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AERIAL SURVEY TECHNIQUES FOR BREEDING WHOOPING CRANES

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Abstract: Since the discovery of nesting whooping cranes in Wood Buffalo National Park, the Canadian Wildlife Service has conducted aerial surveys to monitor the population. Aerial survey techniques have varied over the years; however, they have generally followed the techniques used by the author since 1991. The technique involves flying a combination of circular flights and transects over known nesting territories and similar looking marshes likely to contain breeding whooping cranes. These aerial surveys account for nearly 100% of the breeding whooping cranes each year.

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Whooping cranes (*Grus americana*) are listed as an endangered species in North America (USFWS 1994, Environment Canada 2007). The remnant wild flock of whooping cranes nests mainly in Wood Buffalo National Park in a remote marsh complex along the Sass and Klewi Rivers (Allen 1956). They were first observed in the park by a forestry officer who was returning to Fort Smith by air in 1954. Aerial surveys have been used since that time to document the breeding population of whooping cranes in the park (Novakowski 1966, Kuyt 1995, Johns et al. 2005). This type of survey is especially useful when the species under study is thinly dispersed and inhabits remote locations that are not easily accessible from the ground.

Whooping cranes arrive on the breeding grounds in late April and the first few days of May. After reestablishing their territories, the birds select a wetland to construct a nest. The nests usually take 2-3 days to complete and 2 eggs are laid. Most nests are initiated before 15 May, and the surveys were timed to coincide with the peak of incubation. Single birds incubating on a nest are more easily observed than single birds out feeding, as evidenced by the fact that the non-incubating mate from a breeding pair is not always seen. This paper describes the methodologies and aircraft used for aerial surveys to locate nesting pairs, visit nests, and determine hatching and fledging success.

STUDY AREA

Whooping cranes nest and summer in the northeastern portion of Wood Buffalo National Park and adjacent areas of Alberta and the Northwest Territories. All nesting occurs within a 90-km × 90-km block (8,100 km^2) west of the community of Fort Smith, Northwest Territories (60°0.33′N, 111°52.88′W). Most cranes, however, are found in a 600-km^2 area adjacent to the Sass and Klewi rivers, as well as in a few smaller concentrations in nearby areas (Johns et al. 2005). The nesting grounds themselves are comprised of a myriad of ponds, marshes, and forested ridges in the northernmost portion of the boreal plains ecoregion (Timoney 1999).

METHODS

On the breeding grounds cranes usually occur singly, or in territorial pairs, family groups, or small non-breeding groups of 3-5 individuals. The Canadian Wildlife Service has carried out aerial surveys over the whooping crane summer range since 1955. From 1955 to 1965, surveys were irregular, but from 1966 onwards they have been conducted regularly.

Locations of whooping cranes and nests were plotted on 1:15,800 color infrared aerial photographs. Beginning in 1992, crane locations were also captured as waypoints on a GPS. Transects flown were also recorded with a GPS unit to ensure complete coverage of the census area.

Fixed Wing Aircraft

Fixed wing aircraft were used for breeding pair, hatching success, and fledging success surveys, as well as to search for banded birds. Aerial surveys were conducted in a variety of fixed wing aircraft. Cessna 172 and 185 aircraft were used most often. Flights averaged 3.5 hours each, and 5-8 flights were required to cover the entire nesting area for each of the surveys. Flights were conducted in both morning and afternoon. Observers, usually 2, but occasionally 1, scanned the marsh and upland ridges for whooping cranes, which appeared as large white dots on an otherwise dark, mottled

background.

To determine nest occupancy, transects of varying lengths, with widths averaging approximately 1.0 km (0.5 km on each side of the plane), were flown over known nesting territories occupied in recent years. Flights covered only appropriate habitat and did not search non-wetland areas. Wider transects (up to 1.4 km) were flown over the remainder of the summer range to search for new nesting pairs. Among years, the precise location of transects was not fixed and varied depending on the size, shape, and characteristics of the marsh. When a known territorial pair was not seen on an initial flight, a second set of cross transects was flown perpendicular to the original transect. Circling in ever increasing concentric circles starting in the center of a known territory was also used. This combination of techniques ensured that all known nesting marshes received close to 100% coverage (Fig. 1).

Rotary Wing Aircraft

Rotary wing aircraft were used to determine clutch size, visit nests (Kuyt 1995), and capture flightless young. Bergeson et al. (2001*a*) captured 2-14 day old hatchlings while Kuyt and Goossen (1987) captured 60-80 day old prefledged young. Helicopters have also been used to observe foraging behavior, search for tracks along shorelines (after landing, tracks were followed to search for droppings (Bergeson et al. 2001*b*), install and monitor water level gauges, collect feather and egg shell remains from nests, record unison calls of breeding adults, measure vegetation parameters at nest sites (Timoney 1999), and install blinds and research camps (Bergeson et al. 2001*b*).

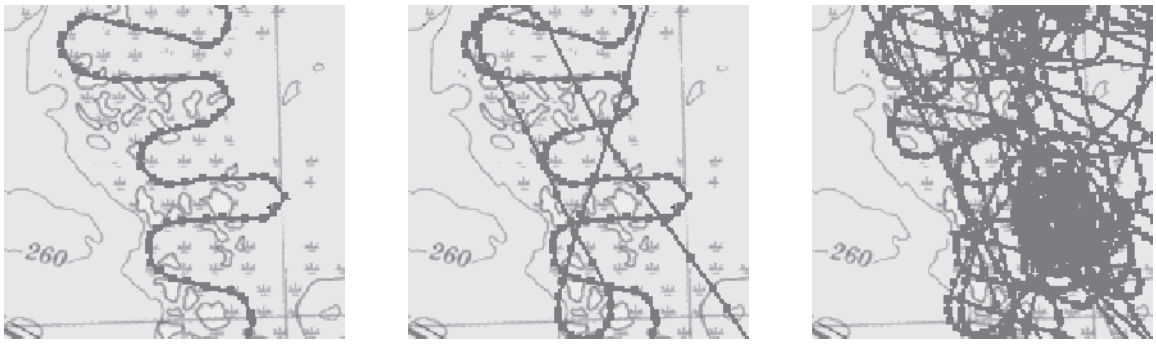
RESULTS

Most surveys for breeding whooping cranes have been in Wood Buffalo National Park; however, they have also included areas adjacent to the park as well. Observations were made on 438 aerial census flights over 18 summers (1991-2008) totaling 1,438 flight hours.

Fixed wing surveys were conducted for breeding pairs (mean = 24.4 hr/yr), hatching success (mean = 29.9 hr/yr) and fledging success (mean = 13.8 hr/yr). In most years, all breeding adult whooping cranes were located (96-100%); these flights were not a sample, but actual, direct measures of the breeding population. If a pair was not located in a particular year, it was usually found the following year.

Helicopters were used to determine clutch size. Incubating birds would stand when the helicopter was an average of 417 m (range 50-1,500 m, $n = 211$) away from the nest and an average of 122 meters (range 18-306 m, $n = 278$) above ground level. When a bird stood it occasionally moved off the nest a short distance (mean = 5.3 m, range 0-25 m, $n = 49$). For best viewing of eggs, the helicopter circled the nest at a mean of 183 meters (range 150-225 m, $n = 52$) distant.

Helicopters were also used when there was a need to land near nests or family groups. Helicopter down times for various research projects were: 1) 7.7 minutes



a. Transects b. Cross transects c. Transects plus circling

Figure 1. Map of whooping crane nesting marsh in Wood Buffalo National Park Canada, with 3 types of survey flights overlaid (from actual GPS paths flown, displayed on 1:250,000 scale map).

(range 3-19, n = 113) for testing and collecting eggs during 1992-1996, 2) 32.8 minutes (range 24-40, n = 6) for capturing, conducting health checks and attaching radio transmitters to 2-14-day old young in 1998, and 3) 25.0 minutes (range 15-31, n = 15, E. Kuyt, Canadian Wildlife Service, deceased, personal communication) for capturing and banding 60-80-day old young in 1978 and 1982.

DISCUSSION

The fixed wing aerial survey techniques developed by the Canadian Wildlife Service as described in this paper are suitable for a highly visible species like the whooping crane. Tundra swans and white pelicans have been seen in the survey area, but their distribution and habitat use allows for easy identification and separation from the cranes. These survey techniques would not be appropriate for the more cryptically colored sandhill crane (*G. canadensis*).

The surveys were used to determine the entire breeding population of whooping cranes nesting in and adjacent to Wood Buffalo National Park. The number of territorial pairs that were observed closely match the number of territorial pairs that were observed on the wintering grounds in Texas (T. Stehn, U.S. Fish and Wildlife Service, personal communication).

These aerial surveys are not appropriate for determining total population size of the flock, since nonbreeding subadults do not all return to the breeding grounds as first year birds. When not found near the breeding grounds, subadults summer in the southern Canadian prairies (Johns 1996) of Saskatchewan, Alberta, and Manitoba. Subadults also summer elsewhere in the Northwest Territories and rarely in British Columbia (Johns et al. 2008). Occasional summer records also occur further south in the United States (M. Tacha, U.S. Fish and Wildlife Service, personal communication).

Use of Fixed Wing Aircraft

Survey height and speed.–The general slope of uplands and the drainage of nesting marshes are oriented from southwest to northeast, eventually draining into the Little Buffalo River. Marshes ranged from a high of 275 m (903 ft) above sea level in the southwest to a low of 175 m (574 ft) in the northeast. Most of the nesting marshes were at approximately 210 m (690 ft) above sea level and were forested. The best altitude for observing cranes was about 245 m (810 ft) above ground level. Since altimeters are scaled in feet and for simplicity, pilots maintained an altitude of 1,500 feet (457 m) above sea level. Occasionally the altitude was adjusted by ±30 m (100 ft) depending on conditions. This altitude was the best compromise between tree height, crane size, and visibility out each side of the aircraft. By maintaining a fixed altitude there was no appreciable difference in size of the observed cranes from the high to low elevation areas since marshes were separated by several kilometers of upland and the transition was gradual. Level flying increased safety margins for airplane operation.

Pilots were fully engaged with maintaining safe airspeed, constant altitude, correct transect location, and circling known territories while maintaining a relatively smooth flight to prevent observer motion sickness. Once birds were seen the pilot first circled them while the observer plotted their location on an aerial photo, and then flew directly over the birds to obtain a GPS waypoint. Having more than one observer was therefore more efficient than having a pilot both observe cranes and fly the plane.

Survey speed was ultimately determined by the stall speed of various aircraft types and load capacity (fuel plus passengers). Where possible an ideal speed of 149-168 km/hour (80-90 knots or 92-104 miles/hr) was maintained. This flight speed optimized competing needs of safety (i.e., fast) and observation conditions (i.e., slow).

Determining presence of bands.–Between 1977 and 1988, 134 whooping cranes were banded with colored leg bands that proved invaluable to monitoring survival and productivity of the population. To observe banded birds, a slow descent into the wind just to the side of each bird was required, such that the low point of the descent (15 m, 50 ft) was just opposite the crane. At this point power was immediately applied to regain altitude. For best visibility it was essential to align the aircraft between the sun and birds to highlight the bands. If the birds were located where a low pass was too hazardous or where their legs were obscured, they were left and checked on a later flight.

Determining clutch size.–Between 1966 and 2002 a low, power-off landing-like approach into the wind, with the landing light on and directed straight at the incubating bird was performed to make incubating cranes stand up

while the observer counted eggs. Power was then applied to regain altitude. Because of frequent surveys on both winter and summer areas, whooping cranes have increased their tolerance to fixed wing over-flights. Evidence of habituation was demonstrated by the greater difficulty in gathering clutch size data from incubating birds as the study advanced (E. Kuyt, Canadian Wildlife Service, deceased, personal communication). The birds became less likely to stand requiring 2 and sometimes 3 passes of the aircraft. In many cases cranes would not stand. These low passes were unsafe because of possible engine failure at low altitude or collision with trees and dead snags. This method of determining clutch size was abandoned in 1996 because of safety concerns.

Determining presence of young.–Most chicks hatched by mid-June and surveys of the nesting pairs were done to determine hatching success. Chicks at this stage were 20-40 cm tall and difficult to see, so observation techniques paralleled procedures with banded cranes, except that the flight path was more over the birds to enable the observer(s) to look almost straight down into the vegetation. The observer(s) were looking for rusty brown chicks between the adults on the edges of ponds or in the uplands within 5 m of the ponds. As above, if the birds were obscured or located in a hazardous place they were left and checked on a later survey. A second chick survey was done near fledging in August. At that time chicks were almost adult sized and easily spotted from higher altitudes. Lower passes were usually not required.

Use of Rotary Wing Aircraft

Determining clutch size.–Because of the problems encountered with using a fixed wing to determine clutch size, and knowing that cranes were intolerant of helicopters (Kuyt 1968), a new technique was developed in 2003. The first reaction to a low level (<200 m above ground level) approach of a helicopter was for an incubating crane to turn and watch the approach, then stand over the nest, and eventually walk off the nest a few meters. If the helicopter continued to approach and land, such as during egg collections, the incubating bird would usually walk into the surrounding tall vegetation or fly off as much as 1 km (Kuyt 1968). Because such activity provided real disturbance to cranes, habituation to over-flights was less likely.

For clutch size determination the incubating bird needed only to stand. To minimize disturbance while locating nests, the helicopter approached from the downwind side facing 45° away from the incubating crane at 304 m (1,000 ft) above ground level. Once the nest was found, the helicopter slowly descended towards the incubating bird, which usually stood when approached within the 417-m threshold. If the incubating bird did not stand, the pilot turned the helicopter towards the nest to direct rotor noise towards the bird. The increased noise usually caused the bird to stand and rarely was a second attempt required. Once birds stood, the helicopter held position and observers used image stabilized, 10× binoculars to determine clutch size. Binoculars with a magnification 15× increased the ease in seeing eggs but had too small a field of view.

Disturbance

Even though cranes have habituated to fixed wing aircraft over-flights, these monitoring techniques may not be benign (Stehn and Taylor 2008). Reactions by whooping cranes to low passes were variable, with subadult groups being more sensitive than territorial adults. Low passes usually solicited 1 of 3 reactions by cranes. They would: 1) stop walking or feeding to watch aircraft, 2) nervously walk or jump, or 3) bunch up into a tighter group (typical of a pair or family group). Disturbance by helicopters is real and in order to keep disturbance to a minimum, I suggest using the approach recommendations provided and to keep the on-ground times for various activities near cranes as short as possible.

Aircraft Types Used

Fixed wing.–A variety of fixed wing aircraft have been used over the course of the study, some better suited than others (Table 1). Aircraft with wheel landing gear are preferred over those with floats because of the increased downward visibility. Floats also increase the stall speed and change the handling characteristics of the aircraft such that maneuverability may become difficult under certain wind conditions.

Rotary wing.–A number of different rotary wing aircraft have also been used during this research, with some being better suited than others (Table 2). Landing

Table 1. Fixed wing aircraft used for whooping crane surveys in Wood Buffalo National Park, with notes on suitability.

Aircraft type	Comments	Recommendation
Single engine:		
Cessna C172	Excellent maneuverability, low stall speed, limited power	Adequate[a]
Cessna C180	Excellent maneuverability, low stall speed, adequate power to weight ratio	Recommended
Cessna C182	Excellent maneuverability, low stall speed, adequate power to weight ratio	Recommended
Cessna C185 with Robertson STOL kit	Excellent maneuverability, low stall speed, good power to weight ratio	Recommended
Cessna C206	Adequate maneuverability, low stall speed, adequate power to weight ratio	Adequate[a]
Cessna C207	Aircraft is large with reduced visibility and is heavy resulting in increased speed	Not recommended
Cessna C210	Adequate maneuverability, low stall speed, adequate power to weight ratio	Adequate[a]
Maule M4	Excellent maneuverability, low stall speed, cramped rear seat	Adequate[a]
Belanca Scout	Excellent maneuverability, low stall speed	Recommended
DeHaviland Beaver	Aircraft is large with reduced visibility and is heavy resulting in increased speed	Not recommended
Twin engine:		
Partenavia PN68 Observer	Excellent visibility, good power to weight ratio	Recommended
Cessna C337	Aircraft is large with reduced visibility and is heavy resulting in increased speed	Not recommended

[a] Adequate: may be used, but there are better choices.

gear makes a large difference in the suitability of these aircraft. High skids are a must, as the sedge (*Carex* spp.) and bulrush (*Scirpus validus*) that are commonly found at most landing spots are tall and could interfere with the tail rotor. Floats have been used on some of the Bell 206 aircraft and although they reduce the useful load of the aircraft, they increase the number of landing options, especially during wet years.

CONCLUSION

Aerial surveys have been conducted over the whooping crane nesting marshes in Wood Buffalo National Park since 1955, and to date there have been no cases of nest abandonment or abandonment of young attributable to this type of survey. The surveys do cause some disturbance to the birds, notably helicopters cause more disturbance than fixed wing aircraft. The recommended altitudes and approaches are the best compromise for monitoring the population and for causing the least amount of disturbance. The use of helicopters to visit nests for testing and collection of eggs and to capture young has not caused the abandonment of eggs or young. It is recommended to use the average helicopter down times as a guide to reduce or eliminate any potential for abandonment. The average down times may also be an appropriate guideline for visiting sandhill crane nests or during capture of their young.

It is imperative to continue surveys of this population of whooping cranes and document population fluctuations and breeding success. Knowing

Table 2. Rotary wing aircraft used for whooping crane surveys in Wood Buffalo National Park, with notes on suitability.

Aircraft type	Comments	Recommendation
Alouette II	Not currently readily available	Not recommended
Bell 47 G4	Small useful load capability, not currently readily available	Not recommended
Bell Jet Ranger 206B	Ideal for small field crew, limited hovering capability	Recommended
Bell Long Ranger 206L	Large and noisy, exceptional hovering capability	Adequate[a]
Eurocopter AStar	Ideal all round machine, exceptional hovering capability	Recommended
Bell 205	Large and noisy, generally too large	Not recommended
Hughes MD-500[b]	Appears to be ideal for small field crew	Appears suitable
Eurocopter EC 120B[b]	Appears to be the best option because of the enclosed tail fan, limited availability	Appears suitable

[a] Adequate: may be used, but there are better choices.
[b] Has not been used for whooping crane related work, but appears to be suitable.

annual breeding parameters has allowed researchers and managers to monitor the cranes and effectively manage issues related to their recovery.

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