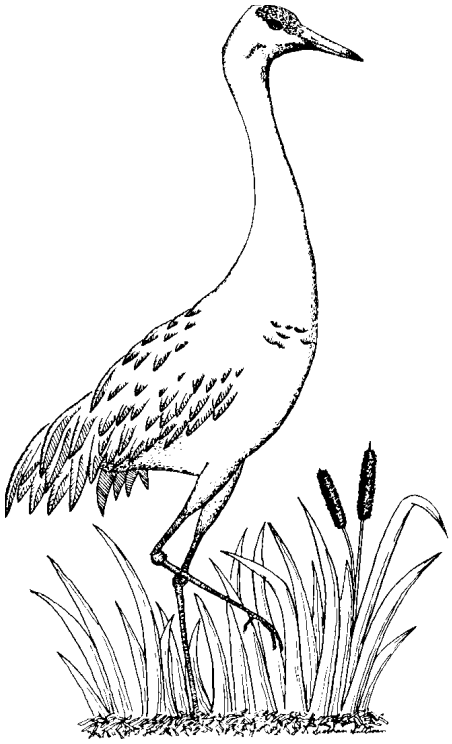
DRAFT

Washington State Recovery Plan

for the Sandhill Crane



Prepared by

Carroll D. Littlefield, HCR-4, Box 212, Muleshoe, TX 79347
Gary L. Ivey, P.O. Box 6953, Bend, OR 97708

Washington Department of Fish and Wildlife
Wildlife Management Program
600 Capitol Way N.
Olympia, WA 98501-1091

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In 1990, the Washington Wildlife Commission adopted procedures for listing and delisting species as endangered, threatened, or sensitive and for writing recovery and management plans for listed species (WAC 232-12-297, Appendix A). The procedures, developed by a group of citizens, interest groups, and state and federal agencies, require preparation of recovery plans for species listed as threatened or endangered.

Recovery, as defined by the U.S. Fish and Wildlife Service, is "the process by which the decline of an endangered or threatened species is arrested or reversed, and threats to its survival are neutralized, so that its long-term survival in nature can be ensured."

This document summarizes the historic and current distribution and abundance of sandhill cranes in Washington and describes factors affecting the population and its habitat. It prescribes strategies to recover the species, such as protecting the population, evaluating and managing habitat, and initiating research and education programs. Target population objectives and other criteria for reclassification are identified and an implementation schedule is presented.

This is the Draft Washington State Recovery Plan for the Sandhill Crane. It is available for a 90-day public comment period. Please submit written comments on this report by **1 November 2001** to:

Harriet Allen
Endangered Species Section Manager
Washington Department of Fish and Wildlife
600 Capitol Way North
Olympia, WA 98501-1091

Cover illustration by Siobhan Sullivan.

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

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EXECUTIVE SUMMARY

The sandhill crane is listed as an endangered species by the state of Washington where it breeds as well as winters. Sandhill cranes also stop during migration on the way to breeding grounds in British Columbia, Alaska, and northern Canada, or wintering areas in California. The greater subspecies breeds in Washington, while Canadian sandhill cranes, and lesser sandhill cranes primarily stop during migration, although some do winter in the state. The greater sandhill cranes in Washington are part of the Central Valley Population. Central Valley birds also nest in Oregon, California, Nevada, and British Columbia. The lessers are of the Pacific Flyway Population, but the Canadian subspecies has not been defined as a population and they need further study to clarify status and distribution.

Greater sandhill cranes occupy breeding territories in wetlands adjacent to riverine systems, closed drainage basins at the base of desert mountain ranges, and isolated mountain meadows. Most pairs select sites isolated from human activity. Irrigation of fields for hay production has increased habitat available to breeding cranes in some regions.

The historical distribution of breeding cranes in Washington was poorly documented, but the few historical accounts detail breeding in south-central, northeastern and southeastern regions, and the southern Puget Sound Basin. There are no records of breeding cranes in the northern Cascade Range, Olympic Mountains, or the Willapa Hills. Crane numbers had been severely reduced due to widespread habitat destruction concurrent with human settlement, and perhaps more importantly, unregulated hunting which continued until passage of the federal Migratory Bird Treaty Act in 1916. The species was extirpated as a breeder from the state after 1941 when the last nest was documented at Signal Peak, Yakima County, in south-central Washington. Some 31 years later, they were again found summering in the Glenwood Valley on Conboy Lake National Wildlife Refuge, Klickitat County in 1972, but it was not until 1979 that nesting was confirmed. A total of 19 territorial pairs was documented in 2000: 16 at Conboy Lake National Wildlife Refuge ; and 1 each on Yakama Indian Nation lands, Yakima County; Panakanic Valley, Klickitat County; and on Washington Department of Natural Resource (WDNR) lands along Deer Creek, Yakima County. The total summer population in Washington in 2000 was 53 birds.

To recover and maintain Washington's breeding, migrating, and wintering sandhill cranes, the existing breeding population needs to be protected and enhanced through management, and habitat needs to be conserved for both breeding and migrating cranes. This plan calls for expansion of the breeding range of greaters into former breeding areas in eastern Washington and provision of habitat for crane staging during migration.

The sandhill crane will be considered for downlisting from State Endangered to State Threatened status when the state's overall summer population reaches at least 150 birds, additional breeding habitat is protected and managed for cranes in southcentral Washington, and water management that provides for breeding cranes is established at Conboy Lake National Wildlife Refuge. The sandhill crane will be considered for downlisting from State Threatened to State Sensitive when the state's summer population of greater sandhill cranes reaches or exceeds 350, breeding habitat is protected in the state, and habitat used by cranes at the major winter and migration stopover sites is conserved and managed for cranes during the migration and wintering periods.

PART ONE: BACKGROUND

TAXONOMY

The sandhill crane (*Grus canadensis*) is 1 of 15 species within the family Gruidae, one of the world's most imperiled avian families. Habitat destruction and hunting have severely reduced several species of cranes; presently 47% are listed as either endangered or threatened, with several at risk of extinction (Ellis et al. 1996). For crane species in general, all but 2 occur in Africa, Australia, or Eurasia. The sandhill and whooping (*G. americana*) cranes are the only family members in North America; however, common cranes (*G. grus*) have strayed into Canada and the United States on rare occasions. Apart from the black-crowned (*Balearica pavonina*), gray-crowned (*B. regulorum*), blue (*Anthropoides paradisea*), and wattled (*Bugeranus carunculatus*) cranes of Africa, and the demoiselle crane (*A. virgo*) of Eurasia, the other 10 species are members of the genus *Grus*.

The sandhill crane was first described by George Edwards in "*A natural history of uncommon birds*" in 1750, based on a specimen collected by James Isham from somewhere near the southwestern shore of Hudson Bay (Houston 1994). The type was termed "brown and ash colour'd crane" (*Grus fusca canadensis*) (Ridgway 1941). With publication of the 10th edition of *Systema Naturae*, Carolus von Linnaeus changed the scientific name to *Ardea canadensis* in 1758. The genus name *Grus* was restored by Brisson in "Ornithologic*"* (5:374) in 1760, and except for a brief period in the early 1920s when the genus name was changed to *Megalornis* (Oberholser 1921), the sandhill crane has remained in the genus *Grus*. Based on DNA-DNA hybridization analyses, the sandhill crane seems to be from an old lineage, not closely related to the other 9 species of *Grus* (Krajewski 1989). It is taxonomically divided into 6 subspecies: Canadian (*G. c. rowani*), Cuban (*G. c. nesiotes*), Florida (*G. c. pratenses*), greater (*G. c. tabida*), lesser (*G. c. canadensis*), and Mississippi (*G. c. pulla*).

The greater sandhill crane was considered a full species during the 1800s after first being described as *Ardea (Grus) mexicana*, based on a specimen collected in Mexico in 1776 (Muller, *Syst. Nat. Suppl.*, p. 110). Vieillot (*Nouv. Dict. Hist. Nat*., xii) changed the name to *Grus mexicana* under the common name "sandhill" or "greater brown" crane in 1817, and *mexicana* was accepted as a full species through the earlier years of the 20th century. It was not until 1918 before *mexicana* was downgraded to a subspecies (*Grus canadensis mexicana*) (Oberholser 1918), but Peters (1925) replaced *mexicana* with *tabida* and proposed replacing *Grus* with *Megalornis*. Thus, for a brief period in the 1920s, the greater sandhill crane was scientifically known as *Megalornis canadensis tabida*. *Megalornis* gained only minor acceptance, and by 1931 the trinomial in present use was standardized by the American Ornithologist's Union Committee on Nomenclature. *Grus* is latin for crane, *canadensis* for "of Canada," and *tabida* for "waste away," referring to the subspecies' diminishing numbers and habitat when described by Peters in the mid-1920s. This form is the largest of the 6 sandhill subspecies, thus its common name "greater." The type specimen is an adult male collected in Nevada by Charles S. McCarthy in the South Fork Valley of the Humboldt River on 19 May 1859 (Specimen number 72695, Museum of Comparative Zoology, Cambridge Massachusetts).

The taxonomic status of sandhill subspecies has been discussed in the literature (e.g., Walkinshaw 1973, Lewis 1977, Tacha et al. 1985). The arctic-breeding lesser sandhill crane was formerly called "little brown crane," but was classified by its current name in the mid-20th Century (Walkinshaw 1949). The Canadian subspecies was described and named by Walkinshaw (1965). In general, the Canadian's breeding grounds are scattered across subarctic Canada between latitude 50° and 60° N, from northern

Ontario through northern Alberta, Saskatchewan, and Manitoba to west-central British Columbia (Meine and Archibald 1996).

DESCRIPTION

Sandhill cranes are large, stately, and symbolic of the remote, isolated wetlands they depend upon. Both sexes are similar in appearance with a bare red forehead, lores, and crown, and feathered whitish cheeks, ear coverts, chin, and upper throat. Pale slate gray, ashy gray, and brownish-gray characterize the body, wing, and tail feathers. The body and wing feathers are frequently stained with rust, particularly in summer and autumn. This reddish-brown coloration is from ferric oxide, not pigmentation (Taverner 1929). Using their beaks, sandhills smear mud onto their feathers; if this occurs in iron-rich soils, the rust coloration results. Cranes have 10 primaries and 16 secondaries, with the innermost secondary coverts and tertials elongate, ornamental, and drooping over the tail. The bare red crown skin of adults is covered with black hairlike bristles, and extends from the base of the bill above the eyes to the back of the head; when territorial or involved in aggressive encounters, the crown area can be extended and the red coloration intensified (Tacha et al. 1992). The adult iris is orangish or reddish; the bill is dull slate to partially olive gray, stout, elongate, with a perforated internasal septum. The legs and toes are blackish. The foot is anisodactyl, with 3 toes forward and 1 back and elevated (hallux) (Tacha et al. 1992). Cranes fly with neck and legs extended except in cold weather; on cold mornings birds will occasionally fly with legs retracted into their belly feathers (Walkinshaw 1953).

Fledged young and immatures have some juvenile body and wing feathers tipped with tawny and ocher during their first autumn and sometimes into early winter. The head and upper neck are cinnamon, with the crown and nape covered with tawny feathers (Johnsgard 1983). The other body feathers are similar to adults, and all feathers are identical by spring. The iris is gray brown to reddish brown until winter.

Lockman et al. (1987) reported measurements taken from adult greater sandhill cranes from Lincoln County, Wyoming (Table 1). Ninety-five percent of all females weighed <5,450 g (12 lbs, 0 oz) and had culmens <108 mm (4.4 in), whereas all males had weights >5,674 g (12 lbs, 8 oz) and culmens >110 mm (4.5 in). Greater sandhill cranes are the largest of the 3 subspecies, lessers the smallest, and Canadians are intermediate. Although greaters and lessers are easy to distinguish from each other with training and experience, the presence of the Canadian subspecies confounds identification, especially between Canadians and greaters.

Adult calls are rattling, loud, and resonating (Johnsgard 1983), whereas full grown young have a shrill *peeeer* (Walkinshaw 1949). The call of the sandhill crane has been described by some as the voice of the Pleistocene.

Table 1. Measurements of adult greater sandhill cranes from Lincoln County, Wyoming (*from* Lockman et al. 1987).

Measurement	Sex	Average	Range	n
Weight	male	5,430 g (11.75 lbs)	4,425 to 6,600 g (9.75 lbs - 14.56 lbs)	101
	female	4,825 g (10.63 lbs)	3,975 to 5,675 g (8.75 lbs - 12.5 lbs)	88
Culmen	male	105 mm (4.3 in)	88 to 120 mm (3.6 - 4.9 in)	109
	female	99 mm (4.0 in)	86 to 110 mm (3.5 - 4.5 in)	89
Tarsus	male	239 mm (9.8 in)	210 to 280 mm (8.6 - 11.4 in)	109
	female	231 mm (9.4 in)	200 to 272 mm (8.2 - 11.1 in)	90
Midtoe	male	94 mm (3.8 in)	80 to 110 mm (3.3 - 4.5 in)	108
	female	91 mm (3.7 in)	82 to 102 mm (3.3 - 4.2 in)	91
Wing chord	male	545 mm (22.2 in)	495 to 600 mm (20.2 - 24.4 in)	105
	female	524 mm (21.4 in)	485 to 575 mm (19.8 - 23.5 in)	90

GEOGRAPHICAL DISTRIBUTION

North America

Of the 6 subspecies of sandhill cranes found in North America, the Cuban, Florida, and Mississippi are nonmigratory, and the Canadian, greater, and lesser are migratory. Little is known about the distribution of the Canadian subspecies, but they are thought to breed in southern Mackenzie, central Alberta, Saskatchewan, and Manitoba to James Bay, with an unknown distribution along the Pacific coast (Cooper 1996). They winter in the southwest United States and Mexico, including the Central Valley of California.

Distinct populations are recognized for both greater and lesser sandhill cranes. Lessers are divided into 2 populations: the Mid-continent Population breeds in western and northern Alaska, northern Canada, and Siberia, and winters in the southwestern United States and northern Mexico; the Pacific Flyway Population breeds in south-central and southwestern Alaska, and winters in California's Central Valley.

Greater sandhill cranes are divided into 5 populations: the Eastern, Prairie, Rocky Mountain, Lower Colorado River Valley, and Central Valley (Littlefield 1999a) (Figure 1). Greater sandhill cranes which breed in Washington are members of the Central Valley Population which is defined as birds which winter in the Central Valley of California. This population is divided into 2 segments because of current disjunct distribution. The southern segment breeds in south-central Washington, eastern and central Oregon, northeastern California, and northwestern Nevada, while the northern segment breeds in British Columbia. Their Oregon breeding range is primarily in the south-central and southeastern portions of the state, but also includes Clackamas County in the northwest, Jackson County in the southwest, and Wallowa County on the northeast (Littlefield et al. 1994, Ivey and Herziger 2000). In California, their

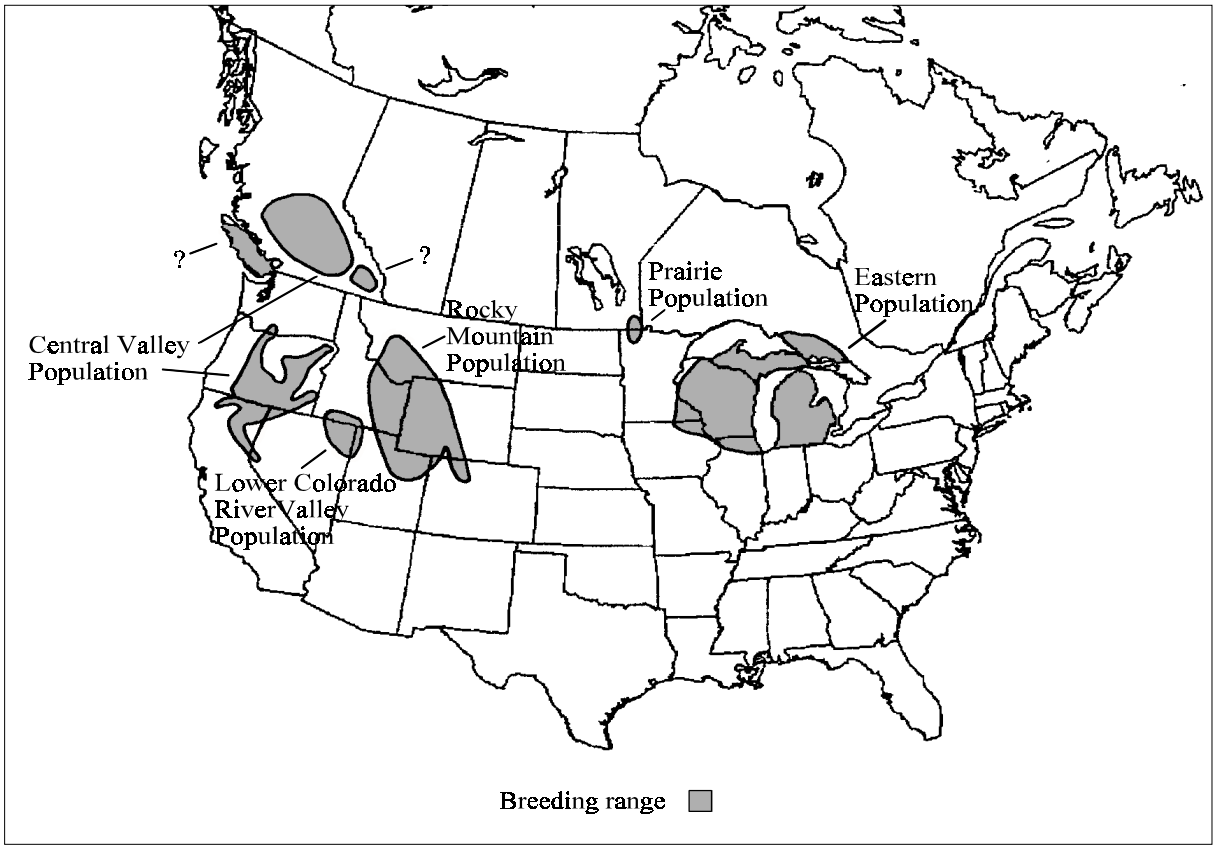

Figure 1. Breeding distribution of greater sandhill cranes in the United States (*from* Tacha et al. 1992, Meine and Archibald 1996, Cooper 1996, Ivey and Herziger, *in prep.*).

breeding range lies within 6 counties in northeastern portions of the state in Modoc, Lassen, Siskiyou, Plumas, Shasta and Sierra (Littlefield et al. 1994, Ivey and Herziger 2001). In northwestern Nevada, a few breed primarily in Washoe and Humboldt counties, with an additional pair in Douglas County near Genoa (American Birds 45:1142, North American Birds 53:414), the southernmost known pair for the Central Valley Population.

The northern segment of the Central Valley Population is widely distributed and much less concentrated than cranes in the southern segment and their exact range is unknown. Identified British Columbia greater sandhill crane breeding areas include the Chilcotin Plateau, Cariboo Basin, Fraser Lowlands, northern Okanogan Valley, East Kootenay Trench, and possibly Vancouver Island, although those birds may be the Canadian subspecies (Cooper 1996). A pair of cranes banded at Malheur National Wildlife Refuge in southeast Oregon during autumn migration was found breeding in the Cariboo Basin of British Columbia and wintering in the Central Valley of California. Other color-marked cranes (marked at Malheur National Wildlife Refuge) have been observed near Hanceville and Fly Lake, BC (T. Pogson, pers. comm.), establishing that birds in central British Columbia are of the Central Valley Population. Cranes breeding in southeastern British Columbia (East Kootenay Trench) are also likely Central Valley Population birds.

Washington

The Greater sandhill crane is the only subspecies that nests in Washington. Currently, the only known breeding sites are: Conboy Lake National Wildlife Refuge in Glenwood Valley and Panakanic Valley, Klickitat County; Polo Field/Signal Peak on Yakama Indian Nation lands, Yakima County; and Deer Creek on Washington Department of Natural Resources lands in Yakima County (Engler and Brady 2000) (Fig. 2). From 1995 through 1997 a pair was on territory 19 km (12 mi) south of Fort Simcoe in an

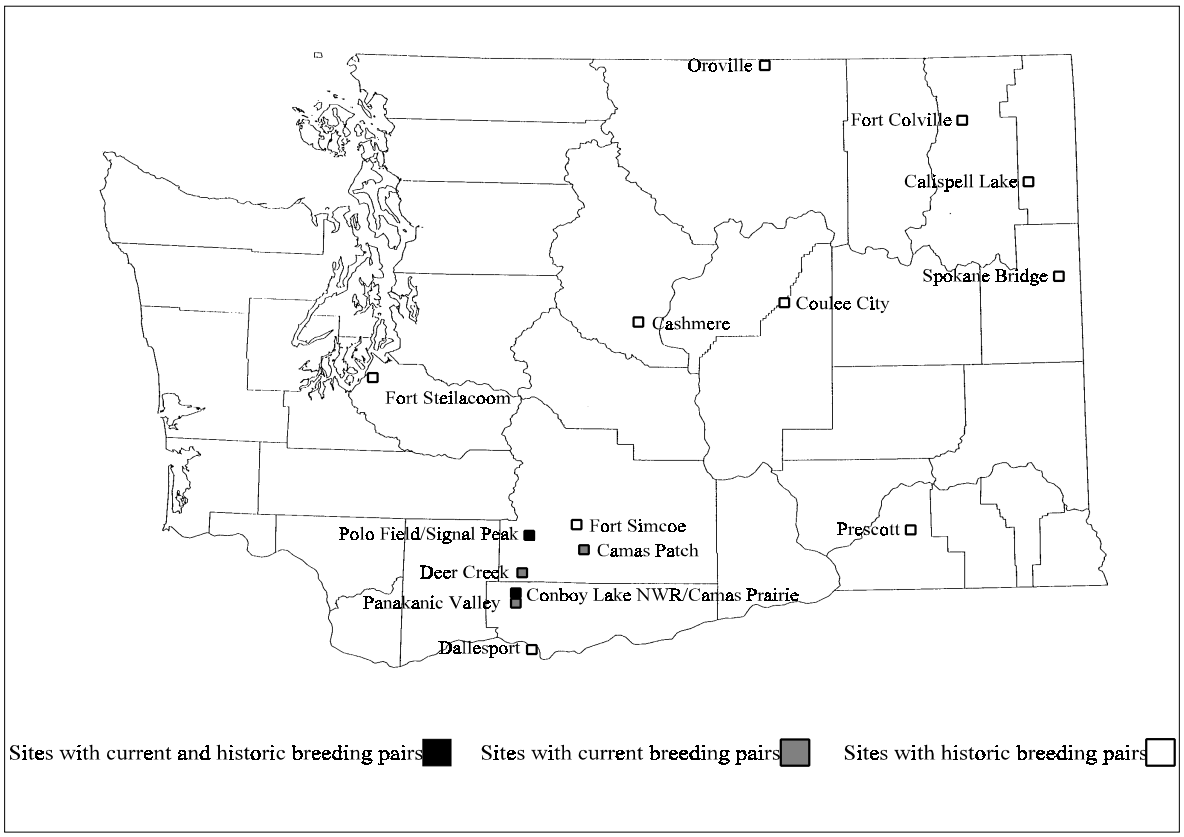

Figure 2. Past and current breeding distribution of greater sandhill cranes in Washington (from Dice 1918, Jewett et al. 1953, and Engler and Brady 2000).

area known as the Camas Patch; this site apparently no longer provides suitable habitat (J. Engler, pers. comm.). All pairs in the Glenwood Valley are listed here as on Conboy Lake National Wildlife Refuge because all territories are at least partially within the boundaries of the refuge (Engler and Brady 2000). Additionally, there have been a few summer records of sandhill cranes from dispersed localities which were not confirmed as breeding (Table 2).

Currently, a few migrant greater sandhill cranes stage at a few sites in Washington as they move to or from breeding areas in British Columbia, but most apparently over-fly the state. We found little evidence that a significant portion of the estimated 2,500 British Columbia greaters stop in Washington. In eastern Washington, documented records of areas where greaters have been observed include a flock containing about 20 greaters near Othello in 2000 (R. Hill, pers. comm.), and 200-300 which annually stop in spring near Waukon, Spokane County (M. Rule, pers. comm.). Migrants have been noted from Grant and

Table 2. Recent breeding-season sightings of greater sandhill cranes in Washington that were not confirmed as breeding (likely subadults).

Location	County	Date	Number	Source
Sequim[1]	Clallam	10 June 1980	3	American Birds 34:923
Lower Columbia River[1]	? [not noted]	June 1982	2	American Birds 36:1009
Nile[1]	Yakima	9 June 1982	1	American Birds 36:999
Ellensburg	Kittitas	3 May 1989	1	Paulson (1989)
Columbia NWR	Grant	5 May 1987	1	American Birds 41:464
Ridgefield NWR	Clark	6 June 1996	1	Field Notes 50:989
Atkins Lake[1]	Douglas	9 June 1996	1	Field Notes 50:989
Ridgefield NWR	Clark	15 June 1997	10	Field Notes 51:1045
near Prosser	Benton	April 1999	1	D. Friesz observation
N. Whidbey Island	Island	4 June 1999	4	*fide* Randy Hill

[1] Probably greater sandhill cranes but not confirmed.

Klickitat counties, and the subspecies also likely occurs in Douglas County (Field Notes 50:989). A few greaters may stop in Adams, Lincoln, and Okanogan counties, particularly during inclement weather, but presently accounts are lacking (R. Friesz and M. Murphy, pers. comms.); there are multiple sightings of lesser or unidentified sandhill cranes there (Appendix B). In western Washington, some greaters may migrate through the Puget Trough region as they are presumed to travel between southwestern British Columbia breeding grounds and staging sites on Ridgefield National Wildlife Refuge, Shilapoo-Vancouver Lake Wildlife Resource Area in southwest Washington, and Sauvie Island (Columbia County), Oregon. Appendix C summarizes records for migrants in the western portion of the state. Most of these birds are presumed to be lessers and Canadians.

The majority of the immense flocks which occur during migration in eastern Washington in spring and autumn mostly consist of lesser sandhill cranes; an estimated 21,000 to 23,000 occur in this region (Littlefield and Thompson 1982). However, lesser sandhill cranes also migrate through the western portion of the state. A coastal migrating segment of the Pacific Flyway Population totaling about 3,800 birds stop annually at Ridgefield National Wildlife Refuge and the nearby Vancouver and Woodland Bottoms area. Lesser sandhill cranes that migrate in eastern and western Washington may constitute two separate population segments (Littlefield 1999a). In addition, an estimated 900 or so Canadian sandhill cranes apparently use migration corridors through western Washington (Pogson and Lindstedt 1991), and perhaps a few may also migrate through the eastern portion of the state.

NATURAL HISTORY

Reproduction

Chronology. In February, greater sandhill cranes begin migrating north from the California Central Valley to their breeding territories. At Conboy Lake National Wildlife Refuge, birds usually arrive

between late February and mid-March. Pairs generally arrive first, accompanied with chicks from the previous year, whereas 2-3 year old birds (subadults) generally arrive a few weeks later. Pairs usually return to the same territory, and generally remain on or near the site for about a month or more before beginning nesting activities, usually in mid-April. Yearling young are driven away when pairs get ready to nest. At Conboy Lake National Wildlife Refuge in 2000, the first nest was noted on 11 April and the first hatching occurred around 11 May; the latest hatch date was 4 July. At Malheur National Wildlife Refuge, the earliest known clutch was on 25 March, but peak of nest initiation is usually around 21 April (C. Littlefield, unpubl. data), suggesting clutches are deposited about the same time in Washington as at other Central Valley Population nesting localities. Thus, the incubation season extends from late March into early July; the brooding season is generally from late April into late August, occasionally extending to early September.

Pair bonding. Greater sandhill cranes generally form lifelong pair bonds and are monogamous and highly philopatric, returning annually to the same breeding territory. Birds usually defer first breeding until ≥ 3 years of age (Drewien et al. 1995), with most nesting for the first time at age 4. A 3-year-old crane from Conboy Lake National Wildlife Refuge was found paired and on territory at Camas Prairie on the Mt. Hood National Forest in Oregon in 2000, approximately 94 km (59 mi) south of Conboy. The pair was acting broody, suggesting that they had a chick (G. Ivey, pers. observ.), but nesting was not confirmed until 2001 when a chick was observed with the pair (J. Engler, pers. comm.). Sandhills have been known to delay breeding until 5 years, and on rare occasions have bred at 2. For example, at Conboy Lake National Wildlife Refuge, 2 two-year-old male color-banded siblings displaced a territorial pair, divided the territory, and nested within 300 m (981 ft) of each other (Engler and Anderson 1998), and at Modoc National Wildlife Refuge in northeastern California, a color-banded two-year-old female successfully nested (Radke and Radke 1986).

Territories. No information is available on territory sizes in Washington, but at Grays Lake National Wildlife Refuge, Idaho, 5 territories ranged from 10 to 23 ha (25-57.5 ac) and averaged 17 ha (42.5 ac) (Drewien 1973), whereas at Malheur National Wildlife Refuge, size varied depending on pair density, ranging from 1.2 to 68 ha (3-170 ac) and averaging 25 ha (62.5 ac) (Littlefield and Ryder 1968). At a high density Malheur National Wildlife Refuge site, 8 territories averaged 9 ha (22.5 ac) (C. Littlefield, unpubl. data).

Nest building, eggs, and incubation. Both pair members participate in nest building. Nests are composed of vegetation from the surrounding wetland left from the previous growing season. Cranes collect nesting material and pile it into a mound, usually in shallow water. The clutch is usually 2 eggs, but occasionally only a single egg is laid, and on rare occasions, 3. At Malheur National Wildlife Refuge, for 974 completed clutches, 84 (8.6%) contained 1 egg, 886 (91%) 2 eggs, 3 (0.3%) 3 eggs, and 1 (0.1%) contained 4 eggs; mean clutch size was 1.92 (Littlefield 1995a). In California, average size for 42 clutches was 1.91 (Littlefield 1995b). Eggs are sub-elliptical to long oval, and vary in color from brownish-buff to light olive, irregularly marked with darker brown, reddish-brown, or pale gray (Tacha et al. 1992). The incubation period is normally 30 days, but the second egg frequently hatches at 29; incubation period may, however, extend to 33 days for fertile eggs and 43 for infertile or addled (Littlefield and Holloway 1987).

Brood rearing and fledging. Since a crane pair initiates incubation shortly after the first egg is laid, there is a 24 to 48 hour difference in hatching times between eggs. Soon after the second chick dries and gains sufficient strength to swim and walk, the adults lead them from the nest to feed in nearby moist meadows or subirrigated ecotones. Both parents tend young and the birds remain as a close family unit through the brooding period. Young chicks are brooded by the female at night, but once they attain sufficient size,

they spend the night roosting in shallow water with their parents. The brooding period lasts from 66-75 days, however, after birds fledge, it takes a few weeks for chicks to become strong fliers. After fledging, cranes maintain their family association as young remain with their parents in migration and winter, usually returning together to breeding grounds the following spring; 2 siblings banded at Conboy Lake National Wildlife Refuge in 1996 were observed together in California the following winter (Engler and Brady 2000). Eleven of 16 chicks color-marked at Conboy Lake National Wildlife Refuge since 1996 have fledged and successfully migrated (Engler and Brady 2000).

Nesting success and recruitment. Nest success can vary considerably between years due to weather, water and habitat conditions and predation pressure. At Conboy Lake National Wildlife Refuge, nest success since 1995 has been 67% (n = 69) (Engler and Brady 2000). In 2000, 7 of 13 nests (54%) hatched young. The pair at the Polo Field on Yakama Nation lands hatched 2 eggs and fledged 1 chick in 1997 (Stepniewski 1999, R. Leach, pers. comm.), but the pair at the Camas Patch was not reproductively successful through 1997, apparently because of early drying and many cattle (R. Leach, pers. comm.). Outside of Conboy Lake National Wildlife Refuge, sites have rarely been monitored for nest success.

Generally, nesting success rates in the Pacific states are less than those reported elsewhere within the subspecies' breeding range. Nesting success ranged from 77 to 78.9% in Michigan (Hoffman 1979, Walkinshaw 1981), 78% in Idaho (Drewien 1973), and 84% in Wisconsin (Bennett 1978), whereas in south-central Oregon, success was 29.8% at Sycan Marsh (Stern et al. 1987), and at Malheur National Wildlife Refuge, 44% were successful from 1966 through 1974 (Littlefield 1976a), and 54% from 1976 through 1989 (Littlefield 1995a). In total, for 1,702 clutches assessed at Malheur National Wildlife Refuge (1966-1998), 978 (57%) hatched at least 1 egg. Elsewhere, 56 nests in northeastern California had an average success rate of 37.5% in 1988, and in another study on privately-owned lands at scattered locations in eastern Oregon, 69.8% of 63 clutches successfully hatched in 1976 and 1986 (Littlefield 1999b).

Reproductive success for this long-lived species is usually low. However, recruitment (or the % of fledged young in the population; calculated using known breeding pairs and counts of fledged young) of Washington pairs has averaged 11.1% (range 0 to 27.3 %) from 1990-2000. Recruitment rates for about 50 breeding pairs at Klamath Marsh in Oregon were 8% in 1993 and 2% in 1994 (Drew et al. 1994). At Malheur National Wildlife Refuge, recruitment for the period 1970-1989 averaged 6.7% and nesting pairs were declining (Littlefield 1995a) and from 1990-1998, recruitment averaged 5.8% (G. Ivey, unpubl. data). Low recruitment (4.5%) was reported for cranes breeding at Sycan Marsh, Oregon (Stern et al. 1987) and for the entire Central Valley Population (5.6-6.1%). These recruitment rates are among the lowest recorded for North American cranes (Drewien et al. 1995). For example, the number of greater sandhill cranes nesting in the Great Lakes region (Eastern Population) has been increasing, and recruitment rates have averaged 12 -12.7% (Lovvorn and Kirkpatrick 1982a). Recruitment for the Rocky Mountain Population ranged from 9.4-12% in the early 1970s and the population was increasing; however, since 1986, recruitment has declined (ranging from 3.4 to 6.5%) and the population is stable or slightly decreasing (Drewien et al. 1995). In the past, an 8-10% annual recruitment rate was considered necessary for population maintenance (Littlefield and Ryder 1968). Recent data suggests that with improved and active management, possibly coupled with a reduction in illegal kills, stability may be maintained with an annual recruitment rate of 7-9%, but a higher rate is needed for a population increase.

Mortality

Greater sandhill cranes can reach an age of at least 30 years in the wild (C. Littlefield and G. Ivey, unpubl. data). If young survive the brooding period, mortality rates decline dramatically once they

develop sufficient flying skills. Primary causes of sandhill crane mortality are predation of young (occasional in adults) and collisions with powerlines. Other sources of fatality include entanglements in fences, diseases, and illegal shooting.

Chick mortality. Predation is the primary cause of chick mortality, but intraspecific aggression (fratricide, infanticide), drowning, starvation, parasites, and accidents such as fence entanglements and road-kills contribute to losses. Coyotes (*Canis latrans*) are thought to be the primary predator of crane chicks at Conboy Lake National Wildlife Refuge (Engler and Brady 2000). To assess chick mortality, several radio-telemetry studies have been completed at different locations within the Central Valley Population's breeding range. At Modoc National Wildlife Refuge in 1990 and 1992 during a period of predator management, 4 of 28 (14%) monitored chicks were killed by minks (*Mustela vison*), 3 (11%) by coyotes, 1 (4%) each were lost to infection and starvation, and 7 (26%) were lost to unknown causes (including tag loss) (DesRoberts 1997). For 10 chicks transmitter-equipped at Klamath Marsh National Wildlife Refuge in 1993 and 1994, 3 (30%) were lost to undetermined predators, 2 (20%) to coyotes, 2 (20%) lost transmitters, 1 (10%) died of exposure, and 2 (20%) were found dead but the causative agent could not be determined (Drew et al. 1994). Eighteen chicks were radio-marked at Sycan Marsh in 1984, and total mortality was 44%. Predation accounted for 83% of the mortalities and all predation except 1 was attributed to coyotes; 1 was attributed to an unidentified raptor. Fratricide accounted for the other explicable death, whereas 2 others apparently died but were not recovered, and 10 (56%) fledged (Stern et al. 1984).

A telemetry study at Malheur National Wildlife Refuge in 1983 and 1984 (a period without predator control) showed that from a sample of 39 transmitter-equipped chicks, 13 were lost to predators, 1 died from a parasitic gapeworm (*Cyathosoma* sp.) infection, 1 drowned, contact was lost with 4, and 3 died from unknown causes in 1983, whereas in 1984, 4 were lost to predators and 10 transmitters malfunctioned, but 8 of these chicks were known to have died before fledging. Of 17 chicks where predator identity was known, coyotes took 13 (77%), great horned owls (*Bubo virginianus*) 2 (12%), raccoon (*Procyon lotor*), 1 (6%), and domestic dog 1 (6%) (Littlefield and Lindstedt 1992). In a more extensive telemetry study conducted on Malheur National Wildlife Refuge from 1991-1998 when predators (particularly coyotes) were being or had recently been intensively managed for 8 years (1986-1993), 219 chicks were transmitter-equipped from 1991 through 1998 (Ivey unpubl. data). Fates of 41 chicks were undetermined and 27 of 178 (15%) fledged. Of the known fates, predators were responsible for 109 (61%), intraspecific causes 11 (6%), parasitic gapeworms 10 (6%), drowning 9 (5%), starvation 4 (2%), unknown deaths 3 (1%), abandoned 1 (<1%), fence entanglement 1 (<1%), vehicle 1 (<1%), hay-swather 1 (<1%), and study-related mortality 1 (<1%). Of the 109 killed by predators, 32 (29%) were lost to minks, 23 (21%) to coyotes, 19 (17%) to great horned owls, 14 (13%) to unidentified predators, 10 (9%) to golden eagles (*Aquila chrysaetos*), 9 (8%) to unidentified raptors, 1 (0.5%) to a northern harrier (*Circus cyaneus*), and 1 (0.5%) to a raccoon. Between 1970-1998 at Malheur National Wildlife Refuge during years when predator control was practiced, chick mortality was 84.4% compared with 91.1% in years when predators were not controlled (G. Ivey and C. Littlefield, unpubl. data).

Adult predation. Few predators are capable of taking subadult or adult greater sandhill cranes; however, there are several records of cranes being attacked by golden eagles (Ellis et al. 1999) and coyotes (Littlefield 1986). Bald eagles (*Haliaeetus leucocephalus*) are known predators of lesser sandhill cranes (Herter 1982, Littlefield 1999a), but greaters usually pay little attention to the species (C. Littlefield, pers. observ.). However, 2 subadult bald eagles were noted stooping at an adult crane after a nest exchange at Conboy Lake National Wildlife Refuge in 1998 (J. Engler, pers. comm.). Certainly both black (*Ursus americanus*) and grizzly bears (*U. horribilis*), gray wolf (*Canis lupus*), mountain lion (*Felis concolor*), and bobcat (*F. rufus*) would be capable of killing adult cranes, but no records exist.

Powerline collisions. Young fledglings are particularly prone to collisions with utility wires, particularly on windy days. Even in adulthood, utility wires pose a threat, and collisions are considered one of the major mortality factors, particularly at staging areas and on the wintering grounds. At a staging site in southwestern Colorado, 15% of 597 powerline mortalities were sandhill cranes (Brown and Drewien 1995). For the Central Valley Population, the critical mortality period is winter. Persistent winter fog in California, coupled with an extensive network of utility lines, frequently kill a number of cranes. Collisions usually occur in the early morning hours as birds leave roost sites and fly to nearby grainfields to feed (Littlefield 1999a). As many as 22 greater sandhill cranes have been killed at a single roost site on a single morning in the Central Valley (R. Schlorff, pers. comm). On the breeding grounds, territorial adults have been found dead beneath utility wires at Modoc National Wildlife Refuge and Pit River Valley, California, and at Malheur National Wildlife Refuge (T. Melanson, pers. comm.; C. Littlefield and G. Ivey, pers. observs.), and at least one crane died after colliding with utility wires at Conboy Lake National Wildlife Refuge (13 August 1984). This specimen is stored in the Burke Museum, University of Washington (Paulson 1989).

Fences. To a lesser extent, collisions or entanglements with barbed-wire fences have resulted in crane deaths. Unlike collisions with utility wires, most known fence mortalities have occurred on the breeding grounds; at least 6 victims have been found in southeastern Oregon (C. Littlefield and G. Ivey, unpubl. data). Of 135 deaths of color-marked greater sandhill cranes in the Rocky Mountain Population, Drewien et al. (*in prep.*) reported 8 (4.5%) died from fence collisions or entanglements.

Disease. Within the Central Valley Population little information is available on diseases; however, avian cholera (*Pasteurella multocida*) has resulted in mortality in San Joaquin County, California (S. Lindstedt, pers. comm.), and botulism (*Clostridium botulinum*, Type C) killed at least 1 crane in Oregon (G. Ivey, pers. observ.), whereas aspergillosis (*Aspergillus fumigatus*), salmonella (*Salmonella tiphimurium*), and avian tuberculosis (*Mycobacterium avium*) have killed sandhill cranes elsewhere in the United States. All of these diseases occur in the west, and certainly cranes in the Pacific states would be susceptible should an outbreak occur (Littlefield 1999a).

Illegal shooting. In the late 1960s and early 1970s, illegal shooting of cranes frequently occurred, particularly in the California Central Valley; several breeding adults were also shot at Malheur National Wildlife Refuge in the 1970s. However, increased public awareness and interest, in addition to increased enforcement, has apparently resulted in this mortality factor being greatly reduced. For example, several cranes were known to have been shot in the Central Valley in 1969 through 1972, but none was known killed in 1991 through 1993 (C. Littlefield, pers. observ.).

Other factors. Elsewhere, other lethal factors have included aflatoxicosis (from spoiled peanuts), lead poisoning, and catastrophic/environmental mortalities (Windingsted 1988). For example, 90 sandhill cranes were killed by lightning in Nebraska in April 1978 and about 600 were killed in an Oklahoma hailstorm on 17 October 1979 (*in* Windingsted 1988), and more than 1000 lesser sandhill cranes died from hail in eastern New Mexico on 15 October 1960 (Merrill 1961). Most unusual was a 4-year-old male greater sandhill crane at Grays Lake National Wildlife Refuge, Idaho, that was killed by a male whooping crane during a breeding territory dispute (Drewien et al. *in prep*.).

Migration and Dispersal

Individual greater sandhill cranes consistently return to the same nesting territories and wintering sites as long as habitat conditions remain suitable (Tacha et al 1992, Drewien et al. 1999). Distances from natal site to first breeding site has not been reported. Males are believed to be more philopatric than females

(Tacha et al. 1992); that is males typically establish a breeding territory closer to their natal site than do females, as is typical in many territorial birds (Greenwood 1980).

Spring migration. Except during inclement weather, adults usually do not linger along the migration corridor as they migrate north to breeding sites, whereas subadults spend some time at traditional spring staging areas. Annual spring use varies, but traditional sites for the Central Valley Population have been identified in California at Davis Creek and Surprise Valley (Modoc County), and Grass Lake and Lower Klamath National Wildlife Refuge (Siskiyou County). Flocks have been seen at these sites in May and well into June (Littlefield et al. 1994). In 2000, an estimated 5,000 greaters were observed at Big Valley (Modoc and Lassen counties) which is an unusually high number for this staging area (W. Epperson, pers. comm.). In Oregon, known staging areas possibly used by spring migrants traveling through Washington include Malheur National Wildlife Refuge, Diamond Valley and Silvies River Floodplain (Harney County), Williamson River Delta and Klamath Marsh (Klamath County), Warner Basin (Lake County), and near Fox (Grant County). In eastern Washington, greater sandhill cranes stage primarily near Waukon and Othello, along with flocks of lessers. In western Washington, greaters may migrate through the Puget Trough region, but there are no recent records. The Canadian and lesser subspecies migrate through the state primarily from February through April with the lessers using two different migration corridors; one route follows the coast while the other remains east of the Cascades (Littlefield 1999a). No Canadian sandhill cranes have been identified using eastern Washington staging areas.

Autumn migration. Migration from Conboy Lake National Wildlife Refuge usually occurs between late September and mid-October (Engler and Anderson 1998). On 29 September 1998, 2 color-banded juveniles from Conboy were noted at Lower Klamath National Wildlife Refuge, indicating the staging area for cranes which breed in Washington. Numbers at Lower Klamath National Wildlife Refuge have been increasing, from a peak of 425 on 24 October 1985 to 1,385 on 28 October 1998; in 2000, the peak was 1,188 on 6 October (J. Beckstrand, pers. comm.). Cranes begin staging in late August and peak numbers are present in mid-to late October. This site is presently the most important staging area for the Central Valley Population. The increased use at Lower Klamath National Wildlife Refuge perhaps reflects an increasing number of breeding pairs within the Cascades in Oregon and to some extent, Washington.

Other than at Glenwood Valley where small flocks of migrant sandhill cranes stage (H. Cole, pers. comm.), there are no known autumn greater records for Washington east of the Cascades; however, large flocks recorded near Othello composed of lessers may contain some greaters. In western Washington, cranes stage at Ridgefield National Wildlife Refuge and also within the Columbia River at Sauvie Island, Oregon. These birds migrate south through the Willamette Valley, with some birds staging at Camas Swale, Lane County, Oregon before moving south to California. Table 3 summarizes autumn counts of sandhill cranes at Ridgefield National Wildlife Refuge. The Canadian and lesser subspecies migrate through the state primarily in late September and October using the same general routes as in the fall.

In the migration corridor to the east, Malheur National Wildlife Refuge was the most important traditional autumn staging area for greaters in the Pacific states until the 1980s (Littlefield 1986). Cranes have arrived at Malheur National Wildlife Refuge as early as 5 August (1977), but birds believed to be from British Columbia generally do not appear until mid-September (Littlefield 1992). Peak numbers were usually present by mid-October, but if mild autumn weather persisted, and grain was abundant, the peak was delayed until early November. Autumn migration out of Malheur usually began in October, but cranes were seen departing as early as 23 August (1968). Normally the majority migrated between 1-15 November. Occasionally a few lingered into December, but normally all had migrated by the end of November; latest departures were 10 December 1947, 20 December 1951, 31 December 1961, 11

December 1965, and 15 December 1977. The mean departure date for 36 years was 16 November. The greatest number ever recorded at Malheur was 3,408 on 25 October 1979 (Littlefield 1986).

Table 3. Numbers of sandhill cranes at Ridgefield NWR, WA and Sauvie Island, OR staging area in autumn, 1991-2000 (USFWS, unpubl. data).

Date	Ridgefield National Wildlife Refuge	Sauvie Island	Total
2 Oct 1991	866	2,368	3,234
7 Oct 1992	331	887	1,218
30 Sep 1993	441	2,592	2,632
6 Oct 1994	415	1,920	2,335
27 Sep 1995	835	1,271	2,107
11 Oct 1995	1,222	2,640	3,615
9 Oct 1996	1,175	2,440	3,216
7 Oct 1997	1,321	1,895	3,862
8 Oct 1998	992	3,281	4,273
12 Oct 1999	1,417	1,629	3,046
12 Oct 2000	1,729	2,265	3,994

Winter. Some cranes appear in the Central Valley in mid-to late September, but most arrive between mid-October and late November. The 2 principal wintering locations for greaters are the rice-growing regions of the Sacramento Valley and the corn-growing areas of the San Joaquin-Sacramento Delta (Delta). Color-marked cranes from Conboy Lake National Wildlife Refuge have been observed on wintering grounds in these 2 regions (Engler and Brady 2000). Further south, cranes were near the Faith Ranch west of Modesto (Stanislaus County) in the early 1970s and in Merced County (primarily Merced National Wildlife Refuge) (Littlefield and Thompson 1979). A few greaters reach Pixley National Wildlife Refuge (Tulare County). Some shifting occurs in early winter, but by mid-January wintering numbers at specific sites have generally stabilized. Conboy Lake National Wildlife Refuge birds have been noted at Butte Sink National Wildlife Refuge (Sutter County), Glenn (Glenn County), and near Thornton (San Joaquin County) (Engler and Brady 2000). Lesser sandhill cranes have also been noted at Thornton (the Delta region), and south and east to the Carrizo Plains (San Luis Obispo County), with greatest numbers occurring in Merced County near Los Banos and Merced (Littlefield and Thompson 1982). A few also winter in the Sacramento Valley. The distribution of wintering Canadian sandhills has not been assessed.

Foraging and Food

Sandhill cranes forage by probing, surface gleaning, and occasionally by spearing. Generally, the species can be categorized as an opportunistic omnivore (Armbruster 1987), feeding on a variety of food items including roots, bulbs, grains, berries, snails, earthworms, insects, amphibians, lizards, snakes, mice, and greens (Ridgway 1895, Barrows 1912, Bent 1926, Gabrielson and Jewett 1940, Brown 1942). Sandhill cranes have also been noted consuming eggs and young birds (Harvey et al. 1968, Littlefield 1976b, Reynolds 1985). In spring, cranes primarily eat macroinvertebrates, with insects (particularly scarab beetle larvae) being of most importance (Davis and Vohs 1993). Another dominant food, at least in portions of its breeding range, is earthworms. These food items are important sources for protein and calcium, nutrients needed for daily maintenance requirements (Reinecke and Krapu 1986). Such food

items are essential, particularly on breeding grounds. The diet of greater sandhill cranes at Conboy Lake National Wildlife Refuge has not been assessed, but Oregon spotted frogs (*Rana pretiosa*) are a suspected prey item; 8 territorial pairs nest or forage regularly at 7 sites which are considered to be the most important core areas for Oregon spotted frog breeding, but it is unknown if these concentrations are related to habitat preference or to the abundance of amphibian prey (J. Engler, pers. comm.). Birds in the area also forage in oat fields (H. Cole, pers. comm.).

In autumn and winter sandhills feed on waste grains to help meet their high energy demands during migration and for survival through the winter period. Migrational staging sites are important for conditioning cranes for migration (Krapu et al. 1985; Krapu and Johnson 1990). Principal grains consumed are milo (Guthery 1972, Buller 1981, Iverson 1981, Iverson et al.1985), corn (McLean 1930, Tanner 1941, Hoffman 1976, Lewis 1979, Crete and Toepfer 1978, Perkins and Brown 1981, Lovvorn and Kirkpatrick 1982b, Walker and Schemnitz 1987, Reinecke and Krapu 1986, Fritzell et al. 1979), wheat (Swarth 1919, Wood 1921, Munro 1950, Madsen 1967, Stephen 1967, Sugden and Clark 1988, Sugden et al. 1988), oats (Madsen 1967, Buller 1981, Tebbel and Ankney 1979), barley (Madsen 1967, Littlefield 1986, Sugden et al. 1988, Drewien and Bizeau 1974, Iverson et al. 1985), and rice (Guthery 1972). Littlefield (1986) described an autumn staging area at Malheur National Wildlife Refuge where most feeding was in barley fields, but in some years oat, rye, and wheat fields were used, when available. Though cranes showed no special preference between oat, rye, and barley, they did prefer wheat. Malheur National Wildlife Refuge feeding fields ranged in size from 10 to 138 ha (25 - 345 ac), and birds concentrated in harvested areas (Littlefield 1986). In landscapes dominated by deep and fertile soils, grit may be a limiting factor, especially for cranes feeding predominately on waste grains (Littlefield and Ivey 2000).

Agriculture in the Sacramento Valley of California, where at least some of the Conboy Lake National Wildlife Refuge cranes winter, is dominated by rice. For 66,044 crane feeding use-days recorded in autumn 1991 through winter 1993, waste rice was the most important, accounting for 71.4% of the observed use (Littlefield 1993a). Although most feeding is in rice stubble fields, use varies depending on agricultural practices. For example, in November 1991 through February 1993, 59.3% of the observed crane feeding use was in unaltered harvested rice fields, with 16.2% in flooded stubble and 14.4% in burned stubble. Autumn-tilled rice stubble received infrequent use (3.3%), as did burned-flooded (0.3%). Newly planted winter wheat was second in importance, but use was of short duration; once seedlings emerged, cranes generally abandoned wheat fields. Though few corn hectares were present, waste corn accrued 7.5% of total use; waste corn, which is rich in carbohydrates, became increasingly important immediately before cranes migrated in February. Finally, 3.9% of the use was on cattle-grazed grasslands; these grasslands, however, were little used before the onset of winter rains. Few cranes were noted on other agricultural crops.

HABITAT REQUIREMENTS

Breeding

Territories. Primary components of a breeding territory are the nest site, roosting area, feeding area, and to some degree, isolation (Armbruster 1987). In the West, greater sandhill cranes occupy breeding territories in wetlands adjacent to riverine systems, closed drainage basins at the base of desert mountain ranges, and isolated mountain meadows. Most pairs select sites rather isolated from human activity; however, a few still breed near Vancouver, British Columbia (Cooper 1996) where urban development has been extensive; these may be the Canadian subspecies. Also, 1 pair was found nesting within the city

limits of Bieber, Lassen County, California (G. Ivey, pers. observ.), and other pairs nest within one half mile of other small towns in northeastern California and eastern Oregon (Littlefield et al. 1994).

At Conboy Lake National Wildlife Refuge, breeding territories include dry grass uplands, partially timbered uplands, emergent marshes and wet meadows (Engler and Brady 2000). This prairie-like valley beneath the southeastern slope of Mt. Adams lies at an elevation of only 555 m (1,820 ft) but the influence from surrounding mountains makes the climate harsh. Valley topography is mostly level in this 14 km (9 mi) long wetland basin. Historically, Conboy Lake was continuously present throughout the year, but as a result of drainage and subsequent agricultural development in the early 1900s, water now gradually recedes during early summer as Camas Drain empties into Outlet Creek. Surrounding uplands are predominately forested with ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*) and lodgepole pine (*Pinus contorta*), with some stands of Oregon white oak (*Quercus garryana*) (U.S. Fish and Wildlife Service 1983).

Nesting habitat. Generally, cranes require wetlands for nesting, and will use a wide range of wetland classes and vegetation types, and occasionally will use uplands. Within the greater sandhill cranes' breeding range, nesting habitat varies from open meadows to deep water bogs and marshes (Armbruster 1987). At Conboy Lake National Wildlife Refuge, areas of the refuge where cranes nest are covered with meadow-like vegetation, including reed canarygrass (*Phalaris arundinacea*), rushes (*Juncus* sp.), sedges (*Carex* spp.), and spikerushes (*Eleocharis* sp.). The greatest part of the lakebed is covered with reed canarygrass (J. Engler, pers. comm.), an introduced and undesirable species (Paveglio and Kilbride 2000). Some areas contain bulrushes (*Scirpus* spp.), cattails (*Typha* spp.), and a few shrubs including Douglas' spirea (*Spirea douglasii*). Native grasses include redtop (*Agrostis alba*) and foxtail barley (*Hordeum jubatum*).

Sandhill cranes nest primarily in seasonally wet meadows where vegetation consists of medium to tall emergent plant species. Roughly 55% of the refuge is comprised of wet meadows. Sedges, spikerushes, rushes, forbs, various native grasses, and reed canarygrass are the primary species present, with the latter being more dominant on drier sites. Peripheral areas (11%) of these meadows are slightly to heavily encroached upon by lodgepole pine, Douglas' spirea, and willow. Approximately half of the crane pairs nest in areas with some trees and shrubs, however, heavy encroachment by these species may preclude nesting cranes. In several instances, crane pairs are known to use dense spirea stands for both a nesting substrate and cover. Cranes also nest in moderate to dense stands of tall emergents such as cattails and bulrushes, however, this habitat comprises less than 5% of the refuge area (J. Engler, pers. comm.).

On Yakama Indian Nation lands, 1 pair nests in a beaver-created meadow covering approximately 79 ha (195 ac) and is vegetated with willows (*Salix* spp.), sedges, tufted hairgrass (*Deschampsia cespitosa*), timber oatgrass (*Danthonia intermedia*), situated between stands of lodgepole pine, Douglas-fir, grand fir, with some ponderosa pine and western larch (*Larix occidentalis*) (Leach 1995). Portions of the meadow have standing water in spring and summer. A pair on Washington Department of Natural Resources land uses a small meadow created by an old road blocking a drainage system; probably a beaver (*Castor canadensis*) dam originally created the meadow (H. Cole, pers. comm.).

Several studies have reported on nest habitat for crane pairs in California, Oregon, and British Columbia. In some areas pairs nest in open, exposed meadows, whereas in others nest preference sites are in dense, coarse emergents. Nesting habitat varies; for example, in northeastern California 44% of 48 nests were in open, shallow-flooded meadows (Littlefield 1995a), whereas 91% of 1,018 nests were in coarse emergents at Malheur National Wildlife Refuge (Littlefield *in press*). At Klamath Marsh National Wildlife Refuge, 32 (63%) of 51 assessed nests were in seasonally flooded meadows (sedge/rush/grass),

whereas 15 (29%) were in hardstem bulrush (*S. acutus*), and 4 (8%) in open water with little or no vegetative cover (Drew et al. 1994). Of interest, 2 pairs in 1993 placed their nests atop 360 kg round hay bales, originally placed on the refuge to provide artificial nesting structures for Canada geese (*Branta canadensis*). Several nests were found on artificial islands with little or no cover on National Forest lands in California in 2000 (Ivey and Herziger 2001). Fifteen crane sites in the central-interior region of British Columbia were in sedge-dominated wetlands surrounded by coniferous forests, with many bays and points of land; pairs have also been found nesting in heavily vegetated bulrush marshes surrounded by rangelands (Cooper 1996).

Nest vegetation. Greater sandhill cranes will use a variety of vegetation types for nesting. At Conboy Lake National Wildlife Refuge, of the nests assessed there in 1996, 1 was composed of 70% sedge, 25% reed canarygrass, and 5% rush. Another was on a small berm; 1 on a small dike vegetated with reed canarygrass; 1 in meter-tall reed canarygrass on saturated soil; 1 composed of 80% reed canarygrass, 10% rush, and 10% sedge; and another in meter-tall spirea and constructed of spirea (Anderson 1998). Nests assessed in 1997 were all composed of and within reed canarygrass, except for 2 in Douglas' spirea (Engler and Anderson 1997). Nests assessed in 1997 were composed primarily of reed canarygrass, except 2 nests constructed of spirea (Engler and Anderson 1997).

In Oregon, crane nesting was studied at Malheur National Wildlife Refuge in most years from 1966-1998. In an early study of 111 nests (1966-1967), broad-fruited burreed surrounded 61 nests (54%), hardstem bulrush 28 (25%), common cattail (*Typha latifolia*) 11 (9.7%), and meadows 11 (9.7%)--90.3% of nests were in coarse emergents with few in open meadows. More recently (1969-1989), an additional 1,018 nests were assessed for vegetative type. Similar to the 1966-1967 study, burreed and hardstem bulrush were used most extensively, with 76.8% (n = 782 nests). There was less use of cattail, rushes, grasses, sedges, and forbs. Alkali (*S. maritimus*) and river (*S. microcarpus*) bulrushes, common reed (*Phragmites australis*), common spikerush (*E. palustris*) and flooded barley stubble each had 1 to 3. Nests among shrubs were a rarity (n = 4). There were 26 nests in grasses, 9 nests in sedges, 2 nests in monotypic forb stands, and 1 nest was on a non-vegetated island. Nest placement at 727 sites was in vegetation with a mean height of 37.3 cm (14.5 in) (range = 0 to 205 cm; 0-80 in). Distance from 515 nest sites to the nearest feeding meadow averaged 40 m (131 ft; range 0 - 345 m or 0-1132 ft) (Littlefield *in press*).

Elsewhere in eastern Oregon, 54 nests on privately-owned wetlands in Harney County were primarily on open, cattle-grazed meadows (40 of 52--77%). Eight (15%) were in burreed, 2 (4%) in hardstem bulrush, 1 (2%) on a non-vegetated island, and 1 (2%) in flooded greasewood (*Sarcobatus vermiculatus*). Vegetation height ranged from 0-50 cm (0-20 in). On privately-owned lands in the Blue Mountains of Grant County, Oregon, 7 (78%) of 9 nests were in meadows, 1 in a beaver pond among a stand of beaked sedge (*Carex rostrata*), and another in a small saltgrass (*Distichlis stricta*) basin.

Water depths at nest sites. Water depth data was not available for Washington nests as nest sites have not been visited while birds were incubating. At 881 nests at Malheur National Wildlife Refuge, water depth averaged 25.8 cm (10 in) (range = 0 - 105 cm; 0-41 in) and 34 were on dry sites (Littlefield, *in press*); at 54 nests on privately-owned wetlands in the Great Basin portion of Harney County, water depth ranged from 0 - 23.6 cm (9.2 in); and on privately-owned lands in the Blue Mountains of Grant County, Oregon depths were 8.5 -15 cm (3.3 - 5.9 in) (Littlefield 1999b). At Sycan Marsh, nests situated in hardstem bulrush were in 40 - 60 cm (15.6 - 23.4 in) (mean = 50.3 cm; 19.6 in) of water, whereas for nests in wet and dry meadow habitats, depths ranged from 0 - 30 cm (0 - 11.7 in). At Klamath Marsh National Wildlife Refuge in 1993, water depths at nest sites averaged 13.1 cm (5.1 in) in meadows, compared to

41 cm (16 in) in bulrush; average depth at all sites was 24.8 cm (9.7 in), and for 13 nests assessed in 1994, depths averaged 18.4 cm (7.2 in) and ranged from 2 - 36.2 cm (0.8 - 14.1 in) (Drew et al. 1994).

Roost sites. Once young fledge, families join with unsuccessful pairs, yearlings, and subadults at communal roosting sites until cranes migrate south. Cranes usually roost by standing in open water where little emergent vegetation is present.

Migration and Wintering Habitat

Foraging habitats. Cranes feed in a variety of habitats; security from disturbance and tradition are key factors in selection of areas during migration and winter. Birds generally concentrate in agricultural regions which have extensive areas of cereal and other small grain crops. However, associated wetlands are still used for some feeding, as well as for nighttime roosting and mid-day loafing (Littlefield and Ivey 2000). Cranes usually leave roosting locations in the early morning and fly primarily to nearby grainfields, where they feed until mid-morning. In mid-day, birds occasionally feed in pastures, alfalfa fields, along canals, ditches, and dikes, or use shorelines and pond, lake, and other wetland shallows where they perhaps obtain essential amino acids and minerals not present in grains (Reinecke and Krapu 1979). In mid-afternoon, most return to grainfields where they feed until early evening before returning to roost sites (Littlefield and Ivey 2000). At Ridgefield National Wildlife Refuge, sandhill cranes use areas with agricultural crops, pasturelands, hayfields, and wetlands (Littlefield 1999a).

Night roosts and loafing areas. At Malheur National Wildlife Refuge, autumn loafing habitat includes shallow ponds, sloughs, lakes, and canals; other than at roosting sites, cranes usually loafed in small water bodies with short vegetation. The nearest shallow water body was frequently used for mid-day loafing, but some cranes regularly flew back to their previous night's roost site. Visibility, which is also an important component for autumn crane habitat, was frequently restricted along canals, but generally a few birds stood on adjoining berms while others loafed below. Dry areas nearby were often used for sitting and napping. Mowed and shallowly flooded meadows were also used extensively when available (Littlefield 1986). On wintering grounds in the Sacramento Valley, loafing sites varied, but 4 types accrued 87.5% of the use: flooded rice stubble 40.5%, rain-pooled rice stubble 20.9%, marsh 14.4%, and burned-flooded rice 11.7% (Littlefield 1993a).

Sandhill cranes migrating and staging within the Lower Columbia River roost on the Ridgefield National Wildlife Refuge and on Sauvies Island, Oregon. Those using the refuge roost primarily on Campbell Lake. Campbell is a large shallow lake that is connected by a slough to the Columbia River. Water levels in the lake rise and fall with the river levels. Depending on the year and season, extensive mudflats and bars are exposed providing considerable roosting habitat. Roosting also occurs in the shallow waters of the lake. During high water events, cranes are known to abandon this roost. Vegetation of the lake is primarily aquatic submergents, but low to tall emergents line the lake edges. Cranes also roost in small numbers on shallow managed units of Bachelor Island and the River 'S' unit when water levels are low and/or management practices have reduced the emergent vegetative cover and provided shallow mudflats. Cranes have also been observed roosting on Post Office Lake and a few small seasonal pools created by Campbell Slough backwaters. These latter sites are open with low vegetation, but not available every year. Post Office Lake is also connected to the Columbia River but is smaller than Campbell Lake. Because this lake lies adjacent to a dead-end countyroad, use is probably limited by traffic. All of these roost sites, other than Campbell Lake, are fairly tenuous as their water and vegetative condition fluctuates annually (J. Engler, pers. comm.).

At the Malheur National Wildlife Refuge staging area, several roost sites were used annually if available; mean water depth at roosts was 11.7 cm (4.6 in) and ranged from 4 to 22.4 cm (1.6 to 8.7 in) (Littlefield 1986). All were in types 3, 4, and 10 wetlands (as described by Shaw and Fredine 1971), averaged 2.2 km (1.3 mi) and ranged from 0.8 - 7.6 km (0.5 - 4.6 mi) from feeding areas. One roost was within 100 m (328 ft) of a well-traveled highway and another about 1/2 mile from a human dwelling, but all other sites were isolated from human activity.

On the wintering grounds, roost sites studied in the Sacramento Valley were in open wetlands or flooded agricultural fields, where cranes tolerated emergent vegetation in peripheral zones, but rarely did they use sites with heavy emergent cover. Water depths ranged from 8.7 - 17.3 cm (3.4 - 6.7 in) (Littlefield 1993b). In the Delta Region, roosts were usually within 2- 4 km (1-2.5 mi) of feeding fields, although cranes will use sites at greater distances; most grain fields on the Delta are within 4 km (2.5 mi) of nocturnal roost sites (Littlefield and Ivey 2000). At one traditional Delta roost, water depths averaged 8.2 cm (3.2 in) and ranged from 5.2 - 11.9 cm (2.0 - 4.6 in).

POPULATION STATUS

Past

North America. Historically, greater sandhill cranes occupied a larger range than they do today. In colonial times, the subspecies commonly occurred east to the Atlantic seaboard, at least in migration, but by the early 1800s their numbers had been greatly reduced. Numbers declined dramatically between 1870 and 1915, as increasing human populations hunted birds, drained wetlands, and built over nesting habitat (Walkinshaw 1949). Cranes last bred in Illinois in 1872 (Bohlen 1989), Indiana in 1897 (Mumford and Keller 1984), Nebraska in 1904 (Cooke 1914), Iowa in 1905 (Anderson 1907), South Dakota in 1910 (Visher 1910), Ohio in 1926 (Peterjohn 1989), and North Dakota in 1941 (Henry 1941).

Similar to eastern North America, western populations decreased in the late 1800s and early 1900s. Cranes were extirpated from Arizona by 1910 (Bailey 1928) and from Washington by 1941. By the early 1940s, cranes were only nesting sparingly in Nevada, Utah, Idaho, Montana, and Wyoming. Walkinshaw (1949) estimated only 1,339 to 1,836 greaters left in the United States in 1944. Little is known about the historic range of lesser and Canadian sandhill cranes.

Washington. As in the rest of the United States, the historic distribution of sandhill crane subspecies in Washington is clouded and somewhat confusing. Most early 20th century ornithologists were reluctant to accept subspecies crane accounts without specimen evidence. Suckley (1860), for example, reported that greaters were very abundant in autumn on the Nisqually Plains near the southern tip of Puget Sound, but this was surely a case of mistaken identity; instead these were likely lessers. This reluctance in accepting records of lessers has resulted in gaps concerning the true historic subspecific status for sandhills throughout the state. However, based on the present distribution of the Pacific Flyway Population of lesser sandhill cranes, the birds observed in the mid-1800s in all likelihood were incorrectly identified by Suckley. Greaters did occur in western Washington, at least as migrants, as 1 was collected by Suckley at Fort Steilacoom (in present day Pierce County) on 1 October 1853 (Baird et al. 1860). This is the only historical greater sandhill crane specimen for the state and is on deposit at the U.S. National Museum in Washington, D.C. (Jewett et al. 1953).

The historical status of breeding greater sandhill cranes in Washington was also poorly documented. Although the evidence of breeding in western Washington is meager, they apparently nested in at least

small numbers. Though there may have been some confusion on subspecific identity, James G. Cooper in the 1850s reported for spring and summer: "In the vicinity of Fort Steilacoom, only stragglers remain to breed," and George Suckley observed that "...a common summer resident arriving at the Straits of Juan de Fuca in large flocks in April and then dispersing in pairs over the interior prairies to build their nest, which are placed amid tall ferns on the highest and most open ground, where they can see the approach of danger. They frequent, at this season, the mountains to a height of 6000 feet above sea level" (Suckley 1860:227-228). The reference to tall ferns may refer to patches of bracken (*Pteridium aquilinum*) that were found on the prairies of south Puget Sound (Perdue 1997). Dawson and Bowles (1909) listed the greater as a "not common summer resident both sides of the Cascades" (p. 620) and suggested that sandhill cranes are found "in mountain meadows of both the Cascade and Olympic Mountains, and upon the lesser prairies which dot the western forest..." (p.621). If in fact sandhill cranes bred in the Olympic Mountains, they were likely associated with birds breeding in southwestern British Columbia (e.g., Burns Bog at Vancouver, B.C.).

In pristine times breeding cranes were perhaps common in the Okanogan Highlands in the north portion of the state. James G. Cooper, who collected in the territory between 1853 and 1855, reported that highland Native Americans in northeastern Washington actually raised young cranes from the nest for food; this would suggest that breeding pairs were rather abundant there in the mid-1850s (Cooper 1860 *in* Jewett et al. 1953). A lone sandhill at Osoyoos meadows, British Columbia, was reportedly the mate of a bird killed in the spring of 1922 near the south shore of Osoyoos Lake in the vicinity of Oroville in Okanogan County (Cannings et al. 1987). This was the last account of a breeding pair of greater sandhill cranes in northern Washington. Cranes found breeding in the northern part of the state were likely affiliated with the pairs which were nesting in northern Idaho (Burleigh 1972) and British Columbia (Cooper 1996).

Breeding cranes apparently occurred at Fort Colville (Stevens County), Calispell Lake (Pend Oreille County), Spokane Bridge (Spokane County), west to Cashmere (Chelan County), and south to Fort Simcoe (Yakima County), Camas Prairie (Klickitat County), Dallesport (Klickitat County) (Jewett et. al 1953), and possibly to the Touchet River near Prescott (Walla Walla County) (Dice 1918) (Figure 2). It is doubtful breeding cranes historically occupied the Columbia Plateau lowlands, as high summer temperatures and early seasonal drying would have perhaps precluded successful reproduction (R. Friesz, pers. comm.). A pair did nest in a slough near Coulee City (Grant County) in 1897 (Jewett et al. 1953); however, Ron Friesz (pers. comm.) suggested the nesting site was perhaps in the Mansfield-St. Andrews area of Douglas County, doubting there would have been any cranes breeding along the Columbia in the late 1800s. Another nest was reported from near Fort Steilacoom (Bent 1926), but evidence is unsatisfactory (Walkinshaw 1949), and perhaps mistakenly refers to the specimen collected there in October 1853. A report of breeding cranes near the Strait of Juan de Fuca (Bent 1926) is perhaps based on a specimen in the British Museum of Natural History collected in June 1858, supposedly on Orcas Island (San Juan County), but listed as "Orcas Id., Vancouver, Id" by Sharpe (1894. *Cat. birds British Museum*, xxiii, p. 255) (Walkinshaw 1949). Thus, it is likely this specimen was actually collected on Vancouver Island, British Columbia, not Orcas Island, Washington. We could find no reliable historical nesting accounts for greaters in the northern Cascade Range, Olympic Mountains, or the Willapa Hills in Washington.

The last historical nesting record was in 1941 near Signal Peak, on Yakama Indian Nation lands (Jewett et al. 1953). On 30 May 1941, John B. Hurley found a nest with 2 eggs on a small brush-covered island at an elevation of 4,500 feet (1,364 m). The nest also contained an addled egg of 1940 vintage (Walkinshaw 1949). This site is apparently the same location where a crane pair re-established in 1991 (Leach 1995). Cranes bred in the Glenwood Valley as well, where the earliest breeding account was of

an egg collected from Camas Prairie (University of Washington collection) on 3 May 1893 (Jewett et al. 1953). Settlers began homesteading the valley in the 1870s, ranching along the lakeshore and clearing the forests for farming. An early settler reported breeding sandhill cranes were there until a drainage ditch was completed around 1910. However, other reports suggest cranes had stopped nesting there before 1900 (USFWS 1983).

Historical migration accounts are limited because of the lack of specimen evidence. Bent (1926) listed earliest spring arrival dates for Puyallup (Pierce County) as 31 March 1915, and North Yakima (Yakima County) as 7 April 1915; other spring records believed to be greaters were from Prescott, 14 April 1908 (Dice 1918), Camas, (Clark County), 26 March 1923, and Dallesport (Klickitat County), 27 April 1924 (Jewett et al. 1953). James Cooper in the 1850s reported for spring : "...arriving at the Straits of Juan de Fuca in large flocks in April and then dispersing in pairs" (Suckley 1860). For autumn, Suckley (1860) commenting on the cranes at Nisqually Plains in 1853 noted: "They commence to arrive from the summer breeding grounds about the last week of September, from which time until about the 10th of November they are plentiful. After this they disappear, probably retiring to warmer latitudes during the cold months." Though many or most of these migrants were perhaps lesser sandhill cranes, some transient greaters were possibly intermixed among the flocks. Little information was found on autumn migration chronology for greaters in south-central Washington, but a late summer wanderer was wading in the Yakima River near Yakima on 15 August 1899 (Dawson 1902), and autumn migrants assumed to be greaters were reported from Cashmere on 23 September 1904 and Richland (Benton County) on 23 September 1918 (Jewett et al. 1953).

Yocom and Hansen (1958) described spring crane migrations in eastern Washington for 1950 and 1951. They indicated 2 areas where cranes stopped in large numbers; one was the Ringwood Lake area in southeastern Lincoln County and the other in Douglas County along the western rim of the Grand Coulee near Steamboat Rock. They also noted that flocks of cranes were observed leaving the state by flying up the Okanogan River and the Columbia River valleys.

Other Central Valley Population range. The earliest greater sandhill crane breeding account for Oregon dates from the mid-1800s when Newberry (1857) reported the species nesting in the alpine meadows of the Cascade Mountains. Though Gabrielson and Jewett (1940) estimated 100 pairs breeding in the Blitzen Valley and in the area east of Steens Mountain, they stated that the subspecies was rapidly disappearing from Oregon. On the California breeding grounds, Coues (1874) reported cranes nesting in northeastern Shasta County near Fort Crook in Fall River Valley. Cranes were also believed nesting in many subalpine meadows in northern California during the mid-1800s (Grinnell et al. 1918). However, by the late 1800s and early 1900s, the nesting population had been severely reduced from widespread human settlement, resultant habitat destruction, and perhaps more importantly, from excessive market hunting in the California Central Valley which began in earnest in 1880 and continued until passage of the federal Migratory Bird Treaty Act in 1916. Market hunting not only impacted the California breeding population, but also played an important role in severely reducing the number of breeding pairs throughout the Pacific Northwest (Littlefield 1993a). As early as the mid-1800s, cranes were reported as always for sale in the markets of San Francisco in autumn and winter (Newberry 1857), sometimes selling for 18 to 20 dollars for replacing the Christmas turkey (Heerman 1853). By the 1920s, breeding greaters had been extirpated from the state. Dawson (1923) reported that if there were any breeding pairs in California, there were probably no more than 6. Walkinshaw (1949) estimated only 3 to 5 pairs nesting in the state in 1944, yet Grinnell and Miller (1944) stated that the subspecies still bred in the northeastern California plateau region west to Siskiyou County, northeastern Shasta County, and south to Honey Lake in Lassen County.

As in other regions, greater sandhill crane numbers dwindled in British Columbia in the late 1800s and early 1900s. Brooks and Swarth (1925) stated that greaters historically had an extensive breeding range, and even into the 1920s still bred near the mouth of the Fraser River, the Okanogan Valley, and more commonly throughout the Cariboo and Chilcotin districts. Pairs reportedly bred regularly near Sumas up to 1902 (Brooks 1917), and a nest was found on Vancouver Island on 15 June 1930 (Laing 1932). By the 1940s, however, breeding pairs were restricted to Lulu Island, the northern part of Vancouver Island, with interior birds restricted to the Cariboo Parklands and in the vicinity of Quesnel (Munro and Cowan 1947); in the Cariboo Parklands pairs were reportedly found only in the remote swamps (Munro 1945). The last known breeding records for the extensive marshes of Okanogan Valley were about the mid-1920s (Cannings et al. 1987), and on Lulu and Vancouver islands, cranes last nested in 1941 and 1946, respectively (Cooper 1996).

Present

North America. After their near extermination in the 19th and early 20th centuries, it has been a slow recovery process for the greater sandhill crane. Even with complete protection after 1916, crane numbers did not begin to rebound until the mid-1940s (Peterjohn 1989). Populations began to increase primarily due to: (1) development of efficient predator control methods for the livestock industry in the west, (2) protection from illegal hunting with enactment of the Migratory Bird Treaty Act in 1916, (3) development of flood-irrigated meadows for cattle forage which increased available habitat. Other than Arizona and South Dakota, breeding crane pairs returned to states where they had been extirpated; for example, North Dakota in 1973 (Fields et al. 1974), Illinois in 1979 (Bohlen 1989), Indiana in 1982 (Mumford and Keller 1984), Iowa in 1992 (Poggensee 1992), Ohio in 1999 (NAB 53:392), and Nebraska in 1999 (NAB 53:392). However, since cranes have traditionally been considered a game species by some, hunting seasons have been proposed and initiated, supposedly to relieve agricultural crop depredation complaints; greaters of the Rocky Mountain Population, for example, have been hunted since 1981, and of 135 recoveries of color-banded birds, 96 (53.6%) were killed by hunters (Drewien et al. *in prep*.). This, coupled with a continually increasing human population, will perhaps continue to threaten crane populations in jeopardy in the future.

The Pacific Coast Population of lesser sandhill cranes is thought to be approximately 25,000 birds; 21,000 to 23,000 for the eastern segment and 3,800 birds for the coastal segment (Littlefield 1999a). Population estimates for Canadians nesting along the British Columbia coast has included 1,500 (Campbell et al. 1990) and 839 (Pogson and Lindstedt 1991).

Washington. After 1941, some 31 years lapsed before greater sandhill cranes were again found in Washington. The subspecies' return apparently began in 1972 when 2 appeared in Glenwood Valley on Conboy Lake National Wildlife Refuge in September, remaining into late November. Though no cranes were noted in 1973, 6 were on the refuge in May 1974. Six were again present in the spring of 1975, 4 of which left in mid-May; the other 2 stayed through the summer, and though nesting was suspected, it was never verified (H. Cole, pers. comm.). Four adults were noted in spring 1976, and 2 again spent the summer; nest building occurred, but no eggs were laid. A pair again occupied the site in 1977 and 1978, with birds observed performing distraction displays before an approaching coyote in 1978; this would suggest a nest or young was present, but neither was found. It was not until 1979 that nesting was confirmed; the pair hatched eggs but fledged no young. Though no additional nests were located from 1980 through 1983, nesting was suspected; during these 4 years from 3 to 5 birds were observed in spring. Though this suggests successful reproduction occurred during the period, it was 1984 when the first fledging was confirmed. Young were again produced in 1985, 1986, and 1988; the breeding population had increased to 2 pairs by 1988 and 3 in 1990, with successful reproduction by at least some

pairs in 1989 and 1990. Not only did the 3 pairs return to Glenwood Valley in 1991, but a fourth pair was discovered at the Polo Field on Yakama Indian Nation lands to the north. The breeding flock in Glenwood Valley remained at 3 pairs through 1994 (Harold Cole *in* Anderson 1995), however, no systematic surveys were conducted until 1995, and based on incidental observations from 1990-1994, it is possible that there were as many as 9 pairs in 1994 (J. Engler, pers. comm.).

Intensive ground and helicopter surveys documented 9 pairs in Glenwood Valley in 1995 with 7 confirmed nests (Engler and Brady 2000). This was a significant increase in known number of territorial pairs, however, Engler and Anderson (1997) stated that "much of this perceived increase is probably due to the detection of formerly unknown pairs." A pair was found at the Camas Patch site in 1995, bringing the total number of pairs for Yakama Indian Nation lands to 2, although nesting was not confirmed until 1996. In 1996, this upward trend continued, as 8 out of 10 pairs were known to nest at Conboy, 2 pairs were known on Yakama Indian Nation lands, and a new pair was found in Panakanic Valley on private lands (nesting was confirmed in 1997). Twelve pairs were nesting on Conboy Lake National Wildlife Refuge in 1997 (Engler and Anderson 1997) with a total Washington population of 34 (including 4 subadults). Near White Swan, along wetlands adjacent to Toppenish Creek, 2 adults and a fledged juvenile were noted on 26 September 1997, but their origin is unknown. Fourteen pairs nested at Conboy Lake National Wildlife Refuge in 1998 with a total state population of 39 (Engler and Anderson 1998).

Table 4. Greater sandhill crane pairs, productivity, and total population estimate in Washington, 1990-2000[1].

Year	No. breeding pairs			Total breeding adults	Subadults (known)	No. young fledged	Recruitment[3] (%)	WA pop. estimate
	Conboy Lake NWR	YIN[2]	Private & WDNR					
1990	3	--	--	6	--	1	14.3	7
1991	3	(1)[3]	--	8	--	1	11.1	9
1992	3	(1)[3]	--	8	--	3	27.3	11
1993	3	(1)[3]	--	8	--	0	0	8
1994	3	1	--	8	--	0	0	8
1995	7 (2)	1(1)	--	22	0	1	4.3	23
1996	8 (2)	2	(1)	26	0	3	10.3	29
1997	12	2	1	30	4	5	14.3	39
1998	14	(2)	(1)	34	5	5	12.8	44
1999	13 (1)	1 (1)	2	36	4	5	12.2	45
2000	13 (3)	1	1 (1)	38	9	6	13.6	53

[1] Data includes confirmed nesting pairs, unconfirmed pairs, and subadults. Data in parenthesis represent territorial pairs without confirmed nesting data; 1990-1994 data is based on incidental observations (*from* Engler and Brady 2000). Systematic surveys of breeding cranes began in 1995.
[2] YIN = Yakama Indian Nation lands.
[3] Recruitment = no. fledged young / no. of breeding adults + fledged young X 100 (excludes subadults).
[4] Leach (1995).

In 1999, 18 nesting pairs (including a new pair along Deer Creek on Department of Natural Resources land and 5 subadults were known Washington residents (Engler and Anderson 1999). In 2000, the state's known greater sandhill crane population was 53 birds, consisting of 19 pairs (15 known nesting), 9 subadults, and 6 fledged young (Engler and Brady 2000). For the period 1990 through 2000, Washington's breeding population fledged 30 chicks, with successful reproduction in all years except 1993 and 1994 (Table 4). The greatest number was 6 in 2000, while 5 chicks fledged during the 3 previous years. Crane production in general has been higher in drier years at Conboy Lake National Wildlife Refuge (Engler and Brady 2000).

Other Central Valley Population range. Beginning in the mid-1940s, Central Valley Population greater sandhill crane pairs began to increase as efficient predator control methods were devised for livestock protection; indirectly this had a positive impact on cranes, as reproductive success increased (Littlefield 1976a). The beginning of crane recovery corresponded closely with the introduction of Compound 1080, a poison used extensively for coyote control throughout much of the western United States between 1944 and 1972 (Littlefield 1995d). Also, several large deep-water marshes, formerly unsuitable for crane nesting, were drained, developed and irrigated for livestock forage. This meadow development provided new habitat for breeding pairs (Littlefield and Thompson 1979). In addition, historical wildlife management programs dealt almost entirely with hunted species; in recent years, management has been broadened to include non-game species, including greater sandhill cranes. These 3 factors plus a protected status have resulted in an increase and subsequent breeding range expansion after nearly 6 decades since the subspecies was almost extirpated.

In Oregon, 947 pairs were counted at 120 sites in 14 counties in 1986 (Littlefield et al. 1994). The state was again surveyed in 1999-2000 and 1,151 pairs were counted; a 22% overall increase (Ivey and Herziger 2000). For California, 276 pairs were recorded in 1988 (Littlefield et al. 1994), and 465 pairs were counted in 2000, a 67% increase (Ivey and Herziger 2001). The largest nesting subpopulation occurred at Malheur National Wildlife Refuge (245 pairs in 1999). These upward trends should continue as long as reproductive success is sufficient, breeding habitat remains secure, and wintering habitat is protected.

There are few data on British Columbia population trends, but presently, it is estimated that more than 2,500 greaters summer in British Columbia, particularly in the Chilcotin and Cariboo districts (Littlefield et al. 1994); however, Cooper (1996) reported that there was no evidence to suggest that provincial numbers were increasing.

HABITAT STATUS

Washington

Breeding habitat. Sandhill crane breeding habitat is somewhat limited in Washington, when compared with the large wetland complexes found in southeastern and south-central Oregon and northeastern California. However, Glenwood Valley has potential for becoming a more important summer crane use-area. On private and federal lands, habitat is available to accommodate an increasing and expanding population (D. Anderson, pers. comm.); however, currently there are limitations on quality of habitat. Wetlands here are comparable to other mountainous locations where cranes abundantly breed; similar areas include Sycan Marsh, Oregon, and Grays Lake National Wildlife Refuge, Idaho, which both support high densities of breeding cranes. There are approximately 6,070 ha (15,000 ac) of crane habitat in the valley; including about 3,035 ha (5,000 acres) of private irrigated pastures near Glenwood which

are potential habitat, but where land use practices may limit future crane numbers. Since Conboy Lake National Wildlife Refuge was established in 1964, 2,353 ha (5,814 ac) have been acquired by the U.S. Fish and Wildlife Service (H. Cole, pers. comm.) and an additional 1,409 ha (3,522 ac) are proposed for acquisition (USFWS 1983). If Conboy Lake National Wildlife Refuge were managed specifically for cranes, it could perhaps accommodate 50 to 75 pairs (C. Littlefield and Steve Thompson, memo to Refuge Manager, Lower Columbia River Complex, Vancouver, WA, dated 26 December 1984). This number is not likely to be realized, however, given the current conditions and water issues in the valley. Breeding pairs have increased from 1 in 1984 to 16 in 2000 and if favorable management practices and environmental conditions continue, crane pairs should continue to increase and eventually disperse onto nearby sites.

Outside the valley, there appears to be no immediate threat to the wetlands where cranes presently breed other than summer livestock grazing on both tribal and privately-owned lands (D. Anderson, H. Cole, and R. Leach, pers. comms.). Potential threats include drainage, trespass grazing, and property sales and subsequent development. The Polo Field site on Yakama Indian Nation lands is located within a grazing unit, but cattle generally do not reach the site until after 15 July ; a 20 m no-entry, no-logging buffer zone surrounds the meadow, but there were about 4 log-truck trips per day on a nearby closed road in 1994 (Leach 1995). However, on a helicopter flight on 9 June 2000, no cranes were seen at the Camas Patch site and the area was dry and being grazed and apparently no longer supporting suitable breeding habitat (Engler and Brady 2000).

Other potential greater sandhill crane breeding habitat that appears to be available includes: 1) Colville Tribal lands (Okanogan County), particularly at Moses Meadows (M. Murphy, pers. comm.); 2) isolated meadows near the Pend Oreille River (Pend Oreille County) (D. Friesz and S. Zender, pers. comms.); 3) 3 large hardstem bulrush marshes on Turnbull National Wildlife Refuge (M. Rule, pers. comm.); and 4) a series of high Cascade meadows 16 - 19 km (10-12 mi) north of Mt. Adams in the Two Lakes area (Yakima County); a single crane was observed at the latter site several years ago, but there was no evidence of nesting (H. Cole, pers. comm.).

On Colville Tribal lands in Okanogan County, no summer cranes have been found (M. Murphy, pers. comm.), but there are isolated remote wetlands with limited human access where cranes might nest (M. Monda, pers. comm.). Other than possible disturbance from livestock grazing and logging, meadow habitat within the 566,800 ha (1,417,000 ac) reservation seems to be well protected. There are also apparently favorable and secure meadows in the Pend Oreille Valley, particularly at Cusick Flat (Pend Oreille County); however, there have been no recent summer crane records for Pend Oreille, Ferry, or Stevens counties (S. Zender, pers. comm.). Additionally, pairs could possibly establish at potential habitat at Turnbull National Wildlife Refuge. The refuge contains a number of semi-permanent and permanent wetlands in depressions, some which are suitable for crane territories, but most are surrounded by steep banks and basalt cliffs (Monda and Ratti 1988) and not suitable for crane territories. Northeast of Turnbull National Wildlife Refuge, most of the suitable wetlands around Spokane have been lost because of residential housing, powerline corridors, gravel mines, and increased forested areas (McAllister 1995).

The high mountain wetlands of the Cascade Range would perhaps provide substantial habitat for breeding sandhill cranes, and isolated sedge meadows occur in the Okanogan Highlands as well (J. Ball, pers. comm.); however, snow frequently lingers well into June. Thus, in most years there might be insufficient time for cranes to successfully reproduce. However, with continual global warming (Neilson and Drapek 1998), these wetlands may eventually become available and important. Crane pairs have

been expanding and successfully reproducing in mountainous situations at more southerly latitudes in Oregon and northeastern California.

Several sites were previously used by breeding cranes but are no longer are suitable habitat. The area around Calispell may have been inundated behind Calispell Dam; Matt Monda (pers. comm.) reported that waterfowl studies have been in progress for a number of years, but there have been no reports of cranes in this area. At Oroville where summer cranes were last reported in 1922, the area presently consists of orchards and grain farms with some wetlands; however, during 40 years of waterfowl surveys, summering cranes have not been observed in this region (M. Monda, pers. comm). Further south in the Columbia River Plateau region, if habitat ever existed, it would have perhaps been lost when the upper Grand Coulee was flooded by the filling of an equalizing reservoir between Coulee Dam and Coulee City in the spring of 1951 (Yocom and Hansen 1960).

Staging and winter habitat. Threats presently exist for sandhill cranes staging in Washington near Ridgefield National Wildlife Refuge. Proposed actions by the Port of Vancouver could result in the destruction of a major crane use-area remaining in the Columbia River bottomlands. The Port has prepared a master plan calling for development of some of the 422 ha south of Ridgefield. This area, between Vancouver Lake and the Columbia River would be developed for both light and heavy industry by using dredge material from a planned U. S. Army Corps of Engineers project (Littlefield 1999a). More habitat losses in this region are anticipated; even on Sauvie Island, former row-crop agricultural land has been converted to tree nurseries (Mark Stern, pers. comm.). This staging area is the only sandhill crane use-area in the United States adjacent to a major metropolitan complex, and habitat will continue to be threatened. Few if any alternate migrational stopover sites are available between northern California and southeastern Alaska, and use-areas need to be protected if this crane flock is to continue to survive.

Other Central Valley Population Range

Breeding habitat. Crane breeding habitat in Oregon and California is under threat from development and incompatible management practices. Habitat is threatened by late irrigation, the presence of cattle on meadows until late spring, draining of wetlands, pivot irrigation replacing flood-irrigated meadows, houses and alfalfa fields encroaching on historic territories, and loss of irrigation rights (Littlefield and Thompson 1979, Littlefield 1989, Ivey and Herziger, 2000, 2001).

Staging and winter habitat. On the wintering grounds in the Central Valley, agricultural lands traditionally used are being lost to urban expansion, as well as conversion to incompatible crops such as vineyards and orchards (Littlefield and Ivey 2000).

CONSERVATION STATUS

The sandhill crane was first granted federal legal protection under the Migratory Bird Act of 1916. There are Presently, the species, its nests, and its eggs are protected from unlawful direct persecution in Canada and the United States under the Migratory Birds Convention Act of 1994. This act prohibits the killing, capturing, injuring, taking, or disturbing of migratory birds, or damaging, destroying, removing, or disturbing of nests. It also prescribes protected areas for migratory birds and nests, and for the control and management of those areas. The Central Valley Population is not subject to legal harvest during hunting seasons, but several other sandhill crane populations are subject to harvest (Tacha et al. 1992).

Washington

The Washington Department of Game (the predecessor to WDFW) listed the sandhill crane as Endangered under Washington Administration Code 232-12-014 in 1981 (Appendix A). Bettinger and Milner (2000) reported that sandhill cranes were in jeopardy in Washington because of their limited distribution, low numbers, poor breeding success and chick survival (in general throughout their range), and loss of shallow marshes and wet meadows for feeding and nesting. The Revised Code of Washington (RCW) prohibits the sale, possession, exchange, buying, transport or shipping of articles made from an endangered species. Though all Washington sandhill subspecies are included under this classification, major emphasis is placed on greater sandhill cranes.

Sandhill cranes are also listed on the WDFW's Priority Habitats and Species List, a list of habitats and species considered priorities for conservation and management. Crane habitats are also listed: breeding areas, regular large concentrations, and migration staging areas. WDFW also has the species on its list of Species of Concern since it is listed as a State Endangered species.

Under the Washington Forest Practices Act, sandhill cranes and their habitat are also protected. In particular, timber harvest, road construction, aerial application of pesticides, and site preparation are restricted within 1/4 mile (0.4 km) of a known active nesting area.

On tribal lands, the Yakama Indian Nation has listed the greater sandhill crane as a Sensitive species in the Yakama Indian Reservation Forest Management Plan (Bureau of Indian Affairs 1993), and it is considered a species of cultural importance (R. Leach, pers. comm). In habitat management guidelines written by the wildlife program of the tribe (Leach et al. 1992), recommendations are to survey for cranes when activities are planned near large wet meadows, and if they are found breeding, a 1/2 mile (0.8 km) no-entry buffer around the meadows should be designated during the breeding season (March-October), and road construction should be avoided within 1/2 mile (0.8 km) of the meadow.

Other Central Valley Population Range

Oregon. The Oregon Fish and Wildlife Commission adopted rule OAR 635-100-0400 requiring the Oregon Department of Fish and Wildlife (ODFW) to develop and maintain a state list of Sensitive Species for vertebrates in the state. ODFW originally included the greater sandhill crane on its first Sensitive Species list (Vulnerable category) in 1989, and the species remains on the latest (1997) list. The Vulnerable listing is defined as "Species for which listing as threatened or endangered is not believed to be imminent and can be avoided through continued or expanded use of adequate protective measures and monitoring" (ODFW 1997).

California. The greater sandhill crane was added to the California list of rare animals on 4 February 1983. The California Endangered Species Act of 1984 reorganized and renamed classifications, resulting in the subspecies being classified as State Threatened. The Act prohibits the taking, possessing, purchasing, selling, importing, or exporting of any animal listed as endangered or threatened. The greater sandhill crane remains Threatened in California, however, efforts are presently underway to develop a recovery plan and recovery strategies to ensure the future viability of the species in the state.

Nevada. The greater sandhill crane has no special status in Nevada, but remains protected from hunting and illegal take, and is considered under purview of Nevada Department of Wildlife's (NDOW) Nongame Wildlife Program (NDOW undated).

British Columbia. Sandhill cranes were first protected in British Columbia under the Migratory Bird Act of 1916, but the act included a clause closing the hunting of swans, cranes, and curlews for only 10 years. However, of all states and provinces of North America, British Columbia alone refused to accept this clause, and so it was amended to give the province an open season on these birds (Leach 1987). Sandhill cranes are now protected by the Migratory Birds Convention Act of 1994 and by the British Columbia Wildlife Act of 1982 (Cooper 1996), which designates wildlife management and critical wildlife areas, and allows the government to sue anyone who damages wildlife habitat at these sites. Sandhill cranes are also on the Blue List as "Vulnerable" (populations may not be in decline, but habitat or other requirements are such that they are vulnerable to further disturbance). However, this status offers no legal protection while population research is being conducted. They were listed because of uncertainties regarding the status of each subspecies, the potential impact of logging on the core population of greaters in the Chilcotin-Cariboo region, the unknown number of breeding pairs, and the general lack of habitat protection across their provincial range (Cooper 1996).

FACTORS AFFECTING CONTINUED EXISTENCE

Breeding Areas

Predation. A major mortality factor which confronts cranes on the breeding grounds is predation on eggs and chicks. An abundance of predators can reduce crane reproductive success; for example, at Malheur National Wildlife Refuge in both 1973 and 1974, only 2 young fledged from 235 pairs (Littlefield 1976a). Though other predators prey on crane eggs and chicks, common ravens, minks, racoons, and especially coyotes are the most destructive, and under certain conditions can be highly detrimental to greater sandhill crane productivity. Coyotes are thought to be the primary predator of crane chicks at Conboy Lake National Wildlife Refuge (Engler and Brady 2000). High predation rates are particularly evident at large breeding locales such as Malheur National Wildlife Refuge and Sycan Marsh, Oregon; reasons for this are unclear but may reflect relatively recent changes in the balance of predator and prey populations in the region. The 1080 ban may have contributed to an increase in coyotes and ravens, the principal nest predators, and these higher numbers have been responsible for low annual recruitment in some areas. Why this effect would be more pronounced on the large wetland complexes is uncertain, but these sites generally support relatively high densities of nesting waterfowl, thus perhaps predator populations occur in greater densities than on smaller wetlands. Additionally, many of the smaller areas are privately-owned and local efforts to control coyotes may effectively reduce predation (Littlefield et al. 1994).

Grazing and haying. In spring, sandhill cranes generally prefer to forage in open, flooded meadows, but frequently these open sites are the result of mowing and livestock grazing practices which can be detrimental to nesting and fledging. Late irrigation and the presence of cattle on meadows until late spring can eliminate crane pairs. Though grazed meadows are generally good foraging sites for cranes, late June and July meadow mowing can kill crane chicks (Littlefield and Ivey 1994), and 10 April-15 July cattle grazing can prevent nesting attempts, or in some cases cause nest abandonment (Littlefield 1989). In mowed meadows, young are highly vulnerable to mowing mortality because of their behavior of hiding in dense vegetation and remaining motionless, waiting for the threat to pass. In addition, meadows are often dried in June for hay harvest, and early drying can result in the unavailability of invertebrate foods, sometimes causing chick starvation. Winter livestock grazing of wetlands generally removes residual cover, leaving crane nests exposed to predators in April and May. At Malheur National Wildlife Refuge, nest success in the absence of predator control was significantly lower in wetlands winter grazed by cattle than in wetlands not grazed (Littlefield and Paullin 1990). Spring grazing can

also be detrimental to nest success. In northeastern California in 1988, 1 pair was known to have immediately abandoned its nest when cattle entered the nesting marsh in May, and summer livestock grazing suppressed crane reproductive efforts in some areas where pairs never attempted to nest (Littlefield 1989). If eggs successfully hatch in grazed areas, there is a potential that chicks will be trampled by cattle. Chicks have been trampled in California (R. Johnstone, pers. comm.) and Idaho (R. Drewien, pers. comm.).

Management of private lands for cranes could be improved by providing irrigation water by early March, excluding livestock from crane habitat during the spring breeding season, maintaining wetland areas through mid-July (which are often drained earlier for haying), delaying hay harvest until after 1 August, and limiting human disturbance to nesting cranes.

Water availability. Because cranes are dependent on wetlands, they are vulnerable to changes in hydrology. Water rights are an issue in some areas, and loss of irrigation rights could eliminate existing habitat for cranes (Ivey and Herziger 2000). Irrigation timing is also important, as cranes should have water applied to their territories by mid-March to prepare for April nesting; water should be maintained through the brooding period (early August). Early drying of wetlands and irrigated fields can lead to increased chick mortality. Historical sandhill crane pairs were absent from some sites surveyed in Oregon and California where irrigation was delayed (Ivey and Herziger 2000, 2001).

Habitat loss. The majority of crane pair territories in Washington is currently on protected lands, primarily those managed by the USFWS, but also by the Yakama Indian Nation and the WDNR. However, in the other Pacific states, cranes nest mostly on unprotected, privately-owned wetlands. During surveys in 1999 and 2000, 63% of 1,616 pairs found in California and Oregon were on private lands (Ivey and Herziger 2000, 2001). Such a large percentage of pairs using private land is reason for concern because decisions of private landowners will greatly effect the future of habitat for sandhill cranes. Harmful management practices such as late irrigation and the presence of cattle on meadows until late spring could eliminate crane pairs. Loss of habitat through drainage of wetlands, replacement of flood-irrigated meadows with sprinkler or pivot irrigation, building construction, and conversion to row crops has also displaced breeding pairs (Littlefield and Thompson 1979, Littlefield 1989, Ivey and Herziger 2000, 2001).

Of major concern, particularly in the western United States, is the introduction of center-pivot irrigation systems onto lands occupied by breeding pairs (Littlefield and Thompson 1979); conversion from wet meadows to alfalfa and other crops has occurred in several crane areas in northeastern California and southern Oregon since the early 1970s, resulting in the loss of several thousand hectares of crane breeding habitat. Where meadows used by cranes were once secure, center-pivot irrigation systems have eliminated this security, and low elevation privately-owned wetlands in the western states are threatened by drainage and subsequent conversion to agricultural crops.

At Conboy Lake National Wildlife Refuge, development of wetland impoundments could displace cranes and reduce the amount of available crane habitat; however, if carefully planned, impoundments may enhance habitat conditions for breeding cranes. Therefore, a habitat development plan for Conboy Lake National Wildlife Refuge should carefully consider the locations of any new impoundments in the context of enhancing crane breeding habitat.

Wintering Areas

Habitat loss. Threats exist for habitat loss near the Ridgefield National Wildlife Refuge/Sauvie Island sandhill cranes staging and wintering area in Clark and Cowlitz counties, Washington, and adjacent Multnomah and Columbia counties, Oregon. A proposed plan would deepen the Columbia River navigation channel and deposit dredge material onto a site currently used by migrating cranes (Littlefield 1999a), and light industrial development is proposed for the Port of Vancouver's property in the Vancouver Bottoms (E. Anderson, pers. comm). In addition, on nearby Sauvie Island, former row-crop agricultural lands have been converted to tree nurseries and cottonwood plantations, and this is happening on the Washington side in the Woodland Bottoms area as well. Few alternate stopover sites are available for cranes migrating through the west side of the state.

Because wintering sandhill cranes feed primarily on waste grain, land use changes are a factor which may impact cranes. In the northern Central Valley (where color-banded Conboy Lake National Wildlife Refuge cranes have been noted), new orchard developments are encroaching onto fields that were once in grain production. In Butte County, orchard hectares have increased, while crops like corn, wheat and barley have declined (Littlefield 1993a). In the San Joaquin-Sacramento Delta region, another important crane wintering location, an increase in vineyards is resulting in a similar pattern; vineyard acres have increased, while barley, sorghum, and irrigated pasture have declined, although corn hectares have changed little (Littlefield and Ivey 2000). Unless this trend is stopped, winter feeding habitats may become a limiting factor.

Changes in farming practices. Farming practices after harvest frequently determine the amount of waste seed available for wintering sandhill cranes. For example, in the northern Central Valley in the early 1990s, 71.4% of crane feeding use was in harvested rice fields, of which 59.3% was in unaltered rice stubble, 16.2% in flooded stubble, and 14.4% in burned stubble (Littlefield 1993a). Autumn-tilled rice stubble had infrequent use (3.3%), as did burned-flooded (5.6%) and tilled-flooded (0.3%). Thus, practices on harvested grainfields can have a serious impact of food availability. Should autumn stubble flooding, burning or tilling increase, crane foraging sites will decrease, and food could become limited.

Waterfowl enhancement. Programs intended to improve habitat for waterfowl ca have negative effects on sandhill crane foraging habitat. Flooded grainfields are generally avoided by cranes, except for infrequent use for roosting and loafing. Dissimilar to ducks and geese, feeding cranes visually surface-glean seeds, and are highly inefficient in finding small unexposed seeds; generally it is only a short time before cranes abandon a grainfield after flooding. As most grain types have declined in the northern Central Valley, rice production has been maintained, though not at the levels planted in the early 1980s. However, there is a newly initiated program which will perhaps have an impact on crane food sources. This program involves paying rice and other grain producers $32/ha ($13/ac) to flood stubble shortly after harvest in early November, and maintain a required water level through the end of February; stubble in harvested fields can be burned before flooding, but not tilled. This "Agricultural Waterfowl Incentive Program" is designed to enhance waterfowl habitat by providing seeds, tubers, graze and invertebrates. In 1998, 49 landowners participated to create 15,769 ha (38,949 ac) of waterfowl habitat, a 75% increase from the proceeding year. Enrolled landowners were predominantly rice producers in the northern Central Valley, with only 1 elsewhere (Garrison 1999). Much of this flooding is in addition to the 24,300 ha (60,021 ac) that were already being flooded before the program was initiated, thus thousands of hectares have been lost to cranes as foraging sites, and thousands of additional hectares are expected to be lost in the future. Should this program continue to gain momentum, it will have a definite negative impact on the remaining winter food resources available to cranes wintering in the Central Valley (Littlefield 1999a).

CONCLUSION

Breeding greater sandhill cranes were extirpated from Washington by 1941. It was not until the 1970s before pairs returned. Nineteen pairs are known to now occupy breeding territories in the state, all in 2 south-central counties--Klickitat and Yakima. The state's summer greater sandhill crane population totaled 53 in 2000 (Engler and Brady 2000). This flock has been increasing relatively rapidly, but remains mostly confined to Conboy Lake National Wildlife Refuge and adjoining wetlands. The extent of crane breeding habitat in Washington has not been assessed in detail, but it does appear adequate to accommodate a substantial increase in nesting pairs, particularly in Glenwood Valley. However, Engler and Brady (2000) stated that "the long-term survival and expansion of the Washington population of sandhill cranes depends on off-refuge nesting and foraging sites as suitable areas within the refuge are limited for continued growth of the population." Therefore, growth of the number of crane pairs in the Glenwood Valley appears contingent on management practices of private lands there. Beyond this valley, habitat deficiencies may limit further population increase. For the immediate future, the welfare of breeding greater sandhill cranes in Washington may hinge on management decisions, additional land acquisitions, and continued high reproductive success at Conboy Lake National Wildlife Refuge.

Habitat is diminishing on crane wintering areas in Washington as foraging areas are being lost to development and converted to incompatible crops (e.g., tree nurseries). Recovery of cranes should include conservation of adequate habitat to maintain a healthy wintering population as well.

PART TWO: RECOVERY

RECOVERY GOAL

The primary purpose of the *Washington State Recovery Plan for the Sandhill Crane* is to identify target population objectives and strategies needed to increase the breeding population of greater sandhill cranes within the state to the point that it can be delisted, and to ensure that essential habitat for migrating and wintering sandhill cranes is conserved for the future (Fig. 3). The recovery objectives should be re-evaluated and revised if necessary in the future to ensure they adequate and realistic. Habitat enhancement and conservation, and implementation of management practices to maintain high reproductive success and low post-fledging mortality will provide for a larger breeding population in the state. Strategies are included also for sandhill cranes which migrate through and winter in the state (3 subspecies), bound to or from breeding grounds in British Columbia, northern Canada and Alaska and southern wintering grounds.

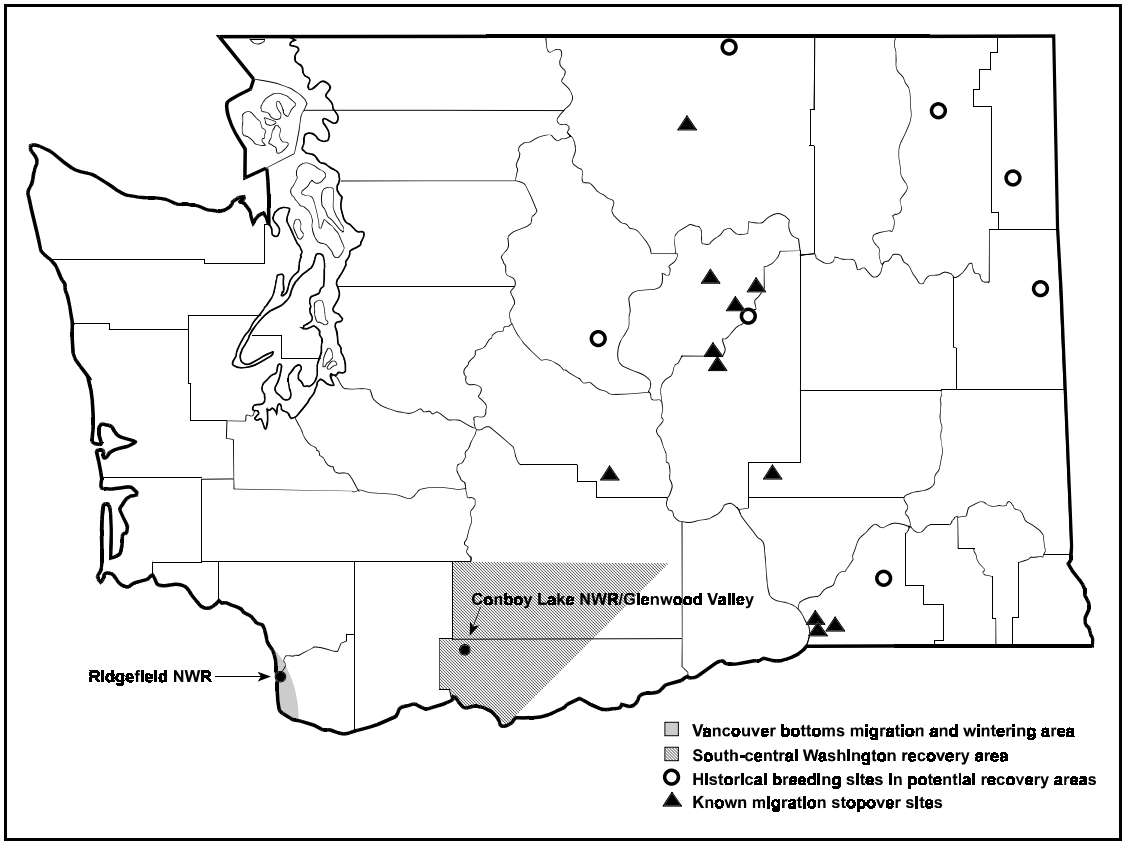

Figure 3. Important areas for sandhill crane recovery, migration, and wintering in Washington.

RECOVERY OBJECTIVES

Under Washington law WAC 232-12-297, Section 4.1, it is stated that "The commission shall delist a wildlife species from endangered, threatened, or sensitive solely on the basis of the biological status of the species being considered, based on the preponderance of scientific data available." Section 4.2 states that: "A species may be delisted from endangered, threatened, or sensitive only when populations are no

longer in danger of failing, declining, are no longer vulnerable, pursuant to section 3.3, or meet recovery plan goals, and when it no longer meets the definitions in sections 2.4, 2.5, or 2.6."

The sandhill crane will be considered for downlisting from State Endangered to State Threatened status when the following objectives are achieved:

1. The state's overall summer population of greater sandhill cranes reaches at least 150 birds (150 summering birds would likely represent 70-80% breeding adults and 20-30% subadults).

2. A total of 8,800 ac of habitat (5,814 ac are currently conserved in Conboy Lake National Wildlife Refuge) is conserved in Glenwood Valley, and 1,000 acres among other sites which support crane breeding habitat.

3. Water management control is established to allow proper management for breeding sandhill cranes at Conboy Lake National Wildlife Refuge.

The sandhill crane will be considered for downlisting from State Threatened to State Sensitive when:

1. The state's summer population of greater sandhill cranes reaches or exceeds 350 (likely including 70-80% breeding adults and 20-30% subadults).

2. A total of 11,000 ac of habitat (5,814 ac are currently conserved in Conboy Lake National Wildlife Refuge) is conserved in Glenwood Valley and at least 3,000 ac is conserved among other sites which support crane breeding habitat.

3. Most of the habitat used by cranes at the major winter and migration stopover sites in southwest and eastern Washington is managed for crane use during the migration and wintering periods.

Rationale

The carrying capacity for breeding greater sandhill cranes within the state is presently unknown, but there appears to be sufficient breeding habitat in the state to support 175 pairs (if properly managed) and perhaps more. However, considering the longevity and philopatric nature of cranes, a summering population of 150 (about 65 territorial pairs and 20 subadults) would probably sustain the state's breeding population and be adequate to downlist it to Threatened. Presently, sufficient habitat appears available for increase and expansion, but breeding pairs are currently restricted to south-central Washington. It may take decades before breeding pairs inhabit other geographical regions unless birds from the Glenwood Valley, eastern Oregon, or British Columbia expand into other parts of eastern Washington, but a broader distribution is important to reduce risk of catastrophic losses to the population. The Conboy Lake National Wildlife Refuge could potentially support about 40 breeding pairs. It is assumed that a population of 150 cranes would have a significant component outside the Glenwood Valley, and a population of 350 would have expanded beyond the current sites in south-central Washington.

Habitats would be considered conserved if they are managed for sandhill cranes; this includes lands on national wildlife refuges, state wildlife areas and other lands with provisions for crane management and conservation (e.g. through a mitigation plan or conservation agreement). Based on an average territory

size of 62.5 ac at Malheur National Wildlife Refuge, 4,063 ac would be needed to support 65 crane pairs in south-cental Washington. Up to 10,125 ac are potentially available in the Glenwood Valley alone (H. Cole, pers. comm.). Achievement of this goal would depend on having favorable habitat and management practices in place on the Refuge and private lands in the valley.

A total of 1,000 ac of managed crane breeding habitat could support 16 pairs at other Washington sites; this is a small number of pairs, but it would provide a nucleus for colonizing a new area.

Habitat also needs to be secured for migrant and wintering cranes in southwest Washington where some important habitat is under threat of loss. Most of these cranes may constitute a distinct population segment of lesser sandhill cranes that migrate west of the Cascades. Important sites on private land in eastern Washington that are consistently used by cranes should be secured with conservation agreements or easements to ensure they are not lost to development or converted to incompatible uses.

For down-listing from Threatened to Sensitive, a summering population of 350 cranes (150 territorial pairs plus 50 non-breeding subadults) would be needed. Broad distribution is important to reduce risk of catastrophic losses to the population. The additional 2,200 ac of habitat in Glenwood Valley could support an additional 35 pairs and 3,000 ac conserved among other sites where cranes are present could support an additional 48 pairs. The total of 14,000 ac of breeding habitat protected in the state would theoretically be adequate to support > 200 pairs. Regions where cranes may re-colonize sites and where crane habitat may need to be assessed include the Okanogan Highlands, southeastern Washington and the northern Cascades.

RECOVERY STRATEGIES AND TASKS

1. Monitor the Washington sandhill crane population.

1.1. Determine breeding population trends through annual surveys.

The two most important parameters for monitoring population trends are numbers of pairs and productivity (recruitment). Surveys of territorial pairs, flocks, and fledged young should be conducted annually at all known breeding locations in the state; pairs are best counted from late March to early May, and fledged young from August through early September.

Population recruitment is defined here as the percentage of fledged juveniles in the population, calculated by dividing the number of fledged juveniles by the total number of cranes in the population (i.e. breeding adults plus fledged juveniles). It is often difficult to determine the number of nonbreeding cranes in local populations (since they resemble adults). [It should be noted that a 10 to 12% rate is generally considered necessary for stability if recruitment is calculated using only breeding adults; if all cranes in adult plumage are used, the stability rate would be 8 to 10%].

Several techniques have been developed for counting sandhill cranes in the Pacific states (*see* Littlefield 1995e). Generally, breeding pairs are individually counted between late March and early May by scanning breeding habitat with a spotting scope. If visibility is restricted by vegetation or other obstructions, ground searching may be necessary. Greater sandhill crane pairs are usually highly philopatric, returning annually to the same breeding territory (Littlefield and Ivey 1995); a known territory should be repeatedly searched until the pair is either located or it is determined that it has been lost, while being careful to

minimize disturbance. For less accessible sites, aerial surveys should be conducted to search for missing or new pairs. A helicopter survey would provide the best data for this purpose, however, helicopter flight time is expensive (currently about $700/hr) and the survey would take about 10 hours (including ferry time) if all territories were surveyed ($7,000). Alternatively, a small fixed-wing aircraft with the capability of slow flight (e.g., Piper Super Cub) could be used; these can be chartered for about $100/hr. For reconnaissance of potential habitat to search for new pairs, use of a fixed-wing aircraft is recommended. A subsequent helicopter flight in late July would improve data on fledging success and would be about half the cost of the pair survey flight.

Cranes in flocks can also be individually counted in the late afternoon as birds are returning to roosting sites, or in the early morning as birds are leaving sites. Roosts can usually be located in the late afternoon by watching cranes as they return from feeding fields to night-time use areas. Once located, counting birds near roosting locations should be done from a distance of >0.4 km (0.25 mi), with the observer being on station 30 minutes before sunrise or 1 hour before sunset; on cloudy afternoons it is best to arrive about 30 minutes earlier. With good visibility, all birds can be individually counted. In some situations crane totals can be obtained without counting near roost sites; if all cranes are feeding together in a particular area such as a grainfield, birds can be individually counted using a spotting scope. These techniques have been useful elsewhere within the Pacific states.

1.2 Survey areas of potential greater sandhill crane breeding habitat.
Conduct surveys of potential breeding habitat to locate new crane pairs annually between April through early June. Areas surveyed should include: private lands adjacent to Conboy Lake National Wildlife Refuge, Trout Lake Natural Area Preserve, Yakima Indian Nation lands, the Cascade Mountains (primarily Gifford Pinchot National Forest), Umatilla National Forest, Turnbull National Wildlife Refuge region, Pend Oreille River Basin, and Colville Tribal lands.

1.3 Monitor numbers of migrant and wintering sandhill cranes.
Conduct weekly counts of crane numbers by subspecies at crane staging sites in the state during spring and autumn migration. Count wintering crane numbers on a bi-weekly basis (for techniques, see Section 1.1).

2. Monitor sandhill crane habitat.

2.1. Assess potential greater sandhill crane breeding habitat.
An assessment of potential sandhill crane breeding habitat should be conducted to determine habitat conditions, identify deficiencies, and develop guidelines for management to enhance suitability for breeding cranes. Wetlands in the southern Cascades region should be assessed first, followed by the Umatilla National Forest, the Spokane region, the northern Cascades, the Pend Oreille River Basin, and Colville Tribal Lands. This assessment could be accomplished over a 2-year period.

2.2. Assess sandhill crane migrational staging habitat in eastern Washington.
For sandhill crane staging areas, condition of habitats should be assessed. Principal feeding areas, roost sites, hazards, and flight distance between roosting and feeding locations should be monitored and documented annually.

3. Protect sandhill crane habitat.

Factors which limit or have the potential to limit the distribution, abundance, and reproductive success of greater sandhill cranes have been investigated elsewhere within the Central Valley Population's range. Similar factors would no doubt impact cranes in Washington, and these are individually addressed. Because of their Endangered status, Washington's sandhill cranes should be protected by securing habitat and applying appropriate management practices to enhance their welfare.

3.1 Protect sandhill crane use-areas through management agreements, conservation easements, and acquisition.

Protect important crane breeding areas, feeding areas, roosting sites, and loafing areas from habitat losses through such means as easements, conservation agreements, joint venture plans, management plans, or acquisition when and where appropriate. For breeding cranes, present priorities should be the privately-owned lands in Glenwood Valley, particularly those adjacent to Conboy Lake National Wildlife Refuge. For wintering and staging cranes, priorities should include unprotected habitat in the Vancouver Bottoms and Woodland Bottoms areas. Seek appropriate mitigation for developments in this region (e.g. proposed industrial developments on Port lands) and seek agreements or easements with landowners to employ crane compatible management practices on crane nesting territories (e.g., delayed hay harvest and livestock grazing). The threat of loss or conversion to key stopover sites in eastern Washington should be assesses, and protection sought for any important sites at risk.

3.2 Discourage water projects which would impact crane breeding habitat.

Work with Drainage Improvement District #1 in the Glenwood Valley to ensure that drainage does not adversely impact breeding cranes on Conboy Lake National Wildlife Refuge. Dissuade the construction of dams or diversions that would impact sandhill crane habitat, either from flooding, dewatering, channeling, or delaying flows to crane use-areas. Upstream dams can have a detrimental impact on breeding cranes, as water is either diverted, delayed, stored, or even more severe, result in downstream drainage and agricultural development. Though no serious problems of this kind have been documented in the United States, examples of resultant consequences have been reported elsewhere, particularly in Africa (e.g., Ajayiolofin 1996, Boyi and Polet 1996).

Two pairs at Conboy Lake National Wildlife Refuge apparently abandoned their territories in 1998 when wetlands and wet meadows were lost to dredging of nearby creeks, and in 2000, 1 pair apparently abandoned when water levels were too high due to a wetland rehabilitation project on an adjacent site (Engler and Brady 2000). Higher water levels likely limit food resources and concentrate predators, but managing higher levels may result in increased crane habitat in the future as wet meadows expand. Engler and Brady (2000) recommend that wetland rehabilitation projects be focused on sites with minimal or poor habitat for cranes, and that areas with productive crane territories be avoided until a plan is developed to minimize negative impacts and maximize benefits to cranes.

3.3 Restore and protect wetlands.

Restore degraded wetland ecosystems by plugging drains, removing dams, or restoring hydrology. Avoid projects that would convert natural wetlands, which are important for cranes, to artificial wetlands such as impoundments, which are not. An in-depth hydrological

study of Conboy Lake National Wildlife Refuge is needed for planning to maximize benefits to cranes and insure that unintended consequences do not occur (Engler and Brady 2000).

3.4 Insist on enforcement of existing wetland protection laws.
Insure enforcement of the 1973 amendments to the Federal Water Pollution Control Act of 1972 (PL 92-500) to avert destruction of crane breeding habitat. Requirements of Section 404 (b) should not be violated. This regulation requires a permit to dredge or fill wetlands. Review Drainage Improvement District #1's Hydraulics Permit and work cooperatively with landowners in the Glenwood Valley to ensure that adequate crane breeding habitat is maintained. Proposed wetland projects should go through NEPA/SEPA legal review and crane needs should be considered during these reviews.

3.5 Protect against road construction projects.
Bettinger and Milner (2000) recommend in the Washington Priority Habitats and Species Program that "construction of roads or buildings should be greater than 500 m (0.3 mi) from roosts and new construction, road building or traffic increases within 800 m (0.5 mi) of feeding areas should be avoided." Discourage road construction projects within 0.8 km (0.5 mi) of occupied crane breeding habitat. The Washington Forest Practices Act currently requires review of activities 0.4 km (0.25 mi) of a known active nesting area. Close non-essential existing roads during the crane breeding season (1 April-10 August).

3.6 Consider sandhill cranes in wetland planning projects.
Consider sandhill crane habitat requirements and include these in wetland habitat restoration and enhancement programs that occur within current and potential crane habitat.

4. Reduce sandhill crane mortality.

4.1 Reduce crane chick mortality from hay harvesting activities.
It is recommended that hay mowing be delayed until after 10 August to prevent the potential for crane chick mortality from harvesting equipment, however, dates should be established using local data when available (Pacific Flyway Council 1997). Currently, the earliest recommended hay date at Conboy Lake National Wildlife Refuge is 1 August, with an extension provision if unfledged chicks are present (Engler and Brady 2000). Harvested hay should be thoroughly removed because decomposing hay masses from the proceeding year's growth can create conditions favorable for aspergillosis, which has been known to kill young cranes.

4.2 Reduce crane mortality from collisions with utility transmission lines.
Where existing utility wires pose an aerial hazard to cranes, line-markers or other devices should be installed on wires to ensure high visibility. It is essential the highest wire also be marked. Where possible, move or bury transmission lines transecting crane habitats. Provide early input into planning and location of utility (powerline) corridors to avoid current and potential crane use-areas.

4.3 Reduce crane mortality from collisions from wire fences.
Where possible, remove internal fences from sandhill crane use-areas. Sandhill cranes are highly prone to collisions with these hazards.

4.4 Protect from harmful livestock grazing.

If grazing is used on these areas, the grazing season should be during the autumn (after 10 August) and winter periods (ending by March), and use should be moderate. Land managers should consider the effects of livestock grazing on crane productivity when developing grazing plans and avoid using grazing during the breeding season.

At Conboy Lake National Wildlife Refuge there is a problem with trespass cattle as authorized grazing was eliminated from the refuge in 1976; there are recommendations to immediately remove trespass cattle and repair fences (Engler and Brady 2000). There is the possibility that a grazing program to manage vegetation may be initiated at Conboy Lake National Wildlife Refuge which would be addressed during the development of a Comprehensive Conservation Plan for the refuge (J. Engler, pers. comm.).

Engler and Brady (2000) stated that trespass cattle were a problem on off-refuge sites. On the Yakima Indian Nation lands there is a potential conflict with cattle grazing for Camas Patch nesting pair. If grazing is continued at this site, there should be an evaluation for fencing the nesting habitat. At the WDNR Deer Creek site, cattle have been found using the nesting area during the breeding season and an evaluation needs to be completed to determine where cattle trespass is taking place and fence repairs needed; refencing may be necessary to protect the wetland from trespass grazing.

On state lands, WAC 232-12-174 states that it is unlawful for any person to allow domesticated animals to be unattended on, or to permit livestock to graze upon land under the control of the department without a written permit from the director. State law WAC 232-12-181 provides for the director to authorize grazing leases when the director determines that the lease will benefit wildlife management programs and will be in the public interest.

4.5 Protect crane nests and chicks from predators.

Predation of eggs and chicks has been documented as one of the most serious limiting factors for cranes in the Pacific states. Predation pressure on the nests and young of pairs which breed in Washington has not been assessed, but coyotes are suspected of taking both eggs and young in Glenwood Valley (H. Cole, pers. comm). If it is determined that predators are limiting or preventing crane subpopulation growth at specific sites in the state, predator control should be considered.

4.6 Protection of crane nest and young from dogs.

Domestic dogs are a potential threat to young sandhill cranes, and unattended dogs have been implicated in nest and chick losses at Modoc National Wildlife Refuge, and suspected losses have occurred at other California locations. In addition, one near-fledged crane chick was apparently killed by a rancher's dog at Malheur National Wildlife Refuge in 1983. Educational efforts should be developed to discourage dog use in areas where greater sandhill cranes nest.

At Conboy Lake National Wildlife Refuge, dogs are required to be on a leash unless used for waterfowl hunting, which is allowed only after cranes have migrated. The trail near headquarters is the only site open to the public. Trespass dogs are occasionally a problem and permittees and in-holders have dogs with them at most times, but in general, there are no documented dog-crane conflicts (J. Engler, pers. comm). On state lands, law WAC 232-12-174 prohibits domestic animals to be unattended.

5. Reduce disturbance factors which may impact breeding sandhill cranes.
Bettinger and Milner (2000) recommend limiting all disturbances during the breeding season (1 April - 10 August).

5.1 Restrict commercial activity in forests near sandhill crane breeding areas.
Landowners should reduce or curtail logging, as well as firewood and mushroom gathering, between 1 April and 10 August within 0.4 km (0.25 mi) of occupied crane breeding habitat. The Washington Forest Practices Act currently requires review of activities 0.4 km (0.25 mi) of a known active nesting area.

5.2 Restrict or eliminate human disturbance near sandhill crane use-areas.
Minimize or eliminate recreational road, horse, ATV, and foot travel within 0.4 km (0.25 mi) of crane nesting, loafing, and roosting sites. Breeding areas should be protected from disturbance from recreational activities (e.g. camping, angling, hiking) between 1 April and 10 August.

5.3 Restrict low-level aircraft disturbance to cranes.
Avoid aircraft activity below 300 m (1,000 ft) over areas used by cranes. Under the Washington Forest Practices Act, aerial spraying may be prohibited within 0.4 km (0.25 mi) of a known active nesting area.

5.4 Restrict construction disturbance to nesting cranes.
Minimize construction, housing, or other developments (including gravel pits), as well as blasting or other disturbances within 1.2 km (.75 mi) of nest sites. Prepare site management mitigation plans, in cooperation with WDFW, where developments impact breeding cranes. Washington's Forest Practices Act requires review of site preparation activities within 0.4 km (0.25 mi) of a known active nesting area.

6. Manage breeding territories.

Depending on reproductive success, a crane pair may annually occupy a breeding territory for 5-6 months. All feeding, nesting, and brood-rearing activities are generally confined to the area within the territory, therefore, it is important that resources be available within this relatively small area to meet the requirements for successful reproduction. Engler and Brady (2000) stated that "a loss of a single crane pair or its territory could have long-term negative consequences to the population." Data supports this conclusion, as since 1995 at Conboy Lake National Wildlife Refuge, 4 pairs have produced 73% of the fledged birds, with 1 pair producing 30% of the total. The loss of one of these pairs due to poor habitat management could indeed effect the productivity of the state's cranes. Individual site plans may be developed to help maintain and enhance habitat conditions for existing pairs in the state.

6.1 Implement favorable water management practices.
Female cranes require essential nutrients, particularly protein and calcium, for egg development; these are obtained primarily from invertebrate and green plant food sources. For soil invertebrates and new plant growth to become available early, a breeding territory should begin receiving water on or before 15 March. Water levels should be maintained to prevent flooding or stranding of nests; these factors will reduce nesting success. At Conboy Lake National Wildlife Refuge, the earliest known nest in 2000 was on 11 April. With an early irrigation regime most young would be capable of flight around 15 July.

Stable water conditions should be maintained through the 30-day incubation period (to provide for increased clutch security from predators), and irrigation should continue through the 70-day fledging period, as young are primarily fed invertebrates, particularly earthworms. Preferred feeding locations are usually in areas with moist or subirrigated soils; sites totally inundated are generally shunned by feeding family units, but are used as roosting sites. Lowering water levels during the brooding period should be accomplished at a slow rate; frequently coyotes will move into a wetland that has been dewatered, and may pose a threat to crane chicks. If draining is essential, channels, canals, ditches, and depressions should remain flooded; this will perhaps help reduce predation on unfledged chicks. Although territories could be dewatered to allow haying, at least some water and moist soil conditions should be maintained in territories through 1 August, unless it has been absolutely determined that the brood has died, moved, or fledged. Rapid and early meadow drying when unfledged young are dependent on invertebrate food sources can result in chick mortality from starvation. Of note, even as chicks are fledging or have recently fledged, they remain vulnerable to predation by coyotes and domesticated dogs. Not until crane family units become aerially mobile should a breeding territory be entirely dried.

At Conboy Lake National Wildlife Refuge, improvements are needed in the water management system to maintain wetland habitats for cranes. A hydrological study is needed to design a simple efficient water system which meets the requirements of cranes and other refuge wildlife.

6.3 Implement favorable wetland vegetation management.

Vegetation management for summer greater sandhill crane use-areas is dependent on the plant species present at a site. Wetlands which are composed of fine grasses and sedges should be left untreated throughout the year. Annual livestock grazing and other treatments are not recommended for these types, but periodic manipulations may be necessary to invigorate these wetlands.

Areas of dense, coarse vegetation should be annually treated by haying, grazing, or burning to prevent matting which reduces productivity and limits feeding options for cranes. Wetlands dominated by such species as beaked sedge and canarygrass are included within the latter category, and methods should be investigated on how to control or eliminate these species, especially reed canarygrass. At Conboy Lake National Wildlife Refuge, haying helps to provide important short-grass habitat, particularly in reed canarygrass where cranes sometimes nest, although appropriate timing is crucial (Engler and Brady 2000). If haying is used as a treatment, vegetation should be mowed after 1 August, with harvested hay removed and fed to livestock elsewhere.

Considering cranes prefer to feed in short vegetation, mowing with hay removal is preferred for crane territory management; however, some vegetation patches should be left for nest placement. Thus, a mosaic of mowed and idle land is ideal for a crane breeding territory, but this land-use regime is frequently complicated because of certain predators, particularly coyotes. At locations with high coyote densities, a 50:50 mowed-idle ratio is recommended, whereas in low coyote density areas a 75:25 ratio would perhaps be sufficient (C. Littlefield, pers. observ.). Educational materials regarding habitat management should be developed and provided to landowners, and cooperative efforts to achieve vegetation management goals on public and private lands should be developed.

Controlled burning has been used in some Pacific Northwest wetlands for managing vegetation. Burning should be used at Conboy Lake National Wildlife Refuge to eliminate encroaching lodgepole pine and other woody vegetation into wet meadows, thus increasing the amount of crane habitat. Prescribed fire can also be used to remove excess residual vegetation and open up dense emergent vegetation. A Prescribed Fire Plan being prepared for Conboy Lake National Wildlife Refuge should include these considerations in order to enhance crane habitat.

Early spring burns have been conducted on crane breeding territories at Malheur National Wildlife Refuge where residual vegetation had accumulated to undesirable levels. Not only can these fires recycle nutrients, they result in soil invertebrate crane food sources becoming available much earlier in spring, which can result in earlier nesting. Though crane pairs generally build their nests in highly exposed situations after a burn, if burns are sufficiently large, success rates can be surprisingly high; mammalian predators, at least, have the tendency to vacate an area soon after an extensive burn. For example, at Malheur, 2,430 ha (6,075 ac) were control burned in March 1985. Eleven crane pairs built nests on the site in April, and though highly exposed, nesting success was 81.8%, significantly higher than the success rate of 38.5% for 39 nests assessed outside the burn (Littlefield et al. *in press.*). However, several previous Malheur burns were relatively small (<250 ha), and these resulted in most crane pairs moving to nearby unburned sites; of 4 nests assessed at these sites, 3 were predated and 1 flooded. Thus, if a large tract of residual wetland vegetation needs to be removed, when and where feasible fire can be used to accomplish the objective, and subsequently benefit cranes.

7. Manage staging and wintering areas

7.1 Implement favorable management of roosting sites.

If it becomes necessary to specifically develop a crane roost site in the state, roosts should be within 3.2 km (2 mi) of grainfields (Bettinger and Milner 2000). Flowing water should be maintained to reduce or prevent the potential for disease outbreaks. Sites need to be designed so they have gently sloping banks which will allow cranes to walk into the water from adjacent uplands. Encroaching coarse emergents such as cattails and tall bulrushes should be controlled if they begin expanding into open water crane use-areas. Where large congregations of cranes occur roosts should be at least 8 ha (20 ac) in size. No site should be developed within 0.8 km (0.5 mi) of a utility transmission line. Ideal water depths for roosting would be between 8 to 20 cm (3 to 8 in), and human disturbance should be minimized and carefully regulated (Littlefield and Ivey 2000). Bettinger and Milner (2000) recommend that hunting should be avoided near established roosts or restricted to 4 hours after sunrise until 2 hours before sunset. However, cranes often return to roost sites during mid-day to loaf and feed, and any hunting may cause birds to abandon roosts; therefore, hunting should be prohibited near roost sites.

7.2 Management of feeding sites.

Adequate feeding areas should be provided in southwestern, south-central and eastern Washington. Cereal grain production in eastern Washington is presently sufficient for any migrant sandhill crane flocks which might use the area. However, autumn food may be a limiting factor for cranes from south-central Washington westward; perhaps additional lands around Conboy Lake National Wildlife Refuge could be acquired and converted to grain crops to provide premigration food for the breeding subpopulation. Unharvested standing

corn has been successful for attracting cranes in both New Mexico and California, and a similar strategy could be developed in the Vancouver Bottoms region. In the Glenwood Valley, corn is not a possible crop because of the short growing season, but winter wheat, oats or barley would be good alternates. Both harvested and unharvested crops would provide favorable autumn feeding sites, and perhaps private landowners could be encouraged to provide grainfield foraging sites. Grainfields should not be autumn plowed or flooded, and low-flying aircraft and hunting should be prohibited. Human disturbance in crane feeding areas should be restricted and a ½ mile buffer should be used to prevent disturbance from recreational activities.

8. Enforce restrictions designed to protect sandhill cranes.

A major threat to breeding greater sandhill cranes is drainage and subsequent loss of wetland nesting habitat. Therefore, existing state and federal regulations to conserve wetlands should be used to protect wetlands important to cranes.

8.1 Enforce existing regulations to protect sandhill cranes.

Federal, state, and local authorities should make an enforcement effort to protect sandhill cranes in the state. Though illegal shooting has declined since the 1970s, there is always the potential that they could be shot by vandals. A more vigorous enforcement effort may be necessary where cranes occur in unprotected areas or in locales where illegal shooting is still considered a problem. Enforcement should also be an ongoing effort at crane breeding territories to prevent disturbance from human factors and dogs. Enforcement should be provided between 1 April-10 August, and beyond if crane family units are still present.

9. Maintain information management and retrieval systems.

Ready access to information collected during surveys and studies will be critical for making management decisions. A centralized information system (Wildlife Resource Data System) exists at the Washington Department of Fish and Wildlife, and a cooperate effort between governmental agencies, conservation groups, and private citizens to submit sandhill crane data to this system is essential. Summaries of data should be periodically prepared and distributed to agencies, groups, and interested persons.

9.1 Maintain a repository for crane data.

Survey and study data should be submitted to the Wildlife Resource Data System soon after gathering. Data entry, manual storage, and incorporation into a GIS system should be completed as appropriate. Efforts to differentiate between subspecies needs to be made, and data should be categorized by subspecies.

Regular information and data exchange between state and federal (including tribal) agencies, conservation groups, and private individuals involved in crane management and surveys will assist in assessment of local, regional, and statewide trends. Trend data should be subspecifically differentiated when possible.

9.2 Produce an annual sandhill crane status update.

A report describing the status of sandhill cranes in Washington, as well as management activities and their effects, should be prepared and distributed annually.

10. Develop public information and education programs.

Cranes often serve as "keystone" species, serving to spark public interest in conservation. Conservation of cranes involves conserving both grasslands and wetlands, and a large number and variety of other organisms which frequent these ecosystems are also indirectly protected (Neumann 1987, Ellis et al. 1996). By encouraging interest in cranes, support would be generated for protection of a wide variety of native wildlife and their habitats.

10.1 Develop information on crane management opportunities for private and public landowners.

Develop "best management practices" information for landowners and employ outreach efforts to implement "crane-friendly" management on private lands. Guidelines for enhancing habitat and managing cranes should be distributed to landowners who own suitable habitats for breeding and wintering cranes. For breeding cranes, landowners in the Glenwood Valley and other currently occupied crane breeding sites should be a priority for receiving crane management materials. For wintering cranes, landowners in the Vancouver Bottoms area should receive crane management information.

10.2 Promote crane viewing and festivals in Washington.

Sandhill cranes are large, usually vociferous, behaviorally unique, and generally attract attention. Crane festivals in Nebraska, Texas, New Mexico, California, and southeastern Washington attract thousands of crane-watchers annually. There has been considerable interest in sandhill cranes among birders, photographers, and other non-consumptive users of wildlife resources in the Pacific Northwest. For example, over 800 people attended the recently established "Annual Sandhill Crane Festival" held in spring 2000 in Othello, and at Malheur National Wildlife Refuge about 70% of the estimated 65,000 public visitors annually specifically ask about cranes (Pacific Flyway Council 1997). The Othello festival is presently attracting nationwide attention and a lengthy account entitled *Sandhill cranes arrive as sign of spring* appeared in the 20 March 1999 edition of the Lubbock Avalanche-Journal in Texas. Such media attention promotes eco-tourism, plus increases public awareness not only locally, but also regionally and nationally. An autumn festival event at the Ridgefield National Wildlife Refuge area could provide similar benefits. Such an event might encourage public awareness for birds using the coastal migration corridor, thus contributing and encouraging management efforts and protection for the flock. This is of particular importance, as some habitat is presently under threat of loss in this area.

10.3 Develop educational materials.

A brochure and poster should be designed to communicate information to the public about sandhill cranes in Washington. Special educational materials should also be designed and distributed to schools.

10.4 Promote volunteer efforts to monitor cranes in eastern Washington.

Conservation organizations and other interested individuals might assist in monitoring cranes in eastern Washington as they do in the western portion of the state. These same individuals might also be recruited to investigate subspecific composition at spring and autumn stopover points (with training). Such data will be important in further assessing the status of migrant sandhill cranes at major staging sites.

11. Conduct research that will facilitate and enhance recovery efforts.

11.1 Study breeding ecology.

Detailed studies on breeding greater sandhill cranes in Washington should be considered if problems become apparent from productivity surveys. Investigations should involve collecting data on basic life history as well as breeding habitat requirements. Currently, productivity of Washington sandhill cranes appears quite high; however, difficulties may develop in the future. Research should focus on mortality factors affecting nesting and fledging success. Nesting data could be collected and assessed regarding chronology, clutch size, clutch success, egg infertility, causative factor if clutch is lost, nest site vegetation, and water depth. Brood survival and causes for mortality could be best assessed by a radio telemetry study.

11.2 Study distribution, abundance, subspecific composition, and derivation of migrant sandhill cranes in Washington.

A study to assess migrant distribution, abundance, subspecies composition, migration pathways, and summering areas would improve knowledge about cranes in Washington. Migrant flocks at staging areas in both eastern and western Washington should be counted and assessed for subspecific composition, habitat use, and migration chronology. Most of the larger cranes staging at Sauvie Island are believed to be the Canadian subspecies (Littlefield and Thompson 1979, Campbell et al. 1990), whereas most at Ridgefield National Wildlife Refuge are believed to be lessers, but detailed field investigations are needed to verify subspecies composition in these areas. Identification of the breeding ground origin of migrants would best be investigated using satellite telemetry technology. Measurements and DNA samples could be taken from captured birds to assess subspecific composition. Birds could also be color-marked to assess migration pathways and site philopatry. This study could also address questions about how many greater sandhill cranes use various Washington migration corridors, and the magnitude of crane migration and staging in the state from a subspecies perspective.

12. Coordinate and encourage cooperation with agencies, landowners, nongovernmental organizations, and funding sources.

Working with others will enhance the potential for the success of Washington Department of Fish and Wildlife's recovery efforts.

12.1 Exchange information between appropriate agencies.

Information exchanges between state, federal, non-profit, and private entities involving sandhill crane management will assist in assessment of local, regional, and state progress and trends.

12.2 Continue interagency working relationships in Glenwood Valley.

Coordinated and cooperative working relationships and agreements between WDFW and the USFWS should continue in the Glenwood Valley.

12.3 Develop relationships and provide management recommendations to landowners.

Develop relationships with private landowners to increase habitat quality on private lands. Where greater sandhill cranes breed, management strategies such as mowing dates, prolonged irrigation, and a rotation grazing system, which would delay livestock entry until

after the breeding season, should be recommended and discussed with individual land owners.

12.4 Pursue funding and multi-agency collaboration for monitoring off-refuge sites. Efforts to obtain funding should be intensified.

Strive to secure funding from grants, conservation organizations, private individuals, or federal agencies to assist in sandhill cranes recovery programs in the state. In order to achieve the objectives of this plan, additional funding and support will be needed. For example, data on nesting and fledging success for pairs at Deer Creek, Panakanic Valley, and Yakama Indian Nation lands are not current and need to be assessed.

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PERSONAL COMMUNICATIONS

David Anderson
Washington Department of Fish and Wildlife
Vancouver, WA

Eric Anderson
U.S. Fish and Wildlife Service
Ridgefield NWR Complex
Ridgefield, WA

Joseph Ball
University of Montana
Missoula, MT

John Beckstrand
U.S. Fish and Wildlife Service
Klamath Basin NWR Complex
Tulelake, CA

Harold Cole
U.S. Fish and Wildlife Service
Conboy Lake NWR
Glenwood, WA

Rod Drewien
Wayan, ID

Joseph Engler
U.S. Fish and Wildlife Service
Ridgefield NWR Complex
Ridgefield, WA

Wade Epperson
California Department of Fish and Game
Ash Creek WA
Bieber, CA

Daniel Friesz
U.S. Fish and Wildlife Service
Ridgefield NWR Complex
Ridgefield, WA

Ronald Friesz
Washington Department of Fish and Wildlife
Ephrata, WA

Jerry Hickman
Washington Department of Fish and Wildlife
Spokane, WA

Randy Hill
U.S. Fish and Wildlife Service
Columbia NWR
Othello, WA

Richard Johnstone
Shasta Community College
Redding, CA

Rose Leach
Montana DNRC, Southwestern Land Office
Missoula, MT

Susan Lindstedt
La Grande, OR

Chris Loggers
U.S. Forest Service
Kettle Falls Ranger District
Colville, WA

Tom Melanson
U.S. Fish and Wildlife Service
Ridgefield NWR Complex
Ridgefield, WA

Matthew Monda
Washington Department of Fish and Wildlife
Ephrata, WA

Maureen Murphy
Colville Tribal Lands
Fish and Wildlife Department
Nespelem, WA

Thomas Pogson
Fairbanks, Alaska

Michael Rule
U.S. Fish and Wildlife Service
Turnbull NWR
Cheney, WA

Ron Schlorff
California Department of Fish and Game
Sacramento, CA

Mark Stern
Oregon Natural Heritage Program
Portland, OR

Steven Zender
Washington Department of Fish and Wildlife
Chewelah, WA

IMPLEMENTATION SCHEDULE

The outline of strategies and tasks on the following pages indentifies co-managers, WDFW involvement, task proirities, and estimates of annual expenditures. The following conventions are used:

Priority 1 Actions necessary to prevent the extirpation of the species from Washington and to monitor the population.

Priority 2 Actions to prevent a significant decline in species population or habitat quality, or some other significant negative impact short of extirpation.

Priority 3 All other actions necessary to meet recovery objectives.

Acronyms:

BLM	USDI, Bureau of Land Management
COE	U.S. Army Corps of Engineers
IWJV	Intermountain West Joint Venture
NPS	USDI, National Park Service
NRCS	USDA, Natural Resource Conservation Service
PCJV	Pacific Coast Joint Venture
USFS	USDA, Forest Service
USFWS	USDI, Fish and Wildlife Service
WCCWG	West Coast Crane Working Group
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
YIN	Yakama Indian Nation
tbd	To be determined. Costs are unknown and may be difficult to determine at this time.

Implementation Schedule for Washington State Recovery Plan for the Sandhill Crane and preliminary cost estimates[a].

Priority	Task	Description	Responsible agency/entity	Total Annual Cost	WDFW share
1	1.1	Determine breeding population trends through annual surveys.	WDFW, USFWS,YIN	$15,000	$8,000
1	1.2	Survey areas of potential sandhill crane breeding habitat.	WDFW, USFWS, USFS, YIN, BLM	$4,500	$2,000
1	1.3	Monitor numbers of migrant and wintering sandhill cranes.	WDFW, USFWS	$5,000	$3,000
1	2.1	Assess potential greater sandhill crane breeding habitat.	WDFW	$8,000	$8,000
1	2.2	Assess sandhill crane migrational habitat in eastern Washington.	WDFW, USFWS	$4,000	$3,000
1	3.1	Protect sandhill crane use-areas through management agreements, conservation easements, and acquisitions.	WDFW, USFWS, IWJV, PCJV	tbd	
2	3.2	Discourage water projects which would impact habitat.	WDFW, USFWS	$500	tbd
2	3.3	Restore and protect wetlands.	WDFW, USFWS, YIN, IWJV	tbd	
2	3.4	Insist on enforcement of existing wetland protection laws.	WDFW, USFWS, COE	tbd	
2	3.5	Protect against road construction projects.	WDFW	tbd	
2	3.6	Consider sandhill cranes in wetland planning projects.	WDFW, USFWS	tbd	
2	4.1	Reduce crane chick mortality from hay harvesting activities.	WDFW, USFWS	tbd	
2	4.2	Reduce mortality from utility transmission lines.	WDFW, USFWS	$2,000	tbd
2	4.3	Reduce crane mortality from wire fences.	WDFW, USFWS	$2,000	
2	4.4	Protect from harmful livestock grazing.	WDFW, WDNR, YIN	tbd	
2	4.5	Protect nests and chicks from predators.	WDFW, USFW	tbd	
2	4.6	Protect nests and young from dogs.	WDFW, USFWS	tbd	
2	5.1	Restrict commercial activity in forests near breeding areas.	WDFW, USFS, WDNR	tbd	
2	5.2	Restrict or eliminate human disturbance near crane use-areas.	WDFW, WDNR, YIN	tbd	
2	5.4	Restrict low-level aircraft disturbance to cranes.	USFWS, WDNR	tbd	

2	5.5	Restrict construction disturbance to nesting cranes.	WDFW	tbd	
2	6.1	Implement favorable water management practices	WDFW, USFWS, YIN	tbd	
2	6.3	Implement favorable wetland vegetation management.	WDFW, USFWS	tbd	
2	7.1	Implement favorable management of feeding sites.	WDFW, USFWS	tbd	
2	7.2	Implement favorable management of roosting sites.	WDFW, USFWS	tbd	
2	8.1	Enforce existing regulations to protect sandhill cranes.	WDFW, USFWS, COE	tbd	
3	9.1	Maintain a repository for crane data, particularly for greater sandhill cranes.	WDFW	$200	$200
3	9.2	Produce a periodic sandhill crane status update.	WDFW, USFWS	$2,000	$1,000
3	10.1	Develop information on crane management opportunities for private and public landowners (one time cost).	WDFW, USFWS, NRCS	$7,000	$5,000
3	10.2	Promote crane viewing and festivals in Washington.	WDFW, USFWS, WCCWG	$1,000	$1,000
3	10.3	Develop educational materials.	WDFW, USFWS,WCCWG	$1,500	$1,500
3	10.4	Promote volunteer efforts to monitor cranes in eastern Washington.	WDFW, USFWS,WCCWG	$2,000	$2,000
3	11.1	Study breeding ecology.	WDFW, USFWS	$10,000	$5,000
3	11.2	Study distribution, abundance, subspecific composition and derivation of migrant sandhill cranes in Washington.	WDFW, USFWS, WCCWG	$18,000	$10,000
3	12.1	Exchange information between appropriate agencies.	WDFW, USFWS, YIN	$100	
2	12.2	Interagency working relationships should continue in Glenwood Valley.	WDFW, USFWS	$200	
2	12.3	Develop relationships and provide management recommendations to landowners.	WDFW, USFWS, WCCWG	$1000	
3	12.4	Pursue funding and multi-agency collaboration for monitoring off-refuge sites. Efforts to obtain funding should be intensified.	WDFW, USFWS, WCCWG	tbd	

[a] Cost figures are preliminary estimates of annual cost and WDFW share for the first 5-year period assuming funds are available. Some tasks require continued funding, while others are one-time expenses or would be incurred for only a few years. Not all activities would be conducted simultaneously.

Appendix A. Washington Administration Code 232-12-297. Section 11 addresses Recovery Plans.

WAC 232-12-297 Endangered, threatened, and sensitive wildlife species classification.

PURPOSE

1.1 The purpose of this rule is to identify and classify native wildlife species that have need of protection and/or management to ensure their survival as free-ranging populations in Washington and to define the process by which listing, management, recovery, and delisting of a species can be achieved. These rules are established to ensure that consistent procedures and criteria are followed when classifying wildlife as endangered, or the protected wildlife subcategories threatened or sensitive.

DEFINITIONS

For purposes of this rule, the following definitions apply:

2.1 "Classify" and all derivatives means to list or delist wildlife species to or from endangered, or to or from the protected wildlife subcategories threatened or sensitive.

2.2 "List" and all derivatives means to change the classification status of a wildlife species to endangered, threatened, or sensitive.

2.3 "Delist" and its derivatives means to change the classification of endangered, threatened, or sensitive species to a classification other than endangered, threatened, or sensitive.

2.4 "Endangered" means any wildlife species native to the state of Washington that is seriously threatened with extinction throughout all or a significant portion of its range within the state.

2.5 "Threatened" means any wildlife species native to the state of Washington that is likely to become an endangered species within the foreseeable future throughout a significant portion of its range within the state without cooperative management or removal of threats.

2.6 "Sensitive" means any wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened in a significant portion of its range within the state without cooperative management or removal of threats.

2.7 "Species" means any group of animals classified as a species or subspecies as commonly accepted by the scientific community.

2.8 "Native" means any wildlife species naturally occurring in Washington for purposes of breeding, resting, or foraging, excluding introduced species not found historically in this state.

2.9 "Significant portion of its range" means that portion of a species' range likely to be essential to the long term survival of the population in Washington.

LISTING CRITERIA

3.1 The commission shall list a wildlife species as endangered, threatened, or sensitive solely on the basis of the biological status of the species being considered, based on the preponderance of scientific data available, except as noted in section 3.4.

3.2 If a species is listed as endangered or threatened under the federal Endangered Species Act, the agency will recommend to the commission that it be listed as endangered or threatened as specified in section 9.1. If listed, the agency will proceed with development of a recovery plan pursuant to section 11.1.

3.3 Species may be listed as endangered, threatened, or sensitive only when populations are in danger of failing, declining, or are vulnerable, due to factors including but not restricted to limited numbers, disease, predation, exploitation, or habitat loss or change, pursuant to section 7.1.

3.4 Where a species of the class Insecta, based on substantial evidence, is determined to present an unreasonable risk to public health, the commission may make the determination that the species need not be listed as endangered, threatened, or sensitive.

DELISTING CRITERIA

4.1 The commission shall delist a wildlife species from endangered, threatened, or sensitive solely on the basis of the biological status of the species being considered, based on the preponderance of scientific data available.

4.2 A species may be delisted from endangered, threatened, or sensitive only when populations are no longer in danger of failing, declining, are no longer vulnerable, pursuant to section 3.3, or meet recovery plan goals, and when it no longer meets the definitions in sections 2.4, 2.5, or 2.6.

INITIATION OF LISTING PROCESS

5.1 Any one of the following events may initiate the listing process.

5.1.1 The agency determines that a species population may be in danger of failing, declining, or vulnerable, pursuant to section 3.3.

5.1.2 A petition is received at the agency from an interested person. The petition should be addressed to the director. It should set forth specific evidence and scientific data which shows that the species may be failing, declining, or vulnerable, pursuant to section 3.3. Within 60 days, the agency shall either deny the petition, stating the reasons, or initiate the classification process.

5.1.3 An emergency, as defined by the Administrative Procedure Act, chapter 34.05 RCW. The listing of any species previously classified under emergency rule shall be governed by the provisions of this section.

5.1.4 The commission requests the agency review a species of concern.

5.2 Upon initiation of the listing process the agency shall publish a public notice in the Washington Register, and notify those parties who have expressed their interest to the department, announcing the initiation of the classification process and calling for scientific information relevant to the species status report under consideration pursuant to section 7.1.

INITIATION OF DELISTING PROCESS

6.1 Any one of the following events may initiate the delisting process:

6.1.1 The agency determines that a species population may no longer be in danger of failing, declining, or vulnerable, pursuant to section 3.3.

6.1.2 The agency receives a petition from an interested person. The petition should be addressed to the director. It should set forth specific evidence and scientific data which shows that the species may no longer be failing, declining, or vulnerable, pursuant to section 3.3. Within 60 days, the agency shall either deny the petition, stating the reasons, or initiate the delisting process.

6.1.3 The commission requests the agency review a species of concern.

6.2 Upon initiation of the delisting process the agency shall publish a public notice in the Washington Register, and notify those parties who have expressed their interest to the department, announcing the initiation of the delisting process and calling for scientific information relevant to the species status report under consideration pursuant to section 7.1.

SPECIES STATUS REVIEW AND AGENCY RECOMMENDATIONS

7.1 Except in an emergency under 5.1.3 above, prior to making a classification recommendation to the commission, the agency shall prepare a preliminary species status report. The report will include a review of information relevant to the species' status in Washington and address factors affecting its status, including those given under section 3.3. The status report shall be reviewed by the public and scientific community. The status report will include, but not be limited to an analysis of:

7.1.1 Historic, current, and future species population trends

7.1.2 Natural history, including ecological relationships (e.g. food habits, home range, habitat selection patterns).

7.1.3 Historic and current habitat trends.

7.1.4 Population demographics (e.g. survival and mortality rates, reproductive success) and their relationship to long term sustainability.

7.1.5 Historic and current species management activities.

7.2 Except in an emergency under 5.1.3 above, the agency shall prepare recommendations for species classification, based upon scientific data contained in the status report. Documents shall be prepared to determine the environmental consequences of adopting the recommendations pursuant to requirements of the State Environmental Policy Act (SEPA).

7.3 For the purpose of delisting, the status report will include a review of recovery plan goals.

PUBLIC REVIEW

8.1 Except in an emergency under 5.1.3 above, prior to making a recommendation to the commission, the agency shall provide an opportunity for interested parties to submit new scientific data relevant to the status report, classification recommendation, and any

SEPA findings.

8.1.1 The agency shall allow at least 90 days for public comment.

8.1.2 The agency will hold at least one Eastern Washington and one Western Washington public meeting during the public review period.

FINAL RECOMMENDATIONS AND COMMISSION ACTION

9.1 After the close of the public comment period, the agency shall complete a final status report and classification recommendation. SEPA documents will be prepared, as necessary, for the final agency recommendation for classification. The classification recommendation will be presented to the commission for action. The final species status report, agency classification recommendation, and SEPA documents will be made available to the public at least 30 days prior to the commission meeting.

9.2 Notice of the proposed commission action will be published at least 30 days prior to the commission meeting.

PERIODIC SPECIES STATUS REVIEW

10.1 The agency shall conduct a review of each endangered, threatened, or sensitive wildlife species at least every five years after the date of its listing. This review shall include an update of the species status report to determine whether the status of the species warrants its current listing status or deserves reclassification.

10.1.1 The agency shall notify any parties who have expressed their interest to the department of the periodic status review. This notice shall occur at least one year prior to end of the five year period required by section 10.1.

10.2 The status of all delisted species shall be reviewed at least once, five years following the date of delisting.

10.3 The department shall evaluate the necessity of changing the classification of the species being reviewed. The agency shall report its findings to the commission at a commission meeting. The agency shall notify the public of its findings at least 30 days prior to presenting the findings to the commission.

10.3.1 If the agency determines that new information suggests that classification of a species should be changed from its present state, the agency shall initiate classification procedures provided for in these rules starting with section 5.1.

10.3.2 If the agency determines that conditions have not changed significantly and that the classification of the species should remain unchanged, the agency shall recommend to the commission that the species being reviewed shall retain its present classification status.

10.4 Nothing in these rules shall be construed to automatically delist a species without formal commission action.

RECOVERY AND MANAGEMENT OF LISTED SPECIES

11.1 The agency shall write a recovery plan for species listed as endangered or threatened. The agency will write a management plan for species listed as sensitive. Recovery and management plans shall address the listing criteria described in sections 3.1 and 3.3, and shall include, but are not limited to:

11.1.1 Target population objectives

11.1.2 Criteria for reclassification

11.1.3 An implementation plan for reaching population objectives which will promote cooperative management and be sensitive to landowner needs and property rights. The plan will specify resources needed from and impacts to the department, other agencies (including federal, state, and local), tribes, landowners, and other interest groups. The plan shall consider various approaches to meeting recovery objectives including, but not limited to regulation, mitigation, acquisition, incentive, and compensation mechanisms.

11.1.4 Public education needs

11.1.5 A species monitoring plan, which requires periodic review to allow the incorporation of new information into the status report.

11.2 Preparation of recovery and management plans will be initiated by the agency within one year after the date of listing.

11.2.1 Recovery and management plans for species listed prior to 1990 or during the five years following the adoption of these rules shall be completed within 5 years after the date of listing or adoption of these rules, whichever comes later. Development of recovery plans for endangered species will receive higher priority than threatened or sensitive species.

11.2.2 Recovery and management plans for species listed after five years following the adoption of these

rules shall be completed within three years after the date of listing.

11.2.3 The agency will publish a notice in the Washington Register and notify any parties who have expressed interest to the department interested parties of the initiation of recovery plan development.

11.2.4 If the deadlines defined in sections 11.2.1 and 11.2.2 are not met the department shall notify the public and report the reasons for missing the deadline and the strategy for completing the plan at a commission meeting. The intent of this section is to recognize current department personnel resources are limiting and that development of recovery plans for some of the species may require significant involvement by interests outside of the department, and therefore take longer to complete.

11.3 The agency shall provide an opportunity for interested public to comment on the recovery plan and any SEPA documents.

CLASSIFICATION PROCEDURES REVIEW

12.1 The agency and an ad hoc public group with members representing a broad spectrum of interests, shall meet as needed to accomplish the following:

12.1.1 Monitor the progress of the development of recovery and management plans and status reviews, highlight problems, and make recommendations to the department and other interested parties to improve the effectiveness of these processes.

12.1.2 Review these classification procedures six years after the adoption of these rules and report its findings to the commission.

AUTHORITY

13.1 The commission has the authority to classify wildlife as endangered under RCW 77.12.020. Species classified as endangered are listed under WAC 232-12-014, as amended.

13.2 Threatened and sensitive species shall be classified as subcategories of protected wildlife. The commission has the authority to classify wildlife as protected under RCW 77.12.020. Species classified as protected are listed under WAC 232-12-011, as amended.

Appendix B. Representative sandhill crane records for eastern Washington in migration, 1964-1999.[1]

Location	County	Number	Date	Comments
SPRING				
St. Andrews	Douglas	800	3 April 1966	
St. Andrews	Douglas	1,000	mid-March 1967	
Sprague	Lincoln	40	23 March 1968	Flying north
St. Andrews	Douglas	2,000	18 April 1970	
Richland	Benton	50	29 April 1970	
Richland	Benton	105+	30 April 1970	
Yakima	Yakima	32	3 May 1970	Flying high
St. Andrews	Douglas	200	8 April 1972	
McNary NWR	Benton	200	20 April 1972	Circled
Mansfield	Douglas	500-700	21 April 1973	
St. Andrews	Douglas	3,000	13-14 April 1973	
St. Andrews	Douglas	600	13 April 1974	
Parker Heights	Yakima	60	April 1975	Tried to land on lawn
St. Andrews	Douglas	3,000	10 April 1976	
Kittitas	Kittitas	700	30 April 1976	Roosted
St. Andrews	Douglas	2,500	9 April 1978	
Crab Creek	Lincoln	500	30 April 1978	
St. Andrews	Douglas	2,500-3,000	early to mid-April 1979	
Othello	Adams	2,000	early April 1982	
St. Andrews	Douglas	1,500	early April 1982	
Richland	Benton	400-500	21 April 1984	3 flocks flying over
Conconully	Okanogan	5,000-6,000	16 April 1984	Flying over
St. Andrews	Douglas	2,000	15 April 1986	
Othello	Adams	-	23 Feb 1988	Arrival date
St. Andrews	Douglas	1,200	21 April 1989	
Blue Creek[2]	Stevens	4	23 April 1984	
Colville River Valley[2]	Stevens	1	Spring 1999	

AUTUMN

McNary NWR	Benton	70	30 Sep 1964	
Turnbull NWR	Spokane	3	7 Oct 1964	
Alkali Lake	Grant	27	11 Oct 1964	
Banks Lake	Douglas	1,000	14 Oct 1967	
McNary NWR	Benton	-	late Sep-early Oct 1968	Flying over
Walla Walla	Walla Walla	8	1 Sep 1969	In harvested corn field
Turnbull NWR	Spokane	3	4 Sep 1969	
Calispell	Stevens	14	28 Sep 1969	Flying
St. Andrews	Douglas	950	29 Sept 1978	
Colville Indian Res.	Okanogan	1,200	1 Oct 1978	
Potholes Reservoir	Grant	30-100	Autumn 1979	
Calispell Lake[3]	Pend Oreille	3	Sep 1980	
Grand Coulee	Grant	1,000	17 Sep 1983	
Soap Lake	Grant	500	20 Sep 1983	Flew over
Walla Walla River	Walla Walla	1	13 Sep 1986	Wallula Delta
Columbia NWR	Grant	650	27 Sept 1988	Spent night
Soap Lake	Grant	>13,000	15 Sep 1992	Flew over in 1.5 hrs
Touchet	Walla Walla	>500	25-29 Sep 1992	
Ione Bridge[2]	Pend Oreille	small flock	Autumn 1995	
Othello	Adams	5,000	21 Sep 1998	

[1] Records from *American Birds*, *Audubon Field Notes*, *Field Notes*, and *North American Birds* unless otherwise noted. Most records probably lesser sandhill cranes.
[2]*Fide* C. Loggers.
[3]*Fide* Steve Zender.

Appendix C. Representative sandhill crane[1] records for western Washington in migration, 1965-1985 (*from* Littlefield 1999).

Location	County	Number	Date	Comments
SPRING				
Cape Flattery	Clallam	68	24 Aug 1974	
Skagit Flats	Skagit	10	Apr-early May 1975	
Tatoosh Island	Clallam	25	6 May 1978	Flying north off Cape Flattery
Dungeness	Clallam	1	2 Apr 1977	
Dungeness	Clallam	3	12 Apr 1977	
Cape Flattery	Clallam	11	1 May 1982	Stopped at mouth of Waatch River
Neah Bay	Clallam	300	14-22 Apr 1984	
Strait of Juan de Fuca	Clallam	93	14 Apr 1984	Crossed from Neah Bay
Cape Flattery	Clallam	3,500	Spring 1985	During hawk-watch
AUTUMN				
Skagit Flats	Skagit	17	25 Sep 1965	
Everett	Snohomish	-	Oct 1972	On tidal flats
Cape Flattery	Clallam	25	4 Sep 1975	Flew south
Dungeness	Clallam	-	12-14 Sep 1981	First migrants arrived
Grays River	Wahkiakum	10-15	16 Sep 1982	Flocks
Dungeness	Clallam	10-15	27 Oct 1982	Flocks

[1] Most records probably lesser sandhill cranes but some are possibly the Canadian subspecies.