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The use of small airplanes to gather swan data in Alaska

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Alaska is the centre of abundance for North America's nesting swans. The Whistling Swan *Cygnus columbianus columbianus* nests on the tundra of western and northern Alaska and east to Hudson Bay in Canada with the greatest density occurring on the 26,000 sq. miles (67,340 sq. km) of the Yukon River Delta. The Trumpeter Swan *Cygnus cygnus buccinator* formerly nested throughout a large portion of western North America but is now confined to a few isolated locations in or near the Rocky Mountains and to portions of the forested regions of Alaska. Today Alaska hosts about three-fourths of the nesting population of Trumpeter Swans and perhaps two-thirds of the Whistling Swans. There are about 22,000 sq. miles (56,980 sq. km) of Trumpeter habitat in Alaska and some 72,000 sq. miles (186,480 sq. km) of Whistler habitat. Stragglers from each species are occasionally found within the range of the other but essentially they use well-separated breeding areas (Figure 1).

Down the years, naturalists have recorded observations of swans in Alaska but because of the large territories used by swans and their wide range in the wilderness it was not possible for ground-bound observers to develop a full picture of swan distribution. In 1954 the first waterfowl biologist-pilot, Henry A. Hansen, came to Alaska and it was immediately obvious that swans, perhaps more than any avian species, lend themselves to study from the air. Swan studies are justified for their own sake but also provide a handy indicator of the well-being of all waterfowl in a given habitat. When swan productivity is low

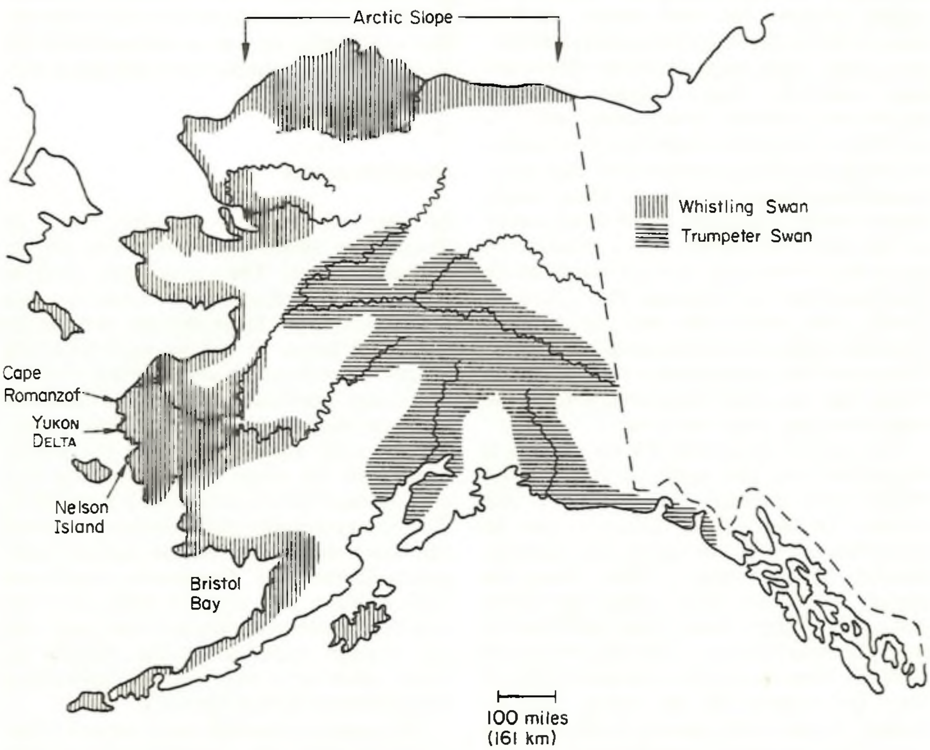

Figure 1. Approximate swan breeding range in Alaska.

most other species are likewise having a poor season, and conversely. In the past 17 years many swan data have accumulated and credible air survey methods have been developed. We have spent more time in the development of techniques than in their application because as yet no one has been assigned full time to swan work.

The purpose of this paper is to describe techniques which if extensively applied could result in a much better understanding of swan population dynamics. It is hoped that it will aid people planning air expeditions in getting more data for their time and money.

Five survey methods are described: (1) complete census; (2) random plot census; (3) line transect surveys; (4) random flight methods; (5) exploratory flight methods. The first two techniques are the most promising for the exclusive study of swans and result in a census. The last three are ways of recording meaningful swan data while engaged in work on other species but result rather in an index than in a census. Pre-planning is in each case the key to producing consistent useable records.

Safety, visibility, speed and range are important considerations in selecting a proper airplane for bird surveys. A float plane is safest for work in extensive wilderness areas; high wing airplanes afford the best visibility; single engine airplanes cruise at acceptably low speeds and a 6- or 7-hour range affords the best time utility. The Canadian-built DeHaviland Beaver on amphibious floats is a seven place, single engine, high wing plane with 7-hours range at 100 mph (160 km/hr). It is a satisfactory plane for surveys but is poor for catching flightless birds for banding. The U.S.-built Cessna 180 and Cessna 185 are the most versatile planes for all phases of swan work. These are five place planes with adequate range and are more manoeuverable on the water than the larger Beaver.

The choice of season for air surveys is dependent on the type of information sought and perhaps the quality of the terrain. In the North, swans scatter to territories as they arrive on the partially thawed nesting range. When disturbed during incubation some American swans will get off their nests and hide behind them or nearby cover. The first month to 6 weeks after hatching is the most difficult time for surveys as the young tend to cluster closely with parents in the thickest cover they can find. In the last 2 or 3 weeks before fledging the young are quite large and are frequently seen in open water and Whistlers often graze or loaf on the open tundra. After fledging the birds begin to leave the nesting territories and gather in pre-migration flocks. They can then be counted or photographed from the air but one can no longer determine their relationship to the nesting habitat. The surveys herein described are useful from the onset of incubation to the time of fledging. Lensink (1973) has shown that the structure of the population changes somewhat as summer progresses. If only one annual survey is possible the last 3 weeks before fledging would probably be the best time. In Alaska we get the best information for either species in late August.

To count eggs in the nest requires flying at less than 100 ft (30 m). With the unaided eye swans can best be found from an elevation of 400–500 ft (120–150 m) although it may be necessary to be lower for brood counts. Some people prefer to work from about 1,000 ft (300 m) with binoculars. The width of the path of observation depends on the altitude. Before starting lineal surveys it is well to measure the distance between two appropriate landmarks and fly over them several times to accustom the eye to the desired limits. Pieces of tape can be placed on the window at eye level and on the wing strut to aid in determining the width of observations from any given altitude.

Complete census

In 1968 we made a complete count of Trumpeter Swans on their entire Alaska breeding range. The census was done in August when the young were not yet fledged but were large enough to be easily seen; 124 hours in the air were required. Planes were flown at about 500 ft (150 m) but it was sometimes necessary to dip down to count broods. Prior to each flight, maps with a scale of 1:63,360 were stacked in order. All the swan habitat on each map was covered before proceeding to the next. The observer in the right hand seat marked the exact flight path of the airplane with pencil on the map. The precise location of each sighting was marked with a dot and numbered consecutively on each map. On the margin were noted the number of birds, adult or young; birds in flight being distinguished by the letter F.

This survey resulted in an actual count of 2,848 birds, 32% of which were cygnets (Hansen *et al.*, 1971). The true population was believed to be somewhat higher since some low density Trumpeter habitat was missed and because some swans conceal themselves. In spite of these known deficiencies, the census stands as a good baseline for comparison with future counts. The most important feature of this type of count is the recording of the exact flight path so that future observers will know exactly where swans were not seen as well as where they were. This is the item most often neglected in air surveys.

Although this count was an attempt to cover thoroughly a very large area it is not always necessary to examine the entire range of a species to get useful information on density, population structure and productivity. The technique could be applied to key portions of swan habitat. Thus, Sladen has made complete counts in the oil development areas of Alaska's Arctic Slope which will show the effect of such disturbance on distribution and productivity. A June count during incubation followed by an August count would result in a more complete picture of a local population and its productivity. Monthly or even weekly surveys would be better still. By careful flying it is possible to count clutch sizes but as some birds sit tighter than others a complete count of eggs in a given area would be difficult to achieve without having to land. Of course any survey is enhanced if it can be repeated year after year to give long term averages and trends.

Random plot census

There is usually a practical limit to the size of a population or a breeding range that can be covered by a complete census. In the case of Whistling Swans with a population thirty to forty times greater than Trumpeters scattered over a range several times larger, a complete census would be exhausting and doubtless a waste of time. Results of equal veracity could be achieved by a random plot count. In this method the entire area is gridded into plots on a map of suitably detailed scale. Thirty or more plots are selected at random for actual census. The size of the plots should be such that some swans occur on each. On the Yukon Delta, Lensink has found (personal communication) that 4-sq. mile (10·36 sq. km) plots are suitable for Whistling Swans. Where densities are lower, larger plots would be needed. Sampling error can be determined by standard procedures for analysing simple or stratified random samples. Plot census can be done at intervals while the birds are on territory, and carried over a period of years would be most valuable.

We have not as yet set up any consistent Whistling Swan sampling by this method. We did use the method over a 31,000-sq. mile (80,000 km^2) area in southeast Alaska to determine the breeding population of Bald Eagles *Haliaeetus leucocephalus*. By sampling thirty plots from 488, we determined a population on territory of 7,287 ± 25% with 95% confidence. We used a plot size of 65 sq. miles (166 sq. km) in this case but were required to fly only the coastline and river valleys in each plot. This survey took 32 hours of air time in a single engine float plane (King, 1972).

Line transect surveys

For the past 18 years the Alaskan breeding population of ducks has been surveyed from the air by a system of lineal transects. This type of survey is described by Crissy (1957) and Martinson & Kaczynski (1967). The transects are marked on detailed maps and are flown at 100 mph (160 kph) at an elevation of 100 ft (30 m) above the terrain. The pilot on the left and an observer on the right record all waterfowl observations within $\frac{1}{8}$-mile (201 m) of each side of the plane. Each observer uses a portable tape recorder. The result of each 16-mile (26 km) segment is a census of 4 sq. miles (10·36 sq. km). The data are converted to an estimate of population within the total square miles of the habitat. Confidence limits can be determined as for a simple random sample.

Swans have been recorded on this survey for the past 14 years as 107 of the segments fall within the breeding range of the Whistling Swan. Although analysis of this swan data has not been exhaustive we have some preliminary findings that show the advantages and weaknesses of this technique.

Advantages include:

(1) An index of population fluctuations over a period of years is derived that would show the occurrence of drastic changes in the breeding population. No upward or downward trend is obvious in Alaska thus far (Table 1).

(2) It is a good method for stratifying swan habitat by mean density per square mile. Figure 2 shows how line transect data is used to stratify

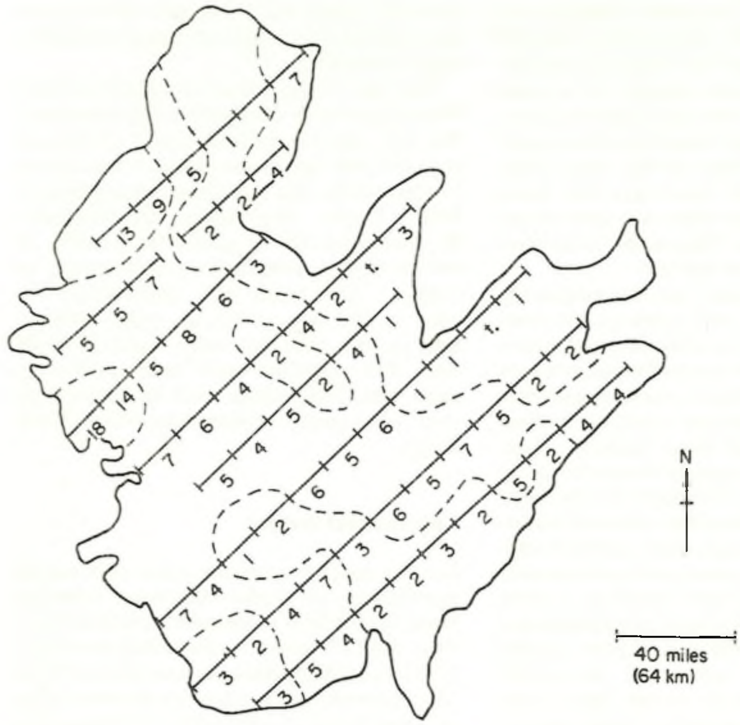

Figure 2. The Yukon Delta showing location of each of the 65, 16-mile line transect survey segments. The number below each segment is the 16-year average number of swans seen there that appear to be on territory. The dotted lines group areas according to density, low averaging from trace (t.)–3, medium 4–8 and high 9–18.

the habitat on the Yukon Delta, providing a good basis for land use and management decisions.

(3) A rough estimate can be made of the swans on territory that are likely to reproduce (breeding population).

Weaknesses include:

(1) The survey was designed to sample ducks, so lacks the precision of a survey specially planned for swans.

(2) The observers must judge the $\frac{1}{8}$-mile observation swath and make accurate observations without benefit of circling or going back to recheck.

(3) At some times the survey is done under cloudy skies and at others bright sun causes water glare that interferes with visibility.

(4) It is difficult to analyse the data without benefit of concurrent ground studies particularly of swan breeding behaviour. We are not sure how many swans are missed. It is not yet known what proportion of single swans actually represent a pair, and which are truly lone birds. Lacking precise data, single birds have been considered a pair in the final analysis (Table 1). This may be more accurate than counting two single sightings as a pair but there is still an unresolved bias.

(5) The survey does not measure clusters of non-breeding birds accurately.

(6) The survey would be improved by being repeated in late August to measure actual production of young.

We must conclude that the line transect method by itself gives a relatively superficial picture of a swan population and that the incubation period is not the best time to do such a survey. When a detailed study of a portion of the swan population is carried through an entire season, the long term transect survey information already gathered will become more valuable.

A line transect survey designed specifically for swans should be planned so some swans occur on every transect. It might be flown somewhat higher than a duck survey permitting a wider survey path.

Table 1. Whistling Swan spring population in Alaska from 1958 to 1971 (excluding the Arctic Slope) as determined from 107 line transects

1958	1959	1960	1961	1962	1963	1964
64,000	59,000	79,000	79,000	56,000	64,000	50,000
1965	1966	1967	1968	1969	1970	1971
62,000	52,000	43,000	50,000	75,000	69,000	61,000

14-year average 62,000; range 43,000–79,000.
(Figures from Chamberlin, Martinson & Clark, 1971).

Random flight method

When making routine flights across swan breeding habitat valuable data can be obtained by recording every swan seen. Nests and clutch sizes can be recorded in this fashion. It is necessary only to fly low enough for swans to be easily seen. The observer need not direct the path of flight, but if he can the quality of brood counts, flock counts, and egg counts are improved. If such flights can be made at least once a week, a good picture of swan productivity and juvenile mortality throughout the nesting season can be obtained.

The best example of this type of survey is from the Yukon Delta where the staff of Clarence Rhode National Wildlife Range have recorded swan data on routine flights since 1963 (Lensink, 1973).

The advantages of this method are that no cost is involved as people are travelling anyway and observations from different areas can be compared if the trips were made at about the same time of year.

Exploratory flight method

An airborne biologist must devote some time to exploring habitat new to him to get the 'feel' of the country before he can set up meaningful surveys. The value of the observations made on such trips can be enhanced if observations are recorded systematically. We have found that over the tundra habitat we can use the techniques of the line transect method to arrive at rough estimates of swans on the breeding grounds. Observations are made in a consistent swath and divided at fixed time intervals. Efforts should be made to reach every part of a given habitat and not to spend too much time in any one area. It is not necessary to fly straight lines. We have used the ⅛-mile (201 m) observation swath and 10 minute intervals which at 96 mph (155 kph) gives us six samples of 2 sq. miles (5·18 sq. km) for each hour flown. With one observer this permits the recording of all Anatidae and other medium sized birds. If swans only are to be recorded a wider observation swath could be covered from a higher altitude. The coverage is doubled of course if there is an observer on each side of the plane. A figure for the number of birds per sample can be expanded to the total area covered. By this method we estimated there were 800 swans on the 23,000 sq. miles (59,570 sq. km) of waterfowl habitat of the Arctic Slope in 1966 (King, 1970).

Discussion

The foregoing methods can be 'tailored' to time and budgetary limitations. Probably the most important feature of the Alaska work has been consistency in planning and recording so that year can be compared to year and area to area. If we continue accumulating data in this fashion we will eventually piece together a good picture of swan population dynamics on the breeding range.

If airborne biologists working full-time on swans were available, the repeated survey of sample plots would be the most advantageous method. The major effort should be a complete random plot survey conducted in August to determine productivity. Before and after this, portions of the area could be examined at weekly or bi-weekly intervals to determine arrival dates, territory size, onset of nest building, egg laying, clutch sizes, hatching dates, mortality rates, brood movements, fledging dates, fall flocking pattern and exodus from the breeding area. A combination of plot counts and random flights might work best. Air surveys cannot answer all the questions of swan biology and ground work will be essential to learn about feeding habits, general behaviour, and causes of mortality. Some aspects of swan behaviour from year to year will require marking individual birds as described by Sladen (1973). An aerial team assigned full time to swan work could probably do a lot of ground observation. Swans during their annual moult or prior to fledging can easily be caught for marking by use of a float airplane.

Although this report relates entirely to the use of airplanes we assume that the methods described could be modified to use from a helicopter.

We conclude that the full understanding of swans on the breeding grounds requires the use of light aircraft for surveys as well as ground access.

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Summary

Single engine airplanes have been used in Alaska for swan population counts over the past 17 years. Five different methods have been developed: (1) complete census; (2) random plot census; (3) line transect surveys; (4) random flight method; (5) exploratory flight method. The first two methods are recommended when full time can be devoted to swan work. The last three are used when the flight is primarily for other purposes.

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