1989 WATERFOWL NESTING STUDY AND NESTING SUMMARY 1984-1989

BIG STONE NATIONAL WILDLIFE REFUGE
ORTONVILLE, MINNESOTA

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FEBRUARY 1989

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Big Stone National Wildlife Refuge

INTRODUCTION

The 1989 nesting season marked the sixth consecutive and final year that Big Stone personnel have conducted waterfowl nesting research. In addition, an experimental predator removal project was initiated in 1987. Skunk only removal from a unit was carried out and nest data was collected and compared to that of a control area where no predator management was conducted. This was designed to determine what effect, if any, skunk removal would have on overall nesting success and productivity of that area. This predator removal project also terminated at the end of the 1989 nesting season. A predator management plan and assessment was completed and approved in 1986. The Minnesota Department of Natural Resources concurred with this experimental predator management program.

Even though 1989 precipitation was less than that of the 1988 drought year, timely rains and adequate runoff dramatically improved breeding conditions on the refuge from those extremely poor conditions experienced in 1988.

This report will summarize our 1989 data and compare pertinent nesting data from those previous years studied.

Study Area

The 1989 nesting study was again conducted entirely within the 10,795 acre Big Stone National Wildlife Refuge (Fig 1). Seven fields were selected totalling 305 acres, a decrease of 54 percent from 1988 and 56 percent from 1987 efforts. Acreage searched in 1989 represents about 6.5 percent of the refuge's grassland habitat. The total study area included 215 acres of dense nesting cover (DNC), 78 acres of seeded warm season natives (WSN) and 12 acres of three year old alfalfa (Table I). No fields of poor WSN or native prairie were searched in 1989 due to either burning or haying of those fields. The overall reduction in habitat searched from previous years was primarily due to a lack of available manpower.

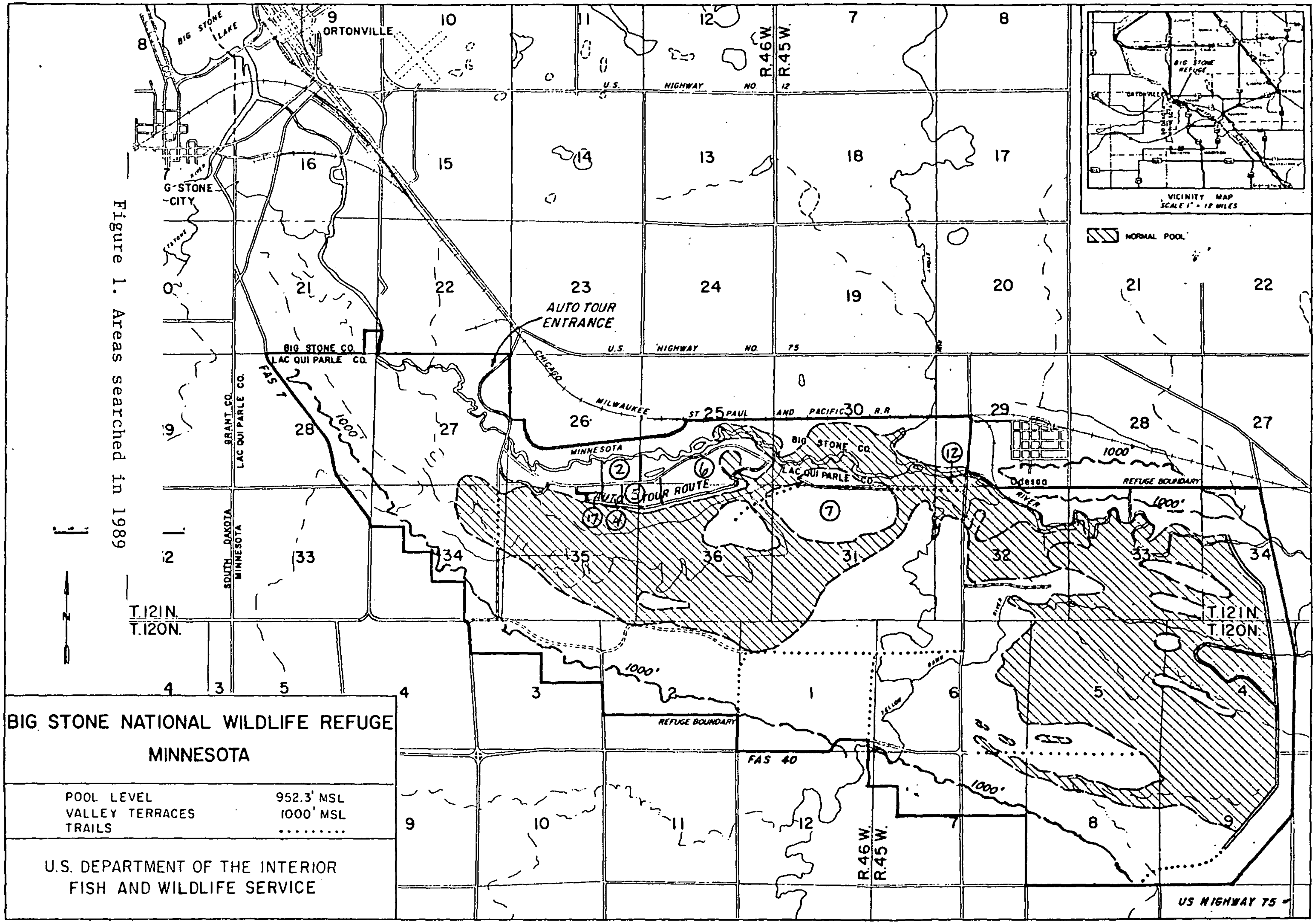

Figure 1. Areas searched in 1989

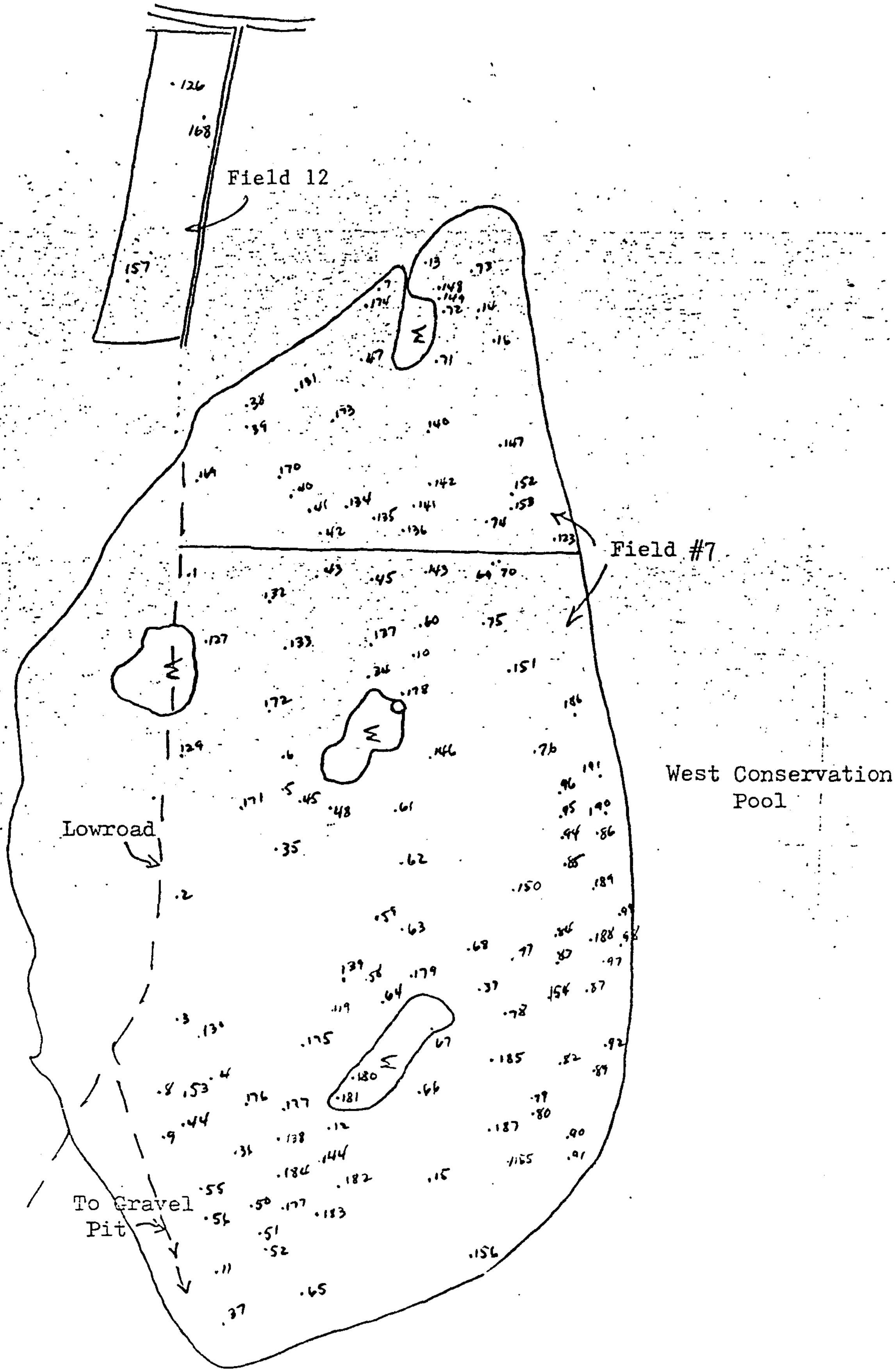

Figure 2 - Field # 7 Predator Management Area

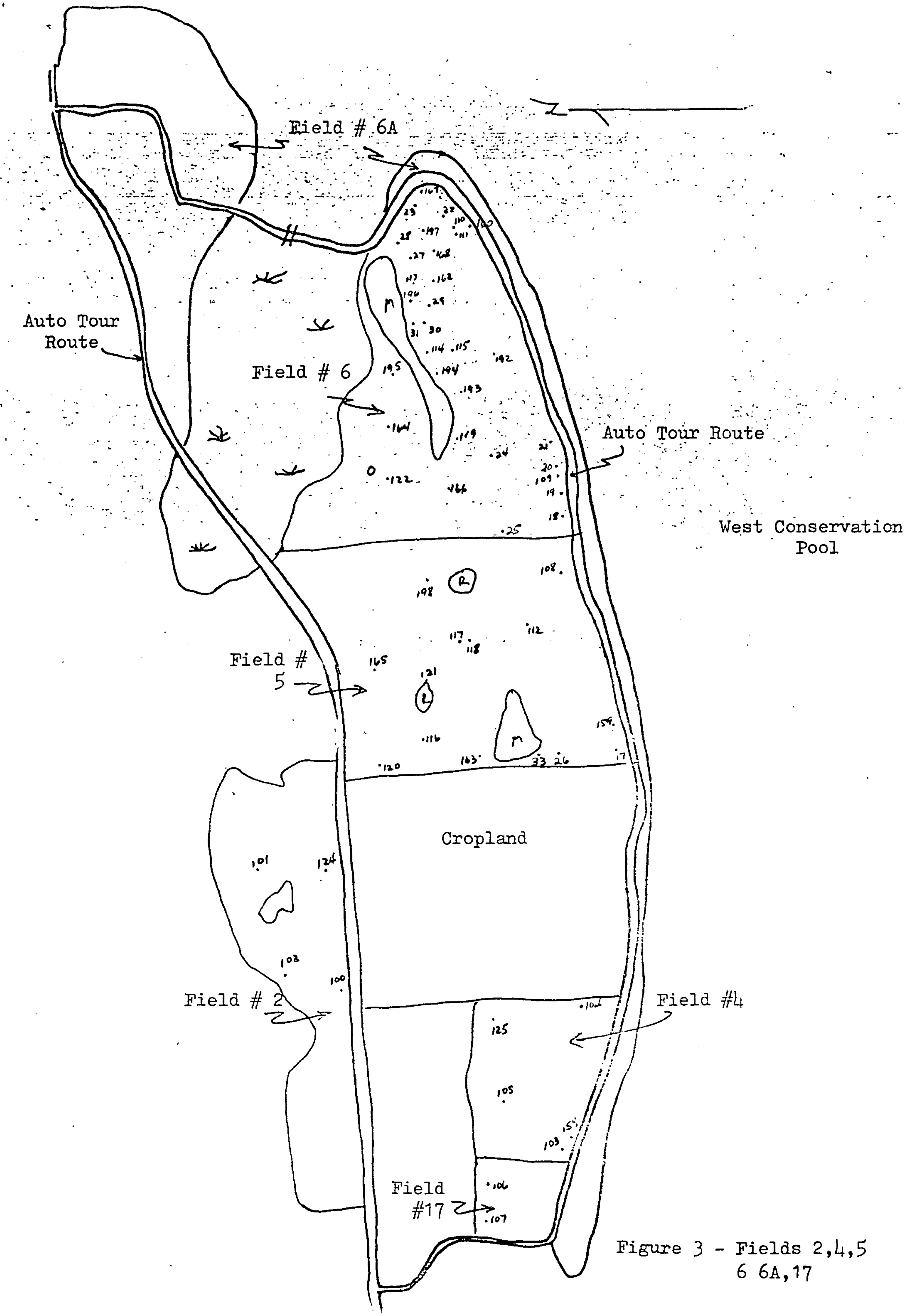

Figure 3 - Fields 2,4,5 6 6A,17

TABLE I - ACREAGE AND HABITAT TYPES OF ALL SEARCHED ACRES IN 1988

Field	Acreage	Habitat Type[1]	Times Searched	Nests Found
2	23	Warm Season Natives	4x	4
4	12	Alfalfa	4x	5
5	39	Dense Nesting Cover-N	4x	17
6	41	Warm Season Natives	4x	37
7	176	Dense Nesting Cover-O	4x	136
12	12	Warm Season Natives	4x	3
17	2	Warm Season Natives	4x	2
7	305	TOTALS		198

[1] (N) New Dense Nesting Cover
(O) Old Dense Nesting Cover

Methods

Similar to previous year studies, nests were located using the standard cable and chain drag as described by Higgens et al. (1977). Again the same vehicles and a four man search team was used and each field was searched a minimum of four times during the nesting season. The first search was conducted beginning May 18. The final search ended June 23. Nest search days were generally from 6 A.M. to approximately 1 P.M., the period hens would most likely be on their nests.

Results and Discussion

Part I. OVERALL NESTING

A total of 198 nests were located during the nesting season (Table I). Specific locations of these nests are shown in figures 2-3. Of the total, 180 (91%) of the nests were blue-winged teal, Anus discors, six (3%) were mallard, A. platyrhychos, seven (3.5%) were gadwall A. strepera three (1.5%) were northern shoveler, A. clypeata and two (1%) were pintail, A. acuta.

Nest Success

All but one of the 198 nests located were normal when found; 197 were used in the various calculations below. One teal nest was destroyed by the search vehicle when found. Only 17 of the 197 nests successfully hatched while 173 (87.8%) were destroyed by predators and seven (3.6%) were abandoned. Combining all species and habitats, the apparent hatch rate was 8.6% (17 of 197 nests). From a total of 1703 exposure days the daily survival rate (probability that a nest would survive one day) was calculated to be .8943. When this survival rate is projected over an average 34 day duration (combined egg laying and incubation periods) of a successful nest, the Mayfield hatch rate was 2.24% (determined by the 40 Percent Mayfield Method recommended by Johnson [1982]). A two percent Mayfield hatch rate corresponds to a hen success rate of about four percent, the probability that a hen will eventually succeed in hatching a clutch of eggs. This was determined from formulae presented by Cowardin and Johnson (1979). This is an unacceptable level needed to sustain a population of waterfowl. Gadwall had the highest

Mayfield success with 12.9 percent, mallard and teal had 2.1 percent and pintail and shoveler each had 0.2 percent success (calculated from only two and three nests respectively).

Nest Density

The total of 198 nests found in 305 acres searched equates to an apparent nest density of one nest per 1.5 acres of grassland or 64.9 nests per 100 acres. Using Miller and Johnson's (1978) formula which corrects for nests initiated and then destroyed and/or not found between searches, the expanded number of nest initiations on 305 acres is 759. This corresponds to a nest density of one nest per 0.4 acres or 249 nests per 100 acres.

In terms of expanded species density, blue-winged teal initiated 667 nests or one nest per .46 acres, mallard initiated 47 nests or one nest per 6.5 acres and gadwall initiated 16 nests or one nest per 19.1 acres searched. Density of shoveler and pintail nests could not be calculated without having any successful nests.

Nest Site Selection

Teal selected nest sites more frequently in DNC and alfalfa then in WSN (153 to 37) or nearly 80 percent. Mallard selected DNC more frequently than WSN (5 to 1) or 83 percent. Gadwall selected DNC more frequently than WSN (7 to 2) or 71 percent. Pintail (2 to 0) and shoveler (3 to 0) also selected DNC over WSN.

The dominant plants associated with teal nest sites were wheatgrass/alfalfa (3%), wheatgrass (19%), bluegrass (16%), brome (20%), big blue/Indiangrass (16%), brome/alfalfa (4%), quackgrass (16%), switchgrass (2%) and wet meadow forbs (4%). Mallard nest sites were dominated by big blue/Indiangrass (17%), brome (33%), quackgrass (33%) and snowberry (17%). Gadwall nests were dominated by big bluestem (14%), brome (29%), snowberry (14%), alfalfa/wheatgrass (29%) and goldenrod (14%). Shoveler nest sites were dominated by bluegrass (67%) and brome (33%). Two pintail nests were found in brome grass.

Egg Laying

Blue-winged teal averaged 10.4 eggs per clutch where full clutches were known. Teal averaged 9.9 eggs hatched per successful nest. Mallards averaged 7.8 eggs per clutch and 3 eggs hatched per successful nest. Gadwall averaged 10.8 eggs per clutch and 9 eggs hatched per successful nest. Shoveler averaged 9.7 eggs per clutch and pintail averaged 10 eggs per clutch with no successful nests.

Predation

Predators accounted for 173 of 180 (96%) of the nests that failed. The seven remaining nests were abandoned. Based on observations made at the nest sites and comparing those observations to known mammalian predator tendencies, we determined that 109 nests (63%) were destroyed by fox, 51 nests (29.5%) were destroyed by raccoon, 12 nests (7%) were destroyed by striped skunks and 1 nest (.5%) was destroyed by mink. These results are not surprising, based on September predator scent post survey results. Big Stone NWR had the highest fox index and second highest raccoon index of all scent stations surveyed in the state.

Part II COMPARISON OF NEST SUCCESS, NEST DENSITY AND PRODUCTION BETWEEN HABITAT TYPES

Nest Success

Mayfield hatch rate during 1989 was again highest in WSN (6.4%) and lowest in DNC overall (1.5%). Breaking down DNC into old seedings and new, old DNC (Field 7) had a success rate of 1.5 percent while new DNC (Field 5) also had a rate of 1.5 percent. Alfalfa had a nest success of 4.7 percent. Table VII in the summary section compares nesting success between habitat types and between nesting seasons from 1984-1989.

Nest Density

Nest densities for all species combined and corrected by Miller and Johnson's (1978) formula were highest in DNC (2.5 nests/acre) and lowest in WSN (1.6). Alfalfa had a nest density of 1.8 nests per acre. Table VII also compares densities of all habitat types and between nesting seasons.

Production

The number of successful nests per acre is a direct function of a specific habitat's productivity. This was calculated to directly compare waterfowl productivity between WSN, alfalfa, and the successional stages of DNC. Successful nests per acre searched for each habitat type was calculated by multiplying the Mayfield hatch rate by the expanded nest density. Productivity in the study area, treated as a whole was only .06 successful nests per acre or 6 nests per 100 acres of refuge grasslands.

WSN were, as they were in 1987 and 1988, more productive than DNC with .10 successful nests per acre compared to .04. Alfalfa's productivity was .08 successful nests per acre but this was based on only five nests located in 12 acres. Table VII in the summary section also compares productivity among habitat types and between nesting seasons.

Part III EXPERIMENTAL PREDATOR CONTROL

Procedures

Big Stone began an experimental three-year predator control program in 1987 where a 196 acre island (Fig. 2) was trapped for skunks prior to and during the nesting season. This area was selected for the study because of the ease of access (service roads connect the island), its isolation from other habitat management activities and three years of nesting data collected on 176 acres of this island prior to the 1987 season. The purpose of the program was to determine what effect, if any, a skunk only removal effort would have on nesting success (See Predator-Habitat Management Plan, December 1987 and Environmental Assessment 1986 for complete background information).

Trapping was done by refuge personnel, summer and/or work study students. Beginning April 19, 1989, ten Tomahawk Model 106 live traps were set out using cat food and fish oil for bait. A total of 388 trap nights were recorded as of June 30, 1989. A total of 24 raccoons, two skunks and two woodchucks were captured. Raccoons and woodchucks were released unharmed at the site. Skunks were euthanized by an injection of T-61 solution. Raccoons were first color-marked to determine if we were recapturing some of the same animals. No marked animals were recaptured.

In years prior to the predator management program, skunk predation was believed to be fairly high. In 1986, skunks were responsible for 23.4 percent loss of nests. In 1987 skunk predation was estimated to be 12 percent loss of those nests destroyed by predators. An outbreak of rabies in the area may have accounted for the reduction. In 1988 no evidence of skunk predation was observed in the predator management area or in the control area and in 1989 skunks accounted for 7 percent of destroyed nests.

Results

Nesting data collected during the pre-trapping years (1984-1986) and the predator control years 1987-1988 is shown in Table II.

TABLE II - WATERFOWL NESTING DATA COLLECTED
FROM PREDATOR MANAGEMENT AREA 1984-1989
(FIELD NO. 7 - FIG. 2)

	1984	1985	1986	1987[1]	1988	1989
Total nests	21	18	44	49	60	136
Number successful	3	10	12	25	3	6
Number unsuccessful	18	8	32	24	57	129
Number of nests predatorized	15	8	29	22	57	124
Number of exposure days	148.5	334.9	561.6	773.4	433.6	1116
Apparent nest success	14.3%	55.6%	27.3%	51.0%	5.0%	4.4
Mayfield nest success	12.4%	43.9%	13.6%	34.3%	0.7%	1.5%
Number of skunks trapped	---	---	---	1	4	2

[1] Skunk removal initiated and continued through 1989.

Concurrently, 129 acres were nest searched as a control (without any predator reduction). These upland areas were near the predator reduction area and included DNC, WSN and alfalfa fields. Table III below displays nesting data collected from the control area, 1987-1989.

TABLE III - WATERFOWL NESTING DATA COLLECTED
FROM NO-PREDATOR REDUCTION AREA - 1987 to 1989

	1987	1988	1989
Total number of nests	87	34	62
Number successful	43	15	11
Number unsuccessful	44	19	51
Number of nests predatorized	38	18	49
Number of exposure days	1170.4	426.6	587
Apparent nest success	49.4%	44.1%	17.7%
Mayfield nest success	26.1%	21.2%	4.5%

Nest initiations in the control area was 239 with a nest density of 1.85 nests per acre. This corresponds to a productivity rate of 9 successful nests per 100 acres. By comparison, the predator reduction area had 400 initiations with a density of 2.27 nests per acre. However productivity was extremely low with 3.4 successful nests per 100 acres. Differences in the Mayfield corrected nest success between the predator reduction area and the control were 1.5% to 4.5%. In 1988 the predator reduction area also showed a significant decrease in success over the control; 0.7 compared to 21.2 percent success. In 1987 nest success was higher in the predator reduction area than the control area (34.3% compared to 26.1%) but in that year only one skunk was removed from the area.

These results are contrary to what one would have expected. By removing one of the three major nest predators, nesting success should increase at least to some degree. However in the predator reduction area excessive fox predation took place and accounted for 76 (58.9%) of 129 nests destroyed by predators in 1989 and nearly 88% in 1988. Raccoon predation accounted for 31 percent and skunk accounted for 6.1% in 1989.

Conclusions

Based on three years of data, removal of only skunks did not reduce predation when an excessive predator population, other than skunks exist and thereby increase nest success significantly to justify the expense. Only a modest increase in manpower and equipment expense would be needed to reduce all major mammalian predators from a small area. However at this time we feel this approach is not appropriate for the refuge in total but is applicable to isolated islands in the east and possibly west conservation pools. This proposal for island predator control will be pursued.

Manpower Cost and Equipment

Primary nest dragging team consisted of Rich Papasso, Team Leader, Butch Christensen, Maintenance Worker, Carole Gerber, Office Assistant, Jim Heinecke, Project Leader and Summer Youth Employee, Scott Drobny. Additional assistance was provided as needed by Volunteer, Selma Felton. Usually four persons were involved in each drag, two operators and two observers. Nest location was much more efficient by triangulation from two observers. Breakdown of costs is shown on Table IV.

TABLE IV MANPOWER AND COSTS

NESTING STUDY	HOURS	COST
Permanent Staff[1]	250	3410
Volunteers/Summer Youth	60	---
Fuel/Supplies	---	220
TOTALS	310	3630
PREDATOR MANAGEMENT		
Permanent Staff	24	348
Summer Youth	25	---
Supplies/Fuel	---	120[2]
TOTALS	49	528

[1]Includes planning, report writing, nest cards and field work.
[2]Prorated over three years.

Part IV NESTING STUDY SUMMARY 1984-1989

INTRODUCTION

The primary goal of Big Stone NWR (approved master plan goals - November 18, 1986) is: to provide migratory bird production, resting and feeding habitat with emphasis on duck production. Over 42% of Big Stone's acreage is in upland grass habitat; native prairie, seeded native grasses, DNC or other tame grasses. Much of the capability of increasing production on the refuge involves management of these uplands to attract nesting hens and improve nest success.

There has been much discussion, as to what constitutes the "best" grassland habitat preferred by nesting ducks. The USFWS has conducted nest studies beginning in the late 1960's from Northern Prairie Wildlife Research Center, Jamestown, ND, and more recently, the Mid-Continent Waterfowl project Fergus Falls, MN, in an effort to answer that question. In Minnesota, most of the Wetland Management Districts have conducted their own nesting studies.

In 1982, the first systematic nest search study was conducted at Big Stone to add to the data collected elsewhere and gain a better prospective on nest density, nest success and habitat preference at Big Stone. Unfortunately, results of this study were not comparable to other nest searches because the Mayfield method, removing hatching rate bias, was not used and an insufficient nest sample was obtained. The first comparable study was begun in 1984 to gather habitat preference, nest density and nest success on the various grassland types. After six years of data collecting, this study was completed in 1989 and was designed to give sufficient data on upland waterfowl nesting habitat preference, nesting success, specific habitat type productivity and major causes of nest failure. Other aspects of waterfowl nesting biology obtained in this study were used to help determine actual yearly waterfowl production and waterfowl production objective setting.

STUDY AREA

The entire six year nesting study was conducted within the 10,795 acre Big Stone National Wildlife Refuge, located in extreme west-central Minnesota, Lac qui Parle County (Fig. 1).

A representation of typical seeded habitat type were selected for comparison purposes. During the study, 3,674 acres of nesting cover were searched averaging 612 acres per nesting season with a range of 746 to a low of 305 acres. The different habitats searched included:

- 2,242 AC DNC
- 1,362 AC Warm season native grasses
- 142 AC Tame grass
- 36 AC Alfalfa
- 12 AC Native prairie

Generally, DNC mixtures consisted of three pounds tall wheatgrass or three pounds crested wheatgrass, three pounds intermediate wheatgrass, two pounds alfalfa and one-half pound of clover per acre. Warm season natives (WSN) seedings consisted of a ten pound per acre pure live seed mixture of Indiangrass, big bluestem, little bluestem and switchgrass. Native grass fields that were sampled originated from imported (Nebraska) seed sources. No indigenous seeded natives were sampled.

We broke DNC and WSN categories down further to more accurately describe the condition of these sampled fields. A brief definition of those sub-divisions follows.

- Old DNC - Defined as stagnated seeding, ranging from 6-14 years old and comprised of legumes and grasses with a greater diversity of invading weeds/forbs, i.e. thistle, goldenrod, brome, quackgrass and bluegrass.

- New DNC - Defined as a rank stand of legumes and wheat grass with little or no invading forbs/weeds although some brome and quackgrass may be present.

- Tame Grass DNC - Defined as a generally monotypic stand of seeded domestic grass, primarily brome with few forbs and little residual ground cover density or height.

- Good WSN - Defined as the typical desired results of warm season native seed downs with Indiangrass, big bluestem and switchgrass with a moderate to dense understory and duff layer. Some invading patches of annual and perennial forbs and grasses are present but low in abundance and distribution.

- Poor WSN - Defined as a poor or spotty seeding with more quack, brome, weeds and forbs.

METHODS

The procedures outlined by Klett, et al (1986) were used throughout the study.

Nests were located by dragging 175 feet of 5/8 inch cable with three looped lengths of ¼ inch chain between two tow vehicles as described by Higgens, et al. (1977). The search team consisted of two drivers and two observers, one located behind each vehicle. A removable platform with hand rails was used behind a John Deere 2520 to safely transport one observer. The other observer was secured with removable hand rails in the back of a pickup truck. Nest location was much more efficient by triangulation from two observers. Most fields were searched an average of four times throughout the nesting season beginning around the first week of May to the last week of June each year.

Essential data were collected at each nest site when first found. This information included species of duck, number and incubation stage of eggs, vegetation density measurements at the nest bowl using a Robel pole and a record of dominant types of vegetation immediately surrounding the nest.

Incubation stage was determined by candling several eggs from each nest with a field candler as described by Weller (1956). Each nest was marked with a willow stake placed ten feet north of the nest bowl. Stakes were marked with flagging for easier relocation. A numbered tag was attached to the stake's base to confirm the nest number for future inspection. This proved particularly important when several nests were located close together. Nests were also mapped to aid in relocation.

Each nest was revisited to determine its fate (hatched, abandoned or destroyed). Revisits were either separate from or during subsequent nest drags but in either case, revisit intervals ranged from 10-15 days. If predicted hatching dates were sooner than the next scheduled search, efforts were made to visit those individual nests more frequently to more accurately predict the date of termination. All pertinent data was transferred to Habitat and Nest Record cards and submitted to Northern Prairie Wildlife Research Center.

Miller and Johnson (1978) pointed out the bias inherent in observed nest density and hatching success data. Traditional methods over-estimated nest success and under-estimated nest density primarily because many unsuccessful nests did not last long enough to be located by search methods. Mayfield (1961, 1975) was the first to recognize this problem. A statistical procedure was developed to compensate for those errors based on observed days of nest exposure. An exposure day is defined as each day a located nest is active and under observation. Johnson (1979) slightly modified the procedure to make it more applicable to waterfowl nesting data. We used this revised procedure, called the Mayfield-40% method, to evaluate density and hatching success of the nests we located. Essentially, when nests had thirteen days or less exposure between the last visit when the nest was viable and the date fate was determined, we used 50 percent of the number of exposure days for that interval. When a nest's fate was determined fourteen or more days after a viable nest visit, 40 percent of the exposure days were used in the calculations. Calculation procedures used in this study also follow those described by Klett et al. (1986) and are listed on the following page.

Nesting Success Calculations

- **Observed Nest Success** = $\frac{\text{Number of Successful Nests}}{\text{Total Number of Nests Found}}$

- **Mayfield Nest Success**

  Daily Survival Rate (DSR) = 1 - Daily Mortality Rate (DMR)

  Where:

  Daily Mortality Rate = $\frac{\text{Number of Unsuccessful Nests}}{\text{Total Exposure Days}}$

  Exposure days were calculated by the 40 percent Mayfield Method proposed by Johnson (1979).

  Success Rate = DSR^{D}

  Where:

  ^{D} = Nest duration in days; the egg laying period + incubation period. For blue-winged teal we used 34 days and for gadwall and mallard we used 35. For overall nest success we used 34 days as a weighted average.

Nest Density

- **Observed Nest Density** - The actual number of nests found per area searched.

$$\frac{\text{Number of Nests Found}}{\text{Acres Searched}}$$

- **Expanded Nest Density** - An estimate of all nests initiated per acre removing the bias of nests initiated and destroyed and therefore not found between searches.

$$\frac{\text{Number of Successful Nests}}{\text{Mayfield Success Rate}} = \text{No. of Nests Initiated}$$

$$\frac{\text{Number of Nests Initiated}}{\text{Acres Sampled}} = \text{Nest Density (\#/Acre)}$$

- **Productivity** - A numerical expression to compare estimated waterfowl production between habitat types.

  Mayfield Success Rate x Expanded Nest Density = Successful Nests/Acre

RESULTS AND DISCUSSION

OVERALL NESTING

A total of 678 nests were located during the study. Nesting species found and percentage of the total are shown in Figure 4.

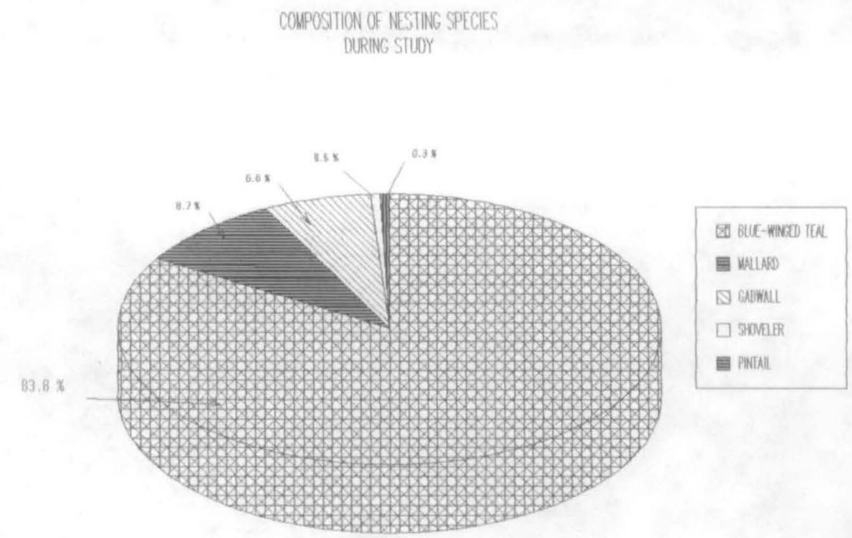

Figure 4. Nesting species found

Nest Success

Of the 678 nests located, 659 were considered normal when found and used in nesting success computations. A total of 179 nests successfully hatched for an apparent nesting success of 27.2 percent. Of the remaining nests, 447 (67.8%) were destroyed by predators and 33 (5%) were abandoned.

From a total of 7,481.8 exposure days, the daily survival rate (probability that a nest would survive one day) was calculated to be .9358. When this survival rate is projected over an average nest duration of 34 days (combined egg laying and incubation periods) of a successful nest, the Mayfield corrected nest success was 10.5 percent (determined by the 40 Percent Mayfield Method recommended by Johnson [1982]). A ten percent Mayfield hatch rate corresponds to a hen success rate (probability that a hen will eventually succeed in hatching a clutch of eggs) of about 23 percent (Cowardin, 1979). Yearly data collected during the study show significant improvement in nest success from 1984 up to 1988. It then declined dramatically over the final two years (Fig. 5).

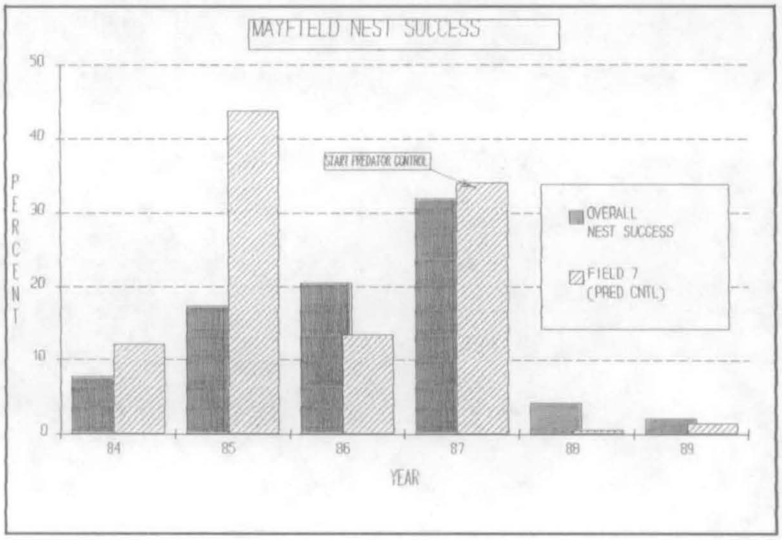

Figure 5. Nest success over study period

Table V below compares apparent and Mayfield nest success between all species found during the study. Overall, gadwall had the highest Mayfield success with 15 percent while mallard and teal had 10.5 and 10.3 percent respectively (Fig. 6).

TABLE V - COMPARISON OF NEST SUCCESS BETWEEN
SPECIES OF WATERFOWL FOUND DURING 1984-1989

	1984			1985			1986			1987			1988			1989		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
BWT	71	21.7	7.6	38	28.9	14.8	100	41.4	22.8	108	51.9	34.0	71	19.7	4.8	180	7.8	2.1
GAD	9	0.0	1.1	7	57.1	47.6	4	25.0	17.0	8	50.0	27.0	10	10.0	1.4	7	28.6	12.9
MAL	5	40.0	19.8	5	20.0	10.2	10	10.0	3.5	20	40.0	22.8	13	23.1	3.4	6	16.6	2.1
SHOV													1	0	3	3	0	0.2
PINT																2	0	0.2

Column A - Number of Nests
Column B - Observed Success (%)
Column C - Mayfield Success (%)

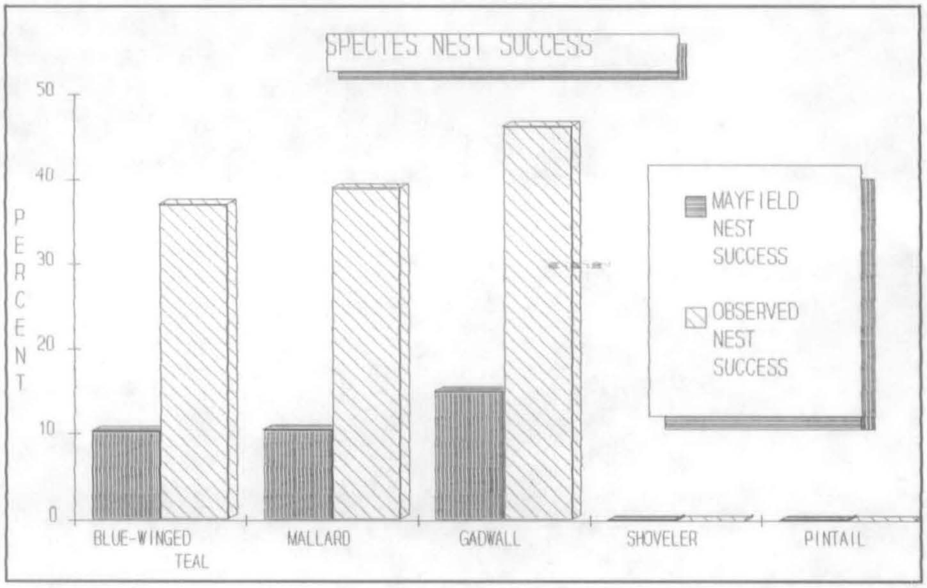

Figure 6. Nest success by species over study period.

Nest Density

The total of 678 nests found in 3,674 acres searched equates to an apparent nest density of one nest per 5.4 acres of grassland or 18.5 nests per 100 acres. Using Miller and Johnson's (1978) formula which corrects for nests initiated and then destroyed or not found between searches, the expanded number of nest initiations on 3,674 acres is 1,686. This corresponds to a nest density of one nest per 2.2 acres or 45.5 nests per 100 acres. Table VI displays nest density over the study period.

TABLE VI - COMPARISON OF NESTING DENSITIES DURING 1984-1989 STUDY PERIOD

	1984	1985	1986	1987	1988	1989
Actual no. nests found	81	51	118	136	94	198
Acres Searched	613	660	746	693	57	305
Apparent nest density (per 100 acres)	13.2	7.6	15.8	19.6	14.3	64.9
Expanded number nest initiations	215	92	203	212	419	759
Expanded nest density (per 100 acres)	35.1	13.9	27.2	30.7	63.7	249

In terms of expanded species density, blue-winged teal initiated 1,444 nests or one nest per 2.5 acres, mallard initiated 153 nests or one nest per 24 acres and gadwall initiated 86 nests or one nest per 42.7 acres searched. Density of shoveler and pintail nests could not be calculated without having any successful nests.

Nest Site Selection

Overall, upland nesting waterfowl nested in DNC fields 70.4 percent of the time compared to 29.6 percent in warm season natives during the study. Since tame grass, alfalfa and native prairie habitats comprised only a very small portion of the total habitat searched and small percentage of nests found, nests that were located there were included in either DNC or warm season native habitats.

By species, 73 percent of blue-winged teal nests were located in DNC, 76 percent of gadwall nests were in DNC and 43.5 percent of mallard nests were in DNC.

Predation

Predators accounted for 450 of 483 (93%) of the nests that failed. Based on observation made at the nest sites and comparing those observations to known mammalian predator tendencies we determined that 228 nests (51%) were destroyed by fox, 109 nests (24%) were destroyed by raccoon, 34 nests (7.5%) were destroyed by skunk and 79 nests (17.5%) were destroyed by unidentified or other predators. No avian predations were known to occur.

COMPARISON OF NEST SUCCESS, DENSITY AND PRODUCTION BETWEEN HABITAT TYPES DURING THE STUDY PERIOD

Mayfield hatch rates were highest in warm season natives for all years except 1985 when DNC was highest. Yet DNC had higher nest densities in four of the six years studied. Tame grass habitat, primarily east pool islands, had the highest hatch rates in two of four years where data was available but sample sizes were too small to compare meaningfully with DNC or warm season natives sample sizes.

Productivity was calculated by multiplying the Mayfield hatch rate by the expanded nest density to compare the actual number of successful nests per acre of each habitat. Despite higher nest densities in DNC in four of the six years, DNC grasses only surpassed warm season natives in productivity only in 1985. This was because hatch rates were considerably lower during those years. However, productivity was not significantly higher in warm season grasses as compared to DNC. Table VII below, compares success, density and productivity among different habitats sampled during the study period.

TABLE VII - NEST SUCCESS, DENSITY AND PRODUCTION BETWEEN HABITAT TYPES

Habitat Type	%Nest Success (Mayfield)						Nest Density[1]						Productivity[2]					
	84	85	86	87	88	89	84	85	86	87	88	89	84	85	86	87	88	89
Seeded Natives	12.7	5.8	24.8	36.1	20.5	6.4	.26	.24	.26	.44	.21	1.6	.03	.01	.06	.16	.04	.10
Good WSN	6.8	8.2	32.2	36.1	20.5	6.4	.37	.23	.28	.44	.21	1.6	.03	.02	.09	.16	.04	.10
Poor WSN[3]	35.5	0	5.7	---	---	---	.28	Unk	.18	---	---	---	.10	Unk	.010	---	---	---
Native Prairie[4]	---	---	---	100.0	---	---	---	---	---	.01	---	---	---	---	---	.40	---	---
DNC (Overall)	5.1	25.8	17.2	27.5	2.5	1.5	.48	.13	.34	.27	.87	2.5	.02	.03	.06	.08	.02	.04
Old DNC	1.6	41.2	15.9	34.5	1.1	1.5	.06	.09	.41	.33	2.13	2.3	.02	.04	.07	.11	.02	.03
Tame Grass[5]	50.3	4.6	45.6	---	4.8	---	.19	1.09	.12	---	.28	---	.10	.05	.06	---	.01	---
Alfalfa	---	---	---	7.3	15.8	4.7	---	---	---	1.14	.53	1.8	---	---	---	.08	.08	.08
All Habitat Combined	7.9	17.5	20.7	32.1	4.3	2.2	.35	.14	.27	.31	.64	1.9.	.03	.02	.06	.10	.03	.05

[1] Expanded nest density is number of nests initiated per acre.

[2] Number of successful nests per acre.

[3] None searched in 1987-1989.

[4] Insufficient data to compute Mayfield and expanded nest densities; number shown is observed success, density and production.

[5] Figures in tame grass represent island habitat for 1986 and 1988.

CONCLUSIONS

Over the six year study, warm season native grass fields sampled, showed a higher productivity rate than DNC fields. However, much of the nesting attempts in DNC were in an area that may be considered a "high risk" site described by Klett and Johnson (1982) where nests are quickly found and destroyed by predators, thus having a very high daily mortality rate. One area (Field 7), throughout the study had significantly higher nest densities. This low, stagnated mixture of domestic and invading grasses and weeds was obviously a preferred nesting area having had a high number of renesting attempts but high nest mortality and low productivity.

Taking this situation into account, productivity could have been equal to or greater than that shown on warm season native areas if "high risk" areas were not present or predation rates were more equalized. Assuming this to be the case, we believe that DNC as well as seeded warm season native grasses be made available for upland nesting waterfowl. Site selection of cover to be seeded, of course, depends on soil types and past farming histories. Relatively low growing grass varieties should be considered where teal are the most abundant nesting species, (85.6% of all nests found on Big Stone) since this species prefers nest sites with lower Robel height-densities than gadwall and mallard, the other two main nesting species. Another factor to consider here is that DNC fields, where tall wheatgrass was dominant or exclusive in an area, nest densities were relatively low as compared with nearby DNC with a greater diversity of plant species.

We also noted a very low incidence (6.3%) of all nests found, regardless of species, in upland sites approaching one-half mile or more from either pairing wetlands or adequate brood rearing habitat. This situation would affect approximately 15-20% of Big Stone's upland nesting cover. This seemed to be true regardless of grassland type or nest cover quality in any given year. Therefore we feel that to maximize upland nesting potential on Big Stone, more wetlands need to be created on existing lands and/or to develop existing, but mostly drained, wetland basins on adjacent lands identified in the Land Acquisition Plan.

In terms of nesting preference relating to warm season natives, we found greater nest densities of all species in native grasses where more plant diversity was present. In other words, more nests were consistently found where native grass planting had been invaded by patches of goldenrod, bluegrass, etc. and greater interspersion of bunch grasses of different heights (big bluestem or Indiangrass and little bluestem).

Lastly, selective predator reduction showed no effect on increased productivity. Total predator removal from a grassland ecosystem the size of Big Stone NWR would not be practical from a manpower and economic point of view nor would it be desirable from a general public standpoint. However, seasonal predator management of all mammalian predators on select grassy islands could be conducted economically with substantial increases in production on these island expected.

In summary the following recommendations are:

- Provide DNC as well as warm season native nesting cover.
- Plant highly variable species of grasses in DNC and warm season native seedings in terms of height, density and phenology.
- Develop more breeding ponds near upland cover where there is a distance of one-quarter mile or more from the main pool areas.
- Increase number of attractive wetlands previously drained on new acquisition tracts of land.
- Conduct mammalian predator control on existing islands in east and/or west conservation pools.
- Construct safe nesting islands on new or existing improvements.
- Increase nesting data base by continuing nesting study on native prairie, islands and alfalfa seedings.

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