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DEMOGRAPHICS OF A DECLINING FLOCK OF GREATER SANDHILL CRANES IN OREGON

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ABSTRACT.—Greater Sandhill Crane (*Grus canadensis tabida*) nesting success at Malheur National Wildlife Refuge, Harney County, Oregon, was 44% for 456 nests during 1966–1974, and increased to 54% for 640 additional nests during 1976–1989. Predators destroyed 241 (38%) clutches in the 1976–1989 period, with Common Ravens (*Corvus corax*) taking 63, raccoons (*Procyon lotor*) 43, coyotes (*Canis latrans*) 28, and unknown predators 107. Most clutches lost to unknown predators were likely destroyed by coyotes. A total of 52 clutches was either abandoned, flooded, or infertile. The mean annual number of fledged young from 1970–1989 was 31, and mean annual young mortality from hatching to fledging was 84.4%. Of young fledged, a total of 438 broods contained one young and 91 had two ($\bar{x}$ = 1.14). The 6.7% mean annual recruitment at Malheur between 1970–1989 probably was responsible for a decline in breeding pairs, from 236 in 1975 to 168 in 1989. *Received 17 Jan. 1995, accepted 15 May 1995.*

Malheur National Wildlife Refuge, Harney County, Oregon (Malheur) is an important Greater Sandhill Crane (*Grus canadensis tabida*) nesting area. Cranes nesting at Malheur are affiliated with the Central Valley Population (CVP) (Braun et al. 1975). An interspersion of meadow-marsh and shrub-covered uplands provide excellent crane production habitat for about 200 pairs (Littlefield and Thompson 1979, Littlefield et al. 1994). Between 1977 and 1989, breeding pairs declined, resulting in a predator management program being initiated in 1986. The principle predators on eggs and prefledged young, coyotes (*Canis latrans*), raccoons (*Procyon lotor*), and Common Ravens (*Corvus corax*) were removed by trapping, toxicants (DRC 1339 for raven control), and shooting (Ivey 1990).

I studied crane productivity at Malheur from 1966–1989. Findings from 1966–1967 were presented by Littlefield and Ryder (1968) and 1968–1974 by Littlefield (1976). The objective of this study is to report annual reproduction in Greater Sandhill Cranes (greaters) nesting at Malheur from 1976–1989 and compare findings with earlier results (1966–1974).

STUDY AREA AND METHODS

Malheur Refuge is in the semi-arid northern Great Basin of southeastern Oregon. Upland vegetation there consists of low shrubs dominated by big sagebrush (*Artemisia tridentata*). The landscape has internal drainage systems and large wetland complexes occur, with one of the largest being the Malheur-Harney Lakes Basin, where Malheur is located. About 12,200 ha of crane breeding habitat occurs within this 75,117 ha refuge. Normally in August,

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TABLE 1

GREATER SANDHILL CRANE CLUTCH SIZES FOR 19 YEARS BETWEEN 1966–1989, AT MALHEUR NATIONAL WILDLIFE REFUGE, OREGON

Year	N	Clutch size				$\bar{x}$ clutch size
		1	2	3	4	
1966	52	4	48	—	—	1.92
1967	56	5	51	—	—	1.91
1969	80	3	77	—	—	1.96
1970	67	2	65	—	—	1.97
1971	74	6	68	—	—	1.92
1973	35	4	31	—	—	1.89
1974	33	—	32	1	—	2.03
1976	74	2	72	—	—	1.97
1977	37	6	31	—	—	1.84
1978	41	5	36	—	—	1.88
1980	28	3	25	—	—	1.89
1981	42	7	35	—	—	1.83
1982	71	7	63	1	—	1.92
1983	62	8	53	—	1	1.90
1984	48	5	42	1	—	1.92
1985	32	1	31	—	—	1.97
1986	60	9	51	—	—	1.85
1987	46	4	42	—	—	1.91
1989	36	3	33	—	—	1.92
Total	974	84	886	3	1	1.92 (0.05)[a]

[a] (SD).

most cranes begin congregating at several barley fields and remain until they migrate to California wintering areas in October and November (Littlefield 1992). Detailed descriptions of Malheur are provided by Littlefield (1990).

Pairs were counted in 1970, 1975, 1978, 1980, 1982, 1985, 1986, and 1989 in March and April. Breeding territories were surveyed until pairs were located or were determined to be missing. I searched for nests in April and May. After a 30-day incubation period, nests were revisited and fates assessed.

Using a 20× spotting scope, I counted fledged broods on refuge grain fields from a vehicle in September before autumn cranes arrived. However, in the western portion of the refuge, pairs often remained in mowed hay meadows, and they were counted in late September from aircraft.

Recruitment is expressed as (number fledged young/fledged young + breeding adults) × 100. Long-term means reported were weighted by year. I used a *t*-test to compare fledging success (young/pairs) for years with and without predator control.

RESULTS

During 19 years between 1966–1989, mean clutch size was 1.92 (Table 1). For 974 completed clutches, 84 (8.6%) contained one egg, 886

TABLE 2

GREATER SANDHILL CRANE NEST FATES AT MALHEUR NATIONAL WILDLIFE, OREGON, 1976–1989 (PERCENTAGE IN PARENTHESES)

		Nest fate					Nests lost to predators			
Year	N	Hatched	Aband.	Flooded	Infert.	Predated	Raven	Raccoon	Coyote	Unk. pred.
1976	52	35 (67)	0	0	1 (2)	16 (31)	4	6	0	6
1977	50	23 (46)	0	0	1 (2)	26 (52)	9	6	3	8
1978	55	19 (34)	1 (2)	10 (18)	1 (2)	24 (44)	7	5	5	7
1980	30	16 (53)	1 (3)	2 (7)	0	11 (37)	4	2	1	4
1981	31	15 (48)	0	0	2 (7)	14 (45)	5	2	0	7
1982[a]	81	54 (67)	2 (2)	0	1 (1)	24 (30)	8	2	3	11
1983[a]	61	38 (62)	3 (5)	3 (5)	1 (2)	16 (26)	2	5	5	4
1984	67	23 (34)	2 (3)	5 (7)	3 (5)	34 (51)	8	5	8	13
1985	50	24 (48)	1 (2)	0	0	25 (50)	7	1	0	17
1986[a]	60	40 (67)	2 (3)	0	2 (3)	16 (27)	2	2	1	11
1987[a]	61	35 (57)	2 (3)	0	3 (5)	21 (34)	4	4	0	13
1989[a]	42	25 (60)	2 (5)	0	1 (2)	14 (33)	3	3	2	6
Total	640	347 (54)	16 (2)	20 (3)	16 (2)	241 (38)	63	43	28	107

[a] Predator management programs in progress.

(91.0%) two eggs, 3 (0.3%) three eggs, and one clutch contained four eggs (0.1%) (Littlefield and Holloway 1987). Nest success for 456 clutches was 44% during 1966–1974 (Littlefield 1976). For 1976–1989 (excluding 1979 and 1988), 640 additional nests were examined and 347 (54%) hatched at least one egg (Table 2). Lowest nesting success was in 1978 and 1984 with 34%, and the highest success was 67% in 1976, 1982, and 1986.

Predators destroyed 241 (38%) clutches, including 63 by Common Ravens, 43 by raccoons, 28 by coyotes, and 107 by unknown predators (Table 2). Coyotes usually removed eggs and ate them at drier sites, leaving little or no evidence at nests. Most clutches lost to unknown predators were likely destroyed by coyotes. Predated nests annually ranged from 26% (1983) to 52% (1977). Other lost clutches included 16 abandoned (2%), 20 flooded (3%), and 16 contained infertile eggs (2%). Fertility rate for 711 eggs was 93.1%.

The mean number of young fledged annually from 1970–1989 was 31. With intensive predator control, 68, 46, 50, and 43 young fledged in 1970, 1971, 1986, and 1987, respectively. Largest numbers fledged in non-predator control years were 43, 47, and 43 in 1972, 1976, and 1978, respectively, and the fewest young fledged was two in 1973 and 1974 (Table

3). Fledging success was higher in years with predator control than in years without control ($t = -2.56$, df = 18, $P < 0.05$).

Average mortality from hatching to fledging was 84.4%, ranging from 66.5% (1970) to 98.8% (1974). Lower mortality was recorded in 1978 (70.1%), and in years with intensive predator control (1986—77.6%; 1987—78.4%; 1989—74.7%). Annual recruitment averaged 6.7% for 1970–1989 (Table 3). Lowest recruitment rates were in 1973 and 1974 (0.4%), 1975 (3.5%), 1985 (2.4%), and 1988 (1.6%); highest recruitment was in years with predator control, including 1970 (12.6%), 1986 (12.1%), and 1989 (12.7%). A total of 438 broods with 1 young and 91 broods with 2 young fledged ($\bar{x} = 1.14$) between 1970–1989; no broods with 3 or 4 young fledged.

DISCUSSION

Mean clutch size at Malheur is generally similar to the 1.96 eggs per clutch reported for cranes in Michigan (Walkinshaw 1973), 1.94 in Idaho (Drewien 1973), 1.91 in Wisconsin (Bennett 1978), and 1.91 in California (Littlefield 1995). Below average annual clutch sizes occurred at Malheur in 1973 and 1977 when severe drought conditions prevailed; however, in four other years, clutch sizes <1.90 occurred without obvious explanation.

Crane nesting success at Malheur was mainly below those reported elsewhere within the subspecies range. In Michigan, nesting success ranged from 77 to 78.9% (Hoffman 1979, Walkinshaw 1981), 78% in Idaho (Drewien 1973), and 84% in Wisconsin (Bennett 1978). However, nesting success was higher than 44% recorded from earlier Malheur studies (Littlefield 1976) and 29.8% success at Sycan Marsh, Oregon (Stern et al. 1987).

Improved nesting success (54%) at Malheur during 1976–1989 was attributable to improved nesting habitat. Between 1974–1983, cattle, which had excessively winter-grazed Malheur wetlands, were substantially reduced in numbers (Littlefield and Thompson 1987), providing residual vegetation for increased nest concealment. Although habitat improvement increased crane nesting success (Littlefield and Paullin 1990), brood survival generally declined and recruitment was <10% except for most years with predator control (Table 3). In 1972, toxicants (primarily Compound 1080) used for coyote control were banned on federal lands, and coyotes increased dramatically in southeastern Oregon (Willis et al. 1993). Radio-telemetry studies on flightless crane chicks at Malheur in the early 1980s showed that coyote predation was primarily responsible for low fledging success (Littlefield and Lindstedt 1992).

The 6.7% mean recruitment at Malheur between 1970–1989 was below

TABLE 3

BREEDING PAIRS, PERCENT MORTALITY OF YOUNG FROM HATCHING TO FLEDGING, NUMBER OF FLEDGED YOUNG, AND RECRUITMENT OF GREATER SANDHILL CRANES AT MALHEUR NATIONAL WILDLIFE REFUGE, OREGON, 1970–1989

Year	Breeding pairs	No. fledged young	Percent young mortality	Percent recruitment[a]
1970[b]	235	68	66.5	12.6
1971[b]	235	46	80.7	8.9
1972	235	43	ND	8.4
1973	235	2	98.0	0.4
1974	235	2	98.8	0.4
1975	236	17	ND	3.5
1976	236	47	84.6	9.1
1977	236	27	85.5	5.4
1978	219	43	70.1	8.9
1979	219	39	ND	8.2
1980	221	34	84.9	7.1
1981	221	23	88.7	5.0
1982[b]	214	25	90.1	5.5
1983[b]	214	39	84.8	8.4
1984	214	8	93.9	1.8
1985	186	9	92.6	2.4
1986[b]	181	50	77.6	12.1
1987[b]	181	43	78.4	10.6
1988[b]	181	6	ND	1.6
1989[b]	168	49	74.7	12.7
$\bar{x}$ (SD)	215 (22.9)	31 (18.8)	84.4 (9.4)	6.7 (4.0)

[a] Recruitment = (no. young fledged/young fledged + no. breeding adults) × 100.
[b] Predator management programs in progress.

desired levels. I attribute low recruitment as being primarily responsible for the declining number of nesting pairs at Malheur (Table 3). In 1970, 235 pairs occupied breeding territories and 236 in 1975. Low recruitment began in 1973, but a decline in nesting pairs was not detected until 1978. From 1978–1981, 219–221 pairs occupied territories, but pairs continued to decline in the mid-1980s and by 1985 had decreased to 186, with only 168 pairs present in 1989 at the end of the study.

Low recruitment (4.5%) was reported for cranes at Sycan Marsh, Oregon (Stern et al. 1987), and for the entire CVP of Greater Sandhill Cranes (5.6–6.1%). This is one of the lowest rates recorded for North American cranes (Drewien et al. 1995). Greater Sandhill Cranes nesting in the Great Lakes region (eastern population) have been increasing, and recruitment rates have averaged 12–12.7% (Lovvorn and Kirkpatrick 1982, Drewien et al. 1995), while cranes breeding in the Rocky Mountain

states (Rocky Mountain population) ranged from 9.4 to 12% in the early 1970's (Drewien et al. 1995) and the population was increasing during this period. Since 1986, recruitment has declined, ranging from 3.4 to 6.5%. Presently, this population is stable or slightly decreasing (Drewien et al. 1995).

Even though other mortality factors are prevalent within the CVP nesting in Oregon and California, the most important population limitation appears to be low annual recruitment. With high predation on eggs by Common Ravens, raccoons, and coyotes, and losses of young to coyotes, few young fledge. Only in years with predator control have recruitment rates exceeded those apparently necessary for population stability at Malheur.

Due to longevity and deferred breeding age of adult Greater Sandhill Cranes (Drewien et al. 1995), a decline in breeding pairs at Malheur did not occur for a number of years. Although recruitment was extremely low in 1973 and 1974, nesting pairs continued to increase through 1975 and remained stable through 1977, followed by a slight decline and again general stability through 1982 (Table 3). With attrition of older breeders, pairs dropped abruptly in 1985, 12 years after declining recruitment was first recorded. This indicates that caution is warranted when an increased mortality factor is introduced into a sandhill crane population, as it may take a number of years before higher mortality results in a decrease in breeding adults.

A predator management program at Malheur was initiated in 1986 to curtail the accelerated decline in breeding pairs. Excluding the severe drought year of 1988, recruitment increased during control years. By 1993, the Malheur breeding population had rebounded to 230 pairs after 8 years of predator control (Ivey 1993).

Because of long-term annual monitoring of the nesting crane population at Malheur, corrective measures were undertaken to reduce predation on eggs and young. Had an annual monitoring program not been in progress, it would likely have been several additional years before the decline was detected and corrective measures initiated. The U.S. Fish and Wildlife Service continues to annually monitor breeding pairs and reproduction, and if new problems are detected corrective management actions will be initiated (G. L. Ivey, pers. comm.). Due to predator control, breeding pairs in 1993 are presently near the peak number (236) recorded in 1975.

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