2008

# Aerial Census Techniques for Whooping Cranes on the Texas Coast

Thomas V. Stehn
*U. S. Fish and Wildlife Service*

Thomas E. Taylor
*Rockport Aerial Services*

# AERIAL CENSUS TECHNIQUES FOR WHOOPING CRANES ON THE TEXAS COAST

**THOMAS V. STEHN**, U.S. Fish and Wildlife Service, P. O. Box 100, Austwell, TX 77950, USA
**THOMAS E. TAYLOR**, Rockport Aerial Services, P. O. Box 1354, Fulton, TX 78358, USA

***Abstract:*** The U.S. Fish and Wildlife Service, using aerial surveys, regularly monitors the whooping crane (*Grus americana*) population wintering along the Texas coast. These regular census flights began in 1950 and have produced a long-term data set on the growth of a small population of endangered birds. This paper describes the specific methodology used by the authors during census flights.

***PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 10:146–151***

**Key words:** aerial, Aransas, census, flights, *Grus americana*, whooping crane.

The only remaining natural flock of whooping cranes (*Grus americana*) winters along a 72 km section of the Texas Coast located about 80 km north of Corpus Christi. The birds arrive in small groups from their Canadian nesting grounds between mid-October and mid-December, and depart starting the last week in March through early May. Since the fall of 1950, the U.S. Fish and Wildlife Service (Service) has done regular aerial census flights to monitor the flock and determine annually the size of the population. Prior to 1950, flights were done intermittently partly because of fuel restrictions during World War II and restricted air space around an Army Air Corps base near the crane area. Flights have generally been conducted weekly during fall and spring migration periods, and normally 2-3 times per month during mid-winter. In most years, the Service has chartered an aircraft and pilot required to have a Part 135 certificate and a low level flight waiver under Federal Aviation Authority regulations. The pilot also must be certified by the Department of the Interior's Office of Aircraft Safety (OAS) and is required to have 200 hours low-level prior flight experience as pilot-in-command to conduct missions below 152 m. Flights in a few years have been curtailed due to lack of a pilot or contract aircraft certified by the OAS. In those instances, Service aircraft have filled in when available.

Census flights have produced a long-term data set for the growth of a small population of endangered birds unparalleled in the study of wildlife. The flights are also important for determining winter range, habitat use, territory establishment, location of subadult use areas, detecting unusual movements and mortality, presence and identification of bands, and documenting human presence in the crane area. This paper describes the specific methodology used by the authors during census flights conducted over the past 23 years. The first author wishes to express appreciation to Tom Taylor and all the other pilots who have conducted these missions safely and always with a cooperative spirit, and to the Service for funding the flights. The views in this paper are those of the authors and do not necessarily reflect the views of the U. S. Fish and Wildlife Service.

## STUDY AREA

Whooping cranes are distributed over 22,096 ha of coastal salt marsh and bay edges with occasional use on adjacent uplands located on the Aransas National Wildlife Refuge (NWR), Lamar Peninsula, Matagorda Island National Wildlife Refuge and State Natural Area, San Jose Island, and Welder Flats (Stehn and Johnson 1987). The whooping crane winter range has gradually expanded as flock size has increased. For example, flights conducted in the 1982-1983 winter covered only a 16-km stretch of Matagorda Island. In 2004-2005, the entire 53-km length of Matagorda was flown. Similarly, the range on San Jose Island has expanded by approximately 14.5 km over the same time period, covering 22.5 km of the island in 2004-2005.

## METHODS

Aerial surveys were conducted in a Cessna high-wing single engine aircraft with usually a single observer. Flights from 1982 to 1986 were conducted in a Cessna 150 and were approximately 3 hours in duration. Starting in the fall of 1986, most flights were done in a chartered Cessna 172. With more whooping cranes to find over a larger area, flights in 2004-2005 took up to 8 hours to cover all areas where cranes might be expected to be present. Usually 4-hour flights originating from the Aransas County airport in Rockport, Texas were conducted in both the morning and afternoon with one stop for lunch and re-fueling. Flights were conducted mostly at a speed of 90 knots at an elevation of 61 m. Crane leg bands were identified by making low (15 m) and slow (60 knots) simulated landing approaches just to one side of the cranes. The winter range was divided into sections, each of which could be covered in about 45 minutes. Transects averaging about 0.4 to 0.5 km in width by 8 km in length were flown over the entire known winter range. The precise location of transects was not fixed and varied weekly depending on a variety of factors. Starting in fall 2001, transects were tracked on a GPS unit to ensure complete coverage of the census area.

Whooping cranes are identified primarily by their white color and large size, with males nearly 1.5 m tall (Lewis 1995). Cranes usually occur in small groups (territorial pairs, family

groups and subadult groups) which make them much easier to find than single birds. Prior to the fall of 1997, locations of all whooping cranes observed were plotted on hand-drawn maps. Since then, locations were plotted on color aerial infrared photographs taken from Texas Digital Ortho Quarter Quads. Crane numbers were denoted either as white-plumaged birds or as juveniles. For example, a typical family group was marked as "2 + 1", whereas an adult pair or group of 2 subadults was marked as "2". In the spring, a close approach had to be made to suspected family groups to be able to differentiate juvenal plumage.

## RESULTS

Observations were made by the first author on 504 aerial census flights over the past 23 winters (1982-1983 through 2004-2005) totaling 2,470 flight hours. Flights were piloted by co-author Dr. Thomas Taylor from fall 1993 through spring 2005.

Nearly all whooping cranes were located on every census flight; usually only a few were overlooked. After we believed that all wintering cranes had arrived and prior to the start of the spring migration, we determined the percentage of whooping cranes located on each census flight out of the total estimated present. The total estimated present was the peak population size derived minus any known winter mortalities. A few whooping cranes occasionally leave the census area for portions of the winter (Stehn 1992) and may go unreported, thus adding error to the total estimated present in the census area. Between the winters of 1988-1989 through 2004-2005, the percentage of cranes located averaged 95.3% on 158 flights. For the same time period, the percentage of cranes found on flights throughout each winter ($n$ = 17) averaged 95.1% and ranged from 89.4% (1993-1994 winter) to 97.9% (1996-1997 winter). Food resources were relatively scarce during the 1993-1994 winter, resulting in increased movement of cranes to unusual locations, making it more difficult to find all the birds. During the 1996-1997 winter, food resources for the cranes were considered good, with at least a few blue crabs available throughout the winter. However, that winter, the cranes still left the salt marsh to seek sources of fresh water to drink.

## DISCUSSION

### Factors Affecting Survey Efficiency

*Visibility*. Sunshine, or at least bright overcast conditions, is extremely helpful to increase detectability of white cranes. Whooping cranes can often be detected at a distance of >1.6 km in sunshine as the bright light reflects off their white feathers. On dark overcast days, one has to be much closer to the cranes before they are sighted, and more cranes are overlooked. However, full sunshine has its drawbacks, since usually one cannot see white cranes when looking towards the sun. On sunny days, transects are flown at right angles to the sun such that the observer always looks away from the sun. This works fine when looking out the observer's side window, but requires looking across the cockpit and out the pilot's side of the aircraft on alternate transects. The pilot's presence blocks visibility, necessitating looking partially through a curved portion of the windshield and having a reduced field of view and a blind spot close to the plane for the observer. The pilot often helps by seeing cranes close to the aircraft on his side of the plane, but he also has to be looking at instruments, maintaining correct transect width by staying on course, looking out for flying birds or other aircraft, picking out emergency landing sites every few seconds and thus cannot be focused entirely on finding cranes. In this situation, it would be very helpful to have a second observer in the back seat on the opposite side of the aircraft from the first observer. However, a second observer has been in the plane only occasionally when graduate students have conducted specific research projects.

Visibility usually varies during the course of a day-long census flight, making it more likely to overlook cranes when visibility decreases. The Texas coast sometimes has morning fog. High humidity can also limit visibility as a haze builds up on the windshield. This necessitates occasional stops to clean the windshield. Alternate landing sites utilized in the crane range include airstrips on both the north and south end of Matagorda Island. However, breaks to clean the windshield lengthens the time period between covering sections of the crane range and potentially slightly increases the chances that cranes will move and be counted twice. Census transect widths are made narrower when visibility is less, but this is not a complete fix, as some birds are still overlooked. Transects must be narrow enough to enable the observer to detect the same cranes on two adjacent transects in order to find all the birds.

*Coverage*. Prior to use of a GPS unit for flight tracking, pilots attempted to fly parallel transects primarily by using landmarks, maintaining a given heading and making turns of equal size. This was very difficult given varying wind speeds and directions, especially on windy days. On long narrow stretches of marsh, such as on the Aransas NWR where transects could be made parallel to the Intracoastal Waterway, coverage was considered complete. On wide stretches of marsh, such as on San Jose Island with less obvious landmarks, cranes were invariably overlooked due to incomplete coverage. Because the whooping crane winter range has expanded so much in size over the past 23 years, a GPS unit is now considered an essential instrument for conducting a census flight. The GPS unit provides course readout to stay on a desired transect. However, there can be a delay of up to 8 seconds to obtain

actual position from the GPS unit, making it more difficult to get on course and accurately mark waypoints. Nevertheless, use of a GPS unit for flight tracking has made it much easier to maintain parallel transects and obtain compete coverage of all marsh areas, and has eliminated discussions held in previous years about what areas had been covered. Before departing a given section of marsh, the pilot looks at all flight paths shown on the GPS screen to ensure complete coverage has been achieved. If an area between two transects is considered too wide, an additional transect is made to obtain more complete coverage.

## Factors Affecting Detection of Birds

*Field of View*. A Cessna 172 has a blind spot directly in front of and below the aircraft created by the location of the motor. If light conditions like a dark overcast are such that the observer is looking out the front of the aircraft, cranes directly in the line of flight must be detected at a considerable distance before they are hidden by the blind spot. When light conditions are poor, the observer can make mistakes in species identification of the birds directly in front of the aircraft. Experience has shown that when cranes are overlooked the airplane has frequently flown directly above them. A Partanavia aircraft with a large "bubble" windshield has greater visibility and a much smaller blind spot and would be a much better aircraft for crane census flights but is not available locally. Use of a helicopter would provide even better visibility, but helicopters are much more disturbing to whooping cranes, are much more expensive, and have never been used for winter population census flights. Helicopters have occasionally been used on the nesting grounds to determine the number of eggs in nests, and for collection of eggs or banding of flightless juveniles (Brian Johns, Canadian Wildlife Service, personal communication).

*Reduced Visibility While Turning*. When the aircraft is turning cranes are often overlooked. It is possible to lower the wing and make a complete circle around a crane without ever being able to see it. Transects have to be laid out so that all parts of the marsh are covered when flying in a straight line. Areas where turns are being made are not considered to have been effectively searched.

*Inefficient Searching*. It is very important for the observer to continually scan with his eyes rather than having a fixed stare at a specific angle from the aircraft because cranes can usually be easily identified if the eyes are covering all the marsh visible from the plane. However, 8 hours is a long time to be trying to locate birds. Observer fatigue is a factor in not finding cranes, especially on hot days with choppy air and bumpy flight conditions that increase air sickness for the first author.

*Plotting Crane Locations*. Cranes can be missed while looking down at photographs to plot the location of cranes just observed. The action can get fast and furious when plotting cranes in the areas of the highest crane density such as on Aransas NWR. Sometimes a crane location is memorized and the cranes plotted a minute or two later when there is less marsh to view or the airplane is making a turn onto the next transect, but this necessitates remembering to plot the cranes observed. Plotting cranes can be easy in portions of the marsh with distinct landmarks, but can be confusing when the marsh in a given area appears similar, especially in wider areas on San Jose and Matagorda Islands. Plotting is made more difficult by variable water levels that change the appearance of the landscape which can look quite different from that shown in the aerial photographs. Plotted locations are generally considered to be accurate to at least 100 meters. Efforts have not been made to plot the exact location of cranes because cranes often walk while foraging and over time cover large stretches of marsh. Whenever the observer is not able to quickly plot cranes accurately, the pilot is asked to record the GPS location which greatly reduces uncertainty by being able to return to the same group of cranes. The cranes can then be circled and plotted, or found again while on the next transect, providing additional time to pick out landmarks. A GPS location is not obtained for every crane encountered because the aircraft would have to deviate from the transect in order to fly directly over the birds to get an accurate location, and, if used alone, the GPS location would not be recording the number of cranes or age class (adult or juvenile) encountered.

*Tunnel Vision*. When finding cranes, the observer usually has to concentrate on finding that specific location on a photograph and plot the birds' location. While looking to gain an image of the specific location, the observer may fail to scan other nearby areas and thus overlook additional cranes. Cranes are not evenly spaced throughout the wintering area, but seem concentrated. Part of this may be due to availability of food resources, but also is believed to be, even though adult birds are territorial, part of the social interactions of the species.

*Presence of Other White Birds and Objects*. During the course of an 8-hour census flight, thousands of other white birds are sighted. These include white pelicans (*Pelecanus erythrorhynchos*), great egrets (*Casmerodius albus*), snowy egrets (*Egretta thula*), the whitish phase of the reddish egret (*E. rufescens*), and occasional flocks of cattle egrets (*Bubulcus ibis*) on upland areas. At a distance these birds can look like whooping cranes. Whooping cranes are differentiated from these other birds primarily by their size, tall upright posture and straight necks. Great egrets or snowy egrets standing on a bush or top of a bank can look as tall as a whooping crane. Whooping cranes bent over to forage, or those feeding in a bayou with tall banks on either side, can look more the height of a great egret. White pelicans at a great distance are as bulky as whooping cranes and cannot be differentiated initially based

on the size of the "white dot" being observed. In flight, white pelicans and whooping cranes look very similar unless the beak, neck, or legs can be seen. The wing beat of the pelican is just a little bit different, especially with the pelican's characteristic flight pattern of flapping the wings 4-5 times and then gliding, whereas whooping cranes normally keep flapping. Whooping cranes are sometimes found within dense concentrations of hundreds of white birds foraging at a concentrated food source. In those situations, the large group of birds must be approached and looked at carefully. Of all birds encountered during census flights, whooping cranes are the least likely to take flight at the approach of the airplane at an elevation of 61 m. Sandhill cranes (*Grus canadensis*) flush more readily than whooping cranes. Great egrets and white pelicans also frequently take flight, thus changing the pattern of white dots on the landscape, depending on where they land. This can lead to uncertainty about whether unidentified white birds seen at a distance that are not found on subsequent transects have moved or have been overlooked.

Other white objects that can look like whooping cranes at a distance include white refuge boundary signs, styrofoam or other objects of trash in the marsh. At a distance, it is not possible to tell which white objects are whooping cranes. The pilot may deviate from a transect to check out a white object, or else may get closer to that object on the return transect. However, sometimes the target object is not seen on the return transect (in the blind spot or up sun from the aircraft, or the birds have moved), adding uncertainty to the census. Experience indicates it is usually best to immediately check out white objects that appear to be cranes and get them identified and plotted so as not to lose track of them. However, this makes for a more chaotic search pattern, requires flying a longer distance, increases the time required to cover a given section of marsh, and makes it more difficult for the pilot to get back on the original transect.

*Crane Movements*. Much to the first author's frustration, whooping cranes are mobile during census flights. Cranes may make local movements that result in them being overlooked. Although cranes usually spend most of their time walking while foraging, they sometimes make a short flight to a different foraging area. Cranes can fly into an area just covered and thus be overlooked, especially when the airplane is at either end of a transect. Transects lengths are kept short, averaging 8 km to try to reduce the amount of crane movement that occurs while a particular section of marsh is being covered, and also increase the chances that flying cranes may be spotted.

Finding a crane group soon after plotting a group nearby may mean the original group of cranes has made a short flight to a new location. If a crane sighting is suspected of being a duplication of cranes already plotted, the aircraft can fly to nearby plotted locations to see if these other cranes are still present. Again, this takes time and increases the chance that additional crane movements will occur. Errors can be made if birds are plotted inaccurately. This can lead to uncertainty if the same cranes are encountered a second time.

Movements are more frequent when food resources are scarce and when cranes are attracted to feed on prescribed burns on the uplands. Movements also increase when cranes are forced to fly to freshwater ponds to drink, when marsh salinities exceed 23 parts per thousand (Allen 1952, Hunt 1987, F. Chavez-Ramirez, Platte River Habitat Whooping Crane Trust, unpublished data). Additionally, cranes make movements to defend their territories. Caution must be used when flying over cranes on prescribed burns, since they are more apt to flush, especially in the presence of sandhill cranes that are even more prone to disturbance than whooping cranes. Aircraft elevation over prescribed burns is frequently increased to 91 m to reduce the chances of flushing the cranes. In winters when cranes are making longer flights to upland areas, these movements can cause much confusion and inaccuracy. Movements are occasionally so numerous that one would have to repeat covering a particular section of marsh to try to get an accurate count, but if cranes move great distances, so much of the crane area would have to be flown a second time that there is just not enough time in the day to do so.

As census flights become longer, chances increase slightly that birds will move from one part of the census area to another and be double-counted. It is not uncommon for territorial and subadult cranes to fly across large bays between different parts of the crane range (Stehn 1992). For example, cranes fly between San Jose Island and the south half of the Aransas NWR (the Refuge), or between Matagorda Island and the north half of the Refuge. Cranes have also been known to fly between Welder Flats and Matagorda Island, and Welder Flats and the Refuge. The observer may become suspicious that such a movement has occurred if one additional family group appears in the crane area or if, for example, a group of 4 subadults is located on San Jose and later on, a group of the same size is found on the Refuge. Sometimes the aircraft can go back to prove that the grouping is not a duplicate sighting, though often the cranes seen earlier in the day cannot be re-located and the findings are inconclusive. Areas are usually covered in the order of where cranes are most likely to make long flights crossing over bays. Doing so lessens the chance of this occurring during that portion of a census flight. It is not possible to totally eliminate duplication from across-bay movements, so it is important to obtain a peak count on more than one flight during the winter to establish the peak population size.

Cranes occasionally fly to forage in grain fields or pastures near wintering areas which can be included on census flights. For example, over a 2.5 month period in the 2000-2001 winter, up to 21 whooping cranes used salt marsh and adjacent farm fields along Burgentine Creek near the northwest corner of

Aransas NWR. Cranes wintering outside the normal winter range go undetected unless reported by other persons. Such reports are usually investigated by staff of Aransas NWR or Texas Parks and Wildlife Department. In December 2001, 2 whooping cranes were reported near Indianola, Texas located 24 km northwest of the known crane range. This area was covered on census flights and the pair remained in the area for the rest of the winter. In December 2004, a fisherman reported a family group of whooping cranes on the north end of Matagorda Island. This area was covered on subsequent census flights, with up to 5 cranes present during the remainder of the 2004-2005 winter. Use of these marshes on the extreme north end of Matagorda had last been documented in the 1995-1996 winter.

Whooping crane subadults occasionally go farther away and can leave the wintering area for months at a time (Stehn 1992). In the 1987-1988 winter, 1 color-banded subadult spent 2 months with sandhill cranes 72 km north of the wintering area (Stehn 1992). Whooping crane juveniles occasionally get separated from their parents during fall migration and end up wintering away from Aransas. These juveniles may return the following fall to areas away from Aransas, but may eventually follow other whooping cranes to Aransas (Stehn 1992). Once reported, arrangements are usually made with other observers to monitor whooping cranes wintering away from the traditional area at Aransas.

In the spring, cranes may sometimes make soaring flights high up on thermals for 10-15 minutes before returning, frequently to the same general area. This is believed to be a sign of "restlessness" as the migration period approaches. On such flights, cranes can be overlooked. If seen in flight, cranes are generally followed, with the airplane trying to stay well above the cranes until the cranes land. If the cranes are lost from sight when in a soaring flight, the airplane quickly breaks off the chase to avoid any chance of accidentally hitting the cranes.

*Single Cranes*. It is much more difficult to find a single whooping crane than a pair or family group. Fortunately, most subadult cranes associate in small groups. The presence of 2 or more birds increases the chances that at least one will be standing upright and clearly identifiable as a crane. With so many other white birds in the marsh, a single whooping crane will invariably be missed sometime during an 8-hour flight. This is especially true during the rare times that a juvenile separates from its parents during the winter, since juveniles are not pure white and thus harder to locate. Singles that are close to other cranes are easy to spot since the observer is focused on the area where the group is. Also, a single crane may sometimes be found in approximately the same general section of marsh for many weeks in a row, making it easier to locate. Of the 1,313 crane groupings located during the 2004-2005 winter that ranged in size from 1 to 7 cranes, 85 were isolated singles not near other cranes. Thus, 93.5% of targets found were groups of 2 or more cranes.

In addition to being aware of factors that influence birds being overlooked, one should also consider that two other factors can affect successful censusing. These are the observer's knowledge of territories and disturbance.

*Knowledge of Territories*. Whooping crane adults almost always return to the same territories annually (Stehn 1992). As the adult cranes return in the fall, the observer creates a written checklist of territorial pairs in the order they are expected to be encountered on a flight. If a known territorial pair or family is overlooked in a given area, additional transects will often be flown in their territory. About half the time, the "missing" cranes are located, having either flown in from another part of their territory, or perhaps having been missed in a blind spot on an earlier transect. A few territories, described by Bonds (2000) as non-contiguous, consist of two separate areas which increase movements for those particular pairs.

*Disturbance*. Census flights do cause some disturbance. However, the disturbance is of short duration (T. Lewis, United States Fish and Wildlife Service, unpublished data). In general, the cranes have become acclimated to overflights of fixed wing aircraft at an elevation of 61 m and the level of disturbance for authorized flights is felt to be acceptable. Low passes to identify color bands can cause an intense reaction, such as whooping cranes running together to form a tighter group. Low passes have also been made with the cranes simply standing without moving, so reaction is highly variable. With only 11.5% of the population currently banded and the percentage of banded cranes continuing to decline over time, fewer low passes are made each winter.

## RECOMMENDATIONS AND CONCLUSIONS

Periodic census flights are essential for determining the total number and distribution of whooping cranes during winter. With good visibility and the relatively common situation of encountering little movement of cranes during a census flight, it is possible to make an accurate census of the population. To keep from overlooking cranes, it is important to make transects narrow enough to detect the same cranes on two adjacent transects, giving the observer two opportunities to see every crane. By making flights on a weekly basis, it is possible to look for distribution patterns that also help to determine the total number of birds. It is important to get the high count for the winter on more than one flight to more accurately determine flock size because cranes do move around and can be counted twice during a census. It is recommended that a second observer be in the aircraft to increase census accuracy. This person could also record detailed habitat use and crane behavior.

When multiple census flights are conducted, the flock

size determined annually is believed to have an accuracy of approximately 99% and is one of the most precise population counts done on any wildlife population in the world. As flock size increases and the number of color-banded birds decreases, the accuracy of the census is expected to decrease.

The annual population census is the most important management action done annually to monitor the Aransas-Wood Buffalo population of whooping cranes. Winter is the only time during the year that whooping cranes can be accurately counted. The birds are more spread out during summer, and the presence of tall trees on the nesting grounds makes it much harder to find all the birds. Thus, it is important to continue periodic census flights throughout the winter to monitor the population, at least as long as it continues to be classified as "endangered". If flock numbers start declining, it would be reasonable to assume that threats to the species are increasing, and that additional management actions would need to be taken.

## LITERATURE CITED

Allen, R. P. 1952. The Whooping Crane – Research Report # 3 of the National Audubon Society New York, New York, USA.

Bonds, C. J. 2000. Characterization of banded whooping crane territories from 1992–93 to 1996–97 using GIS and remote sensing. Dissertation. Texas A and M University, College Station, USA.

Hunt, H. 1987. The effects of burning and grazing on habitat use by whooping cranes and sandhill cranes on the Aransas National Wildlife Refuge, Texas. Dissertation. Texas A & M University, College Station, USA.

Lewis, J. C. 1995. Whooping Crane (*Grus americana*). A. Poole and F. Gill, editors. The Birds of North America, No. 153. The Academy of Natural Sciences, Philadelphia, and The American Ornithologist's Union, Washington, D.C., USA

Stehn, T. V. 1992. Unusual movements and behaviors of color-banded whooping cranes during winter. Proceedings of the North American Crane Workshop 6:95-101.

Stehn, T. V., and E. F. Johnson. 1987. Distribution of winter territories of the whooping crane on the Texas coast. Pages 180-195 *in* J. C. Lewis, editor. Proceedings of the 1985 Crane Workshop. Platte River Whooping Crane Habitat Maintenance Trust, Grand Island, Nebraska, USA.

Cranes wintering near Ascension Chihuahua, Mexico (northwest corner of the state), note the cross-fostered whooping crane with them. Photo by Roderick C. Drewien.