Survival and Distribution of Black-bellied Whistling-duck (*Dendrocygna autumnalis*) in the Southeastern United States

Bradley S. Cohen, *Department of Biology, Tennessee Technological University, Cookeville, TN 38505*

Samantha E. Askin, *Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602*

Gregory D. Balkcom, *Wildlife Resources Division, Georgia Department of Natural Resources, Social Circle, GA 30025*

R. Joseph Benedict, Jr.[1]**,** *Florida Fish and Wildlife Conservation Commission, Tallahassee, FL 32311*

James A. Rader, *Ducks Unlimited, North Charleston, SC 29418*

J. Dale James, *Ducks Unlimited, Ridgeland, MS 39157*

Bret A. Collier, *School of Renewable Natural Resources, Louisiana State University Agricultural Center, 341 Renewable Natural Resources Building, Baton Rouge, LA 70803*

Michael J. Chamberlain, *Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602*

Abstract: Black-bellied whistling-duck (*Dendrocygna autumnalis*; BBWD) is a neo-tropical species distributed in coastal areas of northern South America, Central America, and southern North America. Despite their pervasiveness, the population distribution, survival, and harvest-mortality of BBWD in the southeastern United States remains unclear. We used BBWD sightings reported to eBird to delineate range expansion from 2006–2016 in Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas. Concurrently, we used band-recovery data from 759 BBWD captured in five states (Georgia, Florida, South Carolina, Texas, and Louisiana) from 2014–2017 and Burnham live-dead models to calculate survival, recapture probability, and annual recovery rate. We noted expanding BBWD distribution in the southern Atlantic flyway, and populations during our study period had a relatively high annual survival rate (0.851 ± 0.137; 95% CI range = 0.408–0.979), low recapture probability (0.035 ± 0.010; 95% CI range = 0.019–0.062), and low recovery rate (0.068 ± 0.054; 95% CI range = 0.013–0.280), although the limited number of resightings and recaptures affected uncertainty around our estimates. Future research should continue to refine population vital rate estimates for BBWD, with an emphasis on understanding population abundance and harvest rates.

Keywords: banding, black-bellied whistling-duck, distribution, survival, range expansion, recovery

Journal of the Southeastern Association of Fish and Wildlife Agencies 6:123–128

The goals of waterfowl management are to ensure future sustainability of waterfowl populations and provide recreational opportunities (U.S. Department of the Interior 2012). To meet these goals, managers require information about waterfowl population abundance and demographics that are derived from large harvest databases (Nichols et al. 2007). For example, band-recovery data provide estimates of annual survival and mortality, which are used in conjunction with estimates of population abundance to inform adaptive-harvest strategies and set regulatory frameworks for North American waterfowl (Johnson et al. 2015). However, for some North American waterfowl species, there remains a paucity of information regarding population abundance, distribution, and vital rates such as survival and mortality rates. Therefore, agencies may have difficulty setting data-driven population goals, identifying applied research needs, and shifting regulatory frameworks for some elusive or less studied waterfowl species (Johnson et al. 2015, Roberts et al. 2018, Humburg et al. 2018).

Black-bellied whistling-duck (*Dendrocygna autumnalis*; hereafter BBWD) is a neo-tropical species distributed in coastal areas of northern South America, Central America, and southern North America (James and Thompson 2001). Most BBWD found in Central and South America are residents, whereas BBWD found in southern North America (the extreme northern range) are believed to be migrants (Bolen 1967, James and Thompson 2001). Some BBWD in the southern United States are from established populations in southern Texas and northern Mexico (Bolen and Rylander 1983, Schneider et al. 1993, Potter et al. 2015), but it is speculated that BBWD found in South Carolina and Georgia are

1. Current address: Wildlife and Forestry Division, Tennessee Wildlife Resources Agency, Nashville, TN 37204

from established populations in Florida that were formerly captive birds (Potter et al. 2015). Populations of successful wild breeders were first documented in Florida in the 1980s (Bergstrom 1999), and those birds most likely expanded their range into South Carolina and Georgia (Harrigal and Cely 2004). In 2003, BBWD were classified as a definitive species on South Carolina's state list (Harrigal and Cely 2004).

Black-bellied whistling-duck is a generalist species, using a wide variety of habitat types throughout their annual cycle (Bourne and Osbourne 1978, Delnicki and Bolen 1976, Saunders and Saunders 1981). Availability of suitable nest cavities with shrub understory below them and ponds with vegetation for brooding cover seem to affect habitat suitability (McKenzie and Zwank 1988), but BBWD use habitats ranging from mangrove swamps (Leopold 1959) to cultivated cropland (Bourne 1981, Bolen and Rylander 1983, Bruzual and Bruzual 1983). Black-bellied whistling-duck forage mainly at night (Womack et al. 1977) on general plant matter (Bolen and Forsyth 1967, Bourne 1981, Bruzual and Bruzual 1983). These generalist tendencies allow BBWD to exploit and thrive in a variety of habitats, including agricultural areas, cattle feedlots, stockyards, and urban areas (Bolen and Forsyth 1967, Bourne 1981, Bruzual and Bruzual 1983, Matta et al. 2014). Throughout the southern portion of the Atlantic flyway, BBWD seem most commonly distributed along the Atlantic and Gulf coastal marshes (Harrigal and Cely 2004, Balkcom et al. 2013).

Information on BBWD ecology is relatively sparse, with most research focusing on breeding ecology and reproductive success (e.g., Bolen et al. 1964, Delnicki and Bolen 1976, Bolen and Smith 1979, McCamant and Bolen 1979). Specifically, the population range, survival, and harvest-mortality of BBWD in the southeastern United States remains unclear. Management of BBWD is further confounded because of difficulty estimating their population size. For example, conducting breeding population surveys may be difficult for BBWD because they are cavity nesters with a propensity to reside near human-occupied areas where aerial flights are limited. Anecdotally, personal observations by biologists along the southern Atlantic flyway suggest that BBWD populations are increasing in number, although harvest seems relatively low given BBWD prevalence during the summer months (Balkcom et al. 2013). Therefore, our objectives were to determine the distribution, survival, and annual recovery rates of BBWD in the southeastern United States. Specifically, we were interested in documenting BBWD range expansion over the previous decade (2006–2016) in Georgia, Florida, and South Carolina; using recovery and resighting information to highlight movement corridors; and estimate annual survival and recovery rates to better inform BBWD management.

Methods

Study Area and Banding Dataset

Our analyses used BBWD banded by biologists from five states (Florida, Georgia, Louisiana, South Carolina and Texas) during 2014–2017 (Figure 1). These states worked together on a multi-

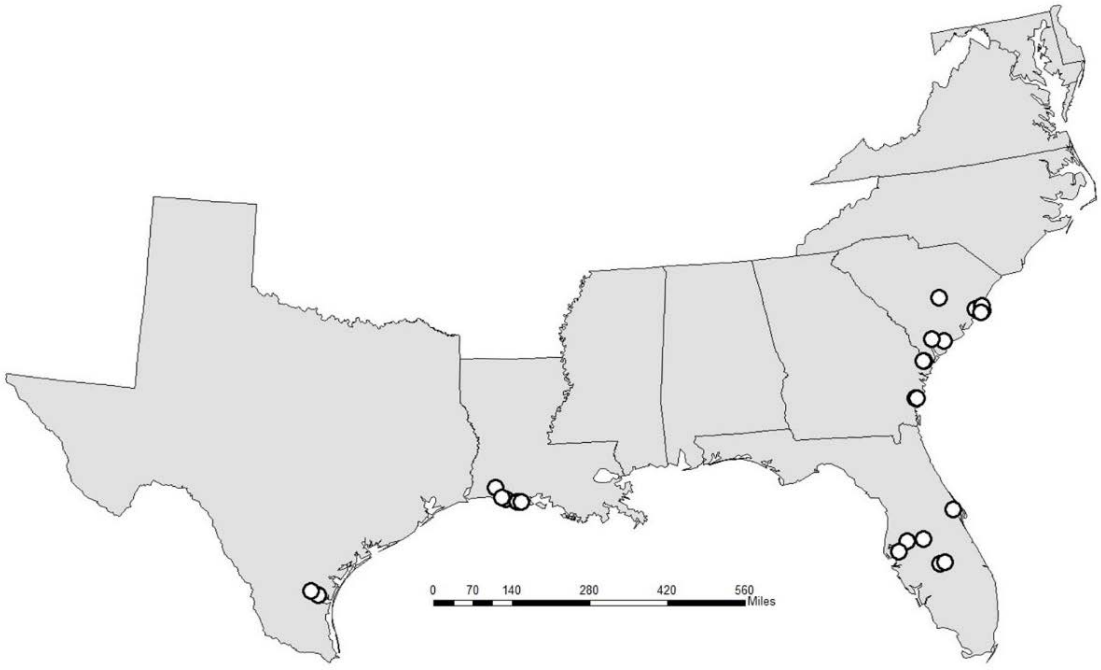

Figure 1. Locations where black-bellied whistling-ducks (*Dendrocygna autumnalis*) were captured and banded from 2014–2017. Band-recovery data were used to calculate survival and annual recovery rates of black-bellied whistling-duck during this study period.

state project to examine the distribution and movement patterns of BBWD utilizing colored, numbered leg bands as the marking tool. Black-bellied whistling-ducks were captured using bait traps, cannon or rocket nets, and night-lighting. Ducks were banded with both a federal numbered aluminum butt-end band (size 7 or 7B) and a plastic colored band with an alphanumeric code (Spinner Plastics, Springfield, Illinois). Colors and codes were state-specific. All capture and banding efforts were completed under each state's federal bird banding permit. Ducks were classified as either after hatch year (AHY) or hatch year (HY) based on plumage characteristics (James and Thompson 2001). Black-bellied whistling-duck are sexually monomorphic (James and Thompson 2001), and some states listed all captured ducks as unknown sex, while other states used cloacal exam to determine sex (Dimmick and Pelton 1994). We obtained banding, recovery, and resighting data from the U.S. Geological Survey Bird Banding Lab, Laurel, Maryland. We summarized bandings and recoveries from 2014–2017 because it was concurrent with a concerted effort by the aforementioned state agencies to band BBWD.

Geographic Range

Understanding the geographic range of an animal species and delineating changes in distribution over time can be difficult with traditional research approaches as they cannot identify immediate shifts in range (Crooks 2005, Coutts et al. 2018). However, recent advances in technology and citizen science have facilitated better data collection and quality, allowing rapid data curation, synthesis, and analysis (Tulloch et al. 2013). To delineate the range expansion of BBWD from 2006 to 2016, we relied on sightings of BBWD reported by volunteers to eBird (ebird.org; Sullivan et al. 2009). eBird is a cooperative partnership which collects information about the distribution and abundance of birds through a global network of volunteers who submit bird observations via the internet to a central data repository (Sullivan et al. 2009). We used eBird data to quantify number of reported sightings of BBWD within each county in Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas.

To explore the potential range of BBWD, we used band-recovery and resighting data to document shifts in locations between where an individual was banded and subsequently recovered or resighted. To understand how far some individuals in the population were moving, we quantified the distance between banding and recovery locations or banding and resighting location for each individual. We then calculated the mean distance between banding and recovery locations, and the standard error and range within our sample.

Survival and Recovery

We used the Burnham (1993) joint live recapture-dead recoveries model in program MARK (Brownie et al. 1985, White and Burnham 1999) and constructed candidate models to represent annual survival (S), recapture rate (p), probability of recovery (r), and site fidelity (F). However, due to the relative paucity of recovery data, we were only able to fit models for constant or time-dependent survival [S(.) or S(t)], and restricted both p and r to be constant over our sampling period. We also constrained the fidelity parameter (F = 1.00) for both models (Burnham and Anderson 2002).

Results

Biologists from Florida, Georgia, Louisiana, South Carolina, and Texas banded 759 BBWD across four summers (209 in 2014, 314 in 2015, 206 in 2016, 30 in 2017; Table 1). We note that 48 BBWD were banded in Texas, whereas 138, 103, 262, and 208 were banded in Louisiana, Florida, Georgia, and South Carolina. Of the 759 BBWD banded, 519 were AHY, 218 were HY, and 22 were of unknown age. Of AHY BBWD banded, 160 were males, 186 were females, and 173 were unknown sex. Of HY BBWD banded, 10 were males, 18 were females, and 190 were unknown sex. Of the 209 BBWD banded in 2014, 187 (89.5%) were not resighted or recovered during our study period. For the 314 BBWD banded in 2015, 290 (92.4%) were never resighted or recovered during our study period. Of the 206 BBWD banded in 2016, 197 (95.6%) were never resighted or recovered during our study period. Lastly, zero of the 30 BBWD banded in 2017 were resighted or recovered during our study period.

Number of BBWD sightings within counties increased from 2006 to 2011, and from 2011 to 2016. In 2006, there were 27 counties with BBWD sightings across Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas; 26 of these had ≤50

Table 1. Banding, resighting, and recovery summary for black-bellied whistling-ducks (*Dendrocygna autumnalis*) banded in Georgia, Florida, Texas, South Carolina, and Louisiana from 2014–2017.

	Year captured	Birds banded (*n*)	Year of resighting or recovery			
			2014	2015	2016	2017
Resightings	2014	209	5	4	6	6
	2015	314	–	12	6	11
	2016	206	–	–	3	5
	2017	30	–	–	–	0
Recoveries	2014	209	4	4	1	0
	2015	314	–	2	2	2
	2016	206	–	–	3	1
	2017	30	–	–	–	0

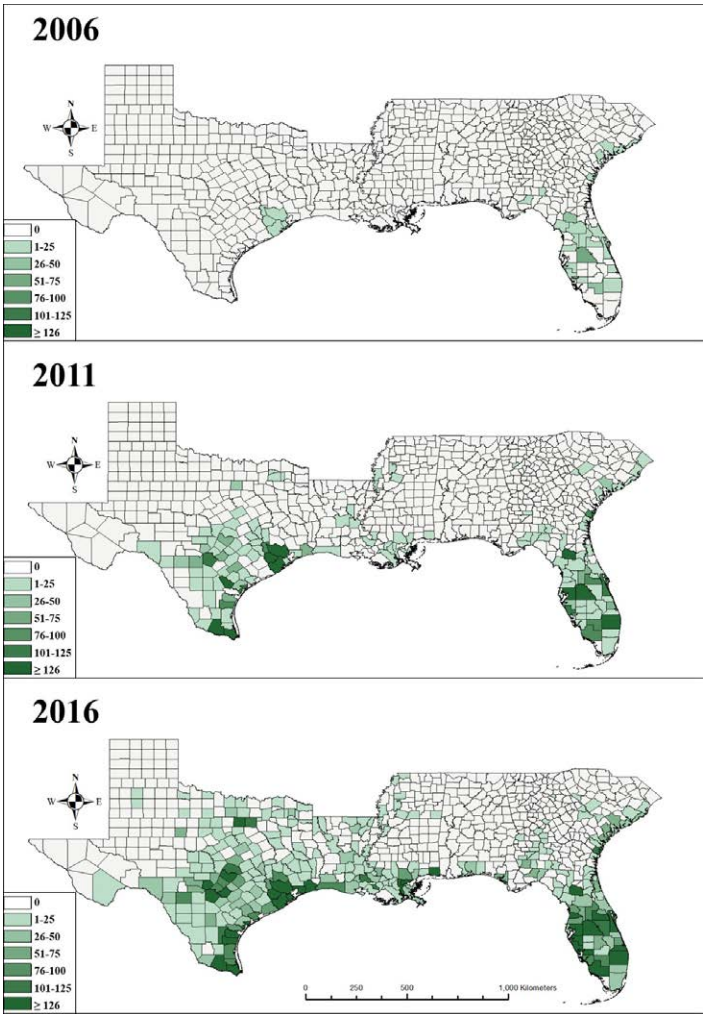

Figure 2. Number of black-bellied whistling-ducks (*Dendrocygna autumnalis*) sightings as reported to eBird in 2006, 2011, and 2016. The geographic range of black-bellied whistling-ducks sightings expanded between 2006 and 2016.

sightings (Figure 2). By 2011, 136 counties had reported sightings of BBWD; 14 of those counties reported ≥125 sightings (Figure 2). By 2016, BBWD were distributed across the entire Florida panhandle, and along the coastal regions of Alabama, Georgia, Louisiana, Mississippi, South Carolina, and Texas. In all, 307 counties had sightings of BBWD in 2016, of which 38 counties reported ≥125 sightings (Figure 2).

Distance between banding and recovery or resighting sites averaged 202.3 ± 28.2 km, ranging from 4.8 to 892.1 km. We documented significant long distance movements for some individuals. For example, 2 individuals banded in South Carolina were recovered in New Jersey. Collectively, banded individuals contributed to 58 resightings and 19 recoveries during 2014–2016, and all recoveries were from hunter harvest (Table 2). Nine BBWD were direct recoveries that were recovered in the hunting season immediately following banding. The other ten recoveries were recovered in subsequent hunting seasons. At the end of the study period, annual survival rate was (S) 0.851 ± 0.137; 95% (CI range = 0.408–0.979), recapture probability (p) was 0.035 ± 0.010 (95% CI range = 0.019–0.062), and probability of recovery (r) was 0.068 ± 0.054 (95% CI range = 0.013–0.280).

Discussion

We noted an annual survival rate of BBWD comparable to or higher than other waterfowl species (e.g., Anderson 1975, Arnold et al. 2002, Olson 2013, Arnold et al. 2016). Conversely, we noted a relatively low annual recovery rate, although we recognize that low numbers of recoveries produced large confidence intervals around those rates. Relatively high survival and low annual recovery rates may partially result from BBWD behaviors (Bolen and McCamant 1977). For example, BBWD often forage at night which likely reduces encounters with hunters (Leopold 1959, Womack et al. 1977). Black-bellied whistling-duck also commonly occupy urban and suburban areas where hunter access may be limited (James and Thompson 2001). Notably, low numbers of recoveries during our study period made it impossible to estimate age- and sex-specific survival and annual recovery rates. Future research should work towards banding birds more extensively both spatially and temporally to facilitate an understanding of age and sex-specific survival and recovery. Additionally, we note that for model optimization we had to fix fidelity (F = 1.00) although there were several records of harvest outside of the banding state. Fixing fidelity to 1.00 may have positively biased our other parameter estimates, resulting in increased survival and recovery estimates. In the future, additional banding efforts across broader spatial extent may assist with the development of multi-strata models where site fidelity can be integrated into the analysis.

As recently as the 1970s, BBWD populations were restricted to southern Texas, with no evidence to indicate a further expansion of their range (Bolen and Rylander 1983, Schneider et al. 1993). We recognize that use of volunteer reports from an online service such as eBird may be biased towards increasing reports temporally as the public became more familiar with eBird. Nonetheless, we offer that our findings clearly demonstrate that the range of BBWD has expanded greatly since 2006, although reasons for this range expansion are speculative. Some have hypothesized that BBWD require tropical climates and northward expansion of their range is temperature-dependent because temperatures in more temperate climates increase the amount of energy required for successful reproduction (Cain 1973). Therefore, warming temperatures associated with climate change may facilitate this northward expansion. We suggest future research should evaluate the potential links be-

tween warming temperatures in temperate areas and BBWD range expansion.

Expanding distribution of BBWD has resulted in the species now being ubiquitous along the southeastern coast. Despite being legal for take, BBWD do not represent a significant proportion of waterfowl in hunter bags (Raftovich et al. 2017). When waterfowl populations could withstand increased harvest, the U.S. Fish and Wildlife Service, working with the respective Flyway Councils, has sometimes responded by allowing separate, earlier hunting seasons. For example, many southeastern states have an early waterfowl harvest season in September that allows hunters to harvest blue-winged (*Anas discors*) and green-winged teal (*Anas crecca*), and in Florida, additionally, wood ducks (*Aix sponsa*). If state agencies were interested in providing greater harvest opportunity for BBWD, they could work together through the Flyway Councils and the National Flyway Council to request that the U.S. Fish and Wildlife Service allow BBWD harvest concurrent with these early teal seasons. However, BBWD are of similar size to and sympatric with mottled ducks along many coastal areas of the Gulf and Atlantic coast (Varner et al. 2014, Shipes et al. 2015, Pollander 2017) and state agencies may need to educate hunters on the physical and flight-related differences between mottled ducks and BBWD to prevent non-target harvest. Nonetheless, BBWD may become a more important game species in the future, and our data suggest that further discussion regarding expanding harvest opportunities may be warranted. Future research should continue to refine population vital rate estimates to limit the uncertainty around our estimates and determine if BBWD harvest is appropriate for its current distribution.

Acknowledgments

We appreciate funding and support provided by the Georgia Department of Natural Resources, Wildlife Resources Division, and the Warnell School of Forestry and Natural Resources at the University of Georgia. We thank the following wildlife biologists for coordinating the BBWD banding in their respective states: Dean Harrigal and Molly Kneece in South Carolina, Jamie Feddersen and Andrew Fanning in Florida, Robert Horan in Georgia, Larry Reynolds in Louisiana, and Kevin Kraii in Texas.

Literature Cited

Anderson, D. R. 1975. Population ecology of the mallard: V. Temporal and geographic estimates of survival, recovery and harvest rates. U.S. Fish and Wildlife Service, Resource Publication No. 125, Washington, D.C.

Arnold, T. W., A. D. Afton, M. J. Anteau, D. N. Koons, and C. A. Nicolai. 2016. Temporal variation in survival and annual recovery rates of lesser scaup. Journal of Wildlife Management 80:850–861.

———, M. G. Anderson, M. D. Sorenson, and R. B. Emery. 2002. Survival and philopatry of female redheads breeding in southwestern Manitoba. Journal of Wildlife Management 66:162–169.

Balkcom, G. D., B. T. Bond, and T. M. Schneider. 2013. Current status and distribution of the black-bellied whistling-duck (*Dendrocygna autumnalis*) in Georgia. Oriole 77:81–84.

Bergstrom, B. J. 1999. First reported breeding of black-bellied whistling-duck in northern Florida. Florida Field Naturalist 27:177–179.

Bolen, E. G. 1967. The ecology of the black-bellied tree duck in southern Texas. Ph.D. Dissertation. Utah State University, Logan, Utah.

——— and B. J. Forsyth. 1967. Foods of the black-bellied tree duck in south Texas. Wilson Bulletin 79:43–49.

——— and R. E. McCamant. 1977. Mortality rates for black-bellied whistling-duck. Bird Banding 48:350–353.

———, B. McDaniel, and C. Cottam. 1964. Natural history of the black-bellied tree duck (*Dendrocygna autumnalis*) in southern Texas. Southwestern Naturalist 9:78–88.

——— and M. K. Rylander. 1983. Black-bellied whistling-duck: zoogeography, ecology and anatomy. Special Publications of the Museum of Texas Tech University 20:1–67.

——— and E. N. Smith. 1979. Notes on the incubation behavior of black-bellied whistling-duck. Prairie Naturalist 11:119–123.

Bourne, G. R. 1981. Food habits of black-bellied whistling-duck occupying rice culture habitats. Wilson Bulletin 93:551–554.

——— and D. R. Osborne. 1978. Black-bellied whistling-duck utilization of a rice culture habitat. Intercencia 3:152–158.

Brownie, C., D. R. Anderson, K. P. Burnham, and D. S. Robson. 1985. Statistical inference from tag-recovery data—a handbook. Second edition. U.S. Fish and Wildlife Service. Washington, D.C.

Bruzual, J. and I. Bruzual. 1983. Feeding habits of black-bellied whistling-duck in the Calabozo ricefields, Venezuela, during the non-reproductive period. Wildfowl 34:20–26.

Burnham, K. P. 1993. A theory for combined analysis of ring recovery and recapture data. Pages 199–213 *in* Marked individuals in bird population studies. J. D. Lebreton and P. North, editors. Birkhauser Verlag, Basel.

——— and D. R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. Second edition. Springer-Verlag, New York, New York.

Cain, B. W. 1973. Effect of temperature on energy requirements and northward distribution of the black-bellied tree duck. Wilson Bulletin 85:308–317.

Coutts, S. R., K. J. Helmstedt, and J. R. Bennett. 2018. Invasion lags: the stories we tell ourselves and our inability to infer process from pattern. Diversity and Distributions 24:244–251.

Crooks, J. 2005. Lag times and exotic species: The ecology and management of biological invasions in slow-motion. Ecoscience 12:316–329.

Delnicki, D. E. and E. G. Bolen. 1976. Renesting by the black-bellied whistling-duck. Auk 93:535–542.

Dimmick, R. W. and M. R. Pelton. 1994. Criteria of sex and age. Pages 169–214 in T. A. Bookhout, ed. Research and management techniques for wildlife and habitats. Fifth ed. The Wildlife Society, Bethesda, Maryland.

Harrigal, D. and J. E. Cely. 2004. Black-bellied whistling-duck nest in South Carolina. The Chat 68:106–108.

Humburg, D. D., M. G. Anderson, M. G. Brasher, M. F. Carter, J. M. Eadie, D. C. Fulton, F. A. Johnson, M. C. Runge, and M. P. Vrtiska. 2018. Implementing the 2012 North American Management Plan revision: populations, habitat, and people. Journal of Wildlife Management 82:275–286.

James, J. D. and J. E. Thompson. 2001. Black-bellied whistling-duck (*Dendrocygna autumnalis*). The Birds of North America. <https://birdsna.org/Species-Account/bna/species/bbwduc>. Accessed 2 March October 2018.

Johnson, F. A., G. S. Boomer, B. K. Williams, J. D. Nichols, and D. J. Case. 2015. Multilevel learning in the adaptive management of waterfowl harvests: 20 years and counting. Wildlife Society Bulletin 39:9–19.

Leopold, A. S. 1959. Wildlife of Mexico—the game birds and mammals. University of California Press, Berkeley.

Matta, N. E., M. A. Pacheco, A. A. Escalante, G. Valkiūnas, F. Ayerbe-Quiñones, and L. D. Acevedo-Cendales. 2014. Description and molecular characterization of *Haemoproteus macrovacuolatus* n. sp. (Haemosporida, Haemoproteidae), a morphologically unique blood parasite of black-bellied whistling-duck (*Dendrocygna autumnalis*) from South America. Parasitology Research 113:2991–3000.

McCamant, R. E. and E. G. Bolen. 1979. A 12-year study of nest box utilization by black-bellied whistling-duck. Journal of Wildlife Management 43:936–943.

McKenzie, P. M. and P. J. Zwank. 1988. Habitat suitability index models: black-bellied whistling-duck (breeding). U.S. Fish and Wildlife Service Biological Report 82(10.150).

Nichols, J. D., M. C. Runge, F. A. Johnson, and B. K. Williams. 2007. Adaptive harvest management of North American waterfowl populations: a brief history and future prospects. Journal of Ornithology 148(Suppl 2):S343–S349.

Olson, D. 2013. Survival and annual recovery rate analysis of green-winged teal. Pages 28–35 *in* Teal Harvest Potential Working Group, editor. An assessment of the harvest potential of North American teal. <http://www.fws.gov/migratorybirds/pdf/surveys-and-data/FinalTealAssessmentReport.pdf>. Accessed 12 May 2017.

Pollander, K. M. 2017. Movements, space use, and habitat selection of the mottled duck in Georgia and South Carolina. Master's Thesis. University of Georgia, Athens.

Potter, E. F., J. F. Parnell, R. P. Teulings, R. Davis. 2015. Birds of the Carolinas, version 2 edition. UNC Press Books, Chapel Hill, North Carolina.

Raftovich, R. V., S. C. Chandler, and K. K. Fleming. 2017. Migratory bird hunting activity and harvest during the 2015–16 and 2016–17 hunting seasons. U.S. Fish and Wildlife Service, Laurel, Maryland.

Roberts, A., J. M. Eadie, D. W. Howerter, F. A. Johnson, J. D. Nichols, M. C. Runge, M. P. Vrtikska, and B. K. Williams. 2018. Strengthening links between waterfowl research and management. Journal of Wildlife Management 82:260–265

Saunders, G. B. and D. C. Saunders. 1981. Waterfowl and their wintering grounds in Mexico, 1937–64. U.S. Fish and Wildlife Service Resource Publication No. 138:1–151.

Schneider, J. P., T. C. Tacha, and D. Lobpries. 1993. Breeding distribution of black-bellied whistling-ducks in Texas. Southwestern Naturalist 38:383–385.

Shipes, J. C., J. B. Davis, E. P. Wiggers, W. E. Mills, R. M. Kaminski, and M. R. Kneece. 2015. Annual habitat selection by mottled ducks in coastal South Carolina. Journal of the Southeastern Association of Fish and Wildlife Agencies 2:268–273.

Sullivan, B. L., C. L. Wood, M. J. Iliff, R. E. Bonney, D. Fink, and S. Kelling. 2009. eBird: a citizen-based bird observation network in the biological sciences. Biological Conservation 142:2282–2292.

Tulloch, A. I. T., H. P. Possingham, L. N. Joseph, J. Szabo, and T. G. Martin. 2013. Realising the full potential of citizen science monitoring programs. Biological Conservation 165:128–138.

U.S. Department of the Interior. 2012. North American Waterfowl Management Plan 2012: people conserving waterfowl and wetlands. U.S. Department of the Interior, Washington, D.C.

Varner, D. M., G. R. Hepp, and R. R. Bielefeld. 2014. Movements and seasonal use of habitats by rural and urban mottled ducks in southeast Florida. Journal of Wildlife Management 78:840–847.

White, G. C. and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46:S120–S139.

Womack, S. M., M. K. Rylander, and E. G. Bolen. 1977. The structure of the retina in four species of whistling-duck, *Dendrocygna*. Texas Journal of Science 29:141–142.