September 2009 Progress Report

True Metabolizable Energy of American Black Ducks Foods

Principal Investigators:

John M. Coluccy, Ph.D.
Manager of Conservation Planning
Ducks Unlimited, Inc
Great Lakes/Atlantic Region
1220 Eisenhower Place
Ann Arbor, MI 48108
734-623-2000
jcoluccy@ducks.org

Tina Yerkes, Ph.D.
Director of Conservation Programs
Ducks Unlimited, Inc
Great Lakes/Atlantic Region
1220 Eisenhower Place
Ann Arbor, MI 48108
734-623-2000
tyerkes@ducks.org

Partners:

John W. Simpson, Winous Point Marsh Conservancy
Pat Devers, USFWS, Black Duck Joint Venture
Paul Castelli, New Jersey Division of Fish & Wildlife
Michael Castelli, Volunteer
Lee Karrh, Maryland Department of Natural Resources

Project Funding & Cooperators:

Black Duck Joint Venture
Ducks Unlimited Inc.
Maryland Department of Natural Resources
New Jersey Division of Fish & Wildlife
Waterfowl Research Foundation
Winous Point Marsh Conservancy

Project Technicians:

John Siekierski
Winous Point Marsh Conservancy
3500 South Lattimore Road
Port Clinton, Ohio 43452
Cell: 419–654–3275
siekierskij@excite.com

Nathan Troyan
Winous Point Marsh Conservancy
3500 South Lattimore Road
Port Clinton, Ohio 43452
Cell: 724–968–6676
ntroyan25mybc3bc3edu@gmail.com

Problem/Issue Statement

Quantifying regional carrying capacity throughout the American black duck (*Anas rubripes*) wintering range is a priority research need identified by the Black Duck Joint Venture (BDJV). Determining carrying capacity requires knowledge of both the types and amounts of different foods available and their nutritional value. Information needs regarding the types and availability of black duck foods along the Atlantic Coast is currently being addressed with ongoing research. However, little information exists regarding the energetic value of these foods.

Justification

American black ducks, a species of international management concern, appear to have increased within the primary breeding range since 1990 (Fig. 1). However, the population size remains 27% below the North American Waterfowl Management Plan (NAWMP 2004) population goal of 640,000. Counter to recent spring survey estimates, the Mid-winter Inventory (MWI) indicates a decline by as much as 60% on traditional wintering areas, with the most substantial losses occurring in the Mississippi and southern Atlantic Flyways. In the Mississippi and Atlantic Flyway, the 2007 mid-winter index was 52% and 14% below the 10-year average, respectively (Fig. 2). Mid-winter counts in both flyways combined currently remain 19% below the 10-year average. There are several possible explanations for this decline, one of which is the loss and/or degradation of non-breeding habitat (Conroy et al. 2002).

Our current understanding of migratory and wintering waterfowl ecology suggests food availability is a key factor limiting waterfowl populations during winter and migration (Haramis et al. 1986, Miller 1986, Conroy et al. 1989, Reinecke et al. 1989, Bergan and Smith 1993, Jeske et al. 1994), and habitat conditions during the non-breeding period may influence survival and subsequent reproductive success (Heitmeyer and Fredrickson 1981, Kaminski and Gluesing 1987, Raveling and Heitmeyer 1989). Determining carrying capacity for any habitat type requires knowledge of both the types and amounts of different foods available and their nutritional value to birds (Miller and Newton 1999, Ballard et al. 2004).

With support from the BDJV, a suite of research studies evaluating the habitat use and food habits of black ducks, and the availability of black duck foods along the Atlantic Coast (New York, New Jersey and Virginia) was recently completed by Ducks Unlimited (DU) and its partners. Esophageal contents from collected birds suggest diets have shifted since the 1980s (Costanzo and Malecki 1989). In addition, food availability data suggests some foods commonly found in the black duck diet in the 1980s are extremely rare (D. M. Cramer, University of Delaware, unpublished report; B. Lewis, Jr., Southern Illinois University, unpublished report; D. Plattner, Southern Illinois University, unpublished data).

Estimates of TME are currently available for 5 species of invertebrates, 1 agricultural food, and the seeds of 5 moist soil plants found in the American black duck

(*Anas rubripes*) diet (Hoffman and Bookhout 1985, Jorde and Owen 1988, Petrie et al. 1998, Sherfy 1999, Checkett et al. 2002, Kaminski et al. 2003, Dugger et al. 2007). This represents a small fraction of the foods eaten by American black ducks. Given the range of values for the few species studied to date, additional work is required to improve our understanding of the foraging landscape for migrating and wintering American black ducks.

Information regarding a food's proximate composition (e.g., fiber content) may provide an indirect measure of metabolizable energy; however, others have found this approach unreliable. Several methods are available for directly estimating metabolizable energy using controlled feeding experiments; however estimates of TME are most accurate (Sibbald 1976, Miller and Reinecke 1984). Unlike estimates of gross energy, the TME method estimates energy available to birds, and TME is preferable over estimates of apparent metabolizable energy because it accounts for fecal and urinary energy of non-food origin. In this study, we propose to estimate TME values for seeds and invertebrates commonly occurring in wetlands along the Atlantic Coast and the black duck diet.

Objectives

The primary objective of this study is to estimate TME values for 6 foods commonly found in wetlands and the black duck diet. These estimates will be combined with food availability, chronology and duration of stay estimates to populate energetic carrying capacity models currently being developed. Ultimately these models will be used to generate science-based habitat objectives during the non-breeding period and target conservation programs along the Atlantic Coast.

Scope & Location

The study will be conducted at the Winous Point Marsh Conservancy located near Port Clinton, OH (41°30'N, 84°59'W). Test foods for feeding trials will be obtained from either a commercial seed supplier (seeds) or natural wetlands (seeds and invertebrates) located on the Atlantic Coast.

Study Design

Feeding trials will be conducted using captive American black ducks >5 month of age provided by a local breeder. When not being used in feeding trials birds will be confined in an unheated pen, subject to natural temperature and photoperiod, and provided with unlimited access to a commercial game bird ration (crude protein $\geq$ 20%, crude fat $\geq$ 3.0%, crude fiber $\leq$ 5.0%), grit, and fresh water (Petrie et al. 1997). Feeding trials will be conducted between September and January following general procedures outlined in Checkett et al. (2002). We will determine TME for seeds of widgeon grass (*Ruppia maritima*), saltmarsh cordgrass (S*partina alterniflora*), widgeon grass vegetation, saltmarsh snails (*Melampus bidentatus*), killifish (*Fundulidae spp.*), and fiddler crabs (*Uca spp.*). Test species were selected based on their common occurrence in wetlands and presence in the diet of American black ducks (Costanzo and Malecki 1989; D. M. Cramer, University of Delaware, unpublished report; B. Lewis, Jr., Southern Illinois University, unpublished report; D. Plattner, Southern Illinois University, unpublished report).

Mature seeds will be obtained from either a commercial seed supplier or natural wetlands, and invertebrates from natural wetlands. Collected seeds will be air-dried for 48 hr and stored at 5°C, following removal of deformed and green seeds. Procedures for TME bioassays will follow Sibbald (1986). We will randomly select 12 birds (6 male and 6 female) to be fed 6 foods using a 6 × 6 Latin Square (LS) design in which all foods will be fed each feeding trial (Table 1). We will select 6 (3 of each gender) additional birds to serve as controls during each bioassay to provide a measure of endogenous contributions to excreta energy (Sibbald 1986). Feeding trials will be separated by a 10-day period to allow birds to recover lost body mass during the previous trial.

Prior to each feeding trial, birds will be placed in individual metabolism cages (20 x 20 x 30 cm), provided *ad libitum* water, and fasted for 48 hrs. Following fasting, but prior to feeding, we will weigh each bird (± 10 g) then attempt to feed each treatment bird a quantity of food equal to 1% of its body weight (Sibbald 1986). Birds will be fed by inserting a clear plastic tube (1.2 x 40 cm) into the esophagus and slowly pouring the food item into the tube using a funnel and pushing the food item down the tube using a wooden dowel. Food items failing to enter the bird's esophagus (e.g., foods clinging to the tube wall) will be collected, weighed, and subtracted from each bird's original dose. Birds that regurgitate any portion of a test food following feeding will be eliminated from the feeding experiment, thus, for some food items, more than one trial will be required to achieve desired sample sizes. Experimental birds will be fed only once during a trial, and all birds will be returned to their metabolic chambers following handling. Metal trays will be placed under each metabolic chamber that will funnel fecal and urinary material into a plastic container. Excreta will be collected from control and experimental cages 48 hrs following feeding.

Following collection of excreta, samples will be processed for analysis in the lab. Feathers and grit will be removed from each sample; the remaining excreta will be oven-dried at 60°C, weighed to the nearest 0.0001 g, and ground with a mortar and pestle. Subsamples of 1.0 g will be oven-dried to a constant mass at 80°C to determine percent moisture. Gross energy (GE_F) of test foods and excreta from fed and fasted birds on duplicate subsamples will be estimated using a Parr adiabatic oxygen bomb calorimeter (30 atmospheres O_2). TME (kcal/g) will be calculated as:

$$TME = ((GE_F \times W_F) - (EE_F - EE_C)) / W_F$$

where GE_F was the gross energy of the food item (kcal/g), W_F was the dry mass fed (g), EE_F was the energy voided as excreta by the experimental bird (kcal/g), and EE_C was the energy voided as excreta by the control bird (kcal/g). The average energy excreted by control birds will be used to estimate EE_C. To account for potentially greater catabolism of body tissue by control birds and avoid overestimating energy derived from non-food origin, TME will be corrected to zero nitrogen balance (TME_N; Parsons et al. 1982, Sibbald and Morse 1982).

The nutrient composition for all food items will be estimated using proximate analysis. Percent moisture will be determined by drying samples in a forced air oven at 100^{o}C and percent nitrogen using the Kjeldahl procedure (Association of Official Analytical Chemists 2000). Percent nitrogen will be multiplied by 6.25 to estimate crude protein. Crude fat will be estimated using ether extraction, acid detergent fiber (ADF) and neutral detergent fiber (NDF) by the Ankom A200 filter bag technique, and ash content by heating in a cold furnace until 625^{o}C after 15 hr (Association of Official Analytical Chemists 2000). Crude fiber will be estimated as ADF*0.80. Nitrogen Free Extract will be calculated as (100% − %water − %crude fiber − %ash − %fat − %crude protein). TME_N values will be expressed as a percentage of gross energy [(TME_N /GE_F)*100%] to estimate digestive efficiency.

Because body mass may influence TME results, we will use a single factor analysis of variance (ANOVA; PROC GLM) to compare body mass among months for birds used in feeding trials and for differences in mean treatment-body mass among test foods. We also will use ANOVA to determine whether TME_N values of test foods are influenced by gender. We will determine whether TME_N of the 6 foods differ by fitting a mixed model ANOVA (Littell et al. 1996). Test species will be treated as a fixed effect, and date of feeding trial and individual bird will be classified as random effects. To further examine differences in TME_N between test foods, we will conduct pair-wise multiple comparisons using a Tukey multiple comparison test.

Preliminary Results

We hired two technicians and started them on the project on August 3, 2009. We purchased equipment, supplies and materials for the laboratory, holding pen and metabolic chambers and constructed bird facilities (holding pen, shelter and metabolic chambers). Our local breeder (Earl Tappenden) suffered a pen collapse during winter 2008/2009 and was unable to provide in-kind birds for the study. Therefore, we purchased and picked up 12 American black duck pairs from a breeder in Lakeville, Minnesota (Tacheny Wildlife; Permit #749956) on August 13, 2009. We modified the study design to include both male and female American black ducks (n = 18; 6 treatment and 3 control birds of each gender) to evaluate differences in TME_N values of test foods by gender. Trial, feeding schedules and cage assignments for male and female American black ducks are presented in Table 1 and 2, respectively.

Saltmarsh cordgrass seed was purchased from Environmental Concern, Inc.'s wetland plant nursery and widgeon grass vegetation and seed was collected by Maryland Department of Natural Resources staff. Following the location of a provider, we elected to substitute widgeon grass seed for vetch seed as a test food. Animal foods (fiddler crabs, killifish and saltmarsh snails) are currently being collected by New Jersey Division of Fish & Wildlife staff and Michael Castelli, a volunteer. Percent moisture was estimated for saltmarsh cordgrass seed and widgeon grass vegetation and will be estimated for remaining test foods upon receipt.

Practice trials were conducted 8/31 – 9/4 and 9/14 – 9/18 to acclimate birds, practice feeding methodology and determine appropriate food volumes to avoid issues with regurgitation (Table 1 & 2). During practice trials, birds were fed varying amounts (0.5 – 1% dry weight of body mass) of saltmarsh cordgrass seed, widgeon grass vegetation, cracked corn, and millet. Regurgitation issues were encountered when individual birds were fed a quantity of saltmarsh cordgrass seed and widgeon grass equivalent to 1% of body mass. Therefore, we will attempt to feed each bird approximately 0.5% of its body mass.

Information regarding the study and study resources (articles, etc.) have been posted on Ducks Unlimited's Great Lakes Atlantic Regional Office Web page at http://www.ducks.org/Conservation/BlackDuckStudy/3410/BlackDuckStudy.html.

Anticipated Output

The ultimate product of this study will be a peer reviewed publication in the Journal of Wildlife Management, Wildlife Society Bulletin or other comparable scientific journal. Additionally, information regarding the study and study resources (articles, etc.) will be made readily available on DU's Great Lakes Atlantic Regional Office Web page (http://www.ducks.org/Conservation/BlackDuckStudy/3410/BlackDuckStudy.html). The greatest benefit of this work will be the development of energetic carrying capacity models to generate science-based habitat objectives for black duck habitat conservation during the non-breeding period. These products will be made widely available and promoted for use by a diversity of partners to focus their conservation efforts on areas of greatest impact. The BDJV will receive annual and final reports documenting progress on the project.

Management Implications

Although food is not the sole factor determining wetland habitat quality, it is a variable that can be manipulated via management and restoration. TME values of American black duck foods derived from this study and information regarding their abundance in different habitats collected during previous research in New York, New Jersey, and Virginia will be used in conjunction with energetic carrying capacity models to generate science-based habitat objectives for habitat conservation during the non-breeding period in the Atlantic Flyway.

Relationship to Other Projects

This study is directly related to ongoing efforts supported by the BDJV to evaluate habitat carrying capacity, migration chronology, and duration of stay for American black ducks in New Jersey, New York and Virginia. The current project will augment these efforts by providing TME values for previously untested foods commonly found in the black duck diet. In concert this work will lead to the development of bioenergetics models to estimate regional carrying capacity.

Literature Cited

Ballard, B. M., J. E. Thompson, M. J. Petrie, J. M. Checkett, AND D. G. Hewitt. 2004. Diet and nutrition of northern pintails wintering along the southern coast of Texas. Journal of Wildlife Management 68:371–382.

Bergan, J. F., and L. M. Smith. 1993. Survival rates of female mallards wintering in the Playa Lakes Region. Journal of Wildlife Management 57:570–577.

Checkett, J. M., R. D. Drobney, M. J. Petrie, and D. A. Graber. 2002. True metabolizable energy of moist-soil seeds. Wildlife Society Bulletin 30:113–119.

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.

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.

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 46:7–16.

Dugger, B. D., M. L. Moore, R. S. Finger, and M. J. Petrie. 2007. True metabolizable energy for seeds of four common moist-soil plant species. Journal of Wildlife Management 71:1964–1967.

Haramis, G. M., J. D. Nichols, K. H. Pollock, and J. E. Hines. 1986. The relationship between body mass and survival of wintering canvasbacks. Auk 103:506–14.

Heitmeyer, M. E., and L. H. Fredrickson. 1981. Do wetland conditions in the Mississippi Delta hardwoods influence mallard recruitment? Transactions of the 46th North American Wildlife and Natural Resources Conference 46:44–57.

Hoffman, R. D., and T. A. Bookhout. 1985. Metabolizable energy of seeds consumed by ducks in Lake Erie Marshes. Transactions of the North American Wildlife and Natural Resources Conference 50:557–565.

Jeske, C. W., M. R. Szymczak, D. R. Anderson, J. K. Ringelman, and J. A. Armstrong. 1994. Relations of body condition to survival of mallards in San Luis Valley, Colorado. Journal of Wildlife Management 58:141–148.

Jorde, D. G., and R. B. Owen. 1988. Efficiency of nutrient use by American black ducks wintering in Maine. Journal of Wildlife Management 52:209–214.

Kaminski, R. M., and E. A. Gluesing. 1987. Density and habitat related recruitment in mallards. Journal of Wildlife Management 51:141–148.

Kaminski, R. M., J. B. Davis, H. W. Essig, P. D. Gerard, and K. J. Reinecke. 2003. True metabolizable energy of Wood Ducks from acorns compared to other waterfowl foods. Journal of Wildlife Management 67:542-550.

Littell, R. C., G. A. Milliken, W. W. Stroup, and R. D. Wolfinger. 1996. SAS System for Mixed Models. SAS Institute Inc., Cary, North Carolina, USA.

Miller, M. R. 1986. Northern pintail body condition during wet and dry winters in the Sacramento Valley, California. Journal of Wildlife Management 50:189–198.

Miller, M. R., and W. E. Newton. 1999. Population energetics of northern pintails wintering in the Sacramento Valley, California. Journal of Wildlife Management 63:1222–1238.

Miller, M. R., and K. J. Reinecke. 1984. Proper expression of metabolizable energy in avian energetics. Condor 86:396–400.

NAWMP. 2004. North American waterfowl management plan: strengthening the biological foundation (Implementation Framework). U.S. Department of Interior, Fish and Wildlife Service, and Environment Canada, Canadian Wildlife Service.

Parsons, C. M., L. M. Potter, and B. A. Bliss. 1982. True metabolizable energy corrected for nitrogen equilibrium. Poultry Science 61:2241–2246.

Petrie, M. J., and R. D. Drobney. 1998. True metabolizable energy estimates of Canada goose foods. Journal of Wildlife Management 62:1147-1152.

Petrie, M. J., R. D. Drobney, and D. A. Graber. 1997. Evaluation of true metabolizable energy for waterfowl. Journal of Wildlife Management 61:420-425.

Raveling, D. G., and M. E. Heitmeyer. 1989. Relationships of population size and recruitment of pintails to habitat conditions and harvest. Journal of Wildlife Management 53:1088–1103.

Reinecke, K. J., R. M. Kaminski, D. J. Moorehead, J. D. Hodges, and J. R. Nassar. 1989. Mississippi Alluvial Valley. Pages 203–247 *in* L. M. Smith, R. L. Pederson, and R. M. Kaminski, editors. Habitat management for wintering and migrating waterfowl in North America. Texas Tech University Press, Lubbock, Texas, USA.

Sibbald, I. R. 1976. A bioassay for true metabolizable energy in feeding stuffs. Poultry Science 55:303–308.

Sibbald, I. R. 1986. The T.M.E. system of feed evaluation: methodology, feed composition, and bibliography. Agriculture Canada, Technical Bulletin 1986–4E.

Sibbald, I. R., and P. M. Morse. 1982. The effects of nitrogen correction and of feed intake on true metabolizable energy values. Poultry Science 62:138–142.

Sherfy, M. H. 1999. Nutritional value and management of waterfowl and shorebird foods in the Atlantic Coastal moist-soil impoundments. Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, USA.

Personnel

Dr. John Coluccy oversees research and planning efforts for Ducks Unlimited's 18-state Great Lakes Atlantic Region. As the Manager of Conservation Planning, John assists with designing, funding and implementing landscape level research with the objective of refining habitat programs within an adaptive management framework. He has experience with a variety of research issues related to wetlands, and breeding, migrating and wintering waterfowl across a broad geographic range including the prairies, Great Lakes, Atlantic Coast, and Gulf Coast. John is a member of the Upper Mississippi River Great Lakes Joint Venture Science Technical Committee and co-chair of the Waterfowl Sub-committee. He is also a member of the Black Duck and Atlantic Coast Joint Venture Science Technical Committees. John has extensive experience with on-the-ground habitat delivery having spent five years directing Ducks Unlimited's conservation programs in Wisconsin, Indiana and southwest Michigan. John received his B.S. in wildlife ecology from the University of Wisconsin in 1985 and his M.S. and Ph.D. in wildlife ecology from the University of Missouri in 1996 and 2001, respectively.

Dr. Tina Yerkes is in charge of landscape level planning and research initiatives for the Great Lakes/Atlantic Region of DU and oversees GIS, communications and habitat delivery programs across the region. She has experience with a variety of research issues related to waterfowl and wetlands: including breeding, wintering, and spring periods. She has mentored and co-advised 10 graduate students to date. She recently completed a large landscape study of breeding mallards in the Great Lakes states that was specifically designed to address uncertainty in habitat conservation program delivery in this area. Current spring and winter focused projects include: Wintering and spring needs of black ducks in New Jersey, New York, and Virginia, The value of urban wetlands for wintering and spring waterfowl in the Meadowlands, New Jersey, and spring needs of dabbling and diving ducks in mid-latitude migration areas of the Great Lakes States.

Schedule

Date	Activity	Actual Accomplishments as of September 2009
July 2009	Hire technicians; purchase materials; construct TME cages	Technicians hired; equipment, materials and supplies purchased
August – September 2009	Collect and/or purchase test foods	Test foods collected and purchased; holding pen and TME chambers constructed; American black ducks purchased and picked up; practice trials conducted
September 2009	Start feeding trials	Commenced feeding trials
December 2009	Complete feeding trials	
September – December 2009	Pick, sieve and dry excreta samples; conduct bomb calorimetry on excreta samples and test foods; conduct proximate analyses of test foods	
January – June 2010	Conduct statistical analyses; prepare and submit manuscript	

Budget

Budget (US $)	**BDJV**	**DU**	**WRF**	**WPMC**	**ET**	**Total**
Category						
Personnel						
PI ($16,800/month × 3 months)	$0	*$28,400*	$22,000	$0	$0	$50,400
Technicians ($2,000/month × 6 months × 2)	$12,000	$0	$12,000	$0	$0	$24,000
Technician Housing & Bird/Lab Facilities	$0	$0	$0	*$19,000*	$0	$19,000
Transportation (vehicles and fuel)	$0	*$10,000*	$0	$0	$0	$10,000
Laboratory Analysis	$18,000	$0	$29,000	$0	$0	$47,000
Materials/Equipment	$0	$0	$12,000	$0	$0	$12,000
Commercial Waterfowl Feed ($50/bag × 30)	$0	$1,500	$0	$0	$0	$1,500
Straw Bedding ($5/bail × 26)	$0	$130	$0	$0	$0	$130
American black ducks ($45/bird × 20)	$0	$0	$0	$0	*$900*	$900
Publications	$0	$2,000	$0	$0	$0	$2,000
Communications	$0	$3,000	$0	$0	$0	$3,000
Total by Funding Source	$30,000	$45,030	$75,000	$19,000	$900	$169,930
Ratio of Cash-Matching Contributions to BDJV Request	2.72:1					
Ratio of In-Kind Matching Contributions to BDJV Request	1.94:1					

BDJV = Black Duck Joint Venture; DU = Ducks Unlimited; WRF = Waterfowl Research Foundation; WPMC = Winous Point Marsh Conservancy, ET = Earl Tappenden

Table 1. Trial, feeding schedule and cage assignments for male American black ducks.

		Male #								
Trial #	**Date**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Practice	8/31 – 9/4									
Break	9/5 – 9/13									
Practice	9/14 – 9/18									
Break	9/19 – 9/27									
1	9/28 – 10/2	SMCG-3	SMCG-2	SMCG-18	SMCG-5	SMCG-16	SMCG-12	C-1	C-11	C-13
Break	10/3 – 10/11									
2	10/12 – 10/16	WGV-13	WGV-17	WGV-4	WGV-3	WGV-11	WGV-8	C-5	C-2	C-12
Break	10/17 – 10/25									
3	10/26 – 10/30	WGS-2	WGS-5	WGS-9	WGS-11	WGS-18	WGS-4	C-8	C-12	C-6
Break	10/31 – 11/8									
4	11/9 – 11/13	SMS-5	SMS-15	SMS-13	SMS-17	SMS-4	SMS-18	C-16	C-8	C-11
Break	11/14 – 11/22									
5	11/23 – 11/27	KF-8	KF-1	KF-7	KF-16	KF-17	KF-2	C-3	C-9	C-10
Break	11/28 – 12/6									
6	12/7 – 12/11	FC-18	FC-13	FC-10	FC-14	FC-6	FC-15	C-7	C-1	C-9
Break	12/12 – 12/20									
7*	12/21 – 12/25									
Break	12/26 – 1/3									
8*	1/4 – 1/8									
Break	1/9 – 1/17									
9*	1/18 – 1/22									
Break	1/23 – 1/31									

WGV = widgeon grass vegetation; SMCG = saltmarsh cordgrass seeds; WGS = widgeon grass seeds; SMS = saltmarsh snail; KF = killifish; FC = fiddler crab; C = control

* Replacement trials if necessary should birds regurgitate

Table 2. Trial, feeding schedule and cage assignments for female American black ducks.

		Female #								
Trial #	**Date**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Practice	8/31 – 9/4									
Break	9/5 – 9/13									
Practice	9/14 – 9/18									
Break	9/19 – 9/27									
1	9/28 – 10/2	SMCG-8	SMCG-14	SMCG-7	SMCG-10	SMCG-4	SMCG-6	C-15	C-17	C-9
Break	10/3 – 10/11									
2	10/12 – 10/16	WGV-7	WGV-9	WGV-14	WGV-18	WGV-15	WGV-16	C-10	C-1	C-6
Break	10/17 – 10/25									
3	10/26 – 10/30	WGS-16	WGS-13	WGS-15	WGS-14	WGS-1	WGS-10	C-3	C-7	C-17
Break	10/31 – 11/8									
4	11/9 – 11/13	SMS-9	SMS-1	SMS-10	SMS-6	SMS-3	SMS-14	C-7	C-2	C-12
Break	11/14 – 11/22									
5	11/23 – 11/27	KF-11	KF-12	KF-18	KF-15	KF-13	KF-5	C-6	C-14	C-4
Break	11/28 – 12/6									
6	12/7 – 12/11	FC-4	FC-16	FC-17	FC-11	FC-5	FC-8	C-2	C-3	C-12
Break	12/12 – 12/20									
7*	12/21 – 12/25									
Break	12/26 – 1/3									
8*	1/4 – 1/8									
Break	1/9 – 1/17									
9*	1/18 – 1/22									
Break	1/23 – 1/31									

WGV = widgeon grass vegetation; SMCG = saltmarsh cordgrass seeds; WGS = widgeon grass seeds; SMS = saltmarsh snail; KF = killifish; FC = fiddler crab; C = control

* Replacement trials if necessary should birds regurgitate

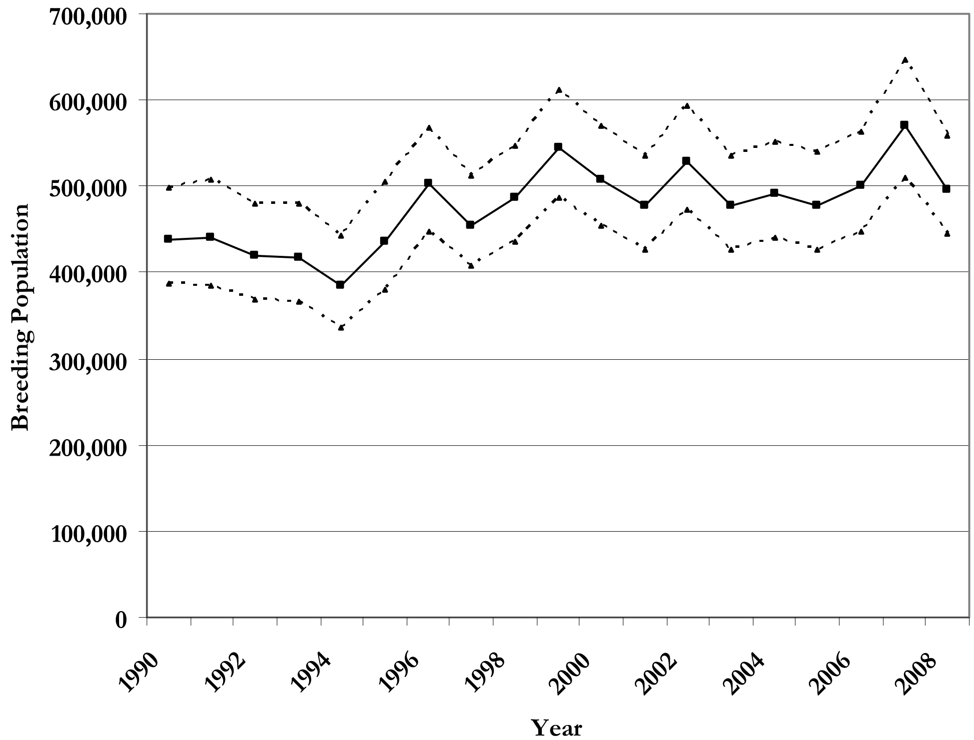

Figure 1. Breeding population estimate and 90% confidence intervals for American black ducks in the eastern survey area, 1990–2008.

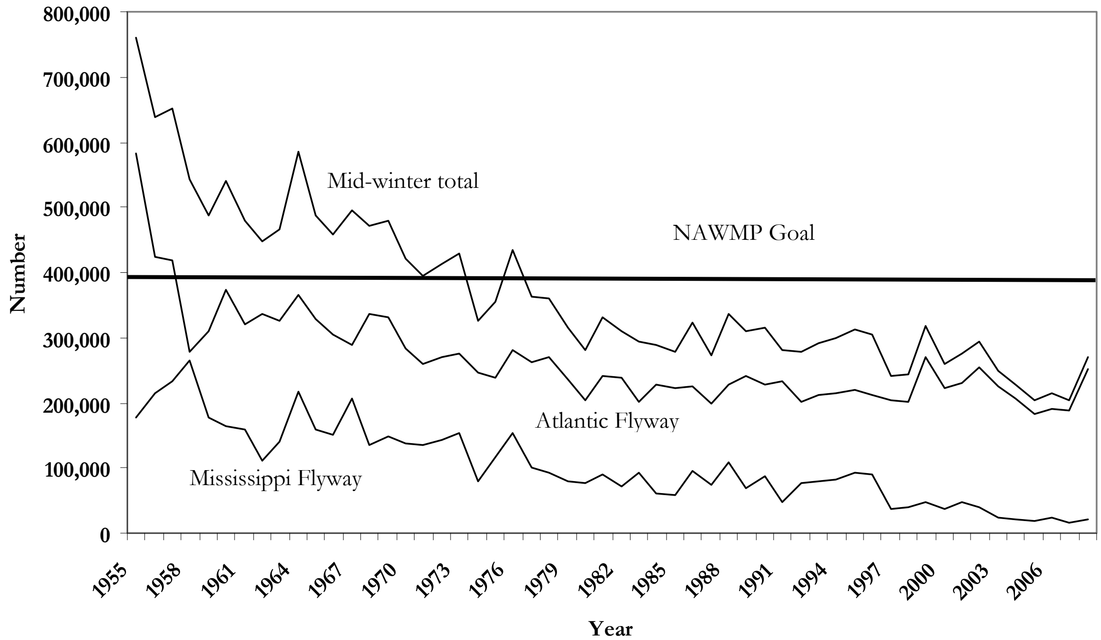

Figure 2. Number of American black ducks counted during the Mid-winter Inventory, 1955–2008.