WING SURVEYS IN THE STUDY OF WATERFOWL POPULATIONS

John Harradine and Ib Clausager

SUMMARY

Knowledge of the relative abundance of each waterfowl species and of its sex and age composition is important for the better understanding of waterfowl biology and management. Counting gives information on abundance and distribution but studies of waterfowl wings give information on population structure and dynamics and the hunters' bag. Hunters have a unique role in contributing such information. Wing studies, begun in Europe in 1965 through British hunters, have developed into an international programme through the IWRB, involving many countries from the Baltic to the Mediterranean. A coordinated international study, concentrating on four important duck species, is now underway. Key areas to be included are the northern breeding grounds, particularly in the USSR and southern wintering grounds around the Mediterranean.

INTRODUCTION

It is widely accepted that a knowledge of the relative abundance of each species of waterfowl, and of its age and sex composition, is important for the better understanding of the biology and the sound management of waterfowl populations.

The counts of ducks and geese conducted by national agencies and internationally by the International Waterfowl and Wetlands Research Bureau (IWRB) provide invaluable numerical and distributional information on Western Palearctic species from year to year, but they normally give little insight into the more detailed composition of the populations. Information on the age and sex composition of populations cannot normally be obtained from hunting bag statistics. Where bag studies are poorly developed or where there is a specific interest in age and sex characteristics of waterfowl populations, wing surveys are a means of obtaining such information. They also provide a means of studying the composition of the hunters' bag and aspects of the impact of hunting on waterfowl populations.

Wing surveys are based on hunters sending in wings of the quarry species they shoot. The characteristics of certain feather groups on the wings, including shape and degree of wear, are then used to distinguish the sexes and immature from adult birds, at least in most species. The proportion of immature birds can be used as an index to the breeding success of each species the previous summer, even soon after the hunting season begins. The age and sex ratios are also used to investigate other aspects of duck population dynamics and migratory behaviour. Where hunting bag statistics are not well advanced, wing studies can be used to break down the total duck bag, estimated by other means, into its constituent species. Actual or potential uses also include: determining temporal and geographical distributions of ducks; mapping flyways and wintering grounds; determining migration periods and the responses of ducks to weather conditions, food availability, disturbance and other factors; sampling for pollutants; and identifying geographical origins of birds through trace element analysis. Wing length in relation to body weight is being used in the UK to monitor the response of ducks to prolonged severe weather.

Wing surveys can provide information not readily obtainable by other means, from a large number of sites, throughout the hunting season, covering a variety of weather and other conditions. Such surveys are both relatively cheap and easy to administer and valuable in utilising the enthusiasm of hunters to contribute to research and the understanding of quarry species.

The main difficulty is to obtain representative samples of wings from each species, age or sex group at different parts of their range. Differential population mortality and migration, and hunter biases when shooting and selecting wings for despatch, all conspire to complicate the relationship between the observed age and sex ratios and other parameters in the received samples and the characteristics of the populations from which they are drawn. Consequently it can be difficult to apply standard statistical treatments to results or to be sure what sample sizes are adequate.

The earliest wing surveys have been used in the United States, beginning in 1961. An annual bag return survey, begun in the early 1950s, had sought information on hunting activity and success and the total duck bag, but reliable details on the species taken were not always obtained. The Waterfowl Parts Collection Survey was therefore used to estimate the species composition, age and sex composition and the geographical and temporal distributions of the bag. A similar survey was introduced in Canada somewhat later.

In Europe the first and longest running study was begun in the United Kingdom in 1965, by the British Association for Shooting and Conservation (BASC). Studies in Finland began in 1966 and also have continued to the present day, through the Finnish Game and Fisheries Research Institute. In 1969 studies began in Russia, Estonian SSR and Sweden, mostly lasting until the mid-1970s. Swiss and German researchers also studied duck wings in the 1970s as did the French Office National de la Chasse from 1976 to 1980. The Danish Game Biology Station began a wing study programme in 1982, since when Estonian SSR, Norwegian,

Dutch, Polish, Swedish and Italian studies have either restarted or begun. Some of them are conducted through governmental game research and management institutes and others through the voluntary efforts of hunting organisations. Over 270,000 wings have been collected, mostly from ducks but some small numbers from geese, waders, coots, and gulls, these being studied also in such countries as Denmark and the Netherlands.

NATIONAL STUDIES

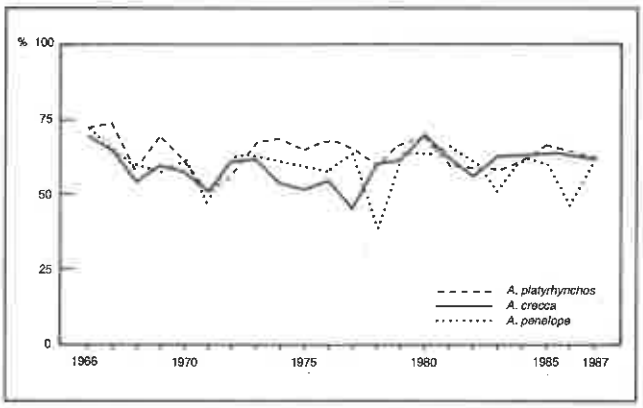
The United Kingdom survey is based on members of BASC, the national hunters' organisation representing over 100,000 shooting sportsmen, sending in wings of the ducks they shoot each season (on average about 3,000) to the Association's headquarters. *Anas platyrhynchos, A. crecca* and *A. penelope* are the only species from which enough wings are received for detailed analysis from year to year (over 26,000, 17,000 and 21,000 wings respectively having been analysed to date). These species comprise some 93% of the total, the remainder being *A. acuta, Aythya fuligula, Ay. ferina, A. clypeata, A. strepera* and *Bucephala clangula*.

The original aim of the Survey was to help explain the variations in the numbers of the main duck species wintering each year in the UK. These are monitored by the Wildfowl and Wetlands Trust's monthly National Wildfowl Counts (Owen *et al.* 1986). If the Survey were successful, a relationship between the annual age ratio (the percentage of immature birds) and the wintering population size should be found. This should especially be so for *A. platyrhynchos* since most are shot in the autumn (Harradine 1985) and their age ratio should reflect the composition of the resident birds in the country at that time, before the arrival of the migrant populations. No correlations have been found, however, between the age ratio and the wildfowl counts for *A. platyrhynchos* in September or January, *A. crecca* in December/January or *A. penelope* in January. It may be that any relationship for *A. platyrhynchos* is masked by the release of several hundred thousand hand-reared birds each year by the hunting community. Weather conditions also are important in influencing the extent of migration from the European continent each winter.

The mean age ratios for these three species for the 22 year period from 1966/67 to 1987/88 are given in Table 1. They are not significantly different. The slightly higher *A. platyrhynchos* ratio may reflect the fact that the species breeds at lower latitudes than the other two species, as well as the large numbers of reared young birds released. Breeding success, as reflected in the age ratio, appears least variable in *A. platyrhynchos* and most in *A. penelope*.

Over 22 years the annual age ratios have varied, *A. platyrhynchos* from 50.3% to 72.7%, *A. crecca* from 44.9% to 70.1% and *A. penelope* from 38.2% to 68.8%, but no clear trend has emerged (Figure 1). There is a significant correlation, however, between the age ratios of the species (Kendal Coefficient of Concordance W = 0.57, Chi Sq. = 35.88, p <0.05), which all come from the same general, although very extensive, breeding area, northern Europe and much of the USSR.

Figure 1
Percentage of immature wings, from *A. platyrhynchos, A. crecca* and *A. penelope* 1966/67-1987/88



The mean sex ratio (percentage of males) for each species from 1966/67 to 1987/88 is given in Table 2. All species show a consistent bias towards males with the *A. crecca* and *A. penelope* percentages both being significantly greater than *A. platyrhynchos* but not different from each other (F = 11.74, p <0.01; Tukey test, p <0.01). Over the 22 years the male dominance has been nearly always more than 50% although *A. crecca* has been most variable (47.6% to 63.1%) and *A. platyrhynchos* least (51.3% to 56.7%).

Table 1
Mean percentage of immature wings received through the duck wing survey from 1966/67 - 1987/88

Species	%	Standard error	Coefficient of variation
Anas platyrhynchos	63.8	1.19	8.65
A. crecca	58.6	1.25	9.77
A. penelope	58.3	1.57	12.34

Table 2
Mean percentage of male wings received through the duck wing survey from 1966/67 - 1987/88

Species	%	Standard error	Coefficient of variation
Anas platyrhynchos	54.0	0.33	2.77
A. crecca	56.9	0.77	6.24
A. penelope	58.3	0.61	4.82

Analysis of the age and sex data shows that in adult *A. penelope* males dominate females by more than 2:1 (Table 3). A less marked dominance occurs in *A. crecca* but none in *A. platyrhynchos*. Amongst the immatures male dominance

Table 3
Mean percentage of adult and immature wings of each sex received through the duck wing survey from 1966/67 - 1987/88

Species	adult male	adult female	immature male	immature female
Anas platyrhynchos	18.6	17.6	35.4	28.4
A. crecca	24.3	17.0	32.6	26.1
A. penelope	29.2	12.5	29.0	29.2

appears in *A. platyrhynchos* and *A. crecca* but not in *A. penelope*. The differences between the sexes tend to be greater amongst the adults, particularly in *A. penelope*.

Although most duck species show approximate parity at hatching, analysis of the sex ratios in the wing samples over the 22 year period has revealed a slight but steady increase in the percentage of males in *A. platyrhynchos* from around 52% to 55% ($y = 52.43 + 0.14(x)$, $r = 0.58$, $p < 0.01$) and a more marked increase in *A. crecca*, from around 54% to 60% ($y = 51.94 + 0.44(x)$, $r = 0.77$, $p < 0.01$). No change is detectable in *A. penelope* (Figure 2). The increase in the *A. platyrhynchos* male proportion is due either to an increase in adult males over the period ($y = 14.23 + 0.45(x)$, $r = 0.69$, $p < 0.01$) or a decline in immature males ($y = 38.22 - 0.32(x)$, $r = -0.52$, $p < 0.05$). The increase in male *A. crecca* wings was apparently due to immature males only ($y = 26.92 + 0.51(x)$, $r = 0.65$, $p < 0.01$), with no change amongst the adults (Figure 3). No changes occurred amongst either immature or adult *A. penelope*.

Figure 2
Percentage of male wings, from *A. platyrhynchos*, *A. crecca* and A. penelope 1967/68-1987/88

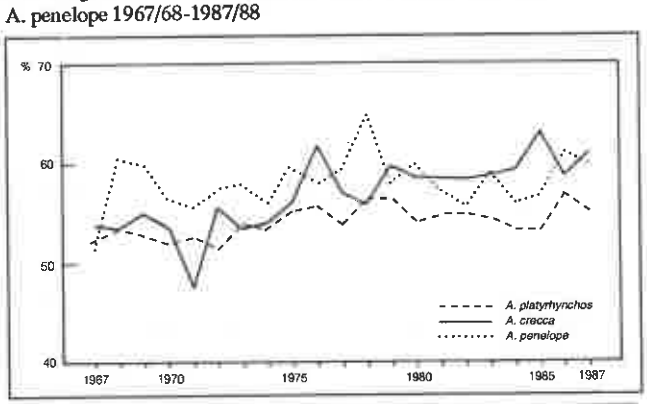
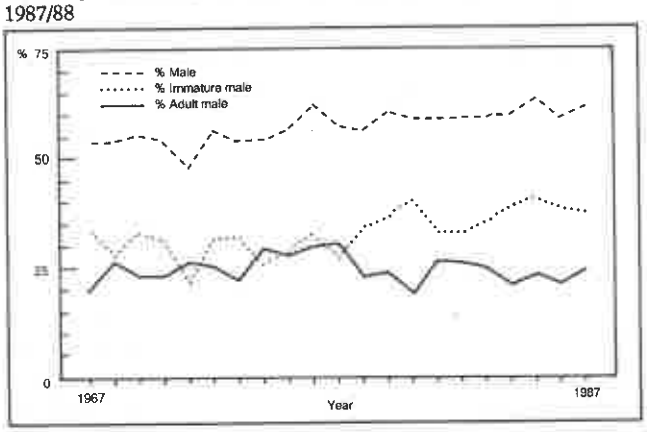


Figure 3
Percentage of male wings, from *A. crecca* wings, by age, 1967/68-1987/88



Many factors operate to reduce the relationship between the age ratio in the UK hunters' bag and the actual production of ducks. Representative samples of wings are difficult to obtain; different ages and sexes of ducks are subject to different behaviour, migration and mortalities; hunters can be selective in their shooting and contributions of samples; and weather conditions can alter duck movements and distribution. Furthermore there is still a considerable lack of information on the production of the ducks themselves on their northern breeding grounds.

All these factors ensure that only comparative studies of the age ratio can be made on the assumption that the above-mentioned and other factors remain more or less similar each year. The UK survey does appear to give a good indication of the quality of the breeding season, since the age ratios of all three main dabbling duck species appear generally to rise and fall together. The age ratio cannot, however, be used as an indication of absolute duck production levels.

It is clear also that the Survey does not readily help to explain changes in the abundance of wintering ducks in the UK. Indeed, Boyd *et al.* (1975) concluded from a preliminary analysis of the Survey's results, that the proportion of young birds in the stock does not have a decisive effect on the UK wintering duck populations, and that often changes may be caused by changes in migratory patterns, such as Harrison (1973) suggested for *A. crecca*. Similar conclusions were drawn by Harradine (1981) and the emphasis on the survey turned towards the information it provided on aspects of wintering duck ecology and the characteristics of the hunters' bag.

The findings relating to sex ratios, though, have proved particularly encouraging. The predominance of males in adult *A. penelope* has been noticeable for many years and led Harrison and Allison (1978) to hypothesise differential migration. Since then ringing studies in the Netherlands have shown that the males tend to migrate ahead of the females in the autumn but the females catch up and overtake the males to winter in more southerly areas (Perdeck and Clason 1983). *A. crecca* also tend to show this behaviour but not *A. platyrhynchos*, a difference explained by the earlier pair bonding of the latter. The release of reared birds again affects results in this species. The reasons for the disproportions amongst the immature sexes is not so clear.

A recent study by Owen and Dix (1986) compared preliminary counts of sex ratios in the British wintering populations of some ducks with the results of the wing Survey. They concluded that the sex ratios given by the Survey accord well with the ratios seen in the populations of the more common species. The authors suggest that inter-sexual competition is the major cause of differential migration, possible leading to greater mortality of females in the less favourable southerly parts of the migratory range. Furthermore, nesting females could well be vulnerable to predation (Johnson and Sargeant 1977) and suffer greater mortality from the stresses of breeding (Owen in press). Finally, males may appear rather more often in the bag if their size, plumage or behaviour makes them more likely than females to be shot, as has been indicated for *A. platyrhynchos* (Martin and Carney 1977).

The long term changes in the sex ratios recorded in this study are particularly interesting although their causes are not yet known. They could reflect changes in migratory behaviour or in the survival of the different ages and sexes. Either way

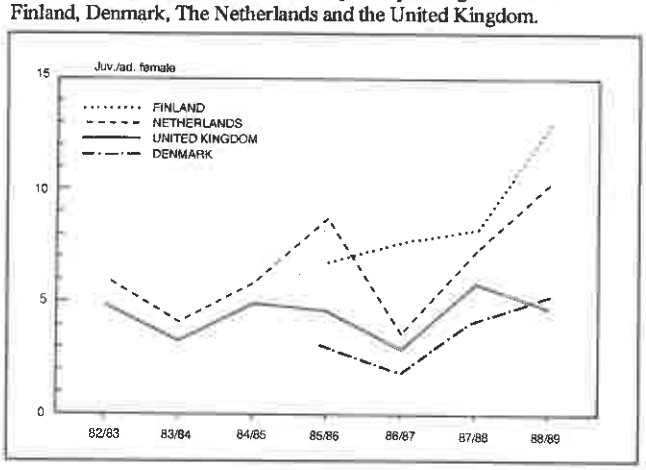
they represent an insight into changes in duck populations not otherwise revealed, which are important to be understood.

INTERNATIONAL STUDIES

The UK findings demonstrate the value of conducting national studies of waterfowl based on their wings. With the growing interest in such studies in Scandinavia and western Europe during the early 1980s it was recognised that there was a need to coordinate the differing studies. Not only would their results become comparable but also, in conjunction with international counts, ringing and bag studies, would contribute more to the fuller understanding of the migratory duck populations. For example, the age ratios in northern European countries are likely to reflect breeding success more closely but changes in the ratios taking place as the hunting season progresses in the migratory range are also likely to be informative. Accordingly the BASC and Danish Game Biology Station established a European Duck Wing Survey in 1984 in order to promote the development and coordination of wing surveys in Europe. In 1986 the EDWS became part of the IWRB's Hunting Harvest Research Group (Wing Survey) and has since been involved in wing surveys in nine countries from the Baltic to the Mediterranean. At its most recent meeting the group identified specific projects for each country to tackle in relation to its own national requirements. All countries then agreed to cooperate in studying internationally important *A. penelope, A. crecca, Aythya fuligula* and *Aythya ferina* populations, as well as *Scolopax rusticola* and *Gallinago gallinago*, through their wings, but in conjunction with counting and ringing data. By way of illustrating the benefits of international cooperation reference will be made to some preliminary results for *A. penelope*.

Since 1982 more than 18,000 *A. penelope* wings have been collected by Finland (annual average 181), Denmark (1,116), the Netherlands (792) and the United Kingdom (885). The age ratio (expressed as the number of immatures per adult female) from these different parts of the range is shown in Figure 4. The decline in the ratio from north to south (earlier French ratios proved similar to those in the Netherlands and UK) is consistent with the generally lower survival of young birds relative to adults, and their (probable) greater vulnerability to hunting mortality through the course of the hunting season. The broad agreement between the age ratios from year to year in the four countries is also encouraging as it helps to validate the use of wings as indicators of annual breeding success.

Figure 4
Number of immature: Adult female *A. penelope* wings collected in Finland, Denmark, The Netherlands and the United Kingdom.



The predominance of males found previously in the UK study is evident also in each of the countries (except in Finland where males leave the breeding areas before the start of the hunting season) - Denmark 55.0%, Netherlands 66.0%, UK 58.0% and France (from previous years) 53.0%.

FUTURE DEVELOPMENTS

There are several areas of further development to be addressed. Amongst the most important is to extend cooperation into the Soviet Union. The huge breeding grounds across the northern USSR are immensely important for the wildfowl wintering in southwestern and western Europe, yet little is known about them and the annual fortunes of the wildfowl breeding there. Contact with research institutes or hunting organisations already monitoring the birds or interested in starting wing or other survey programmes, would establish a direct link with the characteristics of each year's breeding season. This would help to interpret the results of such studies further west and to validate further the use of wings as a tool in wildfowl management.

At the same time, there is a need to complete the coverage of the migratory range of the key duck species by seeking material and information from Mediterranean countries, including France, Spain, Portugal and perhaps North Africa. Of particular interest are the wintering locations of the adult female *A. penelope*, and probably *A. crecca*, which apparently do not spend much time in countries further north. Furthermore, the fact that Italian hunter organisations are beginning wing studies extends the area of interest to countries such as Greece and Turkey, to include the Mediterranean and Black Sea population of *A. penelope*, which has not been doing as well as the northwest European population (Monval and Pirot 1989). Development is required also in connection with wildfowl ringing and counting data so as to interpret the respective results more fully.

One of the recommendations from the International Conference on the Conservation of Wetlands and Waterfowl in 1971 (the "Ramsar Convention") called on waterfowl research organisations to promote hunting research and, *inter alia*, to seek data on breeding success and productivity on the main quarry species, and to study hunting of waterfowl populations through realistic hunting and kill statistics (Carp 1972). The use of duck wings provides another means by which the hunting community can continue to make an important contribution to the understanding and management of our wildfowl populations.

REFERENCES

Boyd, H., Harrison, J. G. & Allison, A. 1975. *"Duck Wings - a study of duck production"*. WAGBI, Rossett, Clwyd. 112p.

Carp, E. 1972. *International Conference on the Conservation of Wetlands and Waterfowl, Ramsar, Iran, 1971*. IWRB, Slimbridge, England. 303p.

Harradine, J. 1981. *The Duck Production Survey, 1978/79-1980/81*. BASC, Rossett, Clwyd.

Harradine, J. 1985. Duck Shooting in the United Kingdom. *Wildfowl* 36: 81-94.

Harrison, J. G. 1973. *A wealth of wildfowl*. 2nd Edition. Corgi, London. 206p.

Harrison, J. & Allison, A. 1978. *The Duck Production Survey 1977-78*. WAGBI, 1978. BASC, Rossett, Clwyd.

Johnson, D. H. & Sargeant, A. B. 1977. Impact of red fox predation on the sex ratio of prairie mallards. *US Fish & Wildl. Serv. Resour. Rep.* 6. 56p.

Martin, E. M. & Carney, S. M. 1977. Population ecology of the mallard: IV. A review of duck hunting regulations, activity and success, with special reference to the mallard. *USDI Fish & Wildl. Serv. Resour. Publ. 130*.

Monval, J-Y. & Pirot, J-Y. 1989. Results of the IWRB International Waterfowl Census 1967-1986. *IWRB Special Publ.* 8. 1p.

Owen, M. In press. Goose condition and migration. Proc. Int. Symp. on Western Palearctic Geese, 1989, Kleve, W. Germany. *Ardea*.

Owen, M., Atkinson-Willes, G. L. & Salmon, D. G. 1986. *Wildfowl in Great Britain. (Second Edition)*. Cambridge University Press. 613p.

Owen, M. & Dix, M. 1986. Sex ratios in some common British wintering ducks. *Wildfowl* 37: 104-112.

Perdeck, A. C. & Clason, C. 1983. Sexual differences in migration and wintering of ducks ringed in the Netherlands. *Wildfowl* 34: 137-143.

John Harradine, British Association for Shooting and Conservation, Marford Mill, Rossett, Clwyd, LL12 0HL, United Kingdom.

Ib Clausager, Game Biology Station Kalø, DK-8410 Rønde, Denmark.