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Black Ducks and Their Chesapeake Bay Habitats: Proceedings of a Symposium

USGS/BRD/ITR—2002–0005
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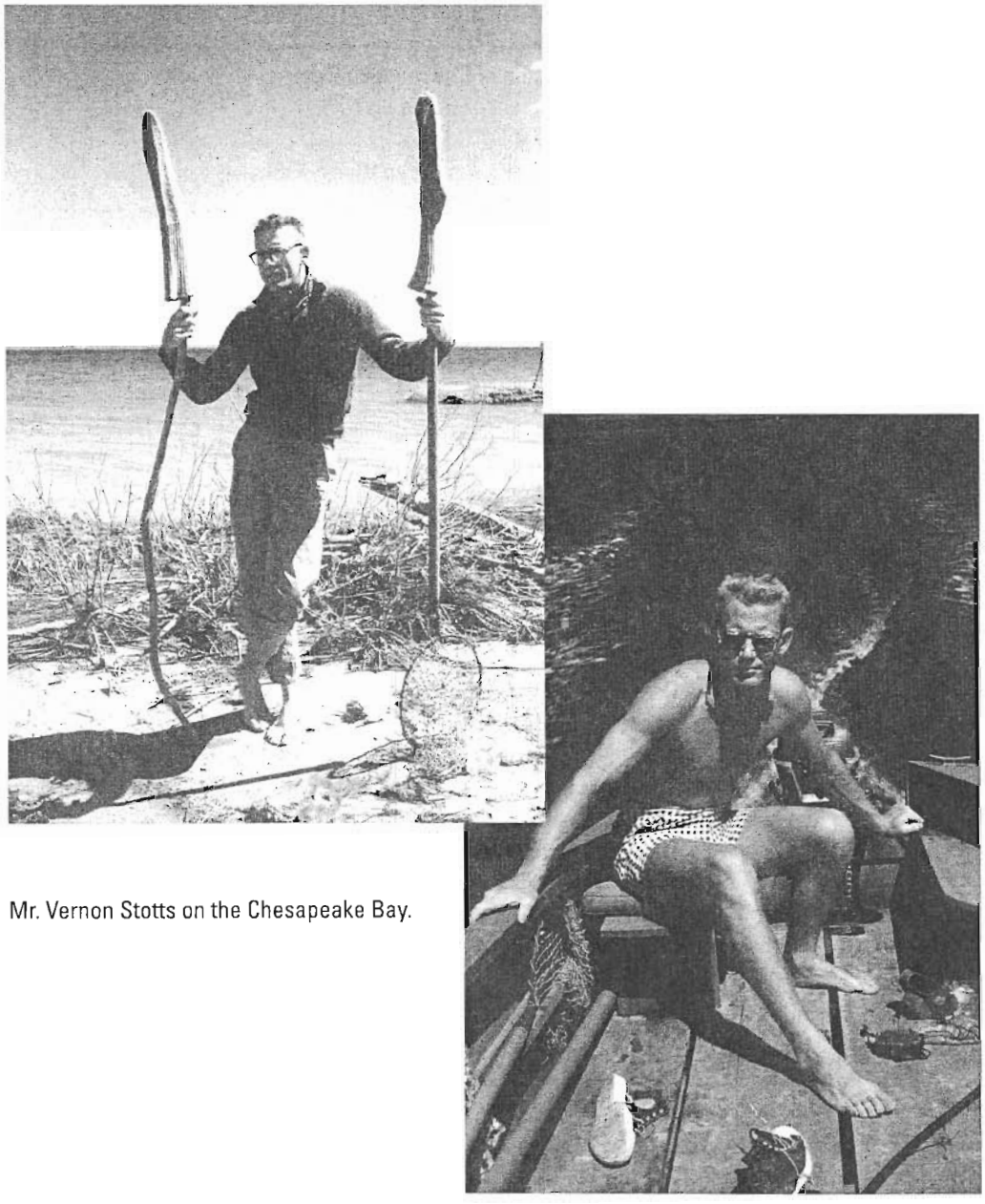
In spite of all his professional accomplishments, anyone who has spent any time with Mr. Stotts is readily impressed with his warm and sincere personality that makes working with him a pleasure. Those who have had the privilege to follow him across one of the Bay's salt marshes have cherished memories of working beside one of the best biologists the wildlife profession has ever produced. For his accomplishments with waterfowl, especially black ducks, and his unbridled enthusiasm and positive attitude about our irreplaceable natural resources, we dedicate this symposium, "Black Ducks and Their Chesapeake Bay Habitats" to Vernon D. Stotts.



Mr. Vernon Stotts on the Chesapeake Bay.

Cover photos: black duck habitat at Savanna Lake, Dorchester County, Maryland (R.E. Stewart, Sr., U.S. Fish and Wildlife Service); Jerry Longcore checking a black duck nest at U.S. Geological Survey, Patuxent Wildlife Research Center; and two male black ducks (Matthew Perry, U.S. Geological Survey, Patuxent Wildlife Research Center).

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Preface

This symposium, "Black Ducks and Their Chesapeake Bay Habitats," held on October 4, 2000, was primarily sponsored and hosted by the Wildfowl Trust of North America located at Horsehead Wetlands Center in Grasonville, Md. Other sponsors included the U.S. Geological Survey's (USGS) Patuxent Wildlife Research Center (Laurel, Md.), Chesapeake College (Wye Mills, Md.), and the Biological Resources Division of the U.S. Geological Survey (Reston, Va.).

It was the first of many planned symposia to discuss an important waterfowl species of Chesapeake Bay and the habitat on which the species is dependent. The black duck, also referred to here as the American black duck (*Anas rubripes*), was a logical species in which to begin the symposia series. As a breeding and wintering Bay duck, it has traditionally epitomized the value of the Chesapeake Bay as well as the problems facing these habitats.

The goal of the symposium was to bring together some of the best experts on the subject and to share this information with a broad spectrum of individuals interested in black ducks and their Bay habitats. It was anticipated that the symposium would result in a better understanding of black duck biology and Chesapeake Bay habitats that would allow managers and conservationists to effectively plan for the future of the American black duck.

Invited papers dealing with black ducks were presented during the day at Chesapeake College, and posters dealing with other waterfowl and habitats of Chesapeake Bay were displayed at an evening reception at the Horsehead Wetlands Center. The subjects of the posters indirectly relate to the welfare of black duck populations and their habitats. Edward Delaney, executive director of the Wildfowl Trust of North America, welcomed the participants of the symposium with a short discussion of the historic reputation of the black duck. Gerald Winegrad, vice president of the American Bird Conservancy, acted as moderator of the symposium and introduced all the speakers. Vernon Stotts, retired biologist and the person to whom this symposium is dedicated, gave an introduction and provided a historic movie of Chesapeake Bay black ducks. All technical aspects of the symposium were the responsibility of myself and my staff at the USGS Patuxent Wildlife Research Center. It was our goal to present a balanced assessment of the status of the black duck that would include all aspects of the species and its habitat in a friendly, open, and professional environment.

Numerous persons expended many hours to make the event successful. Virginia Vroblesky was the person most responsible for all logistical planning for the event. Elaine Wilson was the key contact at Chesapeake College. Volunteers and staff who assisted in advance planning and on the day of the symposium included Dave Houchins, Donna Houchins, Michelle Lawrence, Edward Lohnes, Margaret Maher, Clinton Pinder, Kathy Siegfried, Liz Smith, Chris Snow, and Coreen Weilminster. The assistance of these individuals and others was greatly appreciated.

Numerous persons assisted on the publication of the proceedings including Tammy Charron, Marcia Holmes, Lynda Garrett, Edward Lohnes, and Beth Vairin.

Matthew C. Perry
USGS Patuxent Wildlife Research Center

Symposium Dedication

This symposium is dedicated to Vernon D. Stotts, a retired biologist who has studied various aspects of black ducks in Chesapeake Bay since 1953. His work was conducted as senior waterfowl biologist for the Maryland Department of Natural Resources and after retirement as a contractor of the Annapolis Field Office of the U.S. Fish and Wildlife Service. Mr. Stotts studied the black duck for his master of science degree thesis and has written several important articles about this species. His son, Daniel B. Stotts, has continued the tradition as a waterfowl biologist for the U.S. Fish and Wildlife Service and the U.S. Geological Survey's Patuxent Wildlife Research Center.

Mr. Stotts' contributions to the wildlife profession were clearly stated in the March 29, 1982, Special Recognition Service Award presented to him by Theodore Bookout, president of The Wildlife Society, "for pioneering work in the waterfowl management in the Chesapeake Bay area":

> Few biologists have contributed more to the conservation and management of regional waterfowl populations than Vernon D. Stotts. When the Atlantic Waterfowl Technical Section was formed in 1960, Vern Stotts was elected its first Chairman. His accomplishments in the Chesapeake Bay area include pioneering work in aerial waterfowl population surveys, innovative waterfowl capture methods, quantification of rooted aquatic vegetation and waterfowl abundance, early work on control of exotic vegetation, and comprehensive studies of lead poisoning of waterfowl. Additionally, he was principally responsible for the implementation of Maryland's Open Marsh Management program employing biological methods for mosquito control and marsh management. The Wildlife Society is pleased to recognize the accomplishments and contributions of Vernon D. Stotts through the presentation of its Special Recognition Service Award.

Mr. Stotts was born in Alberta, Minnesota, on November 4, 1927. He served in the U.S. Air Force from February 1946 to January 1949 as a draftsman. He then attended college and received his bachelor of science degree in 1953 from the University of Minnesota, St. Paul. He was a waterfowl technician from 1953 to 1954 with the Maryland Game and Inland Fish Commission. During this time, he studied the breeding biology of the black duck in the Kent Island area of Maryland. This research was used as partial requirements for his master of science degree in plant and animal science, which he received in 1955 from the University of Illinois, Champaign.

Mr. Stotts became waterfowl program manager in 1955 and served in this role until 1981. During this period the Maryland Game and Inland Fish Commission became the Maryland Wildlife Administration. During his long career with the state of Maryland and its portion of the Chesapeake Bay, Mr. Stotts became known as a preeminent waterfowl biologist. He published numerous scientific papers in professional journals and in conference proceedings.

After his retirement in 1981, he became a private consultant and conducted many projects for the Federal and State governments. He conducted numerous banding projects in Labrador and Alberta, Canada, as well as waterfowl surveys closer to home in the Chesapeake Bay. He was a major contributing author of the Canada Goose Management Plan for the Atlantic Flyway as well as local management plans for little known sites such as Days Cove, which is Maryland Department of Natural Resources property on the Gunpowder River. One of his more memorable contracts conducted for the U.S. Fish and Wildlife Service was the survey of breeding black ducks in the Eastern Bay region of Chesapeake Bay. This survey was a modern-day duplication of his previous research in the 1950s. Unfortunately, the disappearance of many of the black duck nesting islands and the much reduced number of black ducks in this region made the survey results disappointing to waterfowl managers and researchers. Mr. Stotts continues

his active role with waterfowl and Bay activities but also enjoys retirement life in his Queenstown home with Shirley, his wife of 40 years.

In spite of all his professional accomplishments, anyone who has spent any time with Mr. Stotts is readily impressed with his warm and sincere personality that makes working with him a pleasure. Those who have had the privilege to follow him across one of the Bay's salt marshes have cherished memories of working beside one of the best biologists the wildlife profession has ever produced. For his accomplishments with waterfowl, especially black ducks, and his unbridled enthusiasm and positive attitude about our irreplaceable natural resources, we dedicate this symposium, "Black Ducks and Their Chesapeake Bay Habitats" to Vernon D. Stotts.

Mr. Vernon Stotts on the Chesapeake Bay.

Contents

Preface iii
Symposium Dedication iv
Contents vi
Abstract 1
Welcome 1
Presentations 2
The American Black Duck: a Species of International Concern—Jerome R. Serie, U.S. Fish and Wildlife Service 2
American Black Duck Summer Range Versus Winter Range: a Dichotomy of Riches—Jerry R. Longcore, U.S. Geological Survey 7
Black Duck Nesting in the Virginia Portion of Chesapeake Bay—Gary Costanzo, Virginia Department of Game and Inland Fisheries 11
Effects of Human Disturbance on Wintering American Black Ducks—John M. Morton, U.S. Fish and Wildlife Service 11
Mallards Replacing Black Ducks: Two Views—Ginger M. Bolen, Eugene Morton, Russell Greenberg, and Scott Derrickson, Smithsonian Institution 16
Breeding Productivity of Smith Island Black Ducks—G. Michael Haramis, Dennis G. Jorde, Glenn H. Olsen, and Daniel B. Stotts, U.S. Geological Survey; and Michael K. Harrison, Sr., U.S. Fish and Wildlife Service 22
The Midwinter Survey of Black Ducks, Locally and Regionally—Dennis G. Jorde and Daniel B. Stotts, U.S. Geological Survey 31
The North American Black Duck (*Anas rubripes*): a Demonstrated Failure in the Application of the Presumed Principles of Waterfowl Management—John W. Grandy, IV, The Humane Society of the United States 35
Posters 36
Evaluation of Vegetative Response to Fire Exclusion and Prescribed Fire Rotation on Blackwater National Wildlife Refuge and Fishing Bay Wildlife Management Area—Connie Flores, U.S. Fish and Wildlife Service 36
Proposed Shallow Water Impoundment at Swan Harbor Farm—Ducks Unlimited, Inc.—Fred Gillotte, Jr., Michael Affleck, and Mark Gorham, Ducks Unlimited, Inc. 36
Reconstruction of Anacostia Wetlands: Success?—Richard S. Hammerschlag, U.S. Geological Survey 36
Pond Use by Wintering Waterfowl on the Northern Virginia Piedmont—Susan Heath, George Mason University 37
Soil Development as a Functional Assessment of a Reconstructed Freshwater Tidal Marsh—Stephanie Kassner and Patrick Kangas, University of Maryland at College Park 38
Understanding Food Webs in the Chesapeake Bay—Janet R. Keough, G. Michael Haramis, and Matthew C. Perry, U.S. Geological Survey 38

The Exotic Mute Swan (*Cygnus olor*) in Chesapeake Bay, USA—Matthew C. Perry, U.S. Geological Survey 38
Seasonal Dynamics of Waterbirds Using Freshwater Tidal Wetlands in the Nonbreeding Season—Christopher Swarth and Judy Burke, Jug Bay Wetlands Sanctuary 39
Marsh Periwinkles (*Littoraria irrorata*) as an Indicator of Mesocosm and Restored Ecosystem Quality—Stacy Swartwood and Patrick Kangas, University of Maryland at College Park 39
Public Policy and the Rocky Mountain Breeding Population of the Trumpeter Swan (*Cygnus buccinator*)—James Tate, Jr., Idaho National Engineering and Environmental Laboratory 40
Summary—Matthew C. Perry, U.S. Geological Survey 41
Attendees 42

Black Ducks and Their Chesapeake Bay Habitats: Proceedings of a Symposium

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Abstract

The symposium "Black Ducks and Their Chesapeake Bay Habitats," held October 4, 2000, provided a forum for scientists to share research about the American black duck (*Anas rubripes*), an important breeding and wintering waterfowl species dependent upon the Chesapeake Bay habitats. American black ducks have declined significantly in the last 50 years and continue to be a species of management concern. The symposium, sponsored by the Wildfowl Trust of North America and the U.S. Geological Survey, highlighted papers and posters on a range of topics, from the traditional concerns of hunting, habitat, and hybridization to the more recent concerns of human disturbance and neophobia. Other presentations provided a historical perspective of black duck management. The direction that black duck conservation initiatives could and/or should take in the future was also discussed. As populations of humans in the Chesapeake Bay region continue to increase, we can expect that these subjects will receive increased discussion in the future.

Welcome

"In fact I know of no Duck more implacably wild."—Herbert K. Job, 1936

Historically, black ducks have had quite a reputation. They are one of the Chesapeake's own native ducks, both breeding and wintering in her waters. Arthur Cleveland Bent wrote in 1923:

> The black duck, by which name it is universally known among gunners, is decidedly the duck of the Eastern States, where it far outnumbers all other species of fresh water ducks. The West has many other species to divide the honors with the mallard, but in the East the black duck stands practically alone. Whereas, this is only one of the many birds which interest ornithologists and bird protectionists, it is the bird of all others which interests the wildfowl gunners of the Eastern States; it is the most important object of their pursuit, the most desirable as a game bird, one of the shyest, most sagacious, and most wary of ducks and the one on which their best efforts are centered. The black duck has shown marked success in the struggle for existence; it is so sagacious, so wary, and so alert that it is one of the best equipped species to survive, even in a thickly settled region where it is constantly beset by hunters, but where, fortunately for its welfare, numerous safe refuges have been established.

According to this reputation, the black duck should have been voted the most likely to succeed. In fact, in 1973, the two longest living ducks on record were both black ducks. Wary, agile, alert, and with healthy, strong populations, the black duck seemed destined to remain the premier duck of the east coast.

However, reputation and reality may be very different. Today's citizens of the Chesapeake Bay region may never have encountered a black duck or recognize the name. It is no longer the duck of the Bay. Population numbers have fallen dramatically since the 1950s. Black ducks were the first species to merit their own Joint Venture under the North American Waterfowl and Management Plan (see page 4), which was not an honor. They also failed to reach the population goals set for the year 2000.

The purpose of this symposium is to bring together some of the finest experts on black duck biology and habitat needs, and to share this knowledge. We hope the symposium proves to be both stimulating and challenging, enabling each of us to undertake further research or habitat restoration efforts. Our ultimate goal is to enable this magnificent bird to regain its reputation. Thank you for the part you are already playing in these efforts.

Edward Delaney
Wildfowl Trust of North America

Biographical Sketch: Edward L. Delaney, is the executive director of the Wildfowl Trust of North America (WTNA).

He has more than 25 years experience as an administrator and educator. He received his Ph.D. in Administrative and Organizational Studies and a master's degree in Human Relations and Social Policy from New York University. Before coming to the WTNA he was a senior fellow and professor at George Mason University in Fairfax, Virginia, and served as president of the Association for Institutional Research, an international society of researchers and planners. He now serves as a board member for the Environmental Fund for Maryland and the Kent Narrows Development Foundation. He is also a member of the Association of Nature Centers Administrators and the Citizens Advisory Committee for the master plan update of Queen Anne's County.

Gerald Winegrad, vice president of the American Bird Conservancy, acted as moderator for the symposium and introduced all the speakers presenting papers.

Biographical Sketch: Gerald Winegrad served in the Maryland Legislature for over 16 years, first as a member of the House of Delegates and then as a State Senator. As chairman of the Senate Environment Subcommittee for 8 years, he wrote, sponsored, or managed nearly all environmental legislation passing the Senate. Winegrad was called the "environmental conscience" of the Senate by the Washington Post, and regional writer Tom Horton wrote that "he is a person who more than any other set Maryland's environmental agenda over the past 16 years." Winegrad is currently vice president of the American Bird Conservancy in Washington, D.C. and a leader in national efforts to conserve avian species.

Presentations

The American Black Duck: a Species of International Concern

Jerome R. Serie, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Laurel, MD 20708 USA, Jerry_Serie@fws.gov

Abstract: Numbers of American black ducks (*Anas rubripes*) declined substantially in the late 1950s and early 1960s and have not recovered to objective levels. Today, in spite of 50 years of dedicated research and management efforts, the black duck remains a species of management concern. I trace this history of concern for black ducks and highlight the major conservation initiatives. I suggest that it is time for a new approach that is specifically designed to reduce uncertainty among factors regulating black duck numbers. As we focus on the black duck in Chesapeake Bay and ponder its future, I stress the need to strengthen conservation partnerships and to gain more direct management control with more rigorous experimentation on smaller spatial scales to increase numbers of black ducks.

The American black duck's preeminence among our native waterfowl is widely recognized, as it is for the esteemed canvasback (*Aythya valisineria*). This mystique among sportsmen, naturalists, and avian ecologists for the black duck's sporting quality, wildness, and unique adaptiveness is richly preserved in our popular and scientific literature and in the minds of all those who esthetically value its character and treasure its haunts. Extensively studied over the years, scientists have documented the black duck's behavior and biology, and know well its specialized niche and place in the ecology of eastern North America. Early records show that black ducks were once the principal game duck in the hunter's bag in the Atlantic Flyway and eastern Canada, similar to the status of the mallard (*Anas platyrhynchos*) among hunters in the Mississippi Flyway. And today, although still highly revered, the black duck's stature is greatly diminished from its former levels and is no longer prominent in the hunter's bag. Thus, from a conservation perspective, the factors governing black duck numbers remain an enigma and continue to present us with a myriad of management challenges.

Today, as we focus on the black duck in Chesapeake Bay, I would like to trace the history of our concerns for this species, both nationally and internationally, and highlight the conservation initiatives in eastern North America that largely stem from this concern. My hope is that, as we chronicle the past history of black duck management and research and ponder its future, we promote renewed interests, develop objectives to reduce management uncertainty, and rededicate our efforts towards resolving the black duck population dilemma.

The first organized efforts to do something for the all-important black duck were set up and financed by Ducks Unlimited (DU) in the mid-1940s. Just as they had launched their ambitious habitat initiatives in prairie Canada in the late 1930s, DU dedicated a research station to investigate the breeding biology of black ducks near Fredericton, New Brunswick, in 1945 and hired Bruce Wright as its director. In 1954, Wright published a definitive book on his research on the breeding ecology of black ducks called "High Tide and an East Wind" (Wright, 1954). In 1946, DU formed a Black Duck Committee, later changed to the Joint Black Duck Committee, to recommend and coordinate DU's black duck program. This committee was comprised of several State game departments, the U.S. Fish and Wildlife Service (USFWS), DU, and certain private organizations. Later, its role was expanded to encourage the development of numerous waterfowl banding, population surveys, and habitat projects. In 1952, the Joint Black Duck Committee was incorporated into the newly established Atlantic Waterfowl Council (also known as Atlantic Flyway Council). The need for information to improve the management of black ducks provided early motivation for the formation of the Atlantic Flyway Council, which was subsequently established to promote waterfowl management in the Atlantic Flyway.

The Atlantic Flyway Council created a Black Duck Committee in 1967 to give added emphasis to the needs of

this species. As its first task, it organized the first Black Duck Symposium, which was held in Chestertown, Maryland, March 5, 1968. Many eastern waterfowl biologists of the time were alarmed by the dramatic downward trend in black duck numbers in the years following the 1950s. Thus, the purpose of that symposium was to bring together most of the known information on black ducks and to give focus to the future needs of the species. The proceedings provide an insightful review and touch on all such pertinent topics as the current status, population dynamics, habitat and breeding ecology, management possibilities, and role of hunting regulations (Barske, 1968). One thing all the participants did agree on was that black duck populations were too low and that something needed to be done. Based on indirect population estimates using banding and harvest data, they projected that the breeding population had declined from roughly 1.5 million birds during the 1950s to about 870,000 during the 1960s, which is a change of about 42% (Addy and Martinson, 1968). The midwinter counts also declined by 30% between these periods. Some debate continues to this day, however, about whether the peak numbers recorded in the 1950s were reliable estimates or overinflated counts. But, we do know that black duck numbers in the midwinter count continued to decline following the 1960s by about 2% annually (Serie, 1990).

The first black duck symposium accomplished its goal of reviewing all the available information and generating productive discussions among biologists about ways to increase the population to the levels of the 1950s. Most of the speakers in attendance felt that hunting regulations needed to be more severely restricted and recommended that the Atlantic Flyway maintain a one black duck daily-bag limit and begin negotiations with Canada to develop a unified harvest management program (Addy and Martinson, 1968). By doing so, participants anticipated a 10% annual recovery and believed that at this rate, the black duck population would be back to the 1950s levels in about 5 years.

In 1982, the Atlantic Flyway Council approved a comprehensive Black Duck Management Plan (Spencer, 1982). The purpose of this plan was to provide guidelines for the cooperative management of black ducks through the year 2000. The goal was to stop the decline and increase the black duck population to such levels that would provide for sustained resource use at or above 1981 levels. A series of strategies were presented to initiate habitat programs, increase productivity, improve monitoring and assessment, and reduce mortality. The long-term objective was to increase the wintering population to 450,000 birds, as measured by the midwinter survey. Although harvest management was viewed as the simplest means of reducing mortality, it was also recognized as the most difficult from a socio-political standpoint. Not everyone could agree that harvest reduction was the appropriate management action in all areas. States and provinces in the Northeast, for example, had not experienced the same declines as elsewhere and hence viewed these measures as too extreme.

The development of Environment Assessments (EA) in 1976, and again in 1983, specifically focused on harvest reduction. Each was designed to restrict daily bag limits and further reduce season lengths. Finally, in 1983, the USFWS asked states to reduce their harvests by 25% from a base level established during the period 1977-81. Since bag limits were one bird daily, most states in the Atlantic Flyway reduced the number of days black ducks could be taken within their regular duck hunting season in order to meet their objective. This strategy has resulted in a 50% reduction in the harvest of black ducks in the Atlantic Flyway from the 1977-81 base level.

The role of hunting mortality in the decline of the black duck has been very controversial and hotly debated for many years, both professionally and privately. Phillips (1923) commented on the marked increase of the black duck following the stoppage of spring shooting in New England in 1908. Further, this emphasis on reducing the kill to arrest the decline and/or increase numbers has been a recurring theme expressed from the late 1960s up to the present time, covering 4 decades of black duck harvest management (Rusch and others, 1989). However, after several attempts to fully evaluate the effects of overharvest, the influence of hunting on black duck populations remains equivocal. Nevertheless, hunting is an important source of annual mortality for the black duck and one that managers have some measure of control over by their ability to set hunting regulations. Although hunting regulations may reduce the annual kill of black ducks, it has been difficult to show a corresponding increase in survival rates (Francis and others, 1998), which may simply be due to changes in nonhunting mortality factors. The nagging question usually comes down to whether harvest restrictions have gone far enough and whether banded sample sizes or numbers of recoveries are adequate to detect these changes. Nevertheless, harvest rates have been reduced as a result of more restrictive hunting regulations beginning in 1984, which may have contributed to the stabilization of the midwinter survey trends in the Atlantic Flyway (fig. 1).

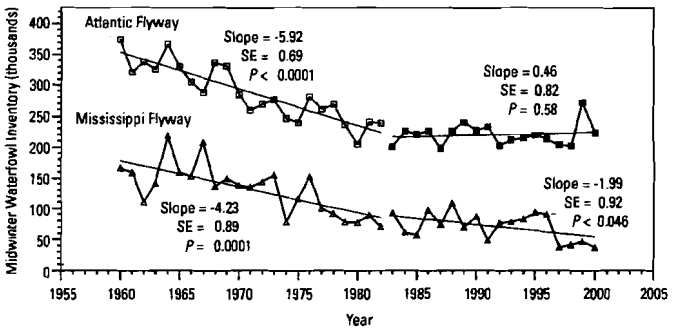

Fig. 1. Midwinter Waterfowl Inventory (MWI) population trends for black ducks in the Atlantic and Mississippi Flyways, 1960-2000.

Over the years, several biologists, professional groups, and concerned citizens have proposed a moratorium on black duck hunting. In 1982, The Humane Society of the United States, along with the Maine Chapter of the Audubon Society, filed suit in Federal Court to prohibit the USFWS from opening the 1982-83 hunting season on black ducks, citing grounds that the USFWS had failed to take necessary corrective action in the face of continued declines (Grandy, 1983). The suit was unsuccessful, but it heightened concerns among wildlife agencies to investigate probable causes for black duck declines. In 1985, the Maine Chapter and the Northeast Section of The Wildlife Society approved resolutions calling for the closure of black duck hunting (Rusch and others, 1989).

Whether overharvest has been the single most important factor in the decline of the black duck is still not totally clear. Most biologists believe that the dynamics in black duck populations likely result from a combination of factors affecting recruitment and mortality. And still, many believe that reducing annual mortality through more restrictive hunting regulations is the most expedient management measure (Longcore and others, 2000). But some would argue that black duck populations in the northeastern portions of its range have not reached such low levels and may not warrant further restrictions in hunting seasons. Hunting seasons have been closed in the past on a number of waterfowl game species as a deliberate management action to improve their status. Such examples include species such as the wood duck (*Aix sponsa*), canvasback (*Aythya valisineria*), redhead (*Aythya americana*), harlequin duck (*Histrionicus histrionicus*), spectacled eider (*Somateria fischeri*), Steller's eider (*Somateria stelleri*), greater snow goose (*Chen caerulescens*), emperor goose (*Chen canagica*), Aleutian Canada goose (*Branta canadensis*), Atlantic Canada goose (*Branta canadensis*), tundra swan (*Cygnus columbianus*), and trumpeter swan (*Cygnus buccinator*).

One of the more significant conservation initiatives to improve the management of black ducks in recent times has been the signing of the North American Waterfowl Management Plan (NAWMP, 1986). The NAWMP (Plan), agreed upon by Canada, the United States, and Mexico, identified a bold new approach to conservation by establishing population and habitat objectives and forming partnerships to achieve them. To accomplish its purpose, this Plan called for the formation of Joint Ventures to cooperatively address specific issues of concern. Most Joint Ventures were regional and focused management efforts on conserving important habitats to maintain continental waterfowl populations. Only two Joint Ventures focused their attention on species that lacked critical databases to monitor their status. One was directed toward arctic nesting geese and the other assigned specifically to a single species, the American black duck. As a result, the NAWMP identified the black duck as a priority species of international concern and called for the formation of the Black Duck Joint Venture (BDJV).

The motivation behind the BDJV was to unite partners (public, private agencies, and interested organizations) for the common purpose of developing and gathering information that could be used to improve the management of black ducks. Further, it set an objective to restore black ducks to their 1970-79 level of abundance, or about 385,000 birds, based on the combined midwinter survey counts in the Atlantic and Mississippi Flyways by the year 2000. Although this objective is much lower than the one established at the first Black Duck Symposium of about 700,000 black ducks, which was based on the 1950s level, the time period of the 1970s was used to set goals for all waterfowl. This recent time period is when populations of most species and their habitats were at acceptable levels for both consumptive and nonconsumptive uses of this resource. Today, the combined midwinter indexes in the Atlantic and Mississippi Flyways for the year 2000 is just over 260,000, or about 30% below goal of the NAWMP.

The BDJV recognized the international problems confronting the management of black ducks and thus coordinated their efforts with wildlife agencies in Canada and the United States. The major thrust of the BDJV was to (1) undertake a monitoring program to determine population trends of black ducks throughout their breeding range, (2) improve banding to better evaluate harvest and distribution changes, and (3) determine through research the important factors influencing the population status and dynamics. The first meeting of the BDJV was held in 1989 with representatives from the USFWS, Canadian Wildlife Service (CWS), Atlantic and Mississippi Flyway Councils, and DU. Annual funding is provided by the various partners in Canada and the United States and is allocated among the various programs. The CWS and USFWS primarily support the breeding ground population surveys, using fixed-wing and helicopter aircraft, while the yearly banding effort receives assistance from the Flyway Councils and provinces in addition to help from the Federal agencies. The research program receives substantial support from DU and the Federal agencies. Expenditures usually top $650,000 annually, and over the life of the BDJV, some $10 million dollars have been spent. Today, not only has the BDJV made great strides towards its objective of gathering, organizing, and distributing scientific information essential to the management of black ducks, but it has established a broader scientific basis for management of all waterfowl in eastern North America.

Recently, the BDJV collaborated with the Georgia Cooperative Fish and Wildlife Research Unit to further investigate the possible factors suspected of playing a role in limiting black duck numbers. By integrating key databases, they developed models to test various hypotheses that include such factors as overharvest, competition with mallards, and quality of breeding and wintering habitat. Presently, the BDJV is revising its research program to incorporate this new information and redirect efforts into those areas more likely to affect black duck population dynamics.

In addition to the efforts of the BDJV, the NAWMP identified the need for several independent habitat initiatives to conserve key black duck habitats in North America. These initiatives include 50,000 acres of migration and wintering habitats along the east coast, 10,000 acres in the Great Lakes-St. Lawrence lowlands of the United States, and another 10,000

acres in the Atlantic Region of Canada. Additionally, some 60,000 acres of breeding and migration habitats were identified for protection in the Great Lakes-St. Lawrence lowlands of Canada. These habitat needs for black ducks were listed as priority objectives of the Atlantic Coast Joint Venture (ACJV), the Eastern Habitat Joint Venture (EHJV), and the Lower Great Lakes-St. Lawrence Basin Joint Venture (GL/SLJV). Thus, in addition to the population goal assigned for black ducks of 385,000 in the midwinter survey, significant habitat goals have been established to protect more than 130,000 acres for breeding, migration, and wintering activities.

Numerous other habitat programs over the years have focused on the needs of black ducks. In the late 1970s and early 1980s, the black duck was the subject of several USFWS generated Concept Plans that identified and prioritized key wintering areas to be preserved and protected on a state-by-state basis. Later in the early 1980s, the USFWS generated Land Protection Plans. Closely following in 1985, the USFWS developed the National Species of Special Emphasis (NSSE) listings, which appropriately included the black duck. The NSSE plans identified population and habitat goals on a regional basis. Countless other Federal and State/provincial management plans and strategies have been devised and revised over the past 20 years, all with the goal to increase black duck numbers and preserve critical coastal and inland habitats for breeding, migration, and wintering activities.

In an attempt to summarize all the technical information available relating to the ecology and management of black ducks, The Wildlife Society charged an Ad Hoc Technical Advisory Committee on Black Duck Conservation and Management with conducting a comprehensive review. Their task was to examine available data on population status, reproduction, and survival of black ducks and to relate any changes in these parameters to changes in habitat, predation, disease, contaminants, harvest, and hybridization with mallards. This review was published in The Wildlife Society Bulletin (Rusch and others, 1989) and provides an excellent overview of the problem and concludes with a number of specific recommendations. More than 150 references were cited in this review. While this paper points out just how extensive our baseline knowledge is on this species, it highlighted several areas of uncertainty, particularly regarding the role of key factors and their influence upon population changes. Because of this continued uncertainty, direct management actions by various conservation agencies have often been detained and unclear. As a result, management recommendations affecting recruitment and mortality factors have been only partly implemented.

A second American Black Duck Symposium was held in Saint John, New Brunswick, in 1990. Over 100 biologists and managers attended this symposium and some 33 research papers were presented (Kehoe, 1990). In addition, five workshop sessions were held, covering such topics as breeding and wintering habitat, productivity and mortality, and black duck–mallard interactions. The participants of each workshop session discussed a wide range of views related to these topics and presented a summary and/or generated a list of recommendations, research needs, and priorities. In large part, the purpose of this symposium and workshop was to identify information gaps and delineate clear objectives that could be used to direct the research efforts of the BDJV. The intent was to bring active managers and biologists together to exchange the most current information on this species, to compare current information with historical information, and to formulate the key questions to be addressed by the BDJV. Since 1990 marked the first year of implementation for the BDJV, this symposium provided renewed emphasis and direction to the black duck as a Species of International Concern. Today, the BDJV continues to provide a framework to unite public and private agencies and organizations for the common purpose of gathering information essential to the management of this important species and serves to restore black ducks to their 1970s level of abundance.

So, what has been accomplished with all these efforts directed toward the black duck since the 1950s? Obviously, our expressions of concern in the late 1960s did not restore black ducks to the levels of the 1950s (~ 580,000), as was the intended winter population goal. Further, wintering goals set in the Atlantic Flyway Black Duck Management Plan (~ 450,000) have not been met. Also, the NAWMP's goal set in the 1980s, to restore black ducks to the level of the 1970s (~ 385,000), has not been met. Further, restrictive hunting regulations to allow a one bird daily bag limit, which was recommended at the first Black Duck Symposium in 1968, were not actually fully implemented until 1983. However, since these restrictive regulations went into effect in Canada and the United States in the mid-1980s, total harvests and harvest rates have been reduced by nearly 50% from the 1981-97 levels and have exceeded our goal of 25%. Increases in survival rates associated with these restrictive hunting regulations are less certain, but there is some evidence of a positive response. To date, we have not seen a significant population increase as a result of these management actions to reduce harvests that would help us to achieve our population goals.

In the last 10 years, the BDJV's efforts have vastly improved our population monitoring program for black ducks and for other waterfowl breeding in eastern North America. Banding efforts have been stepped-up to analyze mortality factors and assess harvest rates. Research has continued to expand our knowledge into many facets of black duck behavior, breeding and wintering biology, and ecological relationships. And, presently, we are integrating various competing hypotheses of black duck population dynamics into models to determine which factors influencing population change are the most plausible. Finally, we are collaborating with Canada to develop an international harvest strategy that can be implemented cooperatively to control mortality associated with hunting. Therefore, upon reflection, a lot has been accomplished, and a lot is being done to improve management capabilities and our understanding of various factors affecting the status of black ducks.

One only needs to review these restorative efforts of the past 5 decades to see that the black duck ranks among one of our most studied migratory game birds. We've examined everything from acid rain, contaminants, predation, nesting success, brood survival, competition with mallards, overharvest, and more. And yet, we recognize that none of these factors likely apply universally throughout the range of the black duck but may be operative on smaller spatial scales. When specific management actions have been applied, our assessment capabilities have been too limited or insensitive to detect a direct positive population response. Every few years, we step back and review the status of the black duck, conclude that its status remains below objective levels, and call for another conference or symposium. Although I have tried to present a fair assessment of our collaborative efforts to increase numbers of black ducks, I may be overly critical. But it seems that we've approached our dilemma with black ducks several times in the past by attempting to find that all-important single factor which through management could be quickly corrected and black ducks restored to desirable levels. Finding a single factor, however, has not proved successful for whatever reason. I believe most biologists now agree that to apply a single solution over the entire range of the black duck is not only not feasible, it is fraught with enormous socio-political obstacles. It is time for a new, more aggressive approach specifically designed to reduce uncertainty among various critical factors regulating black duck populations.

Not all areas of the black duck's range have shown declining populations, and not all areas have the same habitat limitations or mortality characteristics. Therefore, an approach that is specific to a given set of circumstances such as environmental and population parameters on a spatial basis, rather than applied universally among regions, deserves more consideration. I believe we need to narrow our scope, test for specific parameters, and intensify our assessment capabilities. Experimentation must be well designed and more rigorous and must become an integral part of our efforts to detect changes and find solutions. More talk, more study, and more symposia will not reverse the population trend of the black duck. To say we know a lot about the biology and ecology of the black duck is true, but it is also true that we have made little progress toward increasing black duck numbers. Obviously, we have not been successful in applying our knowledge in such a way as to gain direct management control. Yet, if we define our objectives, or better identify our goals, and commit to a rigorous regimen of testing and evaluation on a manageable scale, I think we can be successful in producing a favorable result. To do otherwise, I'm afraid, means that we are simply improving our monitoring capabilities to better document the decline of this species, which we highly prize, rather than actually managing the population to achieve some desirable population level.

I commend the Wildfowl Trust of North America and the USGS Patuxent Wildlife Research Center for hosting this symposium focusing on the black duck in Chesapeake Bay. There have been dramatic habitat changes here and significant changes in numbers of breeding and wintering black ducks in the past few decades. I encourage you to work with the BDJV, the ACJV, and DU, as partners, to improve the status of black ducks in the Bay. It was the intent of the NAWMP and its Joint Ventures to combine our technical and administrative capabilities among public and private agencies and organizations to more effectively guide our management and research activities and improve our understanding of waterfowl populations and their habitats. Conserving the rich legacy of black ducks in Chesapeake Bay is a challenge worth pursuing.

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American Black Duck Summer Range Versus Winter Range: a Dichotomy of Riches

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Abstract: The status of the American black duck (*Anas rubripes*) population has more often been attributed to a single event than to multiple events over time and throughout space. The difference in the quality of the habitat, however defined, within breeding areas in the North and in the southerly wintering areas, especially Chesapeake Bay, also has been proposed as affecting black duck status. The obvious question is "What variable cuts across all habitats, time, and space to affect black ducks?" This paper attempts to answer that question by examining the connectivity of seemingly unrelated variables and events associated with the black duck's summer range and its winter range relative to population change. Insights from examples of relations among these variables reveal how results may be confounded and even misleading. A perspective that may be required to ensure future black duck populations is discussed.

Introduction

When my colleague Matt Perry asked me to participate in this symposium, he suggested I discuss the ecology of the black duck in the Chesapeake Bay. Unfortunately, my experience of actually working in the Bay was, and is, limited. My first exposures to the Bay in the late 1960s were with biologists Fran Uhler and Vern Stotts, whose experience and knowledge of the Bay's riches and its moods far exceeded any insights of mine. And, as for Vern, I am sure they still do. Therefore, instead of discussing ecological specifics of Chesapeake Bay, I will discuss a number of variables as they are associated with summer range (i.e., mostly northern breeding areas) and the more southerly winter range, including the Bay, where most black ducks spend the winter. In doing this, I hope to raise your perception of what affects black ducks on their summer versus their winter range, to provide examples of between-range differences (i.e., the degree of riches, or their lack thereof) for a number of variables that affect black duck status, to examine the confounded nature of relationships among variables, and to identify the common thread that ties variables together and that ultimately will determine the status of the American black duck population.

First, even the name "American black duck" misleads us. More appropriately this duck species should be thought of as the "North American black duck." It is essential to recognize that most of the black duck's summer breeding range, most of the range where adults become flightless during molt, many of the staging areas, and recently, where an increasing number of black ducks spend the winter, is not in the United States but in Canada. An East-West dichotomy also exists between the eastern seaboard Atlantic Flyway and the more midcontinent Mississippi Flyway, and two different political entities are attempting to "manage" this international resource. Because the breeding range overlaps substantially with the wintering range, even the dichotomy of summer versus winter range is blurred. Within both ranges, however, specific locations (e.g., staging areas like Lac Saint Pierre and the Yamaski River in Québec) provide the habitat for the transition from summer to winter. Locally produced black ducks join migrants to feed and rest before moving on. What happens on these staging areas is also important because events there are an integral part of the ebb and flow between breeding and nonbreeding. If a black duck dies at the staging area, it never has the opportunity to survive the winter, which obviously it must if it is to have the opportunity to breed.

What are some of the variables that differ between the summer and the winter ranges? The following variables, although many other variables could be considered, seem important explanations for the long-term decline of the black

duck population: density of the human population, degree of human intrusion, amount of available habitat, fertility of wetlands, opportunity to harvest black ducks (i.e., days in hunting seasons, daily bag limit), numbers of immature black ducks, and numbers of mallards (*Anas platyrhynchos*) and their relationship to black ducks.

Density of the Human Population

Examples of the expanding human population in winter range are well documented. One relevant example is the 38% increase in humans in Maryland counties around Chesapeake Bay. In 1970, 2.0 million people inhabited those counties; now 2.8 million do. This is a population increase of nearly 28,000 people per year. In general, species richness of migratory birds is negatively related to variables that characterize urbanized environments (Cam and others, 2000). The effects of increases in human activities around the Bay, which serves both breeding and wintering black ducks, have been documented (Stotts, 1987; Morton, 1998). Although human populations are increasing in large urban areas within the breeding range farther north, especially in the Toronto, Ontario area, the population increased only by ~26,000 (167,000-192,000) from 1986-91 in 34 counties in southern Ontario (Statistics Canada, 1992). The density of humans is relatively lower over much of the vast expanses of the breeding range in northwestern Maine and in provinces of Canada.

Degree of Human Intrusion

This variable is difficult to quantify in amount and effect, but intrusions into inland habitats of breeding black ducks have increased because of enhanced accessibility from logging roads and all-terrain vehicles. Disturbance of a female during egg laying often causes her to abandon the nest even after being flushed only once; those females that nest along trout streams in early April are especially vulnerable. Conversely, cutover areas in Maine provide habitats where nest success is high. In the Bay, Stotts (1987) and Krementz and others (1992) have documented that humans continue to steal eggs from black duck nests. Intrusion into bogs for commercial production of peat is a concern in Québec because nest success is high in bog habitats (Bélanger and others, 1998). Human intrusion into wintering range, regardless of purpose, can affect feeding opportunities, energy dynamics, and even survival when subfreezing temperatures are prolonged.

Amount of Available Habitat

Loss of wetland habitat in summer range is well documented throughout the United States (Dahl, 1990) and in Chesapeake Bay (Stotts, 1987). Because black ducks prefer the salt marsh component of the Bay in winter and summer, any loss of tidal marsh habitat has a prolonged effect on them. Between 1953 and 1972, about 35,200 ha (21%) of the tidal wetlands in the Northeastern States were lost to filling and diking (F. Ferrigno, written commun. as cited in Heusmann, 1988). By 1986 the amount of coastal wetlands in the North Atlantic States was estimated at ~152,000 ha (Alexander and others, 1986). In Canada, especially in southern Québec, southern Ontario, and along the St. Lawrence River, breeding habitat has been converted to agricultural and urban purposes (Bordage and Reed, 1996; Snell, 1987; Canada Land Use Monitoring Program, 1985), but losses are small relative to the amount of habitat that remains. Expansive areas of summer breeding range still exist essentially unchanged, and in most locales, wetland habitat is continually being created or enhanced by activities of beaver (*Castor canadensis*).

Fertility of Wetlands

The richness of summer and winter range is strikingly different when considering wetland nutrients. The Bay suffers an excess of nutrients, especially phosphorus and nitrogen (Donigian and others, 1994; Preston and Brakebill, 1999), most of which originates in association within urban areas and point sources in the watershed. This excess of riches, or eutrophication of the Bay, has caused a loss of benthic organisms and submerged aquatic vegetation important to black ducks. In contrast, many wetlands of the Northeast and across the boreal forest breeding range have moderate to low amounts of nutrients (reflected in specific conductance of 18-69 S/cm; Longcore and others, 1998), yet these wetlands support black duck broods year after year (J.R. Longcore, USGS Patuxent Wildlife Research Center, unpub. data). Although nutrient dynamics of wetlands is complex and processes vary among wetland types (Kadlec, 1987), wetland fertility does not seem to limit black duck brood production in boreal forest wetlands (Staicer and others, 1994; Longcore and others, 1998). Unfortunately, many wetlands suitable for brood rearing are still devoid of broods in parts of the summer range. Several (~60) large wetlands, many of which were beaver-created flowages that I visited in southern Ontario in 1996, lacked black duck broods and contained few broods of any duck species, except hooded mergansers (*Lophodytes cucullatus*), suggesting that summer range habitats can support a larger breeding population.

Opportunity to Harvest Black Ducks

Because season lengths and bag limits are established by two countries, the opportunity to harvest black ducks is different between much of the summer range in Canada and that in the dual range in the United States. Waterfowl seasons must start early in September before birds migrate for hunters to be able to harvest black ducks in northern parts of Canadian provinces. For example, these early openings in northern zones and late-season closing in December in southern zones result in season lengths of about 92 days in Québec and 86 days in Ontario (K. Dickson, Canadian Wildlife Service,

written commun.). Daily bag limits range from one to four black ducks per hunter among zones of these provinces. In the rest of the range since 1983 and until recent years, season length has been 30 days with a daily bag of one per hunter. From the black duck's viewpoint, direct effects of humans on its population are manifest during nearly 4 months. Indeed, hunters in the winter range, including the Bay, benefited from longer seasons and bag limits in the early years of the black duck's population decline, and hunters in the summer range have reaped the greater benefit for a few years; now harvest is nearly equal between hunters in each range.

Numbers of Immature Black Ducks

Next, it seems important to mention where to find the greatest number of immature black ducks, which is the basis for expanding the existing population and for providing young females to pioneer to areas where stocks have been depleted. Obviously, the northern part of the summer range should have the most immature black ducks in fall because that is where most pairs breed, and the range is expansive from Québec through the Maritime Provinces. During 1993-97, the breeding population of black ducks in the Northeastern United States, excluding Maine, has been estimated as 27,000-38,000 pairs (Heusmann and Sauer, 2000). Three hunting zones in Ontario are noted for their abundant immatures, and from north to south, the number of immatures in the harvest decreases. The salient point is that protecting local breeders and their offspring, wherever they breed, enhances that local population because successful females home to the area they nested in previously. As for Maine, when local breeders were protected with delayed seasons and overall harvest was restricted, the numbers of broods on reference areas were greater in years following restrictions than in years less restrictive.

Numbers of Mallards

And lastly, "where do we have a richness of mallards?" One could state "everywhere" because this adaptable species is tolerant of humans, even rearing broods in marinas. Mallards benefit from human activities in urban settings (Heusmann, 1988), which is in contrast to the lower tolerance of black ducks to human activities. Furthermore, in many parts of black duck range, especially in Chesapeake Bay, historical releases of thousands of mallards may have contributed to increased numbers of mallards in the East. The mallard, however, does not competitively displace the black duck when the two species come into contact in the wild, as suggested by some (Ducks Unlimited, Inc., 1994). When black ducks initiated interactions with mallards in Maine, black ducks did not lose any interactions and displaced mallards within a wetland 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 within a wetland 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 (McAuley and others, 1998). Actual displacement from a wetland was infrequent but equal for each species. The 10-year trend (1990-99) in eastern Canada aerial surveys reveals significant increases in breeding pairs of black ducks, whereas mallard numbers have not increased significantly (Filion and Dickson, 1999). It now seems implausible that the proximate cause of the long-term decline of the black duck population was related to mallard distribution. As numbers of breeding black duck pairs have increased in most survey blocks across the summer range, they do so in concert with a declining harvest and a declining number of hunters. During the last few years, lengths of the hunting seasons have been increased, and U.S. hunters are asking that the black duck bag limit be raised from one to two. Less restrictive regulations, however, may retard and even reverse the ongoing recovery of the black duck population in the Atlantic Flyway.

From the preceding, it is evident that the threads of human influence, both directly and indirectly, are entangled with historical events that have affected the status of the black duck population. Thus, as the human population expands with its attendant demand for space and natural resources, wildlife populations, including the black duck, are destined to be adversely affected. It seems too, that history repeats itself. In 1948 at the Northeast Game Conference, Ludlow Griscom (1948) commented that "Civilization came first in New England with its attendant evils for game (1) destruction of habitats (2) over-shooting (3) general disturbance by an increasing human population."

To perpetuate the black duck will require contributions from all stakeholders. Each must insist that this species be managed as a "North American black duck." The disparity in response of black ducks in the Mississippi Flyway compared with the increasing population in the Atlantic Flyway suggests that a different regulatory approach is needed to achieve a positive population change in the Mississippi Flyway. If managers can transcend local, regional, and political boundaries, they ultimately may achieve a strategic harvest management plan for each flyway that will ensure what is in the best interest of the black duck population. The framework is in place under the North American Waterfowl Management Plan, Black Duck Joint Venture, to objectively and specifically pursue this course of action. Only time will reveal if administrators can surmount differences and summon the will to do what is necessary to ensure the long-term population growth of the American black duck throughout its breeding range. This will be essential to ensure the long-term exploitive use of this species by waterfowl hunters and for enjoyment by the general public.

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Biographical Sketch: Jerry Longcore is a wildlife biologist (research), and leader at the USGS Patuxent Wildlife Research Center field station in Maine, which addresses migratory bird issues in the Northeast. Longcore has led research there for nearly 25 years. He has studied black ducks relative to eggshell thinning, lead poisoning, productivity and habitat use, brood production, interactions with mallards, survival on staging and molting areas, and behavior during winter. He is a long-term member of the North American Waterfowl Management Plan, Black Duck Joint Venture, Technical Committee. Recently his senior-authored life history

account for the American Black Duck was published in "The Birds of North America."

Black Duck Nesting in the Virginia Portion of Chesapeake Bay

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Abstract: We surveyed islands in the Virginia portion of the Chesapeake Bay for the presence of nesting black ducks. Habitat variables were measured at each nest site, and nests on selected islands were monitored to evaluate productivity. Most islands are relatively small and are dynamic systems where elevation, vegetation, and even predator components can change considerably from year to year. Black ducks attempted to nest on nearly all islands surveyed. Nest attempts and nest success was very low on islands with mammalian predators (raccoon [*Procyon lotor*] and red fox [*Vulpes vulpes*]). Other causes of nest failure included tidal inundation, other predators (gulls [*Larus* spp.] and crows [*Corvus* spp.]), and human disturbance. A sample of nesting females was equipped with radio transmitters to evaluate brood movements and survival. Preliminary results indicate that brood movements were limited and that brood survival was low.

Biographical Sketch: Gary Costanzo has served as the waterfowl project leader for the Virginia Department of Game and Inland Fisheries since 1990. His job duties include monitoring waterfowl populations throughout the state, developing strategies to best manage these populations, and conducting research programs to address specific issues and questions. His previous job experience includes work for the U.S. Fish and Wildlife Service at Patuxent Wildlife Research Center in Laurel, Maryland, and Northern Prairie Wildlife Research Center in Jamestown, North Dakota, along with work in other State agencies and in private industry. Costanzo received a master of science degree in wildlife biology from Clemson University and a Ph.D. in wildlife biology from Cornell University. His masters' work focused on the habitat use of wood ducks, and his doctoral research addressed the wintering ecology of black ducks along the east coast.

Effects of Human Disturbance on Wintering American Black Ducks

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Abstract: Human disturbance of wintering waterfowl can be defined as any intentional or unintentional anthropogenic action that elicits a metabolic or behavioral response. Presumably any response causes an immediate increase in energy expenditure that may be offset by three generalized compensatory behaviors: increased energy intake, habituation, and dispersal. Failure to fully compensate behaviorally for increased energy expenditure may lead to reduced physiological condition. I briefly review evidence of these behavioral responses in other wintering waterfowl species and present results from a study of American black ducks (*Anas rubripes*) wintering at Chincoteague National Wildlife Refuge (NWR).

Introduction

Human disturbance of waterfowl and other wildlife may be defined as "any intentional or unintentional anthropogenic action that elicits a metabolic or behavioral response" (Morton, 1995:F 59). Disturbance generally does not include actions that involve a tactile stimulus but rather the visual, olfactive, or aural threat of one. For example, an off-road vehicle that destroys an American black duck nest is not a disturbance (it is a source of mortality), but vehicular noise that flushes a nesting hen is considered a disturbance.

The single most cited effect of human disturbance on waterfowl and other avifauna is the flush response and its consequences. Flying is energetically costly behavior. A black duck consumes 10.4 times more energy in flight than at rest (Wooley and Owen, 1978). The flush response is mediated by several biological and psychological factors that are often time and site-specific: species-specific tolerances, temporal/seasonal differences, predisturbance behavior, landscape, and the previous experience of individuals (Morton, 1995).

Although flight in response to acute disturbance is most obvious to human observers, there are costs associated with nonflight responses at chronic levels. Any behavioral deviation from rest can be energetically expensive. An alert black duck, or one that is walking or swimming, consumes 1.8, 1.4, and 1.8 times, respectively, more energy than a bird at rest (Wooley and Owen, 1978). Waterfowl also must cease whatever other behavior they were engaged in prior to being disturbed. For black duck pairs in early spring, this may mean interruption of courtship and/or nesting activity (Stotts and Davis, 1960). For wintering or migrating waterfowl, this may mean cessation of feeding and/or resting activities (Paulus, 1984; Korschgen and others, 1985; Bélanger and Bedard, 1990). High rates of human disturbance may ultimately lead to reduced fitness of individuals, redistribution of populations, and reduced quality and/or carrying capacity of habitats.

However, I failed to appreciate the potential significance of human disturbance when, in 1985, I initiated a 2-year study of the wintering ecology of American black ducks at Chincoteague, Virginia. I approached this study by asking questions typical of graduate students: Where do black ducks spend their time? What do they do when they're there? What do they eat? How do these behaviors affect their fitness (i.e.,

body condition)? Specifically, my research objectives were to (1) determine habitat use by female black ducks, (2) quantify daily time and energy expenditure of black ducks, (3) quantify changes in carcass composition over winter, and (4) evaluate the Habitat Suitability Index model for wintering black ducks (Morton, 1987). This study was not designed to assess the effects of human disturbance on wintering American black ducks. In fact, at that point in time, I did not consider human disturbance an important issue on their wintering grounds.

In this paper, I review the results of this study and show how they were reinterpreted as my appreciation of the subtle effects of human disturbance developed. My goal is to persuade the reader that human disturbance is a complex phenomenon, a real problem, and a management issue.

Methods

The 25,600-ha study area was located on Virginia's eastern shore of the Delmarva Peninsula and included all of the Chincoteague National Wildlife Refuge (NWR), the southern end of Assateague Island National Seashore, the northern end of Wallops Island, and the southern end of Chincoteague Bay. The study area was composed of 25% upland, 21% open water (> 1 m deep at mean low tide), 21% subtidal water (≤ 1 m deep at mean low tide), 18% saltmarsh (*Spartina* spp.), 5% tidal flat, 4% brackish impoundment, 2% natural pool, 1% shrub wetland, 1% freshwater stream, and < 1% other habitats. Approximately 3,000 American black ducks wintered on the study area during 1985-87.

We systematically radio-tracked 20 (8 adults, 12 juveniles) female black ducks around-the-clock on three consecutive days per week from December 15, 1985 to February 28, 1986. Locations were obtained for each female at 6-hour intervals, four times per day; consequently, two diurnal and two nocturnal locations were collected per female per day. We used a vehicle-mounted null peak system to monitor telemetered ducks and 1:24,000 National Wetland Inventory (NWI) maps to classify habitats (Cowardin and others, 1979). We subsequently processed 1,442 radio locations. See Morton and others (1989c) for further details.

During the winters of 1985-86 and 1986-87, we scan-sampled 179 flocks to quantify the proportion of time spent feeding, resting, standing, walking, swimming, flying, or otherwise engaged in maintenance, alert, courtship, and agonistic behaviors. Flock size ranged from 10 to 880. A flock was observed for an hour or until 20 scans were obtained, whichever came first. When flocks were disturbed by a recognizable source, the source was categorized as natural or manmade. Scan sampling continued while the disturbance was present (or until the flock flew away). Multivariate analysis of variance (MANOVA) suggested that time, tide, and habitat influenced the behaviors of black ducks. Consequently, diurnal time budgets were constructed by distributing 1,471 scans a posteriori over a time-tide matrix within refuge pool, salt marsh, and tidal water habitats. Time budgets were converted to energy budgets by weighting each behavioral category by an appropriate multiple of basal metabolic rate. See Morton and others (1989a) for further details.

Fifty-nine American black ducks were collected during early, mid, and late winter in 1985-86 to assess overwinter changes in physiological condition. From each dried carcass homogenate, we extracted lipids with ethyl ether, used the Kjeldahl method to estimate protein, and estimated ash (i.e., skeletal mass) by combusting in a muffle furnace (Morton and others, 1990). We used the aggregate dry weight and aggregate percent methods to evaluate the food contents in the esophagi and proventriculi (Morton, 1987).

We chose to measure food availability by evaluating the Habitat Suitability Index (HSI) model for wintering American black ducks (Lewis and Garrison, 1984) during the fall of 1985 and the fall of 1986. The model requires that seven variables be assessed: three physical variables are determined from maps and four biological variables are measured in the field before winter. The physical variables are the percentage of subtidal open water less than or equal to 1 m deep (V_1), the percentage of open water area exposed at low tide (V_2), and the percentage of emergent and forest wetland area covered by streams, ponds, and impoundments (V_5). The biological variables are the percentage of subtidal shallows occupied by rooted vascular plants (V_3), the percentage of intertidal mudflat sample plots containing greater than or equal to 300 clams per square meter (V_4), the percentage of bottom substrate of freshwater impoundments and ponds covered by *Ruppia* sp. and *Potamogeton* spp. (V_6), and the percentage of nonforested, emergent marsh that supports greater than or equal to 750 snails per square meter (V_7). See Morton and others (1989b) for details on techniques used to measure these variables.

Results

Radio telemetry data suggested that age affected range and core areas but not habitat selection. Adult female black ducks used one core area and smaller ranges, whereas juvenile females used more than one core area and ranges that were two to three times larger than adults (Program Home Range, see Samuel and others, 1983). Salt marsh, brackish impoundments, and natural pools were used in proportions greater than expected; upland, subtidal water, and open water were used less than expected (Neu's χ^2). Tide, ice, and time of day affected habitat use (log-linear modeling): brackish impoundments at the refuge were used during the day, the salt marsh was used at night, and subtidal water was used during periods of icing (table 1). In refuge pools, black ducks fed the least and rested the most, and in tidal waters, they fed the most and rested the least (MANOVA).

These data gave me a good working model of how American black ducks used the coastal habitats surrounding Chincoteague. Unlike other dabblers that were using the impoundments on Chincoteague NWR, American black ducks made, on average, 3-km crepuscular flights to the surrounding