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Waterbirds around the world

A global overview of the conservation,
management and research of the
world's waterbird flyways

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Monitoring North America's waterfowl resource

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ABSTRACT

Monitoring programs are an essential component of successful waterfowl management in North America. Five major categories of waterfowl monitoring efforts are conducted annually: population surveys; production surveys; habitat surveys; banding and marking programs; and harvest surveys. These surveys and programs are cooperative in nature, and rely on integrated partnerships between federal, state, and provincial agencies, as well as private organizations throughout the continent. Results from these surveys provide estimates of waterfowl population size, recruitment, survival rates, and harvest, as well as a means of evaluating habitat quality. Quantitative assessments of these key parameters provide the foundation for understanding waterfowl population dynamics and making and evaluating harvest management decisions.

INTRODUCTION

One of the primary goals of waterfowl harvest management is to provide equitable hunting opportunity while ensuring the long-term sustainability of the hunted populations. Monitoring bird populations is an essential element in facilitating this task, and is the common basis for regulating hunting activities in all three countries in North America. The signatories of the various migratory bird treaties (United States, Canada, Mexico, Russia, and Japan) share responsibility for conducting the monitoring efforts that are needed to ensure sustainability.

In this paper, we provide an overview of the monitoring programs in North America, which are critical components of successful waterfowl management. There are five major categories of waterfowl monitoring efforts that are conducted annually: population surveys, production surveys, habitat surveys, banding and marking programs, and harvest surveys. These surveys and programs are cooperative in nature, involving biologists and other personnel from federal, state, and provincial agencies, as well as some non-governmental organizations. Information collected in these surveys results in estimates of waterfowl population size, recruitment, survival rates, and harvest, and also provides a means of appraising habitat quality. Together, these estimates provide the foundation for understanding waterfowl population dynamics and making and evaluating harvest management decisions.

POPULATION SURVEYS

Each year, waterfowl population surveys are conducted on breeding and wintering grounds, and during migration. Most of these surveys are broad-scale in nature, wherein pilot-biologists count many species simultaneously, but some are designed to be species- or population-specific. These are primarily aerial surveys, and the data they provide are used independently or in conjunction

with other information to derive annual estimates or indices of abundance for most species of ducks and populations of geese.

Breeding Ground Surveys

The May breeding population and habitat survey is the most extensive and most important of North America's waterfowl population surveys. This survey was initiated on an experimental basis in 1947, became fully operational in 1955 (Martin *et al.* 1979), and has since been conducted annually. This survey is a cooperative effort of the United States Fish and Wildlife Service (USFWS), the Canadian Wildlife Service (CWS), and state, provincial, and tribal agencies. From 1955 to 1995, the May breeding population and habitat survey annually sampled more than 3.6 million square km of waterfowl breeding habitat throughout central Canada, north-central United States, and Alaska (Smith 1995). In 1996, the survey area was expanded to include an additional 1.8 million square km in the north-eastern United States and eastern Canada. In its entirety, this area represents a large portion of the primary duck nesting areas in North America.

The methodology for the May breeding population and habitat survey is described in detail in manuals of standard operating procedures (CWS & USFWS 1977, 1987) and elsewhere (e.g. Reynolds 1987); therefore we will only outline it briefly here. To sample the North American waterfowl breeding habitat efficiently, the area is divided up into 65 strata or areas of similar waterfowl habitat and waterfowl densities. Within each stratum are transect lines that were established to sample the stratum from the air (Fig. 1). Different strata are sampled at different intensities depending on waterfowl densities within the strata. Each transect is further divided into a series of 28.8 km segments (25.6 km in Alaska). In total, over 85 000 km of transects are flown each year using 13 fixed-wing aircraft.

Air crews, each of which consists of a pilot-biologist and an observer, fly along each transect line at an altitude of 30-45 m and a speed of 145-170 km per hour. The pilot-biologist identifies and counts all ducks and geese within 200 m of the transect line on the left side of the aircraft, while the observer is responsible for identifying and counting waterfowl within 200 m on the right side. Observed birds are identified as singles, pairs, flocks, or groups (CWS & USFWS 1977, 1987). Until recently, pilot-biologists and observers recorded their observations on tape recorders, and later transcribed and summarized the data onto paper forms or into a computer. Today, observations are recorded directly in a computer, and each observation is geo-referenced with point locations from the aircraft's Global Positioning System (GPS, see Hodges & Thorpe 2002).

When the survey was first established, population estimates derived from the aerial counts were not adjusted for birds that

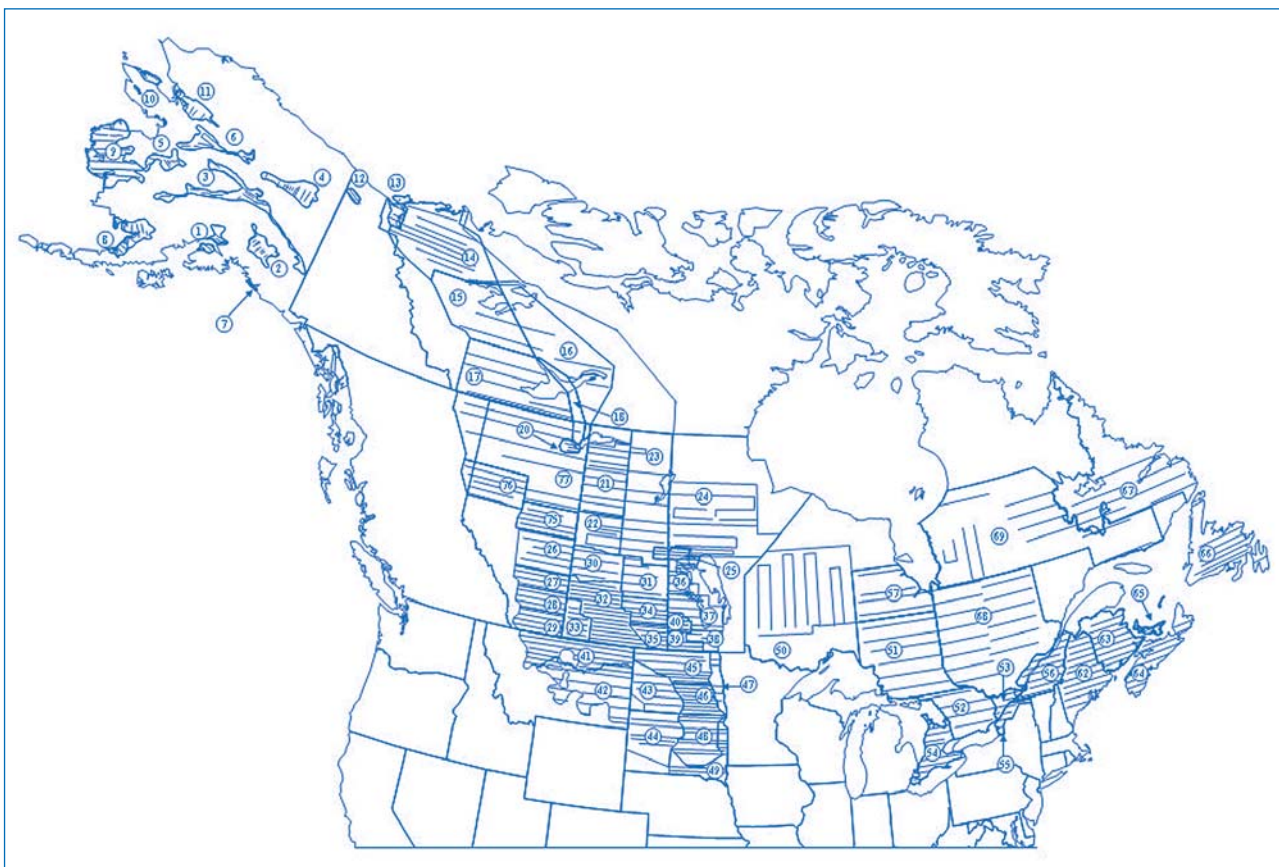


Fig. 1. Strata and transect lines of the May waterfowl breeding population and habitat survey that is flown annually in North America.

could not be seen from the air. To correct for this bias, a subsample of segments was chosen for more intensive scrutiny by biologists on the ground. Ground crews consisting of two to four people coordinate with the air crews and conduct their waterfowl counts on sample segments within three days after the air crew has flown the segment. The ground crew uses GPSs, aerial maps, and past experience to check every wetland and count and identify each duck or goose observed on the sample segments. The use of these “air-ground comparison segments” was first tested in 1959, and the system became fully operational in 1961 in Canada and in 1974 in the United States. Currently, in the United States and Canadian prairies there are 163 air-ground comparison segments. The ground counts provide the basis for developing visibility correction factors to account for the fact that not all birds within 200 m of the transect can be seen from the air. In some northern and eastern strata, where ground access is problematic due to lack of roads, helicopters are used instead of ground crews (e.g. Malecki *et al.* 1981). In these areas, transects are flown by the fixed-wing aircraft and then followed up by a helicopter crew using procedures similar to those used by the ground crews in the prairie areas.

Species-specific estimates of breeding populations are derived by taking the counts obtained from fixed-wing aircraft, adjusting them based on the visibility correction factors, and expanding them over the survey area in each stratum. Martin *et al.* (1979) provided a detailed explanation of the statistical analyses used to derive population estimates and the associated variances.

Although the May breeding population and habitat survey covers a large portion of North America’s primary waterfowl

breeding areas, it is not all-encompassing. Many populations of geese nest in the arctic or sub-arctic regions of Alaska and Canada, and the remoteness and extensive distribution of their habitats make it difficult to acquire population estimates at this season. Therefore, biologists must rely on other surveys to obtain indices of abundance for many populations of geese, including Snow Geese *Chen (Anser) caerulescens*, Ross’s Geese *C. (A.) rossii*, Greater White-fronted Geese *Anser albifrons*, and Canada Geese *Branta canadensis*. One such survey is the arctic-nesting goose survey, where biologists from federal, state, and provincial agencies, and universities, count geese at various locations on the nesting grounds. These surveys are usually conducted from helicopters over historical goose nesting areas (e.g. Reed & Changon 1987), and they are used in conjunction with other population surveys conducted during autumn and winter to provide annual goose population estimates.

Wintering Ground Surveys

The mid-winter survey is another survey of continental waterfowl populations that includes most species of ducks and geese. Conducted annually since 1935, this survey provides estimates of waterfowl on major wintering areas throughout the United States. It is a cooperative effort between federal and state personnel that is usually conducted in January. Unlike the transect-based May survey, the mid-winter survey is primarily a cruise survey during which pilot-biologists and their observers attempt to census birds in the areas they survey. Unfortunately, survey methodology has varied among states, and coverage has varied over years. This lack of standardization, coupled with the cost of conducting the survey, has been the origin of some

criticism (e.g. Eggeman & Johnson 1989). However, although the mid-winter survey only yields general information for most waterfowl species, such as relative abundance and distribution on wintering habitats, it does provide the best population data available for some species, including Tundra Swan *Cygnus columbianus*, Black Brant *Branta bernicla nigricans*, and some other goose populations (Trost *et al.* 1990).

The Mexican waterfowl survey is another winter aerial survey that is conducted cooperatively by biologists from Canada, Mexico, and the United States. Starting in the mid-1930s, this cruise survey covers the major waterfowl wintering grounds of Mexico, including the east coast from Laguna Madre to Tampico, the west coast including the Baja Peninsula, and the interior highlands (Saunders 1952). Parts of the survey are conducted annually, but the entire survey is now carried out at three-year intervals. The Mexican waterfowl survey is not part of the mid-winter survey; however, it augments the winter surveys conducted in the United States by providing additional coverage of waterfowl species that winter extensively in Mexico. For example, species such as Mallard *Anas platyrhynchos* are well covered by the mid-winter survey, but a large proportion of some species such as Blue-winged Teal *A. discors*, Northern Pintail *A. acuta* and Redhead *Aythya americana* winter far into Mexico.

Migration Surveys

In addition to surveys on the breeding and wintering grounds, some population surveys are also conducted during the spring and autumn migrations. An example of a migration survey is the mid-continent Sandhill Crane *Grus canadensis* survey, which is conducted in late March. Nearly the entire population gathers in Nebraska's Platte River Valley at that time, during the northward spring migration. The survey consists of a pilot-biologist and his observer counting birds along established transect lines. It also uses aerial photography of a sub-sample of crane flocks to quantify errors made by the pilot-biologist and observer in the estimation of flock sizes, thereby enabling the development of correction factors to obtain a more accurate estimate of the population size (Benning & Johnson 1987). Another example is the September survey of mid-continent Greater White-fronted Geese that is conducted in the Canadian prairie, where the population gathers during the southward autumn migration.

PRODUCTIVITY SURVEYS

The July duck production survey is very similar to the May breeding population and habitat survey, but instead of counting breeding pairs, pilot-biologists count duck broods, and, whenever possible, identify the broods by age class. They also count pairs and lone males to obtain an index of the late nesting effort, an important component of overall productivity for some species (Reynolds 1987). The survey area is a subset of the May survey area, and fewer transects are sampled. Ducklings cannot be identified to species from the air, and brood counts are not corrected for pilot/observer visibility because broods are difficult to count from the ground. As a result, this survey provides an index of annual production for all ducks in the survey area, but not species-specific estimates.

The wintering grounds are another place for biologists to estimate productivity, especially for Tundra Swans and some species of geese. Adult Tundra Swans and their young of the year are easily distinguishable from the air, because the adults

are white and the young birds have dull gray plumage. The winter productivity counts are generally conducted with the mid-winter surveys, and consist of both transect and cruise surveys.

HABITAT SURVEYS

Knowledge of habitat conditions is an important component in any attempt to predict changes in the size of duck populations. The two major operational surveys used for this purpose are the May breeding population and habitat survey and the July duck production survey. In addition to counting ducks and geese during these surveys, pilot-biologists and their observers also count ponds and assess habitat conditions over the key breeding areas in North America. Pond counts and the changes in pond numbers between May and July have been critical components of the process that predicts annual duck production in the Prairie Pothole Region of the United States and Canada. Furthermore, annual pond counts obtained during the May survey serve as major inputs into the models used to determine annual hunting seasons and regulations (Johnson *et al.* 1997).

Satellite imagery and remote sensing are also two techniques currently being used and/or evaluated to monitor and estimate habitat conditions. For example, biologists can access LANDSAT satellite imagery to determine the amount and distribution of upland and wetland habitat available for breeding waterfowl (Koeln *et al.* 1988). Such imagery is important for targeting where habitat management projects should be undertaken. In addition, Advanced Very High Resolution Radiometry (AVHRR) has recently been used to monitor the timing of snow melt in some of the arctic habitats used by nesting geese (Strong & Trost 1994). In the arctic and sub-arctic regions, the phenology of snow melt and timing of the spring break-up are important variables used for predicting the timing of nest initiation by geese, and ultimately annual goose productivity. Production is usually poor if nesting is delayed much beyond 15 June. These approaches to quantifying and qualifying habitat not only hold promise for improving our estimates of available habitat, but will allow pilot-biologists and observers to concentrate their efforts on counting ducks (Smith *et al.* 1989).

BANDING AND MARKING PROGRAMS

Banding is another important source of information for waterfowl managers. The first large-scale North American banding program was established in 1922 (USFWS & CWS 1989), but it was not until 1946 that an international banding effort was organized to address specific management objectives for ducks (Smith *et al.* 1989).

One of the first uses of banding and recovery location data was to help biologists determine migration routes (Lincoln 1935). Determining the four major migratory pathways, or flyways, in North America led to the establishment of the Flyway System in 1948; Flyways are still the administrative units by which we manage waterfowl today. Understanding migration routes for various species gives biologists insight into the distribution and derivation of the harvest, which allows us to better manage individual populations.

Biologists can also estimate both annual harvest rates and annual survival rates for some waterfowl species from band recovery data. The annual variation in harvest and survival rates has helped biologists understand how breeding habitat conditions and harvest regulations affect survival (e.g. Burnham *et al.* 1984).

Thus, these harvest and survival rates are critical pieces of information that are used to help determine appropriate hunting regulations each year, i.e. the regulations that will result in sustainable harvest levels (Williams *et al.* 1996). Estimating harvest rates from band recoveries requires a thorough understanding of band reporting rates. Reporting rates reflect the willingness of people who recover bands to report this information to the Bird Banding Laboratory. In recent years, use of a toll-free telephone number imprinted on bands has raised reporting rates significantly from the levels that Nichols *et al.* (1995) estimated for the late 1980s. We are currently conducting a comprehensive multi-year investigation to determine what the reporting rates are now, and whether they vary by region, species, and sex.

Currently, biologists band more than 200 000 ducks and nearly 150 000 geese and swans in North America each year. To date, we have concentrated most of our duck banding efforts on Mallards. The Mallard is the most commonly harvested duck in the United States and Canada (USFWS 2003), and much of what we know regarding waterfowl population dynamics and harvest management is due to the continued success of the banding effort devoted to this species.

HARVEST SURVEYS

National surveys of sport hunters have been conducted annually since 1952 in the United States and since 1967 in Canada. Although they have undergone significant changes since their inception, these surveys are still conducted by mail, and consist of asking samples of waterfowl hunters to report the number of ducks and geese they harvest during the hunting season (Martin & Carney 1977, Cooch *et al.* 1978). The surveys provide annual information that allows biologists to evaluate long-term trends in harvest, hunter numbers, hunting pressure, and waterfowl population demographics (Trost *et al.* 1987). This information, coupled with data from other surveys, allows biologists to generate population models that are used to help determine harvest management prescriptions for several species, such as Mallard, Northern Pintail, and Canvasback *Aythya valisineria*.

Both countries currently require all hunters of migratory birds to provide their name and address, either through a migratory bird hunter registration system (United States) or a special migratory bird hunting permit (Canada). This yields sample universes from which the USFWS and CWS select samples of hunters for their "harvest diary" surveys. Each sampled hunter is asked to report the date, location, and the number of ducks and geese taken for each day of waterfowl hunting. Hunters' responses are used to estimate the mean number of ducks and geese harvested per hunter for each state or province. The total number of ducks and geese harvested in each state or province is then estimated by expanding these means by the number of hunters in each state or province.

Both countries also select another sample of hunters annually, and ask them to participate in "parts collection" surveys. Hunters who agree to participate are mailed postage-paid wing envelopes and are asked to send back a wing from every duck and the tail feathers of every goose that they shoot throughout the hunting season. Biologists identify the species, age, and sex of each duck wing in the sample and the species and age of each goose tail. Thus, these surveys yield estimates of the species, sex, and age composition of the harvest. Results of the parts collection surveys are combined with the results of hunting diary

surveys to provide species-specific harvest estimates (Martin & Carney 1977, Cooch *et al.* 1978).

Additionally, a survey of the annual harvest of subsistence hunters has been conducted in Alaska since 1985. For this survey, a sample of households is selected in the parts of Alaska where subsistence harvesting of birds and eggs is legal. Survey forms that show pictures of the various species of birds are hand-delivered to the sample households, and participants are asked to record how many birds and eggs of each species they take over the entire subsistence harvest period (April-October). Harvest estimates are derived in a similar fashion as sport harvest in the United States and Canada, except that species-specific estimates are derived directly from the household reports rather than from a wing survey.

CONCLUSION

Monitoring programs are integral components of migratory bird management in North America. Together, results from these surveys and programs comprise the largest data set on any wildlife species group in the world. Results from these surveys serve as crucial inputs for many waterfowl population models, and are used to help guide biologists in setting and evaluating harvest management and habitat management programs. Furthermore, the success of North America's monitoring efforts is entirely dependent upon cooperation at all levels among the agencies and organizations that are charged with managing this important wildlife resource.

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American White Pelicans *Pelecanus erythrorhynchos*. Photo: U.S. Fish and Wildlife Service.