April 1987

Duck Nest Success and Predators in North Dakota, South Dakota, and Montana: The Central Flyway Study

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Duck Nest Success and Predators in North Dakota, South Dakota, and Montana: The Central Flyway Study[1]

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Abstract.--Data on duck nest success and the distribution and abundance of nest predators were obtained from nine study areas in North Dakota, South Dakota and Montana. Success rates were extremely low due to predation and duck production over much of the region may be insufficient to maintain populations.

INTRODUCTION

Numerous studies during the past 20 years have produced estimates of duck nest success in the Prairie Pothole Region (PPR) of the United States. Recently, Northern Prairie Wildlife Research Center (NPWRC) compiled data from many of these studies into a 15,000-record database for use in a mallard (Anas platyrhyncos) recruitment model (Cowardin et al. 1983 and Johnson et al. 1986). This model is designed to allow managers to evaluate the effectiveness of various management options for improving mallard recruitment. However, two major deficiencies exist in the data base (Klett et al. in press). Although most ducks (>90%) in the PPR nest on private lands (Hochbaum and Bossenmaier 1965, and Cowardin and Johnson 1983[3]), most studies contributing to the data base were conducted on public lands managed for wildlife production. Also, most of the data were obtained from relatively few study areas and there is little comparable information for large portions of the Dakota's and Montana (Klett et al. in press). Additionally, although predation is a major factor limiting duck nest success (Cowardin 1985), few nesting studies have produced concurrent information on which to assess predator populations (Sargeant 1983)[4].

This paper presents data collected during a one-season study designed to obtain estimates of duck nest success by habitat type and estimates of predator populations for nine study areas in North Dakota, South Dakota and Montana. Emphasis was placed on obtaining nest success records for habitats not specifically managed for wildlife in areas with little or no previous duck nest data. Duck nest data were collected to improve the ability of the NPWRC Mallard Model to evaluate management alternatives for increasing duck recruitment in the Central Flyway. Both nest and predator data complement that obtained in Canada during the study of stabilized duck hunting regulations (Greenwood et al. in press).

ACKNOWLEDGEMENTS

This study was a cooperative venture which required the help and assistance of many individuals and agencies. The study was designed and directed by the Duck Recruitment Subcommittee of the Central Flyway Waterfowl Technical Committee which included H. Funk, T. Hinz, J. Hyland, M. Johnson (Chairman) T. Kuck and H. Miller. The study was jointly funded by the ten state wildlife agencies represented by the Central Flyway Council. Portions of this study were financed with Pittman-Robertson funds. The Wildlife Management Institute generously handled financial and accounting logistics. Field work was organized and conducted by the following: North Dakota Game and Fish Department, M. Johnson, D. Orthmeyer, J. Harber and D. Timpe; South Dakota Cooperative Wildlife Research Unit, R. Linder, E. Keyser, R. Libra, K. Shea, C. Olawsky, B. Wangler, M. Kintigh, D. Beck and H. Browers; Montana Cooperative Wildlife Research Unit, J. Ball, S. Sovey, R. Bennett and A. Hetrick. Carnivore track

[1]Paper presented at the Eighth Great Plains Wildlife Damage Control Workshop, Rapid City, South Dakota, April 28-30, 1987.

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[3]Cowardin, L.M. and D.H. Johnson. 1983. A predictive model to guide management or acquisition of waterfowl habitat. Unpublished report. U.S. Fish & Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, North Dakota.

[4]Sargeant, A.B. 1983. Personal communication. Northern Prairie Wildlife Research Center. Jamestown, North Dakota.

searches were conducted by U.S. Fish and Wildlife Service Animal Damage Control field personnel in Montana and North Dakota and by Game, Fish and Parks Extension Trappers in South Dakota. NPWRC, Jamestown, ND, provided much assistance, direction and equipment. L. Cowardin demonstrated the need for this work to the Central Flyway Council and Technical Committee and with D. Johnson provided guidance in study design and implementation. T. Klett and R. Greenwood developed and provided the study manuals and data forms used in the nesting study. A. Sargeant designed, helped direct and provided data analysis of the predator surveys. NPWRC keypunched the data and T. Schaffer compiled and produced computer summaries. The Office of Migratory Bird Management (FWS) provided color infrared aerial photographs of the study transects and NPWRC made black and white enlargements for use as field maps. Private landowners in all three states generously allowed study teams access to their land. Many others also provided field assistance, equipment and help. We express our sincere appreciation to all who contributed to this study.

METHODS

Data were obtained on and near nine Fish & Wildlife Service air/ground comparison transects (Martinson and Kaczynski, 1967) located in North Dakota, South Dakota and Montana (fig.1). Transects were selected because of their proximity to areas with limited duck nest success data. Each transect study area was three miles wide and ranged from 12 to 36 miles in length. Because the Morgan and Plentywood transects in Montana lie directly on the U.S. - Canadian border all work was conducted on the southern one-half of these transects.

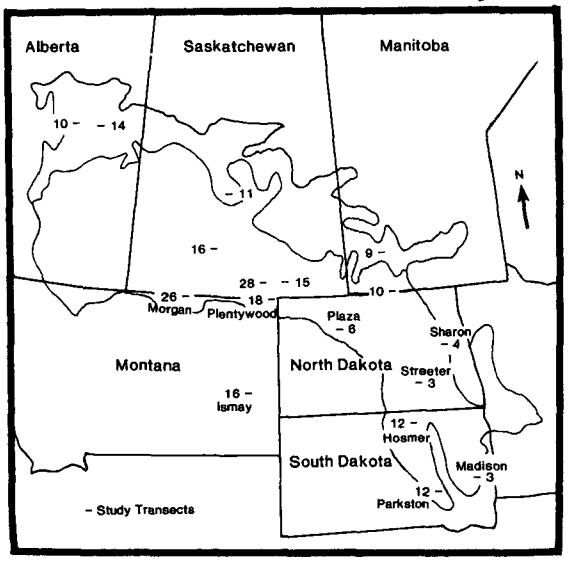

Figure 1.--The Prairie Pothole Region of the United States and Canada with locations of 1983 air/ground transect study areas and Mayfield mallard nest success estimates for South Dakota, North Dakota and Montana (this study) and Manitoba, Saskatchewan and Alberta (Greenwood 1987)[5].

Field crews were instructed to find as many duck nests as possible in each of seven basic habitat types (grassland, hayland, planted cover, cropland, rights-of-way, wetlands and odd areas) during each search of each transect. Habitat classifications follow those of Cowardin et al. (1985) except for planted cover, which we defined as idled stands of grass or grass/legume mixtures such as nesting cover provided on many state and federal wildlife areas (Duebbert et al. 1981). Emphasis was placed on finding nests on private lands and habitats not specifically managed for wildlife. If specific habitat types were not present or landowner permission could not be obtained, searches were conducted on substitute areas nearby. Procedures for searches, marking nests, and determining the stage of incubation, species and nest fate followed those described by Higgins et al. (1977) and Klett et al. (1986). Odd areas such as rock piles, brush clumps or fence rows were searched on foot or (in North Dakota) with a boom-type drag mounted on an ATC.

Searches were conducted between the hours of 0600 and 1400 from May 2 through July 10. The date of first search on each transect was as follows: May 2 - Madison, Sharon, Ismay; May 9 - Hosmer, Streeter; May 16 - Parkston, Plaza; May 17 - Morgan; May 26 - Plentywood. Each transect was searched three times at approximately 21-day intervals. The Sharon transect was searched a fourth time in an attempt to find additional nests.

A nest was defined as a hollow scrape containing one or more eggs. Nest success was calculated using the Mayfield method (Klett et al. 1986) and a standard exposure period of 34 days for all species. A successful nest was one in which one or more eggs hatched. Unsuccessful nests were classified as destroyed due to predation, agricultural practices, weather or other factors or abandoned. Because of the difficulties in making a positive determination from remains at a nest, no attempt was made to identify the species of predator which destroyed a nest (Sargeant 1983)[6]. Nests not revisited to determine fate, abandoned due to investigator influence or damaged by search operations were not included in nest success calculations.

Predator species targeted for assessment on each transect were badger (Taxidea taxus), coyote (Canis latrans), Franklin's ground squirrel (Spermophilus franklinii), long-tailed weasel (Mustela frenata), raccoon (Procyon lotor), red fox (Vulpes vulpes), striped skunk (Mephitis mephitis), American crow (Corvus brachyrhynchos), and black-billed magpie (Pica pica). Surveys conducted were: 1) line transect counts of crows and magpies, 2) livetrapping of Franklin's ground squirrels, 3) carnivore track

[5]Greenwood, R.J. 1987. Personal communication. Data on file Northern Prairie Wildlife Research Center, Jamestown, ND.

[6]op. cit.

counts, and 4) recording of predator sightings. All predator data (except predator sightings) were collected on a 10 mile long predator survey area that extended one-half mile on each side of the center transect road. This area included 40 quarter-section (160 acre) sample areas. Predator sighting data was collected wherever the crews were working on or near the air/ground transects.

Line transect counts of crows and magpies were made by driving the center transect road of the predator survey portion of each study transect on at least three days of each nest search period. Stops were made at the midpoint of each quarter section sample unit to count all crows and magpies seen within a 1/8 mile half-circle radius of the vehicle during a 1-minute period. Data for two adjoining quarter section sample units (one on each side of the road) were usually obtained at each vehicle stop point. In addition to these data, investigators recorded presence or absence of each species in each quarter section sample unit as detected visually or by call, both while driving the transect road and while stopped. Most surveys were conducted during midday, after nest searching was completed, on days when weather conditions were favorable (conditions were specified).

Livetrapping of Franklin's ground squirrels was conducted in early July and consisted of setting four livetraps in each of five "best" sites with brushy or dense vegetation along each linear mile of the predator survey areas. Traps were baited with canned sardines. Trapping sites were no closer than 220 yds. from each other and traps at a site were no closer than 20 yds. from each other. Traps were set at one site along each linear mile in early morning and checked and moved to another site (at least 100 yards away) the next morning. Trapping was conducted on five consecutive days unless interrupted by bad weather in which case trapping resumed when suitable conditions returned. All ground squirrels caught were marked with dye (to determine if recaptures were made) and then released unharmed at the capture sites. Livetrapping surveys were not accomplished on the Morgan and Ismay transects.

Carnivore track counts involved an individual searching for tracks of fox, coyote, skunk, badger and raccoon on each of the 40 quarter-section sample units where trespass was permitted on each predator survey area. One search was conducted on each of the air/ground transects as time permitted during mid-May to late June. The investigators were instructed to spend up to 0.5 hour on each quarter-section sample unit examining "best" sites for tracks of each species. Investigators categorized abundance of tracks and recorded length of small and large canid tracks for reference in assessing canid track identification. Track survey data is expressed as the percent of quarter-section sample units on which tracks were observed.

Study personnel kept daily records of numbers of places on each transect where one or more individuals of specified predator species were seen. Observations made on all portions of the transects were included but most were from the 10 mi. long predator survey areas, because investigators spent most time there. All personnel working with nest search crews were asked to independently supply this information everyday they worked on a transect and to record the amount of time spent on the area and their major work activity. A place where a predator was observed was defined as a 160-yd. diameter area (about 5 acres).

RESULTS

The number of acres of each habitat type searched during all searches are shown in table 1. Because some fields were only searched once, while others were searched up to four times, the number of acres searched represents the combined total of the acres searched during all searches.

A total of 678 nests of 10 duck species was found during the study (tables 1 and 2). Nests of blue-winged teal (Anas discors) were most frequently found (41 percent) followed by gadwall (A. strepera) (19 percent), mallard (15 percent) and Northern pintail (A. acuta) (13 percent). Northern shoveler (A. clypeata), lesser scaup (Aythya affinis), American wigeon (Anas americana), green-winged teal (A. crecca), ruddy duck (Oxyura jamaicensis) and redhead (Aythya americana) comprised the remaining 15 percent of the nests found.

Thirty-eight percent of all nests were found in grassland habitats (49 percent of the acres searched) (table 1). Grassland habitats contained 57 percent of the nests in Montana (78 percent of the areas searched), 50 percent in South Dakota (43 percent of the acres searched) and 27 percent in North Dakota (25 percent of the acres searched). Planted cover which totaled only six percent of the acreage searched contained 21 percent of the nests. Although cropland comprised 20 percent of the acreage searched it contained only four percent of the nests found.

The distribution of nests among habitats by species is shown in table 2. Mallards nests were found most frequently in right-of-ways (29 percent), grassland (25 percent), and planted cover (23 percent). Most gadwall nests (41 percent) were found in planted cover. All other species (except redheads and ruddy ducks) were most common in grassland habitats. Pintails nested more frequently in cropland than any other species and less frequently in planted cover than the other dabblers.

Nest fate was determined for 625 of the 678 nests found (table 3). Overall, 72 percent of the nests did not hatch. The percent of successful nests was higher in Montana (45 percent) than in the Dakotas (24 percent each). Predation accounted for 90 percent of all unsuccessful nests with predators destroying 69 percent of the nests in each of the Dakotas and 49 percent in Montana. Predation rates were highest on the Madison transect in South Dakota (79 percent) and lowest on the Ismay transect in Montana (17 percent).

Table 1.--Number of acres searched (A) and nests found (N) by habitat type during three nest searches[1] on air/ground transects in South Dakota, North Dakota and Montana, 1983.

State and Transect	Grassland		Hayland		Planted Cover		Cropland		Other		Right-of-way		Wetland		Total	
	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N
South Dakota																
Hosmer	1,359	2	486	2	0	0	537	1	95	0	288	3	84	0	2,849	8
Madison	555	38	160	8	267	18	270	1	30	0	148	7	143	6	1,573	78
Parkston	870	41	470	11	0	0	241	3	16	5	278	12	184	4	2,059	76
Subtotal	2,784	81	1,116	21	267	18	1,048	5	141	5	714	22	411	10	6,481	162
North Dakota																
Streeter	912	30	312	9	240	21	955	7	204	26	337	30	15	1	2,975	124
Sharon	879	4	300	2	559	17	1,350	4	166	8	575	19	223	2	4,052	56
Plaza	971	72	407	17	440	63	1,420	9	142	17	444	24	20	5	3,844	207
Subtotal	2,762	106	1,019	28	1,239	101	3,725	20	512	51	1,356	73	258	8	10,871	387
Montana																
Ismay	1,979	10	312	1	0	0	0	0	15	1	33	0	113	2	2,452	14
Plentywood	1,176	46	771	4	235	26	442	4	9	4	42	4	21	6	2,696	94
Morgan	4,686	17	0	0	0	0	170	1	1	3	22	0	59	0	4,938	21
Subtotal	7,841	73	1,083	5	235	26	612	5	25	8	97	4	193	8	10,086	129
Total	13,387	260	3,218	54	1,741	145	5,385	30	678	64	2,167	99	862	26	27,438	678

[1] Four searches were conducted on the Sharon transect.

Table 2.--Number of nests found by species and habitats on air/ground transects in South Dakota, North Dakota, and Montana, 1983. Acres searched in ( ).

Species	Grassland (13,387)	Hayland (3,218)	Planted Cover (1,741)	Cropland (5,385)	Other (678)	Right-of-way (2,167)	Wetland (862)	Total (27,438)
Mallard	25	9	23	3	5	29	5	99
Gadwall	32	11	52	1	11	19	3	129
Wigeon	8	0	3	0	1	0	0	12
G-w Teal	2	0	0	0	1	0	0	3
B-w Teal	119	22	46	7	33	42	9	278
Shoveler	24	3	11	0	7	2	1	48
Pintail	38	9	8	19	4	7	1	86
Redhead	0	0	0	0	1	0	0	1
L. Scaup	12	0	2	0	1	0	4	19
Ruddy	0	0	0	0	0	0	3	3
Total	260	54	145	30	64	99	26	678

Five percent of the nests were destroyed by agricultural operations, while abandonment, weather and other factors caused the loss of only 2 percent of the nests.

Mayfield nest success estimates were calculated from 654 nests of the 678 nests found. Nests for which fates were not known contributed daily survival rate data to the Mayfield nest success calculations (Klett et al. 1986).

The number of successful nests and Mayfield nest success estimates for all nests are shown for each habitat and transect in table 4. Average nest success of all ducks was 11.5 percent in North Dakota, 11.4 percent in South Dakota and 17.5 percent in Montana. Average nest success rates were highly variable between transects ranging from 14 (Hosmer) to 42 (Ismay) percent. Average nest success estimates were highest in hayland (22 percent) and planted cover (19 percent) and lowest in cropland (3 percent). Nest success in grassland was 13 percent. Average nest success was highest in planted cover in North Dakota (19 percent) and in hayland in South Dakota (30 percent) and Montana (62 percent).

Nest success estimates by species and transect are presented in table 5. Mallards and pintails had the lowest nesting success (7 percent). Mallard nest success ranged from 3 percent on the Madison and Streeter transects to 26 percent on the Morgan transect. Pintail nest success ranged from zero (Hosmer) to 60 percent (Morgan). Blue-winged teal success averaged 13 percent ranging from 2 (Hosmer) to 100 percent (Ismay). Gadwall and wigeon had overall success rates of 22 and 25 percent, respectively. Mallard nest success averaged 4.7 percent in North Dakota, 5.4 percent in South Dakota and 18.9 percent in Montana.

Line transect surveys indicated that neither crows or magpies were common on the study transects. Although magpies were known to occur on some of the areas, none were tallied on any of the line transect

Table 3.--Fate of duck nests found on air/ground transects in South Dakota, North Dakota, and Montana, 1983. Percent of total shown in ( ).

State and Transect	Number Successful		Number Destroyed: Predator		Agriculture		Weather		Other		Number Abandoned		Total
South Dakota													
Hosmer	1		5		1		0		0		1		8
Madison	15		61		0		1		0		0		77
Parkston	19		33		5		0		1		1		59
Subtotal	35	(24)	99	(69)	6	(4)	1	(tr)	1	(tr)	2	(1)	144
North Dakota													
Streeter	19		81		11		4		0		1		116
Sharon	10		39		5		0		0		0		54
Plaza	57		130		4		0		0		1		192
Subtotal	86	(24)	250	(69)	20	(6)	4	(1)	0	(-)	2	(tr)	362
Montana													
Ismay	8		2		0		1		0		1		12
Plentywood	34		48		2		0		1		2		87
Morgan	11		8		1		0		0		0		20
Subtotal	53	(45)	58	(49)	3	(3)	1	(1)	1	(1)	3	(3)	119
Total	174	(28)	407	(65)	29	(5)	6	(tr)	2	(tr)	7	(1)	625

tr = <1%

Table 4.--Number of successful duck nests and Mayfield nest success[1] by habitat for air/ground transects in South Dakota, North Dakota, and Montana, 1983.

State and Transect	Grassland N	%	Hayland N	%	Planted Cover N	%	Cropland N	%	Other N	%	Right-of-way N	%	Wetland N	%	Total N	%
South Dakota																
Hosmer	0	<1	0	3	--	--	0	2	--	--	1	15	--	--	1	4
Madison	5	6	4	29	6	17	0	19	--	--	0	<1	0	<1	15	7
Parkston	11	22	4	39	--	--	0	<1	1	9	2	8	1	46	19	19
Subtotal	16	11	8	30	6	17	0	2	1	9	3	4	1	5	35	11
North Dakota																
Streeter	3	7	3	40	3	6	1	5	4	9	5	8	0	2	19	9
Sharon	1	30	1	28	4	11	0	6	3	21	1	1	0	1	10	8
Plaza	19	13	2	4	28	29	0	2	2	9	4	10	2	26	57	15
Subtotal	23	12	6	12	35	19	1	3	9	11	10	6	2	10	86	12
Montana																
Ismay	6	52	1	100	--	--	--	--	1	100	--	--	0	3	8	42
Plentywood	16	11	3	58	11	22	1	<1	1	3	0	3	2	26	34	14
Morgan	10	36	--	--	--	--	0	4	1	<1	--	--	--	--	11	24
Subtotal	32	19	4	62	11	22	1	1	3	4	0	3	2	16	52	17
Total	71	13	18	22	52	19	2	3	13	10	13	6	5	10	174	12

[1] Average Mayfield nest success estimates for habitats and transects is weighted by exposure period and daily mortality rate.

surveys. Crows were detected on seven of the nine study areas but were not abundant anywhere (table 6). No crows were found on the Plaza or Ismay transects. Madison had the highest occurrence rate with crows being detected on an average of only 1.1 percent of the sample plots and on an average of 2.2 percent of the quarter section sample units.

Traps for Franklin's ground squirrels were set during a total of 1394 24-hour trap periods on seven transects. The number of trap-days on each transect were as follows: Hosmer-199, Madison-200, Parkston-200, Plaza-200, Sharon-200, Streeter-199 and Plentywood-196. A total of five Franklin's ground squirrels were captured; one on the Sharon transect and four on the Streeter transect. No animals were captured more than once.

Tracks of five carnivores were found on all transects surveyed except in two cases (table 7). Coyote tracks were not found on the Sharon transect in eastern North Dakota and raccoon tracks were not found on the Morgan transect in north-central Montana. Red fox tracks were found on more than 40 percent of the sample units on all transects except Morgan (17 percent). Red fox tracks were found most frequently on transects in North Dakota. Badger tracks were present on all transects and were more frequent on the Streeter

Table 5.--Number of ducks nests found (N), number of successful nests (S) and Mayfield nest success (%)[1] on air/ground transects in South Dakota, North Dakota, and Montana, 1983.

	South Dakota									North Dakota									Montana												All Transects		
	Hosmer			Madison			Parkston			Streeter			Sharon			Plaza			Ismay			Plenty-Wood			Morgan								
Species	N	S	%	N	S	%	N	S	%	N	S	%	N	S	%	N	S	%	N	S	%	N	S	%	N	S	%				N	S	%
Mallard	5	1	12	15	1	3	6	0	12	21	2	3	4	0	4	29	5	6	3	1	16	14	7	18	2	1	26				99	18	7
Gadwall	0	-	-	2	2	100	3	1	24	22	5	18	6	1	6	66	23	24	1	0	3	25	10	24	4	2	37				128	44	22
Wigeon	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	4	1	14	4	2	100	2	1	10	2	1	30				12	5	26
G-W Teal	0	-	-	1	0	0	0	-	-	0	-	-	1	1	100	1	0	0	0	0	-	0	-	-	0	-	-				3	1	33
B-W Teal	1	0	2	53	12	10	53	15	22	59	10	10	42	8	8	52	15	15	4	4	100	14	5	14	0	-	-				278	69	13
Shoveler	0	-	-	2	0	0	1	0	4	9	0	2	2	0	0	22	6	17	0	-	-	10	3	10	2	0	2				48	9	8
Pintail	2	0	0	5	0	4	10	2	2	13	2	9	1	0	3	24	4	6	2	1	17	21	8	5	8	6	60				86	23	7
Redhead	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	1	0	0				1	0	0
L. Scaup	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	9	3	14	0	-	-	8	-	5	2	1	4				19	4	9
Ruddy	0	-	-	0	-	-	3	-	100	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-				3	1	100
Total	8	1	4	78	15	7	76	19	19	124	19	9	56	10	8	207	57	15	14	8	42	94	34	14	21	11	24				678	174	12

[1] Average Mayfield nest success estimates for transects and species is weighted by exposure period and daily mortality rate.

Table 6.--Average percentage of 1/8 mile radius half-circle sample plots and 160 acre sample units on which crows were detected during line transect counts along a 10 mi predator survey route on air/ground study transects in South Dakota, North Dakota and Montana, 1983.

State and Transect	No. Surveys Conducted	% Plots With Crows	% 160A Sample Units With Crows
South Dakota			
Hosmer	6	0.0	0.8
Madison	9	1.1	2.2
Parkston	9	0.8	1.7
North Dakota			
Streeter	9	0.3	0.3
Sharon	9	0.3	0.6
Plaza	9	0.0	0.0
Montana			
Ismay	7	0.0	0.0
Plentywood	9	1.1	1.1
Morgan	9	0.0	0.3

Table 7. Percentage of ¼-section sample units on each 10 mi transect where tracks of specified carnivores were found during a single search conducted during May or June in South Dakota, North Dakota and Montana, 1983

State and Transect	No. Sample Units Searched	Badger	Coyote	Raccoon	Red Fox	Strpd. Skunk
South Dakota						
Hosmer	40	17	7	35	42	44
Madison	40	22	2	67	45	5
Parkston	34	50	9	79	59	47
North Dakota						
Streeter	40	82	47	65	57	42
Sharon	40	17	0	40	88	70
Plaza	39	18	5	55	69	36
Montana						
Morgan	36	53	14	0	17	69
Plentywood	19	74	42	16	58	95
Ismay	-	-	-	-	-	-

(82 percent) and Plentywood (74 percent) transects. Coyote tracks were uncommon except on Streeter (47 percent) and Plentywood (42 percent). Raccoon tracks were common on all transects in the Dakotas (found on 35 to 79 percent of the sample units) but in Montana raccoons occurred only on the Plentywood (16 percent) transect. Striped skunk were also common, with tracks occurring on 36 to 95 percent of all sample units except for the Madison transect (5 percent).

Data on the occurrence of long-tailed weasels and additional data on Franklin's ground squirrels and magpies were obtained from observation of these species during 2993 investigator hours during 581 investigator days. The results are expressed as an observation rate (the average number of places per day per investigator hour where field personnel saw individuals of each species) (table 8). Franklin's ground squirrels were observed on the Parkston,

Table 8.--Average number of places per day per investigator hour (observation rate) where field personnel saw individual predator species on air/ground study transects in South Dakota, North Dakota and Montana, 1983.

State and Transect	Number Invest. Days	Number Invest. Hours	Franklin's Ground Squirrel	Magpie	Long-tailed Weasel
South Dakota					
Hosmer	83	431	0.000	0.036	0.005
Madison	93	471	0.000	0.000	0.006
Parkston	86	458	0.002	0.000	0.002
North Dakota					
Plaza	54	453	0.000	0.000	0.007
Sharon	63	514	0.012	0.000	0.002
Streeter	49	416	0.002	0.000	0.000
Montana					
Morgan	42	290	0.003[1]	0.000	0.000
Plentywood	58	435	0.002[1]	0.036	0.000
Ismay	53	387	0.000	0.000	0.000

[1] One sighting of a Franklin's ground squirrel was recorded, but the transect is outside the recognized geographic range of the species.

Sharon, Streeter, Morgan and Plentywood transects. The Morgan and Plentywood transects are outside of the recognized range for this species (Hall 1981). Magpies were recorded only on the Hosmer and Plentywood transects. Long-tailed weasels were recorded on all three South Dakota transects and on the Plaza and Sharon transects in North Dakota.

DISCUSSION

Results of this study support previous work showing that upland nesting ducks throughout much of the Prairie Pothole Region have extremely low nest success rates (Cowardin et al. 1985, Greenwood et al. *in press*, Klett et al. *in press*, *and many* others). Of particular significance are the nest estimates obtained for mallard, pintail, and blue-winged teal, three species which are experiencing serious population declines (North American Waterfowl Management Plan 1986).

Cowardin et al. (1985) presented information suggesting that mallards in central North Dakota require a nest success rate of at least 15 percent to maintain a stable population. Similarly, it has been proposed by Klett et al. (in press) that population stability requires nest success rates of 15 percent for pintails and 20 percent for blue-winged teal. Although nest success rates in this study varied by location and habitat, they were generally below these threshold levels (table 5). Results from the study of stabilized hunting regulations show similar results for the Prairie Pothole Region of Canada (Figure 1) (Greenwood 1987)[7].

[7] op. cit.

This study also clearly shows that predation is the most important cause of duck nest failure in the areas studied. Losses to predators were equally high in all three states with predators destroying 88 to 91 percent of all unsuccessful nests. Losses due to agricultural practices, weather and abandonment were insignificant, compared to predation, despite the fact that virtually all nests were found on lands not managed for wildlife production.

While we obtained considerable data on the occurrence of predators between study areas, we were unable to relate differences in nest success rates to differences in predator abundance. This may have been due to several factors including, but not limited to: 1) high predation rates on nearly all transects, regardless of predator populations; 2) effects of compensatory predation (Balser et al. 1968) by different species in different areas; 3) sensitivity of the surveys in detecting differences in predator abundance; and 4) differences in habitat quantity and quality and the abundance of buffer prey species between areas.

Because crows, magpies, long-tailed weasels and Franklin's ground squirrels were scarce to absent in all areas, it seems reasonable that nest predation in this study can be attributed to red fox, skunk, raccoon, badger and coyote. Although, other predators, not surveyed, may have destroyed some nests, most of these five carnivores existed, and were generally abundant on all transects (no data for Ismay). Of these, red fox is considered to be the most serious predator of duck nests. The impacts of red fox predation or prairie nesting ducks has been discussed extensively by Sargeant (1972), Johnson and Sargeant (1977), and Sargeant et al. (1984). Red fox are not only capable of destroying a high percentage of the nests within their territory but they also have a propensity to take nesting hens. Johnson and Sargeant (1977) estimated that red fox take 18 percent of the hen mallards which nest in North Dakota each year and Sargeant et al. (1984) estimated that an average of 900,000 adult ducks (predominantly hens) are killed by red fox in the mid-continent area annually.

The impacts of badgers, skunks and raccoons on nesting ducks is not as well documented, however several studies have demonstrated increased nest success by reducing the number of these predators (Balser, Dill and Nelson 1968, Duebbert and Kantrud 1974, Duebbert and Lokemoen 1980, and Greenwood 1986). Coyotes are generally not a serious nest predator because they occur in low densities and are often beneficial because they tend to exclude red fox from their large territories (Johnson and Sargeant 1977).

While the problem seems clear, the solutions are not. Although predation is the immediate factor responsible for low nest success, the ultimate cause is habitat destruction. The extensive and continuing loss of wetland pair habitat and upland nesting habitat due to intensified agriculture has forced nesting ducks into progressively smaller islands of habitat.

These same islands of cover are also prime areas of predator use (Cowardin, Sargeant and Duebbert 1983) Potentials for dealing with high predation rates on public lands managed for waterfowl production have been discussed by Sargeant and Arnold (1984). However, a relatively small percentage of the total waterfowl population in the Prairie Pothole Region currently nests on these managed areas. While it is important to make dedicated wildlife areas produce to their fullest potential (Duebbert and Lokemoen 1980), it can also be a very costly proposition to do so (Lokemoen 1984). It seems reasonable to direct additional work at improving duck nest success on the private lands where a large percentage of ducks nest (Hochbaum and Bossenmaier 1965 and Cowardin and Johnson 1983[8]) and to continue to work diligently at maintaining waterfowl habitat on both public and private lands.

Some waterfowl biologists argue that once a series of good water years returns to the prairies, ducks will flourish. Unfortunately, good water conditions will attract ducks to many areas of the Prairie Pothole Region where they cannot successfully reproduce because of lack of secure nesting cover and high predation rates (Cowardin et al. 1985). Others believe that restrictive hunting regulations will improve the status of ducks. While harvest strategies which increase the survival of hens can be beneficial, regulations which simply reduce hunting opportunity and the harvest of drakes do not effectively address the problem facing prairie nesting ducks. In our opinion, the continuing trend of decreasing habitat and the increasing impacts of predators will override any potential long term benefits which can be derived from improved water conditions and reduced hunting mortality.

We agree with Sargeant et al. (1984) that in the immediate future, managers seem to have two broad choices, either coping with or reducing high levels of predation. Predator reduction can take several forms: direct control such as trapping, poisoning (currently not permitted) and shooting or indirect control such as more liberal hunting and trapping seasons, altering predator habitats and encouraging alternative competitive species (e.g. coyotes vs. red fox). Regulations which currently protect red fox and encourage the taking of coyotes in North Dakota and South Dakota are detrimental to prairie nesting ducks. These options all have considerable biological, social, economic and moral implications.

Coping with high predation rates entails relatively expensive management options such as electric fences, islands and nest structures (Lokemoen 1984). If the current decline in duck numbers is to be resolved, managers in each area of the prairie pothole region will need to carefully evaluate their local situations and employ management activities which are most efficient in improving production. For example, in areas with low predation rates, production can be improved simply by attracting additional breeding pairs and providing attractive nesting cover. In areas with high predation rates, managers will need to improve nest success by intensive control of predators or by separating nesting ducks from predators using a variety of techniques.

The NPWRC mallard recuritment model will be a valuable tool in making these management decisions. The data collected in this study is now incorporated into the model and has improved its accuracy in predicting the impacts of various management options. The Central Flyway Council has used the model for this purpose (Cowardin et al. 1984[9]) and has incorporated the results into a Central Flyway Mallard Management Plan which provides a set of guidelines designed to maintain a huntable supply of mallards. Other agencies will need to undertake a similar approach if they are to make informed decisions regarding management and preservation of prairie nesting ducks.

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