Transactions of the Illinois State Academy of Science
(1996), Volume 89, 3 and 4, pp. 197-213

Fall and Spring Body Weights and Condition Indices of Ducks in Illinois

Christopher S. Hine and Stephen P. Havera
Illinois Department of Natural Resources
Illinois Natural History Survey
Forbes Biological Station
Havana, IL 62644

Richard M. Whitton
Illinois Department of Natural Resources
Union County Refuge
Jonesboro, IL 62952

Jerome R. Serie
U.S. Fish and Wildlife Service
Patuxent Environmental Science Center
12100 Beech Forest Road
Laurel, MD 20708-4038

ABSTRACT

Body weights and condition indices are used in physiological and ecological studies to measure the health of individual birds. Body weights and condition indices for many species of ducks during fall and spring are lacking for mid-migration areas, such as Illinois, and are desirable for examining various aspects of waterfowl biology and management.

We recorded body weights and wing chord measurements of harvested dabbling (*Anas* spp.) and diving ducks (*Aythya* spp.) during fall 1985 and 1989-1991 along the Illinois and Mississippi rivers. Body weights and wing chord measurements were also examined from diving ducks livetrapped during spring 1977 and 1981-1988 on Keokuk Pool (Pool 19) of the Mississippi River.

Comparisons of body weights collected in the Illinois River valley during fall revealed that adult male and immature female mallards (*Anas platyrhynchos*), immature male gadwalls (*A. strepera*), and immature male green-winged teals (*A. crecca*) were heavier ($P \leq 0.05$) in 1938-1940 than in 1985 and 1989-1991. Fall body weights (1985, 1989-1991) of males were greater ($P < 0.05$) than females for all species examined. Likewise, adults weighed more ($P < 0.05$) than immatures except for wood ducks (*Aix sponsa*). Adult males were the heaviest cohort ($P < 0.05$) for all species during fall. Differences among fall condition indices (1985, 1989-1991) of males and females varied by species. Condition indices were higher ($P < 0.05$) for adults than for immatures in all species except wood ducks. Body weights and condition indices increased ($P < 0.05$) with advancing fall

Julian date for adult male mallards in 1989 and most age and sex classes of lesser scaups (*Aythya affinis*) in 1985.

In spring, male diving ducks were heavier ($P < 0.05$) and had greater ($P < 0.01$) condition indices than females. Adult canvasbacks (*A. valisineria*) were heavier and had higher condition indices ($P < 0.001$) than immatures, and adult males were the heaviest ($P < 0.001$) cohort among canvasbacks. Also, adult male canvasbacks with large body weights appeared early during spring migration of most years.

INTRODUCTION

Bellrose and Hawkins (1947) first studied body weights of ducks in the Illinois River valley during fall, 1938-1940. Their objectives were to determine the weights of various species and to investigate the contention of hunters that ducks were in poor physical condition. Since then, the wetlands, rivers, and agricultural landscapes of Illinois have undergone many changes. However, there have been no subsequent studies on body weights of ducks during fall in the Illinois River valley and only one study, which examined canvasbacks, in the Mississippi River valley bordering Illinois (Serie and Sharp 1989). Similarly, there are few data on body weights and condition of ducks in the Midwest during spring migration. Besides Whitton (1987), whose data we include, just one study has focused on the body weights of ducks in or near Illinois in spring, and that study involved canvasbacks on Pool 19 of the Mississippi River (Barzen 1989).

In this study, we recorded body weights and condition indices from hunter-harvested ducks during fall, compared their weights with those reported 50 years earlier by Bellrose and Hawkins (1947), and investigated changes in these parameters during migration. In addition, we documented body weights and condition indices of diving ducks livetrapped in spring on Pool 19 of the Mississippi River and investigated changes in these parameters during migration.

METHODS

Canvasbacks, lesser scaups, and ring-necked ducks (*Aythya collaris*) were captured from 2 March through 6 April, 1977 and 1981-1988 in swim-in traps baited with corn. The actual period of capture varied among years and was dependent upon the timing of migration and duration of stay with spring phenology. Trap sites were located on the Illinois side of Pool 19 of the Mississippi River from the lock and dam at Hamilton north to Niota. Age determination of lesser scaups and ring-necked ducks by wing plumage in spring is unreliable (Carney 1964); therefore, samples of lesser scaups and ring-necked ducks in spring were pooled for each sex. Body weight was measured with a spring-loaded Homs Model 4 scale ($\pm$10 g). Wing chord length ($\pm$1 mm) was determined as described by Carney (1964).

Hunter-harvested lesser scaups and ring-necked ducks (canvasbacks were protected) were also obtained from this same stretch of Pool 19 in the fall of 1985. The ages of canvasbacks, lesser scaups, and ring-necked ducks in fall were determined by wing plumage (Serie et al. 1982). During fall 1989-1991, samples of hunter-harvested ducks were examined at public hunting areas and commercial waterfowl picking operations throughout the

Illinois River valley. The hunting seasons for 1985 and 1989-1991 occurred for 30 to 40 days ranging between 24 October and 3 December. Harvested ducks were aged by wing plumage (Carney 1964, Serie et al. 1982), by tail feather characteristics (Larson and Taber 1980), and by cloacal examination (Larson and Taber 1980). Body weights of harvested ducks were measured with the Homs Model 4 scale in 1985 and with an Ohaus Port-O-Gram electronic balance Model C3001 ($\pm$1 g) in 1989-1991. Condition indices (body weight [g]/wing chord [mm]) were calculated for both live-trapped and hunter-harvested ducks (Ringelman and Szymczak 1985).

Differences in body weight and condition indices were assessed between age classes, sex classes, and age and sex classes for all species with sufficient sample sizes ($n \geq 5$). Two sample t-tests were used to compare body weights between age and sex classes of ducks (i.e., adult male, immature female) collected in 1938-1940 and those collected in 1989-1991. Two-way analysis of variance (ANOVA) was used to test for differences in body weight and condition indices between sex classes, age classes, and sex/age interaction using PROC GLM and type III sums of squares of the Statistical Analysis System (SAS) (SAS Inst. Inc. 1988a). Tukey/Kramer post hoc multiple comparison tests were employed to detect differences in body weights and condition indices among age and sex classes. Pearson product-moment correlations were utilized to detect relationships of body weights and condition indices with advancing Julian date where sample sizes, distribution of the samples over time, and length of the collection period in fall (15 to 38 days) and trapping period in spring (8 to 22 days) permitted. Statistical tests were computed using SAS (SAS Inst. Inc. 1988a, 1988b) and BMDP Statistical Software (BMDP 1992). All statistical tests were considered significant at $P \leq 0.05$.

RESULTS

I. Fall Body Weights

1938-1940 vs. 1989-1991

Because of small sample sizes, comparisons between body weights collected during the present study and those collected by Bellrose and Hawkins (1947) were limited to mallards, green-winged teals, and gadwalls (Table 1). Differences in body weights for these three species indicated that ducks collected during 1938-1940 were heavier ($P \leq 0.05$) than those collected during 1989-1991. We found differences in body weights for adult male mallards ($t = 2.354$, 378 df, $P < 0.01$) and a smaller sample of immature female mallards ($t = 1.833$, 11 df, $P < 0.05$). However, weights of adult female and immature male mallards did not differ ($P > 0.05$) between time periods (Table 1). Other comparisons revealed differences between body weights of immature male green-winged teals ($t = 2.336$, 6 df, $P < 0.05$) and immature male gadwalls ($t = 3.106$, 9 df, $P < 0.01$).

Age Classes, Sex Classes, Age & Sex Classes, and Dates Within Years

Mallards

Differences occurred in the body weights of male ($\bar{0} = 1{,}223$ g, SE = 7, $n = 281$) versus female mallards ($\bar{0} = 1{,}066$ g, SE = 11, $n = 117$) ($F = 90.12$; 1, 394 df; $P < 0.001$) as well as for adult ($\bar{0} = 1{,}187$ g, SE = 8, $n = 325$) versus immature mallards ($\bar{0} = 1{,}130$ g, SE = 14, $n = 73$) ($F = 24.90$; 1, 394 df; $P < 0.001$). Differences in body weights existed between mallard age and sex classes ($F = 65.05$; 3, 394 df; $P < 0.001$). Adult male mallards were heavier than adult females, immature males, and immature females (Table 1).

Also, immature male mallards weighed more than both adult and immature females, and adult females were heavier than immature females. Weights of adult male mallards increased with Julian date as the fall progressed (r_{xy} = 0.555, P < 0.001) in 1989, but not in 1990 and 1991.

Wood Ducks

Male wood ducks ($\bar{0}$ = 710 g, SE = 10, n = 43) were heavier (F = 8.12; 1, 72 df; P = 0.006) than females ($\bar{0}$ = 654 g, SE = 9, n = 35), but adult and immature wood ducks did not differ in weight (P > 0.05). Age and sex classes were different (F = 5.15; 3, 72 df; P = 0.003), which indicated that adult males weighed more than adult females (Table 1).

Green-winged Teals

Body weights of male green-winged teals ($\bar{0}$ = 372 g, SE = 7, n = 38) exceeded (F = 6.54; 1, 49 df; P = 0.014) those of females ($\bar{0}$ = 349 g, SE = 7 n = 14). Also, adult body weights ($\bar{0}$ = 369 g, SE = 6, n = 46) were greater (F = 5.64; 1, 49 df; P = 0.022) than immatures ($\bar{0}$ = 340 g, SE = 13, n = 6). The only difference found between age and sex classes (F = 5.00; 2, 49 df; P = 0.011) of green-winged teals revealed that adult males weighed more than adult females (Table 1).

Gadwalls

Male gadwalls ($\bar{0}$ = 933 g, SE = 46, n = 12) weighed more (F = 7.09; 1, 19 df; P = 0.015) than females ($\bar{0}$ = 759 g, SE = 33, n = 11) and adults ($\bar{0}$ = 997 g, SE = 54, n = 8) weighed more (F = 10.49; 1, 19 df; P = 0.004) than immatures ($\bar{0}$ = 771 g, SE = 26, n = 15). There were also differences detected between age and sex classes of gadwalls (F = 10.08; 3, 19 df; P < 0.001). Body weights of adult males exceeded those of immature males and immature females (Table 1).

Lesser Scaups

Male lesser scaups ($\bar{0}$ = 853 g, SE = 5, n = 182) weighed more (F = 47.99; 1, 295 df; P < 0.001) than females ($\bar{0}$ = 780 g, SE = 9, n = 117) and adults ($\bar{0}$ = 877 g, SE = 6, n = 139) were heavier (F = 117.55; 1, 295 df; P < 0.001) than immatures ($\bar{0}$ = 779 g, SE = 6, n = 160). Body weight comparisons of age and sex classes of lesser scaups also revealed differences (F = 67.21; 3, 295 df; P < 0.001). Adult males outweighed adult females, immature males, and immature females. Also, adult females and immature males were heavier than immature females (Table 1).

Sufficient sample sizes were available for 1985 to examine changes in body weight over time. Body weight increased with Julian date during fall for adult male (r_{xy} = 0.230, P = 0.029), immature male (r_{xy} = 0.279, P = 0.010), and immature female lesser scaups (r_{xy} = 0.357, P = 0.003).

Ring-necked Ducks

Male ring-necked ducks ($\bar{0}$ = 765 g, SE = 8, n = 42) outweighed (F = 6.03; 1, 65 df; P = 0.017) females ($\bar{0}$ = 653 g, SE = 19, n = 27), and adults ($\bar{0}$ = 786 g, SE = 11, n = 23) weighed more (F = 15.99; 1, 65 df; P < 0.001) than immatures ($\bar{0}$ = 688 g, SE = 13, n = 46). Age and sex classes of ring-necked ducks differed in body weights (F = 20.26; 3, 65 df; P < 0.001). Adult and immature males were heavier than immature females (Table 1).

II. Fall Condition Indices

Age Classes, Sex Classes, Age & Sex Classes, and Dates Within Years

Mallards

Male mallards ($\underline{0}$ = 4.27, SE = 0.02, $\underline{n}$ = 281) had higher condition indices ($\underline{F}$ = 39.92; 1, 394 df; $\underline{P} < 0.001$) than females ($\underline{0}$ = 3.98, SE = 0.04, $\underline{n}$ = 117), and adults ($\underline{0}$ = 4.22, SE = 0.02, $\underline{n}$ = 325) were in better condition ($\underline{F}$ = 20.75; 1, 394 df; $\underline{P} < 0.001$) than immatures ($\underline{0}$ = 4.04, SE = 0.05, $\underline{n}$ = 73). Differences in condition between age and sex classes of mallards ($\underline{F}$ = 24.63; 3, 394 df; $\underline{P} < 0.001$) indicated that adult males had higher condition indices than adult females, immature males, and immature females (Table 1). Both adult female and immature male mallards were in better condition than immature females. The condition indices of adult male mallards increased (r_{xy} = 0.449, $\underline{P} < 0.001$) with fall Julian date in 1989, but not in 1990 and 1991.

Wood Ducks

Condition values for male wood ducks ($\underline{0}$ = 3.18, SE = 0.04, $\underline{n}$ = 43) exceeded ($\underline{F}$ = 4.17; 1, 72 df; $\underline{P}$ = 0.045) those of females ($\underline{0}$ = 2.99, SE = 0.04, $\underline{n}$ = 35), but there were no differences ($\underline{P} > 0.05$) between adult and immature wood ducks. Comparisons of condition indices between age and sex classes ($\underline{F}$ = 2.91; 3, 72 df; $\underline{P}$ = 0.040) showed that adult males were in better physical condition than adult females (Table 1).

Green-winged Teals

Condition indices for male and female green-winged teals did not differ ($\underline{P} > 0.05$). However, adults ($\underline{0}$ = 2.03, SE = 0.03, $\underline{n}$ = 46) were in better condition ($\underline{F}$ = 6.20; 1, 49 df; $\underline{P}$ = 0.016) than immatures ($\underline{0}$ = 1.84, SE = 0.06, $\underline{n}$ = 6). There was also a difference in condition between age and sex classes ($\underline{F}$ = 3.33; 2, 49 df; $\underline{P}$ = 0.044) of green-winged teals, which showed that adult males had higher condition values than immature males (Table 1).

Gadwalls

Differences between condition indices for male ($\underline{0}$ = 3.51, SE = 0.14, $\underline{n}$ = 12) and female gadwalls ($\underline{0}$ = 3.04, SE = 0.12, $\underline{n}$ = 11) were nearly significant ($\underline{F}$ = 4.33; 1, 19 df; $\underline{P}$ = 0.051). Adult gadwalls ($\underline{0}$ = 3.69, SE = 0.17, $\underline{n}$ = 8) were in better condition ($\underline{F}$ = 6.17; 1, 19 df; $\underline{P}$ = 0.023) than immatures ($\underline{0}$ = 3.06, SE = 0.09, $\underline{n}$ = 15). Comparisons of gadwall condition indices between age and sex classes revealed differences ($\underline{F}$ = 6.13; 3, 19 df; $\underline{P}$ = 0.004), which indicated that adult males had higher condition indices than both immature males and immature females (Table 1).

Lesser Scaups

Male lesser scaups ($\underline{0}$ = 4.18, SE = 0.03, $\underline{n}$ = 182) were in better physical condition ($\underline{F}$ = 11.50; 1, 295 df; $\underline{P} < 0.001$) than females ($\underline{0}$ = 3.98, SE = 0.04, $\underline{n}$ = 117), and adults ($\underline{0}$ = 4.32, SE = 0.03, $\underline{n}$ = 139) had higher condition index values ($\underline{F}$ = 97.71; 1, 295 df; $\underline{P} < 0.001$) than immatures ($\underline{0}$ = 3.91, SE = 0.03, $\underline{n}$ = 160). Differences also existed in condition indices between age and sex classes of lesser scaups ($\underline{F}$ = 42.49; 3, 295 df; $\underline{P} < 0.001$). Both adult males and adult females had higher condition indices than immature males and immature females (Table 1). Immature males were also in better condition than immature females. In 1985, condition indices increased with fall Julian date for immature male (r_{xy} = 0.267, $\underline{P}$ = 0.014) and immature female lesser scaups (r_{xy} = 0.355, $\underline{P}$ = 0.003).

Ring-necked Ducks

Condition indices for male and female ring-necked ducks did not differ ($P > 0.05$). However, adult condition indices ($\bar{0} = 3.99$, SE = 0.06, $n = 23$) surpassed ($F = 13.14$; 1, 65 df; $P < 0.001$) those of immatures ($\bar{0} = 3.59$, SE = 0.06, $n = 46$). Condition indices varied between age and sex classes of ring-necked ducks ($F = 12.97$; 3, 65 df; $P < 0.001$). Adult and immature males were in better condition than immature females (Table 1).

III. Spring Body Weights

Age Classes, Sex Classes, Age & Sex Classes, and Dates Within Years

Canvasbacks

Male canvasbacks ($\bar{0} = 1{,}323$ g, SE = 3, $n = 1{,}728$) weighed more ($F = 73.10$; 1, 444 df; $P < 0.001$) than females ($\bar{0} = 1{,}175$ g, SE = 5, $n = 672$), and adults ($\bar{0} = 1{,}307$ g, SE = 3, $n = 1{,}721$) outweighed ($F = 22.83$; 1, 444 df; $P < 0.001$) immatures ($\bar{0} = 1{,}218$ g, SE = 5, $n = 679$). Body weights varied considerably between age and sex classes of canvasbacks ($F = 303.36$; 3, 2,396 df; $P < 0.001$). Adult males were heavier than adult females, immature males, and immature females (Table 2). Adult females outweighed immature females. Immature males were heavier than either adult females or immature females.

There was an inverse relationship ($P \leq 0.05$) between weights of adult male canvasbacks and Julian date during five (1977, 1981, 1983, 1986, 1988) of the seven years that data permitted examination. This indicated that there was a tendency for heavier adult males to arrive on Pool 19 earlier than lighter-weight individuals during spring migration. Body weights of adult female canvasbacks were also inversely related to Julian date ($r_{xy} = -0.346$, $P < 0.001$) in 1977, but weights of adult females increased ($r_{xy} = 0.312$, $P = 0.039$) with Julian date during the spring migration of 1981. No trends were observed between body weight and Julian date for adult female canvasbacks in 1983, 1984, 1987, and 1988. Weights of immature male canvasbacks were greater earlier in the spring migrations of 1977 ($r_{xy} = -0.343$, $P < 0.001$) and 1984 ($r_{xy} = -0.449$, $P < 0.001$); however, no trends existed between body weight and Julian date in 1981 or 1988. Body weights of immature female canvasbacks increased ($r_{xy} = 0.389$, $P = 0.003$) with Julian date in 1981. No relationship existed between body weight and Julian date for immature females in 1977, 1987, and 1988.

Lesser Scaups

Male lesser scaups were heavier ($F = 126.97$; 1, 461 df; $P < 0.001$) than females (Table 2). Sufficient data were available to examine body weight changes over time for male and females in 1977, 1987, and 1988. In 1987, weights of male lesser scaups decreased as Julian date increased ($r_{xy} = -0.208$, $P < 0.001$); however, the opposite occurred in 1988 when weights were the greatest during later dates of the trapping period ($r_{xy} = 0.091$, $P < 0.028$). No trend was observed between weights of male lesser scaups and Julian date in 1977. The only significant relationship between body weight and Julian date for females occurred in 1988 when weight increased with Julian date ($r_{xy} = 0.208$, $P = 0.009$).

Ring-necked Ducks

Male ring-necked ducks were heavier ($F = 20.57$; 1, 47 df; $P < 0.001$) than females during spring (Table 2).

IV. Spring Condition Indices

Age Classes Sex Classes, Age & Sex Classes and Dates Within Years

Canvasbacks

Male canvasbacks ($\bar{0}$ = 5.56, SE = 0.03, $\underline{n}$ = 312) had higher condition indices ($\underline{F}$ = 36.41; 1, 444 df; $\underline{P} < 0.001$) than females ($\bar{0}$ = 5.20, SE = 0.04, $\underline{n}$ = 136), and adults ($\bar{0}$ = 5.53, SE = 0.03, $\underline{n}$ = 323) had higher ($\underline{F}$ = 11.79; 1, 444 df; $\underline{P} < 0.001$) condition indices than immatures ($\bar{0}$ = 5.26, SE = 0.05, $\underline{n}$ = 125). Variances in condition indices of canvasbacks also occurred among age and sex classes ($\underline{F}$ = 22.03; 3, 444 df; $\underline{P} < 0.001$). Adult males were in better condition than adult and immature females (Table 3). Immature male canvasbacks had higher condition indices than immature females. Comparisons of Julian dates and condition indices of adult male canvasbacks were examined for 1986 and 1988; the indices declined (r_{xy} = -0.221, $\underline{P}$ = 0.004) as Julian date increased in 1988 but not in 1986. The condition of adult females, immature males, and immature females did not differ by Julian date ($\underline{P} > 0.05$) in 1986 and 1988 when sample sizes permitted comparisons.

Lesser Scaups

Male lesser scaups had higher ($\underline{F}$ = 73.32; 1, 461 df; $\underline{P} < 0.001$) condition indices than females (Table 3). Condition indices for males (r_{xy} = 0.147, $\underline{P}$ = 0.012) and females (r_{xy} = 0.170, $\underline{P}$ = 0.036) increased with Julian date in spring 1988 but not in 1985.

Ring-necked Ducks

Male ring-necked ducks were in better condition ($\underline{F}$ = 11.22; 1, 47 df; $\underline{P}$ = 0.002) than females (Table 3).

DISCUSSION

Fall body weights of adult male and immature female mallards, immature male gadwalls, and immature male green-winged teals in the Illinois River valley were less during the present study (1989-1991) than during 1938-1940. Several factors, such as weather, deteriorating habitat conditions, food availability, or accuracy of the scales, could have caused these differences. Wetlands and their flora and fauna associated with the Illinois River have been detrimentally affected by sedimentation and unnatural water level fluctuations during the past 50 years (Bellrose et al. 1983, Havera and Bellrose 1985). Consequently, the abundance and diversity of wetland plants important as food sources for ducks in the Illinois Valley have decreased in recent decades (Bellrose et al. 1979). Hier (1989) also found weights of ring-necked ducks collected in Minnesota to be less in 1984-1986 than 30 years earlier, and Afton et al. (1989) stated that weights of lesser scaup in Louisiana were less in 1986 than 20 years earlier. Afton et al. (1989) suggested that these differences could be attributed to annual variation in reproductive effort, deterioration of food resources, increased disturbance on fall migration and winter areas, or a reflection of a long-term decline in the condition of lesser scaups. Human disturbances, primarily associated with boating activities, on Pool 19 of the Mississippi River also presented a problem for waterfowl attempting to fulfill energy requirements during fall and spring migrations (Havera et al. 1992).

Analyses of fall body weights (1985, 1989-1991) revealed that males and adults (except wood ducks) were heavier than their counterparts in all species of ducks examined. Also,

adults were in better condition than immatures in all species with the exception of wood ducks. These results were consistent with many other studies on duck body weights (Owen and Cook 1977, Afton and Hier 1986, Delnicki and Reinecke 1986, Ringelman 1988, Hier 1989, Krementz et al. 1989, Lokemoen et al. 1990, Hohman and Weller 1994). Ringelman (1988) suggested that immature mallards may be in poorer condition because of being displaced to suboptimal foraging areas by dominant birds (i.e., adult males and pairs), particularly during severe weather when competition for food is intense. Afton and Hier (1986) reported that during fall, immature lesser scaups weighed less than adults, but weight increases for immatures were greater than for adults. They attributed these differences to the possibility that immatures may be growing in addition to accumulating nutrient reserves for migration. Serie and Sharp (1989) found that immature male canvasbacks accumulated fat reserves during fall migration and did not reach peak weights until arrival on the wintering areas, whereas adults reached their highest levels of fat storage earlier in migration. In south Florida, immature ring-necked ducks were lower in weight than adults during fall migration, but the two age groups were equivalent in weight by late winter (Hohman et al. 1988).

Fall body weights and condition indices for adult male mallards increased with Julian date in 1989. Fall body weights and condition indices for adult male, immature male, and immature female lesser scaups increased with Julian date in 1985. Sanderson and Anderson (1981) also found that mean body weights of hunter-harvested mallards increased during the season on Lake Sangchris in central Illinois. Takekawa (1987) stated that in many species of waterfowl, fluctuations in body weight follow similar patterns where weights peak as individuals arrive on the wintering areas, decrease through winter, and rebound in the spring. Austin and Fredrickson (1987) reported that female lesser scaups increased lipid reserves during fall migration, and late migrants were generally fatter than early migrants in southwestern Manitoba. Also, Serie and Sharp (1989) reported mean weights increased within age and sex classes by date during fall for migrating canvasbacks.

Analyses of spring body weights and condition indices (1977, 1981-1988) produced results similar to those for fall. Body weights and condition indices for males were higher than those for females, and adults had greater weights and condition indices than immature canvasbacks, lesser scaups, and ring-necked ducks. Evidence from other studies indicates that male diving ducks weigh more than females during spring migration (Lovvorn 1987, Gammonley and Heitmeyer 1990). By the time they reached the breeding grounds in southwest Manitoba, however, Barzen (1989) found that paired female canvasbacks were heavier and contained more fat than males. Other investigators (Hohman 1986, Barzen and Serie 1990, Afton and Ankney 1991) presented body weight data for male and female diving ducks on breeding areas that appeared to support Barzen (1989). Differences occurred when weights of females increased during ovarian follicle development, and males lost weight as time devoted to feeding decreased and time spent guarding their mates from intruding males and predators increased (Hohman 1986, Hohman et al. 1988, Afton and Ankney 1991).

Analyses of our spring body weight data for adult male canvasbacks on Pool 19 indicated that heavier birds generally appeared earlier than lighter individuals. No other investigations of body weights for diving ducks in Illinois or any other spring staging area have

documented similar results. Barzen (1989) reported that body weights for male and female canvasbacks on their northward spring migration changed among sites (Pools 19, 9, 8, 7, North Dakota, and Manitoba), but they did not increase with the Julian date of their collection among these sites. Early spring migration by heavier adult male canvasbacks may indicate that birds in good condition migrate earlier to increase reproductive success (Ankney and MacInnes 1978, Raveling 1979, Krapu 1981, Moller 1994). Thornburg et al. (1988) suggested that declines in spring weights of Canada geese (*Branta canadensis*) in southern Illinois may have been attributed to geese that were in better physiological condition initiating migration at the earliest opportunity. Canvasbacks in poor condition may not be able to endure long-distance flights, thereby causing them to remain in an area longer to increase body reserves or to make shorter flights and delay their migration (Korschgen et al. 1988).

There is strong evidence that body weights and condition are related to waterfowl survival (Burnham and Nichols 1985, Haramis et al. 1986, Takekawa 1987, Pollock et al. 1989, Hohman et al. 1995). Ducks that were heavier and in good condition withstood longer periods of food shortage and cold stress (Calder 1974), and were less vulnerable to natural (Weatherhead 1985) and hunting mortality (Greenwood et al. 1986, Hepp et al. 1986, Blohm et al. 1987, Reinecke and Shaiffer 1988, Heitmeyer et al. 1993) than ducks that were lighter and in poorer physical condition. Several researchers reported that body weight and condition were positively related to winter and annual survival rates of canvasbacks (Haramis et al. 1986, Takekawa 1987, Hohman et al. 1995). Similar relationships were also found for mallards (Hepp et al. 1986, Blohm et al. 1987) and American black ducks (*Anas rubripes*) (Pollock et al. 1989, Longcore et al. 1991).

For waterfowl to maintain sufficient body weight and condition, which may increase survival and reproductive probabilities, high-quality habitats must be provided on migration, wintering, and breeding areas. Greater body weights were associated with the quality of wetlands used by mallards and wood ducks on wintering areas (Delnicki and Reinecke 1986) and for mallards, blue-winged teals (*A. discors*), and gadwalls during the breeding season (Lokemoen et al. 1990). Loesch and Kaminski (1989) also reported that wetland conditions on the wintering grounds affected body condition, survival, and recruitment rates of mallards. Barzen (1989) stated that protection of key staging areas along migration routes may influence recruitment rates of canvasbacks. Many species of waterfowl incur the energy demanding activities of migration, courtship, and molt simultaneously (Weller 1965, Bellrose 1980, Hepp and Hair 1983, Gammonley and Heitmeyer 1990, Hohman et al. 1990). Accordingly, the availability of high-quality habitats throughout the annual range of waterfowl (Korschgen et al. 1988, LaGrange and Dinsmore 1988, Loesch and Kaminski 1989), including the important fall and spring migration areas in Illinois and elsewhere in the heart of the Mississippi Flyway, is imperative to sustain healthy populations.

ACKNOWLEDGMENTS

We thank Illinois Department of Natural Resources personnel at the public hunting areas for their cooperation and B. Redman and L. O'Hara for use of their commercial picking facilities. R.L. Hager, K.L. Hills, F.H. Roetker, and R.A. Williamson provided logistical support for trapping operations. M.M. Georgi and P.H. Soboroff assisted in field operations. J.D. Brawn and A.P. Yetter provided statistical assistance. G.C. Sanderson, W.L. Anderson, A.P. Yetter, W.L. Hohman, P.W. Brown, and C.E. Warwick reviewed and edited the manuscript. M.M. Georgi assisted with data manipulation and L.L. Anderson and K.E. Roat typed the manuscript. Some of the data in this manuscript were collected as partial fulfillment of a Master of Science degree from Western Illinois University for the third author with the financial support provided by R.V. Anderson. This study was funded in part by Pittman Robertson Federal Aid Project W-43-R, with cooperation from the Illinois Department of Natural Resources, Illinois Natural History Survey, and U.S. Fish and Wildlife Service.

LITERATURE CITED

Afton, A.D., and C.D. Ankney. 1991. Nutrient reserve dynamics of breeding lesser scaup: a test of competing hypothesis. Condor 93:89-97.

Afton, A.D., and R.H. Hier. 1986. Fall migration ecology of lesser scaup in Minnesota. DNR Progress Report. Unpublished information.

Afton, A.D., R.H. Hier, and S.L. Paulus. 1989. Nutrient reserves of lesser scaup in mid-winter in southwestern Louisiana. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 43:404-411.

Ankney, C.D., and C.D. MacInnes. 1978. Nutrient reserves and reproductive performance of female lesser snow geese. Auk 95:459-471.

Austin, J.E., and L.H. Fredrickson. 1987. Body and organ mass and body composition of postbreeding female lesser scaup. Auk 104:694-699.

Barzen, J.A. 1989. Patterns of nutrient acquisition in canvasbacks during spring migration. M.S. Thesis, University of North Dakota, Grand Forks. 74 p.

Barzen, J.A., and J.R. Serie. 1990. Nutrient reserve dynamics of breeding canvasbacks. Auk 107:75-85.

Bellrose, F.C. 1980. Ducks, geese and swans of North America. Thirded. Stackpole Books, Harrisburg, PA. 540 p.

Bellrose, F.C., and A.S. Hawkins. 1947. Duck weights in Illinois. Auk 64(3):422-430.

Bellrose, F.C., F.L. Paveglio, Jr., and D.W. Steffeck. 1979. Waterfowl populations and the changing environment of the Illinois River valley. Ill. Nat. Hist. Surv. Bull. 32(1):1-54.

Bellrose, F.C., S.P. Havera, F.L. Paveglio, Jr., and D.W. Steffeck. 1983. The fate of lakes in the Illinois River valley. Ill. Nat. Hist. Surv. Biol. Notes No. 119. 27 p.

Blohm, R.J, R.E. Reynolds, J.P. Bladen, J.D. Nichols, J.E. Hines, K.H. Pollock, and R.T. Eberhardt. 1987. Mallard mortality rates on key breeding and wintering areas. Pages 246-257 in Trans. 52nd N. Amer. Wildl. and Nat. Resour. Conf. 748 p.

BMDP. 1992. Statistical software manual, 7.0 release. BMDP Statistical Software Inc., Los Angeles, CA.

Burnham, K.P., and J.D. Nichols. 1985. Comments on condition bias and band recovery data from waterfowl banding programs. Wildl. Soc. Bull. 13(3):345-349.

Calder, W.A. 1974. Consequences of body size for avian energetics. Pages 86-144 in R.A. Paynter, Jr., ed. Avian energetics. Publ. Nuttall Ornithological Club No. 15.

Carney, S.M. 1964. Preliminary keys to waterfowl age and sex identification by means of wing plumage. U.S. Dep. Inter. Spec. Sci. Rep. 82. 47 p.

Delnicki, D., and K.J. Reinecke. 1986. Mid-winter food use and body weights of mallards and wood ducks in Mississippi. J. Wildl. Manage. 50(1):43-51.

Gammonley, J.H., and M.E. Heitmeyer. 1990. Behavior, body condition, and foods of bufflehead and lesser scaup during spring migration through the Klamath Basin, California. Wilson Bull. 102(4):672-683.

Greenwood, H.R., R.G. Clark, and P. J. Weatherhead. 1986. Condition bias of hunter-shot mallards (*Anas platyrhynchos*). Can. J. Zool. 64:599- 601.

Haramis, G.M., J.D. Nichols, K.H. Pollock, and J.E. Hines. 1986. The relationship between body mass and survival of wintering canvasbacks. Auk 103:506-514.

Havera, S.P., and F.C. Bellrose. 1985. The Illinois River: a lesson to be learned. Wetlands 4:29-41.

Havera, S.P., L.R. Boens, M.M. Georgi, and R.T. Shealy. 1992. Human disturbance of waterfowl on Keokuk Pool, Mississippi River. Wildl. Soc. Bull. 20:290-298.

Heitmeyer, M.E., L.H. Fredrickson, and D.D. Humburg. 1993. Further evidence of biases associated with hunter-killed mallards. J. Wildl. Manage. 57(4):733-740.

Hepp, G.R., and J.D. Hair. 1983. Reproductive behavior and pairing chronology in wintering dabbling ducks. Wilson Bull. 95:675-682.

Hepp, G.R., R.J. Blohm, R.E. Reynolds, J.E. Hines, and J.D. Nichols. 1986. Physiological condition of autumn-banded mallards and its relationship to hunting vulnerability. J. Wildl. Manage. 50(2):177-183.

Hier, R.H. 1989. Fall weights of redheads and ring-necked ducks in northern Minnesota. Prairie Nat. 21(4):229-233.

Hohman, W.L. 1986. Changes in body weight and body composition of breeding ring-necked ducks (*Aythya collaris*). Auk 103:181-188.

Hohman, W.L., and M.W. Weller. 1994. Body mass and composition of ring-necked ducks wintering in southern Florida. Wilson Bull. 106(3):494-507.

Hohman, W.L., T.S. Taylor, and M.W. Weller. 1988. Annual body weight change in ring-necked ducks (*Aythya collaris*). Pages 257-269 in Milton W. Weller, ed. Waterfowl in winter. University of Minnesota Press, Minneapolis. 624 p.

Hohman, W.L., D.W. Woolington, and J.H. Devries. 1990. Food habits of wintering canvasbacks in Louisiana. Can. J. Zool. 68:2605-2609.

Hohman, W.L., J.L. Moore, and J.C. Franson. 1995. Winter survival of immature canvasbacks in inland Louisiana. J. Wildl. Manage. 59(2):384-392.

Korschgen, C.E., L.S. George, and W.L. Green. 1988. Feeding ecology of canvasbacks staging on Pool 7 of the Upper Mississippi River. Pages 237-249 in Milton W. Weller, ed. Waterfowl in winter. University of Minnesota, Minneapolis. 624 p.

Krapu, G.L. 1981. The role of nutrient reserves in mallard reproduction. Auk 98:29-38.

Krementz, D.G., J.E. Hines, P.O. Corr, and R.B. Owen, Jr. 1989. The relationship between body mass and annual survival in American black ducks. Ornis Scand. 20(2):81-85.

LaGrange, T.G., and J.J. Dinsmore. 1988. Nutrient dynamics of female mallards during spring migration through central Iowa. Pages 287-297 in Milton W. Weller, ed. Waterfowl in winter. University of Minnesota Press, Minneapolis. 624 p.

Larson, J.S., and R.D. Taber. 1980. Criteria of sex and age. Pages 143-202 in S.D. Schemnitz, ed. Wildlife management techniques manual. Fourth ed. The Wildl. Soc., Washington, D.C.

Loesch, C.R., and R.M. Kaminski. 1989. Winter body-weight patterns of female mallards fed agricultural seeds. J. Wildl. Manage. 53(4):1081-1087.

Lokemoen, J.T., D.H. Johnson, and D.E. Sharp. 1990. Weights of wild mallard *Anas platyrhynchos*, gadwall *A. strepera*, and blue-winged teal *A. discors* during the breeding season. Wildfowl 41:122-130.

Longcore, J.R., D.G. McAuley, and C. Frazer. 1991. Survival of postfledging female American black ducks. J. Wildl. Manage. 55(4):573-580.

Lovvorn, J.R. 1987. Behavior, energetics, and habitat relations of canvasback ducks during winter and early spring migration. M.S. Thesis, University of Wisconsin, Madison. 172 p.

Moller, A.P. 1994. Phenotype-dependent arrival time and its consequences in a migratory bird. Behav. Ecol. and Sociobiol. 35:115-122.

Owen, M., and W.A. Cook. 1977. Variations in body weight, wing length and condition of mallard *Anas platyrhynchos* and their relationship to environmental changes. J. Zool. (London) 183:377-395.

Pollock, K.H., S.R. Winterstein, and M.J. Conroy. 1989. Estimation and analysis of survival distributions for radio-tagged animals. Biometrics 45:99-109.

Raveling, D.G. 1979. The annual cycle of body composition of Canada geese with special reference to control of reproduction. Auk 96:234-251.

Reinecke, K.J., and C.W. Shaiffer. 1988. A field test for differences in condition among trapped and shot mallards. J. Wildl. Manage. 52(2):227-232.

Ringelman, J.K. 1988. Examining waterfowl condition: skewed ideas on the normal procedure. Pages 277-285 in Milton W. Weller, ed. Waterfowl in winter. University of Minnesota Press, Minneapolis. 624 p.

Ringelman, J.K., and M.R. Szymczak. 1985. A physiological condition index for wintering mallards. J. Wildl. Manage. 49(3):564-568.

Sanderson, G.C., and W.L. Anderson. 1981. Waterfowl studies at Lake Sangchris, 1973-1977. Ill. Nat. Hist. Surv. Bull. 32(4):656-690.

SAS Institute, Inc. 1988a. SAS/STAT user's guide release. 6.06 ed. SAS Institute Incorporated, Cary, NC. 1028 p.

SAS Institute, Inc. 1988b. SAS user's guide: basics. Version 6.06 ed. SAS Institute Incorporated, Cary, NC. 1290 p.

Serie, J.R., and D.E. Sharp. 1989. Body weight and composition dynamics of fall migrating canvasbacks. J. Wildl. Manage. 53(2):431-441.

Serie, J.R., D.L. Trauger, H.A. Doty, and D.E. Sharp. 1982. Age class determination of canvasbacks. J. Wildl. Manage. 46:894-904.

Takekawa, J.Y. 1987. Energetics of canvasbacks staging on an Upper Mississippi River pool during fall migration. Ph.D. dissertation, Iowa State University, Ames. 189 p.

Thornburg, D.D., T.C. Tacha, B.C. Estel, and J.W. Spitzkeit. 1988. Spatial and temporal variation in winter weights of Mississippi Valley Canada geese. Pages 271-276 in Milton W. Weller, ed. Waterfowl in winter. University of Minnesota Press, Minneapolis. 624 p.

Weatherhead, P.J. 1985. Condition bias and band recovery data: a reply to Burnham and Nichols. Wildl. Soc. Bull. 13(3):349-351.

Weller, M.W. 1965. Chronology of pair formation in some nearctic Aythya (Anatidae). Auk 82:227-235.

Whitton, R.M. 1987. Blood lead, ingested shot, and migrational energetics in canvasbacks, lesser scaup and ring-necked ducks on Pool 19, Mississippi River. M.S. Thesis, Western Illinois University, Macomb. 118 p.

Table 1. Body weights, length of wing chords, and condition indices of hunter-harvested ducks in the Illinois and Mississippi river valleys during fall, 1938-1940, and 1985, 1989-1991.

			1938-1940[a]			1985[b], 1989-1991						
				Body wt[c] (g)			Body wt[cd] (g)		Wing chord (mm)		Condition index[d] (g/mm)	
Species	Sex	Age	n	0	SE	n	0	SE	0	SE	0	SE
Dabbling Ducks												
Mallards	M	Ad	631	1,261A	5	220	1,240AB	8	288	0.6	4.31B	0.03
		Im	730	1,175	5	61	1,163B	12	282	0.6	4.13B[e]	0.04
	F	Ad	402	1,084	9	105	1,078B	11	268	0.8	4.02B[e]	0.04
		Im	671	1,034A	5	12	966AB	37	267	1.4	3.62B	0.14
Wood ducks	M	Ad	4	694		37	712B	9	223	1.0	3.19B	0.03
		Im	5	712		6	702	49	223	2.0	3.14	0.20
	F	Ad				20	652B	11	218	1.6	2.99B	0.05
		Im	4	553		13	666	14	218	1.7	3.05	0.07
Green-winged teals	M	Ad	21	390	5	32	378B	7	184	1.1	2.05B	0.04
		Im	38	372A	5	6	340A	13	185	3.7	1.84B	0.06
	F	Ad	10	354	9	14	349B	7	176	1.1	1.98	0.04
		Im	31	336	9							
Gadwalls	M	Ad	16	989	27	6	1,046B	58	272	2.5	3.84B	0.19
		Im	68	907A	14	6	821AB[e]	24	258	0.4	3.18B[e]	0.09
	F	Ad	14	848	18	2	851	40	262	6.4	3.25	0.07
		Im	66	807	14	9	739B[e]	36	247	1.3	2.99B[e]	0.14
Northern pintails	M	Ad	237	1,034	9	4	1,088	31	274	3.0	3.98	0.09
		Im	403	975	5	4	950	70	262	3.0	3.63	0.23
	F	Ad	60	889	14	1	813		255		3.19	
		Im	219	835	9	3	664	69	250	1.7	2.66	0.30

Table 1. Continued.

			1938-1940[a]			1985[b], 1989-1991						
				Body wt[c] (g)			Body wt[cd] (g)		Wing chord (mm)		Condition index[d] (g/mm)	
Species	Sex	Age	n	0	SE	n	0	SE	0	SE	0	SE
American wigeons	M	Ad	19	807	23	3	744	42	260	0.6	2.86	0.17
		Im	82	780	14	2	739	99	258	0.0	2.86	0.39
	F	Ad	16	753	23							
		Im	92	717	9	4	711	52	241	1.0	2.95	0.21
Northern shovelers	M	Ad	16	689		4	702	24	247	1.0	2.84	0.11
		Im	45	671								
	F	Ad	6	621								
		Im	35	590		2	651	6	227	5.7	2.87	0.11
American black ducks	M	Ad	12	1,202	45	2	1,180	97	295	6.4	4.01	0.43
		Im	18	1,175	32							
	F	Ad	10	1,089	41	2	1,017	64	271	4.2	3.76	0.30
		Im	29	1,066	23							
Diving Ducks												
Lesser scaups	M	Ad	9	839		96	893B	6	205	0.6	4.36B[e]	0.03
		Im	26	780		86	809B[e]	6	203	0.6	3.99B	0.03
	F	Ad	6	780		43	842B[e]	11	198	0.7	4.25B[e]	0.06
		Im	27	785		74	744B	10	195	0.7	3.82B	0.05
Ring-necked ducks	M	Ad	9	862		20	787B[e]	12	198	0.8	3.98B[e]	0.06
		Im	9	735		22	744B[e]	10	196	0.9	3.80B[e]	0.05
	F	Ad	5	694		3	780	35	193	3.2	4.04	0.22
		Im	6	658		24	637B	18	187	1.1	3.40B	0.09

Table 1. Continued.

			1938-1940[a]			1985[b], 1989-1991					
				Body wt[c] (g)			Body wt[cd] (g)		Wing chord (mm)		Condition index[d] (g/mm)	
Species	Sex	Age	n	0	SE	n	0	SE	0	SE	0	SE
Buffleheads	M	Ad				4	504	16	175	3.0	2.88	0.11
		Im										
	F	Ad				2	470	77	169	4.2	2.78	0.39
		Im										
Ruddy ducks	M	Ad	3	612		2	479	105	153	0.0	3.14	0.68
		Im				2	523	20	148	2.1	3.55	0.20
	F	Ad	2	549								
		Im										

[a] Data from Bellrose and Hawkins (1947).
[b] Data for 1985 from Whitton (1987).
[c] Values in each row followed by the same letter differ significantly ($P \leq 0.05$).
[d] Values in each column followed by the same letter differ significantly ($P \leq 0.05$) unless noted otherwise.
[e] Values are not significantly different ($P > 0.05$).

Table 2. Body weights by sex and age class of canvasbacks, lesser scaups, and ring-necked ducks livetrapped on Pool 19 of the Mississippi River during springs 1977, 1981-1988[a].

Species	Sex	Age	n	Years	Body weight[b] (g) 0	SE
Canvasbacks						
	M	Ad	1,322	1977, 1981-1984, 1986-1988	1,339A	3
		Im	403	1977, 1981-1984, 1986-1988	1,276A	6
	F	Ad	396	1977, 1981-1984, 1986-1988	1,205A	6
		Im	271	1977, 1981-1984, 1986-1988	1,136A	8
Lesser scaups						
	M	–	1,090	1977, 1985, 1987, 1988	770B	3
	F	–	373	1977, 1985, 1987, 1988	679B	4
Ring-necked ducks						
	M	–	71	1977, 1985, 1987, 1988	744C	7
	F	–	29	1977, 1985, 1987, 1988	651C	16

[a] Data for 1985 and 1986 from Whitton (1987).

[b] Values followed by the same letter differ significantly ($\underline{P} \leq 0.05$).

Table 3. Condition indices of canvasbacks, lesser scaups, and ring-necked ducks livetrapped on Pool 19 of the Mississippi River in spring 1985[a], 1986[a], and 1988.

Species Sex	Age	Years	n	Body weight (g) 0	SE	Wing chord (mm) 0	SE	Condition Indices[b] (g/mm) 0	SE
Canvasbacks									
M	Ad	1986, 1988	249	1,360	8	243	0.4	5.60AB	0.03
	Im	1986, 1988	63	1,286	16	237	0.9	5.43C	0.06
F	Ad	1986, 1988	74	1,235	15	233	0.9	5.29A	0.06
	Im	1986, 1988	62	1,177	16	231	0.7	5.09BC	0.07
Lesser scaups									
M	--	1985, 1988	308	778	4	207	0.3	3.77D	0.02
F	--	1985, 1988	157	697	7	201	0.3	3.48D	0.03
Ring-necked ducks									
M	--	1985, 1988	40	735	10	200	0.6	3.67E	0.05
F	--	1985, 1988	11	628	22	190	2.0	3.30E	0.09

[a] Data for 1985 and 1986 from Whitton (1987).

[b] Values followed by the same letter differ significantly ($P \leq 0.05$).