Kansas Recovery Plan
for the
Snowy Plover (*Charadrius alexandrinus*)

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EXECUTIVE SUMMARY

This recovery plan outlines strategies and methods to recover and eventually delist the snowy plover (*Charadrius alexandrinus*), which is currently designated as a threatened species in Kansas. Implementation of the recovery plan will also benefit plant and wildlife species that share habitat with the snowy plover, especially the federal and state endangered least tern (*Sterna antillarum*).

The snowy plover is a summer resident in Kansas that breeds on sparsely vegetated zones of salt flats, ephemeral wetlands, and riverine sandbars in central and southwestern Kansas. Currently, known breeding sites of the snowy plover in Kansas are limited to two public wetlands in the central part of the state, Quivira National Wildlife Refuge and Cheyenne Bottoms Wildlife Area. Historically, the snowy plover bred along the Cimarron River in Meade, Clark, and Comanche counties and at wetlands and reservoirs in central and southwestern Kansas.

The recovery plan outlines two basic approaches. The first approach is to protect and manage existing breeding populations on public lands through habitat management and species-level management. The second approach is to improve habitat at historic breeding sites by restoring flow, natural hydrological conditions, and riparian habitat at riverine sites, and restoring wetlands at non-riverine sites. Habitat management at the local and watershed levels envisioned in the two approaches will seek to restore natural ecosystem conditions and, in doing so, will provide benefits to a wide variety of native plants and wildlife. Species-level management, consisting of actions such as providing elevated nest sites and providing predator exclosures, will benefit snowy plovers and the federal and state endangered least tern (*Sterna antillarum*), a species that shares similar breeding habitat with the snowy plover.

The estimated five-year cost of implementing proposed recovery tasks on public lands is in excess of $175,000. The cost of recovery on private lands to a level sufficient to delist the snowy plover will depend on which sites are chosen for recovery, landowner acceptance of state and federal conservation programs, and hydrological restoration. The costs of these private lands recovery steps involve numerous variables that cannot be estimated at this time. Downlisting the snowy plover from threatened to SINC might be possible by 2012 if this recovery plan is implemented promptly. Delisting might occur by 2015 if a serious program of habitat restoration on private wetlands and riverine sites is embraced by private landowners and partially funded by public and private conservation agencies and organizations.

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I. INTRODUCTION

This recovery plan addresses the recovery needs of the snowy plover (*Charadrius alexandrinus*) in Kansas. The snowy plover received legal protection as a threatened species by the Kansas Department of Wildlife and Parks (KDWP) in 1987 under the authority of the state's Nongame and Endangered Species Conservation Act of 1975 (K.A.R. 115-15-1 and K.A.R. 115-15-2). As outlined in K.A.R. 115-15-4, this recovery plan outlines specific strategies and methods to recover and eventually delist this shorebird.

A. DESCRIPTION AND TAXONOMY

The snowy plover is a small shorebird (15-17 cm long, 34-58 g) in the family Charadriidae (Page et al. 1995). It is pale brown above, white below, with a black bill and legs. It has a white hind-neck collar, dark lateral breast patches, and dark forehead bar and eye patches. Sexes are similar, although males can be distinguished from females in breeding plumage by black markings on the head and breast. In females these markings are usually dark brown. A similar species is the piping plover, which is slightly larger, has orange legs, and, in breeding plumage, has an orange base to the bill. The life-span of the snowy plover averages three years. The oldest reported individual in the wild was at least 15 years (Page et al. 1995). The oldest age documented in the Great Plains was a banded bird from Cheyenne Bottoms recaptured after 11 years (Boyd 1981b).

The snowy plover has a cosmopolitan distribution. In North America, two subspecies were formerly recognized (American Ornithologist's Union 1957): the western snowy plover (*Charadrius alexandrinus nivosus*), breeding from Kansas, Oklahoma, and Texas west to the Pacific Coast and in Mexico, and the Cuban snowy plover (*C. a. tenuirostris*), breeding on the Gulf Coast from Louisiana to Florida and in the Caribbean. Subsequent studies have questioned the distinction between the two subspecies and currently all snowy plovers in North American are assigned to the *nivosus* group (American Ornithologist's Union 1998).

Breeding data indicate that the Pacific Coast population of the snowy plover differs from interior-breeding populations (U.S. Fish and Wildlife Service 1993). Banding data indicate that snowy plovers are site faithful, i.e., most individuals return to breed at the same site each year. Only two instances of interchange of birds between Pacific Coast and inland breeding sites have been documented (U. S. Fish and Wildlife Service 2001). The degree of interchange between Gulf Coast and inland breeding populations in the Great Plains is not well understood.

B. DISTRIBUTION

The snowy plover has a cosmopolitan distribution and is found in North and South America, Europe, Asia, and North Africa (Page et al. 1995). In North America, the species breeds along the Pacific Coast from Washington south to southern Mexico, and on the Atlantic Coast it breeds along the Gulf of Mexico from south Florida to the Yucatan Peninsula and in the Caribbean. Inland populations of the snowy plover are found in California and southern Oregon east to Utah, central and eastern Colorado, and central Kansas south to central Oklahoma, Texas, and Mexico. Irregular breeding has been reported as far north as Montana and southern Alberta.

In the Great Plains, snowy plovers breed in eastern Colorado, central and southwestern Kansas, and western Oklahoma and Texas. A related species, the piping plover (*Charadrius melodus*) occupies similar habitats to the snowy plover and the two species rarely co-occur on the breeding grounds. Piping plovers breed across much of the northern and central Great Plains from eastern Colorado and northeastern Kansas northwards to Alberta, Saskatchewan, and Manitoba.

In Kansas, snowy plovers have bred along the Cimarron River in Meade, Clark, and Comanche counties, at Cheyenne Bottoms in Barton County, Big Salt Marsh (Quivira National Wildlife Refuge) in Stafford County, Webster Reservoir in Rooks County, Wilson Reservoir in Russell County, and wetlands in Finney County (Boyd 1981a). Breeding is suspected at Dry Lake in Scott County, Cedar Bluff Reservoir in Trego County (Zuvanich and McHenry 1964), along the Arkansas River (Boyd 1981a), and at Slate Creek Marsh in Sumner County (Thompson and Ely 1989). Non-breeding records are known from many additional sites in Kansas (Figure 2).

C. LIFE HISTORY AND ECOLOGY

1. Breeding

a. Reproductive Cycle

Phenology. Snowy plovers arrive at breeding grounds in Kansas in early April (Boyd 1972). The earliest spring arrival date is March 24 (Thompson and Ely 1989). At Cheyenne Bottoms, the earliest egg date is April 22, but most nests are not initiated until June in years with high water levels (Boyd 1972). At Great Salt Plains in Oklahoma, birds arrive in late March or early April and egg laying commences between late April and mid-May depending on whether nesting habitat is flooded (Hill 1985). If the nest is destroyed, snowy plovers readily renest. Because of the high rate of nest loss, the nesting season is prolonged. Nests are initiated until mid-July (Boyd 1972, Hill 1985).

However, the presence of downy young accompanied by an adult on 25 September 2001 at Quivira NWR (T. Hicks, pers. comm.), indicate that nest initiation may occasionally occur into August. In western U.S. populations, production of multiple broods in a nesting season is well documented. Typically, females will remain at the nest, incubating the eggs until hatching, then abandon the young to the care of the male and start a another nesting cycle with a new mate (Warriner et al. 1986). Triple brooding has been observed by birds along the Pacific Coast and double-brooding has been documented at interior sites in the western United States (Page et al. 1995). In contrast, double brooding has not been observed in the Great Plains (Boyd 1972, Hill 1985), the absence of which has been attributed to the shorter nesting season in the Great Plains compared to coastal California (Page et al. 1995). In Kansas, snowy plovers depart from the breeding grounds as early as late July, with many remaining until mid September (Boyd 1972). The latest date for Kansas is October 13 at Cheyenne Bottoms (Cheyenne Bottoms Wildlife Areas, *unpublished data*).

Nesting behavior. Males initiate courtship by constructing multiple scrapes, one of which usually becomes the nest site. Nest scrapes are usually located in bare areas near structure such as sticks, rocks, bones, clumps of vegetation, cow droppings, etc. (Boyd 1972, Hill 1985, Page et al. 1995). Scrapes are constructed by scratching out a shallow depression in the substrate and lining it with pebbles or other debris. Pairs usually copulate near a scrape (Boyd 1972, Buchanan et al. 1991).

Eggs. Eggs are laid in one of the scapes in the territory at intervals of 2-3 days. The usual clutch is three eggs (range 1-5). Nests containing only one egg are usually abandoned (Boyd 1972, Page et al. 1995). Nests with more than three eggs are rare and possibly were laid by more than one female (Page et al. 1995). Boyd (1981b) reported a nest with five eggs at Quivira NWR. Eggs average 31.5 x 23 mm in size (Boyd 1972, Hill 1985) and have a buffy background moderately covered with black or brown small spots and scrawls.

Incubation. Incubation is by both adults. Females incubate during the day and sometimes at night (Boyd 1972, Warriner et al. 1986)). Incubation behavior consists of brooding the eggs in cool weather, and standing over the eggs to shade them or wetting breast feathers to cool them in hot weather (Boyd 1972, Page et al. 1995). The incubation period averaged 25.5 days at Cheyenne Bottoms. Hatching is relatively synchronous. At Cheyenne Bottoms eggs in three-egg nests hatched, on average, within 14 hours of one another (Boyd 1972).

Young birds. The precocial young have buff and gray-colored upperparts with dark spots. Underparts are white, with black legs and bill. Other distinctive markings include a black line behind the eye and white neck band (Page et al. 1995). The young permanently leave the nest within a few hours of the final chick's hatching. Young can walk, run, and swim well soon after

hatching. Parents lead the young to foraging areas where young feed independently but remain together with both parents (Boyd 1972). Foraging areas are usually near water and movements of broods as far as 6 km from the natal area have been recorded on the Oregon Coast (Casler et al. 1992) and 3 km at Cheyenne Bottoms (Boyd 1972). Parental care includes brooding the chicks and avoiding predators by giving warning calls, performing distraction displays, and leading chicks away from predators (Page et al. 1995). Young fledge 28-33 days (average 31 days) after hatching (Warriner et al. 1986).

b. Reproductive Success

Age at first reproduction. Snowy plovers are sexually mature by their first spring after birth and most birds breed as one-year-olds (Warriner et al. 1986).

Clutches. Of 41 nests studied at Cheyenne Bottoms, average clutch size was 2.78 (SD = 0.42, Boyd 1972). Number of clutches per season varies with geographic location. Birds in coastal California may renest twice after successful reproduction and thus may have as many as three successful clutches per season (Page et al. 1995). Birds breeding in the Great Plains renest after unsuccessful nestings, but are not known to attempt to renest after successfully fledging young (Boyd 1972).

Reproductive success. Hatching rates of clutches from 17 studies in North America averaged 53% (range = 12.5-86.8, Page et al. 1995). The proportion of broods that fledged at least one young averaged 61% (SD = 10.9) from four studies (Page et al. 1995). The number of fledged young per successful brood averaged 1.6 birds (SD = 0.21) in four studies (Page et al. 1995). The percentage of chicks that fledged ranged from 39-45% in two studies (Page et al. 1995). Per female, the number of fledged young per nesting attempt was 0.8-0.9 at one coastal California site (Warringer et al. 1986) and 0.5 at one interior California site (Page et al. 1983).

In the Great Plains, hatching rates from observed nests at Cheyenne Bottoms and Great Salt Plains ranged from 47.6 to 58.4% (Table 1). These rates are similar to the average hatching rate for North America (53%, Page et al. 1995). The percentage of eggs that hatch from successful nests in these same studies was high: 82.3% at Great Salt Plains and 92.1% at Cheyenne Bottoms (Table 2). Data on fledging rates of chicks in the Great Plains are scarce.

Table 1. *Hatching rates of clutches of snowy plovers in the Great Plains (modified from Page et al. 1995).*

Location	Years	Percent hatching (sample size: clutches)	Source
Kansas			
Cheyenne Bottoms	1970-71	57.4 (47)	Boyd 1972
Oklahoma			
Great Salt Plains	1972-72	47.6 (21)	Purdue 1976
Great Salt Plains	1977-78	58.4 (89)	Grover and Knopf 1982
Great Salt Plains	1982-84	48.1 (495)	Hill 1985
Great Salt Plains	1991-94	62.0 (175)	Koenen et al. 1996
Great Salt Plains	1995-96	42.9 (415)	Winton and Leslie 2000

Table 2. *Hatching rates of eggs of snowy plovers from successful nests (nests with one or more eggs hatching).*

Location	Years	Percent Hatching	Sample size Eggs (clutches)	Source
Kansas				
Cheyenne Bottoms	1970-71	92.1	76 (27)	Boyd 1972
Oklahoma				
Great Salt Plains	1982-84	82.3	675 (232)	Hill 1985

c. Survival

Rangewide. Maximum age is 15+ years (Page et al. 1995). Estimated mean life span of adults at Great Salt Lake, Utah, was 2.7 years (Patton 1994). Estimated annual survival rates at Great Salt Lake ranged from 0.58 to 0.88, with no significant differences between sexes (Patton 1994). Page et al. (1983) inferred minimum annual survival rates of 0.75 at Monterey Bay, California (Warriner et al. 1986) and 0.78 at Mono Lake, California.

Great Plains. Annual survival of 33 marked birds at Quivira NWR, Kansas, was at least 0.67 between 1980 and 1982 (Boyd 1982).

d. Site Fidelity

Rangewide. Fidelity to breeding sites is high among adults, yet movement among breeding sites within and between years is not uncommon (Patton 1994, Stenzel et al. 1994). Resighting rates of adults among years, a conservative measure of breeding site fidelity, ranged from 40 to 78% at one coastal and two inland sites in California and Oregon (Page et al. 1995).

Great Plains. Data from Boyd (1983) suggest most birds return to the same breeding grounds in successive years but that movement among nesting grounds over 100 miles apart do occur. Of 47 recaptures or resightings of marked birds in Kansas and Oklahoma between 1978 and 1983, five were observed at different breeding sites (Boyd 1983). Moves were recorded between Cheyenne Bottoms and Quivira, between Cheyenne Bottoms and Cargill Salt Plant (Woods County, Oklahoma), and between Cheyenne Bottoms and Great Salt Plains NWR (Alfalfa County, Oklahoma) (Boyd 1983).

2. Feeding Habitat and Habits

Breeding habitat at inland sites consists of unvegetated or sparsely vegetated zones at salt marshes or lakes, reservoirs, ponds, riverine sand bars, and salt-evaporation or agricultural waste-water ponds. Open water is usually present at breeding sites. However, the species will nest at dry salt flats if a source of water is present in the vicinity (Herman et al. 1988). Snowy plovers will drink fresh water where available (Page et al. 1995), but frequently nests at sites where the only available water is highly saline. Dependence on fresh water is reduced by using water from insectivorous diet and utilizing water-conserving behaviors (Purdue 1976, Purdue and Haines 1977).

Foraging behavior of the snowy plover is typical of plovers, and usually consists of running across open ground or through shallow water, visually locating prey, and picking food items from the surface. Other foraging methods include probing burrows for *Bledius* beetles at salt flats in Oklahoma (Purdue 1976, Grover and Knopf 1982), running with mouth open through dense aggregations of flies on the ground and grabbing flies that flush (Purdue 1976), and foot trembling in shallow water (Page et al. 1995).

Food items in the Great Plains consist of a wide variety of invertebrates: flies (*Ephydra* sp.), beetles (*Bledius* sp., *Cicindela* sp.), and many terrestrial insects blown from surrounding areas including grasshoppers, lepidopterans, and beetles (Purdue 1976, Grover and Knopf 1982).

3. Migration

Snowy plovers that breed in Kansas are migratory. Boyd (1982) documented the presence of two birds originally banded at Quivira NWR along the Gulf Coast in Texas, one near High Island on 26 September 1981 and the other on North Padre Island on 14 January 1982. Boyd believes that most birds that breed in the central Great Plains winter along the Texas coast. Other possible winter sites include coastal areas of Mexico (Page et al. 1995). Spring arrival dates in Kansas extend from late March into May (Boyd 1972, Thompson and Ely 1989). The earliest arrival date is 17 March (Cheyenne Bottoms Wildlife Area, *unpublished data*), and most birds are believed to arrive in mid-April (Boyd 1972, Thompson and Ely 1989). Fall migration from Kansas begins in mid-July and extends into early October. Extreme dates of departure, both from Cheyenne Bottoms, are 25 July and 10 October (Boyd 1972).

D. POPULATION STATUS AND TRENDS

1. Great Plains

Estimated numbers of breeding snowy plovers in the Great Plains in the mid-1990s was 2,100 birds: Colorado (100-150), Kansas (160), Oklahoma (up to 850), Texas (500), and New Mexico (300-500) (Page et al. 1995). The number of current breeding sites in the Great Plains is not known although estimates are available for Colorado (a total of 6 sites in the San Luis Valley and lower Arkansas River; Kingery 1998), Kansas (2 sites: Quivira NWR and Cheyenne Bottoms; H. Hands *unpublished data*,and Boyd *unpublished data*), and Oklahoma (at least 5 areas: upper Red River, Hackberry Flats Wildlife Area, upper Canadian River, upper Cimarron River, and Great

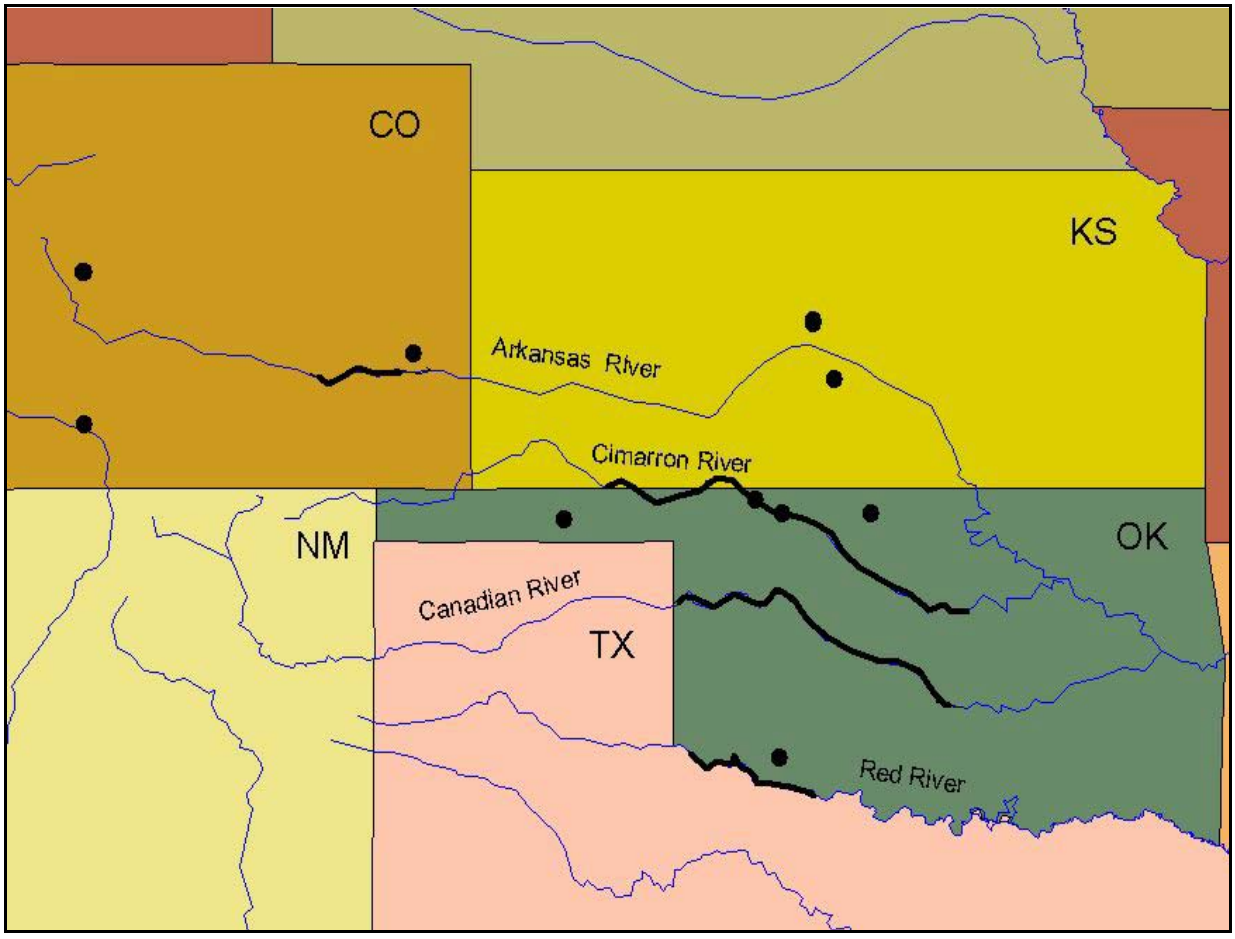

Figure 1. *Recent snowy plover breeding sites in Colorado, Kansas, and Oklahoma. Circles = wetland sites, thick lines = riverine sites.*

Salt Plains NWR; M. Howery *pers. comm*.). Location of recent breeding sites in Colorado, Kansas and Oklahoma are shown in Figure 1. Trends of Great Plains populations are not known.

2. Kansas

Recent. Surveys at Big Salt Marsh at Quivira NWR the past three years recorded 114 birds in 1999, 91 birds in 2000, and 80 birds in 2001 (Table 3). Information on numbers of nests and young are not available. At Cheyenne Bottoms, Helen Hands (*pers. comm*.) estimated the number of adults present during the breeding season at less than 20 for each of the past five years.

Historical. At Quivira NWR, snowy plover nesting was first documented in the late 1950s (Parmelee et al. 1969). Counts of adults are available for most years between 1980 and 2001 (Table

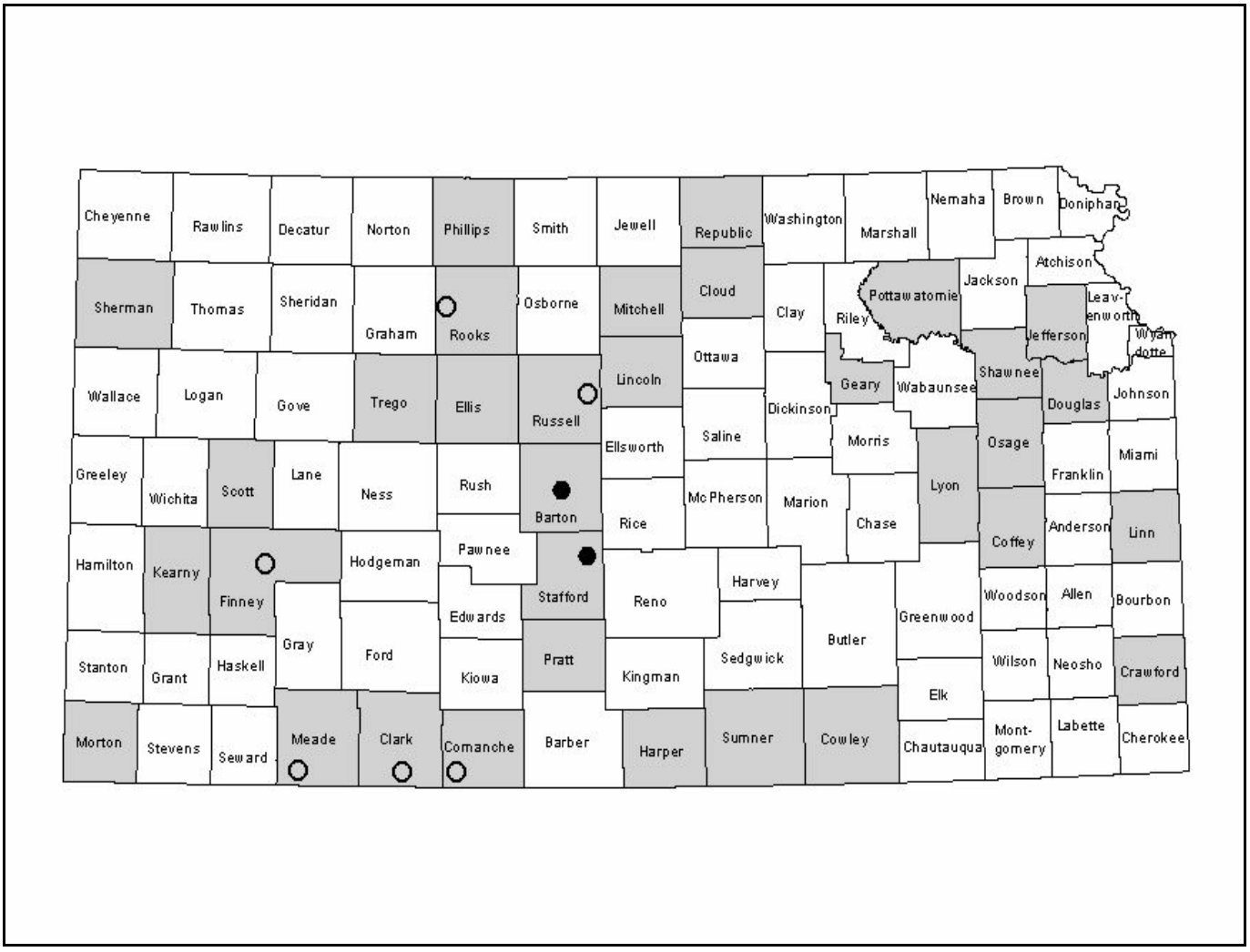

Figure 2. *Snowy plover records in Kansas. Solid circles are recent breeding records, open circles show older records (pre-1985), and shaded counties are those with snowy plover sightings.*

3) but vary in thoroughness due to the challenge of conducting comprehensive surveys (R. Boyd *pers. comm.*). During this period, the numbers of birds at Quivira NWR during May-June surveys has fluctuated from 64 to 252 adults (Table 3). Complete counts of nests at Quivira NWR are only available for 1981-83. During these three years, the number of active nests varied from 21 to 107 (Table 3). Since the early 1980s, snowy plovers have continued to nest regularly at Quivira NWR, but no attempt has been made to quantify total numbers of nests or young. Recent population trends are believed to be stable (Quivira NWR staff *pers. comm.*) to decreasing (R. Boyd *pers. comm.*).

At Cheyenne Bottoms, documentation of snowy plover nesting dates back to 1959 (Parmelee et al. 1969). Boyd (1972) documented a high of at least 27 nests in 1971. Numbers of adults reported since 1980 during the early part of the breeding season have ranged from 2 to 61 adults per year, with a decreasing trend through this period (Table 3).

Nesting by snowy plovers along the Cimarron River was first reported by Goss in 1886 (Tordoff 1956). Studies by Boyd and the Schulenbergs in the early 1980s (Table 3) documented 18-20 adults per year along the Cimarron River in Meade and Clark counties in association with least tern colonies. However, a complete survey of plovers along the Cimarron River in Kansas has never been conducted. Populations were declining in the 1980s (Schulenberg and Schulenberg 1980, 1981, 1982, Boyd 1981a) and the last nesting record for the Cimarron River in Kansas was in 1987 (Table 3). Since that time little survey effort has been devoted to snowy plovers on the Cimarron River.

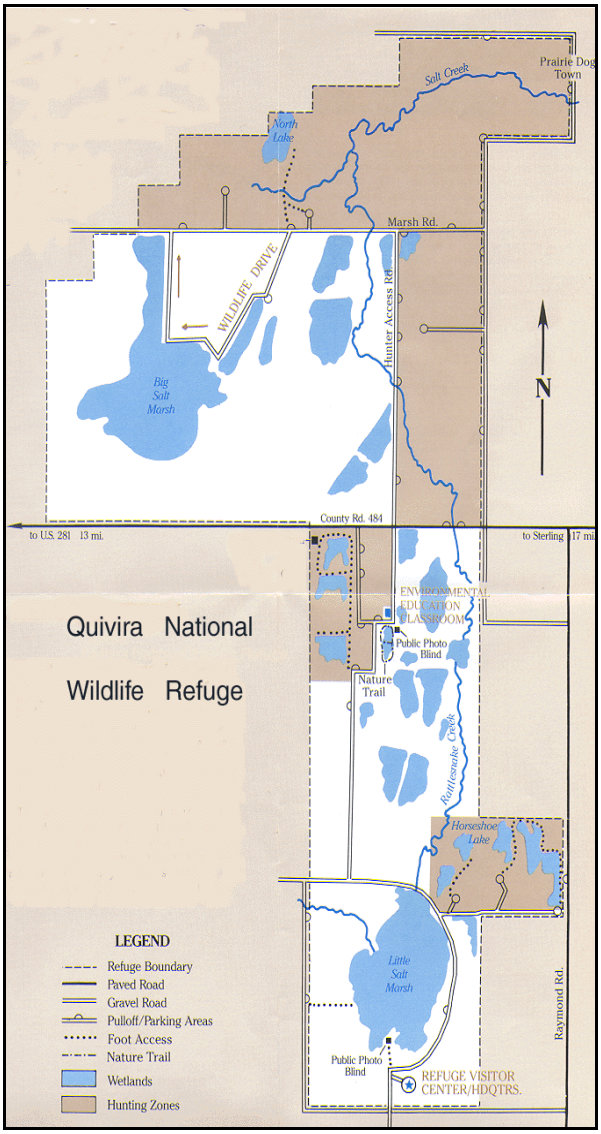

Figure 3. *Map of Quivira National Wildlife Refuge. Snowy plovers breed in the Big Salt Marsh area in the northwestern portion of the refuge.*

Historically, snowy plovers are believed to have nested along the Arkansas River and several other rivers in Kansas but there are no published records (Boyd 1981a). Boyd (1981a) mentions additional sites where breeding was reported for a single year (Table 3): Webster Reservoir in Rooks County, Wilson Reservoir in Russell County, and wetlands north of Garden City in Finney County. Sites with suspected breeding include Dry Lake in Scott County and Cedar Bluff Reservoir in Trego County (Zuvanich and McHenry 1964), and Slate Creek Marsh in Cowley County (Thompson and Ely 1989). A summary of historical and potential breeding sites is presented in Table 4.

Snowy plovers have been recorded at many sites where there was no evidence of breeding (Figure 2). Thompson and Ely (1989) shows records for 33 counties distributed throughout Kansas.

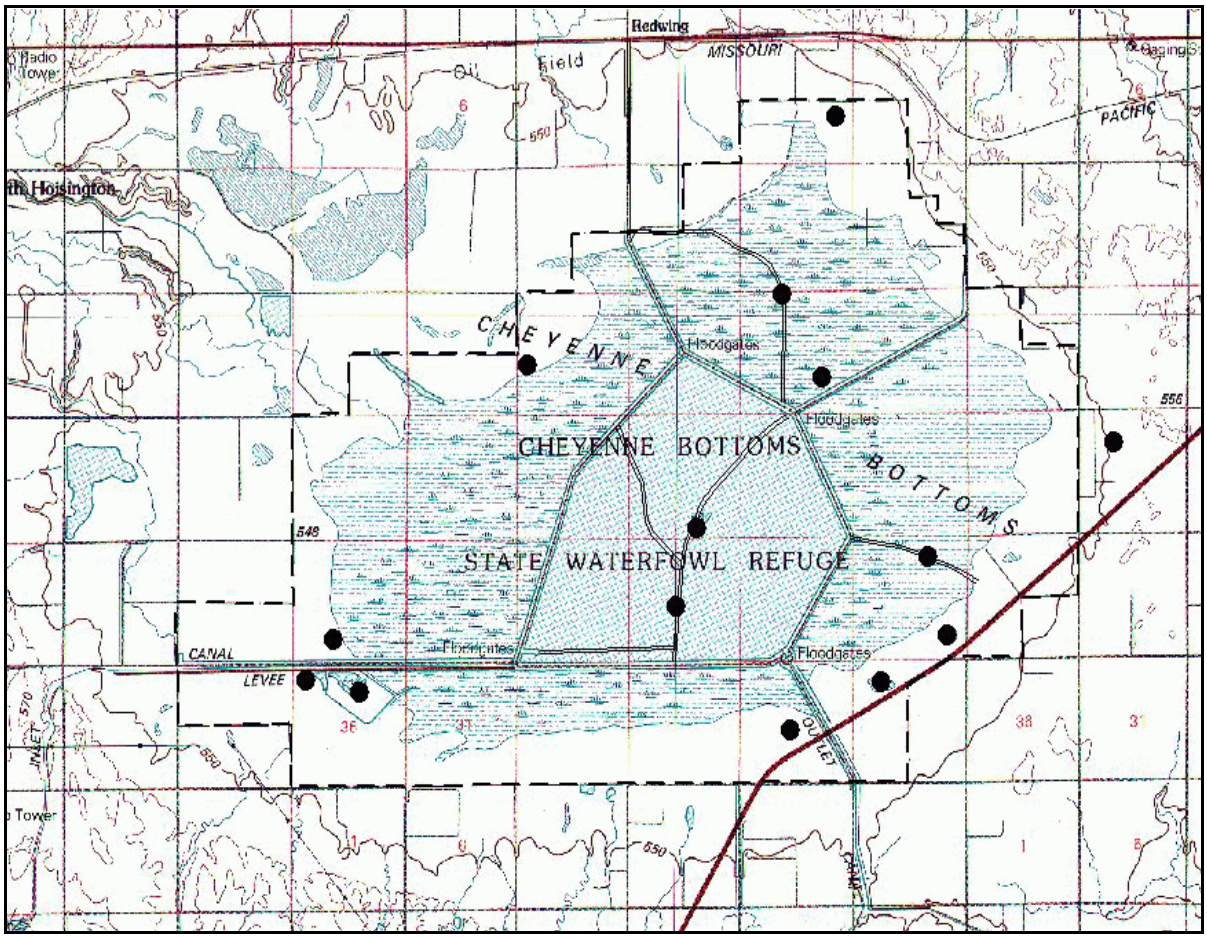

Figure 4. *Recent and past breeding locations (solid circles) of snowy plovers at Cheyenne Bottoms (sources: Boyd 1972, Hands 1996)*

Table 3. *Numbers of adults and nests at snowy plover breeding sites in Kansas. Many surveys were not complete; only those known to be incomplete are footnoted as being so.*

Year	Adults[1]	Nests (young)	Dates	Source
Cheyenne Bottoms				
1959		(1)	8 Aug	Parmelee et al. 1969
1961	8	4	18 July	Parmelee et al. 1969
1962	6	2	23 April	Ferguson 1962
1963	37	1	18 June	Parmelee et al. 1969
1963	2	(2)	21 July	Zuvanich and McHenry 1964
1970	56	20-28	multiple	Boyd 1972
1971	68	27-34	multiple	Boyd 1972
1976	250		17 July	Ed Martinez unpublished ISS data[3]
1977	121		10 July	Ed Martinez unpublished ISS data
1978	42	16-21		Boyd 1981a
1978	82		20 July	Ed Martinez unpublished ISS data
1979	8	0-4		Boyd 1981a
1979	52		20 July	Ed Martinez unpublished ISS data
1980	12	4-6		Boyd 1981a
1980	44		6 June	Ed Martinez unpublished ISS data
1981	6	(2)	2 June	Boyd 1981b
1981	61		30 April	Ed Martinez unpublished ISS data
1982	22	4+	23 June	Boyd 1982
1982	28		30 June	Ed Martinez unpublished ISS data
1983	56		15 May	Ed Martinez unpublished ISS data
1984	50		23 May	Ed Martinez unpublished ISS data
1984	194		11 August	Ed Martinez unpublished ISS data

Year	Adults[1]	Nests (young)	Dates	Source
1985	21		28 May	Ed Martinez unpublished ISS data
1986	26		25 April	Ed Martinez unpublished ISS data
1987	24		23 May	Ed Martinez unpublished ISS data
1990	38		21 July	Ed Martinez unpublished ISS data
1991	28		21 April	Ed Martinez unpublished ISS data
1991		4	summer	Hands (1996)[2]
1992	0		spring	Ed Martinez unpublished ISS data
1992	5		15 August	Ed Martinez unpublished ISS data
1993		1	summer	Hands (1996)[2]
1993	24		15 May	Ed Martinez unpublished ISS data
1994		5	summer	Hands (1996)[2]
1994	5	4	20 May	Helen Hands unpublished ISS data[2]
1995		3	summer	Hands (1996)[2]
1995	0		spring	Helen Hands unpublished ISS data[2]
1996		3	summer	Helen Hands unpublished data[2]
1996	8		16 May	Helen Hands unpublished ISS data[2]
1997	7		24 April	Helen Hands unpublished ISS data[2]
1997		2	summer	Helen Hands unpublished data[2]
1997	19		1 August	Helen Hands unpublished ISS data[2]
1998	2		27 May	Helen Hands unpublished ISS data[2]
1999	4		8 June	Helen Hands unpublished ISS data[2]
2000	6		18 April	Helen Hands unpublished ISS data[2]
2001	2		4 May	Helen Hands unpublished ISS data[2]
Cimarron River (Meade County)				
1980	10	5	14 June	Schulenberg et al. 1980

Year	Adults[1]	Nests (young)	Dates	Source
1981	12	6	1 July	Schulenberg & Schulenberg 1981
1982	8	1	June-July	Schulenberg & Schulenberg 1982
1987	2	1		Boyd 1987
Cimarron River (Clark County)				
1980	8	2	26 July	Schulenberg et al. 1980
1981	6	2	15 June	Schulenberg & Schulenberg 1981
1982	12	3	15 July	Schulenberg & Schulenberg 1982
1983	0	0		Boyd 1983
Cimarron River (Comanche County)				
1886	2	1	June	Tordoff 1956
Finney Basin (Finney County)				
1955	12		12 June	Schwilling 1956
1962	68		July-Aug	Davis 1964
1963	152		April-May	Davis 1964
1963	75+		14 June	Davis 1964
1963	2	1	8 June	Zuvanich and McHenry 1964
Quivira National Wildlife Refuge				
1963	45-50	2	15 June	Zuvanich and McHenry 1964
1980	120	9+	4 July	Schulenburg et al. 1980
1981	120-150			Boyd *unnpublished data*.
1981	65	19	3 June	Schulenburg & Schulenburg 1981
1981	178		8 Aug	Schulenburg & Schulenburg 1981
1981	97		3 June-6 Aug	Boyd 1981b
1981	313		7 August	Boyd 1981b

Year	Adults[1]	Nests (young)	Dates	Source
1982	112	55	9 June	Schulenburg & Schulenburg 1982
1982	150-160	107	multiple	Boyd 1982
1983	80-100	21		Boyd 1983
1984	112		14 Aug	Boyd *unpublished data*
1985	64		30 June	Boyd *unpublished data*
1985	72		10 July	Boyd *unpublished data*
1986	144		29 May	Boyd *unpublished data*
1986	165		12 Aug	Boyd *unpublished data*
1987	252		30 May	Boyd *unpublished data*
1987	235		8 June	Boyd *unpublished data*
1987	217		15 June	Boyd *unpublished data*
1987	242		3 July	Boyd *unpublished data*
1989	142		5 June	Boyd *unpublished data*
1989	209		3 July	Boyd *unpublished data*
1990	25+		10 June	Boyd 1990
1992	122	44+	26 June	Boyd *unpublished data*
1993	76		10 June	Boyd *unpublished data*[2]
1995	44		20 May	Boyd *unpublished data*[2]
1995	216		19 June	Boyd *unpublished data*
1996	153		18 June	Boyd *unpublished data*
1997	74		24 June	Boyd *unpublished data*[2]
1998	84		23 June	Boyd *unpublished data*
1999	114		13 June	Boyd *unpublished data*
2000	91		19 June	Boyd *unpublished data*
2001	80		20 June	Boyd *unpublished data*

Year	Adults[1]	Nests (young)	Dates	Source
Webster Reservoir (Rooks County)				
1963	12	1	27 June	Zuvanich and McHenry 1964
Wilson Reservoir (Russell County)				
1976	?	(2+)		Boyd 1981a

[1] Counts conducted after July 1 may include juveniles and migrants

[2] Incomplete count

[3] International Shorebird Surveys, Manomet Bird Observatory, Massachusetts.

Table 4. *Currently inactive snowy plover breeding sites with confirmed (C) or suspected (S) past breeding activity, or potential (P) for breeding activity.*

Site name	County	Evidence of breeding	Source(s)
Cimarron River	Meade, Clark, Comanche	C	Tordoff 1956, Schulenberg et al. 1980, Boyd 1981a,b, etc.
Finney Basin	Finney	C	Zuvanich and McHenry 1964, Davis 1964
Webster Reservoir	Rooks	C	Zuvanich and McHenry 1964
Wilson Reservoir	Russell	C	Schulenberg et al. 1980, Boyd 1981a
Cedar Bluff Reservoir	Trego	S	Zuvanich and McHenry 1964
Dry Lake	Scott	S	Zuvanich and McHenry 1964
Slate Creek Marsh	Sumner	S	Thompson and Ely 1989, Young *unpub. data*
Arkansas River	various	P	Boyd 1981a
South Fork Ninnescah	Kingman,	P	Schulenberg et al. 1980
Jamestown Wildlife Area	Republic	P	No evidence. Former salt marsh
Playa Lakes	various (southwestern KS)	P	No evidence. Known to breed at playa lakes in Colorado
Little Salt Marsh	Stafford	P	No evidence. Former salt marsh
Spicer and Hargis Lakes	Barber	P	Schulenberg et al. 1980

E. REASONS FOR DECLINE AND CONTINUING THREATS

1. Habitat Loss or Degradation.

Dewatering. Decreasing amounts of surface water have adversely affected snowy plover habitat at several sites in Kansas. Diversion of surface water for irrigation has reduced streamflow in some drainages (Cross et al. 1995). However, the largest impact on surface water has been through groundwater pumping for agricultural irrigation. Flow levels in the Cimarron, Arkansas rivers and other streams in southwestern Kansas have decreased as groundwater pumping increased beginning in the mid-1900s (Tomelleri 1984, Cross et al.1985). Decreased flows affect snowy plover habitat in several ways. Most conspicuously, dewatering has resulted in drying up of streams. For example, some portions of the Cimarron River that supported breeding colonies of least terns and snowy plovers in the 1980s have had little or no flow during the nesting season for much of the past 20 years (Schulenberg and Schulenberg 1980, 1982, Cross et al. 1985, U.S. Geological Survey 2002).

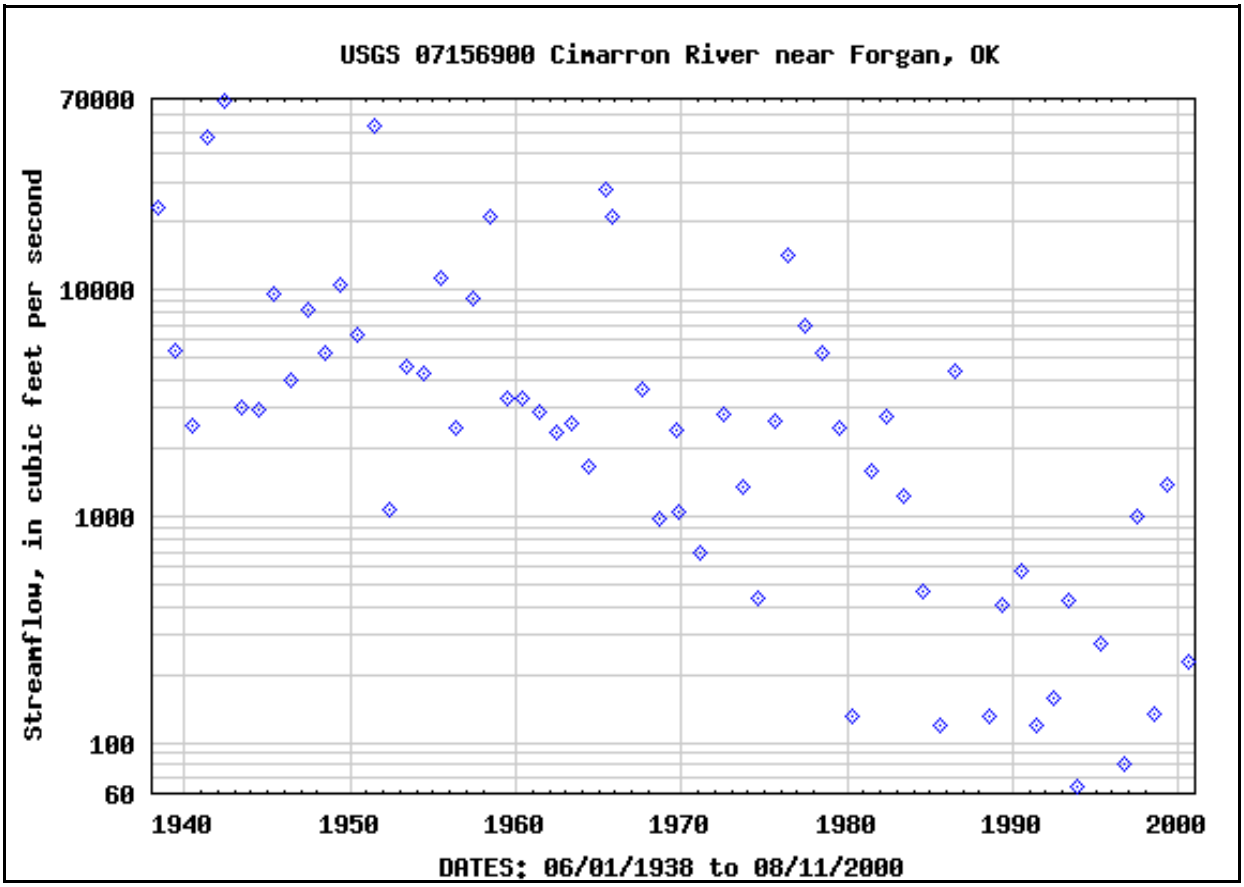

Figure 5. *Annual peak flow on the Cimarron River at Kansas Highway 23 in Meade County. Data from the U.S. Geological Survey.*

A more important consequence of dewatering is that without periodic high flow events nesting habitat is not maintained. High flows act to scour away riparian vegetation and maintains sandbars of sufficient size and elevation that they are protected from flooding during the nesting season (Tomelleri 1984). These consequences of reduced flows are evident in the Cimarron River in Meade and Clark counties where snowy plovers formerly bred. Breeding sites typically consisted of large, unvegetated sandbars separated from the shore by water (Schulenberg and Schulenberg 1980, Boyd *pers. comm.*). As flow decreased beginning in the 1960s (Figure 5; Cross et al. 1985, U.S. Geological Survey 2002), high water events were insufficient to maintain high quality least tern and snowy plover habitat (Schulenberg and Schulenberg 1980, Boyd 1981-94). Least terns, which use similar nesting habitat, were monitored annually along the Cimarron River in Kansas and Oklahoma during 1980-1994 (Schulenberg and Schulenberg 1980-82, Boyd 1981-94) . Boyd (1994) found that in the 125 km stretch of the river between Meade County, Kansas, and Freedom, Oklahoma, the number of active least tern colonies declined from 18 active colonies in 1982 to 4 active colonies in 1993. Boyd (1984) attributed this decline to vegetation encroachment and erosion of historic nesting sites. Along the upper Arkansas River in Kansas, where snowy plovers may have nested historically (Boyd 1981a), dewatering similar to, but more severe, than that on the Cimarron has occurred (Tomelleri, 1984, Cross et al. 1985). In addition, one of the earliest U.S. Army Corps reservoirs in the Central Plains, John Martin Reservoir, was completed on the Arkansas River in southeastern Colorado in 1948. This reservoir, constructed for flood control and irrigation, substantially reduced peak flows downstream on the Arkansas River that would have maintained the open sandbar habitat suitable for snowy plovers. Other land treatment measures, such as terraces and ponds, have undoubtedly had major impacts on surface water runoff and, therefore, impacted streamflows as well (S. Falk, *pers. comm.*).

Wetland Conversion and Development. Several current and historic snowy plover breeding sites have been structurally modified, resulting in habitat alteration, and in many cases, degradation or destruction. Wetlands in the Finney Basin north of Garden City that historically supported snowy plovers (Davis 1964, Zuvanich and McHenry 1964) have been converted to agriculture by ditching and draining and no longer contain suitable habitat (Tom Shane *pers. comm.*). Because wet conversion occurred at many sites prior to any bird surveys, it is likely that snowy plovers historically nested at wetland sites that no longer provide habitat due to wetland destruction.

While the conversion of wetlands for agricultural use is the most common reason for physical alteration of wetlands in the state, wetland alterations have also taken placed at most public wildlife areas and refuges in the state. Alterations aimed at enhancing wetland habitat for waterfowl and other species have in some cases degraded or eliminated snowy plover habitat. Construction of dikes and impoundments have replaced salt flats or other sparsely vegetated habitat preferred by

snowy plovers and replaced it with unsuitable habitat such as open water, flooded marsh, or dense emergent vegetation. By altering the amount, timing, and drainage of water on wetlands, structural developments may affect the salinity and the amount and type of vegetation on affected marshes. Depending on the site, this may have positive or negative affects on snowy plover habitat although negative affects are more common. Creation of physical structures such as dikes or islands have in other instances improved snowy plover habitat by reducing flooding frequency during the nesting season or provide elevated nesting sites. Unfortunately, most of these wetland alterations took place prior to documentation of snowy plover nesting at the sites. Without baseline data on snowy plover nesting activity, it is difficult to determine the net effect wetland development on public lands has had on snowy plovers.

Exotic species. Salt cedar (*Tamarix* sp.) is an exotic that has invaded many riparian and wetland areas in western Kansas. As flows in the Cimarron River have decreased, salt cedar has invaded the river floodplain and is now well established along the river. Because snowy plovers will not use areas with much vegetative cover, species such as salt cedar that can establish and grow at breeding sites pose a threat to breeding habitat. In addition, evidence indicates that the presence of salt cedar at breeding sites results in higher predation on snowy plover nests (Koenen et al. 1996). Salt cedar is also present at Quivira NWR and Cheyenne Bottoms, but at present it does not pose a significant threat to snowy plover habitat. There is increasing data on the use of groundwater by phreatophyte consumption and the effects on streams resulting in loss of flows (S. Falk, *pers. comm*.).

2. Disease and Predation

Loss of snowy plover eggs and young to coyotes, raccoons, ring-billed gulls, and other predators is a common source of nesting season mortality (Page et al. 1995, Winton et al. 2000). At Salt Plains NWR, up to 57.7% of all nest losses have been attributed to coyotes (Grover and Knopf 1982). While nest predation is a natural source of mortality, predation is often higher where plovers nest in human-modified habitats. Such habitats may have predictably high nest concentrations, have nesting sites arranged in a manner easily searched by predators, or have other features that attract predators. Rates of nest loss to predators are often higher where snowy plovers utilize linear, man-made features such as roads or artificial ridges for nesting (R. Boyd *pers. comm*.).

3. Flooding and Weather-related Mortality

Severe weather is among the largest sources of mortality to nesting snowy plovers . Flooding is one of the most common causes of egg and young loss at breeding sites in Kansas and Oklahoma (Boyd 1972, 1981-94; Hill 1985; Grover and Knopf 1982; Koenen et al. 1996) because most nest sites are

located along flood-prone streams and salt flats. Hail is a less frequent, but occasionally devastating, source of mortality that may kill adults as well as eggs and young (Boyd 1992). Weather-related mortality is a natural, stochastic event and thus is unlikely to be an important cause of long-term population declines. Adults often re-nest in response to storm-related nest loss. However, human-induced changes in habitat can increase (or decrease) vulnerability to weather-related events such as flooding. For example, upstream impoundments or other hydrological alterations may increase the frequency of flood events at breeding sites during the nesting season.

4. Disturbance by Humans or Domestic Animals

Disturbance of nest areas is a major source of population decline in coastal populations of the snowy plover (U.S. Fish and Wildlife Service 2001.). At interior sites, including Kansas, nest disturbance by humans is not known to be a significant source of nest loss (Schulenberg and Schulenberg 1980). Most Kansas sites have little human activity. One exception is the Wildlife Drive in the Big Salt Marsh at Quivira NWR, where snowy plovers often nest along the elevated road that receives frequent traffic (R. Boyd *pers. obs*., W. Busby *pers. obs*.). The extent of nest loss due to vehicles at this site is unknown. Another source of disturbance to nesting plovers is trampling of nests by livestock (Boyd 1972). Destruction of least tern and snowy plover nests by trampling has been observed along the Cimarron River (Schulenberg and Schulenberg 1982, Boyd 1992) where cattle congregate along the river.

F. CONSERVATION EFFORTS

1. Exclosures and Fencing

Use of exclosures and fencing to protect nesting plovers can substantially reduce mammalian predation of eggs and young. One approach is to enclose individual nests with mesh fencing (Deblinger et al. 1992, U.S. Fish and Wildlife Service 2001). However, fencing individual nests is labor intensive (Craig et al. 1992) and may actually attract predators (U.S. Fish and Wildlife Service 2001). To date, exclosures around individual nests have not been used on snowy plovers in Kansas.

Another approach has been to place exclosures around nesting colonies of plovers and terns using electric fencing (Boyd 1991, Mayer and Ryan 1991, Koenen et al. 1996, Hands 1996, Winton et al. 2000). Four or five strands of wire have been used, often with the top and bottom strands carrying electricity. Electric fencing has been effective in reducing mammalian predation, principally by coyotes, when installed and operating properly (Boyd 1991, Mayer and Ryan 1991, Hands 1996).

The practice is ineffective if improperly installed or if clogged by debris from flooding or other events (Koenen et al. 1996, Winton et al. 2000).

2. Constructed Nesting Sites

Several methods to provide improved nesting substrates have been employed for snowy plovers. In response to frequent flooding of nests at Quivira NWR, Boyd and Rupert (1991) provided elevated nesting pads of sand and gravel. Pad use by snowy plovers and least terns have substantially reduced loss of nests to summer flooding (Boyd and Rupert 1991, Boyd 1992, 1993, 1994). At Cheyenne Bottoms, constructed islands were utilized by nesting snowy plovers (Hands 1996). Koenen et al. (1996) examined the effectiveness of nesting ridges created from existing substrates at Great Salt Plains NWR in Oklahoma. In general, ridges were not readily occupied by nesting birds and rapid erosion reduced the effectiveness of ridges in protecting nests against flooding.

3. Vegetation Control

Vegetation control has been used at the Meade County oxbow sites on the Cimarron River (Boyd 1986-94) and on constructed nesting islands at Cheyenne Bottoms (Hands 1996). Mechanical (mowing, disking and bulldozer) and chemical (pre-emergent and post-emergent herbicides) control measures were applied prior to the nesting season at both sites with varying success. A disadvantage of these methods was high cost and time demand. However, vegetation control appears to have been instrumental in maintaining suitable habitat at the Meade County oxbow site (Boyd 1986-94). This practice may be necessary at sites with modified habitat where natural processes do not sufficiently limit growth of vegetation.

4. Regulatory Protection

The snowy plover was listed as a threatened species in 1987 under Kansas' Nongame and Endangered Species Act (K.A.R. 115-15-1 and 115-15-2). As a threatened species, the snowy plover is protected from direct take and, within areas of critical habitat, its habitat receives some protection from harmful actions that use public funds. The Act does not regulate actions affecting plover habitat that are privately funded. Additionally, existing regulations have not prevented habitat degradation caused by off-site actions, such as from groundwater pumping.

At the federal level, the snowy plover is protected under the Federal Migratory Bird Treaty Act. The Migratory Bird Treaty Act prohibits taking of birds and their nests, but does not provide habitat

protection. Some protection of nesting habitat could be provided by Section 404 of the Clean Water Act where the U.S. Army Corps of Engineers determines wetlands to be present at sites used by snowy plovers . The Pacific coast population of the western snowy plover (*Charadrius alexandrinus nivosus*) was listed under the federal Endangered Species Act in March, 1993, but this listing does not affect populations in Kansas and the Great Plains.

5. Critical Habitat

Designated Critical Habitat; currently occupied:

All wetlands within Quivira National Wildlife Refuge in Reno, Rice, and Stafford counties.

Designated Critical Habitat; lacking recent documentation of the species:

All land and waters within the current active channel of those reaches of the Cimarron River within Clark, Comanche, and Meade counties.

Recommended additions to critical habitat:

All wetlands within Cheyenne Bottoms Wildlife Area in Barton County.

II. RECOVERY

A. RECOVERY OBJECTIVES

The ultimate objective of this recovery plan is to prevent the extirpation of the nesting population of the snowy plover in Kansas, and to restore the current population so that the species can be removed from the Kansas list of endangered, threatened and SINC species.

B. RECOVERY CRITERIA

The criteria for down-listing the snowy plover from threatened to SINC are:

1. An average of at least 175 breeding adults over the last four years prior to down-listing.

2. Two or more breeding areas with an average of at least 30 breeding adults each in the last four years prior to down-listing.

The criteria for de-listing the snowy plover are:

1. An average of at least 250 breeding adults over the last four years prior to de-listing

2. Four or more breeding areas with an average of at least 20 breeding adults each in the last four years prior to de-listing.

A breeding area is defined here as a geographic area containing contiguous or nearly contiguous suitable habitat such as that found at Quivira NWF, Cheyenne Bottoms, or along portions of the Cimarron River.

III NARRATIVE OUTLINE

1. Protect and manage snowy plover breeding populations and habitat.

1.1. Restore and maintain natural processes that perpetuate high quality breeding habitat.

1.1.1. Encourage basin-wide water conservation to maintain the water supply at breeding sites. One of the main threats to snowy plover nesting sites is decreased water supply, a problem facing most aquatic and semi-aquatic species in western and central Kansas. An example would be participation with the Rattlesnake Creek Partnership Program.

1.1.2. Encourage landowners to participate in Federal and State conservation programs to rehabilitate watersheds. Funding is currently available for a wide variety of watershed enhancement projects (Appendix A).

1.1.3. Remove non-native and invasive vegetation that degrades breeding habitat. Salt cedar and other tall stature plants that invade traditional nesting areas require control at some sites. For example, invasion by salt cedar has eliminated much of the open herbaceous riparian habitat along the Cimarron River in Meade and Clark counties. (See section 1.3.2. for control of vegetation at actual nest sites.)

1.1.4. Restore known and possible historic snowy plover breeding sites where feasible. Several former salt marshes and other sites where snowy plovers were known to have breed or that might have been used for breeding have been altered or destroyed by agricultural development, drainage, impoundments, or other structural modification. Some of the sites are on public lands, such as Slate Creek Marsh, Quivira NWR, and Jamestown Wildlife Area. Sites with the potential to provide significant snowy plover breeding habitat should be evaluated for restoration potential and restored if feasible. See Table 4 for a partial list of potential restoration sites.

1.1.5. Utilize existing federal and state legislation and regulations to protect snowy plovers and their habitat. Habitat deterioration is a major threat to the continued existence of a snowy plover breeding population. Enforcement of existing laws and regulations is essential to protect the species. One example is the need to protect and enforce existing water rights at Cheyenne Bottoms Wildlife Area and Quivira NWR.

1.2. Develop mechanisms for long-term protection and management of snowy plovers and their breeding habitat.

1.2.1. Provide intensive management and protection of snowy plovers on all Federal and State lands. Federal and State land managers should protect and manage all breeding locations on Federal and State lands. Management programs for snowy plovers should be implemented and annually evaluated to ensure that they provide sufficient protection for snowy plovers.

1.2.2. Develop and implement management plans for the snowy plover on all Federal and State lands that support or potentially support the species. Site-specific management plans to protect habitat, enhance reproductive success, and minimize impacts to snowy plovers should be developed and implemented on Federal and State lands that support snowy plovers. Where appropriate, such plans should be incorporated into existing area management plans.

1.2.3 Schedule meetings with shorebird experts and public land managers to discuss conservation and management needs and to share ideas on effective management actions. Providing an opportunity for face-to-face meetings between managers and biologists with snowy plover experience is an effective means for exchanging information about habitat needs and effective management actions.

1.2.4. Obtain long-term agreements with private landowners. Agreements between the Kansas Department of Wildlife and Parks or other conservation entities and private landowners interested in snowy plover conservation should be developed and implemented. Landowners should be appraised of the importance of plover populations on their lands and be provided with

information about available conservation mechanisms, such as agreements and incentive programs.

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1.2.5. Identify snowy plover habitat for acquisition. Federal, State, and private conservation organizations should identify and prioritize snowy plover habitat that is in need of protection. As priority target sites become available, they should be acquired through fee title or conservation easement by public or private conservation organizations.

1.2.6. Develop partnerships with federal and state agencies, local governments, private organizations, industries, and individuals to identify, assess, and mitigate projects that may potentially impact snowy plovers and their habitat. This includes urban, industrial, and agricultural development at or near existing breeding sites.

1.3. Manage and enhance snowy plover breeding sites to maximize reproductive success.

1.3.1. Maintain nesting pads, islands, or other raised areas to protect nests from flooding. Artificial nesting pads at Quivira NWR has reduced nest loss by least tern and snowy plovers . Nest pads should be maintained at Quivira NWR, and similar structures should be developed at other breeding sites if natural substrates do not provide adequate protection from flooding and/or predators.

1.3.2. Control of vegetation at nest sites. Chemical and mechanical control of vegetation may be required at breeding sites where vegetation cover precludes use by snowy plovers for nesting. One of most common species that invades nest sites is Inland saltgrass (*Distichlis spicata*). Expensive and labor intensive, artificial vegetation control should be used only as a last resort at sites where natural processes are not sufficient to create and maintain high quality nesting habitat.

1.3.3. Erect and maintain predator exclosures at snowy plover nest sites. Electric fencing has been successfully employed at Quivira NWR and other sites to reduce predation by terrestrial mammals. Where predation on nests and chicks is high, exclosures can be used to enhance reproductive success.

1.3.4. At artificially-managed sites, manage water and habitat to create and maintain high quality snowy plover breeding habitat. Public wetlands such as Cheyenne Bottoms Wildlife Area and Quivira NWR are managed in part with human-controlled water delivery and habitat manipulation. Where human management has replaced natural processes, developing and maintaining high quality snowy plover habitat should be a management priority.

1.3.5. Coordinate management actions for snowy plovers and least terns. Because of their federal endangered status, least tern breeding colonies have received considerable management. Least tern management should be coordinated with that for snowy plovers to optimize benefits for both species and to assure that least tern management does not adversely affect snowy plovers . One risk of least tern management to snowy plovers is the human disturbance associated with management activity. In general, however, least tern management actions, such as creation of nesting pads and predator exclosures, appear to have benefited snowy plover reproductive success.

1.4. Prevent disturbance of breeding snowy plovers by people and domestic animals. Seasonally close, fence, post, use exclosures, monitor, and enforce regulations in areas used by breeding snowy plovers as appropriate.

2. Monitor snowy plover breeding populations. To determine the status and viability of snowy plover populations, their breeding habitat should be monitored in a systematic fashion. Monitoring can also identify protection and management needs at individual sites.

2.1. Annually monitor population size and distribution at all breeding sites. The number of adults present during the breeding season at individual breeding sites provides information on population trends and fluctuations. This information can be used to identify management needs. Population size should be monitored at least once per year at all breeding sites.

2.2. Monitor productivity. Productivity, the number of young fledged per male, is essential for understanding population trends and which sites act as population sources or sinks. Obtaining productivity data involves color-banding birds and is time-consuming and expensive. Productivity should be monitored at major breeding sites.

2.3. Monitor annual survival. Reinitiate a banding program to supplement existing data on adult survival.

2.4. Monitor breeding activity at all sites to identify factors limiting abundance of breeding adults, clutch hatching success, and chick fledgling success. Monitoring numbers and reproductive success of birds is necessary to identify factors detrimental to snowy plovers and needed management actions.

2.5. Monitor historic and potential breeding sites for breeding activity. Continually evaluate habitat quality at historic and other potential snowy plover breeding sites and monitor for breeding activity if suitable breeding habitat is present. At a minimum, historic sites should be checked every five years for suitable habitat and breeding snowy plovers .

2.6. Improve data recording and management. Record monitoring data in a standardized format, store data in a centralized repository, and make data readily available.

2.7. Coordinate monitoring of snowy plovers and least terns. Because of their federal endangered status, Least Terns have been monitored and managed more thoroughly than snowy plovers . The two species occupy similar habitat and often nest in close proximity, making coordination of monitoring for the two species a logical and potentially cost-saving step.

3. Undertake scientific investigations.

3.1. Improve predation management techniques to protect snowy plover nests and chicks.

3.1.1. Develop improved nest exclosures for snowy plovers and least terns. Currently, predator exclosures at Quivira NWR are designed and placed to protect least terns. Explore whether any exclosure design features need to be added to accommodate snowy plovers.

3.1.2. Investigate methods to protect eggs and chicks from aerial predators. If aerial predators are found to be a significant source of nest or chick

mortality, development of exclosures or other methods to reduce loss to aerial predators.

3.2. Improve methods of monitoring population size and reproductive success of snowy plovers .

3.2.1. Improve methods of monitoring population size. Standard methods for monitoring numbers of adults at breeding sites should be developed. If complete counts are not feasible at all sites, standard methods to estimate population size based on sub-sampling and repeated sampling should be developed and implemented. For an example of standard methods, see Appendix J in the Pacific Coast snowy plover recovery plan (U.S. Fish and Wildlife Service 2001).

3.2.2. Improve methods of monitoring reproductive success. Typically, monitoring of reproductive success is limited to measuring clutch hatching success. However, a much preferred measure of reproductive success, and one critical to determining habitat quality at a site is to determine the number of young fledged per nesting pair or nesting male. Measuring the number of young fledged per pair requires intensive monitoring, and at sites with large numbers of birds, a method of identifying individual adults.

3.2.3. Determine if snowy plovers breeding in Kansas are multi-brooded. Research at Cheyenne Bottoms (Boyd 1972) suggests that birds raise only one brood per year. However, if some adults do raise more than one brood per year, as occurs in coastal and Great Basin populations, this will affect reproductive success.

3.3. Identify snowy plover brood habitat and map brood home ranges. Brood use areas should be determined by mapping brood movements. Brood habitat, which may differ from nesting areas, should then be delineated and protected. Color banding and radio telemetry of adults are recommended tools in determining home range of broods.

3.4. Conduct habitat and hydrological studies in watersheds with snowy plover breeding habitat. Some of the more complex issues identified below will require in-depth studies by experts in hydrology, wetland ecology, etc. Other issues require

on-site management knowledge and will best be addressed by area managers and wildlife staff.

3.4.1. Determine causes of decreased flows in the Cimarron River and the effect of decreased flows on snowy plover habitat, and identify possible solutions. This includes the effect of groundwater pumping and other water uses to riverine flow, the role of periodic high scouring flows in creating suitable snowy plover nesting habitat on sandbars.

3.4.2. Determine effect of management practices on snowy plover habitat on public lands.

3.4.2.1. Determine effect of water management structures and practices on snowy plover habitat at Quivira NWR. Water control structures on the refuge have altered the hydrology in ways that appear to be effecting snowy plover habitat. In particular, Inland saltgrass (*Distichlis spicata*) encroachment has drastically reduced nesting habitat (R. Boyd, *pers. comm.*). The affects of hydrological alterations on the amount and duration of standing water, salinity, and the amount and distribution of vegetation on salt flats are among the factors that should be considered.

3.4.2.2. Determine effect of water management structures and management practices on snowy plover habitat at Cheyenne Bottoms Wildlife Area. Declines in snowy plover breeding populations since the 1970s (Boyd 1981, Cheyenne Bottoms Wildlife Area, *unpublished data*) may be a result of habitat changes. Approaches to improving snowy plover habitat should be studied and appropriate changes implemented.

4. Develop public information and education programs.

4.1. Establish on-site interpretive information and displays at breeding sites.

4.2. Develop and implement educational information for use at schools and nature centers.

4.3 Develop information for posting on an Internet web site. Ideally, this would be part of a site containing information on other non-game wildlife and wetland species in Kansas. Components of the web page should include snowy plover natural history, ecology, conservation issues such as water use and watershed stewardship, the snowy plover recovery plan, and information on other wildlife sharing the same ecosystems.

4.4. Inform Federal, State, and local resource and regulatory agencies of threats to snowy plover breeding sites.

4.5. Work with private landowners at and near snowy plover breeding sites to raise awareness about conservation issues such as habitat needs and water issues.

5. Review progress towards recovery annually and revise recovery efforts as appropriate. The recovery plan must be periodically reevaluated to determine if recovery objectives are being met. Components of the plan may also need to be revised and updated as conditions change.

6. Cooperate with other states and the government of Mexico to protect snowy plovers at breeding and winter locations. The snowy plover population that occurs in Kansas is dependent on breeding, migration, and wintering habitat over a wide geographic area. Research indicates that plovers that breed in Kansas some years may breed at sites in other states in other years. Snowy plover conservation efforts in Kansas should be conducted with an awareness of conservation needs elsewhere and cooperative efforts should be undertaken as appropriate.

IV. IMPLEMENTATION SCHEDULE

General Ranking Categories. Actions necessary to recover the snowy plover are ranked in three categories:

Priority 1. An action that must be taken to prevent the species from irreversible decline or extirpation.

Priority 2. An action that must be taken to prevent a further decline in species abundance, range, or other negative impact to a species short of extirpation.

Priority 3. All other actions necessary to meet recovery objectives.

Table 5. *Implementation schedule for the snowy plover in Kansas. Task numbers correspond with those in Section III.*

Priority	Task No.	Task Description	Duration (years)	Total Cost	FY01	FY02	FY03	FY04	FY05
1	1.1.1	Encourage basin-wide water conservation	ongoing	TBD					
2	1.1.2	Encourage landowners to participate in Federal and State conservation programs.	ongoing	TBD					
2	1.1.3	Remove non-native and invasive vegetation from breeding sites.	3	TBD					
3	1.1.4	Restore known or potential breeding sites.	TBD	TBD					
2	1.1.5	Utilize existing Federal and State legislation and regulation to protect snowy plovers and their habitat	ongoing	TBD					
1	1.2.1	Provide management and protection on all Federal and State lands.	ongoing	TBD					
2	1.2.2	Develop and implement management plans on all Federal and State lands with snowy plover habitat	2	3.0	1.5	1.5			
2	1.2.3	Manager meetings to share effective management tools	2	1.0	0.5		0.5		
3	1.2.4	Obtain long-term agreements with private landowners	TBD	TBD					
3	1.2.5	Identify snowy plover habitat for acquisition	TBD	TBD					

Priority	Task No.	Task Description	Duration (years)	Total Cost	FY01	FY02	FY03	FY04	FY05
2	1.2.6	Develop partnerships with agencies, local governments, and private organizations to identify, assess, and mitigate harmful projects.	ongoing	TBD					
1	1.3.1	Maintain nesting pads and structures to protect nests from flooding	ongoing	5.0	1.0	1.0	1.0	1.0	1.0
3	1.3.2	Control vegetation at nest sites	ongoing	TBD					
2	1.3.3	Erect and maintain predator exclosures	ongoing	5.0	1.0	1.0	1.0	1.0	1.0
2	1.3.4	Manage water and habitat to create and maintain breeding habitat at managed wetlands	ongoing	15	3.0	3.0	3.0	3.0	3.0
3	1.3.5	Coordinate management activities of snowy plovers and least terns.	ongoing	TBD					
3	1.4	Prevent disturbance of breeding plovers by people and domestic animals	ongoing	TBD					
2	2.1	Annually monitor population size and distribution at all breeding sites	ongoing	15.0	3.0	3.0	3.0	3.0	3.0
3	2.2	Monitor productivity	ongoing	TBD					
3	2.3	Monitor annual survival	ongoing	15.0	3.0	3.0	3.0	3.0	3.0

Priority	Task No.	Task Description	Duration (years)	Total Cost	FY01	FY02	FY03	FY04	FY05
2	2.4	Monitor breeding activity at all sites to identify factors limiting abundance of breeding adults, clutch hatching success, and chick fledging success.	ongoing	20.0	4.0	4.0	4.0	4.0	4.0
3	2.5	Monitor historic and potential breeding sites for breeding activity.	3	9.0	3.0		3.0		3.0
3	2.6	Improve data recording and management	ongoing	5.0	1.0	1.0	1.0	1.0	1.0
3	2.7	Coordinate monitoring of snowy plovers and least terns.	ongoing	0					
3	3.1.1	Develop improved nest exclosures for snowy plovers and least terns.	2	4.0	2.0	2.0			
3	3.1.2	Investigate methods to protect eggs and chicks from aerial predators	2	4.0	2.0	2.0			
3	3.2.1	Improve methods of monitoring population size.	2	1.0	0.5	0.5			
3	3.2.2	Improve methods of monitoring reproductive success.	2	3.0	1.5	1.5			
2	3.2.3	Determine if snowy plovers breeding in Kansas are multi-brooded.	2	6.0	3.0	3.0			
3	3.3	Identify snowy plover brood habitat and map home ranges.	1	5.0	5.0				

Priority	Task No.	Task Description	Duration (years)	Total Cost	FY01	FY02	FY03	FY04	FY05
2	3.4.1	Determine causes of decreased flows in Cimarron River and the effect of decreased flows on snowy plover habitat, and identify possible solutions.	3	20.0	10.0	10.0			
2	3.4.2.1	Determine the effect of water management structures and practices on snowy plover habitat at Quivira NWR	2	8.0	4.0	4.0			
2	3.4.2.2	Determine effective methods of creating and maintaining suitable breeding habitat at Cheyenne Bottoms.	2	15.0	7.5	7.5			
3	4.1	Establish on-site interpretive information and displays at breeding sites.	2	2.0	1.0	1.0			
3	4.2	Develop and implement educational information for use at schools and nature centers.	ongoing	3.0	1.0	0.5	0.5	0.5	0.5
3	4.3	Develop education information for posting on Internet web site(s).	1	1.0	1.0				
3	4.4	Inform Federal, State, and local resource and regulatory agencies of threats to snowy plover breeding sites.	ongoing	TBD					
2	4.5	Work with private landowners at and near snowy plover breeding sites to raise awareness about conservation issues such as habitat needs and water conservation.	ongoing	10.0	2.0	2.0	2.0	2.0	2.0

Priority	Task No.	Task Description	Duration (years)	Total Cost	FY01	FY02	FY03	FY04	FY05
2	5	Review progress towards recovery annually and revise recovery efforts as appropriate.	ongoing	TBD					
3	6	Cooperate with other states and the government of Mexico to protect snowy plovers at breeding and winter locations.	ongoing	TBD					

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VI. APPENDIX

Appendix A. *Examples of federal and state conservation programs available to private landowners.*

Conservation Program	Agency	Description
Conservation Reserve Program (CRP)	NRCS	CRP encourages landowners to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as native grasses, wildlife plantings, trees, filterstrips, and/or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover.
Wetlands Reserve Program (WRP)	NRCS	WRP is a voluntary program to restore wetlands on private lands. Participating landowners can establish permanent or 30-year duration conservation easements, or they can enter into restoration cost-share agreements where no easement is involved. For a permanent easement, the landowner receives payment up to the agricultural value of the land and 100% of the restoration costs for restoring the wetlands. The 30-year easement payment is 75% of a permanent easement on the same site and 75% of the restoration cost. The voluntary agreements are for a minimum 10-year duration and provide for 75% of the cost of restoring wetlands. Easements and restoration cost-share agreements establish wetland protection and restoration as the primary land use for the duration of the easement or agreement
Environmental Quality Incentives Program (EQIP)	NRCS	EQIP provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns. The program provides assistance to farmers and ranchers that comply with State and Federal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation. The purposes of the program are achieved through the implementation of a conservation plan, which includes structural, vegetative, and land management practices on eligible land. Five- to ten-year contracts are made with eligible producers. Cost-share payments may be made to implement one or more eligible structural or vegetative practices, such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat.
Wildlife Habitat Incentives Program (WHIP)	NRCS	WHIP provides financial incentives to develop fish and wildlife habitat on private lands. WHIP agreements generally last a minimum of 10 years from the date that the contract is signed.

Conservation Program	Agency	Description
Riparian and Wetland Protection Program (RWPP)	SCC	RWPP is designed to protect and restore riparian and wetland habitats through comprehensive conservation plans. Financial (70/30 cost share, up to $10,000) and technical assistance is available for restoration and protection of wetlands and riparian areas in the following southeastern Kansas counties: Allen, Chase, Cherokee, Greenwood, Lyon, Marion, Morris, Neosho, and Woodson.
Non-point Source Pollution Control Program (NPSPCP)	SCC	NPSPCP provides guidance and funding to conservation districts in the development of NPS management plans. Financial assistance (70/30 cost share) is available (with the exception of Labette County) for projects such as riparian buffers and streambank stabilization. 2.5 million dollars is allocated each year to Kansas' local conservation districts.
Water Resources Cost-share Program (WRCSP)	SCC	WRCSP provides cost-share assistance to landowners for enduring conservation practices, such as tree planting, fencing, and waterways. Each conservation district receives an annual county allocation. Conservation districts set their own local program policy (e.g., determination of eligible practices) and maximum cost-share rate. All counties in Kansas qualify for this program.
Clean Water Neighbors	KDHE	60/40 cost share program (up to $5000). Covers a broad range of nonpoint source pollution (NPS) projects (e.g. well plugging, septic tank improvements, public educational projects)
Stream Steward Program	KDHE	60/40 cost share program (up to $5000). Similar to above but projects must be tied to riparian areas, such as livestock exclusion.
EPA Section 319 Control Grants	KDHE	Section 319 funds have been appropriated to address NPS concerns in Category I HUC-8 watersheds (i.e., HUC-8 watersheds in need of conservation, based on the Kansas Unified Watershed Assessment that was conducted by KDHE and NRCS). Eligible watersheds pertinent to this recovery plan include many HUC-8 watersheds in the central and southwestern Kansas. Funding is available on a 60/40 cost-share basis for the implementation of watershed restoration projects.

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