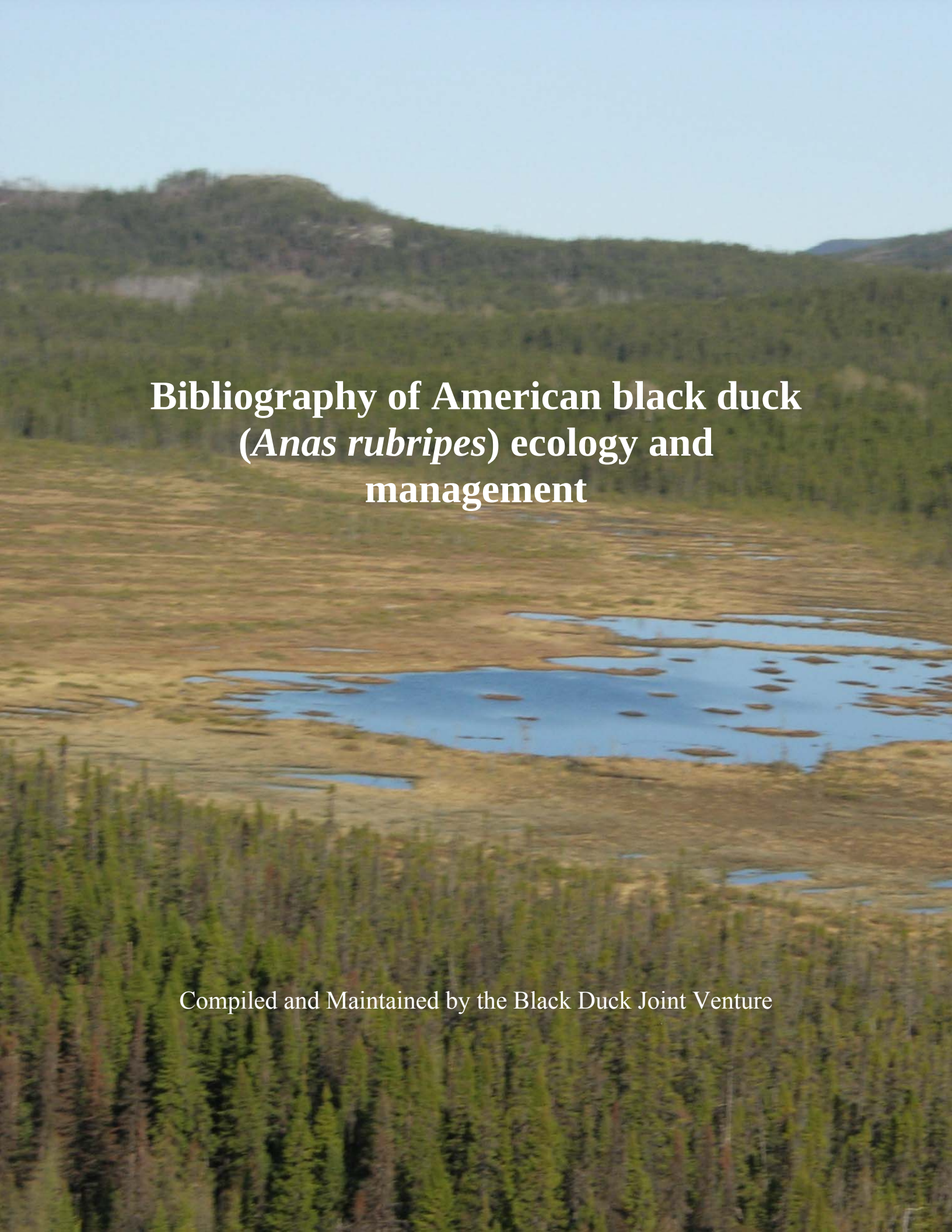

Bibliography of American black duck (*Anas rubripes*) ecology and management

Compiled and Maintained by the Black Duck Joint Venture

INTRODUCTION

A primary goal of the Black Duck Joint Venture (BDJV) is to serve as a 1-stop clearinghouse of scientific information and data related to black duck ecology and management. This electronic annotated bibliography is a principal tool in disseminating information to wildlife managers, researchers, and individuals with an interest in the conservation of the American black duck. The BDJV will continue to revise and update this bibliography annually, or more often as needed, to ensure full representation of historic documents and to incorporate new publications. The date of the latest revision is provided in the footnote. Publications denoted with an * were sponsored, in part, by the BDJV.

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Abstract: Migrations of the species in the area cited, feeding habits, available foods, and their utilization. Probably "through experimentation and management relatively unproductive stretches of marshland can be made to produce an abundance of desirable black duck foods."

Addy, C. E. 1953. Fall migration of the black duck. 19:1-63. U.S. Fish and Wildlife Service Special Science Report Wildlife no. 19, Washington, D. C. USA.

Abstract: Based on analysis of 17,518 shooting recoveries. Introduction discusses limitations on use and interpretation of banding recoveries. The body of the report details patterns of dispersal from important banding stations and summarizes records for states and regions. Time and extent of migration by various populations is dealt with. Migration patterns show considerable variation between banding stations and between regions. Usually there is a significant difference in pattern of dispersal from stations 50-200 miles apart. An important variable between banding stations is percentage of recoveries taken in vicinity of station. This varies from 0 to 80%. A high percentage of local recoveries usually is associated with habitats that serve as wintering grounds, or which are large enough that ducks need not be driven out early in season by shooting or weather. Data indicate that in northern states where wintering or more sedentary populations occur, bait trapping in late summer and fall will not properly sample both sedentary and migrant groups. Characteristics of migration through a major region, or along a particular route, cannot be determined from banding at any one point. Overall population movements can be determined only through analysis of records from a series of banding stations located from Canadian breeding grounds to southern wintering grounds.

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Abstract: Hunter-kill data for each degree block in Ontario and Quebec for the years 1974-85 were analyzed to see how the number of American black duck (*Anas rubripes*) × mallard (*A. platyrhynchos*) hybrids in an area was related to the relative abundance of mallards and black ducks. We also related breeding-ground survey data about changes in numbers of breeding mallards and black ducks, from 1971 to 1985 in Ontario, to those about hybrid incidence in the hunter-kill data. A multiple regression showed that when black duck or mallard numbers were held constant, there was a positive correlation (P 0.01) between numbers of the other species and hybrid numbers. Between 1971 and 1985, the ratio of black ducks: mallards breeding in Ontario declined from about 1:2 to about 1:6 (P 0.001); the decline was greatest in areas that had the highest numbers of hybrids relative to the number of black ducks (P 0.001). We conclude that neither overhunting nor loss of breeding habitat explains this decline, particularly as mallard numbers have shown a compensatory increase. Rather, we suggest that increased mallards in an area cause a decline in black ducks through introgressive hybridization and/or competitive exclusion.

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Abstract: We used allozyme electrophoresis to estimate the degree of genetic differentiation among allopatric and sympatric populations of American Black Ducks (*Anas rubripes*) and Mallards (*A. platyrhynchos*). Mallards were collected in California, Saskatchewan, Manitoba, and Ontario, and Black Ducks were collected in Newfoundland, Nova Scotia, and Ontario. The mean genetic distances, $\bar{D}$, between Black Duck populations (0.0007), between Mallard populations (0.0010), and between Mallard and Black Duck populations (0.0006) were virtually identical; there was as much genetic differentiation within the two species as there was between them. Such small genetic distances are characteristic of local populations of avian species in other orders, and are consistent with what is known about the lack of reproductive isolation between Black Ducks and Mallards. Although the two taxa are still somewhat split on an east-west basis, our genetic data do not support even subspecific status for the Black Duck.

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Abstract: Age-specific studies pertaining to survival and productivity of American black ducks (*Anas rubripes*) are constrained by the fact that no technique has been developed to reliably determine age as second year or after second year from late winter to late spring. We developed a qualitative age-class scoring technique that can be readily used in the field. When tested on 5 independent observers, known-aged birds (n = 106) were correctly classified with 94-98% accuracy. To reduce subjectivity and provide an objective corroboration of age estimates, we also developed multivariate models from measurements of wing feather variables (weight and length of greater secondary covert 9, and width of tertial covert 5) that determined age with >= 90% accuracy (n = 255). There was >= 94% agreement between qualitative and quantitative age assignments of wild birds caught in spring (n = 172). The application of these age determination techniques should be useful in a host of life-history studies conducted on wintering, spring staging, and nesting grounds.

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Abstract: Feeding was restricted without limiting the quality and quantity of food for black ducks (*Anas rubripes*). Nine adult males were fed an extruded diet of two percent fat, 17% protein, and nine percent fiber. Ducks were caged indoors from September (12h light; 17-24°C) to measure balances over 14d when fed ad libitum each day (unfasted) and then fasted for 2d/wk (low-risk) or 4d/wk (high-risk). Birds held mass at 1089g, body water at 800g and dry matter intake at 604g/14d. Intakes increased by 40% (low-risk) and by 133% (high-risk) on feeding days but energy metabolizability (82% to 79%; P<0.01), and fiber digestibility (44% to 9%; P<0.05) were reduced. Fasting regimes were continued in individual outdoor pens for 9wk. Birds gained mass and body water as temperatures declined from 14-21°C to -9-16°C. At week five, low-risk ducks were heavier (1372 vs. 1241g; P<0.05) and fatter (276 vs. 140g; P<0.001) than high-risk birds while body water (894g) and protein were similar between groups (222g). Ducks are unable to increase digestible intakes to compensate for lost foraging time in the fall when nutrient demands for tissue synthesis, thermoregulation, and activity are elevated.

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Abstract: Birds fast intermittently during weather disturbances and migration. We tested responses of black duck to lost feeding days during autumn mass gain. Nine adult males were fed a pelleted diet (1.5% fat, 15.8% protein, and 18.3% neutral detergent fiber) and caged indoors during September and October (12 h light; 17°-24°C) to measure balances over 14 days when fed ad lib. each day and fasted intermittently for two days wk~-1~ (short fast) or four days wk~-1~ (long fast). Body mass (1,081 g), body water content, and metabolizable intakes of energy and protein were maintained as daily intakes of dry matter increased to 1.65 (short fast) and 2.35 (long fast) times the unfasted level. Intermittent

feeding reduced metabolizability of dry matter, energy, protein, and acid detergent fiber. Concentrations of Mn provided similar estimates of metabolizability to direct measures in unfasted birds but underestimated measures of birds on long fasts. Fasting regimes continued outdoors for nine weeks when temperatures declined to -9°C. Birds on short fasts were heavier (1,373 vs. 1,241 g) and fatter (159 vs. 58 g) than those on long fasts, while body water (894 g) and protein (316 g) were similar between groups after five weeks. Birds on long fasts subsequently gained mass when fed daily, but those on short fasts lost mass when fed each day. Omnivorous waterfowl combine ingestive and digestive flexibility with plasticity of body lipid to contend with uncertain food availability.

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Abstract: I measured color patterns of the fifth secondary (S5) and the fifth greater secondary covert (GSC5) feathers on 24 American black ducks (*Anas rubripes*), 30 mallards (*A. platyrhynchos*), and 22 first filial (Fsub1/sub) mallard and black duck hybrids of known genetic origin. I used cluster analysis to group birds based on similiarity in length and area of the white and black portions of both feathers. Each grouping was compared to the known classification for each bird. A distinct color band on GSC5, ranging from white to dark brown, was found on 21 hybrids. The area of this band, regardless of its color, and the length of white along the distal side of the rachis on S5 produced significant separation among all groups (P 0.0001), regardless of sex and age. Using this criterion, only 1 of 22 hybrids was classified as a black duck and 1 of 30 mallards as a hybrid. The length of the white band on the fifth secondary was equally useful in separating all groups. The area of the band on GSC5 is similar to a qualitative criterion used to identify mallard and black duck hybrids. However, with qualitative techniques interobserver variability can introduce error. The quantitative technique I describe eliminates subjectivity.

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paired, the remaining mallard drakes joined black duck courtship groups. Of the 33 unpaired black duck females remaining at this time, only 27% formed intraspecific pairs, whereas 73% selected mallard drakes as mates, despite there being an excess of black duck drakes. Based on these results, a scenario for black duck--mallard hybridization is proposed. It involves ecological factors including the male-biased sex ratio in northern wintering populations, artificial feeding, and roost-site limitation. Other behavioral aspects, such as the earlier pair formation in mallards and the superiority exhibited by mallard drakes when competing for black duck females are discussed.

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> **Abstract**: The authors studied the shared habitat use of mallards and American black ducks on four wetlands in Abitibi, Quebec. Black ducks used scrub-shrub, emergent, and aquatic bed wetlands in 1988, while mallards used only emergent and aquatic bed wetlands. In 1989 both species used available habitats before plants had emerged. After emergence of plants, scrub-shrub was avoided by both species and mallards used aquatic bed wetlands. Mallard use changed from 1988 to 1989, but black duck use did not vary. In 1988 black ducks used forested scrub-shrub wetlands even when availability was low in 1988. Though habitat use overlapped a great deal, the extent of the overlap changed according to water level and habitat availability.

Chasko, G. G., T. R. Hoehn, and P. Howell-Heller. 1984. Toxicity of lead shot to wild black ducks and mallards fed natural foods. Bulletin of Environmental Contaminants and Toxicology 32:417–428.

Chaulk, K. G., and B. Turner. 2007. The timing of waterfowl arrival and dispersion during spring migration in Labrador. Northeastern Naturalist 375:386.

> **Abstract**: Weekly aerial surveys were conducted in central Labrador during the spring staging period (27 April to 29 May, 2000), and the relative abundance of waterfowl was documented. *Anas rubripes* (American black duck) and *Bucephala clangula* (Common Goldeneye) were among the first species to arrive, while peak waterfowl diversity occurred on the latest survey date. Overall, *Branta canadensis* (Canada Geese) were the most abundant species, followed by American black duck and *Anas crecca* (Green-winged Teal). As expected, the relative abundance of these species varied by date and region. By the time of the last survey on 29 May, average flock size had decreased for most species, most likely corresponding with the start of breeding and nest initiation. Our findings could be useful as baseline information for future studies of climate change, may have implications for the management of the aboriginal spring hunt, and also might be used to mitigate the effects of military flying activity.

Chipley, W. H. 1995. Habitat use, daily movements, and survival of female American black ducks wintering in west-central Tennessee. Thesis. Unviersity of Georgia, Athens, GA USA.

Clark, G. M., and V. D. Stotts. 1960. Skin lesions on black ducks and mallards caused by chigger (*Womersia strandtmani* Wharton 1947). Journal of Wildlife Management 24:106–108.

Clark, W. S. 1996. Habitat differences between mallards and American black ducks wintering in Tennessee. Thesis, Tennessee Technological University, Cookeville, TN, USA.

* Clugston, D. A., J. R. Longcore, D. G. McAuley, and P. Dupuis. 1994. Habitat use and movements of post-fledging American black ducks (*Anas rubripes*) in the St. Lawrence estuary, Quebec. Canadian Journal of Zoology 72:2100-2104.

Collins, J. M. 1974. The relative abundance of ducks breeding in southern Ontario in 1951 and 1971. Pages 32–44 in H. Boyd, editor. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–1973. Canadian Wildlife Service Report Series 29.

Conomy, J. T. 1993. Habitat use by, and effects of aircraft noise on the behavior and energetics of wintering dabbling ducks in piney and cedar islands, North Carolina. Thesis, North Carolina State University, Raleigh, NC, USA.

Conomy, J. T., J. A. Collazo, J. A. Dubovsky, and W. J. Fleming. 1998. Dabbling duck behavior and aircraft activity in coastal. Journal of Wildlife Management 62:1127–1134.

> **Abstract**: Examines the behavioral responses of wintering American black ducks, American wigeon, gadwall and American green-winged teal to low-level flying military aircrafts at Piney and Cedar islands in North Carolina in 1991 and 1992. Methodology; Aircraft sound level used in the study; Discussion on the results of the study.

Conomy, J., J. A. Dubovsky, J. A. Collazo, and W. J. Fleming. 1998. Do black ducks and wood ducks habituate to aircraft disturbance? Journal of Wildlife Management

62:1135-1142.

Abstract: Requests to increase military aircraft activity in some training facilities in the United States have raised the need to determine if waterfowl and other wildlife are adversely affected by aircraft disturbance. We hypothesized that habituation was a possible proximate factor influencing the low proportion of free-ranging ducks reacting to military aircraft activities in a training range in coastal North Carolina during winters 1991 and 1992. To test this hypothesis, we subjected captive, wild-strain American black ducks (Anas rubripes) and wood ducks (Aix sponsa) to actual and simulated activities of jet aircraft. In the first experiment, we placed black ducks in an enclosure near the center of aircraft activities on Piney Island, a military aircraft target range in coastal North Carolina. The proportion of times black ducks reacted (e.g., alert posture, fleeing response) to visual and auditory aircraft activity decreased from 38 to 6% during the first 17 days of confinement. Response rates remained stable at 5.8% thereafter. In the second experiment, black ducks and wood ducks were exposed to 6 different recordings of jet noise. The proportion of times black ducks reacted to noise decreased ($P < 0.05$) from first day of exposure (25%) to last (i.e., day 4; 8%). Except for a 2% difference in comfort, we detected no differences ($P > 0.05$) in time-activity budgets of black ducks between pre-exposure to noise and 24 hr after first exposure. Unlike black ducks, wood duck responses to jet noise did not decrease uniformly among experimental groups following initial exposure to noise ($P = 0.01$). We conclude that initial exposure to aircraft noise elicits behavioral responses from black ducks and wood ducks. With continued exposure of aircraft noise, black ducks may become habituated. However, wood ducks did not exhibit the same pattern of response, suggesting that the ability of waterfowl to habituate to aircraft noise may be species specific.

Conrad, W. B., Jr. 1965. A food habits study of ducks wintering on the lower Pee Dee and Waccamaw Rivers, Georgetown, South Carolina. Proceedings of the Annual Conference of Southeastern Association of Game and Fish Commissions 19:93–98.

* Conrad, K. F. 1993. Assessment of the Antigonish River estuary black duck data. Unpublished Report, Environment Canada's Canadian Wildlife Service Atlantic Region.

* Conroy, M., C. J. Fonnesbeck, and N. L. Zimpfer. 2005. Modeling regional waterfowl harvest rates using Markov chain Monte Carlo. Journal of Wildlife Management 69:77–90.

Abstract: We developed models for simultaneous inference on movement and harvest rates, and of factors influencing harvest rates, using band-recovery data and Markov chain Monte Carlo (MCMC) modeling. We modeled variation in harvest rates for American black ducks (*Anas rubripes*) (1971-1994 using recoveries of ducks banded in 3 breeding regions and recovered in 6 harvest regions in Canada and the United States. Models based on season length or bag limit together with season length, and incorporating a random year- and area-specific effect, were superior to other models as gauged by information criteria, fit statistics, and cross-validation. We used these models to generate Posterior predictive distributions for harvest rates as a function of harvest regulations, for application to adaptive harvest management.

Conroy, M. J., and D. G. Krementz. 1986. Incorrect inference regarding the effects of hunting on survival of American black ducks. Wildlife Society Bulletin 14:326–328.

Conroy, M. J., and D. G. Krementz. 1990. A review of the evidence for the effects of hunting on American black duck populations. Transactions of the North American Wildlife and Natural Resources Conference 55:501–517.

Conroy, M. J., G. G. Barnes, R. W. Behke, and T. D. Nudds. 1989. Increasing mallards, decreasing American black ducks—no evidence for cause and effect: A comment. Journal of Wildlife Management 53:1065–1071.

Abstract: Ankney et al. (1987) described an apparent association between the relative abundances of American black duck (*Anas rubripes*) × mallard (*A. platyrhynchos*) hybrids and those of mallards and black ducks, based on harvest and breeding pairs data. They concluded that increases in mallard numbers cause declines in black duck populations, and dismissed habitat change and overhunting as factors contributing to the same. We believe that these conclusions are premature and that their hypothesis of introgressive hybridization as the cause of black duck population decline is not supported by their data. We conclude that other factors, including habitat loss and overhunting, cannot be dismissed as contributing to the decline of black duck populations.

Conroy, M. J., G. R. Costanzo, and D. B. Stotts. 1987. Winter movements of American black ducks in relation to natural and impounded wetlands in Jew Jersey. Pages 31–43 *in* W. R. Whitman and W. H. Meredith, editors. Proceedings of a symposium on waterfowl and wetlands management in the coastal zone of the Atlantic Flyway. Delaware Coastal Management Program, Dover, DE USA.

Conroy, M. J., G. R. Costanzo, and D. B. Stotts. 1989. Winter survival of female American black ducks on the Atlantic coast. Journal of Wildlife Management 53:99–109.

Abstract: We used radio telemetry to monitor the winter survival and cause-specific mortality of 227 female American black ducks (*Anas rubripes*) captured in New Jersey and Virginia, 1983-85. Mean survival rate for 19 December-15 February was 0.65. Survival from hunting and nonhunting risk was 0.84 and 0.78, respectively. Causes of nonhunting mortality included predation and emaciation (winter stress). After-hatch-year (AHY) ducks had a higher probability of survival than hatch-year (HY) ducks (0.73 vs. 0.60); most of this difference was related to survival from nonhunting risk. After-hatch-year ducks with body masses ≥ median had a higher survival probability (0.85) than AHY ducks with median body masses (0.61) because of differential survival from hunting risk. Hatch-year ducks had lower body mass than AHY ducks, but among HY ducks body mass was not related to survival. There were no consistent patterns in survivorship in relation to mean daily temperature, although the timing of the onset of low temperatures and storms may have influenced movement patterns. Our estimated survival rates are consistent with estimates from other studies of seasonal and annual survival. It may be possible to manage habitats for population segments at high risk (HY and low body mass birds), and increase black duck survivorship.

Conroy. M. J., J. R. Goldsberry, J. E. Hines, and D. B. Stotts. 1988. Evaluation of aerial transect surveys for wintering American black ducks. Journal of Wildlife Management 52:694–703.

Abstract: We used an experimental aerial transect survey with stratified random sampling, to estimate the size of the population of wintering black ducks (*Anas rubripes*) in coastal New Jersey during 2 winters, and the coastal Atlantic Flyway (Me. to S.C.) during 4 years. Population estimates were precise (CV 0.20) on a flyway basis, whereas individual strata (states) had coefficients of variation of 0.16-0.71. Population estimates agreed with the conventional mid-winter waterfowl surveys (MWS) for all 4 years (MWS within 95% CI of N). We recommend continuing these surveys to provide precise and statistically defensible population estimates for black ducks. Additional improvements in precision may be achieved using recent developments in estimation such as Bayesian techniques. Techniques to decrease bias through air-ground comparisons are likely to be expensive and will require more

development. Air-ground comparisons can probably be justified if there is a demonstrable need for an estimate of the absolute size of the black duck population versus an index.

* Conroy, M. J., M. W. Miller, and J. E. Hines. 2002. Identification and synthetic modeling of factors affecting American black duck populations. Wildlife Monographs 150.

Abstract: We reviewed the literature on factors potentially affecting the population status of American black ducks (*Anas rupribes*). Our review suggests that there is some support for the influence of 4 major, continental-scope factors in limiting or regulating black duck populations: 1) loss in the quantity or quality of breeding habitats; 2) loss in the quantity or quality of wintering habitats; 3) harvest, and 4) interactions (competition, hybridization) with mallards (*Anas platyrhychos*) during the breeding and/or wintering periods. These factors were used as the basis of an annual life cycle model in which reproduction rates and survival rates were modeled as functions of the above factors, with parameters of the model describing the strength of these relationships. Variation in the model parameter values allows for consideration of scientific uncertainty as to the degree each of these factors may be contributing to declines in black duck populations, and thus allows for the investigation of the possible effects of management (e.g., habitat improvement, harvest reductions) under different assumptions. We then used available, historical data on black duck populations (abundance, annual reproduction rates, and survival rates) and possible driving factors (trends in breeding and wintering habitats, harvest rates, and abundance of mallards) to estimate model parameters. Our estimated reproduction submodel included parameters describing negative density feedback of black ducks, positive influence of breeding habitat, and negative influence of mallard densities; our survival submodel included terms for positive influence of winter habitat on reproduction rates, and negative influences of black duck density (i.e., compensation to harvest mortality). Individual models within each group (reproduction, survival) involved various combinations of these factors, and each was given an information theoretic weight for use in subsequent prediction. The reproduction model with highest AIC weight (0.70) predicted black duck age ratios increasing as a function of decreasing mallard abundance and increasing acreage of breeding habitat; all models considered involved negative density dependence for black ducks. The survival model with highest AIC weight (0.51) predicted nonharvest survival increasing as a function of increasing acreage of wintering habitat and decreasing harvest rates (additive mortality); models involving compensatory mortality effects received ≈0.12 total weight, vs. 0.88 for additive models. We used the combined model, together with our historical data set, to perform a series of 1-year population forecasts, similar to those that might be performed under adaptive management. Initial model forecasts over-predicted observed breeding populations by ≈25%. Least-squares calibration reduced the bias to ≈0.5% under prediction. After calibration, model-averaged predictions over the 16 alternative models (4 reproduction × 4 survival, weighted by AIC model weights) explained 67% of the variation in annual breeding population abundance for black ducks, suggesting that it might have utility as a predictive tool in adaptive management. We investigated the effects of statistical uncertainty in parameter values on predicted population growth rates for the combined annual model, via sensitivity analyses. Parameter sensitivity varied in relation to the parameter values over the estimated confidence intervals, and in relation to harvest rates and mallard abundance. Forecasts of black duck abundance were extremely sensitive to variation in parameter values for the coefficients for breeding and wintering habitat effects. Model-averaged forecasts of black duck abundance were also sensitive to changes in harvest rate and mallard abundance, with rapid declines in black duck abundance predicted for a range of harvest rates and mallard abundance higher than current levels of either factor, but easily envisaged, particularly given current rates of growth for mallard populations. Because of concerns about sensitivity to habitat coefficients, and particularly in light of deficiencies in the historical data used to estimate these parameters, we developed a simplified model that excludes habitat effects. We also developed alternative models involving a calibration adjustment for reproduction rates, survival rates, or neither. Calibration of survival rates performed best (AIC weight 0.59, % BIAS = -0.280, $R^{2}=0.679$), with reproduction calibration somewhat inferior (AIC weight 0.41, % BIAS = -0.267, $R^{2}=0.672$); models without calibration received virtually no AIC weight and were discarded. We recommend that the simplified model set (4 biological models × 2 alternative calibration factors) be retained as the best working set of alternative models for research and management. Finally, we provide some preliminary

guidance for the development of adaptive harvest management for black ducks, using our working set of models.

Conroy, M. J., and W. W. Blanding. 1984. Geographic and temporal differences in band reporting rates for American black ducks. Journal of Wildlife Management 48:23-36.

Abstract: Recoveries of reward- and standard-banded American black ducks (*Anas rubripes*) were used to estimate band reporting rates and to investigate geographic and temporal variability in reporting rate for 1978-80. Reporting rates were higher close (20 km) to the parent banding site in 3 of 42 samples and were higher close to the nearest black duck banding site in 3 of 35 samples. Reporting rates were higher (P 0.05) in Canada than in the Atlantic Flyway for the pre-hunting-season 1980-banded sample, but were otherwise similar among regions. Temporal differences over the duration of the study occurred, but there were no consistent trends over time. The small number of rejections suggests that there is little evidence of differences in band reporting rate by proximity to banding sites, geographic location, or over time. Thus, the best estimate of band reporting rate for black ducks is a constant 0.43. This estimate should be used with caution, because we believe that it overestimates reporting rate due to the unknown proportion of reward bands found that were not reported.

Convers, K. A., and G. A. Kidd. 2001. Duck plague epizootics in the United States, 1967–1995. Journal of Wildlife Diseases 37:347–357.

Abstract: In 1967, the first confirmed diagnosis of duck plague (DP) in the USA was made from pekin ducks (*Anas platyrhynchos domesticus*) on commercial duck farms on Long Island, New York. Within 10 mo, DP was confirmed as the cause of death in migratory waterfowl on a Long Island bay. This paper reviews 120 DP epizootics reported from 1967 to 1995 that involved waterfowl species native to North America or were reported in areas with free-flying waterfowl at risk. Duck plague epizootics occurred in 21 states with the greatest number reported in Maryland (29), New York (18), California (16), and Pennsylvania (13). The greatest frequency of epizootics (86%) was detected during the months of March to June. At least 40 waterfowl species were affected with the highest frequency of epizootics reported in captive or captive-reared ducks including muscovy ducks (*Cairina moschata*) (68%), mallard ducks (*A. platyrhynchos*) (18%) and black ducks (*A. rubripes*) (14%). The greatest number of waterfowl died in three epizootics that involved primarily migratory birds in 1967 and 1994 in New York (USA) and 1973 in South Dakota (USA). The greatest number of DP epizootics reported since 1967 appear to have involved flocks of non-migratory rather than migratory waterfowl; therefore, in our opinion it remains unknown if DP is epizootic in either non-migratory or migratory waterfowl.

Coppen, J. L. 1993. Time-enery budgets of American black ducks and mallards in Autumn. Master's thesis, Ohio State University, Columbus, OH USA.

Corr, P. O. 1985. Black ducks: are the stricter rules working? Maine Fish and Wildlife 27:2–5.

Costanzo, G. R. 1988. Wintering ecology of black ducks along coastal New Jersey. Ph.D. dissertation, Cornell University, Ithaca, NY USA.

Costanzo, G. R. 1990. *Sarcocystis* in American black ducks wintering in New Jersey. Journal of Wildlife Disease 26:387–389.

Costanzo, G. R., and R. A. Malecki. 1989. Foods of black ducks wintering along coastal New Jersey. Transactions of the Northeast Section of the Wildlife Society 46:7–

10.

Coulter, M. W. 1955. Spring food habits of surface-feeding ducks in Maine. Journal of Wildlife Management 19:263–267.

Abstract: Analysis was made of foods eaten by 39 wood ducks, 20 black ducks, 12 green-winged teal, and one blue-winged teal taken from March to May. Sedges (*Carex* spp.) and burreeds (*Sparganium* spp.) comprised 1/2 to 2/3 of the diet of each group of ducks. Animal material made up about 10% of food. Principal foods eaten were those most readily available during periods of high water levels.

Coulter, M. W. 1957. Predation by snapping turtles upon aquatic birds in Maine marshes. Journal of Wildlife Management 21:17–21.

Coulter, M. W., and H. E. Mendall. 1968. Northeastern states. Pages 90–101 *in* P. Barske, editor. Black duck evaluation, management, and research: a symposium. Atlantic Flyway Council and Wildlife Management Institute, Brew Printing Co., Strateford, CT USA.

Coulter, M. W., and W. R. Miller. 1968. Nesting biology of black ducks and mallards in northern New England. Vermont Fish and Game Department Bulletin 68-2, Montpellier, VT USA.

Abstract: Breeding behavior of *Anas rubripes* and *A. platyrhynchos* was observed during several studies in Maine and Vt. during 1938-1964. Nesting began during early Apr., with peak nest-building activity occurring the last half of the month. Mean size of 620 blackduck clutches was 9.5; mallards averaged 9.6 eggs per clutch. Further data on nest construction, choice of nesting cover, and renesting attempts and behavior indicates differences and similarities between species and among individuals. The information presented is discussed in relation to management of cover, predators, and human disturbance.

Cowardin, L. M. 1969. Use of flooded timber by waterfowl at the Montezuma National Wildlife Refuge. Journal of Wildlife Management 33:829–842.

Abstract: Waterfowl use of bottomland hardwood timber stands which were flooded and killed was studied at the Montezuma National Wildlife Refuge, Seneca Falls, New York, from 1962 to 1964. Comparisons of use were made among six habitat types containing dead timber, stumps, and no timber, and with and without emergent vegetation. An index to waterfowl use was derived by direct counts and by counts made with automatic cameras which photographed randomly selected plots in each habitat type. Movement between types was studied by observation of both marked and unmarked birds. The camera index of use showed that cut timber with emergent vegetation received the greatest overall use. Use was positively correlated with the proximity of the plot to emergent vegetation and nearest vegetative type boundary. A stand flooded for 7 years was used primarily by black ducks (*Anas rubripes*) and mallards (*A. platyrhynchos*). Use of stands flooded for 20 years was dominated by American widgeon (*Mareca americana*). Waterfowl spent more time resting than feeding in timbered areas, and more time feeding than resting in marsh areas. Young-of-the-year did not move between pools after they reached the age of IIc (Gollop and Marshall 1954). Use by broods was greatest in areas near emergent vegetation. Flying birds used timbered areas during the daytime and non-timbered areas at night during fall. Flooded dead timber appeared to be attractive to waterfowl because it furnished abundant loafing sites.

Cowardin, L. M., G. E. Cummings, and P. B. Reed. 1967. Stump and tree nesting by mallards and black ducks. Journal of Wildlife Management 31:229–235.

Abstract: Studies conducted 1961-65 at the Montezuma National Wildlife Refuge in New York demonstrated that mallards (*Anas platyrhynchos*) and black ducks (*Anas rubripes*) make extensive use of stumps and dead snags for nest sites. Nest densities in timbered habitats compared favorably with those in untimbered habitats. Nest success was generally higher in timbered than in untimbered areas, except for a newly flooded impoundment where nest success was poor. A simple artificial nest structure was used to increase the number of available nest sites in some of the timbered habitats. Development of stump-nesting populations of ducks may furnish a means of increasing waterfowl production in forested areas.

Daniels, B. A., and R. S. Freeman. 1976. Corrigia-obscura sp-n (*trematoda-dicrocoeliidae*) from the North American black duck. Journal of Parasitology 62:59-62.

Daury, R. W., F. E. Sschwab, and M. C. Bateman. 1993. Blood lead concentrations of waterfowl from unhunted and heavily hunted marshes of Nova Scotia and Prince Edward Island, Canada. Journal of Wildlife Diseases 29:577-581.

Abstract: Blood lead concentrations of juvenile American black ducks (*Anas rubripes*) sampled in unhunted sanctuaries of Nova Scotia (NS) and Prince Edward Island (PEI), Canada, usually were < 30 parts per billion (ppb). Based on gizzard content analyses of juvenile American black ducks from hunted areas, eight (24%) of 33 flightless birds contained ingested lead shot. Blood lead concentrations were > or = 100 ppb in seven of eight juveniles with ingested shot; thus we adopted blood lead concentrations 100 ppb as our threshold indicating exposure to non-background lead. The proportion of both American black ducks and ring-necked ducks (*Aythya collaris*) with elevated blood lead concentrations (> 100 ppb) exceeded 5% in hunted areas sampled in NS and PEI combined. The Canadian Wildlife Service draft policy is to consider replacing lead shot with non-toxic shot for waterfowl and snipe hunting if 5% of American black ducks exceed a blood lead concentration of 200 ppb. American black ducks significantly ($P < 0.05$) exceeded this threshold but ring-necked ducks did not. The source of lead in hunted areas may have been lead shot; we recommend that it be eliminated and replaced by an acceptable non-toxic shot for waterfowl hunting. Twenty four (96%) of 25 of American black ducks overwintering in Sullivans Pond, Dartmouth, NS, contained elevated (> 100 ppb) blood lead concentrations and 19 (76%) had detrimental concentrations (> 200 ppb). We believe that the source of lead at Sullivans Pond was automobile emissions.

Daury, R. W., F. E. Schwab, and M. C. Bateman. 1994. Prevalence of ingested lead shot in American black duck (*Anas rubripes*) and ring-necked duck (*Aythya collaris*) gizzards from Nova Scotia and Prince Edward Island, Canada. Canadian Field-Naturalist 108:26-30.

Dejonghe, J. F. 1981. Analyse des observations d' *Anas discors*, *Anas rubripes* et Calidris minutilla dansl'ancien monde. Alaude 49:250–271.

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Dennis, D. 1987. American black duck. Pages 70–71 *in* M. d. Cadman, P. f. J. Eagles, and F. M. Helleiner, editors. Atlas of the breeding birds of Ontario. University of Waterloo Press, Waterloo, ON Canada.

Dennis, D. B., K. L. Fisher, and G. B. McCulloch. 1984. The change in status of mallards and black ducks in southwestern Ontraio. Pages 27–30 in S. G. Curtis, D. G.

Dennis, and H. Boyd, editors. Waterfowl studies in Ontario, 1973–81. Canadian Wildlife Service Occasional Papers No. 54.

* D'Eon, R. G. 1992. Mallard-black duck behavioural interactions in relation to hybridization Thesis, University of New Brunswick, Fredericton, NB, Canada.

* D'Eon, R. G., N. R. Seymour, G. E. Newsome and A. H. Boer. 1995. A mallard, *Anas platyrhynchos*, increase in the Maritimes: Implications to black ducks *A. rubripes*. Canadian Field-Naturalist 109:459-462.

* D'Eon, R. G., N. R. Seymour, and H. B. Arnold. 1994. Black duck-mallard interactions in relation to hybridization. Canadian Journal of Zoology 72:1517–1521.

DesGranges, J., and C. Gagnon. 1991. Duckling response to changes in the trophic web of acidified lakes. Aquatic Birds in the Trophic Web of Lakes. Proceedings of a Symposium Held in Sackville, NB, Canada. Hydrobiologia 279/280:207–221.

DesGranges, J. –L., and J. Rodrigque. 1986. Influence of acidity and competition with fish on the development of ducklings in Quebec. Water, Air, and Soil Pollution 30:743–750.

DesGranges, J. -L., and M. Darveau. 1985. Effect of lake acidity and morphometry on the distribution of aquatic birds in southern Quebec. Holarctic Ecology 8:181–190.

Abstract: More than half the lakes in the deciduous and boreal forest regions of southern Quebec harbour at least one aquatic bird species during the nesting period. Although the number of nesting pairs per lake is generally small, those pairs are most commonly seen on lakes with a surface area of more than 15 ha, a winter pH lower than that of normal rain (i.e, < 5.6). an irregular shore configuration marked by abundant riparian vegetation, and islands. In a correspondence analysis, the first axis, representing lake acidity, explains 68% of the total variance. The common goldeneye, *Bucephala clangula*, which is frequently seen on the most acidic lakes, and the American black duck, *Anas rubripes*, which tends to avoid acidic lakes, show the largest contributions to that axis. The second axis describes an altitude/surface area gradient and brings the cumulative percentage of explained total variance to 94%; the great blue heron, *Ardea herodias,* and the common loon Gavia immer primarily use large, low-altitude lakes, whereas the ring-necked duck, *Aythya collaris,* and the American black duck are often found on the smaller, higher-altitude lakes. Those results are discussed as they relate to the feeding requirements of the various species of bird and the biology of their main prey. The ecological segregation of the three waterfowl species is attributed to interspecific competition.

Desgranges, J. -L., and M. L. Hunter. 1987. Duckling responses to lake acidification. Transactions of the North American Wildlife and Natural Resources Conference 52:636–644.

Diefenbach, D. R., J. D. Nichols, and J. E. Hines. 1988. Distribution patterns of American black duck and mallard winter band recoveries. Journal of Wildlife Management 52:704-710.

Abstract: We compared the distribution patterns of winter band recoveries of American black ducks (*Anas rubripes*) and mallards (*A. platyrhynchos*) banded in the same breeding areas. Young black ducks wintered northeast of young mallards but no differences in distribution patterns were detected between adult birds of the 2 species. Mallards exhibited greater temporal variation in distribution patterns and less fidelity to wintering areas. We speculate that these differences in distribution patterns are related to different behavioral responses by mallards and black ducks to variation in resource availability. Black ducks may reduce energy expenditure during periods of extreme cold and wait for conditions to improve, whereas mallards may migrate to areas that are warmer or where more food is available. The availability of quality habitat may be critical to the survival of black ducks during harsh weather conditions because of their relative lack of migrational flexibility, whereas mallards may be able to respond by migrating to favorable environments.

Diefenbach, D. R., and R. B. Owen, JR. 1989. A model of habitat use by breeding American black ducks. Journal of Wildlife Management 53:383-389.

Abstract: We developed a linear-logistic model of habitat use for American black ducks (*Anas rubripes*) breeding in Maine during 1986 and 1987. The model predicted wetland use by black ducks using perimeter of surface water, area of flooded timber, presence or absence of beaver (*Castor canadensis*), and visibility of an occupied, human dwelling. The model was robust and had an overall correct-classification rate of 80%. Wetlands influenced by beaver provided quality habitat for black ducks; the management of beaver populations possibly affects quantity and quality of waterfowl habitat. An increase in housing developments could have an adverse effect on the quality of wetland habitats for black ducks in Maine.

Di Giulio, R. T., and P. F. Scanlon. 1984. Heavy metals in tissues of waterfowl from the Chesapeake Bay, USA. Environmental Pollution (Series A) 35:29–48.

Dwyer, C. P. 1992. The breeding ecology of sympatric female mallards, *Anas platyrhynchos*, and American black duck, *A. rubripes*, in a forested environment. Thesis, State University of New York, College of Environmental Science and Forestry, Syracuse, NY, USA.

Dwyer, C. P., and G. A. Baldassarre. 1993. Survival and nesting success of sympatric female mallards *Anas platyrhynchos*, and American black ducks, *A. rubripes*, breeding in a forested environment. Canadian Field-Naturalist :213-216.

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Edinger, B. 2000. Wetland and riparian birds of West Virginia: status, future research and guidelines for constructed wetlands. Proceedings of the West Virginia Academy of Sciences 72:4–5.

Abstract: Birds, along with amphibians, are excellent vertebrate indicators of wetland functioning and values. Wetland birds, often specialist predators high on the food web, indicate an intact trophic

pyramid. They are also sensitive to vegetation type and other landscape parameters. The absence or rarity of wetland birds can indicate problems with wetland quantity or quality. To determine the status of West Virginia's wetland birds, a review of existing records (Hall, 1983; Buckelew and Hall, 1994; lists assembled by bird clubs and state and federal agencies, etc.) and of conservation and management sources (journal articles, Partners in Flight Abstracts of The Nature Conservancy, Birds of North America, etc.) was conducted. Also, from 1996 through 1999, plot censuses of six natural and created wetland habitats in north-central West Virginia and similar studies in riparian communities along five rivers, allowed up to date (if local) data on wetland bird densities. This study provides an overview of the general status of wetland bird communities, important wetland habitat characteristics, long-term population changes, problematic wetland species, recommendations for future wetland bird research, and recommendations for constructed wetlands. West Virginia wetland communities are riverine, lacustrine (reservoirs and lakes), and palustrine (wet meadow, emergent, shrub-scrub, forested, and beaver pond) systems, and the bird community varied from one wetland type to another. For example, isolated and ephemeral beaver ponds, support a high diversity of secondary cavity nesters (high quantity of snags) and black ducks (possibly lessened competition with ma1lards who threaten hybridization and genetic swamping). Wetlands lacking a shrub layer, either naturally or because a constructed wetland was in an early stage of succession, lacked species such as Empidonax flycatchers. In sum, West Virginia's wetland bird species were sensitive to surrounding habitat, type of wetland vegetation, proportion and depth of open water, and availability of mud margin. Threats to wetland-dependent birds in West Virginia continue to be habitat fragmentation, loss, and degradation. Quantified, long-term studies of breeding and non-breeding bird usage of some of West Virginia's larger wetlands are needed to adequately assess population trends. Breeding Bird Survey studies poorly monitor wetland species. At the same time, given the high diversity of migratory wetland birds found in some West Virginia wetlands, additional research is needed into the value of these wetlands, despite their sma11 size, as stopover sites for migratory species. Ecotonal and seasonal use of wetlands by "non-wetland" bird species is a third area needing attention. In the same way red-shouldered hawks have territories that allow feeding in forested wetlands, but are also found in other habitats, several other species of birds may be found to have "habitat mosaic" needs that include wetlands. Finally, since constructed wetlands are a growing part of the wetland mix in West Virginia, mitigation wetlands can be improved as wetland bird habitat if they are sufficiently large, hydrologically joined to rivers, allowed to undergo wetland succession to develop shrub-scrub and organic soils, and surrounded by plant communities complementary to the needs of wetland bird species.

Erwin, M. R., G. M. Sanders, D. J. Prosser, D. R. Cahoon. 2006. High tides and rising seas: potential effects on estuarine waterbirds. Studies in Avian Biology 32:214–228.

Abstract: Coastal waterbirds are vulnerable to water-level changes especially under predictions of accelerating sea-level rise and increased storm frequency in the next century. Tidal and wind-driven fluctuations in water levels affecting marshes, their invertebrate communities, and their dependent waterbirds are manifested in daily, monthly, seasonal, annual, and supra-annual (e.g., decadal or 18.6-yr) periodicities. Superimposed on these cyclic patterns is a long-term (50-80 yr) increase in relative sea-level rise that varies from about 2-4 + mm/yr along the Atlantic coastline. At five study sites selected on marsh islands from Cape Cod, Massachusetts to coastal Virginia, we monitored marsh elevation changes and flooding, tide variations over time, and waterbird use. We found from long- term marsh core data that marsh elevations at three of five sites may not be sufficient to maintain pace with current sea-level rise. Results of the short-term (3-4 yr) measures using surface elevation tables suggest a more dramatic difference, with marsh elevation change at four of five sites falling below relative sea-level rise. In addition, we have found a significant increase (in three of four cases) in the rate of surface marsh flooding in New Jersey and Virginia over the past 70-80 yr during May-July when waterbirds are nesting on or near the marsh surface. Short-term, immediate effects of flooding will jeopardize annual fecundity of many species of concern to federal and state agencies, most notably American black duck (*Anas rubripes*), Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni*), Saltmarsh Sharp-tailed Sparrow (*A. caudacutus*), Seaside Sparrow (*A. maritima*), Coastal Plain Swamp Sparrow (*Melospiza georgiana nigrescens*), black Rail (*Laterallus jamaicensis*), Forster's Tern (*Sterna forsteri*). Gull-billed Tern (*S. nilotica*), black Skimmer (*Rynchops niger*), and American Oystercatcher (*Haemotopus*

palliatus). Forster's Terns are probably most at risk given the large proportion of their breeding range in the mid-Atlantic and their saltmarsh specialization. At a scale of 1-2 decades, vegetation changes (saltmeadow cordgrass [*Spartina patens*] and salt grass [*Distichlis spicata*] converting to smooth cordgrass [*Spartina alterniflora*]), interior pond expansion and erosion of marshes will reduce nesting habitat for many of these species, but may enhance feeding habitat of migrant shorebirds and/or migrant or wintering waterfowl. At scales of 50-100 yr, reversion of marsh island complexes to open water may enhance populations of open-bay waterfowl, e.g., Bufflehead (*Bucephala albeola*) and Canvasback (*Aythya valisneria*), but reduce nesting habitats dramatically for the above named marsh-nesting species, may reduce estuarine productivity by loss of the detrital food web and nursery habitat for fish and invertebrates, and cause redistribution of waterfowl, shorebirds, and other species. Such scenarios are more likely to occur in the mid- and north Atlantic regions since these estuaries are lower in sediment delivery on average than those in the Southeast. A simple hypothetical example from New jersey is presented where waterbirds are forced to shift from submerged natural marshes to nearby impoundments, resulting in roughly a 10-fold increase in density. Whether prey fauna are sufficiently abundant to support this level of increase remains an open question, but extreme densities in confined habitats would exacerbate competition, increase disease risk, and possibly increase predation.

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Finley, M. T., and R. C. Stendell. 1978. Survival and reproductive success of black ducks fed methyl mercury. Environmental Pollution 16:51–64.

Abstract: A diet containing 3 ppm mercury was fed to black ducks (*Anas rubripes*) for periods of 28 weeks during two consecutive breeding seasons. Clutch size, egg production, number of eggs incubated, hatchability, and survival of ducklings were lower during both years in hens fed mercury. Reduced hatchability and poor ducking survival were the most harmful effects. During 2 years, 13 pairs of breeders fed mercury produced only 16 ducklings that survived 1 week compared with 73 ducklings from 13 pairs of controls. Mercury residues in eggs, embryos, and ducklings averaged about 30% lower during the secnd breeding season compared with the first year results. Third eggs laid by treated hens contained a mean of 6.14 and 3.86 ppm mercury during the first and second years. Whole embryos that failed to hatch contained means of 9.62 and 6.08 ppm mercury during the first and second years. Brans of dead ducklings contained between 3.25 and 6.98 ppm mercury and exhibited lesions characteristic of mercury poisoning. Relative tissue mercury levels for treated adult breeders were: feathers greater than liver greater than kidney greater than breast muscle greater than brain. Mercury levels in males and females did not differ.

* Foonesbeck, C. J., and M. J. Conroy. 2004. Application of integrated Bayesian modeling and Markov chain Monte Carlo methods to the conservation of a harvested species. Animal Biodiversity and Conservation 27:267–281.

Abstract Application of integrated Bayesian modeling and Markov chain Monte Carlo methods to the conservation of a harvested species.- When endeavoring to make informed decisions, conservation biologists must frequently contend with disparate sources of data and competing hypotheses about the likely impacts of proposed decisions on the resource status. Frequently, statistical analyses, modeling (e.g., for population projection) and optimization or simulation are conducted as separate exercises. For example, a population model might be constructed, whose parameters are then estimated from data (e.g., ringing studies, population surveys). This model might then be used to predict future population states, from current population estimates, under a particular management regime. Finally, the parameterized model might also be used to evaluate alternative candidate management decisions, via

simulation, optimization, or both. This approach, while effective, does not take full advantage of the integration of data and model components for prediction and updating; we propose a hierarchical Bayesian context for this integration. In the case of American black ducks (*Anas rubripes*), managers are simultaneously faced with trying to extract a sustainable harvest from the species, while maintaining individual stocks above acceptable thresholds. The problem is complicated by spatial heterogeneity in the growth rates and carrying capacity of black ducks stocks, movement between stocks, regional differences in the intensity of harvest pressure, and heterogeneity in the degree of competition from a close congener, mallards (*Anas platyrynchos*) among stocks. We have constructed a population life cycle model that takes these components into account and simultaneously performs parameter estimation and population prediction in a Bayesian framework. Ringing data are used to develop posterior predictive distributions for harvest mortality rates, given as input decisions about harvest regulations. Population surveys of black ducks and mallards are used to obtain stock-specific estimates of population size for both species, for inputs into the population life-cycle model. These estimates are combined with the posterior distributions for harvest mortality, to obtain posterior predictive distributions of future population status for candidate sets of regional harvest regulations, under alternative biological hypotheses for black duck population dynamics. These distributions might then be used for both the exploration of optimal harvest policies and for sequential updating of model posteriors, via comparison of predictive distributions to future survey estimates of stock-specific abundance. Our approach illustrates advantages of MCMC for integrating disparate data sources into a common predictive framework, for use in conservation decision making.

* Francis, C. M., J. R. Sauer, and J. R. Serie. 1998. Effect of restrictive harvest regulations on survival and recovery rates of American black ducks. Journal of Wildlife Management 62:1544-1557.

Abstract: Population management of waterfowl requires an understanding of the effects of changes in hunting regulations on harvest and survival rates. Mean survival and recovery rates of American black ducks (*Anas rubripes*) were estimated during 3 periods of increasingly restrictive harvest regulations: 1950-66, 1967-82, and 1983-93. From the first to the second period, direct recovery rates declined for at least 1 age class in 4 of 6 reference areas, with a mean decline of 14% for adult and 7% for immature black ducks. From the second to the third period, direct recovery rates declined in all areas, declines averaging 37% for adults and 27% for immatures. Estimated mean survival rates increased from the first to the second period, consistent with a model of additivity of hunting mortality. Limited evidence existed for increases in survival rates from the second to the third period for immature males. For adults, however, survival increased less between these periods than would be expected if hunting mortality were additive and changes in recovery rates were proportional to changes in hunting mortality. Changes in survival and recovery rates of black ducks banded postseason were similar to those of adults banded preseason. Comparisons among estimates by degree blocks of latitude and longitude indicate that, at least between 1967 and 1983, estimated survival rates of immature and adult black ducks were lower in areas with high direct recovery rates. Smaller samples of banded birds and changes in banding locations in recent years may be limiting ability to evaluate consequences of recent changes in harvest rates. These correlation-based studies are limited in their ability to explain causes of observed changes in survival rates, suggesting the need for alternative approaches such as adaptive harvest management to increase understanding of the effects of hunting on black duck populations.

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Abstract: We examined habitat use by 112 postfledging American black ducks (*Anas rubripes*) in eastern Maine and southwestern New Brunswick from September through early December of 1985, 1986, and 1987. Ducks were captured on Moosehorn National Wildlife Refuge (NWR), Maine. Palustrine Emergent Wetland was the most preferred habitat type. Riverine habitats were avoided in September, but were used more than, or in proportion to, their availability in November as ice formed on lentic habitats. Black ducks used a greater variety of habitat types during the day than at night, when ducks used mostly large (30 ha) Emergent Wetland marshes. Managed impoundments of Moosehorn NWR were the most used wetlands (66% of all diurnal, 90% of all nocturnal locations). For black duck management, we propose maintaining large (30-50 ha) marshes containing dense emergent vegetation that are located near a complex of diverse wetland types.

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Golden, N. H. 2003. Monitoring of organic and heavy metal contaminants in wildlife: nonlethal methods and species selection. University of Maryland, College Park, MD, USA.

Abstract: This investigation explores the selection of species and endpoints for monitoring contaminants in wildlife, and investigates the use of a specific sampling matrix-the feather-to assess dietary exposure to metallic and organic pollutants in a minimally invasive manner. Feather and blood samples of nestling black-crowned night-herons (*Nycticorax nycticorax*) collected from Pea Patch Island, Delaware revealed elevated concentrations of aluminum, barium, iron, lead, magnesium, manganese, and mercury when compared to samples from Baltimore Harbor and Holland Island, Maryland (reference site). Because of its known deleterious effects on wildlife and the lack of controlled study in species other than waterfowl, lead was chosen from among these elements for further investigation into its distribution and effects in nestling Bcnhs experimentally dosed in the field. Lead accumulated in feathers of 15-day old herons following intraperitoneal exposure ten days prior, and levels in feathers showed strong correlation with values in other internal organs. Furthermore, lead concentrations in feathers were associated with delta-aminolevulinic acid dehydratase depression and reduced tarsus growth rate. in a companion study, activity of cytochrome P450, a biomarker of organic contaminant exposure, was measured in developing feathers of mallards (*Anas platyrhynchos*) and black ducks (*Anas rubripes*) treated with beta-napthoflavone, a known inducing agent. All methods of measuring induction in feather pulp (i.e., traditional enzyme assays, immunoblotting, and immunohistochemistry) gave results that corresponded with the incidence of induction in liver. Immunohistochemical staining proved to be a valid method of assessing P450 activity in a single wing, body, or tail feather, and was successfully used to detect induction in osprey tail feathers collected from a polluted site. Finally, indices were created to assess the utility of terrestrial vertebrate species in the biomonitoring of persistent organic pollutants, cholinesterase-inhibiting pesticides, mercury, lead shot, and petroleum crude oil, and to predict their vulnerability to each of these contaminants. Twenty-five species occurring on the North American Atlantic coast were ranked for each contaminant or contaminant class using Utility and Vulnerability Indices, incorporating elements of exposure potential, geographic occurrence, ease of collection, history of use in contaminant monitoring, sensitivity, and resilience of population.

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Abstract: During winters of 1985-88, we conducted fixed-wing aerial surveys of randomly selected 200- × 400-m plots along the coast of South Carolina to evaluate relative use of managed coastal impoundments and unimpounded tidal wetlands by 7 species of wintering dabbling ducks. In general, occurrence of dabbling ducks in managed coastal wetland impoundments was greater (P 0.005) than expected, and occurrence in unmanaged tidal wetlands was less (P 0.005) than expected for all species except American black ducks (*Anas rubripes*). Macrohabitat variables varied in frequency of association, direction and degree of influence, and yearly occurrence as correlates with dabbling duck abundance, but several consistent patterns emerged. Most species-abundance indices exhibited a frequent positive association with macrohabitat variables descriptive of managed wetland impoundments. We discuss possible explanations for observed dabbling duck-habitat associations and implications for maintaining intensively managed coastal impoundments to support regional waterfowl populations, particularly in highly altered coastal landscapes.

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Abstract: The authors modified conventional, funnel-entrance dabbling duck bait traps to increase captures for banding of American black ducks (*Anas rubripes*) in tidal saltmarsh habitats of Smith Island, Maryland, one of the few remaining strongholds for breeding black ducks in Chesapeake Bay. Traps and trapping techniques were adapted to tidal creeks and refined to improve capture rate, reduce mortality, and minimize interference by gulls. Best results were achieved by synchronizing trapping with predawn, low-tide foraging patterns of black ducks. Trap entrances were critical to retaining ducks, and use of loafing platforms reduced overall mortality to three percent of captures per year. The authors captured 3071 black ducks during the 14-year period, 1984-1997.

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Abstract: The food habits of black ducks (*Anas rubripes*) and the abundance and distribution of invertebrate food organisms were studied in the Penobscot Estuary, Maine, during the fall and winter of 1958-60 on mud flats and tidal marshes. Animal material, chiefly clams, constituted the bulk of the foods eaten. Other prominent animal items were snails and amphipods. Vegetable foods were more important in tidal-marsh habitat than on mud flats. Cordgrasses, primarily stems and leaves, were the principal vegetable food. A definite relationship existed between the availability of food organisms and the kinds of foods consumed by black ducks. The mud flats containing the largest numbers of clams usually attracted the largest numbers of feeding ducks. Feeding areas of vital importance consisted of small portions of mud flats that remained ice-free during periods of severe icing. These areas were emergency feeding spots for the ducks. In a management plan for black ducks in an estuary, it is important that mud flats heavily utilized by feeding ducks, and emergency feeding spots, be preserved. It is suggested that these essential areas can best be identified by direct observation.

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Abstract: A technique for heart rate biotelemetry transmitter implantation was developed to monitor heart rate fluctuations of Black Ducks (*Anas rubripes*) in response to simulated aircraft noise in a large outdoor enclosure. A dorsal subcutaneous approach, with subcutaneous tunneling of lead wires, was employed for placement of the 32 g transmitters. A base-apex lead configuration, with leads anchored at the dorsal cervico-thoracic junction and the caudal keel, yielded the maximal ECG wave-form deflection for triggering the transmitter. Heart rates of six Black Ducks (three in each of two separate trials) were monitored for 3 days pre-noise to establish a baseline, and then for 4 days of simulated aircraft noise. The noise stimulus replicated an FB-111 military jet, and was played 48 times per day at a peak volume of 110 dB. Daily mean heart rates, used as indicators of metabolic rates, did not increase in response to noise. Recognizable acute heart rate increases corresponding with a noise event occurred with increased frequency during the first day of noise presentation, but on subsequent days the responses did not differ significantly from baseline. Acute heart rate responses to aircraft noise diminished rapidly, indicating the ability of Black Ducks to habituate to the auditory component of low altitude aircraft overflights.

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Abstract: I used captive young and adult American Black Ducks (*Anas rubripes*) during October-February 1984-1985 to test whether body weight and age affected time of pair-bond formation. Eighty ducks were marked individually, and 10 ducks (6 males and 4 females, half of each age class) were assigned to each of 8 experimental pens. Ducks in 4 pens received an ad libitum diet of commercial duck food, and ducks in the other 4 pens received a restricted ration of the same food. During early winter ducks in both groups gained weight, but ducks on the restricted diet gained less than birds on the ad libitum diet; peak winter weight of ducks on the ad libitum diet averaged 22% greater than initial body weight compared with 6.5% for ducks on the restricted diet. In late winter ducks on the restricted diet lost 28.7% of peak winter weight, and ducks on the ad libitum diet lost 19.3%. Weight loss of ducks on the ad libitum diet began before weather conditions became severe and coincided with a reduction in food consumption. This result supports the idea that weight loss of waterfowl in late winter is controlled endogenously. Individuals on the ad libitum diet paired earlier than those on the restricted diet, and pair bonds were stronger. Adults of both sexes paired earlier than young ducks, but differences for females were not significant statistically. Age and energy constraints are factors that can affect intraspecific variation in pairing chronology.

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Abstract: Aggressive behavior of six species of dabbling ducks was studied from November through February in 1978-1979 and 1979-1980, to investigate effects of dominance on distribution of sexes. Eighty-nine percent of aggressive interactions (n = 1,266) were intraspecific. Rate and intensity of aggression remained approximately stable throughout winter. Sex, pair status and aggressiveness influenced dominance rank. Individuals initiating conflicts usually won the encounters. In intraspecific interactions, males dominated females when both were either paired or unpaired, but paired individuals dominated unpaired individuals regardless of sex. Early pair-formation may be advantageous in wintering dabbling ducks because the resulting higher dominance may give better access to food. Sex ratios differed among the six species. Males predominated in all species; however, species that formed pair bonds early in the winter had less disparate sex ratios than species pairing later. Differences in sex

ratios among species may have been in response to the influence that pair status had on dominance rank. Paired females were more dominant than unpaired females and were protected by their mates from engaging in aggressive encounters. Females of late-pairing species remained subordinate for a greater proportion of the fall and winter. We suggest that females of late-pairing species are more likely to be excluded from preferred feeding sites, which may necessitate moving to other areas. These results support the hypothesis that behavioral dominance influences differential distribution of males and females during the nonbreeding period.

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Abstract: During the past 100 years, the status of the mallard (*Anas platyrhynchos*) in the Northeast has changed from that of rare migrant to major game bird, a change associated both with release of game farm stock and an eastward expansion of the mallard's breeding range. The close relationship between mallards and black ducks (*Anas rubripes*) is leading to increasing hybridization as the species come in contact, particularly in inland park situations. The black duck possesses few traits to prevent hybridization, and its continued existence as a distinct species is threatened.

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Abstract: Efforts to tailor waterfowl hunting regulations to conditions in the Atlantic Flyway have been hampered by lack of information on local breeding populations. The Atlantic Flyway Council's technical section voted at its 1987 winter meeting (Atlantic Flyway Council Technical Section, Toronto, Canada) to establish a regional waterfowl breeding survey. Consequently, an annual survey was started in 1989 and further refined in 1993 using results from 1989 to 1992. During 1993-1997, annual spring surveys of more than 1,450 randomly selected 1- kmsup2/sup plots, stratified by physiographic strata, were conducted in the Atlantic Flyway from New Hampshire to Virginia to estimate breeding populations of mallards (*Anas platyrhynchos*), American black ducks (*A. rubripes*), wood ducks (*Aix sponsa*), and Canada geese (*Branta canadensis*). Ground crews systematically surveyed all potential waterfowl habitat for these species in each plot. The adjusted mean mallard pair estimate over the 5-year period was 375,962 (range 310,299-415,182, mean SE 25,761) for the region surveyed. The estimate for black duck pairs was 31,154 (range 27,164-37,521, mean SE 4,978), and for wood duck pairs it was 240,473 (range 218,959-281,916, mean SE 25,408). Total number of Canada geese increased from 526,663 in 1993 to 892,278 in 1997. Population estimates for other species had unacceptably large standard errors.

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Abstract: Although the American black duck (*Anas rubripes*) has been designated a priority species in eastern North America, no systematic survey has been done in the agricultural lowlands of southern Québec, where the species is suspected to be relatively abundant and cohabits with the mallard (*Anas platyrhynchos*), often considered as a competing species. During the spring of 1998 and 1999, we surveyed breeding waterfowl in 343 4-km^2 plots distributed in the lowlands of the St. Lawrence Valley and Lac-Saint-Jean, Canada, and in agricultural areas of Abitibi-Témiscamingue, Canada. American black duck densities were higher in dairy farm and forested landscapes (>39 indicated breeding pairs [IBPs]/100 km^2) than in cropland landscapes (8 IBPs/100 km^2). Mallard densities were similar across all landscape types (30–43 IBPs/100 km^2). Habitat modeling using data derived from satellite imagery indicated that the presence of black ducks decreased with increasing areas of corn, ploughed fields, and deciduous forests, whereas it was favored in areas where topography was undulating with slopes of 10–15%. The same parameters had the opposite effect on mallard presence. The odds of black ducks being present were doubled where mallards were present, indicating that both species seem to be attracted to areas supporting adequate habitats, which contradicts the hypothesis of competition between these 2 species to explain for recent declines in the black duck population. Results of our habitat analyses support the hypothesis that habitat changes may be a primary factor leading to these declines. Dairy farm landscapes are of great importance for black ducks, and the conversion of this type of landscape toward a cropland landscape represents a threat to an important portion of the population of this species.

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Abstract: Understanding immune function in the context of other life-history traits is crucial to understand the evolution of life histories, at both the individual and species levels. As the interest in assessing immune function for these comparative purposes grows, an important question remains unanswered: can immune function be broadly characterized using one or two simple measures? Often, interpretation of individual assays is ambiguous and relationships among different measures of immune function remain poorly understood. Thus, we employed five protocols to measure 13 variables of immune function in ten species of waterfowl (Anseriformes). All assays were based on a single blood sample subdivided into leukocyte (blood smear) and plasma (frozen until analysis) components. All assays were run using samples from every individual, and a nested analysis was used to partition variation/covariation at the levels of species and individuals within species. We detected positive correlations between functionally related measures of immunity within species, but these were absent from comparisons between species. A canonical correlation analysis revealed no significant relationships between the plasma and leukocyte assays at the levels of both individual and species, suggesting that these measures of immunity are neither competitive nor synergistic. We conclude that one measure of each assay type may be required to maximally characterize immune function in studies of a single species, while the same is not true in studies among species.

* McAuley, D. G., D. A. Clugson, and J. R. Longcore. 1998. Outcome of aggressive interactions between American black ducks and mallards during the breeding season. Journal of Wildlife Management 62:134-141.

Abstract: American black duck (*Anas rubripes*) numbers have declined during the past several decades, while mallards (*A. platyrhynchos*) have expanded their range eastward. Competitive exclusion of black ducks from wetlands by mallards has been proposed as a principal cause of the decline. We studied a sympatric population of black ducks and mallards in Maine during the early breeding season to document behavior and interactions. We observed 832 aggressive interactions; most (72%) were interspecific. When a choice was available, both species interacted more often with conspecifics than with the other species (P 0.028). On wetlands occupied simultaneously by both species, numbers of intraspecific interactions initiated by each species were similar (P = 0.470). The proportions of won (initiator displaces recipient of attack), lost (initiator displaced), and "no change" outcomes of these interactions were different (P 0.001). When black ducks initiated interactions with mallards, black ducks did not lose any interactions and displaced mallards 87.2% of the time; no change occurred during 12.8% of the interactions. When mallards initiated interactions with black ducks, mallards displaced black ducks 63.3% of the time but were displaced by black ducks 15.0% of the time; no change occurred during 21.7% of the interactions. Displacement from wetlands was rare (38 of 229 interspecific interactions) and was equal between species.

* McAuley, D. G., D. A. Clugston, and J. R. Longcore. 2004. Dynamic use of wetlands by black ducks and mallards: Evidence against competitive exclusion. Wildlife Society Bulletin 32:465-473.

Abstract: The decline of the American black duck (*Anas rubripes*) has been attributed to competition from mallards (*A. platyrhynchos*) that led to exclusive use of fertile wetlands by mallards. Data from annual breeding waterfowl surveys provide instantaneous, single observations of breeding pairs, which are used to estimate breeding population size and evaluate the condition of habitat. Data from these surveys have been used to document habitat use by black ducks and mallards. We used quiet-observation surveys from elevated platforms to study sympatric black ducks and mallards in northern Maine during the breeding season. Our objectives were to document occupancy of wetlands by breeding black ducks and mallards throughout the day during prenesting and early nesting periods to determine whether 1) wetlands were occupied by only a single species, 2) pairs of the same species occupied wetlands throughout the period, and 3) single observations of short duration adequately determine numbers and species using a wetland. We observed ducks at 5-minute intervals from elevated platforms on wetland margins to determine numbers and species of indicated pairs using each wetland over time. We visited 80% of the wetlands ≥2 times, with mean total time per wetland averaging 267 minutes. For each wetland we determined the most frequently observed grouping of black ducks and mallards from all combinations recorded during all intervals (e.g., 1 black duck [BD] pair during 9 intervals; 2 mallard [MA] pairs and 1 BD pair during 22 intervals; 0 pairs during 3 intervals). A single pair, a lone male, or no ducks were recorded during 34% of the 5-minute intervals. For wetlands with ≥2 hours of observations (n=65), all but 2 were used by ≥2 different combinations of ducks. On most wetlands, the most frequent grouping was observed during <40% of the intervals. To simulate aerial surveys, we randomly selected 1 5-minute interval for each wetland. On average, the number of indicated pairs recorded during random 5-minute intervals was less than half of the total black duck pairs (2.0 vs. 4.4, P= 0.009), total mallard pairs (1.1 vs. 2.6, P=0.0001), and pairs of both species combined (3.2 vs. 7.0, P=0.0001) determined for each wetland based on total observations. On wetlands used by both species, random counts detected one or both species 49% of the time. Although 53 of the 65 wetlands observed ≥2 hours were used by both species, random visits detected both species on only 27 wetlands. Our data do not support assertions that the mallard has caused the decline of black ducks through interspecific competition for habitat, or that wetlands are occupied continuously by single pairs that aggressively exclude conspecifics. Our data indicated that single, short-duration visits with disturbance to wetlands are unreliable and inappropriate to document seasonal use of wetlands by breeding black ducks and mallards.

McCall, T. C., T. P. Hodgman, D. R. Diefenbach, and R. B. Owen, Jr. 1996. Beaver populations and their relation to wetland habitat and breeding waterfowl in Maine. Wetlands 16:163–172.

McCorquodale, D. B., and R. W. Knapton. 2003. Changes in numbers of wintering American black ducks and mallards in urban Cape Breton Island, Nova Scotia. Northeastern Naturalist 10:297-304.

McGilvrey, F. B. 1966. Fall food habits of ducks near Santee Refuge, South Carolina. Journal of Wildlife Management 30:577–580.

Abstract: During the 1961 waterfowl hunting season, 360 stomachs of 10 duck species were collected from hunters near the Santee National Wildlife Refuge, Lake Marion, South Carolina. Based on percentage of total volume, 20 of the most important foods are listed. The six most important duck species in the kill were: mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), widgeon (*Mareca americana*), pintail (*Anas acuta*), black duck (*Anas rubripes*), and green-winged teal (*Anas carolinensis*). Six plant species made up 5 percent or more of the total volume of food items found in the stomachs of all ducks. Only seeds of oaks (Quercus sp.), corn, sweet gum (*Liquidambar Styraciflua*), and button-bush (*Cephalanthus occidentalis*) were consumed. Some seed, but mostly the vegetative portions of hydrochloa (*Hydrochloa carolinensis*) and only the vegetative portions of southern rice cutgrass (*Leerisa hexandra*) were taken. The more important game ducks concentrated on the refuge farmlands when water levels were below 72 feet mean sea level (msl). When levels reached 75 feet msl, natural foods became available, ducks dispersed from refuge areas, and hunting success increased greatly.

McGilvrey, F. B. 1971. Conditioning black ducks to nest in elevated cylinders. Transactions of the Northeastern Section of the Wildlife Society 28:213–220.

McKinney, R. A., S. R. McWilliams, M.A.Charpentier. 2006. Waterfowl-habitat associations during winter in an urban north Atlantic estuary. Biological Conservation 132:239-249.

McLaughlin, J. D., and M. D. B. Burt. 1973. Changes in the cestode fauna of the black duck, Anas rubripes (Brewster). Canadian Journal of Zoology 51:1001–1006.

McNicol, D. K., B. E. Bendell, and R. K. Ross. 1987. Studies of the effects of acidification on aquatic wildlife in Canada: waterfowl and trophic relationships in small lakes in northern Ontario. Canadian Wildlife Service Occasional Papers No. 62.

McNicol, D. K., P. J. Blancher, and B. E. Bendell. 1987. Waterfowl indicators of wetland acidicfication in Ontario. International Council of Bird Preservation, Technical Publication 6:149–166.

Mehrle, P. M., M. T. Finley, J. L. Ludke, F. L. Mayer, and E. T. Kaiser. 1979. Done development in black ducks as affected by dietary toxaphene. Pesticide Biochemistry and Physiology 10:168– 173.

Mendall, H. L. 1948. Waterfowl management possibilities in Maine. Bulletin of the Maine Audubon Society 1:23–26.

Summary: Black ducks increased in 1946 on managed marshed on the Moosehorn National Wildlife Refuge, even though the population as a whole was in a decline. In 1947 they increased 70%, against a statewide increase of 25%.

Mendall, H. L. 1949. Breeding ground improvements for waterfowl in Maine. Transactions of the North American Wildlife Conference 14:58–63.

Abstract: The Maine Cooperative Wildlife Research Unit has carried on waterfowl life history and management studies since 1938, principally on the black duck and the ring-necked duck. The duck population is sparse and there is low productivity. Adverse water conditions account for most of the trouble. Extremes in water levels destroy nests directly and favor destruction of nests by predators. Marshes on the Moosehorn National Wildlife Refuge in eastern Maine were improved for ducks by stabilizing the water level and planting food.

Mendall, H. L. 1949. Food habits in relation to black duck management in Maine. Journal of Wildlife Management 13:64–101.

Abstract: "As one phase in a black duck research program, a food habits study was carried out in Maine from 1938 to 1946 inclusive. A total of 605 stomachs was collected." Maine black ducks use 3 general habitats: inland fresh water, inland tide water, and coastal water. Stomachs were collected in fall from each of these habitats, in winter from the open coastal waters, and in spring and summer from fresh waters. Food tabulations are given for each season and habitat. In fall and spring marsh and water plants predominated. Winter food and food of downy young was largely animal. Water levels are the most important factor influencing black duck food habits; other factors are food abundance, food preference, and hunting pressure.

* Merendino, M. T. 1994. The relationship between wetland productivity and the distribution of breeding mallards, black ducks, and their brood: historical and spatial analysis. Dissertation, The University of Western Ontario, ON, Canada.

Abstract: During the last 50 years mallards have increased dramatically in southern Ontario and have completely replaced black ducks in many areas. In northern Ontario, black ducks densities appear stable at present, however, mallard densities now exceed 60 pairs/100 km$/sp2$ in many areas. I examined historical and spatial distributions of mallards and black ducks in Ontario in relation to water chemistry and physical habitat characteristics. My objectives were to determine (1) if mallards invaded the most fertile wetlands, and (2) if mallards replaced black ducks on the most productive wetlands. I used Canadian Wildlife Service survey data (1971-87) to define 7 wetland categories regarding changes in mallard and black ducks distributions in southern Ontario. In northern Ontario, I used 1990-1992 breeding pair survey data to define wetlands as used by mallards only black ducks only, shared, or vacant. Habitat was evaluated based on water chemistry and physical characteristics. In southern Ontario, wetlands where mallards first appeared were, on average, more fertile than those where mallards later appeared. Wetlands where mallards first replaced black ducks were more fertile than those where black ducks were replaced later. On Canadian Wildlife Service plots in southern Ontario, black duck ducks persist only on wetlands with extremely low fertility. Major conclusions for southern Ontario: (1) Mallards did not invade southern Ontario randomly with respect to wetland fertility, but invaded the most fertile wetlands first. (2) Mallards replaced black ducks from fertile wetlands, and black ducks are now restricted to the least fertile area of southern Ontario. In north-central Ontario, mallards occupy the most fertile wetlands, with areas dominated by mallards having the most fertile wetlands. Major conclusions for northern Ontario: (1) Wetland fertility has played a major role in the distribution and abundance of mallards in north-central Ontario. (2) Areas that support the most

breeding mallards have the most productive wetlands. (3) Mallards and black ducks appear to select for similar wetland characteristics and likely compete for breeding sites. Mallards and black ducks are ecological equivalents, therefore competition for breeding sites is likely. Of the many factors suggested as causing the decline of the black ducks the mallard may be having the most significant impact.

* Merendino, M. T., and C. D. Ankney. 1994. Habitat use by mallards and American black ducks breeding in central Ontario. The Condor 96:411-421.

Abstract: Mallards (*Anas platyrhynchos*) were virtually absent from central Ontario as recently as 1948 but now exceed 60 pairs/100 kmsup2/sup in some areas. Black Duck (*A. rubripes*) numbers in central Ontario appear stable with breeding densities in some areas exceeding 40 pairs/100 kmsup2/sup. Densities of breeding Mallards and Black Ducks exhibit spatial variability suggesting that habitat quality may influence distributions. We used data from Canadian Wildlife Service breeding pair surveys to classify wetlands as used only by breeding Mallards, used only by breeding Black Ducks, shared by Mallards and Black Ducks, or vacant (i.e., not used by either species). We evaluated wetland fertility by analyzing water chemistry (color, pH, conductivity, alkalinity [CaCOsub3/sub], calcium, magnesium, sodium, potassium, total phosphorus) and physical characteristics (shoreline irregularity index [SI], percent open water, wetland size) for 447 wetlands. Wetlands that Mallards shared with Black Ducks or solely occupied were the most fertile. Vacant wetlands were least fertile. Areas that supported few Mallards or Black Ducks had relatively infertile wetlands; Mallards predominated in areas with relatively fertile wetlands. We conclude that wetland fertility has influenced the distribution of Mallards and Black Ducks in central Ontario. Mallards and Black Ducks apparently prefer wetlands with similar characteristics (i.e., high fertility, moderate open water, high SI, and small size), so competition for breeding sites is likely. Historical data from Ontario lead us to suspect that this competition may have contributed to the decline in Black Duck numbers.

* Merendino, M. T., C. D. Ankney, and D. G. Dennis. 1993. Increasing mallards, decreasing American black ducks: more evidence for cause and effect. Journal of Wildlife Management 57:199-208.

Abstract: We used Canadian Wildlife Service (CWS) survey data (1971-87) to define 7 wetland categories regarding historical changes in mallard (*Anas platyrhynchos*) and black duck (*A. rubripes*) distributions in southern Ontario to examine the hypothesis that mallards first invaded and then replaced black ducks on fertile wetlands. Wetlands were defined as: Mallards 1970's-wetlands where mallards invaded in the 1970's but were never recorded as being used by black ducks; Mallards 1980's-wetlands where mallards invaded in the 1980's but were never recorded as being used by black ducks; Black Ducks Replaced 1970's-wetlands where mallards replaced black ducks in the 1970's; Black Ducks Replaced 1980's-wetlands where mallards replaced black ducks in the 1980's; Mallards/Black Ducks-wetlands that mallards and black ducks coinhabited; Black Ducks Only-wetlands used only by black ducks; and Unused. We also evaluated water chemistry (pH, conductivity, alkalinity [CaCOsub3/sub], calcium, magnesium, sodium, potassium, and total phosphorus) and physical characteristics (shoreline irregularity index [SI], percent emergent cover, wetland size, distance to disturbance, growing degree days, and no. of wetlands in an individual survey plot) for 131 wetlands. Wetlands where mallards first appeared (e.g., Mallards 1970's) were, on average, more fertile than those where mallards later appeared. Wetlands where mallards first replaced black ducks (e.g., Black Ducks Replaced 1970's) were more fertile than those where black ducks were replaced later. On CWS plots, black ducks now persist only on wetlands with extremely low fertility. Mallards and black ducks seem able to coexist, at least temporarily, on wetlands with high amounts of emergent cover and/or SI, or in plots with many wetlands. We conclude that mallards, via competitive exclusion of black ducks from productive wetlands, have greatly contributed to the recent decline of black ducks in southern Ontario.

Merendino, M. T., C. D. Ankney and R. K. Ross. 2000. A helicopter-based survey of waterfowl broods in central Ontario. Canadian Field-Naturalist 114:296-300.

Abstract: The Precambrian shield region of central Ontario supports numerous breeding waterfowl, but only localized attempts of document brood production have been undertaken. During summers of 1990 and 1991, we conducted brood surveys, via helicopter, on 13 100-km² (10 km X 10 km) survey plots. The most common broods were mallard, black duck, wood duck, hooded merganser, and ring-necked duck. Observations of these species were in proportion to, or greater than, expected frequencies compared to abundance of breeding pairs. Class IIb-III brood sizes for all species were similar to those reported from ground surveys in other areas of eastern Canada and the United States. Peak hatching for all species occurred from 1 June to 15 July. Based on numbers of breeding waterfowl and the general agreement between brood and pair ratios, considerable waterfowl production likely occurs in central Ontario. We suggest that brood surveys in central Ontario start no earlier than 25 June and end by 25 July. Surveys are expensive, so effort should be stratified based on breeding pair densities. For cost-effectiveness, a single survey in late July may provide a reliable production index for both early and late-nesting species.

* Merendino, M. T., G. B. McCullough, and N. R. North. 1995. Wetland availability and use by breeding waterfowl in southern Ontario. Journal of Wildlife Management 59:527-532.

Abstract: Studies have documented breeding waterfowl use of habitat in the Prairie Pothole Region; however, the difficulty in surveying forested areas has inhibited large scale studies of use of habitat in eastern Canada. We examined waterfowl use of 15 wetland habitats in 132,000 kmsup2/sup of southern Ontario, Canada. We obtained data from plots that were surveyed by the Canadian Wildlife Service during 1981 and 1987. Open water lakes accounted for 47% of available habitat in the study area; however, they were avoided (P 0.001) by blue-winged teal (*Anas discors*), mallards (*A. platyrhynchos*), and wood ducks (*Aix sponsa*). Beaver (*Castor canadensis*) ponds accounted for 25% of the wetland area and were preferred (P 0.001) by wood ducks and were used by mallards, black ducks (*A. rubripes*), blue-winged teal, and ring-necked ducks (*Aythya collaris*). Other habitats composed 0-6% of available wetlands and accounted for 0-10% of waterfowl use on study plots in southern Ontario. The percentage of wetlands occupied by breeding waterfowl varied from 11% for bogs and seasonal basins to 50% for deciduous swamps. The more common breeding species in southern Ontario (mallard, wood duck, blue-winged teal) exploited many habitats. Management efforts should focus on emergent or wooded habitats, especially beaver ponds, that provide habitat for many breeding waterfowl.

Morgan, R. P., D. W. Merritt, S. B. Block, M. A. Cole, S. T. Sulkin, and F. B. Lee. 1978. Biochemical identification of mallard-American black duck hybrids through breeding program and in nature. Transactions of the Northeast Section of the Wildlife Society 35:225–236.

Morgan, R. P., D. W. Meritt, S. B. Block, M. A. Cole, S. T. Sulkin, F. B. Lee, and C. J. Henny. 1984. Inheritance patterns of enzymes and serum proteins of mallard-black duck hybrids. Biochemical Systematics and Ecology 12:119-123.

Morgan, R. P., D. W. Meritt, S. B. Block, and S. T. Sulkin. 1984. Frequency of mallard-black duck hybrids along the Atlantic coast determined by electrophoresis and plumage analysis. Review of Systematics and Ecology 12:125-128.

Morton, E. S. 1998. Pairing in mallards and American black ducks: A new view on population decline in American black ducks. Animal Conservation 1:239-244.

Morton, J. M. 2002. Effects of human disturbance on wintering American black ducks. Pages 11–16 in M. C. Perry, editor. Black ducks and their Chesapeake Bay habitats: proceedings of a symposium. Information and Technology Report USGS/BRD/ITR 2002–2005. USGS, BRD, Reston, VA USA.

Morton, J. M., A. C. Fowler, and R. L. Kirkpatrick. 1989. Time and energy budgets of American black ducks in winter. Journal of Wildlife Management 53:401–410.

Abstract: We used scan sampling techniques to quantify behavior and energy expenditure of American black ducks (*Anas rubripes*) at Chincoteague National Wildlife Refuge (NWR), Virginia, during the winters of 1985-86 and 1986-87. Time, tide, and habitat influenced black duck behaviors; therefore, diurnal time budgets were constructed by distributing scans over a time-tide matrix within refuge pool, saltmarsh, and tidal-water habitats. Black ducks observed during the day fed least and rested most when in refuge pools, and fed most and rested least when in tidal waters. Estimated daily energy expenditure (DEE) of American black ducks wintering at Chincoteague NWR was similar to values reported in Maine at a given temperature. Although DEE of undisturbed and disturbed flocks were similar, black ducks curtailed feeding and increased time spent in alert and locomotion behaviors in response to disturbance. We suggest that human disturbance of wintering black ducks impairs their physiological condition, thereby reducing winter survival and/or nutrient reserves carried to the breeding grounds.

Morton, J. M., R. L. Kirkpatrick, D. W. Howerter, T. H. Eason, and C. M. Long. 1994. Depletion of lipid, lean, and ash masses in food restricted American black ducks. Canadian Journal of Zoology 72:1492–1496.

Abstract: We investigated the rate and order of depletion of lipid depots and other body components in American black ducks (*Anas rubripes*) responding to food restriction. Forty-one hatching-year ducks were placed on one of four diets to induce high variability in body composition. Regression analyses suggest that for every 1-g decrease in body mass, lipids decreased 0.53 g, water decreased 0.36 g, ash-free nonlipid dry mass (NLDM) decreased 0.05 g, and ash decreased 0.02 g. However, depletion rates were not uniform among lipid sources. Both lipid mass and lipid depletion rate were ranked in descending order: subcutaneous, carcass, omental, and visceral. Despite disproportionately low depletion rates, intraperitoneal depots were depleted before subcutaneous or carcass lipids. We also found evidence of a sexual difference in endogenous nutrient utilization by American black ducks in response to food restriction. Males reduced NLDM (mostly breast muscle), visceral lipids, and subcutaneous lipids concomitantly. In contrast, females did not utilize NLDM but depleted visceral and subcutaneous lipids at rates 146–175% higher than males. These data suggest that relationships between depot and total body lipid masses are not necessarily uniform. Furthermore, it may not be possible to apply some measures of physiological condition equitably to both sexes of Anatinae.

Morton, J. M., and R. L. Kirkpatirck, and M. R. Vaughan. 1990. Changes in body composition of American black ducks wintering at Chincoteague, Virginia. The Condor 92:598-605.

Abstract: Fifty-nine American Black Ducks (*Anas rubripes*) were collected during early, mid-, and late winter 1985-l 986 at Chincoteague,V irginia to assesso verwinter changesi n physiological condition. Lipid Index (LI = grams lipid/gram nonlipid dry carcass x 100) values of adult males were relatively high throughout winter, whereas LI values of both female age classes were low in early winter, peaked by midwinter, and remained high into late winter. Juvenile females had consistently lower LI values than adult females, indicating that juvenile females may be physiologically disadvantaged during winter. Protein mass did not vary over winter, but tended to be less in juvenile females than adult females. In contrast, Reinecke et al. (1982) found that lipid and protein masses of female American Black Ducks

(both age classes) wintering in Maine decreased between fall and winter. This disparity may be explained by latitudinal differences in winter severity and diet. We argue that improved physiological condition, as a result of wintering farther south, may influence overwinter survivorship more strongly than reproductive potential during the subsequent spring.

Morton, J. M., R. L. Kirkpatrick, M. R. Vaughan, and D. F. Stauffer. 1989. Habitat use and movements of American black ducks in winter. Journal of Wildlife Management 53:390–400.

Abstract: We determined habitat use and movement patterns of 22 female American black ducks (*Anas rubripes*) wintering at Chincoteague National Wildlife Refuge (NWR), Virginia, with radio telemetry and aerial survey techniques during 15 December 1985-28 February 1986. Proportional use of saltmarsh, impoundment, and natural pool habitats was greater (P 0.05) than availability, whereas that of upland, subtidal water, and open water was less than availability. Tidal flat, stream, and shrub wetland were used in proportion to availability. Monitored ducks used refuge pools and impoundments during the day and saltmarsh habitats at night. Subtidal water was used during periods of icing. Juvenile females used range and core areas 2-3× larger (P 0.02) than adults. Adults used 1 core area, whereas juveniles normally used 1. Habitat use was affected by the day-night cycle and a tide-ice interaction.

Moser, J. D. 1983. The incidence of shot ingestion in New York waterfowl: results of a 1977–1983 gizzard collection study. Transactions of the Northeast Section of the Wildlife Society 40:110–117.

Nelson, W. O., and P. G. C. Campbell. 1991. The effects of acidification on the geochemistry of Al, Cd, Pb, and Hg in freshwater environments: a literature review. Environmental Pollution 71:91–130.

Newell, K. L., and H. Boyed. 1978. The sport kill of black ducks in Canada, 1968–76. Pages 84–100 *in* H. Boyd and G. H. Finney, editors. Migratory game bird hunters and hunting in Canada. Canadian Wildlife Service Report Series No. 43.

Nichols, J. D. 1991. Science, population ecology, and the management of the American black duck. Journal of Wildlife Management 55:790-799.

Abstract: This essay deals with the relevance of some of the ideas of Romesburg (1981) to population ecology and management of the American black duck (*Anas rubripes*). Most investigations dealing with the effects of hunting regulations on black duck populations have used the hypothetico-deductive (H-D) approach of specifying a priori hypotheses and associated deduced predictions. These investigations have not used manipulative experimentation, however, but have involved severely constrained analyses of historical data and have thus produced weak inferences. The 1982 lawsuit over black duck hunting regulations, the current uncertainty about appropriate black duck management actions, and the frequent skirmishes in the published literature of black duck population ecology are natural consequences of these weak inferences. I suggest that we attempt to take advantage of management and other manipulations by treating them as an opportunity to learn something via experimentation, as recommended by Macnab (1983) and Walters (1986).

Nichols, J. D. 1993. Responses of North American duck populations to expolitation. Pages 498-525 *in* C. M. Perrins, J. D. Leberton, and and Hirons, G. J. M., editors. Bird populations studies: Their relevance to conservation and management. Oxford University Press, Oxford, England.

Nichols, J. D., H. H. Obrecht, and J. E. Hines. 1987. Survival and band recovery rates of sympatric American black ducks and mallards. Journal of Wildlife Management 51:700-710.

Abstract: Banding and recovery data from American black ducks (Anas rubripes) and mallards (A. platyrhynchos) banded in the same breeding or wintering areas over the same time periods were used to estimate annual survival and band recovery rates. Recovery rates, based on preseason bandings, were very similar for sympatric black ducks and mallards and exhibited similar patterns of year-to-year variation for the 2 species. Tests for differences between the species in annual survival rates yielded equivocal results. We tentatively conclude that annual survival rates of mallards generally were not higher than those of black ducks banded in the same areas. The apparent difference in population status between black ducks and eastern mallards does not seem to result from differences in mortality rate. Nevertheless, we should attempt to identify management practices that might increase survival probabilities of black ducks.

Nichols, J. D., M. J. Conroy, D. R. Anderson, and K. P. Burnham. 1984. Compensatory mortality in waterfowl populations: a review of the evidence and implications for research and management. Transactions of the North American Wildlife and Natural Resources Conference 49:535–554.

Nudds, T. D. 1990. Patterns in breeding waterfowl communities. Pages 540–567 *in* B. D. J. Batt, A. D. Afton, M. G. Anderson, C. D. Ankney, D. H. Johnson, J. A. Kadlec, and G. L. Krapu, editors. Ecology and Management of Breeding Waterfowl. University of Minnesota Press, Minneapolis, MN USA.

Nudds, T. D., M. W. Miller, and C. D. Ankney. 1996. Black ducks: Harvest, mallards, or habitat? Pages 50-60 *in* J. T. Ratti, editor. Seventh International Waterfowl Symposium. Institute for Wetland and Waterfowl Research, Memphis, TN USA.

* Ouellet, C. 1994. Déplacements migratoires du Canard noir au Sud du Québec à l'automne. (Fall movement of black ducks in southern Québec). Thesis. Université du Québec à Montréal.

Owen, R. B., Jr., and K. J. Reinecke. 1979. Bioenergetics of breeding dabbling ducks. Pages 71–93 *in* T. A. Bookhout, editor. Waterfowl and wetlands—an integrated review. Proceedings of the 1977 Symposium, Madison, WI USA.

* Parker, G. R. 1991. Survival of juvenile American black ducks on a managed wetland in New Brunswick. Journal of Wildlife Management 55:466–470.

Abstract: I used radio telemetry to estimate survival rates of 103 local juvenile American black ducks (Anas rubripes) in southern New Brunswick. Prehunting (mid-Jul-Sep) survival rates of juveniles were 0.787 ± 0.114 (SE) in 1987 and 0.976 ± 0.044 in 1988. Survival rates declined by 54% in 1987 and by 43% in 1988 during the first 2 weeks of the hunting season (1-15 Oct). Most mortality of juvenile black ducks from hunting occurred on opening day (1987, 80.9%; 1988, 85.0%). Unretrieved kills and cripples represented 25.0% in 1987 and 38.0% in 1988 of total measured kill. Managed wetlands on the Atlantic Coast may enhance habitat for production of black ducks but they also concentrate hunters, especially on opening day. The high loss of local black ducks to hunting on these marshes may negate benefits of increased production.

* Parker, G. R. 1998. Dispersal and mortality of juvenile American black ducks, *Anas rubripes*, on wetlands under different management strategies. Canadian Field-Naturalist 112:586-595.

* Parker, G. R., M. J. Petrie, and D. T. Sears. 1992. Waterfowl distribution relative to wetland acidity. Journal of Wildlife Management 56:268-274.

Abstract: We measured the influence of water acidity on the presence of fish and abundance of aquatic invertebrates to better understand how those variables influence the distribution of waterfowl broods on unmanaged freshwater wetlands in southern New Brunswick. Broods of piscivorous waterfowl were most common on wetlands with pH ≥5.5; whereas wetland selection by broods of insectivores was unaffected by acidity. Wetlands with the most invertebrates and most broods and ducklings of insectivores contained no fish. Abundance of aquatic invertebrates was most important in influencing use of wetlands by insectivorous waterfowl, especially American black duck (*Anas rubripes*). Biomass (dried mass) and diversity of aquatic invertebrates were greater (P 0.005) on wetlands where black duck broods 1-36 days old were observed than on wetlands where broods of those ages were not seen. There were no (P 0.10) differences in invertebrate mass or diversity between wetlands with and without black duck broods 37-55 days old. It appears that the presence of fish and/or high acidity affect wetland selection by broods of black ducks when they are young, but broods may choose wetlands based on criteria other than invertebrate abundance as they age and plants become more important in their diets.

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Pearce, P. A., I. M. Price, and L. M. Reynolds. 1976. Mercury in waterfowl from eastern Canada. Journal of Wildlife Management 40:694–703.

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Abstract: Few species in wildlife management have generated as much debate as the American black duck (*Anas rubripes*; Nudds et al. 1996). Mid-winter inventories (MWI) of black ducks were began in 1955, and indicate a 60% decline in population size over the past 4 decades (Serie 1998). Although efforts to address this decline were organized as early as 1968 (Barske 1968), interest in the black duck increased greatly in the 1980's following a lawsuit against the U.S. Fish and Wildlife Service by the Humane Society. Prior to this lawsuit, the black duck had been an important species in the overall harvest of waterfowl within the Atlantic Flyway (Bellrose 1980).

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Abstract: Divergent population trends of mallards (*Anas platyrhynchos*) and black ducks (*Anas rubripes*) in eastern North America have been attributed to differences in reproductive rates. In order to test this hypothesis, the authors compared breeding parameters of radiomarked mallards and black ducks in an agricultural environment in midwestern New Brunswick. No differences in clutch size, nest success, hen success, duckling survival, or hen survival were detected during the breeding season. Reproductive success of both species appeared to be at or above the level needed to maintain population size. These results support a growing body of evidence that mallards are not more productive than black ducks in agricultural or forested environments. Moreover, earlier studies indicate no difference in annual survival rates between the two species. Given the failure of this and other studies to detect differences in vital rates of the two species, divergent population trends of mallards and black ducks present somewhat of a paradox. The authors hypothesize that differences in the population status of mallards and black ducks are the result of differences in breeding propensity that may arise from competition for breeding resources.

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Abstract: The breeding biology of black ducks (Anas rubripes) was studied in an estuarine habitat over the period 1963-73. Nests were located on islands and on the mainland in the vicinity of tidal marshes. Of 590 nests, 248 (42 percent) reached the hatching stage; the mainland-nesting portion of the population showed a nest success of 28 percent (N = 83 nests), those using the main nesting island, Ileaux-Pommes, 44 percent (N = 478 nests), and those using other islands 52 percent (N = 29 nests). On Ile-aux-Pommes annual nest success varied between 30 and 71 percent. Unsuccessful clutches were lost to predation (mainly gull [Larus sp.] and crow [Corvus brachyrhynchos] on islands, red fox [Vulpes fulva] and crow on mainland) or desertion. Fifty-two nests (9 percent of total) were judged to have been abandoned as a direct result of disturbance by the investigator. Annual fluctuations in nesting success could not be clearly attributed to weather factors, the quantity or quality of concealing cover, or to predator or competitor density. Nesting success did not vary according to laying date, but did vary in relation to the stage of nesting; the probability of loss was much greater during egg-laying than during incubation. Through renesting, nest losses were compensated for in some years but not in others. On the average, 65 percent of island nesting pairs brought off broods. Using capture-recapture techniques and visual observation, I estimated that 55 percent of all broods produced flying young, and 34 percent of ducklings that hatched reached flight age. On the basis of these estimates, 100 breeding pairs would

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Abstract: Based on 32 adult black ducks (*Anas rubripes*) collected during the nesting seasons of 1974-76, the proportion of macroinvertebrates (as aggregate [average] percent of dry weight) in the diet of males, egg-laying females, and postlaying females was 60, 75, and 55%, respectively. Sample sizes were small, and the differences associated with sex and reproductive condition were not significant. Molluscs, isopods, ephemeropteran and odonate nymphs, and coleopteran, trichopteran, and dipteran larvae contributed 74% of the dry weight and 64% of the gross energy ingested. Data from proximate analyses of 9 invertebrate and 9 plant foods were combined with food habits data to estimate the nutrients available to breeding hens. We concluded that females with access to an adequate amount of natural food including invertebrates and the seeds and tubers of aquatic plants would obtain sufficient minerals, protein, and energy for reproduction. Food quality does not appear to limit the density of black ducks nesting in Maine.

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pectoral muscle weight, and fat, moisture, and protein content. Variation of body weight within and among seasons was correlated more strongly with carcass protein content, and with fat content during seasons of heavy lipid deposition, than with three structural size variables (culmen, tarsus, and sternum). Regression equations including fat and protein as independent variables accounted for 80-90% of the annual and seasonal variation in body weight; structural size variables alone accounted for less than 30%. Immature females averaged 54 and 99 g lighter, and carried 54 and 59 g less fat than adults during the fall and winter. Ducks of both age classes lost weight in December and January. Adult and immature females metabolized 59 and 64 g of fat and 17 and 25 g of protein in winter compared with 46 g of fat during the nesting season. Nutrient reserves are thus equally as important for the winter survival of these birds as for successful reproduction. Seasonal changes in carcass composition suggest that (1) fat deposited in late fall provides an energy reserve during winter, (2) a reduction in lean weight during winter may lower daily energy requirements and increase the effective amount of energy reserves, and (3) declining body weights during late winter may be an endogenous rhythm that reflects a shift in the expected benefits of an energy reserve compared to the costs of carrying additional weight.

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Abstract: Movements and wetland selection by brood-rearing black ducks (Anas rubripes) were studied in Maine during 1977–80. Eight radio-marked hens moved their broods an average of 1.2 km from the nest to rearing pond, but only 1 hen initiated secondary brood movements. Half of 85 broods reared in the study area used only 3 wetlands, and most rearing ponds contained active beaver (Castor Canadensis) colonies. Brood-rearing hens preferred emergent ponds over lakes and evergreen scrub-shrub wetlands, and did not occurpy dead scrub-shrub, unconsolidated bottom, or aquatic bed wetlands. Rearing ponds were large and possessed extensive area of flooded mountain alder (Alnus incana), willow (Salix spp.), and herbaceous vegetation. Wetlands avoided by brood-rearing hens were those with large areas of open water, submergent aquatics, or ericaceous shrub vegetation.

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Abstract: Duckling survival among broods reared by 8 radio-marked and 28 unmarked black ducks (Anas rubripes) was studied in Maine during 1977-80. The mean class III brood size of 5.26 yielded an apparent survival rate of 0.6152 from hatching to fledging. However, by using the method described by Mayfield (1961, 1975), survival was estimated as 0.4244, indicating that average class III brood size overestimated recruitment by 45%. Young ducklings (class Ia-IIa) had a survival rate of 0.6073, which was significantly lower than the 0.6988 rate for older ducklings. At least 1 unmarked and 5 radio-marked hens lost all their ducklings. Total-brood survival was estimated at 81%. The lower survival of ducklings of radio-marked hens (0.9517/day) compared with those from unmarked females (0.9895/day) was attributed to better doc- umentation of total-brood loss for radio-equipped birds. Ducklings hatched after 14 June had lower survival (0.1007) than did young from earlier nests (0.3713). Our study showed a lower survival rate than usually is attributed to this species, with productivity

approaching the low levels reported for black ducks breeding in estuarine habitats of the St. Lawrence River.

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Abstract: Incubation rhythms and brood attentiveness of radio-marked Black Ducks (*Anas rubripes*) were studied in southcentral Maine during 1977-l 980. Recess duration and frequency differed between three females nesting near wetlands (K = 82 min, 2.3 recesses/day) and two nesting at upland sites (X = 183 min, 1.1 recesses/day), but incubation constancy was similar for all birds (K = 86.7%). A fourth wetland-nesting female apparently responded to the absence of down and concealing cover at the nest site by taking shorter and fewer recesses (X = 34 min, 1.0 recesses/day) than did other wetland-nesters with typical nests. Wetland-nesters took longer recesses with increasing air temperature and following long incubation sessions. After their ducklings were two weeks old, two brood rearing females began leaving their broods to forage on nearby wetlands. Duration of rearing recess (X = 56 min) and total recess time (K = 94 min/day) were less during this mid-rearing stage than during the latter part of rearing (K = 265 min, 488 min/day). The two hen-brood bonds terminated at 43 and 48 days. We suggest that small endogenous nutrient reserves and the low density of invertebrate foods, typical of Black Duck breeding habitat, were critical factors affecting the evolution of Black Duck incubation behavior. Bouts of inattention during brood rearing may have also evolved in relation to food requirements; by foraging on wetlands away from their broods, females avoid competing with offspring for common
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Abstract: Data from band recoveries and recapture rates are essential for testing influences on key demographic parameters of avian populations. I used recaptures and recoveries of leg-banded birds to test the influence of condition on the probability of survival and to compare site fidelity of American black ducks (*Anas rubripes*) and mal- lards (*A. platyrhynchos*) to the wetlands of southwestern Lake Erie. I live-trapped and banded 996 black ducks and 1,168 mallards from October through January during 3 annual staging periods (1990-1993) on Ottawa National Wildlife Refuge (NWR) in Ohio, USA. Ducks were aged, sexed, and weighed; total body length, wing chord, culmen, and tarsus also were measured to compute condition indices. I used multiple-logistic regression models to test influences of condition, date of initial capture, and species on the probabilities of recapture and band recovery for each age-sex class. Black ducks were more likely to be recaptured than mallards in all age-sex classes within a season and during subsequent seasons. Body condition had a positive influence on

recaptures during subsequent field seasons for adults. Analyses of within-season band recovery for adult males of both species indicated that birds with lower condition were more likely to be harvested. The opposite relationships between condition and the probability of recapture and direct recovery support the contention that poor body condition increased vulnerability to hunting for adult males.

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Abstract: We compared condition indices of interacting American black ducks (*Anas rubripes*) and mallards (*A. platyrhynchos*) during staging to contrast changes in energy reserves that potentially influence survival or other population parameters. We live-trapped and banded 1,126 black ducks and 1,292 mallards from October through January during 1990-1993 on Ottawa National Wildlife Refuge (NWR) in Ohio, USA. Ducks were aged, sexed, and weighed; total body length, wing chord, culmen,and tarsus were measured to compute condition indices. The condition indices were used as dependent variables in multiple regression models to measure influences of annual date, species, and ambient temperature for each age-sex class. Adult male black ducks usually had slightly high-er (1% to 3%) condition indices than adult male mallards. Initially, in 1990 and 1992, juvenile female mallards had 6% higher condition indices than juvenile female black ducks, but during these 2 years, black duck juvenile females improved condition at higher rates than their mallard counterparts. Temperature effects on condition of live-trapped birds were noted, especially during November 1991, when decreased body weights corresponded with frozen wetland foraging areas. Daily temperature similarly influenced black duck and mallard egress from the Lake Erie marshes. Species differences in breeding chronology and breeding ground could influence the body condition of these birds and the observed seasonal trends. The poor body condition of juvenile black duck females observed during some years could possibly contribute to lower survival and reproductive performance during the following spring if these differences continue through the remainder of the winter.

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Summary: The purpose of this paper is to summarize technical information related to the population ecology and harvest of black ducks. We address the rate of decline in various indices with particular

attention to comparisons among years, regions, and species. We attempt to relate trends The purpose of this paper is to summarize technical information related to the population ecology and harvest of black ducks. We address the rate of decline in various indices with particular attention to comparisons among years, regions, and species. We attempt to relate trends

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Abstract: Lead poisoning from the ingestion of spent shotgun pellets has been recognized as an important disease of North American waterfowl since Bellrose's (1959) research >40 years ago. Nation-wide regulations banning the use of lead shot for waterfowl hunting were established in 1991. We compared the prevalence of lead exposure in American black ducks (Anas rubripes) wintering on 2 areas in Tennessee before (1986-88) and after the ban (1997-99) to assess the effect of the ban on lead shot on this species. Prevalence of elevated blood lead in black ducks declined by 44% from before (11.7% prevalence) to after (6.5% prevalence) the implementation of non-toxic shot. The reduction in lead exposure was pronounced in adult black ducks (from 14.3% to 5.3%). However, prevalence in lead exposure remained similar in juvenile black ducks (from 8.2% to 8.3%). Additional evidence from lead ingestion and lead poisoning mortality events also indicates that lead exposure has declined in waterfowl in the Mississippi flyway. We believe that lead ingestion will continue to decline, despite the persistence of lead shot in some wetlands. The impact of reduced lead exposure on waterfowl populations needs to be assessed.

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Abstract: American black ducks (*Anas rubripes*) wintering in Tennessee during 1986 to 1988 were tested for exposure to lead. Twelve percent of the birds had blood lead concentrations exceeding 0.2 ppm. Significant differences in the prevalence of lead exposure were found for adults (14.4%) and juveniles (8.2%). Exposed birds had higher blood lead concentrations at one study site, corresponding with a lower survival index.

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Abstract: The effects of acidification on wildlife inhabiting aquatic or semi-aquatic environments are reviewed, with particular reference to the possibility for increased dietary exposure to Hg, Cd, Pb and/or Al, and decreased availability of essential dietary minerals such as Ca. It is concluded that: (1) piscivores risk increased exposure to dietary methyl-Hg in acidified habitats, and Hg concentrations in prey may reach levels known to cause reproductive impairment in birds and mammals; (2) piscivores do not risk increased exposure to dietary Cd, Pb or Al because these metals are either not increased in fish due to acidification, or increases are trivial from a toxicological perspective; (3) insectivores and omnivores may, under certain conditions, experience increased exposure to toxic metals in some acidified environments. Exposure levels are likely to be sufficiently low, however, that significant risks to health or reproduction are unlikely. More importantly, these wildlife species may experience a drastic decrease in the availability of dietary Ca due to the pH-related extinction of high-Ca aquatic

invertebrate taxa (mollusks, crustaceans). Decreased availability of dietary Ca is known to adversely affect egg laying and eggshell integrity in birds, and the growth of hatchling birds and neonatal mammals. Acidification-related changes in the dietary availability of other essential elements, such as Mg, Se and P, have not been established and require further investigation; (4) herbivores may risk increased exposure to Al and Pb, and perhaps Cd, in acidified environments because certain macrophytes can accumulate high concentrations of these metals under acidic conditions. The relative importance of pH determining the metal concentrations of major browse species, and the toxicological consequences for herbivorous wildlife, is not well established and requires further study. A decreased availability of dietary Ca is also likely for herbivores inhabiting acidified environments.

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Abstract: We investigated whether the blood parasite Leucocytozoon simondi could slow mallard (*Anas platyrhynchos*) population growth in the east that has been associated with American black duck (*A. rubripes*; hereafter black duck) population decline. Susceptibility to parasites was compared among F1 ducklings produced from crosses between mallard and black ducks from areas of Leucocytozoon endemicity (Ontario), and between mallards from an area free of Leucocytozoon (Saskatchewan). We produced 6 "types" of ducklings: Ontario black duck x Ontario black duck (OB x OB), Ontario black duck x Ontario mallard (OB x OM), Ontario black duck x Saskatchewan mallard (OB x SM), OM x OM, OM x SM, and SM x SM. We predicted that because of probable coevolution of black ducks and Leucocytozoon, black duck ducklings would have resistance to the parasite. We also predicted that Ontario genes would confer some resistance to ducklings because these ducklings' parents had survived exposure to Leucocytozoon. In contrast, we predicted that mallard and Saskatchewan genes would not confer resistance, i.e., OB x OB ducklings would have greatest resistance to Leucocytozoon, SM x SM ducklings would have least, and remaining duckling types would have intermediate resistance. Of 169 ducklings exposed in 2 years in 3 geographically separate locales, none died, showed noticeable symptoms, or otherwise behaved abnormally. Nonetheless, weekly blood smears indicated that 91% of ducklings became infected, and many developed intense para- sitemias. However, infection intensities were not different among the 6 duckling types. In addition, hematocrits were not lowered by intense infections. These results suggest that the effects of Leucocytozoon on wild waterfowl populations have been overestimated, and that Leucocytozoon will not prevent further range expansion of mallards.

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Abstract: The blood parasite *Leucocytozoon simondi* is often associated with heavy mortality of ducks and geese, especially domestic ones, in North America. In contrast, in a previous study we found no mortality from L. simondi in our wild stock of mallard (*Anas platyrhynchos*) and American black duck (*Anas rubripes*) ducklings. However, because parasites can slow growth, which could extend the interval during which ducklings are susceptible to predators, we tested for parasite effects on growth rates. We analysed growth rates over the first 20 days of life, based on tarsus length, culmen, bill width, body mass, and a principal component of structural size. Growth rates of infected ducklings were not lower than those of uninfected ducklings. Similarly, more intense infections did not have a greater effect on growth rates. Hence, growth rates were not negatively affected by L. simondi, which suggests that effects of this parasite on wild duck populations have been overestimated.

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Sparling, D. W. 1990. Acid precipitation and food quality: inhibition of growth and survival in black ducks and mallards by dietary aluminum, calcium and phosphorus. Archives of Environmental Contamination and Toxicology 19:457–463.

Abstract: In areas impacted by acid precipitation, water chemistry of acidic ponds and streams often changes, resulting in increased mobilization of aluminum and decreased concentration of calcium carbonate. Aluminum binds with phosphorus and inhibits its uptake by organisms. Thus, invertebrate food organisms used by waterfowl may have inadequate Ca and P or elevated Al for normal growth and development. Acid rain and its effects may be one of the factors negatively impacting American black ducks (*Anas rubripes*) in eastern North America. One-day old mallards (A. platyrhynchos) and black ducks were placed on one of three Ca:P regimens: low:low, normal:normal, and low:high with each regimen divided further into three or four Al levels for 10 weeks. 45% of the black ducks died on nine different diets whereas only 28% of the mallards died on three different diets. Mortality was significantly related to diet in both species. Growth rates for body weight, culmens, wings, and tarsi of both species on control diets exceeded those on many treatment diets but the differences were less apparent for mallards than for black ducks. Differences among treatments were due to both Ca:P and Al levels. Over a period of two to three weeks, high Al diets coupled with low Ca and P were most toxic to ducklings. Al was toxic even when Ca and P levels approximated generally accepted dietary levels. Elevated levels of P may reduce mortality of birds on high Al compared with those on diets with low Ca and P, but comparable Al levels.

Sparling, D. W. 1990. Conditioned aversion of aluminium sulfate in black ducks. Envrionmental Toxicology and Chemistry 9:479–483.

Sparling, D. W. 1991. Acid precipitation and food quality: effects of Al, Ca, and P on bone and liver characteristics in American black ducks and mallards. Archives of Environmental Contamination and Toxicology 19:457–463.

Abstract: American black ducks (*Anas rubripes*) and mallards (*A. platyrhynchos*) were fed diets varying in concentrations of aluminum (Al), calcium (Ca), and phosphorus (P) for 10 weeks to identify toxic effects of Al under conditions representative of areas with acid precipitation. Femur and liver tissues were analyzed for Al, Ca, and P concentrations and structural characteristics. At two weeks of age, both species demonstrated pronounced differences in femur Al and P concentrations and femur mass from dietary Al and interaction between Ca:P regimen and Al; Low Ca:Low P enhanced Al storage and decreased P and mass in femurs. Femur Ca was lowest in the Low Ca:Low P regimen but was not affected by dietary Al. At 10 weeks, femur and liver Al continued to vary with dietary Al. Elevated Al and reduced Ca lowered modulus of elasticity. Femur P increased with elevated dietary P in

black ducks. Elevated dietary P negated some of the effects of dietary Al on femur mass in black ducks. Reduced Ca concentrations weakened bones of both species and lowered both Ca and P. An array of clinical signs including lameness, discoloration of the upper mandible, complete and greenstick fractures, and death were responses to elevated Al and Ca:P regimen. Black ducks seemed to display these signs over a wider range of diets than mallards. Diets of 1,000 mg/kg Al had toxic effects on both species, particularly when combined with diets low in Ca and P.

Spelman, L. H., W. J. Fleming, G. S. Davis, and M. K. Stoskopf. 1995. Effect of exogenous adrenocorticotropic hormone administration on plasma corticosterone concentrations in American black ducks (*Anas rubripes*). Journal of Wildlife Diseases 31:136-141.

Abstract: A protocol for the adrenocorticotropic (ACTH) stimulation test in American black ducks (*Anas rubripes*) was established with synthetic ACTH, cosyntropin (Cortrosyn); ACTH stimulation testing was conducted on 31 adult ducks (14 males, 17 females) in September 1993. Plasma corticosterone concentrations were measured on heparinized blood samples collected 30 min, and 1, 2, and 4 hr post-injection. In comparison with saline controls, cosyntropin (0.25 mg/duck) produced a two- to three-fold increase in corticosterone 30 min after administration. Maximal concentrations ranged from 132 to 312 ng/ml and occurred between 1 and 2 hr post-injection. Corticosterone concentrations declined to basal, pre-injection values after 4 hr. Endogenous ACTH release in response to handling stress was evident in control ducks after saline injection but did not interfere with interpretation of the stimulation test. Recommendations for the ACTH stimulation test in black ducks include a 30 min acclimatization period for recently captured or relocated ducks and determination of plasma corticosterone concentration 1 to 2 hr following intramuscular injection with 0.25 mg cosyntropin.

Spencer, H. E., Jr. 1979. Black duck management plan for North America. Black Duck Committee, Atlantic Flyway Council, Augusta, ME, USA.

Staicer, C. A., B. Freedman, D. Srivastava, N. Dowd, J. Kilgar, J. Hayden, F. Payne, and T. Pollock. 1991. Use of lakes by black duck broods in relation to biological, chemical, and physical features. Aquatic Birds in the Trophic Web of Lakes. Proceedings of a Symposium Held in Sackville :185-199.

Stendell, R. C., R. I. Smith, K. P. Burnham, and R. E. Christensen. 1979. Exposure of waterfowl to lead: a nationwide survey of residues in wing bones of seven species, 1972–73. U.S. Fish and Wildlife Service Special Science Report Wildlife no. 223.

Stevens, C. E., T. S. Gabor, and A. W. Diamond. 2003. Use of restored small wetlands by breeding waterfowl in Prince Edward Island, Canada. Restoration Ecology 11:3-12.

Abstract: Since 1990 under the Eastern Habitat Joint Venture over 100 small wetlands have been restored in Prince Edward Island, Canada. Wetlands were restored by means of dredging accumulated sediment from erosion to emulate pre-disturbance conditions (i.e., open water and extended hydroperiod). In 1998 and 1999 we compared waterfowl pair and brood use on 22 restored and 24 reference wetlands. More pairs and broods of Ring-necked ducks, Gadwall, Green-winged Teal, and American black ducks used restored versus reference wetlands. In restored wetlands waterfowl pair density and species richness were positively correlated with wetland/cattail area, percent cattail cover, and close proximity to freshwater rivers. In addition, a waterfowl reproductive index was positively correlated with percent cattail cover. Green-winged Teal pair occurrence in restored wetlands was positively correlated with greater amounts of open water and water depths. American black duck pairs

occurred on most (86%) restored wetlands. Restored small wetlands likely served as stopover points for American black duck broods during overland or stream movements, whereas they likely served as a final brood-rearing destination for Green-winged Teal broods. We suggest that wetland restoration is a good management tool for increasing populations of Green-winged Teal and American black ducks in Prince Edward Island.

Stevenson, A. L., A. M. Scheuhammer, and H. M. Chan. 2005. Effects of nontoxic shot regulations on lead accumulation in ducks and American woodcock in Canada. Archives of Environmental Contamination and Toxicology 48:405–413.

Abstract: Prior to the first nontoxic shot zones being established in Canada, a nationwide survey of lead (Pb) concentrations in wing bones of hatch year (HY) dabbling and diving ducks determined the incidence of elevated Pb exposure in waterfowl in different parts of the country (Scheuhammer and Dickson 1996). The main objectives of the present study were (1) to compare these previously collected data with the incidence of elevated Pb accumulation in the same species several years after the establishment of a national regulation in 1997 prohibiting the use of Pb shot for waterfowl hunting; and (2) to survey waterfowl hunters to determine reported levels of compliance with the nontoxic shot regulation. Average bone-Pb concentrations in dabbling ducks (mallards [*Anas platyrhyncos*] and American black ducks [*Anas rubripes*] combined) decreased significantly between 1989-1990 and 2000 (11 μg/g vs. 4.8 μg/g, respectively [$p < 0.011$), Ring-necked ducks (*Aythya collaris*) showed a similar decrease in mean bone-Pb concentrations, from 28 μg/g to 10 μg/g ($p < 0.01$). These declines in bone-Pb concentration were consistent with the results of a large anonymous hunter survey, which indicated a high level of reported compliance (>80%) with the nontoxic shot regulation among waterfowl hunters residing in Ontario and British Columbia. Conversely, American woodcock (Scolopax minor), an important upland game species not affected by the nontoxic shot regulation, showed no decrease in mean bone-Pb concentration since the national regulation came into effect (19 μg/g in 1995 vs. 21 μg/g in 2000). A majority (70%) of waterfowl hunters in British Columbia and Ontario who also hunt upland game birds report continued (legal) use of Pb shot for upland game bird hunting.

Stevenson, H. M., and B. H. Anderson. 1994. The birdlife of Florida. University Press of Florida, Gainseville, FL USA.

Stewart, R. E. 1958. Distribution of the black duck. U.S. Fish and Wildlife Service Circular 51.

Stewart, R. E. 1962. Waterfowl populations in the upper Chesapeake region. U.S. Fish and Wildlife Special Science Report—Wildlife 65.

Stotts, V. D. 1959. A study of the breeding ecology of black ducks on the upper eastern shore of the Chesapeake Bay in Maryland from 1953 to 1959. Final Report Maryland Pittman-Robertson Project W-30-R-7. Maryland Game and Inland Fish Commission, Annapolis, MD USA.

Stotts, V. D. 1963. Waterfowl investigations: physical characteristics, growth, and development of the black duck. Project No. MD W-030-R-11/Job 09. Maryland Department of Game and Inland Fisheries, Annapolis, MD, USA.

Stotts, V. D. 1968. Habitat and breeding ecology, east central United States. Pages 102–112 *in* P. Barske, editor. The black duck: evaluation, management, and research: a symposium. Atlantic Flyway Council and Wildlife Management Institute, Washington D.C., USA.

Summary: This paper covers that portion of the black duck's breeding range in states of the Atlantic Flyway from Pennsylvania and New Jersey south. This restriction will mean that a large part of the breeding range, located from Ohio west, will be omitted from discussion by the symposium with regard to habitat and breeding ecology.

Stotts, V. D. 1987. A survey of breeding American black ducks in the Eastern Bay Region of Maryland in 1986. Report for contract no. 14-16-005-86-017 for U.S. Fish and Wildlife Service, Annapolis, MD USA.

Stotts, V. D., and D. E. Davis. 1960. The black duck in the Chesapeake Bay of Maryland: Breeding behavior and biology. Chesapeake Science 3/4:127-154.

Abstract: The breeding behavior and biology of black ducks, Anas rubripes, were observed from 1953-1958 on the upper Eastern Shore of Chesapeake Bay in Maryland. Ducks were trapped, banded and marked during the study in an essentially estuarine habitat, which was frost-free from mid-April to early November. The general habitat adjoining the Bay consisted of cultivated fields, pine woods with dense underbrush, extensive marshes in some areas, and duck blinds. Resident black ducks began to pair in the late summer and reached a peak in early April just before the height of the breeding season. Few if any young were observed to pair in the early fall. In the spring the male defended a territory for each clutch, generally using some promontory along the shore. The male remained nearby while the female built her nest, gradually deserting his mate during incubation. Eventually the pairing bond dis-appeared, although some males probably paired again with renesting hens. Females renested one or more times when the eggs were destroyed or even when the ducklings disappeared on the first day after hatching. At least eight out of 51 marked ducks were known to have renested. The dates of first laying varied from March 9 to March 27. The nesting peaks occurred about April 20. The first hatching occurred in early April; the last in early August. The date by which 50 percent of the nests were started was significantly earlier in 1953 than in 1957 or 1958 but no other differences were significant. Comparison of the peaks of hatching and of laying showed that in 1958 a loss of early clutches occurred. Nests were built most extensively in woods, less so in fields and marshes and markedly on duck blinds. They were constructed from adjacent material (leaves, grass, twigs, pine needles) in shallow basins, which were occasionally used by renesting females. Usually the nest site was covered by honeysuckle, poison ivy, brush, or grasses. Spacing between nests was determined by available cover; sometimes they were placed within a few feet of each other. The density varied from 0.6 to 15.2 nests per acre. The average number of eggs in a clutch declined from 10.9 to 7.5 during the season (360 clutches). Young females laid smaller average clutches (9.2) than adults (9.7). Primary clutches were larger (9.1) than secondary clutches (8.1) for the same females. The incuba-tion period averaged 26.2 days (51 clutches). Neither size of clutch nor season had a signif-icant effect on incubation period. About 5.6 percent of the eggs did not hatch. The fate of nesting was determined for 574 nests. During the six years, 38.0 percent hatched at least one egg, 11.5 percent were abandoned, and 50.0 percent were destroyed (34.0 percent by crows). Although complete and incomplete clutches were equally suscepti-ble to predation, over half (51.8 percent) of the destruction of complete clutches occurred in the first week of incubation. An average of 9.6 percent of eggs in successful clutches was taken by crows. Estimations of production indicated that 100 females would raise 510 young to flying age and that the population in the area would decline if the mortality rate of females from flying age to breeding exceeded 78 percent.

Temple, E. R. 1993. Black duck reproduction in high and low noise level environments in the Pamlico Sound region of North Carolina. Thesis, North Carolina State University, Raleigh, NC, USA.

* Tisdale, C. 1995. Aggression among captive mallards and black ducks during the breeding season.. Thesis, MacDonald College, McGill University., Ste. Anne de Bellevue.

Titman, R. D., and N. R. Seymour. 1981. A comparison of pursuit flights by six North American ducks of the genus *Anas*. Wildfowl 32:11–18.

Trautman, M. B. 1940. The gizzard shad as an important food for ducks in their inland lakes and reservoirs of Ohio. Ohio Division of Conservation Bulletin 13.

Trautman, M. B. 1943. Normal flight of a black duck after healing of wing fractures. Wilson Bulletin 55:

Trautman, M. B. 1947. Courtship behavior of the black duck. Wilson Bulletin 59:26–35.

Summary: References in the literature concerning courtship behavior of the Black Duck (Anus julvigula rubripes Brewster)* in autumn and winter are few and are usually confined to a brief statement that courtship does occur (Townsend, 1916: 9). There is a larger literature relative to courtship in spring (Sawyer, 1909: 195-196; Townsend, 1916: 13-15; Phillips, 1923:SO; Bent, 1923:Sl). These descriptions emphasize the spectacular courtship flight rather than courtship behavior on water or land.

U.S. Fish and Wildlife Service. 2002. John H. Chafee National Wildlife Refuge: comprehensive conservation plan. U.S. Fish and Wildlife Service, Rhode Island, USA.

Abstract: John H. Chafee NWR constitutes a part of the Rhode Island refuge complex, and is located in the towns of South Kingstown and Narragansett, Washington County, Rhode Island. A comprehensive conservation plan (CCP) was drafted in order to guide refuge management over a 15-year period, and realize the system's mission. The CCP provides a clear-cut method in order to ensure a secure and sound future for wildlife, habitats, and public use opportunities. The John H. Chafee Refuge was developed to safeguard and promote black duck, shore birds, and other waterfowl populations, fish and additional wildlife species, and to offer scope for scientific research, environmental education, and recreation facilities. The primary and most important goal is the protection and improvement of federal trust resources and threatened or endangered species and habitats. The second goal aims at re-building and preserving natural ecological resources to develop sound ecosystem performance. The third goal is the development of a program to safeguard land species, habitats, and ecosystems. Other goals involve provision of high standard, wildlife-oriented public opportunities, and environmental education, offering help in recruitment of staff and securing funds to attain the recognized goals. Many institutions, organizations, and volunteers aid the refuge complex management. Besides these goals, there are two important levels of monitoring and evaluation. The first level of implementation monitoring checks whether the management is acting according to the plan. The second level of effectiveness monitoring determines whether the goals are being actually achieved. The goals and objectives in the CCP are subject to changes to suit the changing biological conditions, and new information acquired through scientific research.

U.S. Fish and Wildlife Service. 2002. Trustom Pond National Wildlife Refuge: comprehensive conservation plan. U.S. Fish and Wildlife Service, Rhode Island, USA.

Abstract: Trustom Pond National Wildlife Refuge is located on the south coast of Rhode Island in South Kingstown, Washington County. The Comprehensive Conservation Plan (CCP) provides the statement of desired future conditions for habitat, wildlife, visitor services, and facilities. It ensures that the policies and goals of the refuge system and legal mandates are reflected. The plan provides long term continuity and direction for management, proper direction for staffing, operations, maintenance, and development of budget requests. The plan ensures compatibility of current and future public use. The planning process for the refuge began in February 1998. Information on natural resources and public use at the refuge was collected and a long term vision and goals were developed. Protection, restoration, and maintenance of endangered and threatened species, coastal sandplain, maritime natural communities, wetlands, and biological significant areas were the important issues of the plan. Management of the refuge habitat, public use and access, and hunting were also included in the plan. Provision of staff, operations, and maintenance support to accomplish the goals and objectives of the refuge were addressed. Goals and strategies for the refuge were developed after reviewing applicable laws and policies, regional plans, and the purpose of the refuge. The refuge system has more than 25 step-down management plans. These plans have described management actions to be followed to achieve objectives and implement strategies. Annual implementation monitoring will be achieved through use of a checklist. The effects of management on species, populations, habitats, refuge visitors, and ecosystem integrity will be periodically evaluated. The major goal of the Refuge is to provide nesting habitat for piping plovers through proper habitat management, protection from predators and education for beach users. Protection is also extended to least terns, American black ducks, and other waterfowl and shorebirds. The Plan also recommends creating a baseline inventory of species occurrence for future management decisions.

White, T. O. 1994. Body composition, activity budgets, and food habits of American Black Ducks wintering in west-central Tennessee. Thesis, Tennessee Technological University, Cookeville, TN. USA.

Winner, R. W. 1959. Field-feeding periodicity of black and mallard ducks. Journal of Wildlife Management 23:197–202.

Winner, R. W. 1960. Fall and winter movements of black duck and mallard ducks. Journal of Wildlife Management 24:332–335.

Abstract: This paper summarizes the results of a study of fluctuations in fall and winter populations of black ducks (*Anas rubripes*) and mallard ducks (*A. platyrhynchos*) in central Ohio. The primary objectives were to estimate the duration of stopover of individual birds, and to determine if there was any correlation between local weather conditions and the departure of birds from the study area. Duration of stopover was estimated by trapping and color marking birds; the marked individuals were censused daily until all had departed from the study area. The total population was also censused daily, and weather conditions for those periods when the population decreased in size were ex-amined for any weather factor or factors that might be consistently associated with departures. This paper is a contribution from the Ohio Co-operative Wildlife Research Unit and the Ohio State University Ornithology Laboratory: U.S. Fish and Wildlife Service, Ohio Division of Wild-life, Wildlife Management Institute, and The Ohio State University cooperating. I am grateful to Eugene H. Dustman and Loren S. Putnam for advice and encouragement throughout the course of the study. Information on the freezeup of the Lake Erie marshes was provided by Robert Donohoe.

Winner, R. W. 1972. Activity of black duck and mallard ducks in a controlled environment. Journal of Wildlife Management 36:187–191.

Abstract: The diel activity patterns of mallard (Anas platyrhynchos) and black (A. rubripes) ducks were recorded under controlled environmental conditions. Both species exhibited a bimodal activity pattern when exposed to decreasing light intensity during the final hour of the photoperiod. Under conditions of constant light intensity, the second activity peak of the black ducks disappeared but that of the mallards persisted. This differential dependence on changing light intensity as a stimulus to activity agrees with data previously collected on the behavior of the two species under field conditions.

Wooly, J. B., and R. B. Owen, Jr. 1978. Energy costs of activity and daily energy expenditure in the black duck. Journal of Wildlife Management 42:739–745.

Abstract: Heart rates of 3 wing-clipped black ducks (*Anas rubripes*) were successfully monitored for up to 11 days in the field. The energy costs of several activities, such as swimming, feeding, and preening, were calculated using regressions of metabolism on the heart rate previously determined in the laboratory for each duck. Total daily energy expenditure during midsummer using time-activity analyses of non-radioed black ducks was 1.5 to 2 times the resting metabolic rates measured in the laboratory. Preliminary data indicate that the energy costs for laying females may be as high as 3.4 times the resting rates.

Wright, B. S. 1947. The black duck in eastern Canada. Master's thesis, University of Wisconsin, Madison, WI USA.

Wright, B. S. 1954. High tide and east wind: the story of the black duck. Stackpole Co., Harrisburg, PA, and Wildlife Management Institute, Washington, D.C. USA.

Summary: Semi-technical treatise on the natural history and management of the American black duck.

* Zimpfer, N. L., and M. J. Conroy. 2006. Modeling movement and fidelity of American black ducks. Journal of Wildlife Management 70:1770-1777.

Abstract: Spatial relationships among stocks of breeding waterfowl can be an important component of harvest management. Prediction and optimal harvest management under adaptive harvest management (AHM) requires information on the spatial relationships among breeding populations (fidelity and inter-year exchange), as well as rates of movements from breeding to harvest regions. We used band-recovery data to develop a model to estimate probabilities of movement for American black ducks (*Anas rubripes*) among 3 Canadian breeding strata and 6 harvest regions (3 in Canada, and 3 in the United States) over the period 1965- 1998. Model selection criteria suggested that models containing area-, year-, and age-specific recovery rates with area- and sex-specific movement rates were the best for modeling movement. Movement by males to southern harvest areas was variable depending on the originating area. Males from the western breeding area predominantly moved to the Mississippi Flyway or southern Atlantic Flyway ([PSI]ij = 0.353, SE = 0.0187 and [PSI]ij = 0.473, SE = 0.037, respectively), whereas males that originated in the eastern and central breeding strata moved to the northern Atlantic flyway ([PSI]ij = 0.842, SE = 0.010 and [PSI]ij = 0.578, SE = 0.0222, respectively). We used combined recoveries and recaptures in Program MARK to estimate fidelity to the 3 Canadian breeding strata. Information criteria identified a model containing sex- and age-specific fidelity for black ducks. Estimates of fidelity were 0.9695 (SE = 0.0249) and 0.9554 (SE = 0.0434) for adult males and females, respectively. Estimates of fidelity for juveniles were slightly lower at 0.9210 (SE = 0.0931) and 0.8870 (SE = 0.0475) for males and females, respectively. These models have application to the development of spatially stratified black duck harvest management models for use in AHM.

* Zimpfer, N. L., and M. J. Conroy. 2006. Modeling movement and fidelity of American black ducks. Journal of Wildlife Management 70:947–954.

Abstract: Understanding the relationship between the annual reproductive success and changes in environment is important for appropriate waterfowl management. We developed predictive models of American black duck (*Anas rubripes*) production rates as a function of biotic (black duck and mallard [*A. platyrhynchos*] abundance) and abiotic factors (spring precipitation and temperature) across predefined breeding areas, from 1990 to 2001. We used male age ratios in the fall population, estimated from wing samples of harvested black ducks corrected for differential vulnerability via band-recoveries, as the index to annual reproduction. Information criteria suggested that a model containing predictors for density-dependence, competition with mallards, spring precipitation, and temperature and stratum-specific coefficients was the best model of black duck production rates. However, coefficients of this model were highly imprecise, leading to relatively poor predictive ability, possibly due to multicollinearity among predictors and the relatively short time span of analysis. We fit several models that included only black duck and mallard abundance as predictors; of these, models with constant slopes and stratum-specific intercepts performed best. Model-averaged parameter estimates supported inverse relationships between black duck and mallard abundance and age ratios, with stronger relative effects for black duck density-dependence. Both effects have implications for adaptive harvest management, in that harvest potential for black ducks may differ greatly depending on combinations of number of each species and the relative belief in alternative hypotheses about the impacts of mallards. Much variability in age ratios remained unexplained by our models, some possibly due to the lack of habitat explanatory variables but also apparently due to random factors. Model improvement could be achieved by incorporating recent developments in the modeling of random effects, especially via Markov Chain Monte Carlo methods. More research is also needed to incorporate recently acquired habitat predictors into predictive modeling for black ducks and other ducks breeding in eastern North America. These results provide critical input for models of adaptive harvest management, currently under consideration as an approach for developing an international (Canada-U.S.) harvest strategy for black ducks.