STATE OF WASHINGTON June 2002

Sandhill Crane Recovery Plan

by Carroll D. Littlefield
and Gary L. Ivey

Washington Department of
FISH AND WILDLIFE
Wildlife Program
Wildlife Diversity Division

WDFW 735

Washington State Recovery Plan

for the Sandhill Crane

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June 2002

Approved:

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Director, Washington Department of Fish and Wildlife **Date**

In 1990, the Washington Wildlife Commission adopted procedures for listing and de-listing 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.

The draft state recovery plan for the sandhill crane was reviewed by researchers and state and federal agencies. This review was followed by a 90-day public comment period. All comments received were considered in preparation of this the final recovery plan. For additional information about sandhill cranes or other state listed species, contact:

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This report should be cited as:

Littlefield, C. D., and G. L. Ivey. 2002. Washington State Recovery Plan for the Sandhill Crane. Washington Department of Fish and Wildlife, Olympia, Washington. 71 pages.

Cover design and illustration by Darrell Pruett. Crane photo courtesy of Northwest Trek

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ACKNOWLEDGMENTS

The following individuals deserve acknowledgment for their assistance during the development of the *Washington State Recovery Plan for the Sandhill Crane.*

The following individuals provided information on crane observations or habitat use: Eric Anderson, William R. Applegate, Joseph Ball, John Beckstrand, Brain Calkins, Rod Drewien, Joe Engler, Wade Epperson, Daniel Friesz, Ronald Friesz, Jerry Hickman, Randy Hill, Richard Johnstone, Rose Leach, Susan Lindstedt, Chris Loggers, Tom Melanson, Matthew Monda, Maureen Murphy, Michael Rule, Ron Schlorff, and Steven Zender. Steve Manlow provided copies of correspondence concerning the Vancouver bottomlands.

Darrell Pruett created the illustration of subspecies and for the title page. Peggy Ushakoff and Darrell Pruett created the map figures. Caroline Herziger provided assistance with word processing and created figures for the draft plan. The cover photograph of a crane was provided by Northwest Trek.

We appreciate the critical reviews provided by the following biologists and wildlife managers on drafts of the plan: Eric Anderson, Joseph Engler, Harold Cole, Caroline Herziger, Harriet Allen, David Anderson, and David Hays. Substantial comments on the draft report were received from Karen McGaffey and Derek Teaney. Derek Stinson and Harriet Allen edited the Plan.

Lastly, we are most grateful to Thomas Hoffman of the West Coast Crane Working Group for providing most of the funding for preparation of the Draft Recovery Plan. The remainder of funding was provided by the Washington Department of Fish and Wildlife.

EXECUTIVE SUMMARY

The sandhill crane has been listed as an endangered species by the state of Washington since 1981. Sandhill cranes are represented in Washington by a small number of greater sandhills that breed in Klickitat and Yakima Counties, about 23,000 lesser sandhills that stop in eastern Washington during migration, and 3,000-4,000 sandhills (Canadians and possibly some lessers and greaters) that stop on lower Columbia River bottomlands. Up to 1,000 sandhills have wintered on lower Columbia bottomlands in recent years, but most of the cranes seen in Washington winter in California. The greater sandhill cranes that breed in Washington are part of the Central Valley Population, so called because they winter in California's Central Valley. Other members of this population nest in Oregon, California, Nevada, and interior British Columbia. The lesser sandhill cranes are of the Pacific Flyway Population that stop during migration on the way to breeding grounds in Alaska or wintering areas in California. The Canadian sandhill cranes have not been defined as a population, and recent studies of the mid-continent population suggest that they may not differ genetically from greaters. Some breed along the coast of central British Columbia and winter in Washington, while some stop during migration en route to wintering areas in California. Further studies are needed to clarify their status and distribution.

The historical distribution of breeding cranes in Washington was poorly documented, but the few historical accounts mention breeding in south-central, northeastern and southeastern regions, and the southern Puget Sound Basin. 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. No nests produced chicks to fledging age in 2001, probably due to factors relating to drought conditions; the total summer population was 50.

Factors affecting Washington's breeding greater sandhills include predation, incompatible grazing and haying practices, water availability and management, and habitat loss. Crane habitat on the lower Columbia bottomlands between Vancouver and Woodland is threatened with industrial development, conversion of agricultural lands to cottonwood plantations, tree nurseries, or other incompatible uses and crane use is affected by disturbance by hunters and other recreationists.

The goal of the recovery plan is to restore a healthy breeding population of cranes and to maintain the flocks that winter or stop in Washington. To reach this goal, this plan calls for expansion of the breeding range of greaters into former breeding areas in eastern Washington and protection of habitat for crane wintering and staging during migration. The Plan identifies recovery objectives that must be reached, and outlines strategies to use in meeting them before down-listing of the species to threatened or sensitive can occur.

The sandhill crane will be considered for down-listing from State Endangered to State Threatened status when the state's overall breeding population reaches at least 65 territorial pairs with an average annual recruitment rate of >8 %, and effective water management control is established at Conboy Lake National Wildlife Refuge. The sandhill crane will be considered for down-listing to State Sensitive when the state's breeding population reaches at least 130 territorial pairs with an average annual recruitment rate of >8 % ,

and habitat used by cranes at the major staging sites in eastern Washington is protected through management agreements or easements. Also, for down-listing to sensitive, habitat needed to maintain 2,000 migrant and 500 wintering cranes should be secured and managed for cranes on the lower Columbia River bottomlands in Washington. Recovery objectives may need to be updated as better information is available about habitat needs.

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*. *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 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 taxonomic status of sandhill subspecies has been discussed in the literature (e.g., Walkinshaw 1973, Lewis 1977, Tacha et al. 1985). The Canadian subspecies was described and named by Walkinshaw (1965), but its validity has been questioned by Tacha et al. (1985). Recent genetic studies of the mid-continent population found that individuals identified as greater and Canadian sandhills based on morphology were not different genetically based on mitochondrial DNA (Glenn et al. 2002, Rhymer et al. 2001).

DESCRIPTION

Sandhill cranes are large, stately, and symbolic of the remote, isolated wetlands they depend upon. The 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). Sandhills smear mud onto their feathers using their beaks; if this occurs in iron-rich soils, the rust coloration results. The purpose of this behavior is unknown. 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 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. This red papillose

skin is connected to muscles and when the bird is territorial or involved in aggressive encounters, the crown area can be expanded and the red coloration intensified (Grooms 1992, 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 elevated hind toe (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.

Sandhill cranes are large birds, standing about 4 ft tall, and often weighing over 10 lbs (Tacha et al. 1992). Adult male greater sandhill cranes from Lincoln County, Wyoming averaged 11.75 lbs and weighed up to 14.6 lbs. (Lockman et al. 1987). Females averaged 10.6 lbs, and weighed up to 12.5 lbs. 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) (Lockman et al. 1987). Greater sandhill cranes are the largest of the 6 subspecies, lessers the smallest, and Canadians are intermediate (Fig. 1). Although with training and experience greaters and lessers are easy to distinguish from each other, the presence of the Canadian subspecies confounds identification, especially between Canadians and greaters. When birds are captured, anatomical measurements can be taken to verify subspecies identity (Table 1).

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. Sandhills have an extraordinarily long trachea (≈48 in) coiled within their chest that apparently improves the harmonics of their vocalizations (Grooms 1992).

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. 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 mostly 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 (Meine and Archibald 1996) (Fig. 2). The greater sandhill cranes that breed in Washington are members of the Central Valley Population which is defined as greater sandhills that 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 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 near Vancouver, although these latter birds may be the Canadian subspecies (Cooper 1996). A pair of cranes banded at Malheur National Wildlife Refuge in southeast Oregon during autumn

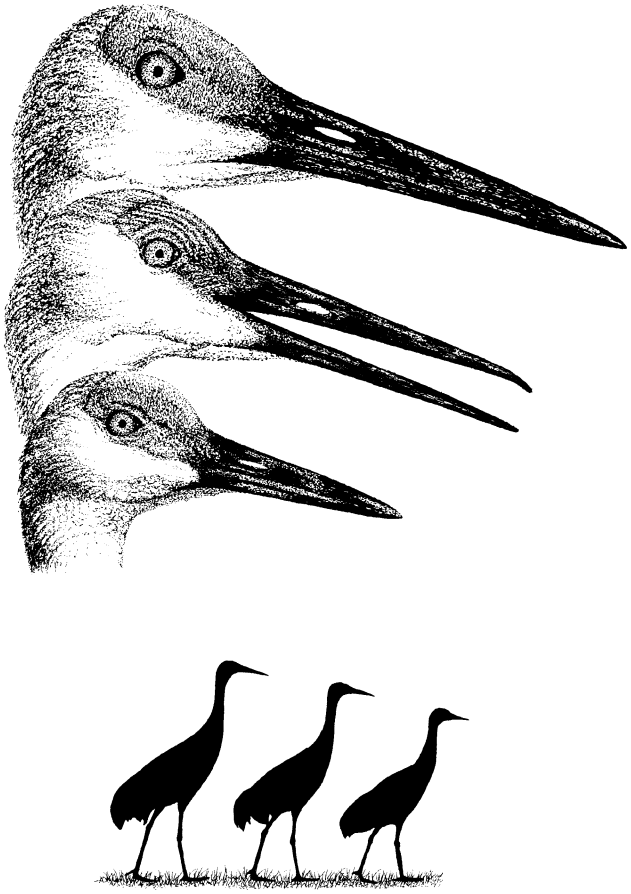

Figure 1. Relative size of 3 sandhill crane subspecies: greater (top and left); Canadian (middle); and lesser (bottom and right).

Table 1. Anatomical dimensions (mm) of greater, Canadian, and lesser sandhill crane subspecies (from Johnson and Stewart 1973).

Subspecies	Sex (n)	Exposed culmen[a]	Tarsus[b]	Longest toe
Greater Sandhill	M (11)	131.8 ±5.0	236.5 ±8.3	87.2 ±2.5
(*G.c. tabida*)	F (10)	120.4 ±2.9	228.3 ±6.3	84.5 ±2.6
Canadian Sandhill	M (51)	119.7 ±5.9	230.6 ±9.5[c]	86.4 ±3.2
(*G.c. rowani*)	F (33)	114.1 ±3.9	217.0 ±7.6	83.3 ±3.7
Lesser Sandhill	M (31)	97.3 ±3.9[c]	187.5 ±14.4	75.4 ±3.2
(*G.c. canadensis*)	F (17)	92.0 ±5.2	179.2 ±10.8	73.4 ±4.8

[a] Exposed culmen = the length between the tip of the bill and the edge of the feathering at its base.
[b] Tarsus = lower leg bone
[c] Sample size was 1 less than indicated.

migration was found breeding in the Cariboo Basin of British Columbia and wintering in the Central Valley of California. Other marked cranes from Malheur have been observed near Hanceville and Fly Lake (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.

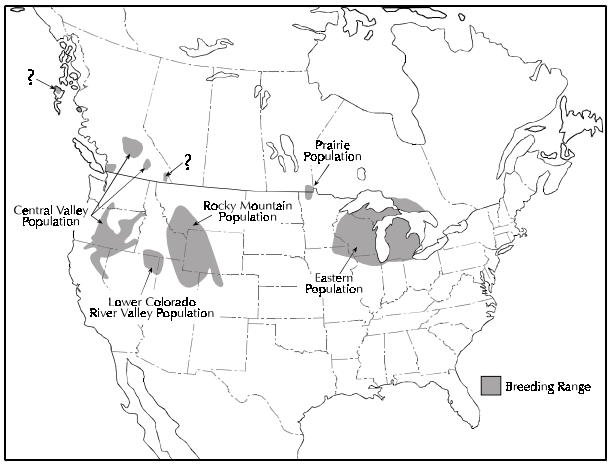

Figure 2. Breeding distribution of greater sandhill cranes in the United States (*from* Tacha et al. 1992, Cooper 1996, Meine and Archibald 1996, Ivey and Herziger, *in prep.*).

Little is known about the distribution of the Canadian subspecies in the Pacific Flyway, but they are thought to breed along the Pacific Coast in British Columbia (Cooper 1996). 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). Some Canadians winter at Ridgefield National Wildlife Refuge in southwest Washington (Clark County) and adjacent Sauvie Island in Oregon (Multnomah and Columbia counties) (Ivey et al. *in prep.*). Six Canadian sandhills marked in 2001-2002 on Sauvie Island and Ridgefield NWR returned to their summer range along the coast of British Columbia and southeastern Alaska; 5 of 6 used offshore islands (Ivey et al. *in prep.*)

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 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. 3). 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). From 1995 through 1997 a pair was on territory 19 km (12 mi) south of Fort Simcoe in an area known as the Camas Patch; this site apparently no longer provides suitable habitat (J. Engler, pers. comm.). 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 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 significant numbers of 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 also been noted from Grant and 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 D). In western Washington, some greaters may stage at Ridgefield National Wildlife Refuge, but their occurrence there has not been confirmed. Appendix E summarizes records for migrants in the western portion of the state. Most of these birds have been presumed to be lessers, but a recent study suggests they may be Canadians (Ivey at al. *in prep.*).

Most of the estimated 21,000 to 23,000 cranes that occur during migration in eastern Washington are lesser sandhill cranes (Littlefield and Thompson 1982). Also, this subspecies was believed to migrate through the western portion of the state, staging at Ridgefield National Wildlife Refuge (Kramer et al. 1983). However, Pogson and Lindstedt (1991) estimated 900 or so Canadian sandhills in this area in the early 1980s, and during winter 2001-2002 and spring 2002 all of the cranes observed at Ridgefield and Sauvie Island Wildlife Area were Canadians, while no lessers were observed (Ivey et al. *in prep.*).

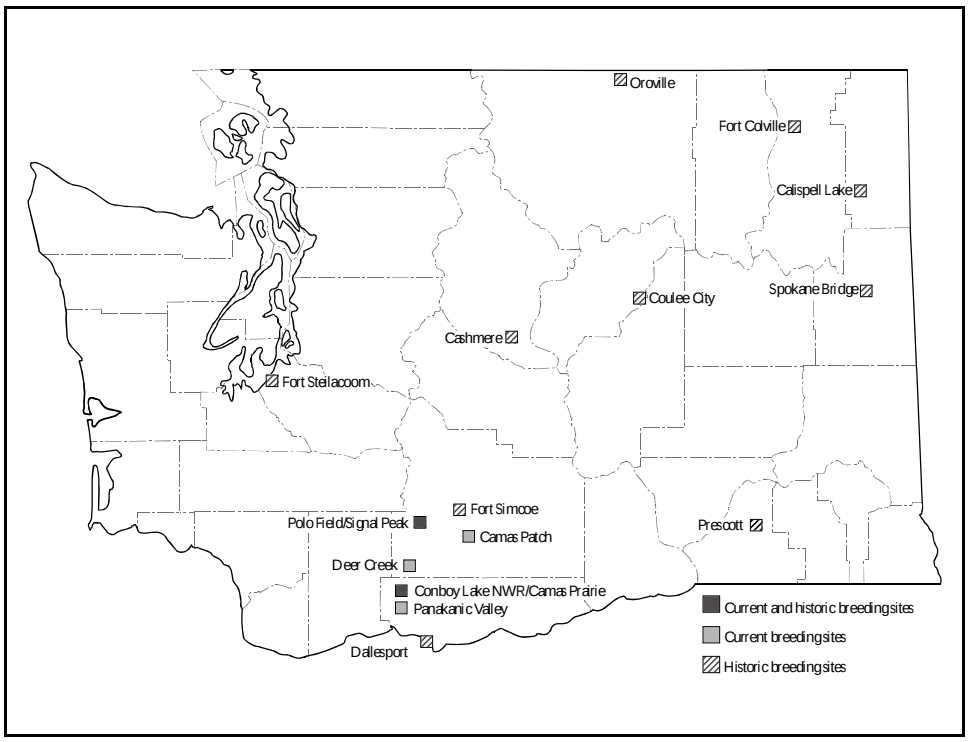

Figure 3. Known past and current breeding distribution of greater sandhill cranes in Washington (from Dice 1918, Jewett et al. 1953, and Engler and Brady 2000).

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
Wenas Lake	Yakima	20 June 1981	3	J.Smith/B. Lamb (WDFW files)
Anatone	Asotin	Jul-Aug 1981	1	Canyon Birders Audubon
Field Spring State Park	Asotin	26 Jul 1981	4	Canyon Birders Audubon
Glenoma	Lewis	14 Jul 1981	1	Tahoma Audubon
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
N. Whidbey Island	Island	4 June 1999	4	*fide* Randy Hill
Tiger Meadow, 7 mi	Pend Oreille	summer-early	1	J. McGowan, USFS

[1] Probably greater sandhill cranes but not confirmed.

NATURAL HISTORY

Reproduction

Sandhill cranes have a life history strategy that involves a low reproductive rate but high investment in the pair bond and in defending the breeding territory. This is in contrast to some birds, like California quail (*Callipepla californica*), that live short lives but lay large clutches (12-16 eggs) and, given favorable conditions, can raise large broods that more than compensate for high mortality rates. Cranes usually take 3 or more years to mature, may nest for several years before successfully hatching eggs, then still may not be successful in raising a chick. When successful, cranes rarely raise more than 1 young. Sandhills compensate for this low production with a relatively long life of up to 30 years or more (C. Littlefield and G. Ivey, unpubl. data).

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 (J. Engler, pers. comm.). 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. Sandhills in a growing population may pair and defend a territory at 2 years of age, but the chance of nesting success probably improves as the birds mature. Birds usually defer first breeding until $\geq$ 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 they had a chick (G. Ivey, pers. observ.). Nesting of the pair was confirmed on 20 May 2001 when 2 chicks were observed and both are believed to have fledged (M. Gould, pers. comm. to J. Engler). Sandhills have been known to delay breeding until 5 years, but 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). Most of the successful reproduction (>75%) in the mid-continent population occurs in birds > 8 years old (Tacha et al. 1992).

Territories. Sandhill cranes defend exclusive nesting territories, and foraging habitats rarely overlap. They are highly philopatric, usually returning annually to the same breeding territory. Nine pairs observed at Conboy Lake National Wildlife Refuge over 2-6 nesting seasons had territories (including both nesting and foraging sites) that averaged 140 ha (345 ac), and ranged from 58 - 218 ha (143-540 ac) (J. Engler, pers. comm.). 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 1.9 (Littlefield 1995a). In California, average size for 42 clutches was 1.9 (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, Littlefield 1995c). 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 fledging 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, other Washington 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 (% of fledged young in the population; calculated using known breeding pairs and counts of fledged young) in Washington has averaged 10% (range 0 to 27.3 %) from 1990-2001 (Engler and McFall 2001). 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 - 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.

Longevity and 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. The mean life expectancy for Florida sandhills that reached independence was 7 years (Tacha et al. 1992). In an eastern population of greater sandhills, annual survival rate (all post-juvenile age classes combined) was 0.874 for males and 0.858 for females (Tacha et al. 1992). 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 were lost to undetermined predators, 2 to coyotes, 2 lost transmitters, 1 died of exposure, and 2 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 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 (G. 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, 29% were lost to minks, 21% to coyotes, 17% to great horned owls, 13% to unidentified predators, 9% to golden eagles (*Aquila chrysaetos*), 8% to unidentified raptors, 0.5% to a northern harrier (*Circus cyaneus*), and 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 adult or subadult greater sandhill cranes. There are, however, several records of cranes being attacked by golden eagles (Ellis et al. 1999) or coyotes (Littlefield 1986), and there are records of bobcats (*F. rufus*) killing cranes in other regions. 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.), and migrant and wintering cranes at Ridgefield National Wildlife Refuge and Sauvie Island took flight from approaching bald eagles (G. Ivey, pers. obs.). Certainly both black (*Ursus americanus*) and grizzly bears (*U. horribilis*), as well as gray wolves (*Canis lupus*) and mountain lions (*Felis concolor*) would be capable of killing adult cranes.

Powerline collisions. Young fledglings are 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 one 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.). One crane died after colliding with utility wires at Conboy Lake National Wildlife Refuge in August 1984 (Paulson 1989). Also, 2 migrant lesser sandhills were found dead under a

powerline in Douglas County in October 1981 (Appendix B).

Fences. To a lesser extent, collisions and 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 from 1991 - 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 1,000 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 have not been reported. Males are believed to be more philopatric than females; that is males typically establish a breeding territory closer to their natal site than do females, as is typical in many territorial birds (Tacha et al. 1992, Greenwood 1980).

Spring migration. Except during inclement weather, adult greater sandhills 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 Oregon, known staging areas 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

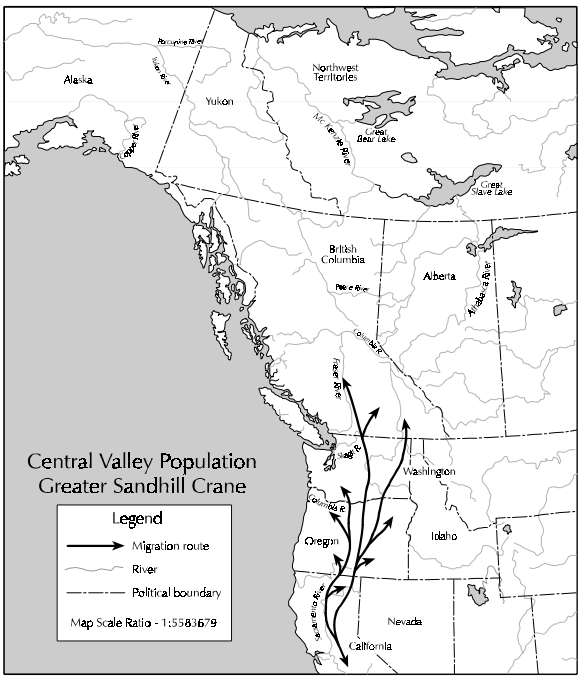

Figure 4. Migration routes of Central Valley Population of greater sandhill cranes (based on Littlefield and Thompson 1979, Campbell et al. 1990, and Pacific Flyway Council 1997).

County). In eastern Washington, small numbers of greater sandhill cranes stage primarily near Waukon and to a lesser extent Othello, along with flocks of lesser sandhills (Fig. 4). In western Washington, a few greaters may migrate through the Puget Trough region, but there are no recent records.

The lesser and Canadian subspecies migrate through the state primarily from February through April. The Pacific Flyway lesser sandhills primarily follow an inland route east of the Cascades en route to breeding grounds in Alaska at Cook Inlet, Bristol Bay, and the Alaska Peninsula (Figure 5). It is uncertain if any lessers migrate through western Washington, but no Canadian sandhill cranes have been identified using eastern Washington staging areas. Canadian sandhills migrate through western Washington apparently en route to scattered breeding sites along the coast of British Columbia and southeast Alaska (Fig. 6). Canadians marked at Ridgefield National Wildlife Refuge and Sauvie Island Wildlife Area flew out to the coastline, possibly following the Columbia River, then flew along the coast northward to Cape Flattery and the British Columbia and Alaska coasts (Ivey et al. *in prep.*). The number of sandhill records at Elma, Olympia, Montesano, and around Puget Sound suggest they often do not follow the Columbia, and occasionally travel through the Puget trough (Appendix E).

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. 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 the pre-migration aggregation of the local breeders and subadults at Glenwood Valley, there are no certain autumn records of greater sandhills for eastern Washington. Large flocks of lessers may contain some greaters, however, because greaters that breed in interior of British Columbia presumably migrate through the state. The Canadian and lesser subspecies migrate through the state primarily in late September and October using the same general routes and staging areas as in the spring. Birds using the western portion of the state 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 Sauvie Island and Ridgefield National Wildlife Refuge. Although these data suggest an increasing trend, this may be due to refined survey efforts in recent years. The annual survey is affected by timing and water levels at the traditional roost sites (J. Engler, pers. comm.; see also Appendix B). Past efforts to visually differentiate between the 3 subspecies during these surveys were not very successful. In October 1973, 327 "large cranes" were recorded at Sauvie Island, along with 1,100 lessers, but a bird that was illegally killed there was identified as a Canadian (Littlefield and Thompson 1979). Also, during a recent effort to capture and mark cranes for a satellite telemetry study, no lessers were observed in late November 2001 or during March and April 2002 (G. Ivey, pers. obs.). The question of the status of lesser sandhill cranes in this region needs further study.

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 there 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).

Winter. The only wintering area for sandhill cranes in Washington is the lower Columbia bottomlands near Vancouver, Ridgefield, and Woodland (Appendix C). All cranes observed wintering at Ridgefield National Wildlife Refuge and Sauvie Island Wildlife Area, Oregon, in late November 2001 and February 2002 were Canadian sandhills, and based on observations of marked birds, wintering cranes regularly move back and forth between

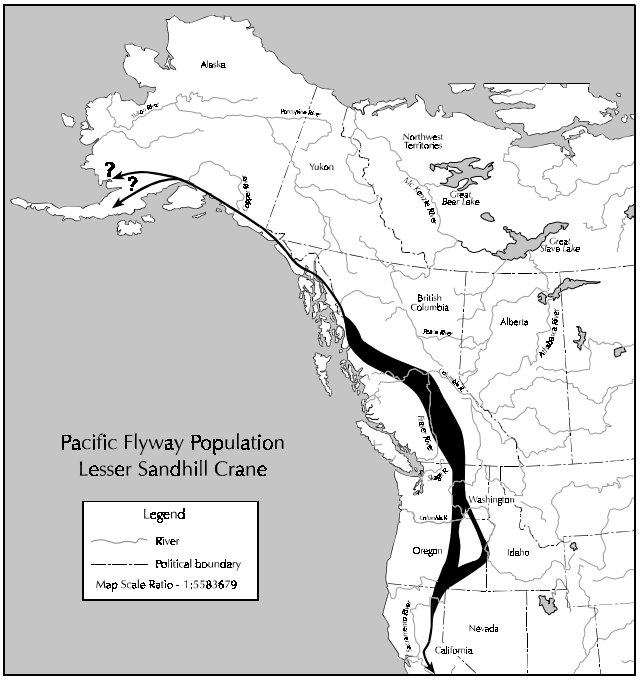

Figure 5. Migration route of the Pacific Flyway lesser sandhill cranes (based on Littlefield and Thompson 1982, Alaska Dept. Fish and Game 2001, Ivey et al. in prep., and records in Appendix E).

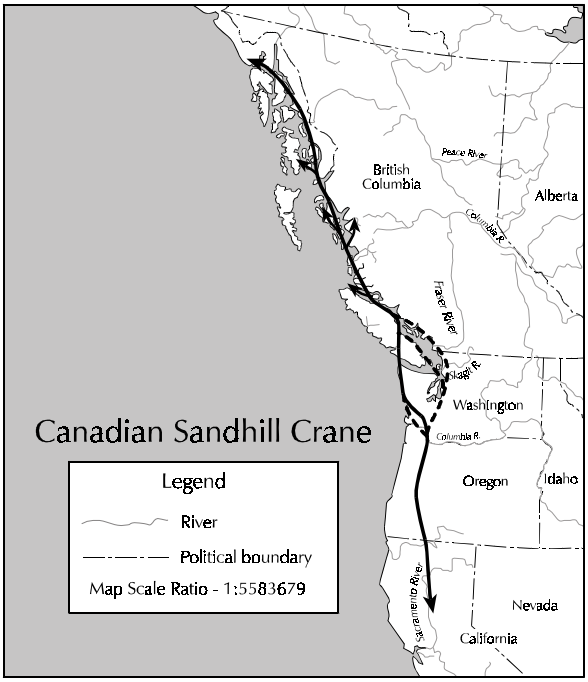

Figure 6. Migration route of Canadian sandhill cranes (based on Ivey et al. and records in Appendix E).

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

Date	Ridgefield National Wildlife Refuge[a]	Sauvie Island[b]	Total[c]
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
9 Oct 2001	2,209	1,875	4,084

[a] Includes birds on Vancouver bottoms and Woodland area.
[b] Includes nearby Oregon sites.
[c] Numbers peak in the first half of October in most years. Apparent increases or changes in numbers may be due to refinements in survey effort or timing.

these areas (Ivey et al. *in prep.*). Though not known to be a historical wintering area, an average of few hundred, but up to 1,000 cranes have wintered in the area during the last 7 or 8 years (J. Engler, pers. comm.; Appendix C).

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 (Delta region, San Joaquin County) (Engler and Brady 2000). Lesser sandhill cranes have been noted at Thornton, 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 described.

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 may include Oregon spotted frogs (*Rana pretiosa*); 8 territorial pairs nest or forage regularly at 7 sites which are considered to be core areas for spotted frog breeding. The behavior of cranes foraging in pastures prior to nesting, suggested that they were eating worms and beetles (J. Engler, 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, corn, wheat, oats, barley, and rice (Swarth 1919, Wood 1921,McLean 1930 Tanner 1941, Munro 1950, Madsen 1967, Stephen 1967, Guthery 1972, Drewien and Bizeau 1974, Hoffman 1976, Crete and Toepfer 1978, Fritzell et al. 1979, Lewis 1979, Tebbel and Ankney 1979 Buller 1981, Iverson 1981, Perkins and Brown 1981, Lovvorn and Kirkpatrick 1982b, Iverson et al.1985, Littlefield 1986, Reinecke and Krapu 1986, Walker and Schemnitz 1987, Sugden and Clark 1988, Sugden et al. 1988). Cranes using the Ridgefield - Sauvie Island area have been observed feeding on corn, barley, green grasses, and chufa (nutsedge) tubers (*Cyperus esculentus*) (G. Ivey, pers. obs.).

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 organic 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, the water level in Conboy Lake remained high later into the season, and portions held more or less permanent water. Ditching and agricultural development in the early 1900s, has speeded annual drying. Water now gradually recedes during early summer as Camas Ditch empties into Outlet Creek. Surrounding timbered 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*) (H. Cole, pers. comm.; U.S. Fish and Wildlife Service 1983).

Nesting habitat. Generally, sandhill 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, 55% is comprised of wet meadows; where cranes nest the vegetation includes reed canarygrass (*Phalaris arundinacea*), rushes (*Juncus* sp.), sedges (*Carex* spp.), and spikerushes (*Eleocharis* sp.). Portions of the lakebed are dominated by reed canarygrass (J. Engler, pers. comm.), an introduced and undesirable species (Paveglio and Kilbride 2000), but most areas are a mixture of canarygrass and native species. The prevalence of canarygrass and natives vary with weather and hydrology, but canarygrass often appears dominant because it is tall and later-growing than native species (J. Engler, pers. comm.). Some areas contain bulrushes (*Scirpus* spp.), cattails (*Typha* spp.), but these are less than 5% of the refuge area. Native grasses include redtop (*Agrostis alba*) and foxtail barley (*Hordeum jubatum*).

Peripheral areas of these meadows (11%) are slightly to heavily encroached upon by lodgepole pine, Douglas' spirea (*Spirea douglasii*), and willow which crane pairs use for both nesting substrate and cover. Approximately half of the crane pairs nest in areas with some trees and shrubs, however, heavy encroachment by these species may preclude nesting cranes.

On Yakama Indian Nation lands, 1 pair nests in a meadow covering approximately 79 ha (195 ac) that is vegetated with willows (*Salix* spp.), sedges, tufted hairgrass (*Deschampsia cespitosa*), and timber oatgrass (*Danthonia intermedia*). It is situated between stands of lodgepole pine, Douglas-fir, and grand fir, with smaller amounts of 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.

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 2001). 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, nesting habitat has been characterized during occasional post-breeding season visits to nest locations (E. Anderson, pers. comm.). In 1996, nest vegetation was occularly estimated at five sites: nest composition ranged from predominantly reed canarygrass to entirely spirea. Overall, the 1996 nests were determined to consist of 49% reed canarygrass, 23% spirea, 16% *Carex* spp, 9% *Juncus*, 2 % unidentified vegetation, and 1% rose (Anderson 1996). Nests assessed in 1997 were composed primarily of reed canarygrass, except two 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 (*Sparganium eurycarpum*) 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 2001).

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 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 (Littlefield 1999b).

Water depths at nest sites. Water depth data were not available for Washington nests as 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 2001); 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) (Stern et al. 1987). 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 migrating south. Cranes usually roost by standing in open water where little emergent vegetation is present.

Wintering and Staging Areas

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 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 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 may 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. Sandhill cranes migrating and staging within the lower Columbia River roost on the Ridgefield National Wildlife Refuge and on Sauvie 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, the River 'S', and Carty units 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 lies adjacent to a dead-end county road and use is probably limited by traffic. None of these roost sites, other than Campbell Lake, is consistently suitable because their water and vegetative condition fluctuates annually (J. Engler, pers. comm.). Cranes also roost on nearby Sauvie Island, particularly at Sturgeon Lake.

At Malheur National Wildlife Refuge, autumn loafing habitat included 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).

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 fresh or saline emergent wetlands and ranged from 0.8 - 7.6 km (0.5 - 4.6 mi) from feeding areas (mean = 2.2 km or 1.3 mi). One roost was within 100 m (328 ft) of a well-traveled highway and another about 0.8 km (0.5 mi) from a human dwelling, but all other sites were isolated from regular 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 used 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 1942. 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 specimen in at the U.S. National Museum in Washington, D.C. is the only historical greater sandhill crane specimen for the state (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, George Suckley in the 1850s reported for spring and summer: "In the vicinity of Fort Steilacoom, only stragglers remain to breed," and James Cooper observed:

"...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 and Cooper 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). Most of those prairies are gone; less than 3% of the 150,000 ac of historical prairie are still dominated by native prairie vegetation (Crawford and Hall 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 part of a population of 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, Washington (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 northeastern part of the state were likely affiliated with the pairs which were nesting in northern Idaho (Burleigh 1972) and southeastern 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) (Fig. 3). 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.). Jewett et al. (1953) mention a pair that nested in a slough near Coulee City (Grant County) in 1897; however, Coulee City is in the Grand Coulee where it would have been very hot and dry, and no wetlands existed before the Columbia Basin Project. Ron Friesz (pers. comm.) suggested the nesting site may have been on the Waterville Plateau in the Mansfield-St. Andrews area of Douglas County (~10 mi NW of Coulee City) where large shallow wetlands exist and migrant cranes stage. 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 crane nesting accounts for 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. 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 and Cooper1860). For autumn, Suckley 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... In the fall they are found on *all* the prairies near Fort Steilacoom." Most of these migrants were probably lesser sandhills cranes, but some greaters and Canadians may have been 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 and the resulting habitat destruction, and perhaps more importantly, from excessive market hunting in the California Central Valley. Market hunting 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 to replace the Christmas turkey (Heerman 1853). By the 1920s, breeding greaters had been virtually 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 market 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; of 135 recoveries of color-banded birds, 96 were killed by hunters (Drewien et al. *in prep*.). This, coupled with a continually increasing human population, will perhaps threaten crane populations far into the future.

In the mid-1980s, the Central Valley Population of large sandhills was estimated to total 6,000 - 6,800; this included at least 839 Canadian sandhills (Pogson and Lindstedt 1991). The Pacific Flyway Population of lesser sandhill cranes is thought to be approximately 23,000 birds (Kramer et al. 1983).

Washington. After 1941, some 31 years lapsed before summering greater sandhill cranes were again found in Washington. The subspecies' return apparently began in 1972 when 2 appeared at 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 the following year. 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 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 39.

Two adults and a fledged juvenile were observed along wetlands adjacent to Toppenish Creek near White Swan 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 44 (Engler and Anderson 1998). 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). No chicks were known to survive to fledging in 2001, probably due to factors related to drought conditions; only about 20-25% of the wetlands typically available at Conboy Lake were present (Engler and McFall 2001). An unusually high number of elk (*Cervus elaphus*) were present, probably due to dry conditions in the surrounding mountains, and likely caused the abandonment of 2 nests. The pair that had been nesting in Panakanic Valley was not observed in 2001, though two younger banded birds were present and may nest there in future years. Assuming there was 1 nesting pair on the Yakama Indian Nation lands, there were 40 breeding adults and 10 known subadults for a total population of 50.

For the period 1990 through 2001, Washington's breeding population fledged 30 chicks, with successful reproduction in all years except 1993 ,1994, and perhaps 2001 (Table 4). The greatest number was 6 in 2000, while 5 chicks fledged annually during the 3 previous years.

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)[4]	--	8	--	1	11.1	9
1992	3	(1)[4]	--	8	--	3	27.3	11
1993	3	(1)[4]	--	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
2001[5]	14 (2)	(1)	1(2)	40	10	0	0	50

[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).

[5] Drought conditions in 2001 negatively affected production; 1 pair was assumed to be present on the YIN which was not surveyed (Engler and McFall 2001).

A total of 17 chicks have been banded at Conboy since 1996, but 6 probably did not survive to migrate. Of the remaining 11, 10 returned to the Glenwood Valley the following spring. Of these birds, 3 males have established territories on Conboy, 1 occupied a territory in Panakanic Valley in 2001, and a female has nested with an unmarked male in Mt Hood National Forest in Oregon (Engler and McFall 2001).

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 (sodium fluoroacetate), 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 recent years, wildlife management programs that historically dealt almost exclusively with hunted species have been broadened to include non-game species, including sandhill cranes. These 3 factors plus a protected status have resulted in an increase and subsequent re-occupation of breeding range left vacant for several decades.

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% 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 that provincial numbers were increasing. The sandhill crane population in the Georgia Depression was recently red-listed by the Provincial government.

HABITAT STATUS

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 in Glenwood Valley are comparable to other mountainous locations where many cranes breed. Sycan Marsh, Oregon, and Grays Lake National Wildlife Refuge, Idaho, are similar areas which support high densities of breeding cranes. There are approximately 6,070 ha (15,000 ac) of potential crane habitat in the Glenwood Valley, but this includes about 3,035 ha (5,000 acres) of private irrigated pastures near Glenwood where land use practices reduce the suitability to cranes. 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 is generally 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. No cranes were observed by helicopter at the Camas Patch site on 9 June 2000 and the area was dry and being grazed and may no longer be suitable breeding habitat (Engler and Brady 2000). 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).

Other potential greater sandhill crane breeding habitat that appears to be suitable 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.). Cranes have also been sighted, and may nest at Trout Lake Natural Area Preserve, a 327 ha (920 ac) wetlands complex in Klickitat County recently acquired by Washington Dept. of Natural Resources. Several other summer crane records since 1980 may have been subadults seeking a territory (see Table 2, p.5). The most recent was a bird that summered on Tiger Meadow in Pend Oreille County in 2001.

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 very few recent summer crane records for Pend Oreille, Ferry, or Stevens counties (S. Zender, pers. comm.). Additionally, potential nesting habitat exists 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 and not suitable for crane territories (Monda and Ratti 1988). 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 encroachment by forest (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, if global climate change lengthens summers, these wetlands may eventually become suitable. 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 suitable habitat. The nesting site near 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 Banks Lake, an equalizing reservoir between Coulee Dam and Coulee City, in the spring of 1951 (Yocom and Hansen 1960).

Staging and Wintering Habitat

Lower Columbia bottomlands. The lower Columbia bottomlands staging area is the only sandhill crane use-area in the United States adjacent to a major metropolitan area, and habitat will continue to be threatened. About 4,000 cranes stop during migration, and up to 1,000 winter in the area. Few, if any, alternate migrational stopover sites are available between northern California and southeastern Alaska for birds which migrate west of the Cascade Range. Habitat in the area needs to be protected if this crane flock is to continue to survive. A total of 3,044 h (7,518 ac) are owned by wildlife agencies and protected from development, but several thousand acres of habitat have no conservation status. The U.S. Fish and Wildlife Service owns 5,150 ac at Ridgefield National Wildlife Refuge, and WDFW owns 2,371 ac at Shillapoo Wildlife Area. In addition, 416 ac adjacent to Vancouver Lake are owned by Vancouver/Clark County Parks.

Presently, about 70% of Shillapoo Wildlife Area is used as pasture or agriculture lands (35% each). Pheasant releases at 2 sites result in high hunter use of some agricultural fields and pheasant season coincides with the fall peak of crane migration. Crane use of otherwise suitable habitat is reduced by the presence of hunters during upland bird and waterfowl seasons, and people training dogs at other times. Future plans include restoration of Shillapoo Lake (900 ac) that would flood

agriculture fields and pastures and restore native wetland vegetation. About 950 ac of pasture and cropland will remain for geese and cranes. The effects on cranes of this change are not clear. Some seasonal foraging area for migrants may be lost, but roosting sites and native foods may increase.

The Port of Vancouver owns the 1,011 ac "Columbia Gateway" property. It is agricultural, woodland, and wetland, and perhaps 75% receives a high level of use by cranes. The Port has prepared a master plan calling for development of >700 ac for industry and port facilities (Port of Vancouver1998). The development would use fill, including dredged material from deepening of the Columbia River navigation channel by the U. S. Army Corps of Engineers, to raise the area above seasonal flooding.

Other habitat losses in this region are anticipated. Former row-crop agricultural land on Sauvie Island has recently been converted to tree nurseries (M. Stern, pers. comm.). Additional agricultural lands on Sauvie and Woodland bottoms have been planted to cottonwood plantations. Other uses that have been responsible for incremental losses of crane habitat include tulip production, berry crops, smaller industrial developments, residential development, and public recreational development.

Eastern Washington. Sandhill cranes use agricultural fields and wetlands for staging at several locations in eastern Washington, including the Columbia National Wildlife Refuge (23,200 ac) and Potholes Reservoir Wildlife Area (32,500 ac). Cranes have staged on the Waterville Plateau in the Mansfield/St. Andrews area for many years (R. Friesz, pers. comm.; Appendix B).

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 wintering habitat. On the wintering grounds in the Central Valley, agricultural lands traditionally used by cranes 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. 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, as are several other sandhill crane populations (Tacha et al. 1992).

Washington

The Washington Department of Game (the predecessor to WDFW) listed the sandhill crane as Endangered in 1981 (Washington Administration Code 232-12-014; see also WAC 232-12-297, 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 has been 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. Crane habitat is not explicitly protected by state law, but as habitat of a state endangered species, it would be protected by ordinance in many counties. Under the state's Growth Management Act, counties are required to identify critical areas and can also select species of local significance. Many counties have adopted the state's list of endangered, threatened, and sensitive species, and require review and mitigation before issuing permits for projects that would impact habitat.

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 list (1997). 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). The Georgia Depression population, which includes the few pairs breeding near Vancouver was recently Red-listed by the Ministry of Sustainable Resource Management.

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 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 ban on the use of Compound 1080 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. Frequently these sites are the result of mowing and livestock grazing practices which can be detrimental to nesting and fledging. Though meadows are generally good foraging sites for cranes, late June and July meadow mowing can kill crane chicks as they hide in dense vegetation and remain motionless, waiting for the threat to pass (Littlefield and Ivey 1994). In addition, meadows are often dried in June for hay harvest, and early drying can result in the unavailability of invertebrate foods, sometimes contributing to 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 nesting success; 10 April - 15 July grazing can prevent nesting attempts, and in some cases, cause nest abandonment (Littlefield 1989). Crane chicks have been trampled by cattle in northeast California (R. Johnstone, pers. comm.) and Idaho (R. Drewien, pers. comm.).

Management of lands for cranes could be improved by excluding livestock from crane habitat during the spring breeding season, delaying hay harvest and grazing until after 10 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). Historical sandhill crane pairs were absent from some sites surveyed in Oregon and California where irrigation was delayed (Ivey and Herziger 2000, 2001). Early drying of wetlands and irrigated fields can lead to increased chick mortality.

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).

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.

Staging and 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 (see Lower Columbia bottomlands, p. 21). There are several important migration stopover sites in eastern Washington on private farmland, which are only protected from development by their farmland value and rural locations. These sites may be threatened in the future by residential development or conversion to incompatible crops.

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, an increase in vineyards is resulting in a similar pattern; vineyard hectares 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. In the Vancouver-to Woodland bottomlands the availability of corn may be affected by the status of the local dairy industry. The number of dairy farms in the area has been declining. Planting of crops on state wildlife area lands depends on lessees because public funding is rarely available. On the Shillapoo Wildlife Area, WDFW plans to restore Shillapoo Lake which will flood some pasture and agricultural fields, but 385 ha (950 ac) of ag/pasture will remain for geese and cranes. Corn planted on Ridgefield National Wildlife Refuge (100 ac in recent years) has helped compensate for losses on state and private lands.

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 on food availability. Should autumn stubble flooding, burning, or tilling increase, crane foraging sites will decrease, and food could become limited.

Waterfowl enhancement and mitigation practices. Programs intended to improve habitat for waterfowl can 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 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 additional fields are expected to be lost in the future. Should this program continue to gain momentum, it will have a negative impact on the remaining winter food resources available to cranes wintering in the Central Valley (Littlefield 1999a).

Wetland mitigation projects often focus on creating waterfowl habitat which may not be suitable for sandhill crane use. Mitigation and other wetland projects in crane wintering and staging areas should be planned to provide sandhill crane foraging and loafing habitats in addition to waterfowl and other wetland goals. Proposals to mitigate wetland filling associated with Port of Vancouver development are focused on open-water habitat for ducks and geese, and do not address loss of sandhill crane habitat values.

Human disturbance. In southwestern Washington, activities to reduce Canada goose depredation of crops with hazing, propane cannons, extended hunts, dogs, field flags, and other scaring devises, have also effectively reduced usable wintering/migration habitat on private lands (E. Anderson, pers. comm.). Upland bird and waterfowl hunting in agricultural fields, pastures and wetlands affect crane use of habitat at many sites, as does disturbance by dog training on the Shillapoo Wildlife Area. A bicycle path under development on Port of Vancouver property near Vancouver may impact crane feeding areas.

CONCLUSION

Breeding greater sandhill cranes were extirpated from Washington by 1942. It was not until the 1970s that pairs returned to breed. 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 currently totals about 50. 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 on private lands there. Nesting habitat outside Glenwood Valley is limited, but may be adequate to allow colonization by a scattering of breeding pairs. 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.

Major staging areas for migrating sandhills in eastern Washington are not immediately threatened, but staging and wintering habitat on the Vancouver-to Woodland bottomlands along the Columbia River are being lost to development and conversion to incompatible crops (e.g., tree nurseries, cottonwoods). Recovery of cranes should include conservation of habitat sufficient to allow growth of the nesting population, as well as maintenance of migrant and wintering flocks.

PART TWO: RECOVERY

RECOVERY GOAL

The goal of the *Washington State Recovery Plan for the Sandhill Crane* is to restore a healthy breeding population and to maintain the flocks that winter or stop during migration in Washington. The Recovery Plan identifies target population objectives and strategies needed to increase the breeding population of greater sandhill cranes to the point that it can be de-listed, and to conserve essential habitat for the nonbreeding flocks of sandhill cranes annually present in Washington (Fig. 7). The recovery objectives should be re-evaluated and revised if necessary in the future to ensure they are 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.

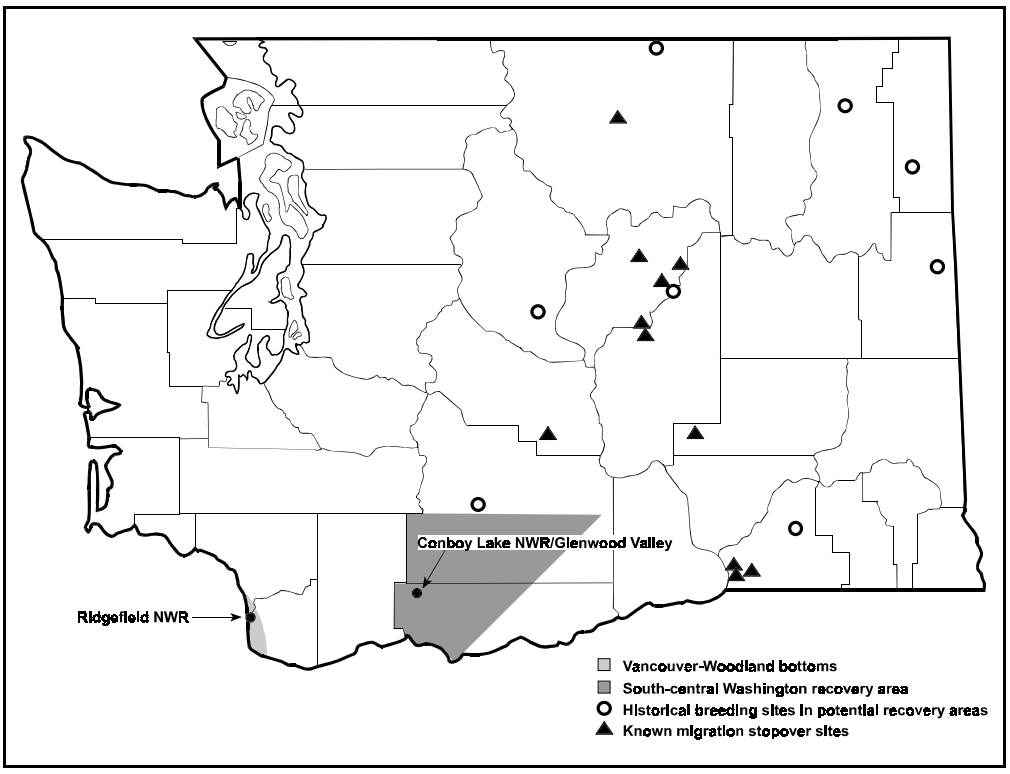

Figure 7. Important areas for sandhill crane recovery, migration, and wintering in Washington.

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."

Objectives to down-list from State Endangered to State Threatened status are:

1. A breeding population of ≥65 territorial pairs of sandhill cranes, with at least 15 of these at sites outside the Glenwood Valley, with an average annual recruitment rate of >8 % for the 5 year period prior to down-listing.

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

Objectives to down-list from State Threatened to State Sensitive are:

1. A breeding population of 130 pairs of sandhill cranes, including at least 40 of these outside the Glenwood Valley, with average annual recruitment of >8 % over the 5 year period prior to down-listing.

2. Habitat used by cranes at the major migration stopover sites in eastern Washington is managed to be compatible with crane use during the migration periods and is protected through management agreements or easements.

3. Secure and manage foraging and roosting habitat sufficient to maintain 2,000 migrant and 500 wintering sandhill cranes on the lower Columbia bottomlands in Washington.

Rationale

Considering the longevity and philopatric nature of cranes, a breeding population of 65 territorial pairs (plus subadults would be >160 birds) would probably sustain the state's breeding population and be adequate to down-list the species to Threatened. The carrying capacity for breeding greater sandhill cranes within the state is presently unknown, but it appears there may be sufficient breeding habitat in the state to support 175-200 pairs, if properly managed. 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 expand into other parts of eastern Washington from the Glenwood Valley, eastern Oregon, or British Columbia, 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, but it is important to have a significant component outside the Glenwood Valley in case an event (e.g. disease, volcanic eruption) affects all the birds in the valley.

Based on an average territory size of 25.3 ha (62.5 ac) at Malheur National Wildlife Refuge, 1,645 ha (4,063 ac) would be needed to support 65 crane pairs in south-cental Washington. There are 2,100 ac of nesting habitat on Conboy Refuge, and another 1,350 ac on private inholdings (J. Engler, pers.comm.) that may eventually be acquired by the refuge. The total of 3,450 ac of nesting habitat could support up to 55 territories, and there is additional nesting habitat in the Glenwood Valley, though much of it may never be managed in a way that is compatible with crane nesting. The objective of 15 pairs outside the Glenwood Valley is a small number, but it would provide a nucleus for colonizing new areas. Maintaining 15 pairs would require nearly 405 ha (1,000 ac) of habitat. Recruitment, or the percent of

the population consisting of fledged young, is calculated using known breeding pairs and counts of fledged young. Growing populations typically have a recruitment rate of 10% or more. The Washington population averaged 10% recruitment from 1990-2001. Recent data suggest that a recruitment rate of 7-9% may be typical for a stable population.

The establishment of effective water management at Conboy Lake NWR was included because water management has been a problem and Conboy supports most of the breeding population. Complex hydrology, old water control infrastructure, private inholdings, and a shortage of staff prevents effective management of water levels on the refuge. Owners of some inholdings de-water fields for hay harvest, just when crane chicks are hatching. Dredging of creeks in 1998 resulted in the abandonment of 2 crane territories.

For down-listing from Threatened to Sensitive, a breeding population of 130 cranes (with subadults would total >325 birds) would be needed. This large a breeding population may require cranes to expand their range well beyond the current sites in south-central Washington. 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. Habitat for 130 pairs would involve at total of around 3,290 ha (8,125 ac), including 1,012 ha (2,500 ac) outside the Glenwood Valley to support 40 pairs.

Important sites in eastern Washington that are consistently used by migrant cranes should be secured with conservation agreements, easements, or acquisition to ensure they are not lost to development, planted to incompatible crops, or converted to non-agricultural uses.

Habitat also needs to be secured for migrant and wintering cranes in southwest Washington. Important habitat in the Vancouver area is threatened by development. For this flock, the Vancouver-to Woodland bottomlands is the only western Washington staging area and, including Sauvie Island Oregon, the only known traditional stopover site between southeastern Alaska stopover points and California wintering areas (Littlefield 1999a). The wintering birds there were thought to be part of a coastal segment of the Pacific Flyway Population of lesser sandhill cranes (Littlefield 1999a), but new data indicate they may be a population of Canadian sandhills (G. Ivey, pers. obs.). Little is known about the status of Canadian sandhills in the Pacific Flyway, but existing information suggests it is the smallest population and perhaps the most imperiled and the Ridgefield/Sauvie Island area is a critical staging area for this population. Securing sufficient habitat in Washington to support half the cranes that use the area (2,000 migrants and 500 winterers) is an interim objective. The amount of foraging habitat needed is unknown and roosting habitat availability needs further assessment. Migrant cranes stop for a few weeks, and a few hundred hectares of corn may be sufficient. Five hundred wintering birds may require 400 to a thousand ha depending on forage and roosting opportunities, and how it is managed. This objective should be revised as additional data becomes available on habitat needs.

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 (breeding adults, fledged juveniles, plus 1 to 3 year old nonbreeders). It is often difficult to determine the number of nonbreeding cranes (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 7 - 9%.

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.

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, Yakama 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. For reconnaissance to search 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.

1.3. Monitor numbers of migrant and wintering sandhill cranes.

Conduct counts of crane numbers at crane staging sites in the state during spring and autumn migration. Weekly counts should be conducted to identify the migration peak, and surveys in subsequent years could focus on a 2 week period when the peak is expected. Count wintering crane numbers on a monthly basis, and coordinate with counts on the Oregon side of the Columbia. More information is needed about numbers of different subspecies in southwest Washington during winter and migration, but identifying birds to subspecies in mixed flocks is very difficult (see research task 11.2).

Cranes in flocks can 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.

2. Inventory and assess sandhill crane habitat.

2.1. Inventory and 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 the Colville Indian Reservation. This assessment could be accomplished over a 2-year period.

2.2. Inventory and assess sandhill crane staging habitat in eastern and southwest Washington.

For sandhill crane staging areas, the 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. Results from crane surveys and assessments in southwest Washington should be used to identify habitat improvement and acquisition needs to maintain crane flocks.

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.

3.1.1. Protect breeding habitat.

For breeding cranes, present priorities should be the privately-owned lands in Glenwood Valley, particularly those adjacent to Conboy Lake National Wildlife Refuge. Acquire lands, or seek agreements or easements with landowners to employ crane compatible management practices on crane nesting territories (e.g., delayed hay harvest and livestock grazing).

3.1.2. Protect staging and wintering habitat.

For staging and wintering cranes, priorities should include unprotected habitats in the Vancouver bottoms and Woodland bottoms areas. Protect habitat used by cranes from development (e.g., proposed industrial developments on Port lands) and incompatible recreation and other uses. Ensure that any mitigation for development of crane habitat replaces crane habitat value. The threat of loss or conversion to key stopover sites in eastern Washington should be assessed, and protection sought for any important sites at risk.

3.2. Discourage water projects which would impact crane breeding habitat.

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.

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 negatively impact sandhill crane habitat, either from flooding, de-watering, 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 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).

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. Maintain water levels from mid-March to early August. 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. 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.). Used properly, grazing can help provide short grass foraging sites, especially in areas of dense reed canarygrass.

Engler and Brady (2000) stated that trespass cattle were a problem on off-refuge sites. On the Yakama Indian Nation lands there is a potential conflict with cattle grazing for the 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.

3.5. 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 filling of wetland habitats in the Vancouver bottoms needs to be avoided, minimized, and mitigated to address loss of crane habitat values. Proposed wetland projects should go through NEPA/SEPA legal review and crane needs should be considered during these reviews.

3.6. 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).

3.7. Consider sandhill cranes in wetland planning projects.

Consider sandhill crane habitat requirements and include these in wetland habitat restoration, enhancement, and mitigation programs that occur within current and potential crane habitat in breeding and migrational staging areas.

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, local data should be used when available to establish dates (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 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 and initiated if necessary to prevent declines.

4.5. 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 sandhill cranes.

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. Logging activity may have prevented nesting at some sites in the past, and could inhibit cranes from re-occupying suitable habitat.

5.2. Restrict or eliminate human disturbance near sandhill crane use-areas.

5.2.1. Minimize disturbance to cranes at breeding areas.

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

5.2.2. Minimize disturbance of staging and wintering cranes.
Minimize disturbance of migrant and wintering cranes by upland bird and waterfowl hunters and dog training on the Shillapoo Wildlife Area and other public lands where a problem is identified. Seek ways of reducing disturbance of cranes by waterfowl hunting on nearby private lands. Protect staging areas in eastern Washington if disturbance becomes a problem.

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 where needed 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 11 April. With an early irrigation regime generally pairs would nest earlier and their young would be capable of flight earlier.

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 10 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 10 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 or mechanical methods could 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 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. 2001). However, several previous Malheur burns were relatively small (<250 ha), and these resulted in most crane pairs moving to nearby unburned areas; 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. Manage 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 unless the line is fitted with markers to increase its visibility. 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. Manage 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, and around Ridgefield National Wildlife Refuge for staging and wintering cranes. 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. Designated crane foraging sites 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 with a half mile (0.8 km) buffer.

8. 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.

8.1. 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.

8.2. Produce sandhill crane status update periodically.
A report describing the status of sandhill cranes in Washington, as well as management activities and their effects, should be prepared and distributed annually, and a more in-depth status update prepared periodically.

9. Develop public information and education programs.

Cranes often serve 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.

9.1. Develop information on crane management opportunities for private and public landowners.
Priority Habitats and Species management recommendations (Bettinger and Milner 2000) should be provided to 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. Where appropriate, site specific plans should be developed for interested landowners,

particularly in and around the Glenwood Valley, and in the Vancouver to Woodland bottoms area.

9.2. Promote crane viewing and festivals in Washington.

Sandhill cranes are large, usually vociferous, behaviorally unique, and generally attract attention. The annual staging of cranes on the Platte River in Nebraska attracts tens of thousands of visitors who contribute $15 million annually to local economies (Grooms 1990). Crane festivals in Texas, New Mexico, California, and southeastern Washington also 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 1,400 people attended the recently established "Annual Sandhill Crane Festival" held in March 2002 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 annual festival event at the Ridgefield National Wildlife Refuge called 'Birdfest' is held each October and should be supported. This event encourages public awareness for birds using the area, thus contributing to and encouraging management efforts and protection of birds in the area including cranes. This is of particular importance, as some habitat is presently under threat of loss in this area.

9.3. Develop educational materials and facilitate local school field trips.

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.

9.4. 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.

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

10.1. 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, most of the production has been by a few pairs, and other 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.

10.2. Study distribution, abundance, subspecific composition, and origin of migrant sandhill cranes in Washington.

A study to assess migrant distribution, abundance, subspecies composition, migration chronology and pathways, summering areas, and habitat use would improve knowledge about cranes in Washington. Most of the wintering cranes, and most of the large cranes staging at Sauvie Island and Ridgefield National Wildlife Refuge may be the Canadian subspecies (G. Ivey, pers. obs.), but additional 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. A study to identify the breeding ground origin, migration pathways, and subspecies composition of migrants using telemetry is currently underway in the Ridgefield area (Ivey et al. *in prep.*). More work is needed to clarify subspecies composition there. Additional studies 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.

10.3. Investigate migrant and winter habitat use on the Vancouver-Woodland and Sauvie Island bottomlands and quantify habitat needs.

The types and quantities of habitat needed by migrant and wintering cranes in southwest Washington should be investigated. Habitat needs in Washington are complicated by the fact that cranes readily fly back and forth across the Columbia to use sites on Sauvie Island, Oregon. Planning of management and habitat restoration activities in the area would be better able to address crane needs with better information. A better understanding of habitat needs is required to identify management and acquisition targets and revised recovery objectives.

11. 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.

11.1. Develop a Washington-Oregon cooperative conservation agreement to maintain the migrant and wintering flocks on the lower Columbia bottomlands (Vancouver to Woodland and Sauvie Island).

Cranes cross the Columbia freely using habitats in both Washington and Oregon. A bi-state agreement that identifies habitat management and acquisition targets would help ensure success of maintaining the agricultural and wetland habitats needed.

11.2. Exchange information between agencies.

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

11.3. 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.

11.4. 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.

11.5. 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 crane 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.

12. Update recovery plan and status report.

12.1. Revise recovery objectives based on research and habitat assessments and identify objectives for de-listing.
Assessment of potential breeding habitat, population monitoring, and studies of habitat use in southwest Washington should provide needed information to identify acreage and management needs for revising recovery objectives. Recovery objectives for de-listing should be identified.

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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	$3,000
2	1.3	Monitor numbers of migrant and wintering sandhill cranes.	WDFW, USFWS	$5,000	$3,000
2	2.1	Inventory and assess potential greater sandhill crane breeding habitat.	WDFW, USFS, USFWS, YIN	$12,000	$8,000
2	2.2	Inventory and assess sandhill crane staging habitat in eastern and southwest 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	$100,000	$50,000
2	3.2	Discourage water projects which would impact habitat.	WDFW, USFWS	$500	$250
2	3.3	Restore and protect wetlands.	WDFW, USFWS, YIN, IWJV	$5,000	$1,000
2	3.4	Protect from harmful livestock grazing.	WDFW, WDNR, USFWS, YIN	$3,000	$500
2	3.5	Insist on enforcement of existing wetland protection laws.	WDFW, USFWS, COE	$2,000	$500
2	3.6	Protect against road construction projects.	WDFW	$500	$500
2	3.7	Consider sandhill cranes in wetland planning projects.	WDFW, USFWS	$1000	$500
2	4.1	Reduce crane chick mortality from hay harvesting.	WDFW, USFWS	$500	0
2	4.2	Reduce mortality from utility transmission lines.	WDFW, USFWS	$1,000	$500
2	4.3	Reduce crane mortality from wire fences.	WDFW, USFWS	$2,000	$1000
2	4.5	Protect nests and chicks from predators.	WDFW, USFWS	$1,000	$500
2	4.6	Protect nests and young from dogs.	WDFW, USFWS	$100	0
2	5.1	Restrict commercial activity in forests near breeding areas.	WDFW, USFS, WDNR,YIN	$600	$200
2	5.2	Restrict or eliminate human disturbance near crane use-areas.	WDFW, WDNR, YIN	tbd	tbd
2	5.3	Restrict low-level aircraft disturbance of cranes.	USFWS, WDNR	$300	0

Implementation Schedule and Cost Estimates (cont'd)

Priority	Task	Description	Responsible agency/entity	Total Annual Cost	WDFW share
2	5.4	Restrict construction disturbance to nesting cranes.	WDFW, WDNR	$500	$250
2	6.1	Implement favorable water management practices	WDFW, USFWS, YIN	$10,000	$500
2	6.3	Implement favorable wetland vegetation management.	WDFW, USFWS	$5,000	$1,000
2	7.1	Implement favorable management of roosting sites.	WDFW, USFWS	$1,000	$300
2	7.2	Implement favorable management of feeding sites.	WDFW, USFWS	$10,000	$3,000
3	8.1	Maintain a repository for crane data, particularly for greater sandhill cranes.	WDFW	$300	$300
3	8.2	Produce sandhill crane status updates periodically.	WDFW, USFWS	$2,000	$1,000
3	9.1	Develop information on crane management opportunities for private and public landowners (one time cost).	WDFW, USFWS, NRCS	$7,000	$5,000
3	9.2	Promote crane viewing and festivals in Washington.	WDFW, USFWS, WCCWG	$1,000	$1,000
3	9.3	Develop educational materials.	WDFW, USFWS, WCCWG	$1,500	$1,500
3	9.4	Promote volunteer efforts to monitor cranes in eastern Washington.	WDFW, USFWS,WCC WG	$2,000	$2,000
2	10.1	Study breeding ecology.	WDFW, USFWS	$10,000	$5,000
3	10.2	Study distribution, abundance, subspecific composition and derivation of migrant sandhill cranes in Washington.	WDFW, USFWS, WCCWG	$18,000	$10,000
2	10.3	Quantify habitat needs for migrant and wintering flocks in southwest Washington.	WDFW, USFWS, WCCWG	$20,000	$10,000
2	11.1	Develop Washington-Oregon conservation agreement for lower Columbia bottonlands	WDFW, USFWS, ODFW	$30,000	$10,000
3	11.2	Exchange information between agencies.	WDFW, USFWS, YIN	$100	$50
2	11.3	Continue interagency working relationships in Glenwood Valley.	WDFW, USFWS	$500	$250
2	11.4	Develop relationships and provide management recommendations to landowners.	WDFW, USFWS, WCCWG	$1000	$300

Implementation Schedule and Cost Estimates (cont'd)

Priority	Task	Description	Responsible agency/entity	Total Annual Cost	WDFW share
3	11.5	Pursue funding and multi-agency collaboration for monitoring off-refuge sites. Efforts to obtain funding should be intensified.	WDFW, USFWS, WCCWG	$1000	$300
3	12.1	Revise recovery objectives and update Plan	WDFW	$2400	$2400

[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.

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 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. Migrant sandhill cranes counted in the Ridgefield National Wildlife Refuge and Sauvie Island area, 1991-2001 (source U.S. Fish & Wildlife Service).

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Location	2 Oct	7 Oct	30 Sep	6 Oct	11 Oct	9 Oct	7 Oct	8 Oct	12 Oct	12 Oct	9 Oct
Campbell Lake, Ridgefield NWR	866	291	441	54	757	983	455	921	1,226	1,583	1,429
Bachelor Is.	0	0	ns[a]	ns	365	111	240	26	73	146	10
River "S", Ridgefield NWR	ns	ns	ns	ns	100	81	126	0	100	0	ns
Post Office Lake, Ridgefield NWR	ns	ns	ns	ns	ns	ns	231	0	ns	0	0
Fowler Lake, Ridgefield NWR	ns	ns	ns	ns	ns	ns	ns	45	18	ns	443
Roth/RVS Dike, Ridgefield NWR	ns	ns	ns	ns	ns	ns	269	0	ns	ns	ns
Vancouver bottoms	ns	40	ns	361	ns	0	ns	ns	ns	ns	327
Rentenaar Point, Sauvie Is., OR	ns	257	595	788	951	507	765	355	51	65	ns
The Narrows, Sauvie Is., OR	851	341	537	836	1,055	1,640	897	1,711	556	730	721
Big Wash, Sauvie Is.,OR	ns	ns	ns	ns	ns	ns	ns	215	522	868	358
Coon Point, Sauvie Is., OR	1,517	1,517	1,460	296	634	293	233	1,000	500	602	702
Gilbert Island, Sauvie Is., OR	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	94
Total	3,234	1,218[b]	2,632[c]	2,335	3,862	3,615	3,216[d]	4,273	3,046	3,994	4,084

[a] ns = not surveyed.
[b] Count missed the peak migration, based on earlier data.
[c] Estimated total after subtracting flocks that were probably counted twice.
[d] Roost counts low due to high water and did not use traditional roosts; many cranes counted in flight and potentially counted more than once; most likely duplications were subtracted from total.

Appendix C. Sandhill cranes counted during aerial surveys[a] on lower Columbia bottomlands, 1994-2000.

Date	Ridgefield NWR	Woodland bottoms	Vancouver bottoms & Shillapoo	Sauvie Is., Scappoose, Deer Island, OR	Total
Mid-winter Survey					
4 Jan 1994	0	40	2	18	60
20 Jan 1995	0	0	0	85	85
10 Jan 1996	55	0	10	125	190
Dec 1996	0	40	0	150	190
3 Jan 1997	10	45	0	105	160
7 Jan 1998	15	0	200	90	305
15 Jan 1999	30	10	2	765	807
4 Jan 2000	0	0	0	50	50
Dark Goose Survey					
14 Nov 1994	100	220	440	485	1245
31 Oct 1995	5	145	170	230	550
4 Nov 1996	0	115	0	35	150
4 Nov 1997	87	475	50	140	752
18 Nov 1999	155	0	0	75	230
Oregon Dept Fish & Wildlife, 1999 Crane Use Surveys					
6 Oct 1999	800	ns	364	1361	2552
22 Oct 1999	168	60	145	45	418
17 Nov 1999	470[b]	520	0	494	1484
10 Dec 1999	36	0	0	452	488

[a]Data provided by U.S. Fish and Wildlife Service.
[b] Includes 250 cranes on Bachelor Island.

Appendix D. Sandhill crane records for eastern Washington in migration, 1955-2001[1].

Location	County	Number	Date	Comments
SPRING (Jan - Jun)				
near Sprague Lake	Lincoln	100±	3 Apr 1955	R. Ward
near Sprague Lake	Lincoln	30	17 Apr 1955	Spokane Birding Club
Spokane area	Spokane	11	20Apr 1955	flying over; R. Ward
Little Spokane River	Spokane	7	26 Mar 1956	flying over; M. Haggin
near Sprague	Lincoln	80	13 Apr 1957	W.Hall/L.LaFave
near Sprague	Lincoln	200±	11 Apr 1959	Spokane Birding Club
Sprague area	Lincoln	600±	22 Mar 1960	L. LaFave
Sprague area	Lincoln	155±	20 Mar 1961	Spokane Birding Club
Sprague area	Lincoln	80	28 Mar 1961	Spokane Birding Club
Reardan area	Lincoln	50	2 Apr 1961	Spokane Birding Club
near Harrington	Lincoln	150	16 Apr 1961	Spokane Birding Club
Sprague area	Lincoln	175+	31 Mar 1962	J. Acton
Liberty Lake/Saltese	Spokane	22	31 Mar 1962	
N of Sprague	Lincoln	150+	8 Apr 1962	Spokane Birding Club
Columbia Nat. Wildl. Refuge	Grant	20	15 Apr 1962	flying; P. Lehenbauer
7 mi NE Sprague	Lincoln	300+	spring 1962	L. LaFave
Sprague area	Lincoln	300	24 Mar 1963	J. Acton
near Sprague	Lincoln	100+	2 Apr 1963	Spokane Audubon
6 mi N Sprague	Lincoln	7	6 Apr 1963	L. LaFave/W.Hall
11 mi SE Harrington	Lincoln	9	13 Apr 1963	L. LaFave
Columbia Nat. Wildl. Refuge	Grant	-	20 Mar 1964	first flights of year; P. Lehenbauer
St. Andrews area	Douglas	420	29 Mar 1964	J. Acton
5 mi N Sprague	Lincoln	12-15	5 Apr 1964	W. Hall/L. LaFave
Sprague	Lincoln	6	18 Apr 1964	J. Acton
Columbia Nat. Wildl. Refuge	Grant	3	7 May 1964	unusually late; P. Lehenbauer
Sprague area	Lincoln	300+	13 Mar 1965	early; J. Acton
Sprague area	Lincoln	500	28 Mar 1965	Spokane Audubon
near Sprague	Lincoln	100+	3 Apr 1965	W. Hall
Sprague area	Lincoln	75+	26 Mar 1966	W. Hall
St. Andrews	Douglas	800	3 Apr 1966	
near Sprague	Lincoln	400+	18 Mar 1967	W. Hall
St. Andrews	Douglas	1,000	mid-Mar 1967	
Turnbull Nat. Wildl. Refuge	Spokane	25	19 Jan 1978	flying over
N of Sprague	Lincoln	40	23 Mar 1968	Flying north; Spokane Audubon
Sprague area	Lincoln	300+	6 Apr 1968	Spokane Audubon
Sprague area	Lincoln	15	23 Mar 1969	Spokane Audubon
near Almira	Lincoln	17	20 Apr 1969	W. Hall
St. Andrews	Douglas	2,000	18 Apr 1970	
Sprague area	Lincoln	20	22 Mar 1970	Spokane Audubon

Appendix D. Migrant crane records in eastern Washington (cont'd)

Location	County	Number	Date	Comments
Richland	Benton	105+	30 Apr 1970	
Yakima	Yakima	32	3 May 1970	Flying high
St. Andrews area	Douglas	100's	Mar 1971	Spokane Audobon
Sprague area	Lincoln	50	27 Mar 1971	Spokane Audubon
Columbia Nat. Wildl. Refuge	Grant	16	2 Apr 1971	feeding in corn
Sprague area	Lincoln	20	17 Mar 1972	W. Hall
1 ½ mi S St. Andrews	Douglas	1000-1500	22 Mar 1972	resting on pond; R. Friesz
1 ½ mi S St. Andrews	Douglas	500-600	29 Mar 1972	R. Friesz
Richland	Benton	20	4 April 1972	flying high; P. Woodley
Leahy Junction area	Douglas	100's	19 Apr 1972	circling: R. Friesz
McNary Nat. Wildl. Refuge	Walla Walla	200	20 Apr 1972	circling; E. Barney
Horse Heaven Hills	Yakima	100±	27 April 1972	E. Boohay
St. Andrews	Douglas	200	8 Apr 1972	
McNary Nat. Wildl. Refuge	Benton	200	20 Apr 1972	Circled
1 ½ mi S St. Andrews	Douglas	250	Mar 1973	R. Friesz
1 ½ mi S St. Andrews	Douglas	1000-1500	Mar 1973	resting on pond; R. Friesz
Yakama Indian Reservation	Yakima	12	2 Mar 1973	flock; E. Cardiff
McNary Dam	Benton	1	10 Mar 1973	feeding; C. Corder
Sprague area	Lincoln	300+	25 Mar 1973	J. Acton
Sprague area	Lincoln	21	5 Apr 1973	W. Hall
St. Andrews	Douglas	3,000	13-14 Apr 1973	
Mansfield	Douglas	500-700	21 Apr 1973	
McNary Nat. Wildl. Refuge	Walla Walla	100	22 Apr 1973	flying over; E. Barney
Richland	Benton	42	2 May 1973	flying; E. Hanson
St. Andrews	Douglas	3,000	May 1973	flying; M.Sharp
Pumphouse Pond, Yakama Indian Reservation	Yakima	2	22 May 1973	flying; E. Grassman
N of Sprague	Lincoln	19	14 Mar 1974	Spokane Audubon
Ellensburg area	Kittitas	5	16 Mar 1974	R. Dixon
Richland	Benton	150	18 Mar 1974	flying; S. Smith
St. Andrews	Douglas	600	13 Apr 1974	
Trinidad area	Grant	small flock	14 Apr 1974	flying N; P. Cheney
Parker Heights	Yakima	60-70	2 May 1974	tried to land on lawn; Mrs. C.Olsen
Sawyer area	Yakima	100's	spr 1974	flew over
1 mi S Lowden	Walla Walla	4	25 Feb 1975	L.Colburn/F. Perry
Okanogan R., Ellis Forde	Okanogan	1	8 Apr 1975	R. Friesz
nr Ft. Okanogan	Okanogan	25±	20 Apr 1975	E. Hunn
SW St. Andrews	Douglas	several 100's	23 Apr 1975	P. Cheney
below Parker	Yakima	2	16 Feb 1976	A. Horschel
McNary Nat. Wildl. Refuge	Walla Walla	1	18 Feb 1976	subadult

Appendix D. Migrant crane records in eastern Washington (cont'd)

Location	County	Number	Date	Comments
Parker Heights	Yakima	60	Apr 1975	Tried to land on lawn
N of Sprague	Lincoln	39	21 Mar 1976	Spokane Audubon
Othello	Adams	70	31 Mar 1976	flying; E. Sipeo/J.Good
NW Sim's Corner	Douglas	200	31 Mar 1976	flushed from field; R.Friesz
St. Andrews	Douglas	3,000	10 Apr 1976	
Okanogan	Okanogan	75	10 Apr 1976	flights of 50, 25; R.Friesz
S St. Andrews	Douglas	40	16 Apr 1976	P. Cheney
2 mi SE Sim's Corner	Douglas	500-600	20 Apr 1976	feeding in wheat stubble; R. Friesz
Okanogan-Pogue Mt.area	Okanogan	100-150	24 Apr 1976	R. Friesz
Buena Heights	Yakima	100	29 Apr 1976	Yakima Audubon
Kittitas	Kittitas	700	30 Apr 1976	roosted
Chief Joseph Pool	Douglas	9	26 Feb 1978	flying above river; B.Langstaff
4 mi W Omak Lake	Okanogan	60	Mar 1978	in plowed field; R.Starkey
Benton City	Benton	100	11 Mar 1978	flying; R. Fitzner
5 mi S Irby	Lincoln	13	15 Mar 1978	flying low westerly
Moses Lake area	Grant	100	16 Mar 1978	flying N; D. Blatt
Ephrata	Grant	49	16 Mar 1978	flying N; R. Friesz
1 1/4 mi W St. Andrews	Douglas	800-1000	20 Mar 1978	resting on lake; R. Friesz
8 mi SE Mansfield	Douglas	1200	29 Mar 1978	feeding in stubble; Dr.Stout/R.Friesz
near Cow Lake	Adams	-	1 April 1978	D. Whiteman
St. Andrews	Douglas	3000-5000	9 Apr 1978	pond; W. Hall
Pine Creek area	Okanogan	125	10 Apr 1978	2 flights (75, 50) headed N; R. Friesz/J. Danielson
5 mi. W of Othello	Adams	100+	11 Apr 1978	in corn stubble; T. Flint
Leader Lake	Okanogan	14	13 Apr 1978	flying N; C. Christensen
Stevens Lake	Okanogan	18	14 Apr 1978	flying N; B. Hebner
4 mi SE Mansfield	Douglas	316	14 Apr 1978	feeding flights; R. Friesz
Bridgeport Bar islands	Douglas	7	15 Apr 1978	resting/preening; V. Marr
near Sprague	Lincoln	46	16 Apr 1978	Spokane Birding Club
Aeneas Mt	Okanogan	2000-3000	17 Apr 1978	flying N; J.King/D.Zeigler
2 mi N Sim's Corner	Douglas	199	17 Apr 1978	R. Friesz
Ephrata	Grant	100	19 Apr 1978	flying N; D.Zeigler
Park Lake	Grant	300	19 Apr 1978	flying NW; B.Zook/D.Blatt
Haynes Lake	Douglas	150-200	22 Apr 1978	P. Cheney
Brewster	Okanogan	200	23 Apr 1978	flying N; D. Bowman
Conconully Lake	Okanogan	30	23 Apr 1978	flying due N; R.Friesz
Wells Dam	Douglas	250+	24 Apr 1978	migrating N; V. Marr
4 mi SE Mansfield	Douglas	several 100s	27 Apr 1978	flying; L.Carrin/D. Whitmire
S end of Chopaka Lake	Okanogan	49	27 Apr 1978	circling lk; B. Hebner
Horse Spring Coulee	Okanogan	250	28 Apr 1978	flying high up; B. Hebner

Appendix D. Migrant crane records in eastern Washington (cont'd)

Location	County	Number	Date	Comments
Twisp area	Okanogan	30	30 Apr 1978	flew over; B. Alexander
Brewster	Okanogan	300	30 Apr 1978	flying N; D. Bowman
Crab Creek	Lincoln	500	30 Apr 1978	
O'Sullivan Dam area	Grant	450	30 Apr 1978	Yakima Audobon
near Chewelah	Stevens	1	14 May 1978	S.Zender
E of Sylvan Lake	Lincoln	4	12 Mar 1979	feeding in stubble
Squaw Cr., Yakima Firing Ctr	Yakima	20+	18 Mar 1979	flying; H. Beecher
Creston Butte area	Lincoln	2	26 Mar 1979	J. Hickman
St. Andrews	Douglas	150-200	26 Mar 1979	in stubble; D. Zeigler
Hallin Lake area	Adams	30	31 Mar 1979	resting; D. Whiteman
St. Andrews	Douglas	2,500-3,000	early-mid Apr '79	
Desert Wildlife Area	Grant	500+	5 Apr 1979	flying; J. Evans
4 mi S Ephrata	Grant	200	6 Apr 1979	flying; J. Evans
Winchester Wasteway	Grant	150	14 Apr 1979	flying high; T. Thompson
Browns Lake area	Okanogan	17	14 Apr 1979	flying N; J. King
Winchester Wasteway	Grant	150	19 Apr 1979	circling; J.Selch/T. Thompson
Saddle Mtn Game Range	Grant	8	22 Apr 1979	flying over
Bridgeport Bar	Douglas	225±	27 Apr 1979	flying N; M.Hallet
W of Yakima	Yakima	100-150	27 Apr 1979	circling Summitview
Crescent Bar	Grant	19	23 Feb 1980	N.Central Wa Audubon
between Adrian & Stratford Rd	Grant	35-40	18 Mar 1980	circling; G.Call
St. Andrews	Douglas	3000-5000	5 Apr 1980	N.Central Wa. Audubon
Rat lake	Okanogan	53	13 Apr 1980	flying N; V Marr
St. Andrews	Douglas	1000-1500	14 Apr 1980	scattered flocks feeding; R. Friesz
Keystone	Adams	4	16 Apr 1980	feeding; Phillips
Ephrata	Grant	300	21 Apr 1980	flying: B Jahn
Sunnyside Wildlife Area	Yakima	73	22 Apr 1980	flying N; J McGowan
Salmon Creek	Okanogan	4000-5000	24 Apr 1980	circling, flying N; J King
Burbank	Walla Walla	200±	24 Apr 1980	flying; M.Quinn
Short Mtn	Okanogan	48	25 Apr 1980	flying N; J Danielson
10 mi S Creston	Lincoln	119	15 Apr 1981	2 flocks headed NW; J. Hickman
Wenas Lake	Yakima	3	20 June 1981	flew in pm, gone in am; J Smith/B Lamb
Richland	Benton	75	7 Mar 1982	Lower Col.Basin Audubon
S of Othello	Adams	1000±	15 Mar 1982	feeding; J. Coykendall
Moses Lake	Grant	200-250	19 Mar 1982	flying N; W. Myers
Moses Lake	Grant	300-350	22 Mar 1982	flying N; W. Myers
Othello	Adams	2,000	early Apr 1982	
St. Andrews	Douglas	1,500	early Apr 1982	
N of Sim's Corner	Douglas	1500-2000	5 Apr 1982	flying; R. Friesz
N of Sim's Corner	Douglas	2000-3000	13 Apr 1982	flying; D. Zeigler

Appendix D. Migrant crane records in eastern Washington (cont'd)

Location	County	Number	Date	Comments
Bridgeport Bar	Douglas	35	21 Apr 1982	flying; M. Hallett
High Prairie Campgrd (T3N R13E)	Kittitas	60-70	23 Apr 1982	flying; Bellingham
"Scoot Barrs"	Lincoln	250-300	11 Apr 1983	flying S/SW; T Hood
Rocklyn	Lincoln	46	17 Apr 1983	flying NW; J.Hickman
Starzman Lake	Okanogan	550±	24 Apr 1983	circling
Yakima R, Dammon Rd bridge	Kittitas	21	4 May 1983	flying; Swedberg
Richland	Benton	400-500	21 Apr 1984	3 flocks flying over
Conconully	Okanogan	5,000-6,000	16 Apr 1984	Flying over
Blue Creek	Stevens	4	23 Apr 1984	C. Loggers
Hollebeke Habitat Mgmt Area (on Snake River)	Walla Walla	1	26 June 1985	feeding in inlet; C.Smith
Sprague Lake	Lincoln	11	16 Mar 1986	T.Hood
St. Andrews	Douglas	2,000	15 Apr 1986	
Othello	Adams	-	23 Feb 1988	Arrival date
St. Andrews	Douglas	1,200	21 Apr 1989	
Waukon	Lincoln	500+	9 Apr 1995	WOSNews[b]
Waukon	Lincoln	900	26 Mar 1996	WOSNews
Columbia Nat. Wildl. Refuge	Adams/Grant	10,000	7 Mar 1996	Estimate; WOSNews
Scootenay Reservoir	Franklin	1,000	3 April 1996	WOSNews
Othello	Adams	1,200	6 Apr 1996	
Sims Corner	Douglas	2,000	13 Apr 1997	High count
Scooteney Reservoir	Franklin	1,200	17 Mar 1998	WOSNews
Browns Lake	Lincoln	800	25 Mar 1998	WOSNews
Drumheller Rd	Spokane	450	25 Mar 1998	WOSNews
Atkins Lake	Douglas	1,300	15 Apr 1998	WOSNews
Alderdale	Klickitat	500	26 Apr 1998	WOSNews
Colville River Valley	Stevens	1	Spring 1999	C. Loggers
Scooteney Reservoir	Franklin	900	6 Mar 1999	WOSNews
Columbia Nat. Wildl. Refuge	Adams/Grant	4,500	31 Mar 1999	High count
Loomis	Okanogan	2,230	21 Apr 1999	WOSNews
Columbia Nat. Wildl. Refuge	Adams/Grant	2000	29 Mar 2000	
Browns Lake	Lincoln	600	17 Mar 2001	WOSNews
Othello	Adams	1000	23 Mar 2001	WOSNews
AUTUMN (Jul - Dec)				
Clarkston	Asotin	3	23 Aug 1946	Murrelet 32:23-24
Cow Lake area	Adams	2	6 Sep 1958	W Hall/L.LaFave
Banks Lake	Grant	13	10 Sept 1960	L.Kline
St.Andrews area	Douglas	262	21 Oct 1962	J. Acton
Soap Lake	Grant	60+	6 Oct 1963	J.Acton

Appendix D. Migrant crane records in eastern Washington (cont'd)

Location	County	Number	Date	Comments
Banks Lake	Grant	1	3 Sep 1964	W.Hall
McNary Nat. Wildl. Refuge	Walla Walla	70	30 Sep 1964	M.Aldons
Stubblefield Lk, Turnbull NWR	Spokane	3	7 Oct 1964	Barwey
Alkali Lake	Grant	27	11 Oct 1964	L.LaFave
Banks Lake	Douglas	10	9 Oct 1966	J.Acton/W.Hall
Banks Lake	Douglas	1,000+	14 Oct 1966	J.Acton/W.Hall
Stubblefield Lk, Turnbull NWR	Spokane	3	22 Aug 1967	J.Malcom
W of Spokane	Spokane	5	22 Oct 1967	Spokane Audubon
Walla Walla	Walla Walla	8	1 Sep 1969	In harvested corn field
Turnbull Nat. Wildl. Refuge	Spokane	3	4 Sep 1969	
Calispell Lake	Stevens	14	28 Sep 1969	Flying over: W.Hall
tri-cities	Benton	75	2 Oct 1970	E.Moore
Desert Wildlife Area	Grant	15	18 Aug 1971	flying; P.Cheney
tri-cities	Benton	many	23 Sep 1971	flying (200 at a time); E.Moore
Columbia Nat. Wildl. Refuge	Grant	1	21 Nov 1971	D. Brown
tri-cities area	Benton	27	15 Sep 1972	E.Moore
Moses Lake	Garnt	93	24 Sep 1972	2 flocks, circling S; R.Friesz
nr Lowden	Walla Walla	75	3 Oct 1973	S.Muse
tri-cities area	Benton	150	4 Oct 1974	flying; C.Corder
tri-cities area	Benton	150	13 Oct 1974	flying; T.Greager
Yakima Delta	Benton	3	10 Nov 1974	1 crippled; R.Woodley
tri-cities	Benton	300	12 Oct 1975	R.Woodley
Columbia Nat. Wildl. Refuge	Grant	30	21 Oct 1975	over Royal Lk; D.Brown
Columbia River -near Vantage	Kittitas	50	24 Oct 1975	R Dixon
near Lowden	Walla Walla	8	3 Nov 1975	R.Morgan/S.Muse
tri-cities	Benton	600+	26 Sep 1976	flying over daily; R.Fitzner
McNary Nat. Wildl. Refuge	Walla Walla	25	3 Oct 1976	E.Hunn
St.Andrews/Dry Falls area	Douglas	300	7 Oct 1976	D. Paulson
Murphy Lakes	Douglas	610	17 Sep 1977	V. Marr
Washburn Is, Wells Pool	Okanogan	2	26 Sep 1977	flying; B.Langstaff
Richland	Benton	64	2 Oct 1977	flying; R.Fitzner
4 mi NE Oroville	Okanogan	50-60	22 Sep 1978	flying SE; J.Danielson
Aeneas Mtn	Okanogan	40	23 Sep 1978	flying S: J.King
W side Sinlahekin Valley	Okanogan	180	24 Sep 1978	flying S
Potholes Reservoir	Grant	29	25 Sep 1978	flying N; D.Blatt/B.Zook
1 ½ mi S St. Andrews	Douglas	1011	29 Sept 1978	resting/feeding; D.Dotson/T.Thompson
Freidlander Lk, Colville Indian Res	Okanogan	1,000±	1 Oct 1978	resting at lake C.Rieck/R.Knight
near Davenport	Grant	3	1 Oct 1978	wading in crk; J.Hickman
Royal Slope area	Grant	75	2 Oct 1978	flying S; G.Call

Appendix D. Migrant crane records in eastern Washington (cont'd)

Location	County	Number	Date	Comments
7 mi E Davenport, headwaters Cottonwood Cr	Grant	1	12 Oct 1978	flying; J.Hickman
Tonasket	Okanogan	74	20 Sep 1979	flying S; J.Danielson
Omak	Okanogan	34	1 Oct 1979	flying S; J.Danielson
Monse	Okanogan	780	2 Oct 1979	feeding in grain field; V.Marr
St. Andrews	Douglas	75	15 Oct 1979	flying; R.Friesz
Hq.Pond, Turnbull Nat. Wildl. Ref	Spokane	1	22 Oct 1978	feeding; J & M Hickman
Crab Creek HMA	Grant	29	5 Oct 1979	flying; A.Bakker
Reardon, Audubon Lake	Lincoln	1	6 Oct 1979	flying; D.Casper
near Davenport	Lincoln	8	7 Oct 1979	feeding in stubble
Potholes Reservoir	Grant	several 100s	18 Oct 1979	flying; R.Friesz
Lime Lk (near Metaline Falls)	Pend oreille	3	23 Oct 1979	in field; S.Zender & Burke
N of Walla Walla	Walla Walla	70	27 Oct 1979	flying; D.Mudd/L.Boe
Calispell Lake	Pend Oreille	3	Sep 1980	S. Zender
Short Mtn	Okanogan	100	17 Sep 1980	flying,circling; V.Marr
Ephrata	Grant	250±	18 Sep 1980	flying S; R.Friesz
Anatone	Asotin	1	Jul-Aug 1981	Canyon Birders Audubon
Fields Spring State Park	Asotin	4	26 Jul 1981	Canyon Birders Audubon
Selah gravel pits	Yakima	1	7 Aug 1981	in brush; P. Mongillo
E of Othello	Adams	45	29 Sep 1981	flying; T&R Lloyd
Murphy Lakes	Douglas	2	1 Oct 1981	dead under powerlines
Ice Harbor Dam	Walla Walla	100	28 Sep 1982	flying S; D.Mudd
near Chief Joseph Dam	Douglas	60-65	13 Sep 1983	flying; Hallett & Marr
Grand Coulee	Grant	1,000	17 Sep 1983	
Soap Lake	Grant	500	20 Sep 1983	Flying S; D.Parker
Omak	Okanogan	30	11 Sep 1984	flying S; R.Friesz
Aeneas Mtn Lookout	Okanogan	100±	21 Sep 1984	R&RLloyd
Walla Walla River	Walla Walla	1	13 Sep 1986	Wallula Delta
Badger Canyon	Benton	400	28 Sep 1986	flying; H.Porter
Richland	Benton	200	28 Sep 1986	flying; M Gregor
Columbia Nat. Wildl. Refuge	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	
Waterville Plateau	Douglas	400	1 Oct 1995	
Richland	Benton	400	12 Oct 1995	
Ione Bridge	Pend Oreille	small flock	Autumn 1995	C. Loggers
Toppenish Creek	Yakima	2	26 Sep 1997	R. Leach
Yakima River Delta	Benton	100	19 Sep 1998	
Othello	Adams	5,000	21 Sep 1998	
Columbia Nat. Wildl. Refuge	Adams/Grant	1,000+	4 Oct 1999	WOSNews

Appendix D. Migrant crane records in eastern Washington (cont'd)

Location	County	Number	Date	Comments
12 mi E Othello	Adams	4	2 or 3 Aug 2001	flying toward Scooteney Res.; G. Ivey
Sheep Lake	Whitman	2	11 Aug 2001	D. Weber, Inland NW Birders
Tiger Meadows, 7 mi SSW Ione	Pend Oreille	1	summer-early Nov 2001	J. McGowan

[a] Records from *American Birds*, *Audubon Field Notes*, *Field Notes*, *North American Birds*, Washington Department of Game (1979), or WDFW files, unless otherwise noted. Most records probably lesser sandhill cranes.

[b] Source is Washington Field Notes, in *WOSNews*, the newsletter of the Washington Ornithological Society, Seattle.

Appendix E. Sandhill crane records for western Washington[1], 1965-1986 (*from* Littlefield 1999a and WDFW files) and 1993-2001(*from* WOSNews and USFWS files).

Location	County	Number	Date	Comments
SPRING (Jan - June)				
Westport	Grays Harbor	1	12 June 1927	flying; E.Kitchen
Lincoln Creek, near Centralia	Lewis	10	26 Apr 1972	marshy area; C. Smith
Shillapoo Lake	Clark	20-40	26 Apr 1972	B. Howe
Skagit Wildlife Area	Skagit	2	6 Apr 1975	B.Harrington-Twiet et al.
mouth of Humptulips River	Grays Harbor	1	19 Apr 1975	Black Hills Audubon
Skagit Flats	Skagit	10	Apr-early May 1975	
Stiegerwald Lake	Clark	9	25 Feb 1976	feeding; W. Cady
Ridgefield National Wildlife Refuge	Clark	15	13 Mar 1976	
between Maytown & Tenino	Thurston	1	18 Apr 1976	Black Hills Audubon
Dungeness	Clallam	3	7 May 1976	S. Smith
Dungeness	Clallam	3	5 Apr 1977	D. Smith
Dungeness	Clallam	3	12 Apr 1977	D. Smith
4 mi NE Fife	Pierce	1	Apr 1977	R. Starkley
Puyallup	Pierce	1	1/21-2/17/1978	feeding; S.Fink
Woodland	Cowlitz	90+	11 Mar 1978	feeding, corn stubble; Suhadolnik
W of Woodland	Cowlitz	13	25 Mar 1978	Suhadolnik
Woodland	Cowlitz	90+	11 Apr 1978	feeding, corn stubble; L. Kerr
Bachelor Island	Clark	250+	11 Apr 1978	feeding w/geese; R.Peolker
Neah Bay	Clallam	157+	11 Apr 1978	migrating; L.Stream/C. Rieck
Neah Bay	Clallam	200	11 Apr 1978	L.Kerr
Snoqualmie Wildlife Area	King	1	15 Apr 1978	C. Young
Tatoosh Island	Clallam	25	6 May 1978	Flying north off Cape Flattery
near Grass Creek	Grays Harbor	2	27 May 1978	H. Penttila
Forks	Clallam	43	14 Mar 1979	flying over; S. Miller
Ridgefield National Wildlife Refuge	Clark	400±	24 Mar 1979	Tahoma Audubon
Camano Island	Island	12	27 April 1979	flying N toward Skagit Bay; Stendal
Stanwood area	Snohomish	1	10 May 1979	feeding in marshy pasture; B.Dreher
E of Sedro-Woolly	Skagit	5	4 Jan 1980	feeding; Stendal & Parker
Burlington	Skagit	1	early 1980	Pilchuck Audubon
Oyhut Wildlife Area ("Ocean Shores Game Range")	Grays Harbor	1	20 Apr 1980	Tahoma Audubon
Woodinville	King	1	10 May 1980	Seattle Audubon
near Sequim	Clallam	3	10 June 1980	flying; Seattle Audubon
Austin Point, NW of Ridgefield	Cowlitz	2	June 1980	Austin Pt. DEIS
Enumclaw	King	1	3 May 1981	feeding/flying; B&C Sweigard
near Montesano	Grays Harbor	150	spring 81-82	feeding; J.Raymond
E of Barney Lake	Skagit	1	13 Mar 1982	Pilchuck Audubon
Ridgefield National Wildlife Refuge	Clark	35	1 Apr 1982	feeding w/ geese; B.Everitt
Post Office Lk, Ridgefield NWR	Clark	9	1 Apr 1982	feeding w/ geese; B.Everitt

Appendix E. Crane records for western Washington (cont'd)

Location	County	Number	Date	Comments
mouth of Lewis River	Clark	18	20 Apr 1982	flying; P. Miller
Cape Flattery	Clallam	11	1 May 1982	Stopped at mouth of Waatch R.
Ridgefield National Wildlife Refuge	Clark	38	18 Mar 1984	flying/feeding; B. Leonard
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
near Longview	Cowlitz	82	14 Apr 1986	flying/feeding; P. Millar?
Willapa Bay	Pacific	53	12 Apr 1994	
Skagit Flats	Skagit	4	24 Mar 1995	flew over
Aberdeen	Grays Harbor	80-90	11 Apr 1995	
Cape Flattery	Clallam	500	4 Apr 1996	1,104 from 3-28 Apr.
Vancouver bottoms	Clark	500	3 Jan 1998	E. Anderson
Elma	Grays Harbor	17	6 May 1998	
Vancouver bottoms	Clark	1210	24 Feb 1999	T.Sutera, USFWS
Vancouver bottoms	Clark	1214	2 Mar 1999	T.Sutera, USFWS
Shelton Airport	Mason	29	5 May 1999	15 on 3 Apr
Point No Point	Kitsap	12	26 Mar 2000	
Snow Creek	Clallam	150	12 Apr 2000	
Hoquiam	Grays Harbor	91	8 Apr 2001	
AUTUMN (July-Dec)				
S of Snohomish	Snohomish	6	Oct 1957	Murrelet 38:36-37
Cape Flattery	Clallam	68	24 Aug 1974	
Skagit Flats	Skagit	17	25 Sep 1965	
near Chehalis River	Lewis	25	Sep 1971	flying; J. Howerton
Vancouver Lake area	Clark	-	25 Aug 1972	D. Blaire
Everett	Snohomish	-	Oct 1972	On tidal flats
Cape Flattery	Clallam	25	4 Sep 1975	Flew south
3 mi W Langley	Island	30	Oct 1975	marshy area; R.Fitzner
S of Lynden	Whatcom	3	22 Oct 1975	flying; J. Skriletz
Skagit Wildlife Area	Skagit	9	1 Oct 1976	flying; T. Lloyd
Nisqually National Wildlife Refuge	Thurston	2 or 3	3 Oct 1976	D. Castron; A. Nikerson
near Beaver	Clallam	25	23 Sep 1977	G.Pavel
Skagit WLA	Skagit	1	15 Sep 1977	flying; N.Cascades Audubon
Lake Crescent	Clallam	6	Sep 1977	flying; A.Bennett
Packwood area	Lewis	1	11 Oct 1977	immature; R. Scharpf
Shillapoo marsh	Clark	lg. flock	30 Dec 1977	C. Stockley
Montesano area	Grays Harbor	6	17 Sep 1978	flying; H. Penttila
S of LaPush	Clallam	7	5 Oct 1978	flying; A. Raminer
Bogachiel R. nr Forks	Clallam	3	6 Oct 1978	T. Rymer
N of LaPush	Clallam	9	14 Oct 1978	flying over; R. Harkins

Appendix E. Crane records for western Washington (cont'd)

Location	County	Number	Date	Comments
Ridgefield National Wildlife Refuge	Clark	140	5 Nov 1978	L.Bauman/C. Mann
Nisqually National Wildlife Refuge	Thurston	6	28 Sep 1979	feeding; Tahoma Audubon
Skagit WLA	Skagit	4	3 Oct 1979	flying; J. Garrett
Riffe Lake	Lewis	-	9 Oct 1979	feeding; G. Oakerman
Cattle Pt., San Juan Is.	San Juan	2	11 Nov 1979	flying; Seattle Audubon
Stanwood	Snohomish	3	9 & 21 Nov 1979	feeding; R. Johnson; B.Dreher
near Enumclaw	King	7	20 Aug 1980	feeding; CB Richards
Neah Bay	Clallam	15	8 Sep 1980	flying; D&S Smith
Nisqually National Wildlife Refuge	Thurston	2	13 Sep 1980	T. Bock
Magnuson Park, Seattle	King	1	14 Sep 1980	flying; Seattle Audubon
Julia Butler Hansen Nat.Wildl. Refuge	Wahkiakum	115	14 Sep 1980	flying SE; A. Clark
S of Artic	Grays Harbor	10	early Oct 1980	flying S; T. Owens
Univ. District, Seattle	King	2	12 Oct 1980	flying; Seattle Audobon
Skagit Wildlife Area	Skagit	5	12 Oct 1980	flying SE; J. Garrett
Nisqually National Wildlife Refuge	Thurston	-	19 Oct 1980	T. Bock
Stanwood	Snohomish	1	Oct 1980	feeding; N.Cascades Audubon
I-5 Arlington Exit	Snohomish	2	21 Nov 1980	flying; B.Kavanaugh/H.Beecher
Glenoma	Lewis	1	14 July 1981	flying; Tahoma Audubon
Dungeness golf course	Clallam	6	30 Oct 1981	flying; D. Smith
Nisqually National Wildlife Refuge	Thurston	2	12 Sep 1981	R. Hudson/J Kooser
Dungeness	Clallam	-	12-14 Sep 1981	First migrants arrived
Grays River	Wahkiakum	10-15	16 Sep 1982	Flocks
west Dungeness	Clallam	10-15	27 Oct 1982	flying; S. Smith
E of old Hwy 99 & Hwy 530	Snohomish	1	16 Oct-7 Nov 1983	immature; T. Spencer
Trap Creek, near Willapa	Pacific	7	17 Sep 1984	6 large, 1 small; B&P Steere
Ridgefield National Wildlife Refuge	Clark	800-900	16 Oct 1984	feeding; B. Wiseman
Vancouver bottoms	Clark	50	17 Nov 1985	flying; J. Zarnowitz
Tumwater	Thurston	2	20 Sep 1986	flying/calling; T. Owens
Montesano	Grays Harbor	10	20 Sep 1995	
Elma	Grays Harbor	29	29 Sep 1995	
Olympia	Thurston	15	2 Sep 1996	12 at Nisqually NWR on 9/22
Menlo	Pacific	5	24 Sep 1996	
Custer	Whatcom	10	30 Sep 1996	
Salt Creek County Park	Clallam	52	5 Oct 1997	26 on 9/30
Tokeland	Pacific	8	21 Sep 2000	
Elma	Grays Harbor	7	24 Sep 2000	
Dungeness	Clallam	300	14 Nov 2000	
Pierce National Wildlife Refuge	Skamania	2	19 Sep 2001	flying over; another small group heard attempting to roost at NWR or on nearby shore; J. Engler

[1] See also Appendix B for additional crane records on the lower Columbia bottomlands.

Section	Comment and response
Natural History	The plan does not devote sufficient attention to lesser sandhill cranes that stage in Washington, particularly the Coastal Segment that uses the Ridgefield NWR and Vancouver and Woodland bottomlands. All subspecies of sandhill are listed as endangered in Washington.
	Although the breeding greater sandhills were the focus of the listing, we agree that technically all subspecies are listed, and conservation of migrants, particularly the coast group is important. Some greater sandhills may use the same habitat as the other subspecies during migration, and the Canadian sandhill population may also be imperiled. We have increased the attention devoted to migrant and wintering cranes in the state.
	The migration section focuses almost exclusively on greater sandhills, and should address lessers and the staging areas used by the coastal segment.
	We added some material on lesser and Canadian sandhills.
	Table 3 is misleading, because it might be interpreted to indicate an increase in cranes at Ridgefield/Sauvie, but this is probably due to increased effort; surveys have not been comprehensive or systematic.
	We added a footnote to clarify this point.
Habitat Requirements	Please add a paragraph about wintering at Ridgefield
	Done.
Factors Affecting	The "Factors affecting" discussion should include a section on staging areas; widespread hunting in the wet meadows where lessers feed and loaf threatens the continued use of the Coastal Segment staging area. The City of Vancouver is building a bicycle path through part of the feeding area in the Port of Vancouver Gateway Properties.
	We added a section on human disturbance and mentioned these problems.
	The staging and wintering habitat in the Vancouver/Woodland bottomlands area is crucial habitat of migrating cranes, yet the Port of Vancouver proposes to develop 422 ha for industry.
	We have added discussion of this issue in the Plan.
	The value of Ridgefield/Vancouver Lake bottomlands for cranes is threatened by Corps of Engineers/Port of Vancouver proposals to mitigate wetland loss by focusing on open water duck habitat.
	We added mention of this to the section on waterfowl enhancement.
Recovery Objectives	Criteria for down-listing focuses exclusively on greater sandhills; criteria should address the coastal segment of lesser sandhills.
	We added an objective to secure and manage staging and wintering habitat on the lower Columbia bottomlands in order to down-list to sensitive.
	The population objectives for down-listing should be increased, or there should be separate targets for inside Conboy refuge and areas outside the refuge.

Section	Comment and response
	We revised the recovery objectives and included a stipulation that a portion of the breeding population occur outside the Glenwood Valley..
Rationale	The recommendation to secure habitat for migrants (in Rationale of recovery section) should not be limited to eastern Washington.
	We revised this.
Recovery Strategies and Tasks	All the management recommendations in Priority Habitats and Species should be included in the list of recovery strategies.
	Recovery plans are not intended to give detailed management recommendations (such as avoid fall plowing, etc), but more broadly outline strategies.
	We strongly support the recommendation (Task 1.3) for more comprehensive efforts to survey migrating cranes by subspecies.
	More data is definitely needed on subspecies representation in the migrants in western Washington, but they can reliably be distinguished in the field only by experienced observers. Capture and marking projects will be needed to gather this and to refine knowledge about migration and breeding grounds. One such project is underway.
	The recommendation (Task 2.2) to assess migration habitat should not be limited to eastern Washington.
	Agreed. We revised this.
	The recommendation to seek appropriate mitigation (under Task 3.1) should include the caveate that impacts should be mitigated if they cannot be avoided.
	Agreed. We added this.
	Task 3.4 discussion of ensuring compliance with wetland laws should mention the filling of wetlands in the Vancouver bottoms area.
	We added this.
	Task 4.5 should state that if predators are reducing crane subpopulations at specific sites in the state, predator control should be instituted. The design of predator control strategies should involve the public so that measures are readily available should predator problems arise.
	We adjusted the language here, but it would be costly to develop a contingency plan with public involvement for local predator control activities that may never be needed.
	The recommendation to minimize disturbance and construction activities (Tasks 5.2 and 5.4) should apply to feeding areas as well as nesting, loafing, and roosting sites.
	Added this.
	The recommendation (Task 7.2 discussion) to acquire and manage additional lands for grain production should apply to the Ridgefield area as well as those near Conboy Lake NWR.
	It applies to both, but is probably more important for Ridgefield.

Section	Comment and response
	Task 10.2 suggests an autumn festival event at Ridgefield; such an event "Birdfest" already occurs annually. *We added mention of this festival. WDFW staff may be available to help with the event if needed in the future.* WDFW should work with schools, develop educational materials about cranes and facilitate field trips. *We added this to task 9.3.* The feasibility of relocating pairs to potential breeding habitat should be investigated. *Translocation of breeding pairs would be risky and expensive. Cranes are very philopatric and an established pair would likely simply return to their usual territory. It is stressful for the birds and would put birds at risk that are already attempting to breed. It would likely only be considered in the future if the Glenwood Valley was at capacity and birds were not spreading on their own to habitat available elsewhere.*
Implementation	The cost estimate for survey and assessment of potential breeding areas is inadequate, and WDFW's shares for several tasks are too low. The species is not federally listed, so the state needs to assume a heavier burden as federal funding for cranes is likely to take a back-seat to listed species. *We revised the cost estimates and WDFW share for survey and habitat assessment; however, covering a wide area of Forest Service and Yakama Indian Nation lands would likely require involvement by their staff.* Many crucial tasks lack cost estimates. *We filled in all the estimates; however, many figures are rough approximations because it is very difficult to predict costs of activities such as land purchases, unknown amounts of fencing, costs and not harvesting grain, etc.*