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ANNUAL MOVEMENTS OF PACIFIC COAST SANDHILL CRANES

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Abstract: The subspecies composition of migratory sandhill cranes (Grus canadensis) which stage and winter along the Lower Columbia River in northwest Oregon and southwest Washington is uncertain, but may include all 3 using the Pacific Flyway: lesser (G. c. canadensis), Canadian (G. c. rowani), and greater (G. c. tabida). However, the status of rowani has been debated. During 2001-02, we captured and marked 8 cranes using a noose line trapping technique, and attached Platform Transmitter Terminals (PTTs) to 6 to ascertain locations of their breeding areas, migration corridors and winter sites. Morphometric data were collected for subspecies determination. From measurements and their summer distribution, we conclude that they are likely the intermediate rowani form. Because of their limited numbers, distinct coastal migration path, and habitat issues at breeding, staging, and wintering areas, we recommend that conservation efforts be increased and that they be managed as a unique population.

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Key words: Alaska, British Columbia, California, Canadian sandhill crane, Grus canadensis rowani, noose line, Oregon, Pacific Flyway, Ridgefield National Wildlife Refuge, satellite tracking, Sauvie Island Wildlife Area, Washington.

Most sandhill cranes (Grus canadensis) migrating in the Pacific Flyway between breeding grounds in Alaska and British Columbia (B.C.), Canada, and wintering areas in California use an interior route, east of the Cascade Mountains through B.C., Washington, Oregon, and northeast California (Littlefield and Ivey 2002, Petrluka and Rothe 2005). A smaller group of cranes migrate, stage and winter along the Lower Columbia River, west of the Cascades in Oregon and Washington. They primarily use Ridgefield National Wildlife Refuge (NWR), Washington, Sauvie Island Wildlife Area (WA), Oregon, and surrounding areas (Littlefield and Ivey 2002). However, the subspecies composition, nesting areas, migration routes and chronology, and other wintering sites of these flocks were unknown. In 2001, we initiated a study of sandhill cranes wintering in the Lower Columbia River region and used satellite telemetry techniques to determine their seasonal and annual movements and identify subspecies wintering in the region.

STUDY AREA

Cranes were captured at 2 sites in the Lower Columbia River region: Ridgefield NWR and Sauvie Island WA. Ridgefield NWR lies between channels of the Columbia River and contains 2,085 ha in Clark County, Washington. Across the river in Oregon, sets the 4,673 ha Sauvie Island WA, in Multnomah and Columbia counties. Cranes regularly moved between these 2 sites, and also used private agricultural fields, including Squaw Island, Vancouver Bottoms, and Woodland Bottoms in Washington, and east of Scappoose along the Multnomah Channel in Oregon. Habitats used foraging areas (primarily corn and barley fields, pastures, and wetlands) and roost sites. The most consistent roost locations were shallow wetlands on and near Ridgefield NWR, including the mostly private Canvasback Lake and Wigeon Pond on Bachelor Island, and Campbell Lake on the Roth Unit; smaller wetlands were occasionally used, particularly on the Roth Unit. At Sauvie Island, Sturgeon Lake was the principal roost site.

METHODS

Trapping efforts were conducted intermittently between 21 October 2001 and 4 April 2002 in order to increase our chances of capturing unrelated birds. We captured cranes using noose lines, an ancient bird-catching technique from India recently introduced to North America (Hereford et al. 2000). We constructed our own lines from a template provided by T. Grazia of Mississippi Sandhill Crane NWR, with some modifications. To construct the nooses, we used 100-lb test monofilament fishing line to form loops of about 15 cm in diameter, and attached each to a wooden stake (12 cm long, 0.64 cm diameter) made from pine dowels. Stake ends were sharpened to a point and stakes with nooses were then tied to a nylon cord about 30 cm apart, with 25-50 on each line. Snap swivels were tied at each end of the lines so they could be linked together.

We located crane foraging sites and returned after dark to bait potential trapping locations with partially shucked ears of field corn. After cranes used a bait site, lines were set during pre-dawn hours by pushing stakes into the earth about 20 cm apart to form a wall of upright, overlapping nooses. Several lines were placed at each site, and weights were attached to the ends to prevent entangled birds from flying away with them. The noose lines were monitored from a distant blind with binoculars and spotting scopes to minimize disturbance. Cranes feeding on the bait had to do so in close proximity to nooses, and if they stepped into one, their leg or foot became snared.
Leg strain was minimized by the elastic nylon line and the few stakes which were pulled from the soil by struggling birds.

Captured cranes were hooded to limit stress and the following measurements were taken to delineate subspecies: exposed culmen (base of the upper mandible to the tip), body mass (to the nearest gr), nares to tip of culmen (anterior end of nostril to tip), tarsus (tibio-tarsus joint to the distal edge of the last leg scale above the toes), and wing chord (unflattened wing from carpal joint to tip of longest primary). We then attempted to determine subspecies by comparing our data to those in the published literature. A blood sample was also collected to determine sex and for genetic analyses. Individual cranes were assigned a number between 1 and 8 in the order they were captured for purposes of identification in the text.

If multiple birds were captured in the same flock, only 1 was fitted with a PTT (30g Birdborne) manufactured by North Star Science and Technology, LLC (Technology Center Bldg. Room 4.036, 1450 S. Rolling Rd., Baltimore, MD 21227 USA) which were mounted on blue plastic leg bands engraved with alphanumeric codes. These satellite transmitters were placed above the tibio-tarsus joint, with the 2 halves attached by rivets and quick-drying epoxy (Ellis et al. 2001). The opposite leg was marked with 2 short colored plastic bands of a unique combination and a U.S. Fish and Wildlife Service (USFWS) aluminum band. Other cranes captured in the same flock received colored plastic and USFWS bands only. PTTs were programmed to activate for 8 hrs after 60 hrs of deactivation in order to last about 1 year; locations were recorded from satellites about every 3 days. Cranes were tracked via the Argos Satellite System with data downloaded via the Internet and points were mapped electronically.

RESULTS

We captured 4 cranes at Ridgefield NWR (2 in November 2001, and 2 in February 2002), and 4 at Sauvie Island WA (3 in March and 1 in April 2002). Measurements of these birds are summarized in Table 1. Results of genetic analyses of mitochondrial DNA assigned all 8 birds to the G. c. tabida subspecies (K. Jones, Kansas State University, personal communication); however, this grouping includes birds which would be classified as G. c. rowani, morphologically.

Longevity of the PTTs varied; 2 PTTs lasted 4 months, one 9 months, and the other 3 lasted 13-16 months. Cranes 1 and 2, captured in November 2001, wintered in the Lower Columbia River region and all 8 cranes remained in this region until spring migration. The 2 cranes without PTTs were last observed in late March 2002, while the first PTT birds moved north by 13 April, with the last migrating by 19 April. Data from crane 3 suggested that the migration route may have followed the Columbia River northwest, and all birds proceeded north along a coastal route. Their path followed the Washington coast, crossed Cape Flattery on the northwestern tip of Washington, continued across central Vancouver Island, and then along the coast of B.C. (Fig. 1). All cranes arrived within their summer ranges by 21 April 2002.

Final summer destinations were primarily the B.C. coast: Dowager Island (Crane 5), Princess Royal Island (Crane 8), McCauley Island (Crane 2), and near Port Edward, B.C., the only mainland site (Crane 7). Two other cranes traveled north to Dall Island (Crane 3) and Prince of Wales Island (Crane 1), Alaska. Cranes 1 and 7 spent several days at staging areas within their summer range before moving to a final destination, including one that reached southern Alaska but backtracked south to B.C. All 6 birds summered at these locations where we presume they nested (Fig. 2).

Only 3 PTTs were transmitting at the onset of fall migration. Crane 7 began to move south by 6 September 2002, and Crane 1 by 14 September; average time spent on the breeding grounds was approximately 132 days. A third PTT (Crane 8) continued to send data from the same B.C. location through the winter and into the following summer, and we presume this bird either died or the PTT became detached; however, it may have overwintered, as there are a few winter records for the nearby Queen Charlotte Islands (Campbell et al. 1990). At the onset of fall migration Crane 7 used several areas just south of Prince Rupert, B.C from 6-19 September before returning to Sauvie Island WA, its original capture site, on 22 September. Crane 1 apparently did not linger in B.C., but used the same migration route as in spring, with data locations to the east of Prince Rupert, and over central and southern Vancouver Island, B.C. It arrived along the East Fork of the Lewis River, just east of Ridgefield NWR, by 24 September. By 27 September, it returned to the Ridgefield NWR/Woodland Bottoms area where it had been captured and spent the previous winter (Fig. 3). It remained in the area until the PTT failed on 4 November 2002. Time spent on migration from summering areas to the Lower Columbia River region was approximately 15 days for these 2 cranes.

By 14 October, Crane 7 shifted to Ridgefield NWR, and by 30 October, it started to migrate south, likely through the Willamette Valley of Oregon, moving through south-central Oregon, just southwest of Klamath Falls, near Lower Klamath NWR, and stopping at Butte Valley Wildlife Area, Siskiyou County, California. By 2 November 2002, it was southwest of Chico in the Sacramento Valley of California (Fig. 3), and remained in that general area for the duration of the winter (approximately 111 days). Total time for migration from summer to final winter locations was 57 days (including 48 days at the Lower Columbia River region) for Crane 7, compared to only 13 days for Crane 1 which wintered in the Lower Columbia River region.

Crane 7 returned to Sauvie Island WA on 24 February 2003, and departed by 16 April, the same date as the previous spring. It arrived back at its previous summer location near Port Edward, B.C. by 19 April. Spring migration time for Crane 1 from California to B.C. also took approximately 57 days with 38 days spent in the Lower Columbia River region.
Table 1. Measurements of sandhill cranes captured at Ridgefield NWR, Washington, and Sauvie Island WA, Oregon, 2001-02.

<table>
<thead>
<tr>
<th>Crane</th>
<th>Exposed culmen (mm)</th>
<th>Nares to tip (mm)</th>
<th>Tarsus (mm)</th>
<th>Mass (g)</th>
<th>Wing chord (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Males:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crane 1</td>
<td>118.0</td>
<td>71.0</td>
<td>N/A</td>
<td>4960.0</td>
<td>515.0</td>
</tr>
<tr>
<td>Crane 2</td>
<td>119.0</td>
<td>74.0</td>
<td>200.0</td>
<td>5610.0</td>
<td>545.0</td>
</tr>
<tr>
<td>Crane 5</td>
<td>109.7</td>
<td>72.7</td>
<td>215.0</td>
<td>N/A</td>
<td>492.0</td>
</tr>
<tr>
<td>Crane 8</td>
<td>105.9</td>
<td>71.6</td>
<td>203.0</td>
<td>5500.0</td>
<td>495.0</td>
</tr>
<tr>
<td>Mean</td>
<td>113.2</td>
<td>72.3</td>
<td>206.0</td>
<td>5356.7</td>
<td>511.8</td>
</tr>
<tr>
<td>SE</td>
<td>3.2</td>
<td>0.7</td>
<td>4.6</td>
<td>200.9</td>
<td>12.2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crane 3</td>
<td>122.5</td>
<td>72.6</td>
<td>208.0</td>
<td>4280.0</td>
<td>460.0</td>
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<td>Crane 4</td>
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<td>61.7</td>
<td>194.0</td>
<td>4960.0</td>
<td>495.0</td>
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<tr>
<td>Crane 6</td>
<td>113.2</td>
<td>72.0</td>
<td>207.0</td>
<td>4450.0</td>
<td>465.0</td>
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<tr>
<td>Crane 7</td>
<td>103.3</td>
<td>67.8</td>
<td>172.0</td>
<td>4100.0</td>
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<tr>
<td>Mean</td>
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<td>68.5</td>
<td>195.3</td>
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<td>463.8</td>
</tr>
<tr>
<td>SE</td>
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<td>2.5</td>
<td>8.4</td>
<td>185.2</td>
<td>12.3</td>
</tr>
</tbody>
</table>

Fig. 1. Spring migration route of PTT-marked sandhill cranes, 2002.
DISCUSSION

Subspecies

It should be noted that past morphometric studies (Tacha et al. 1985) and more recent studies of crane genetics (Rhymer et al. 2000, Glenn et al. 2002, Petersen et al. 2003) support subspecies designations of *tabida* and *canadensis*, but not *rowani*, and one study suggests that *rowani* is a hybrid of *tabida* and *canadensis* (Peterson et al. 2003). However, the cranes sampled for these studies did not include any from B.C. or the Pacific Flyway. In contrast, studies of chick development (Baldwin 1977) and measurements of specimens and live birds, including those from coastal Alaska, indicated that *rowani* were probably distinct (Johnson and Stewart 1973, Johnson et al. 2005). Regardless of the genetic uniqueness of what have been called subspecies, the populations of birds differ in a variety of ways, including morphology (Aldrich 1979, Johnson et al. 2005), migrational timing and pathways (e.g., Johnson and Stewart 1973, Petrula and Rothe 2005, this study), and chick development rates and onset of homeothermy (Baldwin 1976). Also, the distributions of the 3 subspecies indicate they generally breed in different areas: most *canadensis* breed in the arctic and subarctic regions of North America; *rowani* in boreal and parkland ecoregions of Canada and Alaska; and *tabida* in various regions of the United States and southernmost Canada (Johnson et al. 2005). Because these different populations behave differently in their annual movements and face different threats, it appears prudent to manage them individually.

Morphological data suggest that the cranes in our study are *rowani*, while the genetic analysis assigned them to the *tabida* subspecies; however, this category combines *tabida* with *rowani* and 3 other recognized subspecies (*G. c. pratensis*, *G. c. pulla*, and *G. c. nesiotes*) which are very similar genetically. Because of our small sample size, we could not make statistical comparisons of our morphological data nor determine subspecies with absolute confidence. Generally, all measurements fell within the ranges reported for *rowani* (Walkinshaw 1965, Stephen 1967, Johnson and Stewart 1973, Schmitt and Hale 1997, Johnson et al. 2005) (Figs. 4-8). Our measurements of exposed culmen, mass, and wing chord of males were within the ranges reported for *rowani* and *tabida*, while measurements for the nares to the tip of the culmen, tarsus and wing chord of females were within the ranges reported for *rowani* and *canadensis*; they were generally smaller than measurements reported for Rocky Mountain Population *tabida* (Lockman et al. 1987). Johnson and Stewart (1973) noted that wing chord, tarsus, and exposed culmen were the most useful parameters in determining racial composition. Disparities in some measurements may indicate morphological differences between Pacific Flyway and the Central Flyway cranes; most of the morphological and historic data were collected from birds in the Central Flyway.
In addition, all birds in the hand and those carefully observed in the field appeared to have the physical characteristics of *rowani*. Head profiles were large and flat, similar to those of *tabida* that we had previously handled in Oregon, but with smaller bills. They also lacked the round head and fine, short bill of *canadensis* we had observed in California and eastern Oregon and Washington. We also noted that captured cranes had shorter unfeathered portions of the legs above the tibio-tarsal joint than *tabida*, as multiple colored leg bands had fit well below the feathers on *tabida*, while they overlapped onto the feathers of birds in this study.

There is apparent confusion in historic subspecies designations within the range of these cranes because of the presence of this intermediate-sized subspecies was not described until the mid-1960s (Walkinshaw 1965). Since measurements used for differentiation between *canadensis* and *tabida* overlapped with what is currently identified as *rowani*, historic accounts of cranes in this region were identified as either greaters or lessers. *G. c. canadensis* were reported nesting in southeast Alaska (Gabrielson and Lincoln 1959), while in the Lower Columbia River region, *canadensis* were reported in migration (Anthony in Gabrielson and Jewett 1940:228), but Gabrielson and Jewett questioned this designation without specimens. However, an injured bird that died near Portland, Oregon, was identified as *canadensis* by Jewett (1954). *G. c. canadensis* was reported nesting at Fort Steilacoom, near Olympia, Washington (Suckley and Cooper 1859), but others subsequently questioned this designated and theorized that they were *tabida* (Dawson and Bowles 1909, Jewett et al. 1953). Accounts of migrant subspecies in Oregon’s Willamette Valley have also varied: one author reported that both *canadensis* and *tabida* were present in migration, with a small flock of *canadensis* wintering near Corvallis (Storm 1941), while others described *tabida* in migration but did not mention wintering birds (Woodcock 1902, Gabrielson

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**Fig. 3.** Fall migration route and winter destination of PTT-marked sandhill cranes, 2003.
More recent information supports the conclusion that the cranes using the Lower Columbia River region are likely *rowani*. In B.C., coastal-nesting cranes have been reported as *rowani* (Pogson and Lindstedt 1991, Cooper 1996), and this region is within the subspecies’ range described by Meine and Archibald (1996). *Rowani* may also extend north to the central coast of Alaska where some captured cranes at the Copper River Delta had measurements which suggested this subspecies (Herter 1982). In contrast, *tabida* likely nest in the interior of B.C. (Cooper 1996), and *canadensis* which have been PTT-tagged on their breeding grounds at Cook Inlet and Bristol Bay in Alaska migrated through interior B.C., eastern Oregon and Washington, northwest Nevada, and northeast California dur-
ing both spring and fall (Petrula and Rothe 2005), and did not use the Lower Columbia River region.

It is likely that the birds in this study are also associated with the small, remnant group of cranes which breed in the Fraser Lowlands of B.C. near Vancouver. Information on the subspecies breeding there has also been conflicting, as museum specimens have been classified as both *tabida* and *rowani*, and was further complicated by the release of 17 *tabida* young (from the Rocky Mountain Population) in 1981 (project success unknown) (Campbell et al. 1990). However, live birds observed there in 2003 at the George C. Reifel Migratory Bird Sanctuary appeared to be *rowani* (R. Drewien, and G. Ivey, personal observation).

Fig. 6. Comparisons of measurements of nares to tip of bill of sandhill cranes (n = 8) to Schmitt and Hale (1977) (n = 1,475).

Fig. 7. Comparisons of tarsus measurements of sandhill cranes (n = 7) to studies summarized in Schmitt and Hale (1977) and Johnson et al. (This Volume) (n = 2,803).
Importance of Study Area for Sandhill Cranes

The Lower Columbia River region is the only major sandhill crane stopover site between northern breeding areas and wintering sites in California. Cranes have been recorded using the region since at least the early 1800s when noted by Lewis and Clark (Burroughs 1961), and 893 “intermediate-sized” cranes were counted on Sauvie Island in 1982 (Pogson and Lindstedt 1991). In recent years, up to 4,273 have been counted in this region during early fall (Littlefield and Ivey 2002). During spring migration, we estimated 1,900 in March 2002; however, we did not have access to all areas. If conclusions of G. c. rowani using the region are correct, then staging counts may represent the entire population nesting in coastal B.C. and southeast Alaska. Historic accounts of cranes using the coast and islands of B.C. have dated back to the late 1700s (Leach 1979).

We obtained limited information on other staging areas, but all appeared to be of minor value to cranes than the Lower Columbia River region, where Crane 7 stayed 38 days in the fall of 2002, and upon returning in the spring of 2003, remained for about 48 days. To the north, Crane 1 remained at Banks Island for almost 2 weeks, and Crane 8 was at Swindle Island for over 1 week; both these areas were just south of summer destinations. Small flocks of cranes have also been reported staging at Burns Bog in the Fraser Lowlands of B.C. in spring and fall (Cooper 1996).

To the south of the Lower Columbia River region, cranes were historically abundant in migration in the Willamette Valley of Oregon in the mid-to late 1800s, and they may have wintered there as well before wetlands were replaced with agriculture and hunting pressure increased (Taft and Haig 2003). Currently, cranes are regularly heard over the valley in migration (Stern et al. 2003). In northeast California, Crane 7 stopped briefly at Meiss Lake, where around 1,500 cranes (tabida and canadensis) were historically reported to use the area for 3 to 4 weeks (McLeod 1954). Approximately 500 birds spend about 3 weeks there, including color-marked tabida from east of the Cascades (D. Van Baren, Butte Valley WA, Calif. Dept. of Fish and Game, personal communication). Therefore, this area is used by both coastal and interior migrating cranes. Staging crane numbers have increased at Lower Klamath NWR in northeast California in recent years (D. Mauser, Klamath Basin NWRs, personal communication), and Crane 7 may have stopped there as well.

In addition, the Lower Columbia River region also serves as a wintering site for a few hundred cranes. Reports of wintering birds date back as far as the early 1800s by the explorers, Lewis and Clark, but these reports were judged inaccurate by Gabrielson and Jewett (1940). Currently, exact wintering numbers are unknown, but have been as high as 1,000 (Littlefield and Ivey 2002). During our study, the 2 cranes captured in November 2001 (Cranes 1 and 2) remained in the region at least 134 and 140 days after capture, respectively, before migrating north, and likely were present at least 30 days prior to capture. The number of rowani wintering in California in 1983-84 was estimated as 258 (Pogson and Lindstedt 1991).

Rowani may also nest in the Lower Columbia River region in very small numbers. The first summer record on Sauvie Island was possibly in 1989 (Johnson 1990), and a pair with young was reported in 2002 (M. Nebeker, Sauvie Island WA,
personal communication). Cranes have also been observed at Ridgefield NWR during the summer (Littlefield and Ivey 2002). Historically, the nesting area of these birds may have extended from Alaska to Oregon.

**Trapping Methods**

While trapping cranes with the portable noose line technique is safe, it has limitations. Cranes apparently could see the nooses, as when only a few were in the area, they carefully stepped around them to feed on the bait, and were only captured when they were crowded on the bait and distracted by each other. Waterfowl appeared much less wary, and were more readily trapped; we caught 9 Canada geese (*Branta canadensis*) and 4 mallards (*Anas platyrhynchos*). Unfortunately, their capture hindered chances of catching cranes, which were alert when waterfowl were captured and flushed when we removed waterfowl from lines. We found no evidence of injuries to any birds captured by this technique.

Regardless of the method, other factors would hinder any trapping efforts in the study area. The cranes here were exceptionally wary, so that we often had to watch the bait site with a scope from >0.8 km away or they would not approach; they were much more sensitive to our presence than *tabida* we had captured at Malheur NWR in southeast Oregon. This behavior is likely due to their remote nesting grounds and limited contact with humans. Also unlike *tabida*, they completely ignored piles of whole-kernel corn which we used for bait, a popular enticement at Malheur NWR; they preferred field corn cobs partially husked to expose the kernels. At Sauvie Island WA, after much of the available corn was consumed, cranes showed minimal interest in our bait. They fed mostly by digging, and were likely searching for nut sedge (*Cyperus esculentus*) (M. Nebeker, Manager, Sauvie Island WA, personal communication).

Trapping difficulties were compounded by the daily unpredictability of these birds in their feeding and roosting habitats. This behavior may have been linked to regular disruptions of feeding birds by bald eagles (*Haliaeetus leucocephalus*), coyotes (*Canis latrans*), and low-flying craft. Use of wetland sites was also irregular; heavy rains and high tides caused rising water levels and consequent shifting of roost areas. Trapping was further complicated with the opening of goose hunting when cranes were flushed from their roosts before dawn, apparently causing about 700 of the 1,000 birds present to migrate from the area on opening day.

**CONCLUSION**

Sandhill cranes captured and observed at the Lower Columbia River region appeared to be *rowani* based on morphological measurements, general features in the hand and in the field, migration patterns, and summer locations. While all 3 subspecies have been reported to be possible in the area in recent years (Littlefield and Ivey 2002, Stern et al. 2003), we found no evidence of the presence of *canadensis* or *tabida*. Perhaps they use the region during early fall migration, but none were identified during late fall or spring. Although recent genetic evidence concludes that *rowani* and *tabida* should be considered the same subspecies, given that there are morphological and their breeding distribution does not appear to overlap in the Pacific Flyway they should be considered separate populations.

Currently, all crane subspecies are considered Endangered in Washington (Littlefield and Ivey 2002) and Vulnerable (Blue-listed) in B.C. (Blood and Backhouse 1999). The Lower Columbia River region is critical for these cranes, as it is their only major staging area between northern breeding and California wintering areas, and also serves as a wintering site for several hundred. Considering that this area is near the metropolitan complex of Portland, Oregon, and Vancouver, Washington, the threat of loss of privately-owned crane habitats is significant. Some vital areas have recently been lost to agricultural conversions to incompatible crops such as tree nurseries, flowers, berries, and industrial, residential, and public recreation developments, and the possible expansion of the Port of Vancouver poses an additional threat of habitat loss (Littlefield and Ivey 2002). In addition, disturbances at roost sites occur on both public and private lands (e.g., waterfowl hunting).

Potential threats exist at other areas which at least some of these birds utilize. On the central coast of B.C., logging, livestock grazing, and hydrocarbon exploration and development potentially threaten breeding crane habitat (Cooper 1996). In the lower Fraser River valley (Fraser Lowlands) in B.C., peat harvest and a landfill which will continue to grow and possibly affect water quality are habitat issues at Burns Bog, and disturbance may be responsible for declines in breeding pairs there and at nearby Pit Polder (Cooper 1996). Loss of habitat and disturbance were likely factors in the extirpation of nesting cranes from Vancouver Island since 1941, as well as Lulu Island in the lower Fraser River Valley since 1946 (Cooper 1996). In Alaska, cranes are susceptible to sport and subsistence hunting. For Central Valley of California, crane wintering habitat has been replaced by urban expansion and conversion to incompatible crops (e.g., orchards and vineyards) (Littlefield and Ivey 1999). Therefore, the small size of this population of coastal-nesting cranes, coupled with threats to their habitats at breeding, staging, and wintering areas, merits elevating conservation efforts and managing them as a population, separate from the interior-nesting *tabida*.

**ACKNOWLEDGMENTS**

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ciliated our use of Ridgefield NWR for trapping and housing, and Mark Nebecker of Sauvie Island WA supported our efforts there. Tracy Grazia of the Mississippi Sandhill Crane NWR kindly demonstrated use of the noose line system and assisted with early field work. Joe Engler and Eric Anderson of Ridgefield NWR helped with logistics and early capture attempts, and Mark Stern of The Nature Conservancy discussed local crane issues and donated one morning to assist with fieldwork. Ken Jones of Kansas State University, Manhattan, conducted mitochondrial DNA analysis and determined the sex of the birds we captured. Comments on earlier drafts provided by John Corney, Rod Drewien, and Bruce Dugger were greatly appreciated.

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