Effects of Specialized Grazing Systems on Waterfowl Production in Southcentral North Dakota

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The recent decline in numbers of several waterfowl species (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1986, U.S. Fish and Wildlife Service and Canadian Wildlife Service 1988) and poor nesting success indicates that there is insufficient production of ducks in the prairie pothole region to maintain populations at desirable levels (Klett et al. 1988). About 50 percent of the ducks in North America are produced in the prairie pothole region and about 95 percent of the production occurs on private lands (Smith et al. 1964). Thus, a major effort to reverse the decline in duck numbers should emphasize the use of new and improved management techniques on private lands, particularly the use of new rangeland grazing systems.

Numerous studies have evaluated the effects of grazing on duck production (Kirsch et al. 1978) in North America. However, most of these evaluations were designed to compare differences of duck production between grazed lands and idle lands or among different land uses. Also, nearly all of the earlier studies of grazing effects involved seasonlong grazing treatments with occasional differences in grazing intensities (Kirsch 1969). Seasonlong grazing has been shown to be detrimental to production of most upland nesting birds (Kirsch et al. 1978) and also to maximum livestock production (Kirby and Nyren 1988, Barker and Nyren 1988). During the 1970s and 1980s considerable agriculture research was directed at increasing red meat production on private lands via the implementation of various kinds of grazing systems. However, there were fewer evaluations of the effects of various grazing systems on wildlife (Peek and Dalke 1982). To help fill this information void, a study of livestock and waterfowl relationships was initiated in 1982 on the Central Grasslands Research Center, an experimental facility of North Dakota State University, Fargo, North Dakota.

Our study objectives were (1) to determine the effects of complementary, seasonlong, short duration, switchback and twice-over rotation grazing treatments and an idle treatment on upland vegetation characteristics, duck nest densities, nest site selection and nesting success, (2) to compare livestock production on these same grazing treatments and (3) to determine if any of the grazing systems benefited both upland nesting ducks and livestock production more than the others.

Study Area

Research was conducted on the Central Grasslands Research Center (Nyren 1986), approximately 41 miles (65 km) southwest of Jamestown, North Dakota, within the Missouri Coteau physiographic region. The Center occurs in Sections 14, 22, 23, 24, 25, 26, 36 T138N, R70W; Section 1, T137N, R70W; Sections 30, and 31, T138N, R69W; and Section 6, T137N, R69W (Lura 1985). Nesting studies were carried out on Sections 14, 24, 25 and 31. The Center is generally characterized by "hummocky," irregular, rolling plains containing numerous wetlands and potholes and a poorly integrated natural drainage system (Lura 1985). At maximum capacity, ephemeral, temporary, and seasonal wetlands (Stewart and Kantrud 1971) comprise approximately 9 percent of the total station area (Lura 1985). Wetlands are essential for attracting waterfowl. The idle area and switchback grazing system contained 14 and 10 percent wetland, respectively, compared to 6 percent on the twice-over rotation, 4 percent on the short duration, 4 percent on the complementary and 4 percent on the seasonlong grazing treatments when basins were at full capacity.

Vegetation typical of northern mixed grass prairie is found on the Center (Whitman and Wali 1975, Lura et al. 1988, Barker and Whitman 1988, Küchler 1964). The nesting habitat was comprised of five range site types of which 41 percent was overflow, 7 percent was wetland, 49 percent was silty, 2 percent was thin upland and 1 percent was shallow-to-gravel. Overflow sites also included wet meadow areas. The complementary and twice-over rotation grazing systems also contained 50.0 and 10.5 percent reseeded cover, respectively, by land area.

Climatic Conditions

North Dakota has a continental climate characterized by warm summers and cold winters. January is the coldest month and July is the warmest. The mean annual precipitation for the past 37 years on the study area was 17.6 inches (44.7 cm), with 80 percent falling between April and September. The annual precipitation was 23.0 (58.4), 18.9 (48.0), 19.8 (50.3), 17.9 (45.6), 27.2 (69.1), 17.9 (45.6), 7.7 (19.5) and 18.4 inches (46.7 cm) in 1982 through 1989, respectively. A drought began in September 1987 that greatly reduced range forage production in 1988. The average length of the freeze-free period for the area is 120–125 days (Ramirez 1972).

Grazing Treatments

Five grazing treatment areas and a non-grazed, idle treatment area were evaluated in this study. All treatment areas were contiguous, with similar topography and equal chance of predator influences. Extensive details of annual cattle herd size, stocking rates, dates of rotation, grazing dates and grazing system schematics were presented for each treatment during a series of studies (Messmer 1985, Hertel 1987, Sedivec 1989). The idle treatment in Section 24 consisted of 320 acres (130 ha) that was last grazed in 1979. Fifty acres (20 ha) were mowed in September 1985 and all 320 acres (130 ha) were mowed in mid-July 1988, a drought year.

Section 25 (259 ha) was divided equally in 1982 into seasonlong and short duration grazing treatments. The seasonlong treatment consisted of one 320 acre (130 ha) pasture and was grazed by one herd at a recommended stocking rate (U.S. Soil Conservation Service 1984) averaging 0.68 AUM/acre (1.7 AUM/ha) since 1984. Livestock were free to graze any area within the seasonlong pasture. The 320-acre (130 ha), short duration grazing treatment consisted of eight 40-acre (16.2 ha) pastures, each grazed by one herd at an average stocking rate of 1.01 AUM/acre (2.5 AUM/ha) since 1984. Each of the eight pastures in the short duration grazing treatment were grazed for 5 days during each of four rotations during the grazing season, with 35 days rest between rotations. In 1989 the grazing period between rotations varied, beginning with 3 days and followed by 4 days, 6 days and 7 days per rotation. The number of days rest ranged from 21 on the first rotation to 49 on the last rotation.

Section 31 was divided equally into two replications of the twice-over rotation grazing treatment. In 1983 and 1984 each replication consisted of three 80-acre (32.4 ha) pastures and were grazed by one herd at an average stocking rate of 0.93 AUM/acre (2.3 AUM/ha), respectively. Each pasture was grazed for 28-day periods and then rested for 56 days during each of two rotations. In 1985 through 1989, each replication consisted of four 80-acre (32.4 ha) pastures which were each grazed by one herd at an average stocking rate of 1.0 AUM/acre (2.4 AUM/ha). Each pasture was grazed for 20 days and then rested for 60 days during each of two rotations.

In 1987 two replications of a switchback grazing treatment were implemented on a 160-acre (64.8 ha) plot in Section 30. Each replication consisted of two 40-acre (16.2 ha) pastures and each were grazed by one herd at an average stocking rate of 1.1 AUM/acre (2.6 AUM/ha) in 1987 and 1989 and 0.7 AUM/acre (1.6 AUM/ha) in 1988. Each pasture was grazed for 20-day periods and then rested for 20 days during each of four rotations.

In 1985 a complementary grazing treatment was implemented on 170 acres (68.8 ha) of Section 14. This treatment consisted of three tame pastures and one native pasture. Livestock began grazing in a 30-acre (12.1 ha) crested wheatgrass (*Agropyron desertorum*) pasture and were then rotated sequentially to an 80-acre (32.5 ha) native pasture, a 30-acre (12.1 ha) Russian wildrye grass (*Elymus junceus*) pasture, and a 30-acre (12.1 ha) altai wildrye grass (*Elymus angustus*) pasture. On the complementary grazing treatment stocking rates averaged 1.0 AUM/acre (2.4 AUM/ha) for all years, 1985–1989, except 1988. Cattle stocking rates were reduced by about 40 percent on all grazing treatments in 1988, a drought year.

Methods

Nest Searches

Nest searches were conducted between 1 May and 15 July, 1984 through 1989. Four searches were made at three-week intervals in 1984, 1987, 1988, and 1989. Three nest searches were conducted at four-week intervals in 1985 and 1986. Five nest searches were conducted at 18-day intervals between 15 April and 10 July in 1983. Nest searches were performed between 7:00 a.m. and 1:00 p.m., since that time period has the highest probability of hens being on their nests (Klett et al.

1986). Nests were found by dragging a five-sixteenths inch (8 mm diameter), 100 foot long (30.5 m) chain between two 200 cc all terrain cycles according to methods described by Higgins et al. (1969, 1977).

Each site from which a duck flushed was considered a nest if at least one egg was present in a scrape. Data recorded at each nest site included date, treatment, duck species, number of eggs, stage of embryo development (Weller 1956) and dominant plant species. Visual obstruction readings, modified from Robel et al. (1970) were taken at each nest site. All nests were marked by placing a small, red, surveyor's flag at 12 feet (4 m) distance. Nest sites were also plotted on aerial photographs to aid relocation every 7–10 days to determine their fates. Nests in which at least one duckling hatched and left the nest site were classified as successful.

Vegetation Sampling

Visual obstruction readings to the nearest inch (0.25 dm) (Robel et al. 1970) were used to determine a height and density index of the vegetation at each of the management treatment areas. Readings of heights of 100 percent obstruction were taken along permanent transects. These transects were proportionately allocated (Messmer 1985) on the basis of range sites present within each treatment (Table 1). Each transect lay in a north-south direction from fenceline to fenceline and contained 25 stations 30 paces apart. Four visual obstruction readings were obtained per station twice each field season; once about 25 April for residual vegetation and once about 25 May prior to grazing but after the onset of new vegetative growth.

Estimates of Nest Success

Daily nest survival rates were calculated according to the Mayfield (1961, 1975) method as modified by Johnson (1979). Nests were excluded from analysis if nest abandonment occurred due to search activities, if nests were destroyed by nest search activities or if we were unable to relocate nests.

Mayfield nest success was calculated from daily nest survival rates following Johnson (1979). Thirty-five days of exposure was used for computing Mayfield nesting success for redheads (*Aythya americana*) and mallards (*Anas platyrhyncos*), 34 for blue-winged teal (*A. discors*), gadwalls (*A. strepera*), American wigeon (*A.*

Table 1. Percentages of various range sites for five grazing treatments and one idle treatment at the Central Grasslands Research Center, North Dakota.

	Size		Range site percentages				
Treatment	Acres	(ha)	Overflow[a]	Silty	Wetland[b]	Other sites	Seeded
Seasonlong	320	(130)	43.5	49.9	3.1	3.5	—
Short duration	320	(130)	49.6	46.3	4.1	—	—
Switchback	160	(65)	40.3	49.5	10.2	—	—
Twice-over rotation	640	(259)	20.7	59.0	6.3	3.5	10.5
Complementary	170	(69)	18.9	25.0	4.2	1.9	50.0
Idle	320	(130)	75.2	8.8	14.1	1.9	—

[a]Overflow range sites include wet meadow sites.
[b]Wetland percentages include basins at 100 percent capacity.

americana), green-winged teal (*A. crecca*), lesser scaup (*Aythya affinis*) and northern shovelers (*Anas clypeata*), and 33 for northern pintails (*A. acuta*). Total nesting density for all duck species combined was obtained from survival rates of individual species weighted by each species nesting density.

Livestock and Forage Performance

Forage production and range utilization estimates were determined annually on all treatment areas. Portable cages 2.5 by 5 feet (0.8 by 1.5 m) were placed on plots in each treatment and paired with grazed plots, all of which were clipped throughout the grazing season. The initial clipping plus growth in the cages were used to estimate forage yield. Forage disappearance weights from grazed plots were used to determine percent utilization.

Livestock were randomly sorted and weighed on and off grazing treatments to obtain production values for average daily gain (ADG) and average seasonal (about 160 days) gain (AG) (pounds/acre; kg/ha) for calves. Additional weights were taken at 84 days into the grazing season and every 28 days thereafter. The experimental livestock breed consisted of a Hereford-Angus-Gelbvieh cross.

Statistical Treatment

Mayfield nesting success and number of ducklings hatched per 100 acres (40.5 ha) were tested for significant ($P < 0.05$) main effects and two-way interaction using analysis of variance and then fit in a model including only significant effects. Where significant differences were detected, a Waller-Duncan T-test was used to separate the means.

Results

Nest Numbers

Nine duck species were found nesting on the station. Of the 1,601 duck nests found, 36.1 percent were blue-winged teal, 22.9 percent gadwall, 17.9 percent mallard, 13.1 percent northern pintail, 5.6 percent northern shoveler, 1.9 percent American wigeon, 1.6 percent lesser scaup, 0.7 percent green-winged teal and 0.2 percent redhead.

Range Site Selection

Nest site selection was determined for overflow, wet meadow, silty, thin-upland, and shallow-to-gravel range sites, and reseeded grasslands within each treatment. Generally, most blue-winged teal and lesser scaup nested nearest to water, whereas mallards, northern pintails, gadwalls, northern shovelers, and American wigeon nested near water and also as far away as a mile (1.6 km) from water. Of 1,119 nests, 77.8 percent were initiated in overflow range sites, 19.3 percent in silty, and 2.9 percent in the other range sites (Table 2). The importance of overflow range sites to duck nesting within mixed-grass prairie grasslands was illustrated by the fact that these sites comprised only 41.4 percent of the upland area but contained 77.8 percent of all nest initiations.

Table 2. Comparison of duck nest site selection among range sites at the Central Grasslands Research Center for all years 1985 through 1989.

Species	Number of nests	Percentage of nests n range sites		
		Overflow	Silty	Other
Mallard	210	93.0	5.0	2.0
N. Pintail	147	73.0	23.8	3.2
Gadwall	285	84.3	11.8	3.9
Blue-winged teal	357	68.1	29.5	2.4
Others	120	74.5	20.0	5.5
Total	1,119	77.8	19.3	2.9

Residual Cover

The idle treatment averaged significantly more ($P < 0.05$) residual and early green-up cover prior to grazing than any of the grazing treatments for 1983 through 1988 (Table 3). Mean visual obstruction readings among the grazing treatments averaged highest on the switchback grazing treatment, but barely so.

Nesting Density

Nest densities were highest in the idle treatment in 1983, 1984, 1985 and 1988; in the short duration grazing system in 1986, and in the switchback grazing system in 1987 and 1989 (Table 4). Nest densities in the idle area ranged from 2.4 times greater than the grazing treatments in 1983 to an equal density in 1987. For all seven years, the idle area nest densities averaged 1.6 times greater than any of the grazing treatments.

Among the grazing systems, nesting densities were highest in the twice-over rotation grazing treatment in 1983, 1984, 1985 and 1988, in the short duration grazing treatment in 1986, and in the switchback grazing treatment in 1987 and 1989. Nesting

Table 3. Mean visual obstruction readings taken in vegetative cover on the various grazing treatments and idle area at the Central Grasslands Research Center, 1983 through 1989.

Treatment	April 25 Residual cover Visual obstruction readings		May 28 Before grazing early green-up Visual obstruction readings	
	Inches	Decimeters	Inches	Decimeters
Seasonlong[a]	2.9	0.7	5.6	1.4
Short duration[a]	2.5	0.6	5.6	1.4
Twice-over[a] rotation	2.5	0.6	6.0	1.5
Complementary[b]	2.4	0.6	6.0	1.5
Switchback[c]	3.2	0.8	6.9	1.8
Idle[d]	5.5	1.4	11.3	2.9

[a] = 7 years.
[b] = 5 years.
[c] = 3 years.
[d] = 6 years of annual measurements.

Table 4. Density of nests found per 100 acres (40.5 ha) on the various grazing treatments and idle treatment at the Central Grasslands Research Center in 1983–1989.

	Density of nests per 100 acres (40.5 ha)							
Treatment	1983	1984	1985	1986	1987	1988	1989	Avg.
Seasonlong	4.3	7.1	3.7	5.3	24.4	11.9	10.6	9.6
Short duration	9.0	15.4	5.0	11.7	27.8	14.4	7.8	13.0
Twice-over rotation	11.9	15.6	7.6	9.6	18.6	15.9	12.8	13.2
Complementary	—[a]	—[a]	4.1	4.7	10.0	3.5	5.9	5.6
Switchback	—[a]	—[a]	—[a]	—[a]	30.3	13.0	13.8	19.0
Idle area	22.1	26.7	10.4	11.1	23.3	18.6	—[b]	18.7

[a]Treatment was not in operation in these years.
[b]Hayed during drought year.

densities varied with the amounts of overflow range sites, residual vegetation, wetland availability and treatment area free of livestock during the critical nesting period.

Nesting Success

Nesting success was significantly higher ($P < 0.05$) on the twice-over rotation grazing treatment than on all the grazing treatments and the idle treatment, except for the switchback treatment, 1983–1989 (Table 5). Nesting success on the idle area ranged from 6.6 percent in 1983 to 16.3 percent in 1985 and 1987, but was always exceeded by productivity on at least one grazing treatment in every year. Nesting success on the twice-over rotation grazing treatment was consistently higher than on the idle area, ranging from 2.3 times greater in 1984 to 6.2 times greater in 1986. Nesting success was greater in short duration and seasonlong grazing treatments than the idle area in all years except 1984.

Cowardin et al. (1985) suggested that a Mayfield nesting success of 15.2 percent was needed to maintain a waterfowl (mallard) population. According to this criterion, the idle area only maintained a population in two of six years, the twice-over rotation grazing treatment in seven of seven years, the short-duration grazing treatment in six of seven years, the seasonlong grazing treatment in three of seven years, the

Table 5. Percentage of Mayfield duck nesting success occurring on the grazing treatments and idle treatment at the Central Grasslands Research Center, 1983 through 1989.

	Percentage nesting success							
Treatment	1983	1984	1985	1986	1987	1988	1989	Average[a]
Seasonlong	12.0	11.7	40.3	52.8	41.3	14.7	13.3	26.6 wx
Short duration	22.0	1.0	17.9	60.8	25.4	22.7	36.2	25.6 xy
Twice-over rotation	17.0	31.4	54.6	43.2	49.3	34.0	16.4	34.7 w
Complementary	—	—	8.0	20.8	8.7	3.3	3.2	8.8 xyz
Switchback	—	—	—	—	29.8	17.4	11.9	22.7 xyz
Idle area	6.6	13.6	16.3	7.0	16.3	7.0	—	11.3 yz

[a]Means with the same letter are not significantly different ($P > 0.05$).

complementary in one of five years and the switchback grazing treatment in two of the three years it was in operation.

Cattle Effects

The average beginning date of grazing on the station was May 28 for 1983 through 1989. Over 57 percent of 1,198 nests found during the seven years were initiated before grazing began (Table 6). After the onset of grazing, 27.7 percent of duck nests found were initiated in idle pastures, 12.9 percent in pastures when cattle were present and 2.1 percent in pastures after cattle began rotations. Sixty-five percent of the clutches initiated after the onset of grazing were initiated on pastures free of cattle at the time.

Rest intervals between rotations varied among the grazing treatments. The twice-over rotation grazing treatment allowed for 60 days rest between rotations, leaving a high percentage of land with no cattle present during the critical nesting period. About 37 percent of nests found on the twice-over rotation grazing treatment were initiated in pastures when cattle were absent (Table 6). The short duration grazing treatment allowed 35 days rest between rotations and 29.2 percent of the nests in this treatment were also found in ungrazed pastures. The switchback grazing treatment allowed 20 days of rest between rotations and 12 percent of the nests found in this treatment were in ungrazed pastures.

Duck Production

Although duck nest densities were highest on the idle area in four out of six years (Table 4), it produced fewer successful nests and ducklings per 100 acres (40.5 ha) than four of the five grazing treatments (Table 7). Overall, the twice-over rotation, short duration, switchback grazing and seasonlong treatment areas produced more successful nests and ducklings per 100 acres (40.5 ha) than the idle and complementary grazing treatment areas. However, only production from the switchback treatment averaged significantly greater ($P < 0.05$) than on the idle treatment, 1985–1989.

Table 6. Percentage of nests initiated on each entire grazing treatment area before the grazing season, in ungrazed pastures, while cattle were present and on pastures after cattle were rotated, for all years, 1983 through 1989.

		Percentage of nest initiations			
Grazing treatment	Total nests found	Before the grazing season	In ungrazed pastures	In pastures while cattle were present	In pastures after cattle were rotated
Seasonlong	216	61.1	—	38.9	—
Short duration	294	67.7	29.2	1.8	4.9
Twice-over rotation	549	54.9	37.2	6.9	0.9
Complementary	48	0.0[a]	75.0	25.0	0.0
Switchback	92	64.1	12.0	17.4	6.5
Average of all treatments	240	57.1	27.9	12.9	2.1

[a]Grazing begins about 30 days earlier on this treatment than on the others.

Table 7. Mean annual production of forage, livestock and ducks on grazing and idle treatments at the Central Grasslands Research Center, North Dakota, 1985–1989.

			Mean Annual Production			
			Forage	Calf gains[a]	Ducks	
Treatment	Years averaged	Percentage utilization	lbs/acre	lbs/acre	Successful nests/ 100 acres (40.5 ha)	Ducklings[b] hatched/ 100 acres (40.5 ha)
Seasonlong	5	54	2,863	44	4.6	49 u
Short duration	5	62	2,732	61	5.3	59 tu
Twice-over rotation	5	54	2,580	62	6.6	63 tu
Complementary	5	59	1,962	59	1.4	12 v
Switchback	3	57	3,226	61	7.7	65 t
Idle	4	0	—	0	5.9	47 u

[d]Daily calf gains averaged about 2.2 lbs/day (1.0 kg/day).
[e]Means with the same letter are not significantly different ($P > 0.05$).

Livestock and Forage Performance

Average daily calf gain for the years 1985 through 1989, approximately 2.2 lbs/day (1.0 kg/day), was similar among all grazing treatments except one. Average seasonal calf gain per acre was lower on the seasonlong grazing treatment than on the twice-over rotation, switchback, short duration, and complementary grazing treatments (Table 7) (Animal and Range Sciences Department 1982–1989). Higher stocking rates on twice-over rotation, short duration, complementary, and switchback grazing treatments account for the higher average seasonal calf gain per acre than on the seasonlong grazing treatment.

Higher stocking rates are possible on the rotational grazing treatments because of the rest periods from grazing and better livestock distribution during rotations. Forage utilization data are used by managers to justify stocking rates on various grazing treatments. Generally, range specialists and scientists suggest that only 50 to 60 percent of the vegetation should be grazed annually for proper range use. For the years 1985 through 1989, average forage utilization ranged from 54 percent on the seasonlong and twice-over rotation grazing treatments to 62 percent on the short duration grazing treatment (Table 7). Thus, proper range use occurred among all of the grazing treatments during the study.

Summary and Discussion

The nest success rates of ducks and the mean annual production of ducks on specialized grazing systems in this study were much higher than our initial expectations. With the exception of the complementary grazing treatment, the other four grazing treatments (seasonlong, short duration, twice-over rotation, and switchback) all produced ducks at an average rate of 1.5 to 2 times that believed necessary to sustain a duck population. The lowest duck production on any of the grazing treatments exceeded reported duck production on intensively-farmed tillage lands which are the other alternative land use on private lands in much of the prairie pothole region (Higgins 1977). The mean annual nest success rates for ducks in four of the five grazing treatments in this study also exceeded average rates reported from other recent duck studies (Greenwood et al. 1987, Klett et al. 1988), some of which included public lands. Our complementary grazing treatment produced the least amount of forage and ducklings while the seasonlong grazing treatment had the lowest rate of beef production and the second lowest duck production.

Although there were differences in duck nesting success rates and production of forage, beef and ducklings among the specialized grazing systems, we are reluctant to unconditionally recommend one grazing system over another for extensive use on private lands. First, in actual application, pasture sizes and distribution in specialized grazing systems on private lands would be greater than most of those used in our experiments. Second, a landowner's choice of a specialized grazing system will depend considerably on the size of the operation, the size and composition of the cattle herd(s), the land management plan already in operation, and the availability and distribution of fences and water sources. For example, a twice-over rotation system can usually be implemented with the current fences and water supplies on any ranch, whereas a short duration system usually requires more fencing, a central water supply and more labor to make the frequent herd rotations.

A major advantage of twice-over rotation, short duration, switchback and complementary grazing systems over a seasonlong grazing treatment is the elimination of grazing on pasture portions of a system until mid-June to mid-July. This provides undisturbed cover for nesting waterfowl. Once cattle are placed on a seasonlong pasture, the entire area is disturbed, either by grazing effects on cover or cattle presence. Livestock production also averaged higher on the twice-over rotation, short duration, switchback and complementary grazing systems than on seasonlong grazing. Obviously there was no livestock production on the idle area, but neither was there any waterfowl production enhancement on the idle treatment area over the grazed treatment areas, except for the complementary grazing system. The poorer duck production values on the complementary grazing treatment may have been partially due to the earlier grazing initiation on this treatment (approximately 30 days earlier) than on the other grazing treatments, to the continual presence of cattle after their entry into the system and to the 10-inch (25 cm) spacing between rows in the seeded fields; seeding at 6 and 7 inch (15 and 18 cm) spacing is the more common practice.

With the pasture and herd sizes and season of grazing used in this study, we were able to provide suitable residual cover for ducks with 50–60 percent range utilization. Residual vegetation in spring was an important component of nesting habitat for early nesting ducks such as mallards and pintails. In order to provide suitable amounts of residual cover with minimal disturbance during nest initiation, cattle grazing should not begin on North Dakota "native" rangeland until after the third or preferably fourth week in May. Late May to early June is also the suggested starting period for grazing native vegetation in North Dakota to improve range condition. Delaying initiation of grazing until about June 1 will benefit waterfowl by allowing over 50 percent of the ducks to initiate nests before grazing begins.

Greenwood et al. (1987) found that large native pastures containing western snowberry (*Symphoricarpos* spp.) and wild rose (*Rosa* spp.) provided the most important and successful nesting sites for upland nesting ducks in southcentral Canada. Western snowberry was also an important cover species at most of the nest sites in our study, and was often associated with Kentucky bluegrass (*Poa pratensis*). Overflow range sites and western snowberry were strongly associated, and were also highly selected by ducks for nesting sites. The importance of these two habitat components to nesting ducks must be considered by resource managers during grassland management planning because livestock producers often consider reduction or elimination of brush to enhance grass production. Several cool-season grasses grow well in the shade of western snowberry, and this combination provides both early and late livestock forage and wildlife cover. Thus, we recommend retention of western snowberry for duck nesting sites in native rangeland and, when possible, overflow range sites should be a consideration of habitat preservation and management strategies.

Much of the native prairie grassland of the prairie pothole region of Canada and the United States has already been converted to annually-tilled cropland, particularly those areas with the best soils. Thus, much of today's livestock and duck production occurs on poorer quality soils, many of which are marginally suited for cultivation. Boyd (1985) has pointed out the potential threat of this situation to continental duck populations. But, any chance for conversion of cropland back to grassland solely for livestock production would be entirely dependent on sustained high prices for livestock products. Since this is unlikely, the next best means to encourage landowners to retain their current grassland base is to demonstrate how higher income can be gained from these same grasslands. We believe our results demonstrate how higher beef production, which equates to higher income, can be gained from mixed grass prairie by using specialized grazing systems while simultaneously providing habitat conditions wherein ducks can also reproduce at sustainable levels.

Although we strongly support the extensive use of specialized grazing systems on private lands, we do not advocate their carte blanche use on public lands, many of which are managed specifically for wildlife production. However, specialized grazing systems may be adaptable to some joint habitat management projects involving a combination of private and public grasslands. They also provide a potential means of incentive to influence landowners not to convert Conservation Reserve program (CRP) grasslands back to cropland at the end of the contract period.

The overall importance of our findings is manifest to the current trend of emphasizing greater duck production on private lands (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1986, Dornfeld and Warhurst 1988). Most private land operators are willing to implement new land-use practices for financial incentives, usually not for wildlife incentives. We believe our findings provide evidence of a means to provide private ranchers and farmers in the prairie pothole region of North America with financial incentives to retain or better manage rangelands for both beef and wildlife production.

Management Recommendations

To mutually benefit duck and cattle production on private rangelands, we recommend greater use of specialized grazing systems. We propose that this would be best achieved through proper demonstration, education and extension because if grazing systems are improperly operated or are overutilized, the long-term sustainable benefits may be forfeited for short-term economic gains. Relative to natural resources, benefits can be equated to more grassland than cropland, better wildlife habitat, less soil erosion, less chemical use, and better water quality.

For future research consideration, we recommend studies to determine thresholds for minimal and optimal amounts, heights, and distribution of western snowberry, select grass species, and spring residual cover that is necessary to provide suitable and secure nesting sites for ducks in native rangelands. We also recommend further evaluation of the response of wildlife, livestock and vegetation on rangelands where specialized grazing systems are being operated by private ranchers and farmers.

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