Eye Colour, Aging, and Decoy Trap Bias in Lesser Scaup, *Aythya affinis*

MARIE FAST[1,5], ROBERT G. CLARK[1,2,3], RODNEY W. BROOK[1,4], PETER L. F. FAST[1,5], JEAN-MICHEL DEVINK[1,6], and STEVE W. LEACH[2]

[1] Department of Biology, University of Saskatchewan, 112 Science Place, Saskatoon, Saskatchewan S7N 5E2 Canada
[2] Environment Canada, Prairie and Northern Wildlife Research Centre, 115 Perimeter Road, Saskatoon, Saskatchewan S7N 0X4 Canada
[3] Corresponding author: e-mail: bob.clark@ec.gc.ca
[4] Present address: Wildlife Research and Development Section, Ontario Ministry of Natural Resources, 2140 East Bank Drive, Peterborough, Ontario K9J 7B8 Canada
[5] Present address: Département de biologie, Université du Québec à Rimouski, 300 Allée des Ursulines, Rimouski, Québec G5L 3A1 Canada
[6] Present address: New Brunswick Department of Natural Resources, 1350 Regent Street, Room 120, Fredericton, New Brunswick E3C 2G6 Canada

Fast, Marie, Robert G. Clark, Rodney W. Brook, Peter L. F. Fast, Jean-Michel DeVink, and Steve Leach. 2008. Eye colour, aging and decoy trap bias in Lesser Scaup, *Aythya affinis*. Canadian Field-Naturalist 122(1): 21-28.

Researchers routinely assume that samples of trapped or captured animals are representative of the overall population, though these assumptions are not always evaluated. We used decoy-trapped Lesser Scaup (*Aythya affinis*) to assess the reliability of classifying females as yearlings or adults from a distance, based on documented age-related eye-colour changes, and also to evaluate the presence of sex, condition and age biases in decoy trapping. We compared eye colour of trapped females to photographs of known-age females following a published procedure while females were (1) in traps (by using spotting scopes or binoculars) and (2) in-hand. Assuming in-hand age assessments were correct, we found that adults aged from a distance were frequently misclassified as yearlings, but yearlings were never misclassified as adults. Distance between observer and female, overall observation quality, and cloud cover did not influence age assignment success. A larger proportion of males was captured than observed during a survey of the local breeding population. We also found that decoy-trapped females had lower body mass and were more likely to be yearlings compared to pass- and jump-shot females from the same area. We conclude that female Lesser Scaup cannot be accurately aged from a distance using eye colour and concur with other researchers that possible sex, age and condition biases should be evaluated when using decoy traps.

Key Words: Lesser Scaup, *Aythya affinis*, age bias, aging techniques, body condition bias, decoy trap, sex bias, trap bias, Saskatchewan, Northwest Territories.

In wildlife studies, individual animals are often sampled and their age, sex, and condition are determined. An implicit assumption of many studies is that different cohorts of a population are equally likely to be encountered relative to that of the wild population at a given time and place. However, true random samples are difficult to collect as some individuals may have an increased probability of being captured. By evaluating sampling techniques, possible biases in sampling can be discovered, minimized and compensated for.

Researchers sample wildlife populations in numerous ways to collect information uniquely suited to the research questions being asked. Age-ratio information is useful for understanding population dynamics and making wildlife management decisions, and may be collected by examining trapped individuals or those killed by hunters or disease (e.g., Lack 1968; Johnson et al. 1992). Age structure also provides a basis for assessing age-specific vital rates (Newton 1988) and estimating productivity. However, some sampling methods (trapping, hunting, observation, collection of diseased animals) could produce biased estimates (Bellrose et al. 1961; Weatherhead and Greenwood 1981). Trauger (1974) used the unique characteristic of age-related eye-colour change to develop an aging technique for female Lesser Scaup (*Aythya affinis*, hereafter scaup), and used this technique to estimate annual fluctuations in female age composition of scaup breeding populations by estimating the age of female scaup from a distance. However, the reliability of this method has not been assessed.

Decoy traps are a common capture technique for waterfowl and other birds (e.g., Rogers 1964; Anderson et al. 1980; Weatherhead and Greenwood 1981; Grand and Fondell 1994; Guyn and Clark 1999); however, the use of decoys has been shown to bias sampling for some species, with individuals of one sex (Grand and Fondell 1994), age group (Weatherhead and Greenwood 1981), or body condition (Weatherhead and Greenwood 1981) being more susceptible to capture than others. Given that decoy traps work by attracting individuals into enclosures, it is reasonable to assume that some may be more vulnerable than others, possibly due to differences in experience (age), aggression (e.g., breeding stage), or promiscuity (Weatherhead and Greenwood 1981; Grand and Fondell 1994). Few studies have reported sex biases for decoy traps. Grand and Fondell (1994) found relatively few Northern Pintail (*Anas acuta*) females were captured in decoy traps compared to baited rocket-nets, but found no difference in number of males captured. Rogers (1964) and Anderson et al. (1980) captured more male than female scaup in decoy traps but did not explicitly test for a sex bias.

Other studies have compared trapping methods to assess body condition and age related trap bias. Guyn and Clark (1999) found no difference in age or body size of decoy-trapped versus nest-trapped Northern Pintails. Grand and Fondell (1994) found relatively few older Northern Pintail females captured in decoy traps compared to baited rocket-nets but found no difference in body mass of either sex between capture methods. Decoy-trapped Red-winged Blackbirds (*Agelaius phoeniceus*) were on average younger and had lower body mass when compared with a mist-netted sample leaving roost sites (Weatherhead and Greenwood 1981). These studies assumed that alternative methods (i.e., rocket-netting, and roost-capture) were not age or condition biased.

In this study, we evaluated field techniques specific for the study of scaup. Here, we evaluated the (1) accuracy of Trauger's (1974) distance aging method and (2) potential sex, body condition and age biases for decoy trapping. We determined the efficacy of using eye colour as a method for aging female scaup from a distance by comparing estimated age classes of birds while in-hand with those estimated for the same birds at various distances using spotting scopes or binoculars. We evaluated sex bias by comparing the ratio of males to females captured in decoy traps versus the ratio observed in the local population during pair surveys. Age- and body-mass-related trap biases were also evaluated by comparing mass and age of decoy-trapped females with shot females.

Methods

Accuracy of distance aging

We captured known-age female scaup on nests from 1998 to 2000, using nest traps (Weller 1957) or mist nets on St. Denis National Wildlife Area (SDNWA; 52º13'N, 106º04'W), located 40 km east of Saskatoon, Saskatchewan, Canada. The SDNWA was described in detail by Sugden and Beyersbergen (1985) and Woo et al. (1993). Nesting female scaup were aged in-hand by two or more observers using the eye colour chart provided in Trauger (1974). Trauger's (1974) eye colour chart provides examples of the progressive change in eye colour from brown to yellow as female scaup age from yearlings to adult birds (3+ years). Age was assigned by consensus (agreement of eye colour chart number) but, if not possible, we recorded individual eye-colour numbers from Trauger's (1974) chart (each age class is represented by two or more chart eye-colours). If observers disagreed on the age class or the consensus age class did not correspond to the actual age of the female, the in-hand assignment for that female was scored as being incorrect. The accuracy of in-hand aging was determined by comparing a female scaup's known age to that estimated during recapture.

Work was also conducted on the Yellowknife Study Area (YKSA), located 16 km northwest of Yellowknife (62º 28'N, 114°24'W), Northwest Territories, Canada. The YKSA was described in detail by Trauger (1971) and Fournier and Hines (1999). We trapped pre-laying scaup between 18 May and 2 June 2000, 24 May and 7 June 2001, 31 May and 16 June 2003, and 2 June and 13 June 2004. Decoy traps were modified from Rogers (1964) and Anderson et al. (1980), and live captive-bred female scaup were used to decoy wild birds. Traps were placed on ponds with frequent scaup use.

We classified female scaup into two age classes, yearlings (1 year old) or older (2+ years), by comparing their eye colour to the eye colour chart examples of known-aged female scaup provided in Trauger (1974). Trauger (1974) reported that 66% of known-age two-year-old females had eye colour that was indistinguishable from three- and four-year-olds. By contrast, he found little overlap in eye colour between yearlings versus three- and four-year-old birds. Accordingly, we classified females as yearlings if their eye colour was brown to olive brown; females with eye colour ranging from olive yellow to yellow were classified as two-year-old or older.

We estimated scaup eye colour for females captured in decoy traps using either spotting scopes (20 – 60×) or binoculars (8 – 10×). Two observers estimated each female's age and distance from observer to the trap (to nearest 10 m). Each observer also estimated the percent cloud cover (to assess light quality, 0% to 100%) and their individual observation quality (1 = excellent to 4 = poor, based on observation obstructions, light quality, wind and distance to trap). We then aged the same females in-hand. Observers recorded age assignment in confidence and did not age the female for both age assignments (i.e., each female was aged by at least three researchers) such that observers alternated between age assignment methods (i.e., from a distance versus in-hand) to reduce observer bias in 2000; however, only two observers were present in 2001. In 2003 and 2004, females were only aged in-hand by two observers after being removed from the trap. Age was assigned by consensus; if none could be reached then individual eye colour chart numbers (Trauger 1974) were recorded.

Decoy trap sex bias

Sex was recorded for all decoy trapped scaup captured on the YKSA from 2000 to 2004. Pair survey data were also collected on all ponds on the YKSA and completed during systematic surveys over 2 – 3 days (Trauger 1971; J. E. Hines, Canadian Wildlife Service, unpublished data). These surveys occurred in early June each year, during the last few days of the trapping period.

Decoy trap condition and age bias

In 2003 and 2004, we collected female scaup by pass- and jump-shooting (see Greenwood et al. 1986) on wetlands within 75 km northeast of Yellowknife, east of the YKSA where scaup were trapped. We collected female scaup from 24 May to 17 June 2003 and 26 May to 20 June 2004 (overlapping with the decoy-trapping period). Most were collected immediately before and after the decoy-trapping period. All birds were weighed (nearest 5 g) immediately after retrieval and ingesta were removed and weighed (nearest 1 g) later during dissections. We calculated ingesta-free body masses (IFmass) of shot birds by removing actual ingesta mass. All decoy-trapped females from the YKSA were weighed (nearest 5 g) after capture; no mass adjustment was made for these birds because they would have little remaining ingested food after being held in traps for periods of 1-3 hours, then retrieved and handled (Dufour 1991).

Shot females were assigned an age class using eye colour (Trauger 1974; also see above) and wing plumage criteria (Carney 1992); in 2003 and 2004, 24 and 25 females were assigned an age class, respectively. The wing plumage aging criteria for female scaup is based on appearance of tertials, greater tertial coverts, and middle and lesser coverts, allowing fall- and winter-shot females to be aged as immature or adult (Carney 1992). Juvenile scaup females moult a few innermost wing coverts in their first spring (before one-year-old), and therefore retain most of their juvenile wing plumage characteristics (Basic I Plumage) until they moult from Basic I to Definitive Alternate Plumage during their second fall (Palmer 1976; Austin et al. 1998). Therefore, in spring, a female less than a year old would be correctly aged as a one-year-old based on wing plumage and eye colour. When disagreement between aging techniques occurred or when aged using wing plumage only (five in 2003, five in 2004), females were classified into a general category, after hatch year (AHY), for this analysis.

Statistical Methods

Accuracy of distance aging – Field methods and observers differed between 2000 and 2001 when collecting distance-eye-colour data, so years were analyzed separately. The accuracy of distance-aging was determined by comparing age assignments from distant observations versus in-hand age determination, using a Fisher's exact test (PROC FREQ; SAS Institute 2000). We assumed in-hand designation was correct when both observers agreed on female age. We modeled effects of overall observation quality ([observer one individual observer quality + observer two individual observer quality]/2), percent cloud cover, distance from observer to trap, and the interaction between observation quality and distance from observer to trap on the success of age assignment using general linear models (PROC GLM; SAS Institute 2000). Simpler models were considered (Appendix 1) and the most plausible model was selected using Akaike's Information Criterion corrected for sample size (AIC_c) and model weight (w_i; Burnham and Anderson 1998).

Sex bias – We evaluated the possibility of sex bias using a chi-squared test (PROC FREQ; SAS Institute 2000) to compare the sex ratio of trapped scaup (not including recaptures) with that estimated for the YKSA population during annual breeding pair surveys conducted in June (J. E. Hines, CWS, unpublished data).

Body condition and age bias – Body mass and age (yearling, adult and AHY) in the decoy-trapped sample were compared to collected females. We initially plotted data to identify outliers or nonlinear patterns, but none were detected. Least squares means (LSmean) and standard errors (SE) were computed to describe year and method-specific variation in body masses of females. We modeled effects of year (2003, 2004), collection method (decoy trap, shot), day and all two-way interactions on IFmass using general linear models (PROC GLM; SAS Institute 2000). Reduced models were also considered (Appendix 1) and the most plausible models were selected using AIC_c and model weights (w_i; Burnham and Anderson 1998). Contingency tables were evaluated using a *G*-test (PROC FREQ; SAS Institute 2000).

Results

Accuracy of distance aging

Twelve known-age female scaup were captured and aged at SDNWA in spring from 1998 to 2000. When observers agreed, most females were aged correctly as either yearlings or adults (8/9, 89%). Observers disagreed three times on age assignment (3/12, 25%), all of which occurred when classifying known-age yearlings (n = 1) and 2 year-olds (n = 2).

A total of 43 decoy-trapped females was aged both from a distance and in-hand on the YKSA during May and June 2000, 2001. There was agreement between observers for 89% and 82% of females aged in-hand in 2000 and 2001, respectively. When both observers agreed on age, for both in-hand and distance aging (60% in 2000 and 41% in 2001), age assignments were correct for 100% of yearlings (n = 5) and 56.3% of adults (n = 16) in 2000, and 100% of yearlings (n = 2) and 80.0 % of adults (n = 5) in 2001. Assuming in-hand age assignments are correct when both observers agree, in 2000, aging from a distance underestimated the age of female scaup (Fisher's exact, 2-sided, P = 0.04, n = 21, Figure 1); many adults were mis-assigned as yearlings. However, in 2001, only one female's age was underestimated from a distance (n = 7).

There was no significant difference between years in observers' ability to age females correctly ($\chi^2_1 = 0.87$, P = 0.35). Our ability to age females correctly from a distance was best modeled when we included distance as a covariate (AIC_c = –38.42, w = 0.20); however, considerable variation remained (r^2 = 0.003). This model was only slightly better than the models which included the effect of cloud (ΔAIC_c = 0.09, w = 0.19), overall observation quality (ΔAIC_c = 0.20, w = 0.18), and cloud with overall observation quality (ΔAIC_c = 0.90, w = 0.13).

Decoy trap sex bias

We caught 52 (n = 35 in 2000; n = 17 in 2001) female and 164 (n = 81 in 2000; n = 83 in 2001) male scaup in decoy traps during May and June on the YKSA. Relatively more males were captured in traps than were observed during a survey of the study area (2000: χ^2_1 = 8.2, P < 0.005; 35 females and 81 males decoy-trapped; 254 females and 317 males observed on June survey; 2001: χ^2_1 = 21.9, P < 0.005; 17 females and 83 males decoy-trapped; 191 females and 271 males observed on June survey) (Figure 2).

Decoy trap condition and age bias

We shot 29 and 30 and decoy-trapped 17 and 25 females in 2003 and 2004, respectively. Overall, females were heavier in 2003 than in 2004 (LSmean ± SE: 727 ± 8 g versus 676 ± 7 g), and shot female averaged ~31 g heavier than decoy-trapped females (717 ± 7 g versus 686 ± 8 g). Variation in female body mass was best modeled by including effects of year, collection method, day and the interaction between day and year in the model (AIC_c = 375.08, w = 0.351, R^2 = 0.369). This model was slightly better than the two next best which either lacked the interaction term between day and year (ΔAIC_c = 1.18, w = 0.194), or lacked collection method (ΔAIC_c = 1.23, w = 0.190). Two additional plausible models (ΔAIC_c < 2.70) included effects of collection method, year, day and interactions involving year*day and year*method (w = 0.112), or simply included year and day effects (w = 0.095). Because the year*day and, to a lesser extent, year*method interactions were influential, we analyzed each year separately. Body mass did not vary with age; after accounting for year, method, day and day*year interaction effects, 63 adult females (mean ± SE, 706 ± 7 g) averaged 13 g heavier than 24 yearling females (693 ± 11 g), whereas 14 AHY females had intermediate masses (701 ± 15 g). In a separate analysis of 2003 females, variation in body mass was only weakly related to age (LSmean ± SE, adjusted for collection date: adult = 728 ± 14 g, yearling = 718 ± 14 g) or collection method (trap = 713 ± 16 g; shot = 733 ± 14 g). There was considerable annual variation in the proportion of yearlings captured in decoy traps, ranging from 16-82%, with an overall average of 37% during 2000-2004. Of birds collected by shooting, 17% of 24 and 92% of 25 were yearlings, versus 82% of 17 and 81% of 21 females captured in decoy traps, in 2003 (G_1 = 18.8, P < 0.001) and 2004 (G_1 = 1.23, P = 0.27), respectively.

Discussion

Accuracy of distance aging

The distance-aging technique for female scaup did not provide a reliable estimate of population age ratio (yearling:adult) when compared to in-hand aging and would result in an overestimation of yearlings (assuming in-hand age was correctly assigned). Distance aging was not strongly affected by estimates of observation quality (e.g., estimated distance to the trap, percent cloud cover, and overall observation quality) though our sample size many not have been adequate to fully assess these potential covariates. The technique's inaccuracy may be due to observers' inability to distinguish subtle colour differences between yearlings and two-year-olds. Trauger (1974) described the colour for yearlings as dark brown, olive brown and light olive brown versus light olive brown and olive yellow for two-year-olds (i.e., overlapping). This overlap in colour could explain the disagreement that occurred between observers handling both known-age and trapped females . Additionally, Trauger (1974) also suggested that within-season eye-colour changes may occur, especially in these age classes; and could also explain our discrepancies. If we had chosen to classify female scaup aged from a distance into ≤ two-year-olds and ≥ three-year-old categories, we might have increased our age classification success. However, the age categories that we chose represented both a change in eye colour and a biologically important change in female reproductive performance; yearling female diving ducks (including *Aythya* spp.) typically are less likely to nest during poor habitat conditions, have smaller clutches, lower nest success, and lower renesting rates than older females (Afton 1984; Serie et al. 1992; Blums et al. 1997; Hohman and Eberhardt 1998; Woodin and Michot 2002).

Sex bias

We found a male capture bias for decoy traps compared to the local population of males observed during surveys. Similarly, Grand and Fondell (1994) and Guyn and Clark (1999) decoy trapped 4 to 10 times more male Northern Pintails than females. Anderson et al. (1980) also captured more male than female scaup using decoy traps but captured more female Canvasbacks (*Aythya valisineria*) and Redheads (*Aythya americana*) than males. They suggested this was due to a greater proportion of unpaired male scaup than Canvasbacks or Redheads in the area and because of species' behaviour differences. June breeding survey data for the YKSA indicated the majority of males were paired (paired = 192, unpaired = 64 in 2000; paired = 190, unpaired = 81 in 2001, J. E. Hines, CWS, unpublished data). As these surveys occurred during the end of the trapping period, the estimate for unpaired males may be biased low for the entire trapping period. However, we suggest that behaviour of scaup (i.e., largely nonaggressive, social, common mate changes during early breeding season; Austin et

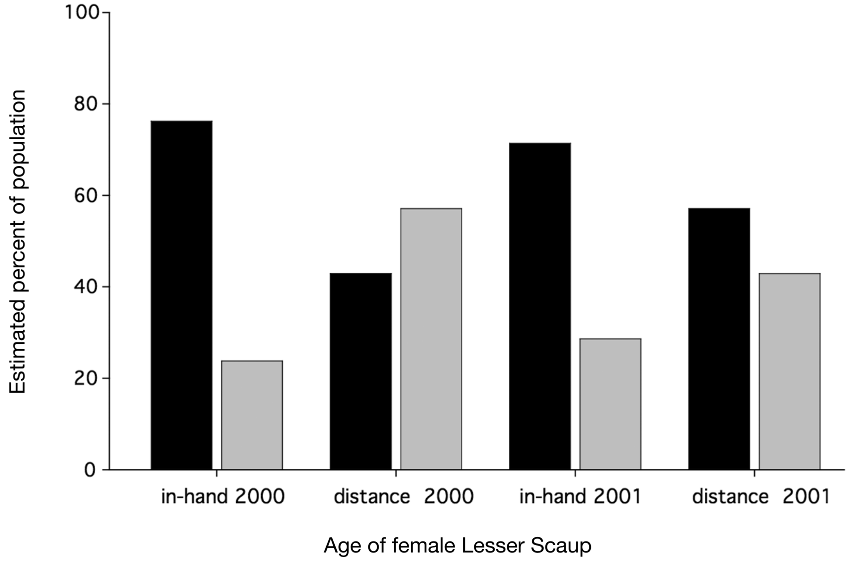

FIGURE 1: Age distribution of adult and yearling female Lesser Scaup trapped on the Yellowknife Study Area, May and June 2000 ($n = 21$) and 2001 ($n = 7$), as determined by in-hand and distant eye-colour aging technique. Black bars indicate adults and grey bars indicate yearlings.

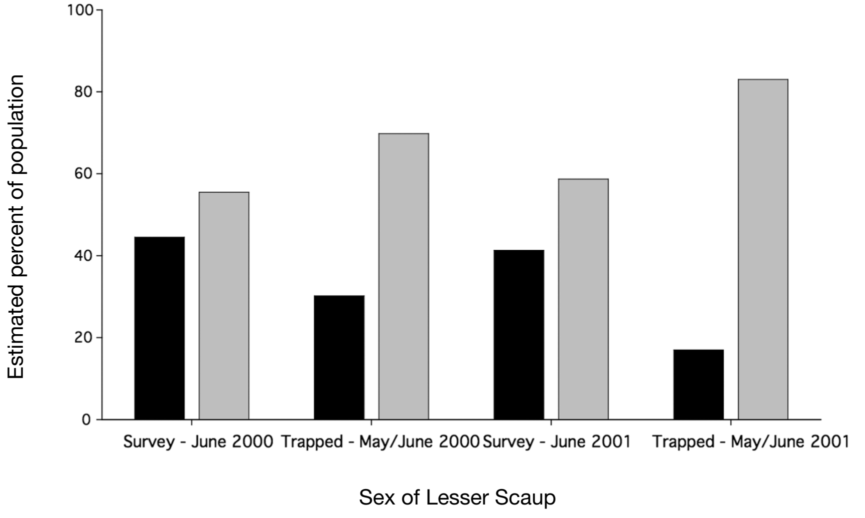

FIGURE 2. Percentage of Lesser Scaup estimated from a June breeding survey and decoy-trapping on the Yellowknife Study Area, May and June 2000 and 2001. Black bars indicate females and grey bars indicate males.

al. 1998) may also be important in explaining sex trap bias than male pair status.

Body condition and age bias associated with decoy traps

Pass- and jump-shooting are methods often used to collect waterfowl specimens to avoid bias associated with other methods including decoying, baiting or calling (Greenwood et al. 1986; Heitmeyer et al. 1993; Anteau and Afton 2004; this study). Although it is possible that certain individuals may be more susceptible to pass and jump-shooting (e.g., if larger or smaller-bodied birds are more likely to survive crippling injury and escape recovery; if birds of a certain size class are more likely to fly along wetland edges where hunting risks may be greater), most shot birds were recovered (>80%) and we believe the method likely provides a more representative sample of local populations than other sampling techniques. Decoy-trapped females were lighter than shot females after accounting for temporal effects and ingesta mass. The difference was more pronounced in 2004, when females generally were lighter than in 2003, possibly due to a late spring thaw (Environment Canada 2004*) which may have reduced food availability (Devink et al. 2008). We suspect the mass difference between methods was due to a greater proportion of yearlings or poorer quality females in the decoy-trapped sample, but could not test this hypothesis. Ryan (1972) and Anderson and Warner (1969) found yearling scaup were lighter and smaller (respectively), but we were unable to detect differences in female weight between age classes. These potential age and body condition biases should be an important consideration for research assuming an unbiased sample of the population.

The trap and age estimation biases we report likely transcend species (e.g., scaup, Rogers 1964; Canvasback, Redhead, and scaup, Anderson et al. 1980; Northern Pintail, Grand and Fondell 1994; Guyn and Clark 1999; Red-winged Blackbirds, Weatherhead and Greenwood 1981; Brown-headed Cowbirds (*Molothrus ater*), Dufour and Weatherhead 1991) where aging is much more difficult and age-specific capture bias is more difficult to determine. We recommend that researchers using decoy traps recognize that age, condition, and sex bias likely occur, and acknowledge this during analysis and reporting. We do not recommend using the eye-colour change technique to age female scaup from a distance.

Acknowledgments

We are especially grateful to J. E. Hines for providing YKSA breeding pair survey data. We are also grateful to K. Bourassa and S. Haszard for their assistance in trapping and aging female scaup, and G. Mack, W. Davis, and H. Remenda for their assistance in collecting and dissecting scaup. The authors thank the Northern Scientific Training Program, Ducks Unlimited Canada, Natural Sciences and Engineering Research Council, Delta Waterfowl, and the Canadian Wildlife Service, Yellowknife, for providing financial and logistical support during the field season. The Canadian Wildlife Service, Saskatoon, and University of Saskatchewan provided logistical support during manuscript preparation. Also, thanks to A. J. Erskine for valuable suggestions which greatly helped improve the manuscript.

Documents Cited [marked * in text]

Environment Canada. 2004. Climate trends and Variations Bulletin: Spring 2004, Regional Temperature. Internet WWW page, at URL: <http://www.msc.ec.gc.ca/ccrm/bulletin/spring04/regional_e.cfm> Version modified on 2004-06-02.

Literature Cited

Afton, A. D. 1984. Influence of age and time on reproductive performance of female Lesser Scaup. Auk 101: 255-265.

Anderson, M. G., R. D. Sayler, and **A. D. Afton.** 1980. A decoy trap for diving ducks. Journal of Wildlife Management 44: 217-219.

Anderson, B. W., and **D. W. Warner.** 1969. A morphological analysis of a large sample of lesser scaup and ring-necked ducks. Bird-Banding 40: 85-94.

Anteau, M. J., and **A. D. Afton.** 2004. Nutrient reserves of Lesser Scaup (*Aythya affinis*) during spring migration in the Mississippi Flyway: A test of the spring condition hypothesis. Auk 121: 917-929.

Austin J. E., C. M. Custer, and **A. D. Afton.** 1998. Lesser Scaup (*Aythya affinis*). *In* The Birds of North America, number 338. *Edited by* A. Poole and F. Gill. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington.

Bellrose, F. C., T. G. Scott, A. S. Hawkins, and **J. B. Low.** 1961. Sex ratios and age ratios in North American ducks. Illinois Natural History Survey Bulletin 27: 391-474.

Blums, P., R. G. Hepp, and **A. Mednis.** 1997. Age-specific reproduction in three species of European ducks. Auk 114: 737-747.

Burnham, K. P., and **D. R. Anderson.** 1998. Model selection and inference: a practical information-theoretic approach. Springer-Verlag, New York, New York.

Carney, S. M. 1992. Species, age and sex identification of ducks using wing plumage. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.

Devink, J-M., R. G. Clark, S. M. Slattery, and **D. L. Trauger**. 2008. Are late-spring boreal lesser scaup (*Aythya affinis*) in poor body condition? Auk 125: 291-298.

Dufour, K. W. 1991. Condition bias and band-recovery data: an investigation using mallards. M.Sc. thesis, University of Western Ontario, London, Ontario.

Dufour, K. W., and **P. J. Weatherhead.** 1991. A test of the condition-bias hypothesis using Brown-headed Cowbirds trapped during the breeding season. Canadian Journal of Zoology 69: 2686-2692.

Fournier, M. A., and **J. E. Hines.** 1999. Breeding ecology and status of the Red-necked Grebe, *Podiceps grisegena*, in the subarctic of the Northwest Territories. Canadian Field-Naturalist 112: 474-480.

Grand, J. D., and **T. F. Fondell.** 1994. Decoy trapping and rocket-netting for northern pintails in spring. Journal of Field Ornithology 65: 402-405.

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

Guyn, K. L., and **R. G. Clark.** 1999. Decoy trap bias and effect of markers on reproduction of Northern Pintails. Journal of Field Ornithology 70: 504-513.

Heitmeyer, M. E., L. H. Fredrickson, and **D. D. Humburg.** 1993. Further evidence of biases associated with hunter-killed mallards. Journal of Wildlife Management 57: 733-740.

Hohman, W. L., and **R. T. Eberhardt.** 1998. Ring-necked Duck (*Aythya collaris*), The Birds of North America, number 659. *Edited by* A. Poole. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington.

Johnson, D. H., J. D. Nichols, and **M. D. Schwartz.** 1992. Population Dynamics of Breeding Waterfowl. Pages 446-485 *in* Ecology and Management of Breeding Waterfowl. *Edited by* B. J. Batt, A. D. Afton, M. G. Anderson, C. D. Ankney, D. H. Johnson, J. A. Kadlec, and G. L. Krapu. University of Minnesota Press, Minneapolis, Minnesota.

Lack, D. 1968. Ecological adaptations for breeding in birds. Methuen, London.

Newton, I. 1988. A key factor analysis of a sparrowhawk population. Oecologia 76: 588-596.

Palmer, R. S., *Editor.* 1976. Handbook of North American birds. Volume II. Waterfowl. Part 1. Yale University Press, New Haven, Connecticut.

Rogers, J. P. 1964. A decoy trap for male lesser scaup. Journal of Wildlife Management 28: 408-410.

Ryan, R. A. 1972. Body weight and weight changes of wintering diving ducks. Journal of Wildlife Management 36: 759-765.

SAS Institute. 2000. SAS/STAT user's guide. Version 8: SAS Institute, Inc., Cary, NC.

Serie, J. R., D. L. Trauger, and **J. E. Austin.** 1992. Influence of age and selected environmental factors on reproductive performance of Canvasbacks. Journal of Wildlife Management 56: 546–556.

Sugden, L. G., and **G. W. Beyersbergen.** 1985. Farming intensity on waterfowl in Saskatchewan parklands. Wildlife Society Bulletin 12: 22-26.

Trauger, D. L. 1971. Population ecology of Lesser Scaup (*Aythya affinis*) in subarctic taiga. Ph.D. dissertation, Iowa State University, Ames, Iowa.

Trauger, D. L. 1974. Eye colour of female lesser scaup in relation to age. Auk 91: 243-254.

Weatherhead, P. J., and **H. Greenwood.** 1981. Age and condition bias of decoy trapped birds. Journal of Field Ornithology 52: 10-15.

Weller, M. W. 1957. An automatic nest-trap for waterfowl. Journal of Wildlife Management 21: 456-458.

Woo, M., R. D. Rowsell, and **R. G. Clark.** 1993. Hydrological classification of Canadian prairie wetlands and prediction of wetland inundation in response to climatic variability. Canadian Wildlife Service Occasional Paper Number 79, Saskatoon, Saskatchewan.

Woodin, M. C., and **T. C. Michot.** 2002. Redhead (*Aythya americana*). *In* The Birds of North America, number 695. *Edited by* A. Poole. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington.

Received 8 November 2005
Accepted 14 July 2009

APPENDIX 1. Table of models considered in statistical analysis (and compared on basis of AIGc values) for (a) determining if observation variables (overall observation quality, distance from observer to trap, percent cloud cover) had an influence on an observers' ability to correctly distance age female scaup and (b) determine if collection variables (collection method, day, year) had an influence on ingesta-free mass of female scaup.

a) MODEL	*n*	K
dist	28	3
cloud	28	3
avqual	28	3
cloud, avqual	28	4
avqual, dist	28	4
avqual, dist, cloud	28	5
cloud, dist	28	4
cloud, avqual dist*avqual	28	5
avqual, dist, cloud, dist*avqual	28	6

b) MODEL	*n*	*K*
method year day	102	5
method year	102	4
method day	102	4
year day	102	4
method	102	3
day	102	3
year	102	3
method year day method*year	102	6
method year method*year	102	5
year day year*day	102	5
method year day day*method	102	6
method day day*method	102	5
method year day method*year year*day	102	7