Volume III, Chapter 14
Sandhill Crane

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14.0 Sandhill Crane *(Grus Canadensis)*

14.1 Introduction

The sandhill crane (*Grus canadensis*) is one 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; 47% now are listed as either endangered or threatened, with several at risk of extinction (Ellis et al. 1996). For crane species in general, all but two 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.

The sandhill crane has been listed as an endangered species by Washington since 1981. The species is 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 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.[1]

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

[1] The majority of this chapter is taken from C.D. Littlefield and G. L. Ivey, Washington State Recovery Plan for the Sandhill Crane, WDFW, 2002.

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, cranes were again found summering in 1972 in the Glenwood Valley on Conboy Lake National Wildlife Refuge, Klickitat County, 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 one each on Yakama Indian Nation lands, Yakima County; Panakanic Valley, Klickitat County; and on 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 breeding greater sandhills in Washington 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, enough 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.

14.2 Description

Sandhill cranes are large, stately, and symbolic of the remote, isolated wetlands they depend on. 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 three toes forward and one elevated hind toe (hallux) (Tacha et al. 1992). Cranes fly with neck and legs extended except in cold weather; on cold mornings birds occasionally will 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 feet tall, and often weighing over 10 pounds (Tacha et al. 1992). Adult male greater sandhill cranes from Lincoln County, Wyoming, averaged 11.75 pounds and weighed up to 14.6 pounds. (Lockman et al. 1987). Females averaged 10.6 pounds, and weighed up to 12.5 pounds. Ninety-five percent of all females weighed < 12 lbs, 0 oz (5,450 g) and had culmens <4.4 in (108 mm), whereas all males had weights >12 lbs, 8 oz (5,674 g) and culmens >4.5 in (110 mm) (Lockman et al. 1987). Greater sandhill cranes are the largest of the six subspecies, lessers are the smallest, and Canadians are intermediate (Figure 14-1).

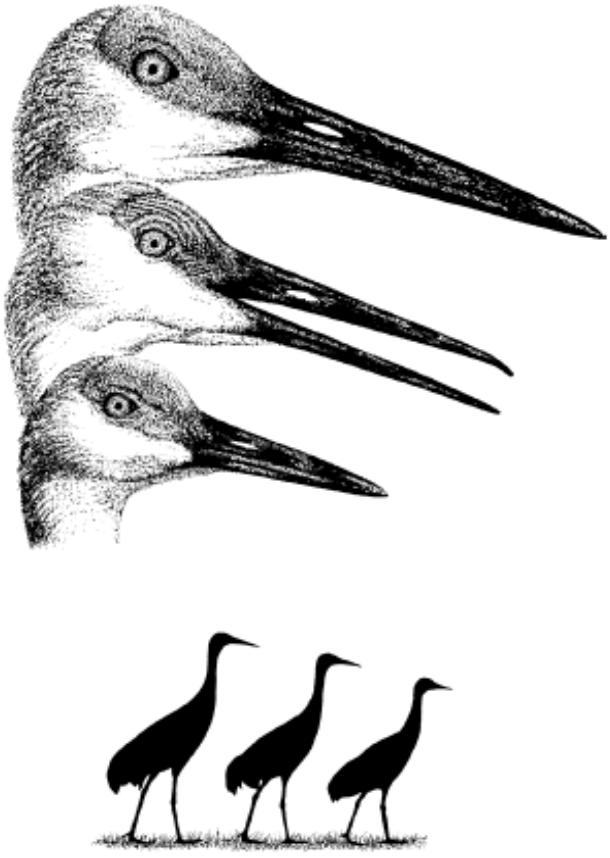

Figure 14-1. Relative size of three sandhill crane subspecies: greater (top and left); Canadian (middle); and lesser (bottom and right).

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 14-1).

Table 14-1. Anatomical dimensions (mm) of greater, Canadian, and lesser sandhill crane subspecies.

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

Source: Johnson and Stewart, 1973

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).

14.3 Distribution

14.3.1 North America

Of the six subspecies of sandhill cranes found in North America, the Cuban, Florida, and Mississippi are nonmigratory, and the lesser, greater, and Canadian are migratory. Distinct populations are recognized for both lesser and greater sandhill cranes.

- *Lessers* are divided into two 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.
- *Greaters* are divided into five populations: the Eastern, Prairie, Rocky Mountain, Lower Colorado River Valley, and Central Valley (Meine and Archibald 1996) (Figure 14-2). The greater sandhill cranes that breed in Washington are members of the Central Valley Population—greater sandhills that winter in the Central Valley of California. This population is divided into two segments because of their current disjunct distribution:
  - The southern segment breeds in south-central Washington, eastern and central Oregon, northeastern California, and northwestern Nevada with a pair in Douglas County, Nevada (American Birds 45:1142, North American Birds 53:414) marking the southernmost known pair for the Central Valley Population.
  - The northern segment of the Central Valley Population breeds in British Columbia, and is widely distributed and much less concentrated than cranes in the southern segment; their exact range is unknown.

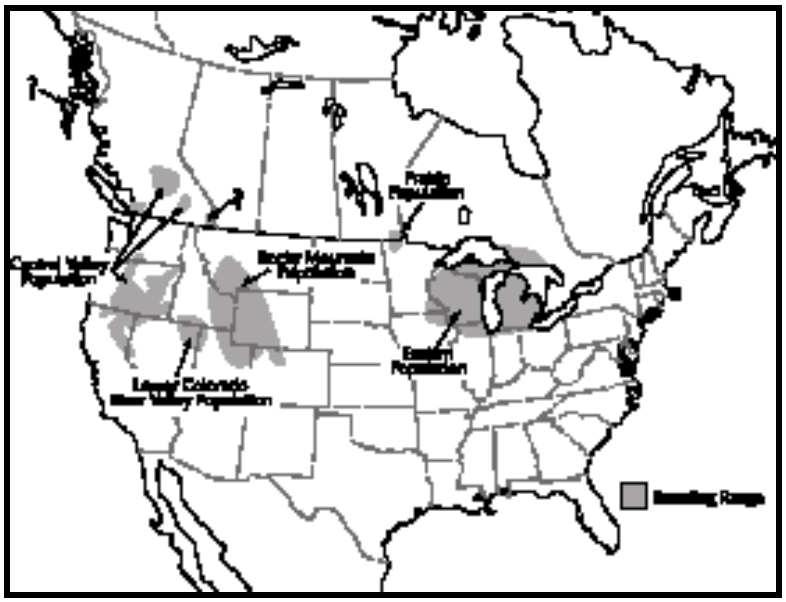

Figure 14-2. Breeding distribution of greater sandhill cranes in the United States (from Tacha *et al.* 1992, Cooper 1996, Meine and Archibald 1996, Ivey and Herziger, in prep.).

- *Canadians* are thought to breed along the Pacific Coast in British Columbia, although little is known about their distribution in the Pacific Flyway (Cooper 1996). Some Canadians winter at Ridgefield National Wildlife Refuge (NWR) 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 2001–02 on Sauvie Island and Ridgefield NWR returned to their summer range along the coast of British Columbia and southeastern Alaska; five of the six used offshore islands (Ivey et al. in prep.).

14.3.2 Washington

The greater sandhill crane is the only subspecies that nests in Washington. The only known breeding sites are: Conboy Lake NWR and Panakanic Valley, Klickitat County; Polo Field/Signal Peak on Yakama Indian Nation lands, Yakima County; and Deer Creek on WDNR lands in Yakima County (Engler and Brady 2000) (Figure 14-3). All pairs in the Glenwood Valley are listed here as on Conboy Lake NWR because all territories are at least partially within the boundaries of the refuge (Engler and Brady 2000). From 1995–97, a pair was on territory 12 mi (19 km) south of Fort Simcoe in an area known as the Camas Patch; this site apparently no longer provides suitable habitat (J. Engler, personal communication). Additionally, a few summer records of sandhill cranes from dispersed localities have not been confirmed as breeding (Table 14-2).

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. Little evidence is apparent that significant numbers of British Columbia greaters stop in Washington. In eastern Washington, a flock was documented as containing about 20 greaters near Othello in 2000 (R. Hill, personal communication), and 200-300 stop annually in spring near Waukon, Spokane County (M. Rule, personal communication). Migrants also have 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 accounts are lacking (R. Friesz and M. Murphy, personal communications); there are multiple sightings of lesser or unidentified sandhill cranes there. In

western Washington, some greaters may stage at Ridgefield NWR, but their occurrence there has not been confirmed. Most migrants in the western portion of the state have been presumed to be lessers, but a recent study suggests they may be Canadians (Ivey at al. in prep.).

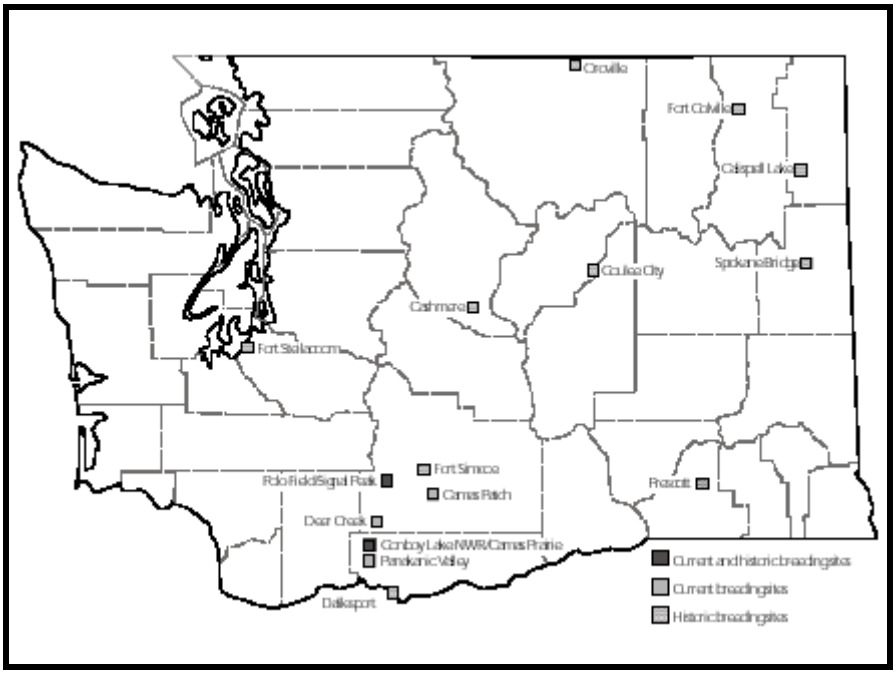

Figure 14-3. Known past and current breeding distribution of greater sandhill cranes in Washington (from Dice 1918, Jewett *et al.* 1953, and Engler and Brady 2000).

Table 14-2. 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.

Most of the estimated 21,000-23,000 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 NWR (Kramer et al. 1983). However, Pogson and Lindstedt (1991) estimated 900 or so Canadian sandhills in this area in the early 1980s; during winter 2001–02 and spring 2002, all of the cranes observed at Ridgefield NWR and Sauvie Island Wildlife Area were Canadians, while no lessers were observed (Ivey et al. in prep.).

14.4 Natural History

14.4.1 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 contrasts to some birds, like California quail, 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 three or more years to mature, may nest for several years before successfully hatching eggs, and still may not be successful in raising a chick. When successful, cranes rarely raise more than one 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).

14.4.1.1 Chronology

In February, greater sandhill cranes begin migrating north from the California Central Valley to their breeding territories. At Conboy Lake NWR, 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, personal communication). Pairs usually return to the same territory, and generally remain on or near the site for 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 NWR in 2000, the first nest was noted on April 11 and the first hatching occurred around May 11; the latest hatch date was July 4. At Malheur NWR, the earliest known clutch was on March 25, but peak of nest initiation is usually around April 21 (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.

14.4.1.2 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 > 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 NWR was found paired and on territory at Camas Prairie on the Mt. Hood National Forest in Oregon in 2000, approximately 59 mi (94 km) south of Conboy. The pair was acting broody, suggesting they had a chick (G. Ivey, personal observation). Nesting of the pair was confirmed on May 20, 2001, when two chicks were observed; both are believed to have fledged (M. Gould, personal communication 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 NWR, two 2-year old male color-banded siblings displaced a territorial pair, divided the territory, and nested within 981 ft (300 m) of each other (Engler and

Anderson 1998). At Modoc NWR in northeastern California, a color-banded 2-year old female successfully nested (Radke and Radke 1986). Most successful reproduction (>75%) in the Mid-Continent Population occurs in birds > 8 years old (Tacha et al. 1992).

14.4.1.3 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 NWR over 2-6 nesting seasons had territories (including both nesting and foraging sites) that averaged 345 ac (140 ha), and ranged from 143-540 ac (58-218 ha) (J. Engler, personal communication). At Grays Lake NWR, Idaho, five territories ranged from 25-57.5 ac (10-23 ha) and averaged 42.5 ac (17 ha) (Drewien 1973), whereas at Malheur NWR, size varied depending on pair density, ranging from 3-170 ac (1.2-68 ha) and averaging 62.5 ac (25 ha) (Littlefield and Ryder 1968). At a high-density Malheur NWR site, eight territories averaged 22.5 ac (9 ha) (C. Littlefield, unpubl. data).

14.4.1.4 Nest Building, Eggs, & 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 two eggs, but occasionally only a single egg is laid, and on rare occasions, three. At Malheur NWR, for 974 completed clutches, 84 (8.6%) contained one egg, 886 (91%) two eggs, 3 (0.3%) three eggs, and 1 (0.1%) contained four 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; however, the incubation period may extend to 33 days for fertile eggs and 43 for infertile or addled (Littlefield and Holloway 1987).

14.4.1.5 Brood Rearing & Fledging

Since a crane pair initiates incubation shortly after the first egg is laid, there is a 24–48 hour difference in hatching times between eggs. Soon after the second chick dries and gains sufficient strength to swim and walk, the adults lead the chicks from the nest to feed in nearby moist meadows or subirrigated ecotones. Both parents tend the 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. Two siblings banded at Conboy Lake NWR in 1996 were observed together in California the following winter (Engler and Brady 2000). Eleven of 16 chicks color-marked at Conboy Lake NWR since 1996 have fledged and successfully migrated (Engler and Brady 2000).

14.4.1.6 Nesting Success & Recruitment

Nest success can vary considerably between years due to weather, water and habitat conditions, and predation pressure. At Conboy Lake NWR, 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 two eggs and fledged one chick in 1997 (Stepniewski 1999, R. Leach, personal communication), but the pair at the Camas Patch was not reproductively successful through 1997, apparently because of early drying and many cattle (R. Leach, personal communication). Outside of Conboy Lake NWR, 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 77-78.9% 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 NWR, 44% were successful from 1966–74 (Littlefield 1976a), and 54% from 1976–89 (Littlefield 1995a). In total, for 1,702 clutches assessed at Malheur NWR (1966–98), 978 (57%) hatched at least one 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 0-27.3 %) 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 NWR, recruitment for the period 1970–89 averaged 6.7% and nesting pairs were declining (Littlefield 1995a) and from 1990–98, 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.

14.4.2 Longevity & 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.

14.4.2.1 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 are thought to be the primary predator of crane chicks at Conboy Lake NWR (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 NWR in 1990 and 1992 during a period of predator management, four of 28 (14%) monitored chicks were killed by minks, three (11%) by coyotes, one (4%) each were lost to infection and starvation, and seven (26%) were lost to unknown causes (including tag loss) (DesRoberts 1997). For 10 transmitter-equipped chicks at Klamath Marsh NWR in 1993 and 1994, three were lost to undetermined predators, two to coyotes, two lost transmitters, one died of exposure, and two 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 one was attributed to coyotes; one was attributed to an unidentified raptor. Fratricide accounted for the other explicable death, whereas two others apparently died but were not recovered, and 10 (56%) fledged (Stern et al. 1984).

A telemetry study at Malheur NWR in 1983 and 1984 (a period without predator control) showed that from a sample of 39 transmitter-equipped chicks, in 1983 13 were lost to predators, one died from a parasitic gapeworm infection, one drowned, contact was lost with four, and three died from unknown causes; in 1984, four were lost to predators and 10 transmitters malfunctioned, but eight 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 two (12%), raccoon one (6%), and domestic dog one (6%) (Littlefield and Lindstedt 1992). In a more extensive telemetry study conducted on Malheur NWR when predators (particularly coyotes) were being or had recently been intensively managed for 8 years (1986–93), from 1991–98, 219 chicks were transmitter-equipped (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 nine (5%), starvation four (2%), unknown deaths three (1%), abandoned one (<1%), fence entanglement one (<1%), vehicle one (<1%), hay-swather one (<1%), and study-related mortality one (<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, 8% to unidentified raptors, 0.5% to a northern harrier, and 0.5% to a raccoon. Between 1970–98 at Malheur NWR, 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).

14.4.2.2 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 killing cranes in other regions. Bald eagles are known predators of lesser sandhill cranes (Herter 1982, Littlefield 1999a), but greaters usually pay little attention to the species (C. Littlefield, personal observation). However, two subadult bald eagles were noted stooping at an adult crane after a nest exchange at Conboy Lake NWR in 1998 (J. Engler, personal communication), and migrant and wintering cranes at Ridgefield NWR and Sauvie Island took flight from approaching bald eagles (G. Ivey, personal

observation). Certainly both black and grizzly bears, as well as gray wolves and mountain lions would be capable of killing adult cranes.

14.4.2.3 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 a major mortality factor, 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 kills cranes—usually in the early morning as birds leave roost sites and fly to nearby grainfields to feed (Littlefield 1999a) (R. Schlorff, personal communication). On the breeding grounds, territorial adults have been found dead beneath utility wires (T. Melanson, personal communication; C. Littlefield and G. Ivey, personal observation). One crane died after colliding with utility wires at Conboy Lake NWR in 1984 (Paulson 1989) and two migrant lesser sandhills were found dead under a powerline in Douglas County in 1981.

14.4.2.4 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 six 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.

14.4.2.5 Disease

Within the Central Valley Population, little information is available on diseases; however, avian cholera has resulted in mortality in California's San Joaquin County (S. Lindstedt, personal communication), and botulism killed at least one crane in Oregon (G. Ivey, personal observation), whereas aspergillosis, salmonella, and avian tuberculosis have killed sandhill cranes elsewhere in the United States. All of these diseases occur in the west, and cranes in the Pacific states certainly would be susceptible should an outbreak occur (Littlefield 1999a).

14.4.2.6 Illegal Shooting

While cranes were frequently shot illegally in the late 1960s and early 1970s, increased public awareness and interest, in addition to increased enforcement, have apparently resulted in this mortality factor being greatly reduced. For example, several cranes were known to have been shot in the Central Valley in 1969–72, but none is known to have been killed from 1991–93 (C. Littlefield, personal observation).

14.4.2.7 Other Factors

Elsewhere, other lethal factors have included aflatoxicosis, 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 in October 1979 (in Windingsted 1988), and more than 1,000 lesser sandhill cranes died from hail in eastern New Mexico in October 1960 (Merrill 1961). Most unusual was a 4-

year old male greater sandhill crane at Grays Lake NWR, Idaho, that was killed by a male whooping crane during a breeding territory dispute (Drewien et al. in prep.).

14.4.3 Migration & 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).

14.4.3.1 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 NWR (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 NWR, Diamond Valley, and Silvies River Floodplain (Harney County), Williamson River Delta and Klamath Marsh (Klamath County), Warner Basin (Lake County), and near Fox (Grant County). In eastern Washington, small numbers of greater sandhill cranes stage near Waukon and, to a lesser extent, Othello, along with flocks of lesser sandhills (Figure 14-4). In western Washington, a few greaters may migrate through the Puget Trough region, but there are no recent records.

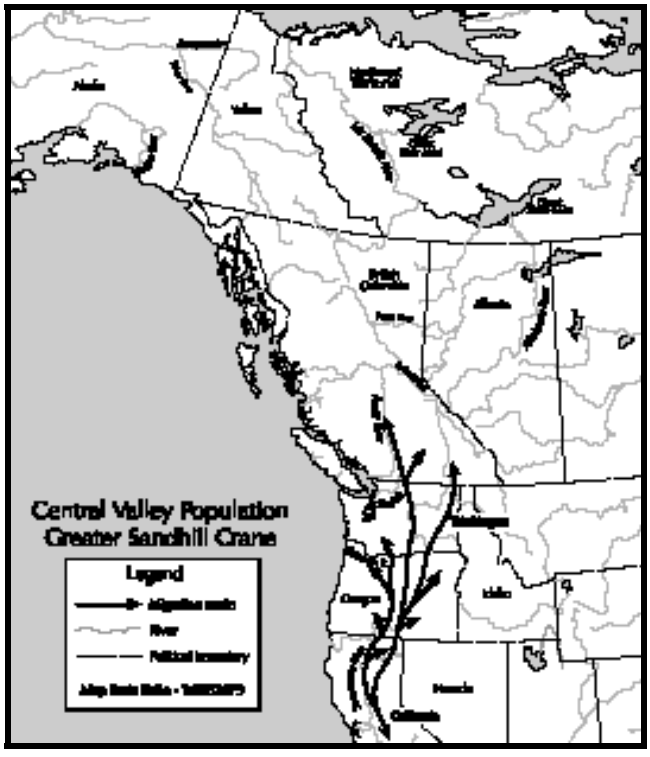

Figure 14-4. Migration routes of Central Valley Population of greater sandhill cranes (based on Littlefield and Thompson 1979, Campbell et al. 1990, and Pacific Flyway Council 1997).

The lesser and Canadian subspecies migrate through the state primarily from February–April. The Pacific Flyway lesser sandhills 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 14-5). 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 (Figure 14-6). Canadians marked at Ridgefield NWR and Sauvie Island Wildlife Area flew out to the coastline, possibly following the Columbia River, and flew along the coast northward to Cape Flattery and the British Columbia and Alaska coasts (Ivey et al. in prep.). The number of sandhills recorded at Elma, Olympia, Montesano, and around Puget Sound suggest they often do not follow the Columbia, and occasionally travel through the Puget Trough.

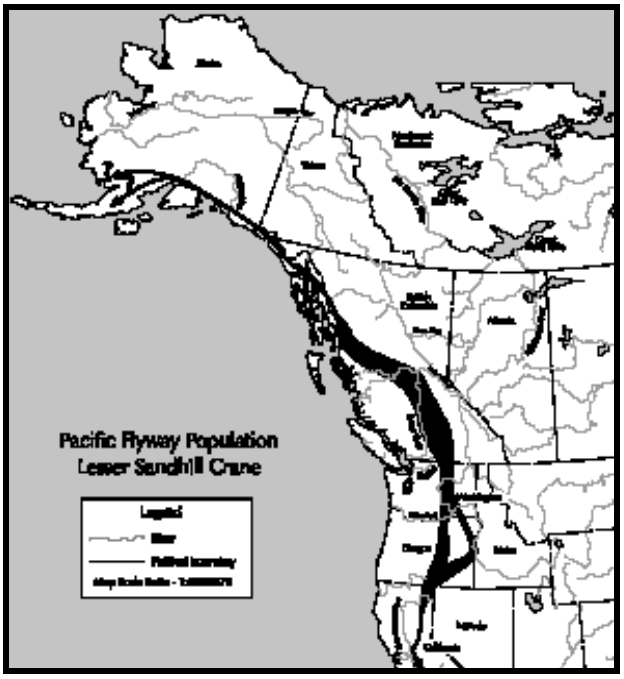

Figure 14-5. Migration route of the Pacific Flyway lesser sandhill cranes (based on Littlefield and Thompson 1982, Alaska Dept. Fish and Game 2001, Ivey *et al.* in prep.).

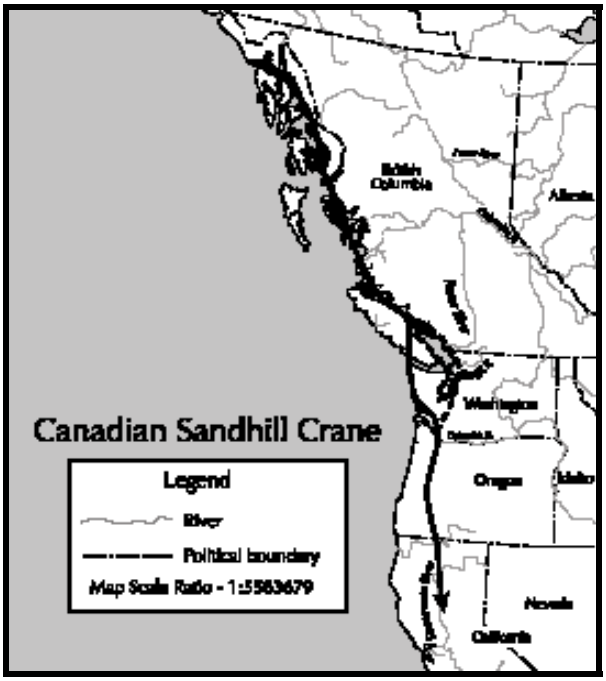

Figure 14-6. Migration route of Canadian sandhill cranes (based on Ivey *et al*. and records).

14.4.3.2 Autumn Migration

Migration from Conboy Lake NWR usually occurs between late September and mid-October (Engler and Anderson 1998). On September 29, 1998, two color-banded juveniles from Conboy were noted at Lower Klamath NWR, indicating the staging area for cranes which breed in Washington. Numbers at Lower Klamath NWR have increased from a peak of 425 on October 24, 1985 to 1,385 on October 28, 1998; in 2000, the peak was 1,188 on October 6 (J. Beckstrand, personal communication). Cranes begin staging in late August and peak numbers are present in mid- to late October. The increased use at Lower Klamath NWR 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 in Lane County, Oregon, before moving south to California. Table 14-3 summarizes autumn counts of sandhill cranes at Sauvie Island and Ridgefield NWR. 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, personal communication). Past efforts to visually differentiate between the three 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–April 2002 (G. Ivey, personal observation). The question of the status of lesser sandhill cranes in this region needs further study.

Table 14-3. Numbers of sandhill cranes recorded at Ridgefield NWR and Sauvie Island staging area in autumn, 1991–2000.

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

In the migration corridor to the east, Malheur NWR 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 August 5 (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 August 23 (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 December 10, 1947; December 20, 1951; December 31, 1961; December 11, 1965; and December 15, 1977. The mean departure date for 36 years was November 16. The greatest number ever recorded at Malheur was 3,408 on October 25, 1979 (Littlefield 1986).

14.4.3.3 Winter

The only wintering area for sandhill cranes in Washington is the lower Columbia bottomlands near Vancouver, Ridgefield, and Woodland. All cranes observed wintering at Ridgefield NWR 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 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 seven or eight years (J. Engler, personal communication).

Some cranes appear in the Central Valley in mid- to late September, but most arrive between mid-October and late November. The two 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. The distribution of wintering Canadian sandhills has not been described.

14.4.4 Foraging & 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 also have 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 NWR has not been assessed, but may include Oregon spotted frogs (Rana pretiosa); eight territorial pairs nest or forage regularly at seven sites which are considered to be core areas for spotted frog breeding. The behavior of cranes foraging in pastures before nesting suggested that they were eating worms and beetles (J. Engler, personal communication).

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, personal observation).

Littlefield (1986) described an autumn staging area at Malheur NWR 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 NWR feeding fields ranged in size from 25-345 ac (10 to 138 ha), 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 NWR cranes winter, is dominated by rice. 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.

14.5 Habitat Requirements

14.5.1 Breeding

14.5.1.1 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. With a few exceptions, most pairs select sites rather isolated from human activity (Cooper 1996; G. Ivey, personal observation; Littlefield et al. 1994).

At Conboy Lake NWR, 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 1,820 ft (555 m) but the influence from surrounding mountains makes the climate harsh. Valley topography is mostly level in this 9 mile-long (14 km) 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 have 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, Douglas fir, grand fir, and lodgepole pine, with some stands of Oregon white oak (H. Cole, personal communication; USFWS 1983).

14.5.1.2 Nesting Habitat

Generally, sandhill cranes require wetlands for nesting, 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 NWR, 55% comprises wet meadows; where cranes nest, the vegetation includes reed canarygrass, rushes, sedges, and spikerushes. Portions of the lakebed are dominated by reed canarygrass (J. Engler, personal communication) (Paveglio and Kilbride 2000), but most areas are a mixture of canarygrass and native species. The prevalence of canarygrass and natives varies with weather and hydrology, but canarygrass often appears dominant because it is tall and later-growing than native species (J. Engler, personal communication). Some areas contain bulrushes and cattails, but these are less than 5% of the refuge area. Native grasses include redtop and foxtail barley.

Peripheral areas of these meadows (11%) are slightly to heavily encroached upon by lodgepole pine, Douglas' spirea, 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, but heavy encroachment by these species may preclude nesting cranes.

On Yakama Indian Nation lands, one pair nests in a meadow covering approximately 195 ac (79 ha) that is vegetated with willows, sedges, tufted hairgrass, and timber oatgrass. It is situated between stands of lodgepole pine, Douglas fir, and grand fir, with smaller amounts of ponderosa pine and western larch (Leach 1995). Portions of the meadow have standing water in spring and summer. A pair on WDNR 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 other nest preference sites are in dense, coarse emergents. Nesting habitat varies from open shallow-flooded meadows, to coarse emergents, seasonally flooded meadows (sedge/rush/grass), hardstem bulrush, and open water with little or no vegetative cover ((Littlefield 1995a, Littlefield 2001, Drew et al. 1994). 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).

14.5.1.3 Nest Vegetation

Greater sandhill cranes will use a variety of vegetation types for nesting. At Conboy Lake NWR, nesting habitat has been characterized during occasional post-breeding season visits to nest locations (E. Anderson, personal communication). In 1996, nest vegetation was occularly estimated at five sites: nest composition ranged from predominantly reed canarygrass to entirely spirea.

In Oregon, crane nesting was studied at Malheur NWR in most years from 1966–98. In an early study of 111 nests (1966–67), broad-fruited burreed surrounded 61 nests (54%), hardstem bulrush 28 (25%), common cattail 11 (9.7%), and meadows 11 (9.7%)—90.3% of nests were in coarse emergents with few in open meadows. An additional 1,018 nests were assessed in 1969–89); as with the 1966–67 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. Nests among shrubs were a rarity (n = 4). Nest placement at 727 sites was in vegetation with a mean height of 37.3 cm (14.5 in) (range = 0-205 cm; 0-80 in). Distance from

515 nest sites to the nearest feeding meadow averaged 131 ft (40 m; range 0-1,132 ft or 0-345 m) (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, two (4%) in hardstem bulrush, one (2%) on a non-vegetated island, and one (2%) in flooded greasewood. Vegetation height ranged from 0-50 cm (0-20 in). On privately-owned lands in the Blue Mountains, seven of nine nests were in meadows, one in a beaver pond among a stand of beaked sedge, and another in a small saltgrass basin (Littlefield 1999b).

14.5.1.4 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 NWR, 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, 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 NWR 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).

14.5.1.5 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.

14.5.2 Wintering & Staging Areas

14.5.2.1 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 with extensive areas of small grain crops. However, associated wetlands are still used for some feeding, as well as for nighttime roosting and midday loafing (Littlefield and Ivey 2000). Cranes usually leave roosting locations in the early morning and fly to nearby grain fields, where they feed until mid-morning. In midday, 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 NWR, sandhill cranes use areas with agricultural crops, pasturelands, hayfields, and wetlands (Littlefield 1999a).

14.5.2.2 Night Roosts & Loafing Areas

Sandhill cranes migrating and staging within the lower Columbia River roost on the Ridgefield NWR and on Sauvie Island, Oregon. Those using the refuge roost primarily on

Campbell Lake, a large shallow lake connected to the Columbia River by a slough. 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 also have 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, personal communication). Cranes also roost on nearby Sauvie Island, particularly at Sturgeon Lake.

14.5.3 Population Status

14.5.3.1 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 1870–1915, as increasing human populations hunted birds, drained wetlands, and built over nesting habitat (Walkinshaw 1949). 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. This reluctance has resulted in gaps concerning the true historic subspecific status for sandhills throughout the state. Greaters did occur in western Washington, at least as migrants, as one was collected by Suckley in present-day Pierce County in October 1853 (Baird et al. 1860). This specimen in at the US National Museum in Washington, DC 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 also was 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 6,000 feet above sea level (Suckley and Cooper 1860:227-228).

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).

Among other locales, breeding cranes apparently occurred at Camas Prairie and Dallesport—both in Klickitat County) (Jewett et. al 1953). 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, personal communication). The last historical nesting record was in 1941 near Signal Peak, on Yakama Indian Nation lands (Jewett et al. 1953) on a small brush-covered island at an elevation of 4,500 feet. This site is apparently the same location where a crane pair re-established in 1991 (Leach 1995).

Historical migration accounts are limited because of the lack of specimen evidence. Bent (1926) listed earliest spring arrival dates for Camas in Clark County as March 26, 1923, and Dallesport as April 27, 1924 (Jewett et al. 1953).

Yocom and Hansen (1958) described spring crane migrations in 1950 and 1951, noting that flocks of cranes were observed leaving the state by flying up the Okanogan River and the Columbia River valleys.

14.5.3.2 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. 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 two appeared at Conboy Lake NWR in September, remaining into late November. In 1996, eight out of ten pairs were known to nest at Conboy, two pairs were known on Yakama Indian Nation lands, and a pair

was found in Panakanic Valley on private lands (nesting was confirmed in 1997). By 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).

For the period 1990–2001, Washington's breeding population fledged 30 chicks, with successful reproduction in all years except 1993, 1994, and perhaps 2001 (The greatest number was six in 2000, while five chicks fledged annually during the three previous years.)

Table 14-4. Greater sandhill crane pairs, productivity, and total population estimate in Washington (1990–2000)[1] .

Year	No. Breeding Pairs			Total Breeding Adults	Subadults (known)	# Young Fledged	Recruitment[3](%)	WA Population 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; 1990–94 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).

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 1944–72 (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 three factors—plus protected status—have resulted in an increase and subsequent re-occupation of breeding range left vacant for several decades.

14.6 Habitat Status

14.6.1 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, personal communication); 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 NWR, Idaho, are similar areas which support high densities of breeding cranes. There are approximately 15,000 ac (6,070 ha) of potential crane habitat in the Glenwood Valley, but this includes about 5,000 ac (3,035 ha) of private irrigated pastures near Glenwood where land use practices reduce the suitability to cranes. Since Conboy Lake NWR was established in 1964, 5,814 ac (2,353 ha) have been acquired by the USFWS (H. Cole, personal communication) and an additional 3,522 ac (1,409 ha) are proposed for acquisition (USFWS 1983). If Conboy Lake NWR 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, Washington, dated December 26, 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 one 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, personal communications). Potential threats include drainage, trespass grazing, and property sales and subsequent development. No cranes were observed by helicopter at the Camas Patch site on June 9, 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 July 15; a 20-meter no-entry, no-logging buffer zone surrounds the meadow, but there were about four 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, personal communication); 2) isolated meadows near the Pend Oreille River (Pend Oreille County) (D. Friesz and S. Zender, personal communications); 3) large hardstem bulrush marshes on Turnbull NWR (M. Rule, personal communication); and 4) a series of high Cascade meadows 10-12 mi (16-19 km) 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, personal communication). Cranes have also been sighted, and may nest at Trout Lake Natural Area Preserve, a 920-acre (327 ha) wetlands complex in Klickitat County recently acquired by WDNR. Several other summer crane records since 1980 may have been subadults seeking a territory (see Table 14-2). 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, personal communication), but there are isolated remote wetlands with limited human

access where cranes might nest (M. Monda, personal communication). Other than possible disturbance from livestock grazing and logging, meadow habitat within the 1,417,000 ac (566,800 ha) 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, personal communication). Additionally, potential nesting habitat exists at Turnbull NWR. 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 NWR, 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, personal communication); 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 personal communication) 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, personal communication). 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).

14.6.2 Wintering & Staging Habitat

14.6.2.1 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 7,518 ac (3,044 h) are owned by wildlife agencies and protected from development, but several thousand acres of habitat have no conservation status. USFWS owns 5,150 ac at Ridgefield NWR, 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 two 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 1,100 acre-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 acres for industry and port facilities (Port of Vancouver 1998). The development would use fill, including dredged material from deepening of the Columbia River navigation channel by the ACOE, 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, personal communication). 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.

14.6.2.2 Eastern Washington

Sandhill cranes use agricultural fields and wetlands for staging at several locations in eastern Washington, including the Columbia NWR (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, personal communication).

14.6.2.3 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).

14.6.2.4 Staging & 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).

14.7 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 which 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).

14.7.1 Washington

The Washington Department of Game (the predecessor to WDFW) listed the sandhill crane as endangered in 1981 (WAC 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. Crane habitats—breeding areas, regular large concentrations, and migration staging areas—are also listed. 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 GMA, 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 also are 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, personal communication). 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.

14.8 Factors Affecting Continued Existence

14.8.1 Breeding Areas

14.8.1.1 Predation

A major mortality factor that 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 NWR in both 1973 and 1974, only two young fledged from 235 pairs (Littlefield 1976a). Though other predators prey on crane eggs and chicks, common ravens, minks, raccoons, 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 NWR (Engler and Brady 2000). High predation rates are particularly evident at large breeding locales such as Malheur NWR 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).

14.8.1.2 Grazing & 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 NWR, 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; grazing from April 10–July 15 can prevent nesting attempts, and in some cases, cause nest abandonment (Littlefield 1989). Cattle have trampled crane chicks in northeast California (R. Johnstone, personal communication) and Idaho (R. Drewien, personal communication).

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.

14.8.1.3 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.

14.8.1.4 Habitat Loss

Most crane pair territories in Washington are 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 harmful management practices such as late irrigation and the presence of cattle on meadows until late spring could eliminate crane pairs. Loss of habitat has also displaced breeding pairs (Littlefield and Thompson 1979, Littlefield 1989, Ivey and Herziger 2000, 2001).

At Conboy Lake NWR, 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 NWR should carefully consider the locations of any new impoundments in the context of enhancing crane breeding habitat.

14.8.2 Staging & Wintering Areas

14.8.2.1 Availability of Winter Foraging Habitat

Numbers of cranes at Ridgefield have increased, which indicates either increased production on the breeding grounds or a redistribution of cranes using the Lower Columbia River habitats.

It seems likely that the amount of migration/wintering habitat is limited for Canadian Sandhill Cranes. Migrating and wintering sandhills forage in cropland on waste grain in agricultural fields, pastures and in wet meadows and shallow marshes. The amount of protected habitat in the lower Columbia River subbasin in Washington consists of a total of 7518 acres (3044 ha), of which 5150 acres are within Ridgefield NWR, and 2371 acres at Shillapoo Wildlife Area (Washington Dept. Fish and Wildlife). About 70% of Shillapoo WA is in pasture or agricultural fields; future plans include restoration of Shillapoo Lake to benefit waterfowl, which may reduce crane foraging habitat, but could increase potential crane roosting habitat depending on levels of disturbance. About 950 acres of pasture and cropland would remain for geese and crane foraging. Whether these acreages are bioenergetically sufficient to sustain the numerical crane objectives is unclear. Wintering populationsof Canada geese also use the areas for feeding. In addition, 416 acres adjacent to Vancouver Lake are owned by Vancouver/Clark County Parks, and the Port of Vancouver owns 1,011 acres (Columbia Gateway), a portion of which will be included as habitat mitigation for cranes.

Thousands of additional acres have no conservation status, and habitat losses are anticipated. Potential or actual crane habitat on the lower Columbia River bottomlands between Vancouver and Woodland is threatened with industrial and residential development. Aditionally, agricultural lands have been planted to cottonwood plantations and other crops (berries, tree nurseries, tulips, small industrial, residential, etc.), that are incompatible with cranes. In Washington, counties require that potential impacts to the habitats of endangered species be reviewed. Mittigation may be required concurrent to development, and so some level of protection may result.

The availability and loss of foraging habitat (including waste grain fields) is probably the most important specific limiting factor factor for migrating and wintering sandhill cranes. This would include conversion of grain crops managed for waterfowl to other waterfowl forage, such as in moist soil management.

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 950 ac (385 ha) of agricultural/pasture lands will remain for geese and cranes. Corn planted on Ridgefield NWR (100 acres 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.

Waterfowl Enhancement & 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 grain field 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, the Agricultural Waterfowl Incentive Program is designed to enhance waterfowl habitat by providing seeds, tubers, graze and invertebrates. In 1998, 49 landowners participated to create 38,949 ac (15,769 ha) of waterfowl habitat, a 75% increase from the proceeding year. Enrolled landowners were predominantly rice producers in the northern Central Valley, with only one elsewhere (Garrison 1999). Much of this flooding is in addition to the 60,021 ac (24,300 ha) already being flooded before the program was initiated; thousands of acres 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 habitat that 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, although a portion of this mitigation effort will also be directed towards providing crane forage habitat.

14.8.2.2 Availability of Roosting Habitat

For roosting, secure habitat is needed in the form of shallow lakes, wet meadows, and/or occasionally agricultural fields. Some of the considerations in the subsection above on foraging habitat also apply to roosting habitat. Roosting cranes are extremely vulnerable to disturbance.

In southwestern Washington and northeastern Oregon, activities to reduce Canada goose depredation of crops with hazing, propane cannons, extended hunts, dogs, field flags, and other scaring devices, have also effectively reduced usable wintering/migration habitat on private lands (E. Anderson, personal communication).

Recreational use, such as hunting, dog training, bird watching, hiking and jogging, is allowed on some wildlife refuges and management areas such as the Shillapoo Wildlife Area, Sauvie Island Wildlife Area and at the Ridgefield National Wildlife Refuge (Littlefied and Ivey 2002). These activities reduce the area's usefulness to sandhill cranes for foraging and sanctuary. Disturbances on managed wildlife areas also move cranes from public lands to private agricultural lands, where they may cause depredations.

While there are currently a number of refugia for wintering cranes, there is also an increasing recreational pressure on these areas and indeed all areas, which may become a limiting factor in the future. A bike-path/jogging trail recently built on Port of Vancouver

property threatens a crane use area. Disturbance at daytime and night-time roosts is particularly problematic.

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