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Use of 35-mm Color Aerial Photography to Acquire Mallard Sex Ratio Data

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Introduction

Sex ratios of North American ducks have been reported by Bellrose *et al.* (1961), Smart and Carney (1966), Sorenson *et al.* (1979), and others. The significance of mallard sex ratios on wintering grounds is discussed by Dzubin (1970) and Sugden *et al.* (1974). The need for a simple technique to rapidly accumulate sex ratio data on mallards for waterfowl research and management was identified in the minutes of the 1973 Central Flyway Technical Committee Meeting held at Denver, Colorado.

Abstract: *A conventional 35-mm camera equipped with an f2.8 135-mm lens and ASA 64 color film was used to acquire sex ratio data on mallards (Anas platyrhynchos) wintering in the Platte River Valley of south-central Nebraska. Prelight focusing for a distance of 30.5 metres and setting of shutter speed at 1/2000 of a second eliminated focusing and reduced image motion problems and resulted in high-resolution, large-scale aerial photography of small targets. This technique has broad application to the problem of determining sex ratios of various species of waterfowl concentrated on wintering and staging areas. The aerial photographic method was cheaper than the ground ocular method when costs were compared on a per-100 bird basis.*

To date, acquisition of mallard sex ratio data has been limited to ground observation; however, Munroe and Trauger (1976) made a preliminary assessment of large format color aerial photography to study canvasbacks (*Aythya valisineria*) on pools of the Upper Mississippi River.

The objective of this study was to develop an aerial photographic technique to easily discern and count male and female mallards (*Anas platyrhynchos*) wintering in riverine habitats.

This information will ultimately be used as part of a nutrition and energetics study of wintering mallard populations. This project is a part of a comprehensive study of migratory bird habitat and use of the Platte River Valley being conducted by a research team of U.S. Fish and Wildlife Service biologists from the Northern Prairie Wildlife Research Center, Jamestown, North Dakota.

The aerial photography was acquired along 92 kilometres of the Platte River between Gibbon and Darr in south-central Nebraska. This section of the river consists of a shallow braided channel and wooded sandbars. Wintering flocks of mallards seek shelter and food in the widely distributed ice-free areas of these channels.

Methods

The photography was obtained on 31 January 1980, from a Cessna 180 aircraft with three crew members; pilot, photographer, and data recorder. The sky was clear, wind speed less than 10 mph,

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and temperature −10°C. Visibility at Kearney where the flight originated was seven statute miles. There was no apparent change in visibility over the target area. A Nikon F2 motor drive camera equipped with a 135-mm Nikor *f*2.8 lens was used. Since in-flight lens settings are difficult to make because of aircraft vibration, pre-flight *f*-stop and focus settings were made and secured with masking tape to prevent slipping. Depth of field varies with focal length and aperture selected. Because the 135-mm lens set at *f*2.8 is out of focus at 30.5 m when set at infinity, the camera was focused at 30.5 m before leaving the ground. Franz (1976) gives tables for depth of field and provides an authoritative guide to technical detail requirements in surveillance photography. Mallard concentrations, which had been located during a previous census, were distributed along the river channels. All flocks were photographed except scattered isolated birds. Upon detecting a group of birds, the aircraft was slowed to 90 knots at 30.5 metres above ground level, and 10 degrees of flap was applied. The right window was opened and the camera motor drive activated as the aircraft passed over the flock. The camera was hand-held (out the window) at a near-vertical angle. Location of the flock, number of frames exposed, and roll number were recorded after each photo run.

Overlap was not a problem because of our speed, altitude, frame rate combination. At an altitude of 30.5 m, a 135-mm lens on a 35-mm format covers 5.48 by 8.23 m square. As our ground speed was approximately 46.36 m/second, we therefore could not attain any overlap unless we used a frame rate in excess of five frames per second. We normally fired two frames per second.

Ektachrome film was processed locally and Kodachrome film was processed by the Eastman Kodak Company. This was done in order to subjectively compare the two films. Sex ratio data were interpreted by projecting the 35-mm slides onto a screen with a Kodak carousel projector. Bill color and plummage characteristics were used to identify sex. Male mallards have an olive green bill, green head with a white stripe at the base of the neck, and a light gray body with a black wedge pattern extending from the neck to the tail. Females have a yellowish bill, a mottled brown body, and a white tail (Figure 1). These characteristics were easily discerned on most of the photographs. If a bird were in tree shadows or in flight and could not be sexed, other members in that same habitat were rejected to eliminate differential visibility bias.

Sex ratio data were also collected on the study area by ground counts one week before, during, and one week after the aerial flight. Groups of mallards were located with a 20 power spotting scope, and birds in the scope's field-of-view comprised the sample. All groups of mallards within the scope's range were counted.

Results

Eleven rolls of film were exposed and 18 groups of mallards were photographed during the 2-hour flight, yielding over 350 35-mm photographs. Of these, 158 were classified as usable. Unusable photographs were eliminated if significant proportions of birds were flying or an adverse sun angle was encountered. A male/female sex ratio of 1.58:1 (61 percent males ± 1 percent) was obtained from photointerpretation (Table 1). By comparison, 19 groups of mallards were sampled with the ground technique. This yielded a sex ratio of 56 percent ± 9 percent. The difference in ratios between air and ground methods was compared by chi-square in a two-way contingency table, and was not significant ($P > 0.05$).

Sex ratios among mallards resting on ice and snow (1.07) differed from those in the water (1.63) ($P < 0.001$), indicating a significant difference in sex ratios in different habitats.

In order to examine the relationship between group size and sex ratio, the absolute number of birds in the flocks was regressed against the percentage of males in the flock. A correlation coefficient of 0.28 was obtained. This was not significant at the 0.05 level of probability. Our flock data was relatively limited ranging from 242 to 1525 birds. Others (Haramis, unpublished manuscript) have found the flocks size and composition varied in differing habitats for canvasbacks (*Athya valisineria*) but present no evidence for a relationship between the percent males and absolute flock size. Bellrose (1961) made an extensive review of sex and age ratios in North American ducks but he makes no mention of absolute flock size or its relationship to sex ratio. In summary, available evidence, though limited, indicates that there is no relationship between sex ratio and absolute flock size.

The aerial data are more precise because of the large sample size. Where high precision is needed (i.e., ± 1 percent at $P > 0.05$), relatively large samples must be obtained. When samples of such magnitude are necessary, the efficiencies of aerial acquisition are apparent from Table 2. The direct cost/100 birds is $1.93 for aerial data compared to $7.01 for ground information. Caution is advised in directly comparing our aerial data against the ground data. Counts from the ground sampled flocks of mallards were only visible from roads. The aircraft sample data were composed of groups of mallards visible from roads and from relatively inaccessible channels surrounded by hardwoods.

Discussion

The technique described here has wide scale application for acquiring sex ratio data on waterfowl. However, care must be taken in operating at the low altitude required to secure the necessary photography. Not all light aircraft are suitable

FIG. 1. Group of mallard males and females on Platte River.

for this type of flying and many commercial operators do not have the necessary skills. High-winged aircraft such as a Cessna 180, 182, 206 or Piper Super Cub can be used; only pilots with a minimum 200 hours of low level flying experience should be considered for such assignments. The pilot in this study had 1000+ hours of low level flying experience.

A motor drive attachment is essential for this type of photography as only one photo run can usually be made over a mallard flock before it takes flight. ASA 64 film was the minimum speed usable with the *f*2.8 135-mm lens and at a shutter speed of 1/2000 sec. The scale selected (approximately 1:225) may seem large, but was required to allow differentiation of species and sexes. Mal-

TABLE 1. COMPARISON OF AERIAL AND GROUND DATA FOR DETERMINING MALLARD SEX RATIO.

Data Type	Males	Proportion Males	95% Confidence Level	Females	Proportion Females	95% Confidence Level	Total	Ratio Males/ Females
Aerial Data								
Observed on ice or snow	597	0.52	±0.05	556	0.48	±0.05	1,153	1.07
Observed on water	8860	0.62	±0.01	5422	0.38	±0.01	14,282	1.63
Total	9457	0.61	±0.01	5978	0.39	±0.01	15,435	1.58
Ground Data								
Total Observed	185	0.56	±0.09	143	0.44	±0.09	328	1.29

* 95% confidence level based on binomial formula given by Snedecor and Cochran (1976).

lards were readily distinguishable on both Kodachrome and Ektachrome film. There were subtle tone differences, but both films were considered technically equivalent for this application. However, the Ektachrome film may be processed locally whereas Kodachrome must be sent to a Kodak facility. It is therefore advantageous to use Ektachrome film in cases where rapid turnaround time is required.

Previous attempts at acquiring mallard sex ratio data using photography were not successful. A two-camera attempt using Hasselblads failed because shutter speed (1/500 sec) was insufficient to stop image motion. An attempt was made with black-and-white photography (Nikon *f*2 35 mm with H and W VTE PAN film) by the senior author, but results were inconclusive, principally because gray tones were not adequate for separating males from females under varied lighting conditions. M. Haramis (Fish and Wildlife Service, Migratory Bird and Habitat Research Laboratory, Laurel, Maryland, personal communication) had similar problems with large format black-and-white photography of canvasbacks on Chesapeake Bay in Virginia, and eventually used small format color photography to acquire sex ratio data.

In this project we reduced image motion by flying at a relatively low ground speed and by using a camera with the fastest shutter speed commonly available. The problem of image motion is beyond the scope of this paper, but it is worth noting that image motion is a major obstacle in obtaining high resolution photography of relatively small targets such as migratory birds.

Sex ratios derived from populations of birds resting on ice or snow are different from ratios taken from birds on water (Table 1). Any estimate of the sex ratio of the total population can only be unbiased if the birds are sampled in proportion to their abundance within these two environments. It is, therefore, appropriate to insure that both environments be sampled to obtain unbiased data. This observation would apply to both aerial and ground data. Our aerial data are minimally biased because photography included birds both on a snow background and in the water.

In this paper we did not focus upon observer

TABLE 2. COST COMPARISONS OF AERIAL VERSUS GROUND TECHNIQUES OF OBTAINING MALLARD SEX RATIO DATA.

	Ground	Aerial
Sample Size	328	15,435
Group Sample	19	158
Percent of Estimated Population*	1.8	86
Sex Ratio	1.29:1	1.58:1
Field Time (hrs)	2	2
Man Hours	2 @ $6.50**	6 @ $6.50** 20 @ $10.00***
Cost of Wages**	$13	$239
Equipment and Fuel Costs	$10	$60
Total Costs	$23	$299
Cost/100 Birds	$7.01	$1.93

* Based on a population estimate of 17,893 mallards derived from previous days ocular census.

** Based on an average wage of $6.50/hour.

*** Photointerpretation time at $10/hour.

classification errors because of time and funding limitations. Our opinion is that observer classification errors are probably minimal because the biologists responsible for photointerpretation both had considerable field experience studying mallards. We do not wish to convey the impression that we have collected completely unbiased data. We do feel, however, that the order of magnitude of the bias is small. Further work refining collection techniques needs to be done as well as work on observer classification error rates.

This technique has application in sex ratio work on other species of waterfowl. It may also have application for determining racial composition of Canada geese (*Branta canadensis*) on their wintering grounds, an important research need.

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