PROGRESS REPORT - 1991

Predator Control to Enhance the Production of Greater Sandhill Cranes on Malheur National Wildlife Refuge

Malheur National Wildlife Refuge
Harney County, Oregon

by

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TABLE OF CONTENTS

EXECUTIVE SUMMARY-MALHEUR PREDATOR CONTROL PROGRAM, 1991

The nesting population of greater sandhill cranes on Malheur National Wildlife Refuge, Oregon had declined from 236 pairs in 1971 to 181 pairs in 1986 when predator control began. The population has continued to decline to 168 pairs in 1989. Some of the decline is attributed to lost habitat on Mud, Malheur and Harney Lakes due to record high lake levels (14 pairs). Losses on Mud, Malheur, and Harney lakes had already taken place by 1986, but could not be verified until a comprehensive pair count was completed in 1988. The remainder of the decline is attributed to the low recruitment of young into the population during the years 1971 through 1985.

In 1991, a total of 214 crane pairs were counted on the refuge. This represents a significant increase compared to the 177 pairs counted in 1990. This is an increase of 37 pairs over 1990 numbers. These new recruits are a result of our efforts towards reducing predator impacts on crane production.

In 1991, 219 coyotes were removed by the following methods: aerial gunning (36 percent), calling and shooting (20 percent), trapping and snares (37 percent), and denning (7 percent). An estimated 33 ravens were removed using 33 dozen eggs injected with DRC-1339 and an additional 15 ravens were shot. Three raccoons were taken by trapping plus five by shooting, for a total of eight.

Sandhill cranes experienced a poor production year in 1991. Overall sandhill crane hatching success was only 50 percent. This is considerably below our control program goal of 75%, and is the lowest nesting success recorded for the Malheur crane flock during the predator control program. Predators took 25 percent of the monitored nests this year (raven - one percent, raccoon - zero, coyote - five percent, and unidentified predators - 18 percent). Flooding and infertile or rotten eggs accounted for losses of 12 and 13 percent of nests, respectively. Although predation accounted for loss of 25% of the nests, it is likely that many of the nests which were recorded as predated were flooded and/or abandoned and then predated because of the cool wet weather in May. This poor weather caused flooding of several nests in the Blitzen Valley, and apparently killed embryos in some eggs, as several pairs were sitting on eggs containing dead embryos.

Crane colts were counted from the air on 4 September in the Double-O and Blitzen Valley using ADC's Husky aircraft. This aerial data was supplemented with ground counts in the Blitzen Valley. Using a combination of ground and aerial count data, a total of 15 colts produced was tallied on the refuge in 1991. Only one colt was recorded in the Double-O, one from Malheur Lake, and the remainder from the Blitzen Valley.

The sandhill crane objectives of the 1991 effort were to have a nesting success of 75%, fledging success of 25%, and recruitment of 15%. The actual outcome was 50 percent nesting success and seven percent fledging success, yielding a recruitment rate of 3.4 percent. Poor weather appeared to be the main cause of low productivity this year, although a study of crane colt survival showed predators to be a problem still.

LIST OF TABLES

ACKNOWLEDGEMENTS

This was the third year of an extended five-year predator control effort. It was carried out without any major difficulties. Animal and Plant Health Inspection Services (APHIS) employee Buster Gibson did the majority of predator control work, assisted by Miles Hausner, Alan Armistead and Bill Delepierre. Gary Ivey, Malheur Refuge Wildlife Biologist, was responsible for coordination of the program with APHIS. Gary was responsible for the sandhill crane nest monitoring and was assisted by several refuge employees. Gary also did the colt counts on the fall staging areas. Rick Vetter was responsible for coordination of the Canada goose nesting studies and Gary coordinated the duck nest monitoring. Gary, Refuge Manager Forrest Cameron and Tom Hoffman (APHIS) worked together to administer the control program.

I. INTRODUCTION

On 25 November 1985, the U.S. Fish and Wildlife Service (Service) issued a final environmental assessment entitled "Alternatives to Enhance the Production of greater sandhill cranes on Malheur National Wildlife Refuge, Oregon". This assessment, herein known as the "EA", outlined a 21 percent decline in breeding pairs of sandhill cranes on Malheur National Wildlife Refuge from 236 in 1971 to 186 in 1985. The primary cause for this decline was low recruitment of young due to high nest predation by ravens, raccoons and coyotes, and high predation by coyotes on colts before fledging. In an average year, predators destroyed 45 percent of all crane nests on the refuge and 85 percent of the colts that hatched failed to fledged.

The EA proposed that efforts to improve sandhill crane nesting habitat continue and that coyotes, ravens and raccoons would be controlled for three years (1986-1988). The purposes of the control efforts were to: 1) increase sandhill crane nesting success to 75 percent, fledging success to 25 percent, and annual recruitment to a minimum of 15 percent on a sustained basis, 2) reach refuge production objectives of 150 crane colts annually, and 3) reverse the current downward trend in the refuge crane population.

Progress reports such as this one have been prepared each year since the program began. These progress reports provide details of each year's activities.

In 1986, predator control was conducted on approximately 27,000 acres (14 percent) of Malheur Refuge. One hundred sixty-six coyotes, 11 raccoons and an estimated 44 ravens were removed the first year. Overall crane production was 50 colts, the highest count since 1970. Recruitment of crane colts in the predator control area was 14.9 percent, the highest ever recorded on the refuge.

Because the first year's effort was successful, the predator control area was expanded in 1987 to include approximately 85,000 acres (46 percent) of the refuge as outlined in the initial EA. Four hundred and sixty coyotes, 124 ravens and 16 raccoons were removed in 1987. Overall crane production in 1987 was 43 colts and recruitment was 10.6 percent.

The program was continued in 1988, when 226 coyotes, 102 ravens and 12 raccoons were removed. Crane nest success set an all-time record at 76 percent. Due to an unusually early migration, most of the refuge cranes left the area before the colt counts were conducted, making production estimates impossible.

Following the successful three years of the trial predator control program, a new draft EA to extend the program was

released for public review and comment on February 10, 1989. The plan called for extension of the control program for an additional five-years (through 1993) to enhance the distressed refuge sandhill crane flock. It was approved by the Regional Director on March 29, 1989.

In 1989, 226 coyotes, 28 raccoons, and 39 ravens were removed. Crane nest success was 61 percent. Crane production was 49 colts fledged, the second best year since the predator control began.

In 1990, 156 coyotes, 19 raccoons, and 43 ravens were removed. Crane nest success was a record 83 percent. Crane production was at least 22. Most cranes migrated early, probably causing some colts to be missed during the counts.

This report details the results of the 1991 efforts.

II. METHODS

Predator control methods included aerial gunning, calling and shooting, trapping, snares and denning for coyotes; DRC-1339 egg baits and shooting of ravens; and trapping and shooting for raccoons. Greater sandhill crane and waterfowl nesting and production were monitored. Following is a discussion of each control method and associated monitoring:

A. Predator Control

1. Aerial gunning was conducted by APHIS personnel using flight of a low level fixed-wing airplane. Control was accomplished using twelve-gauge shotguns with No. F steel shot from aircraft.

2. Trapping was used for both raccoons and coyotes and was done solely by APHIS personnel. Traps with off-set jaws were used with fetid scent baits. Non-target species were released unless they were too stressed or injured, in which case they were humanely killed with a small caliber firearm. All traps were set out of direct view from the refuge public access roads. Live traps were used along waterways open to public fishing to avoid possible conflicts with fishermen or their pets.

3. Snares were used by APHIS personnel for both coyotes and raccoons. Operational criteria for snares were basically the same as traps, except that fetid scents were not used.

4. Calling and shooting was conducted by APHIS and refuge personnel, and involved coyotes and ravens. Coyotes were called using a variety of calls (howlers,

squeakers, etc.), and shot with scope-mounted rifles. Ravens were shot in the control areas on an opportunistic basis, incidental to other activities.

5. Denning was used by APHIS personnel at active dens and involved the placement of a gas cartridge in the den. The den's entrance was covered with dirt and the cartridge consumed the oxygen in the den, killing the coyotes by suffocation. Denning involved coyotes only.

6. Trained dogs were used by APHIS personnel to locate adult coyotes near den sites.

7. DRC-1339 Egg Baits were used strictly for raven control. The chemical was injected into domestic chicken eggs at a rate of one milliliter (ml) of a 10 percent solution per egg. Three or four treated eggs were placed conspicuously in "dummy" nests to simulate natural nests. Dummy nests were monitored and consumed eggs were replaced until the target ravens were removed, usually within a few days.

B. **Crane and Waterfowl Monitoring**

1. Sandhill cranes: Refuge sandhill crane pairs were tallied while they were on their territories during spring months. Data were collected from 77 crane nests in 1991. Nests were re-examined to determine fates by examining egg shell remains and other evidence found at each nest. In early September, young cranes were censused and the number of young produced was determined. The established procedures for nesting studies (used 24 years) and fall colt counts (used 20 years) were followed and data collection was consistent with past methods.

2. Waterfowl: Nesting data are routinely collected on Malheur Refuge for ducks and Canada geese to determine nesting success. This information is used in estimates of waterfowl production on the refuge. In 1991, data were collected on 135 Canada goose and 158 duck nests on the refuge. These nests were usually located early in incubation and revisited after calculated hatch dates to determine fates.

III. RESULTS AND DISCUSSION

A. Predator Control

1. Coyotes: According to the Oregon Department of Fish and Wildlife, the coyote index for the Harney County area was the same in 1991 as it was in 1990. The refuge coyote population was higher in the spring of 1991, versus 1990. The January refuge coyote scat survey, used to measure relative abundance of coyotes in the area, showed an increase from an index of .14 scats per mile per day in 1990, to .26 scats per mile per day. Coyote numbers greatly increased on the refuge in August and September 1991, and the fall coyote scat index increased from .38 in 1990 to .43 in 1991.

   Coyote control work began on 7 February when the first coyote was shot from the air by APHIS personnel. The last coyote removed was trapped on August 30. During this period, 219 coyotes were removed by all methods (Table 1).

   This year's coyote control efforts were very similar to our 1990 efforts. The size of the control area (85,000 acres) and staff time (5 1/2 staff months) was unchanged from last year. The relative importance of various control methods was also similar to 1990 (Table 2). For the second year, trapping accounted for the majority of the coyote take, followed by aerial gunning.

   Aerial gunning accounted for 36 percent of all coyotes taken. The aerial gunning activities are summarized in Table 3. The difference between total hours flown and total hours hunted represents commuting time between the Burns Airport and the refuge. The nine flights conducted in 1991 was up 125 percent from the four flown in 1990. Total hours hunted was 48.6, up 96 percent from 1990. Efficiency of aerial gunning efforts in 1991 was 1.6 coyotes per hour, compared to 2.2 coyotes per hour in 1990, 2.1 coyotes per hour in 1989, 4.0 coyotes per hour in 1988, 3.6 coyotes per hour in 1987 and 4.8 coyotes per hour in 1986.

   Traps and snares accounted for 37 percent of all coyotes taken and snares, two percent. Trapping and snaring activities are summarized in Table 4. Overall trapping effort with leg-hold traps was 18 percent higher than in 1990, while use of snares was 31 percent less.

Trapping efficiency (leg-hold traps only) for 1991 was one coyote per 260 trap nights, a five percent decline from last year's rate of one coyote per 248 trap nights. Snare efficiency was one coyote per 203 snare nights this year versus one coyote per 587 snare nights last year.

The maximum number of traps in the field at any one time was 134 in 1991, or approximately one trap per 634 acres of control area. This was less intense than last year (1 trap per 594 acres), and much less than the 1986 maximum of one trap per 450 acres.

The maximum number of snares used in 1991 was 11 (one snare per 7727 acres), the same as in 1990, versus one snare per 5313 acres in 1989, one snare per 2930 acres in 1988, one snare per 1850 acres in 1987, and one snare per 710 acres in 1986.

Calling and shooting accounted for 20 percent of the coyotes taken. These were taken by both APHIS and refuge personnel.

Two active dens were located within the control area during the 1991 season. These dens were gassed for a total estimated kill of 10 coyotes.

There were four crane nest losses attributed to coyotes in 1990 and 14 nest losses attributed to unidentified predators.

Table 1. Summary of coyotes taken by all methods on Malheur Refuge, Oregon, March 1 through August 31, 1991.

	Number of Coyotes Removed - by Method					
Month	Aerial Gunning	Calling/ Shooting	Traps	Snares	Denning	Total by Month
February	20	2	0	0	0	22
March	16	18	12	0	0	46
April	0	2	12	3	0	17
May	0	2	11	0	5	18
June	11	2	13	1	10	37
July	18	3	15	0	0	36
August	14	14	15	0	0	43
TOTALS	79	43	78	4	15	219

Table 2. Estimated coyote kill by method as outlined in the Environmental Assessment versus actual kill by method, 1986 through 1991 at Malheur Refuge, Oregon.

	Percent of Total Coyotes Taken						
Method	Estimate	1986	1987	1988	1989	1990	1991
Aerial Gunning	75%	51%	80%	56%	19%	8%	36%
Denning	10%	3%	6%	7%	19%	18%	7%
Trapping & Snares	8%	27%	7%	27%	46%	44%	37%
Calling & Shooting	7%	19%	8%	10%	15%	28%	20%

Table 3. Summary of coyotes removed by aerial gunning on Malheur Refuge, Oregon in 1991.

Date	Hours Flown	Hours Hunted	No. Coyotes Killed	Coyotes per hour of hunting
02/07	2.0	1.0	11	11.0
02/25	4.0	3.0	9	3.0
03/28	5.0	4.0	11	2.8
03/29	4.0	3.0	5	1.7
06/10	9.4	8.4	11	0.8
07/10	8.7	7.7	14	1.8
07/23	10.2	9.2	4	0.4
08/13	9.3	8.3	10	1.2
08/14	5.0	4.0	4	1.0
TOTALS	57.2	48.6	79	1.6

Table 4. Summary of 1991 trapping activity in the predator control area, Malheur Refuge, Oregon.

Dates	Equipment in Field			Number of Trap Nights	
	#Days	Traps	Snares	Traps	Snares
02/26-02/28	3	47	2	141	6
03/01-03/02	2	71	3	142	6
03/03-03/09	7	87	7	609	49
03/10-03/16	7	89	7	623	49
03/17-03/23	7	91	8	637	56
03/24-03/31	8	90	4	720	32
Feb/Mar Totals:	34	---	--	2872	198
04/01-04/06	6	94	6	564	36
04/07-04/13	7	97	4	679	28
04/14-04/20	7	93	9	651	63
04/21-04/27	7	94	9	658	63
04/28-04/30	3	95	9	285	27
April Totals:	30	---	--	2837	217
05/01-05/04	4	95	11	380	44
05/05-05/11	7	93	7	651	49
05/12-05/18	7	104	7	728	49
05/19-05/25	7	109	4	763	28
05/26-05/31	6	116	4	696	24
May Totals:	31	---	--	3218	194
06/01-06/01	1	116	4	116	4
06/02-06/08	7	127	4	889	28
06/09-06/15	7	126	3	882	21
06/16-06/22	7	131	2	917	14
06/23-06/30	8	134	3	1072	24
June Totals:	30	---	--	3876	91
07/01-07/13	13	134	3	1742	39
07/14-07/20	7	133	2	931	14
07/21-07/31	11	132	2	1452	22
July Totals:	31	---	--	4125	75
08/01-08/03	3	130	2	390	6
08/04-08/10	7	132	2	924	14
08/11-08/17	7	123	1	861	7
08/18-08/28	11	109	1	1199	11
August Totals:	28	---	--	3374	38
OVERALL TOTALS:	184	---	--	20302	813

2. Raccoons: A total of eight raccoons were removed from the refuge in 1991. Three were trapped by the APHIS trapper, and five were shot by APHIS and refuge personnel.

3. Ravens: Fifteen active raven nests were located on or near the refuge in 1991, only one of which was in the predator control area. Ravens were removed from this site by shooting.

   Between 26 March and 30 June, 33 dozen bait eggs were placed in the predator control area. Since the local breeding population was known to be small, we presumed that most of the ravens killed were either non-breeders or migrants that were passing through and hunting in the predator control area. Based on the refuge staff's professional judgement, it is estimated that one raven was removed for each dozen eggs placed in the control area, therefore, the total DRC-1339 take is estimated to be 33. An additional 15 ravens were shot, making the total estimated raven kill 48.

   Egg baits were again placed as selectively as possible, only in those areas where ravens were observed hunting in or near crane nesting territories. Egg placement was terminated in late June when all sandhill cranes had completed incubation.

   Egg baits were again successful in reducing raven predation on crane eggs this year. Typically, ravens destroyed 17 percent of the monitored crane nests (see page 23 of the 1985 EA). In 1991, ravens destroyed only one of the monitored crane nests.

4. Non-target mortalities: Table 5 summarizes all non-target mortalities associated with this year's trapping efforts. The total number of non-target animals caught was 26, with three mortalities. The sandhill crane suffered a fractured toe which did not appear to be a serious injury. No dead magpies or gulls were found in the predator control area; however, magpies did occur in areas where bait eggs were placed. Gulls were uncommon in the areas where bait eggs were placed.

Table 5. Non-target species caught, released, and/or killed on Malheur Refuge, Oregon, during trapping activities in 1991.

Species	Total Number Caught	Number Released	Number Killed
Porcupine	9	8	1
Badger	11	9	2
Bobcat	5	5	0
Sandhill Crane	1	1	0
Total	26	23	3

B. Sandhill Crane Production

This year, water supplies were generally normal in the Blitzen Valley, and dry in the Double-O. However, the Blitzen Valley experienced an unusual water year. Water runoff was predicted to be 52 percent of normal in early March. Extensive spring rains brought streamflow in the Blitzen River to about 102 percent of normal by late May, versus 68 percent of normal in 1990, 134 percent in 1989, 38 percent in 1988, 58 percent in 1987, and 94 percent in 1986. Until the May rains, water shortages for irrigation left many crane nesting areas dry. Low water supplies generally negatively effect crane production because some crane territory sites don't get irrigated and many areas dry up too early, limiting feeding habitat for young cranes. Unfortunately, the came at the wrong time for nesting cranes, as many nests were inundated by rising water levels.

Sandhill crane pairs were tallied while they were on their territories during spring months. A total of 214 crane pairs on territory were tallied for the refuge in 1991. This represents an increase of 37 pairs over 1990 numbers. These new recruits are a result of our efforts towards reducing predator impacts on crane production. Table 6 summarizes numbers of active crane territories by biological unit.

Table 6. Number of sandhill crane pairs found on territories in 1991 at Malheur National Wildlife Refuge, by Biological Unit.

	Biological Unit								
	1	4-5-6	7	8	9	10	11	12	TOTAL
Number of crane pairs:	30	5	23	30	24	11	34	57	214

A total of 35 new territories were identified this year. Nine territories which were recorded as inactive in 1990 were found to be occupied this year, and seven territories which had been active in 1990 were inactive this year. These losses and gains in territory activity can be attributed to shifting of territory sites, pair mortality, and recruitment of new pairs. These new recruits are a result of our efforts towards reducing predator impacts on crane production.

A total of 77 crane nests were located in 1991. Table 7 summarizes nest fate data for crane nests monitored on the refuge since 1966. Overall nesting success was 50 percent in 1991. This is the poorest hatch since the predator control program began in 196. Predation accounted for 25 percent of nest losses, while flooding and infertile or rotten eggs accounted for 12 and 13 percent, respectively. Although predation accounted for loss of 25 percent of the nests, many of the nests which were recorded as predated were probably flooded and/or abandoned and then predated because of the cool wet weather in May. This poor weather caused flooding of several nests in the Blitzen Valley, and apparently killed embryos in some eggs, as several pairs were sitting on eggs containing dead embryos.

Crane colts were counted from the air on 4 September in the Double-O and Blitzen Valley using ADC's Husky aircraft. This aerial data was supplemented with ground counts in the Blitzen Valley. Using a combination of ground and aerial count data, a total of 15 colts were produced on the refuge in 1991. Only one colt was recorded in the Double-O, one from Malheur Lake, and the remainder from the Blitzen Valley.

Assuming all 214 refuge crane pairs nested, and with 50 percent nesting success, an estimated 107 nests hatched. Using an average clutch size of 1.92, an estimated 205 colts hatched. With 15 crane colts fledging, estimated brood survival was 7.4 percent. Conversely, mortality was 92.6 percent. This brood survival rate is well below the predator control plan goal of 25 percent.

Refuge biologist conducted a telemetry study of crane colt mortality this year. Data from this pilot year of the study showed mortality to be 93.3 percent (one out of 15 fledged). This rate is very close to the mortality rate suggested by the other refuge data (92.6 percent). Predation was the most important factor in colt losses during the study, and mink were the most important predator.

Table 7. Nest fates of Greater Sandhill Crane nests monitored on Malheur National Wildlife Refuge, Oregon; 1966-1991 (percentages in parentheses).

Year	Sample Size	NEST STATUS								
		Hatched	Abandoned	Flooded	Infertile	Predated	Raven	Raccoon	Coyote	Unknown
1966	51	18 (35)	7 (14)	0	0	26 (51)	9	6	4	7
1967	59	25 (42)	1 (2)	0	0	33 (56)	13	14	--	6
1969	88	52 (59)	3 (3)	1 (1)	0	32 (36)	10	12	1	9
1970	86	44 (45)	4 (5)	0	0	38 (50)	17	9	1	11
1971	83	44 (53)	0	0	0	39 (47)	16	10	1	12
1973	49	10 (20)	1 (2)	0	1 (2)	37 (76)	20	4	5	8
1974	50	18 (36)	2 (4)	0	0	30 (60)	14	2	7	7
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	81	54 (67)	2 (2)	0	1 (1)	24 (30)	8	2	3	11
1983	60	38 (63)	3 (5)	3 (5)	1 (2)	15 (25)	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	60	40 (67)	2 (3)	0	2 (3)	16 (27)	2	2	1	11
1987	61	35 (57)	2 (3)	0	3 (5)	21 (34)	4	4	0	13
1988	67	51 (76)	3 (5)	0	1 (1)	12 (18)	4	1	0	7
1989	70	43 (61)	2 (3)	0	2 (3)	23 (33)	9	4	3	7
1990	60	50 (83)	4 (7)	0	1 (2)	5 (8)	2	2	0	1
1991	77	39 (50)	0	9 (12)	10 (13)	19 (25)	1	0	4	14
TOTAL:	1337	716 (54)	40 (3)	30 (2)	30 (2)	520 (39)	175(13)	104(8)	51(4)	190(14)

Table 8 summarizes colt mortality rates and recruitment estimates for the refuge crane population since 1970. Estimated mortality was high this year. Table 8 also expresses recruitment as colts fledged per 100 pairs. This provides a more comparable number between years. The number of colts fledged per 100 pairs for the five year periods before the control program averaged 9.8, compared to 17.2 for the five years of predator control. Keep in mind that in 1988 and 1990, colt counts were incomplete.

Low productivity this year is believed to be due to dry conditions which delayed nest initiation, poor weather in May which reduced nest success, and poor colt survival. Another factor which may have affected productivity is the inexperience of new young crane pairs. At least 35 pairs nested for their first time this year. According to C.D. Littlefield (personal communication), young cranes are generally unproductive for the first few years of attempted breeding and must learn to become good parents to successfully raise young.

Table 8. Estimated mortality and recruitment rates for Greater Sandhill Cranes nesting on Malheur National Wildlife Refuge; 1970-1991.

Year	Percent Mortality	No. Young Fledged	Percent Recruitment	Colts fledged/ 100 pairs
1970	66.5	68	12.5	28.9
1971	80.7	46	8.9	19.6
1972	**	43	8.3	18.3
1973	98.0	2	0.4	0.8
1974	98.8	2	0.4	0.8
1975	**	17	3.5	7.2
1976	84.6	47	9.1	19.9
1977	85.5	27	5.8	11.4
1978	70.1	43	8.9	19.6
1979	**	39	8.1	17.8
1980	84.9	34	7.1	15.5
1981	88.7	23	5.0	10.5
1982	90.1	25	5.5	11.7
1983	84.8	39	8.4	18.2
1984	93.9	8	1.8	3.7
1985	92.6	9	2.4	4.8
1986	77.6	50	12.1	27.6
1987	78.4	43	10.6	23.7
*1988	**	6	2.1	3.3
1989	75.0	49	12.7	29.1
*1990	87.7	22	5.8	12.4
1991	92.6	15	3.4	7.0

* Dry years, cranes migrated early, therefore counts should be considered low.
** Data insufficient to estimate mortality.

C. Waterfowl

1. Canada geese: The refuge-wide nest success for Canada geese was 29 percent in 1991, compared to 1990's 53 percent. Nest success for Canada geese ranged from 12 percent on Malheur, Mud and Harney lakes, to 54 percent in the upper Blitzen Valley.

   Nest predation increased from last year's rates in all units except the upper Blitzen Valley (Table 9). Predators took 70 percent of all monitored nests as follows: coyote - 12 percent; raccoon - 1 percent; raven - 1 percent; and unidentified predator - 54 percent.

The average goose brood size at fledging in 1991 was 3.4 (n=75). In 1990, the average was 3.8. The lower brood size may have been due to the dry conditions through the previous winter, which limited available habitat for broods on the refuge, and probably resulted in poor prenesting condition of adults.

Table 9. Summary of predation rates of sampled Canada goose nests from the major units of Malheur Refuge, 1974-91.

Year	Double-O (Unit 1)	Lakes (Units 2-6)	Lower Blitzen (Units 7-9)	Upper Blitzen (Units 10-12)
1974	71%	*	64%	64%
1975	*	*	*	*
1976	*	*	*	*
1977	77%	25%	54%	49%
1978	*	*	*	*
1979	*	*	0%	69%
1980	*	*	28%	71%
1981	*	*	*	*
1982	71%	42%	48%	55%
1983	*	*	*	*
1984	48%	63%	69%	85%
1985	*	29%	*	62%
1986	74%	33%	38%	15%**
1987	25%**	27%	9%**	14%**
1988	57%**	55%	51%**	40%**
1989	41%**	27%	35%**	36%**
1990	63%**	47%	26%**	53%**
1991	76%**	88%	65%**	46%**

* no data. **Predator control in effect.

2. Ducks: Overall dabbling duck nesting success in 1991 was 12 percent, while diving duck success was 38 percent. Dabbling duck nesting success in 1990 was 41 percent. The major problem causing lower success this year was extensive flooding in the Blitzen Valley. Overall duck production in 1991 was estimated at 5431, compared to 10105 in 1990.

D. Funding and Staff

Under a cooperative agreement between the Service and APHIS, the refuge reimbursed APHIS $14,013 for aircraft services and the trapper's salary in 1991.

Buster Gibson was the APHIS trapper again this year. In addition to salary and aircraft expenses, the refuge provided APHIS with a pickup truck for the predator control period. The truck was driven 11,411 miles which cost $3,155 (GSA rental and mileage fees).

E. Conflicts and Problems

Predator control efforts went very well again this year. There were no major problems encountered and few complaints were received. Public access roads were not closed this year during aerial gunning actions and no conflicts or problems were encountered.

Control activities were done discretely and without conflict with other refuge users to the extent that most visitors were not even aware that it was going on.

IV. CONCLUSIONS

Results of the predator control efforts at Malheur Refuge in 1991 were not as good as we would have liked, however they were good considering the extreme weather conditions in May, which resulted in nest flooding and apparently increased brood mortality. Crane nest success was low, predominately due to flooding of nests in the Blitzen Valley. Without the control program, it is likely that almost no colts would have fledged in 1991. The 15 colts produced will contribute to the population's growth in future years.

V. RECOMMENDATIONS

1. Continue the crane colt mortality studies using radio telemetry to determine current causes of colt mortality under a predator control regime.