using a multiparameter probe were taken at each site. Parameters measured included dissolved oxygen, pH, electrical conductivity, and temperature. Additionally, water chemistry information was obtained from USGS stations located on the James River including turbidity, TDS, and nutrient levels.

4. Photographic documentation: Each site was photographed to document general appearance.

5. Land use: General land use in the surrounding area was recorded at each site. This was classified as rangeland, cropland, idled, etc.

6. A general written description of the site was made including upstream influences, evidence of cattle erosion, feed lot influence, and any other observations of conditions which would affect the quality of the aquatic habitat or presence of fish.

Results and Discussion

James River

The composition of 160 transects (5,395 m or 17,804 ft) of river bottom was examined. Muck and silt constituted 71.6 percent of the substrate. Riffles and pools constituted less than 1 percent of the stream sections with the rest being classified as run type of habitat. Stream width varied considerably from a minimum of 9 m (30 ft) to a maximum of 107.5 m (355 ft). The average depth encountered was 1.1 m (3.2 ft.) with a maximum depth of 2.45 m (8.1 ft). Twenty-three species of aquatic plants were encountered with pond weed (Potamageton, sp.) the most prevelant. The James River showed a wide variation in physical habitat. The variation in habitats with regards to width, depth, and

available cover are displayed in Figure 32. Average width, average depth, and percent of cover provided by aquatic vegetation are illustrated in Figures 33, 34, and 35.

Sheyenne River

A total of 466.6 m (1,540 ft) of river bottom was examined for composition. Muck and silt comprised 57.7 percent and 25.7 percent of the substrate, respectively. The stream width varied from 12.4 m (41 ft) to 48.1 m (158 ft) averaging 23.4 m (77 ft). The average stream depth for the sites examined was 0.9 m (3.0 ft).

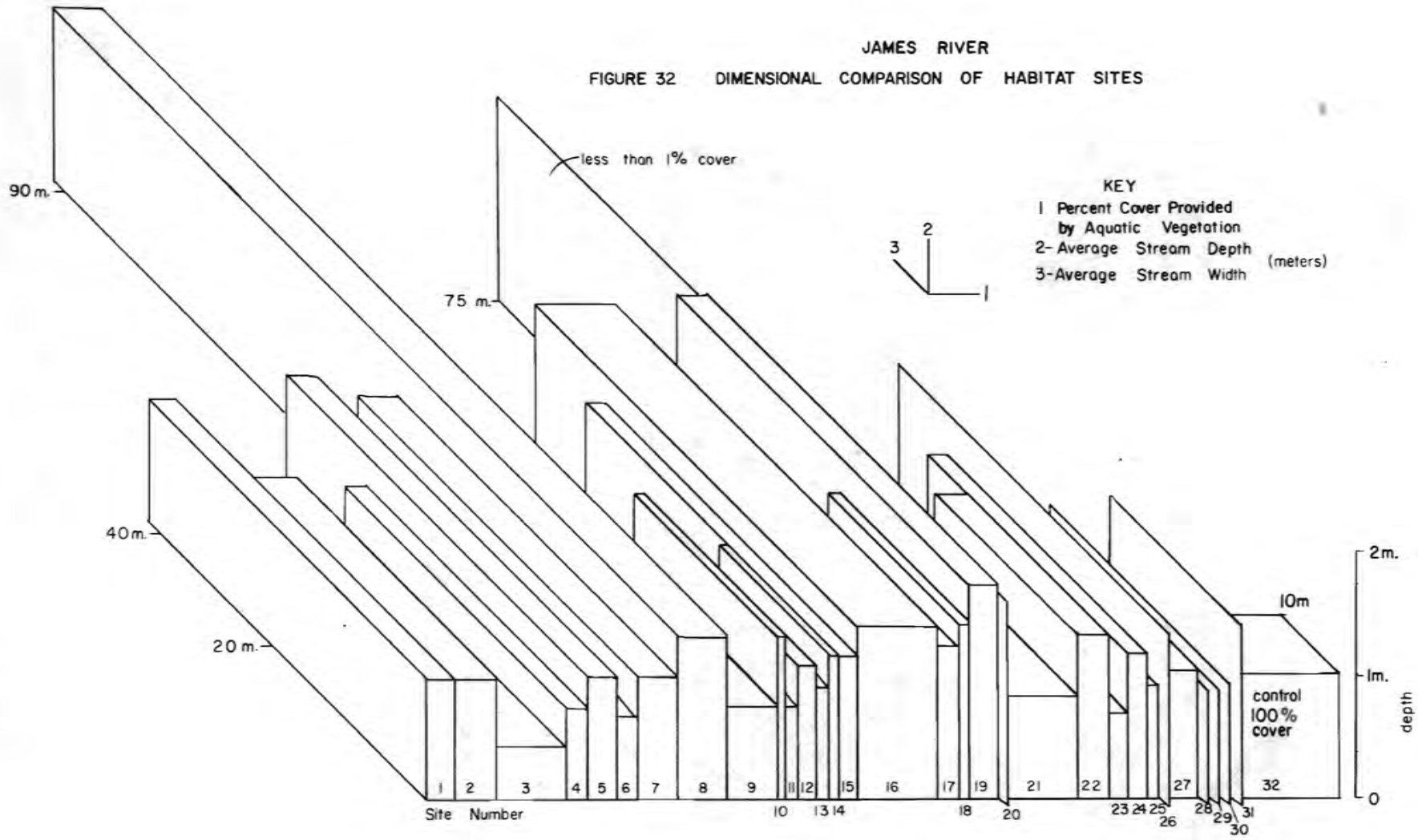
General

Methods used in 1979 will be used on selected sites in continuing years. Much analysis and background information needs to be gathered before any specific determination of habitat quality with relation to the fish species present or potentially inhabiting the receiving streams can be made. These studies show this technique can be used to accurately document physical changes in aquatic habitat due to GDU. This can be accomplished if 3 to 5 years of data are collected on the receiving streams before GDU flows enter them. The 3- to 5-year period is needed due to the variations in annual precipitation experienced from year to year in North Dakota.

Further research needs include documenting the fish species which occur at each site, and the habitat needs of those fish.

JAMES RIVER

FIGURE 32 DIMENSIONAL COMPARISON OF HABITAT SITES



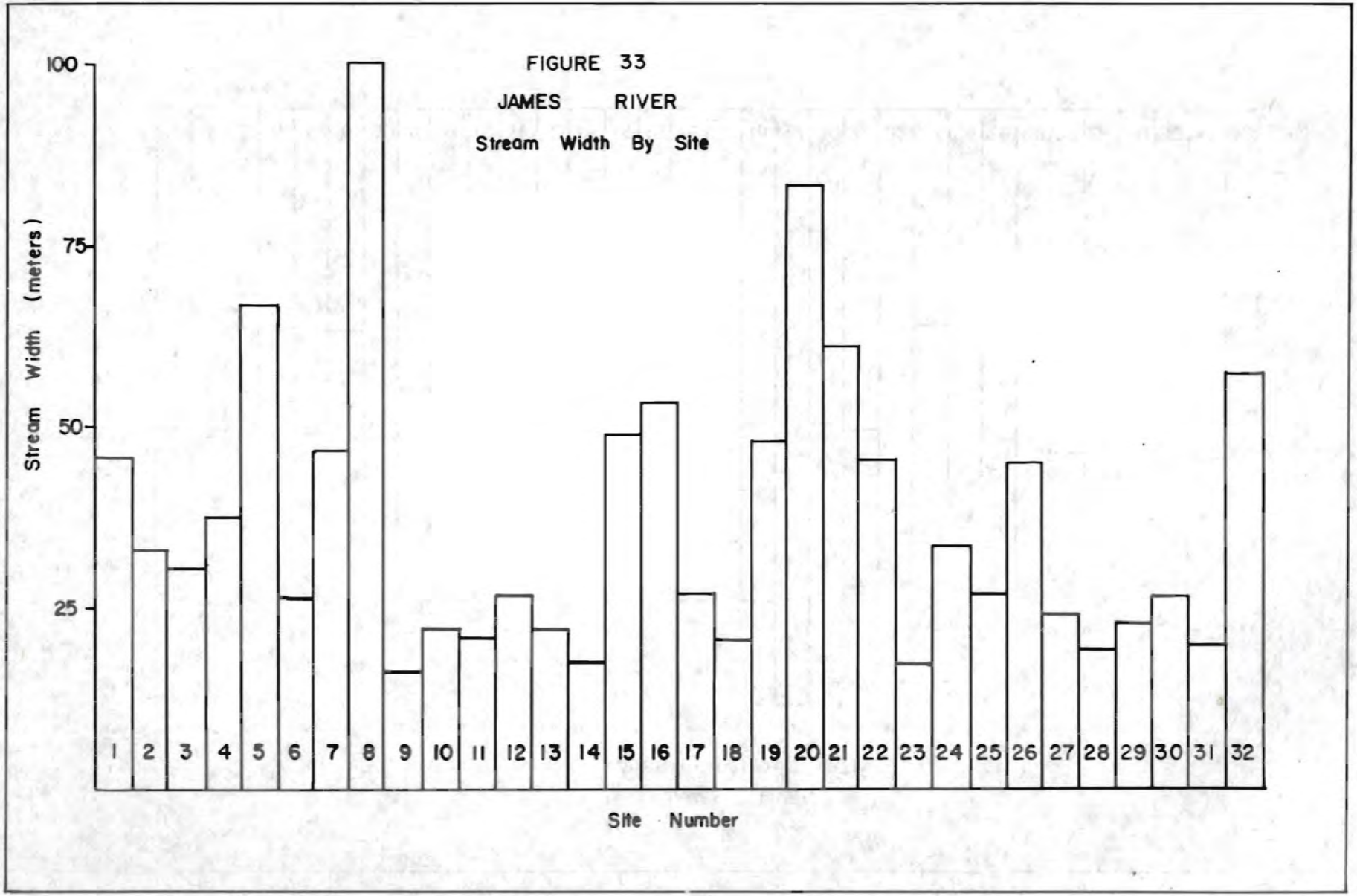
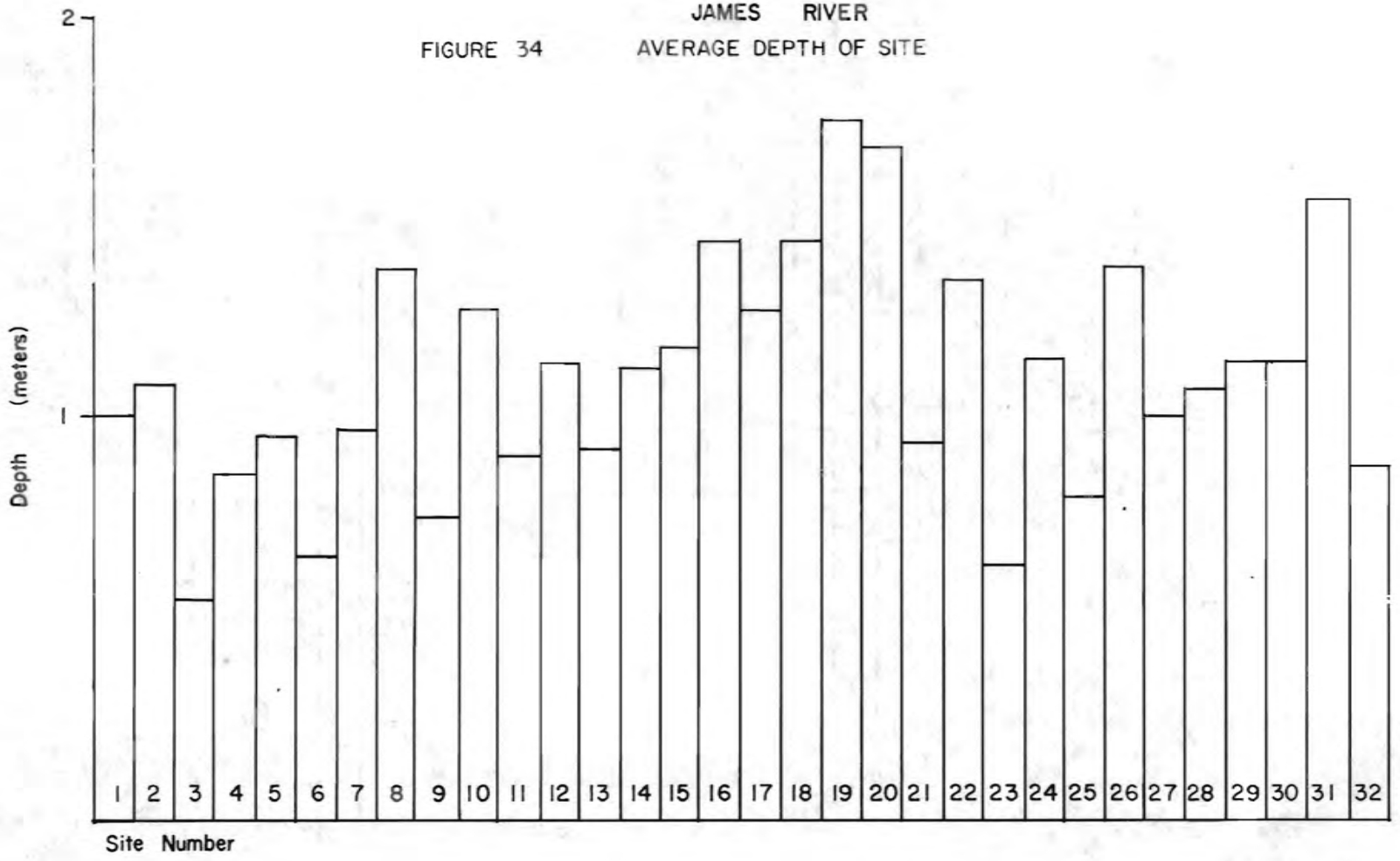


FIGURE 33
JAMES RIVER
Stream Width By Site
Stream Width (meters)
100
75
50
25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Site Number

JAMES RIVER

FIGURE 34 AVERAGE DEPTH OF SITE



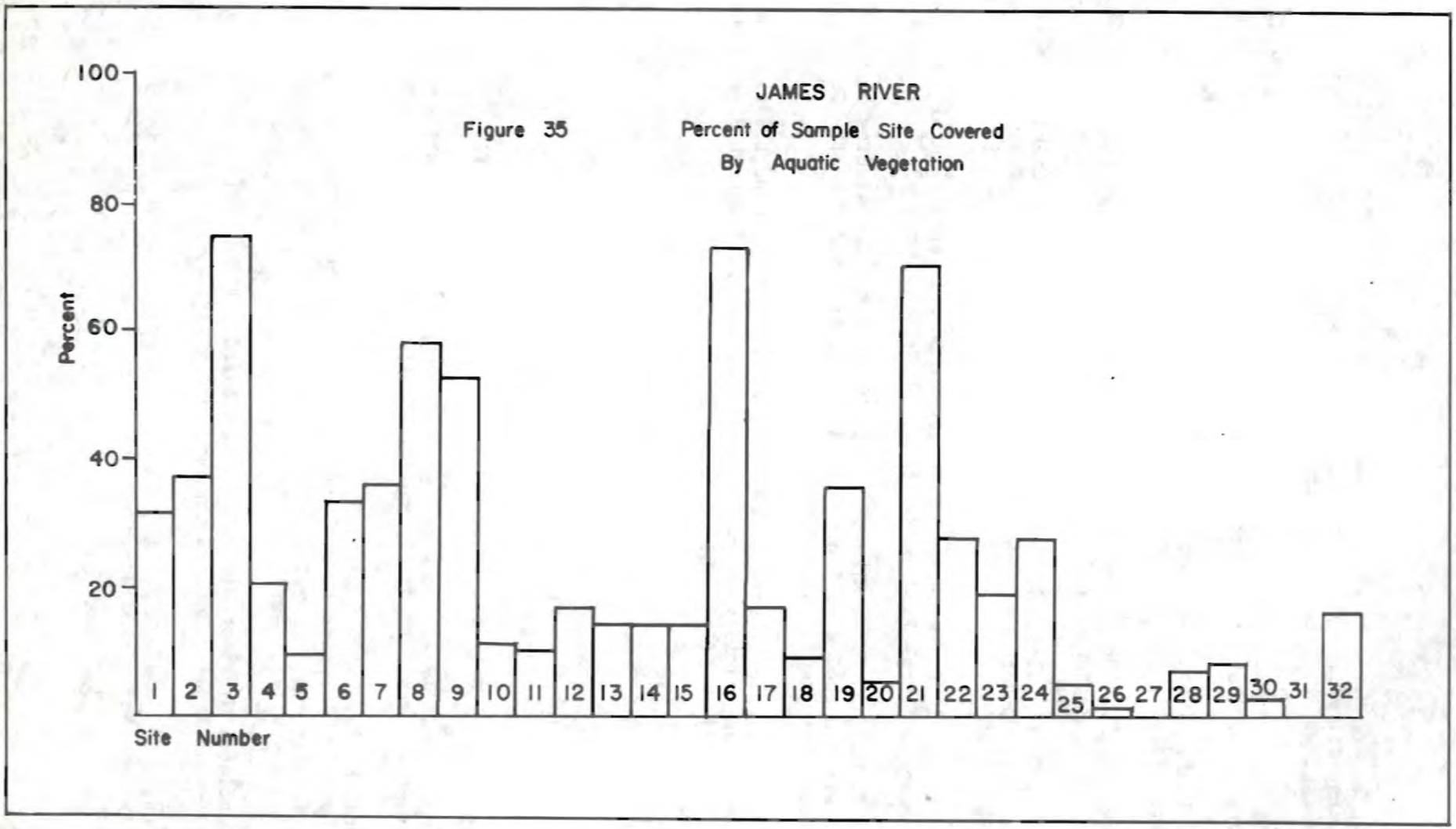

JAMES RIVER
Percent of Sample Site Covered
By Aquatic Vegetation
100
80
60
40
20
Percent
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Site Number

Figure 35

LITERATURE CITED

Basket, T. S., M. J. Armbruster, and M. W. Sayre. 1978. Biological perspectives for the mourning dove call-count survey. Trans. N. Am. Wildl. Nat. Resour. Conf. 43:163-180.

Cain, S. A., and G. M. de aliveira Castro. 1959. Manual of Vegetation Analysis. Harper and Brothers, N.Y. pp. 127-129.

Cline, D. R. 1965. Woodland pond habitat selection in ducks. M.S. Thesis, Univ. of Minnesota, Minneapolis. 142 pp.

De Bates, L. W. 1964. The value of the type I wetland. Presented at Minn. Regional Conf. 7 pp.

Duebbert, H. F. 1969. High nest density and hatching success of ducks on South Dakota CAP land. Trans. N. Am Wildl. Nat. Resour. Conf. 34:218-228

Dwyer, T. J. 1970. Waterfowl breeding habitat in agricultural and nonagricultural land in Manitoba. J. Wildl. Mgmt. 34(1):130-136.

Evans, C. D., and K. E. Black. 1956. Duck production studies on the prairie potholes of South Dakota. U.S. Fish and Wildlife Service Spec. Sci. Rept. Wildlife No. 32. 59 pp.

Golley, F. B., J. B. Gentay, L. D. Caldwell, L. B. Davenport, Jr. 1959. Number and variety of small mammals on the AEC Savannah River Plant. J. Mammal. 46(1):1-18.

Griffith, R. 1948. Improving waterfowl habitat. Trans. N. Am. Wildl. Conf. 13:609-618.

Hammond. M. C. 1969. Notes on conducting waterfowl breeding population studies in the North Central States. pp. 238-254 in Saskatoon Wetlands Seminar. Can. Wildl. Serv. Rep. Ser. 6.

_____. 1979. Waterfowl brood survey manual. Mimeo. 44 pp.

Higgins, K. F. 1977. Duck nesting in intensively farmed areas of North Dakota. J. Wildl. Mgmt. 41(2):232-242.

Higgins, K. F., L. M. Kirsch, H. F. Duebbert, A. T. Kleet, J. T. Lokemoen, H. W. Miller, and A. D. Kruse. 1977. Construction and operation of cable-chain drag for nest searches. U.S. Fish and Wildlife Service Wildl. Leafl. No. 512. 14 pp.

International Garrison Diversion Study Board. 1976. Report to the International Joint Commission. 255 pp.

Kantrud, H. A. 1973. Preliminary list of natural areas in North Dakota. Prairie Nat. 5(3):33-39.

Keeler, J. E. Mourning dove. In: Sanderson, G. C., Editor. 1977. Management of Migratory Shore and Upland Game Birds. Inter. Assoc. of Fish and Wildl. Agencies. 358 pp.

Keith, L. B. 1961. A study of waterfowl ecology on small impoundments in southeastern Alberta. Wildl. Mono. 6. 88 pp.

Kirsch, L. M. 1956. Spring grouse census and habitat inventory methods. Fish and Wildlife Service Wildl. Mgmt. Ser. Leafl. No. 13. 7 pp.

_____. 1969. Waterfowl production in relation to grazing. J. Wildl. Mgmt. 33(4):821-828.

Krapu, G. L. and H. F. Duebbert. 1974. A biological survey of Kraft Slough. Prairie Nat. 6(3):33-55.

Lingle, G. R. 1977. Food habits and sexing-aging criteria of the white pelican at Chase Lake National Wildlife Refuge, North Dakota. M.S. Thesis. Michigan Technological University. Houghton. 57 pp.

Linhart, S. B., and F. F. Knowlton. 1975. Determining the relative abundance of coyotes by scent station lines. Wildl. Soc. Bul. 2(3):119-124.

Matthiessen, P. In: Stout, G. D., Editor. 1967. The Shorebirds of North America. New York. Viking Press. pp. 19-135.

Mohler, L. L. 1963. Winter surveys of Nebraska prairie chickens and management implications. J. Wildl. Mgmt. 27(4):737-738.

Oetting, R. B., and J. F. Cassel. 1971. Waterfowl nesting on interstate highway right-of-way in North Dakota. J. Wildl. Mgmt. 35(4):774-781.

Page, G., and M. Bradstreet. 1968. Size and composition of a fall population of least and semipalmated sandpipers at Long Point, Ontario. Ontario Bird Banding. 4:82-88.

Page, R. D., and J. F. Cassel. 1971. Waterfowl nesting on a railroad right-of-way in North Dakota. J. Wildl. Mgmt. 35(3):544-549.

Post, W., and M. M. Browne. 1976. Length of stay and weights of inland migrating shorebirds. Bird Banding. 47:333-339.

Robel, R. J., J. N. Griggs, J. J. Cebula, N. J. Silvy, C. E. Viers, and P. G. Watt. 1970. Greater prairie chicken ranges, movements, and habitat usage in Kansas. J. Wildl. Mgmt. 34(2):286-306.

Rogers, J. P. 1959. Low water and lesser scaup reproduction near Erickson, Manitoba. Trans. N. Am. Wildl. Conf. 24:216-223.

_____. 1964. Effect of drought on reproduction of the lesser scaup. J. Wildl. Mgmt. 28(2):213-222.

Roughton, R. D. 1979. Developments in scent-station technology. Proceedings of First Midwest Furbearer Conference, Manhattan, Kansas. April 11-13, 1979. (Proceedings in press).

Salyer, J. W. 1962. Effects of drought and land use of prairie nesting ducks. Trans. N. Am. Wildl. Nat. Resour. Conf. 27:69-79.

Schroeder, C. H. 1978. Waterfowl populations study. North Dakota Game and Fish Department. Pittman-Robertson Report No. 786. Mimeo. 44 pp.

Serr, E. M. 1978. Breeding Season - Northern Great Plains Region. Am. Birds. 32(6):1176.

Sowls, L. K. 1955. Prairie Ducks. The Stackpole Company. Harrisburg, Penn., and Wildl. Mgmt. Inst. Washington, D. C. 193 pp.

Sparling, D. W. 1979. Reproductive isolating mechanisms and communication in greater prairie chickens (Tympanuchus cupido) and sharp-tailed grouse. Ph. D. Thesis. University of North Dakota. 238 pp.

Stewart, R. E. 1975. Breeding birds of North Dakota. Tri-college Center for Environmental Studies. Fargo, North Dakota. 295 pp.

Stewart, R. E., and H. A. Kantrud. 1972. Population estimates of the breeding birds in North Dakota. Auk. 89:766-788.

_____. 1973. Ecological distribution of breeding waterfowl populations in North Dakota. J. Wildl. Mgmt. 37(1):39-50.

U.S. Department of Interior. August 10, 1979. Joint memorandum from the Project Manager, Missouri-Souris Projects Office, U.S. Bureau of Reclamation, Bismarck, and the Area Manager, U.S. Fish and Wildlife Service, Bismarck, to the Regional Directors of the USBR and USFWS.

U.S. Department of the Interior, Bureau of Reclamation. 1979. Final Comprehensive Supplementary Environmental Impact Statement, Garrison Diversion Unit, Pick-Sloan Missouri Basin Program, North Dakota. INT FSES 79-7.

_____. 1979. Garrison Diversion Unit Biological Investigations: 1978 Annual Report. 107 pp.

U.S. Department of the Interior, Fish and Wildlife Service. 1975. Cooperative Breeding Bird Survey of North America. Migratory Bird and Habitat Research Laboratory, Laurel, Maryland. Mimeo. 4 pp.

_____. 1977. Standard operating procedures for aerial waterfowl breeding ground population and habitat surveys. Mimeo. 78 pp.

_____. 1978. Analysis of effects and methods for compensating for the Impacts of the Garrison Diversion Unit Alternatives on Wildlife. 280 pp.

Weller, M. W., B. H. Wingfield, and J. B. Low. 1958. Effects of habitat deterioration on bird populations of a small Utah marsh. Condor. 60(4):220-226.

Zimmer, K. J. 1979. A birder's guide to North Dakota. Denver, Colorado. L&P Press. 114 pp.

APPENDIX A - SUMMARY OF BIOLOGICAL CONTRACTS

Remote Sensing

Title: "An Analysis of a Remote Sensing Technique for Project Planning"

Contract No.: 60-V0011

Contractor: Environmental Research and Technology, Inc., 696 Virginia Road, Concord, MA 01742

Objective: Provide data describing land use and habitat using remote sensing techniques for the Central Section, Garrison Diversion Unit.

This data is to be used in a geographical information system for quick analysis of project impacts using various alternatives.

Progress: Color infra-red photographs were taken; initial field checking has been conducted and the technique was determined highly accurate. Final digitization of the data is being conducted by New Mexico State University Physical Sciences Laboratory.

Dakota Skipper

Title: "A Report on the Status of the Dakota Skipper (*Hesperia dacotae*) Within the Garrison Diversion Unit, North Dakota"

Contract No.: 9-01-62-08340

Contractor: Dr. Tim L. McCabe, New York State Museum, State Education Building N-982, Albany, NY 12234

Objectives: (1) Determine the present distribution of the Dakota skipper on lands proposed for irrigation development on the Garrison Diversion Unit, and (2) determine the amount, quality, and location of habitat suitable for Dakota skipper on lands proposed for irrigation development on the Garrison Diversion Unit.

Progress: Final report was issued from field work completed during the summer of 1979. Two sites within GDU contained the Dakota skipper. Dr. McCabe felt that the proposed GDU would not have any impact on the Dakota skipper.

Whooping Cranes

Title: "An Evaluation of the Impact of the Garrison Diversion Unit On Whooping Crane (Grus americana) Migration Habitat"

Contract No.: 14-16-0009-78-091

Contractor: University of Wisconsin, 750 University Avenue, Madison, WI 53706

Objectives: (1) To compile a catalog of information from all confirmed sitings of whooping cranes within the GDU area between 1950 and 1980, (2) to identify, quantify, and delineate on maps those wetlands with the GDU area that in 1979 were suitable for migrant whooping cranes to use for roosting, and (3) to provide on the basis of available information, an assessment of wetlands in the GDU area that will be suitable for migrant whooping cranes to use after the project is completed.

Progress: All field data was collected and compiled during the fall of 1978 and summer of 1979. Data analysis is now complete, and the final report is due in February 1980.

Fish Distribution

Title: "Distribution of Fishes in North and South Dakota Basins Affected by the Garrison Diversion Unit"

Contract No.: 9-07-60-V0029

Contractor: Dr. John B. Owens, University of North Dakota, Grand Forks, North Dakota 58201

Objectives: (1) To determine the present distribution of fish in the waters of North and South Dakota affected by the GDU, (2) to document the life histories of the fishes in the GDU system, and (3) to publish a book containing all the fishery information to date regarding the occurrence, distribution, and life history information of the fishes in the GDU system.

Progress: All work has been completed to date. Final publication is in draft form and will be completed and published in spring of 1980.

Fish Parasites

Title: "Analysis of Piscive Parasito-Fauna in Streams Within the Area of the Garrison Diversion Unit, North Dakota"

Contract No.: 14-06-600-1560A

Contractor: Dr. Harry Holloway, University of North Dakota, Grand Forks, North Dakota 58201

Objective: To determine the present occurrence of fish parasites in streams within the GDU.

Progress: All work has been completed and individual reports for each drainage within the GDU have been received. A final report is expected to be completed in 1980.

Utah Chub

Title: "Distribution of Utah Chub in the Missouri River Drainage"

Contract No.: 8-07-60-V0214

Contractor: Montana Department of Fish and Game, Route #3, Box 213, Bozeman, MT 59715

Objective: (1) To determine the present distribution of Utah chub in the Missouri River basin, (2) to determine the rate of downstream movement of the Utah chub since its introduction in the Missouri River system.

Progress: All work has been completed and a final report received. Since Utah chub was introduced to the system in 1935 at Hebgen Lake in 1935, it travel 312.7 river km (194.3 mi) from Hebgen Dam to Hansen Dam, and was first noticed in Hansen Lake 35 to 40 years later. This yields a dispersal rate ranging 8.9 km (5.5 mi) to 7.3 km (4.5 mi) per year.

Title: "A Study of Eggs and Early Larvae of the Utah Chub, *Gila atraria*"

Contract No.: 230-137-8

Contractor: Dr. Charles R. Berry, Utah State University, Logan, Utah 84322

Objective: To determine the variability of Utah chub egg and larvae size within and between chub populations in three Western states and to develop cultural methods for the laboratory maintenance of the Utah chub.

Progress: All work has been completed. The draft final report has been received and the final report will be completed in March 1980. Egg and larval sizes were determined and a manual for culture of Utah chub has been developed.

GPO 856-505