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

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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.

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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

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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).

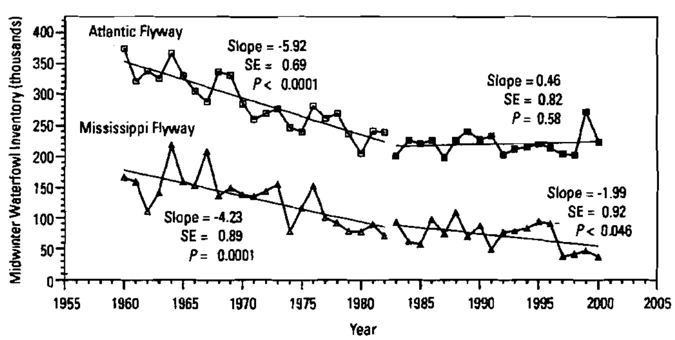

Fig. 1. Midwinter Waterfowl Inventory (MWI) population trends for black ducks in the Atlantic and Mississippi Flyways, 1960-2000.

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

Table 1. Proportional day and night use of three habitats by female black ducks wintering at Chincoteague, Virginia, December 15, 1985 - February 28, 1986.

Habitat	Radio locations	
	Day (n = 753)	Night (n = 689)
Refuge pool	0.519	0.110
Salt marsh	0.396	0.595
Tidal water	0.085	0.295

salt marsh and subtidal waters where they continued to feed at night. I assumed that I was documenting a habitat use pattern that was both "natural" and unique to black ducks, at least among the waterfowl assemblage at Chincoteague. However, I wondered why black ducks even bothered to leave the salt marsh in the morning when it was clear that they experienced more competition from other dabblers in the crowded impoundments on the refuge. Stomach content analysis also indicated that many of the food items originated from the salt marsh (e.g., saltmarsh snails [*Melampus bidentatus*]), mummichog and killifish [*Fundulus* spp.], fiddler crabs [*Uca* spp.] and sea lettuce [*Ulva lactuca*]).

Except for permitted hunting on Wildcat Marsh, waterfowl hunting is prohibited and public access is restricted on Chincoteague NWR. Rather than the more conventional and biologically oriented analyses of use of naturally occurring habitat types (table 1), we re-categorized types to reflect administrative boundaries. A 2 x 2 contingency analysis suggests that use of habitats on and off the Chincoteague NWR was dependent on time of day ($\chi^2 = 321$, df = 1, $P < 0.001$). More than 75% of locations that occurred on Chincoteague NWR were collected during daylight hours; conversely, most nocturnal locations occurred off the refuge (fig. 1). Aerial surveys showed that many black ducks continued to use the refuge during the day even when ice cover on the impoundments made open tidal water outside the refuge a more favorable habitat.

What might explain this redistribution of the black duck population along administrative boundaries? Use of the salt marsh and associated waterways by commercial oystermen and fishermen, recreational hunters, and automobile and boat traffic obviously occurred more frequently off the refuge, particularly during the day. During the course of the two field seasons, my behavioral sampling of black duck flocks (i.e., time budgets) was frequently interrupted by disturbances, both human and natural. A 2 x 2 contingency analysis suggests that disturbance levels on and off Chincoteague NWR tended to differ ($\chi^2 = 3.26$, df = 1, $P < 0.08$). Of 125 flocks sampled on the refuge, only 18% were disturbed, whereas 30% of 54 flocks off the refuge were disturbed (fig. 2).

What is the effect of disturbance on American black ducks? Of the 179 flocks sampled during this study, 38 were disturbed at least once during the 1-h observation period. In response to disturbance, black ducks fed less and increased time spent in alert and locomotion behaviors (table 2). Not only was energy intake curtailed, but the estimated mean hourly rate of energy expenditure for disturbed flocks was twice that of undisturbed flocks (Morton and others, 1989a). Of the 38 disturbances, 66% were of human origin and 24% were natural. Natural disturbances included snow geese (*Chen caerulescens*), Canada geese (*Branta canadensis*), Northern harriers (*Circus cyaneus*), bald eagle (*Haliaeetus leucocephalus*), great black-backed gull (*Larus marinus*), raccoon (*Procyon lotor*), sika deer (*Cervus nippon*), and two unknown sources. Human disturbances included automobiles, pedestrians, hunters and oystermen, aircraft, and boats. Behavioral responses to human and natural disturbances differed (table

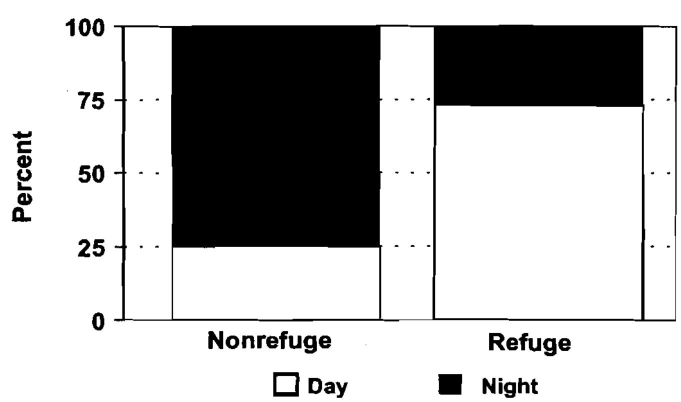

Fig. 1. Diel distribution of telemetered American black ducks (n = 1,442 radio locations) on and off the Chincoteague National Wildlife Refuge during winter 1985-86 ($\chi^2 = 321$, df = 1, $P < 0.001$).

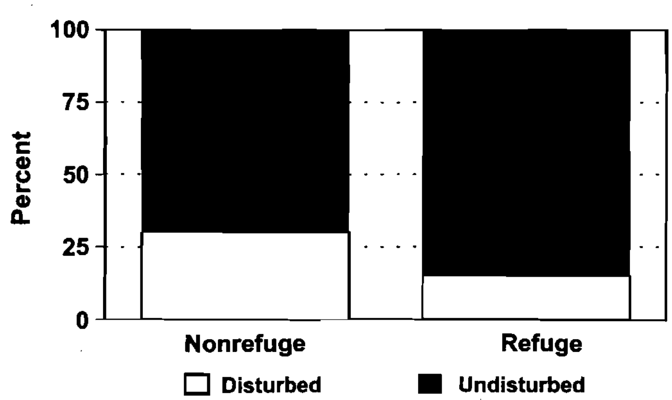

Fig. 2. Percentage of wintering American black duck flocks on (n = 125) and off (n = 54) the Chincoteague National Wildlife Refuge that were disturbed during time budget sampling 1985-86 ($\chi^2 = 3.26$, df = 1, $P < 0.08$).

Table 2. Time (percent) spent in different behaviors by wintering American black ducks under ambient and disturbed environmental conditions during daylight hours.

Behavior	Ambient[1]	Disturbed	
	n = 1471	Human (*n* = 39)	Natural (*n* = 17)
Feed	36.2	9.0*	25.8*
Rest	36.7	13.0	12.9
Stand	0.6	2.7	0.9
Walk	1.1	1.0	1.0
Swim	14.7	40.1*	20.7*
Fly	0.5	19.6	17.1
Maintenance	8.6	4.9	8.2
Alert	1.2	9.7	13.0
Courtship	0.1	0.1	0.1
Agonistic	0.2	0.0*	0.4*

[1]Ambient includes all scans from 179 flocks, whether disturbed or not. Values are least square means that were derived by weighting behavioral proportions for three habitat types (salt marsh, impoundments, and tidal waters) by proportional habitat use (adapted from Morton and others, 1989a).

*Significantly ($P \leq 0.05$) different response to human and natural disturbance (Wilcoxon 2-sample test).

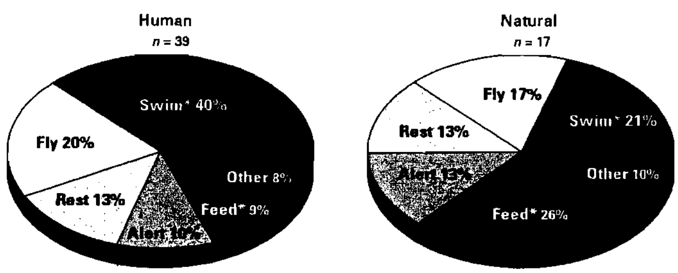

Fig. 3. Behavioral responses of wintering American black ducks to human and natural disturbances (*n* = 56 scans from 38 flocks). Asterisk indicates significantly different proportions (Wilcoxon 2-sample test, $P \leq 0.05$).

2; fig. 3). Flocks disturbed by human activity swam more and fed less than those disturbed by natural sources (Wilcoxon 2-sample test, $P \leq 0.05$).

The previous analysis underestimates the time spent flying in response to disturbance. This is simply because if a flock flushed between scan sampling intervals, the sampling was aborted. Almost 50% of disturbed flocks flushed, a behavior that expends five to six times more calories per unit time than any other behavior. However, the flush response was dependent on the disturbance source ($\chi^2 = 3.3$, df = 1, $P < 0.08$). Whereas 60% of flocks disturbed by human activity flushed, only 23% of flocks disturbed by natural sources took flight (fig. 4). Anecdotally, it was also apparent that black ducks were relatively intolerant of disturbances. Whenever

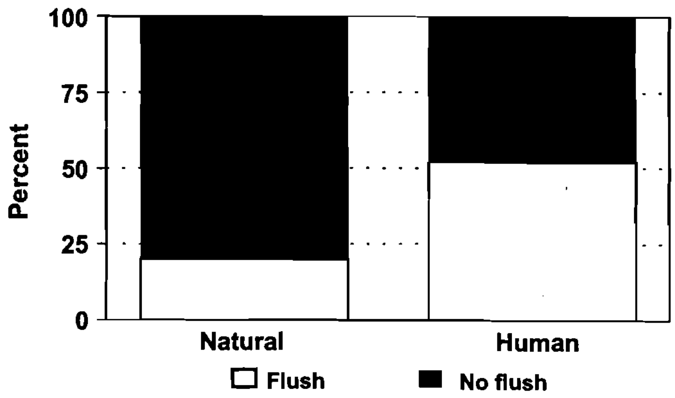

Fig. 4. Percentage of wintering American black duck flocks that flushed in response to natural (*n* = 13) and human (*n* = 25) disturbances at Chincoteague National Wildlife Refuge ($\chi^2 = 3.3$, df = 1, $P < 0.08$).

they occurred in mixed flocks with other dabbling waterfowl, black ducks almost invariably were the first to flush.

Discussion

There is a landscape component to human disturbance that is likely to be missed in most studies. Sincock and others (1966) were among the first to recognize that waterfowl tolerance of disturbance is likely relative to the level of disturbance on adjoining areas. They argued that the waterfowl response to hunting and boating activity in Back Bay, Virginia, was dependent on the level of similar activities immediately south in Currituck Sound, North Carolina. Although based on sparse data, I can only conclude that human activities outside the Chincoteague NWR were frequent enough to drive American black ducks out of the salt marsh. Mendall (1949) similarly found evidence that black ducks in Maine changed their diurnal foraging cycle to one dominated by nocturnal feeding in response to fall hunting pressure.

American black ducks wintering at Chincoteague experienced reduced energy intake while doubling energy expenditure during observed disturbances. Even if flight time per disturbance is short, the additional time spent resettling between landing and continuation of feeding may become lengthy even at low disturbance rates (Bélanger and Bedard, 1990). The cumulative effects of reduced energy intake, reduced feeding time, and increased energy expenditure may become prohibitive for refuging waterfowl at some point. Modeling of the energetics of snow geese staging at Arctic NWR suggest that reduced feeding time and energy intake have greater effects on daily fat gain than increased energy expenditure due to flight (Brackney, 1987).

Lack of a behavioral response does not mean lack of a metabolic or physiological response. Ball and Amlaner (1980) demonstrated that an alert but caged Herring gull (*Larus argentatus*) shows an increasing heart rate in response to an approaching human. Similarly, MacArthur and others (1982) found that mountain sheep (*Ovis canadensis*) had elevated heart rates when disturbed by aircraft despite showing no evidence of a behavioral response. Although there is some question as to the relationship between heart rate and metabolic rate (Wooley and Owen, 1977), it is clear that wildlife are responding with a heightened state of vigilance even when there is no apparent behavioral response.

In general, human disturbance increases maintenance costs by increasing energy expenditure and decreasing energy intake. I proposed that birds wintering in north temperate climates can ultimately respond to disturbance-induced costs by increasing energy intake, habituating, and/or dispersing (Morton, 1996). Increased energy intake compensates for increased maintenance costs, habituation effectively reduces elevated maintenance costs, and dispersal avoids disturbance. These responses are not mutually exclusive; for example, Owens (1977) observed that brant (*Branta bernicla*) avoided heavily disturbed feeding sites in early winter but used all such areas later as food stocks became depleted elsewhere. Failure to respond adequately with one or more of these three strategies will likely result in impaired fitness (e.g., reduced body mass or fat reserves) of individuals or reduced populations. This model emphasizes that behavioral responses to disturbance are intrinsically linked to food quality and availability. It is easy to understand why some researchers argue that the converse is true: human disturbance effectively lowers habitat quality, carrying capacity, or functional availability of habitats (Bélanger and Bedard, 1989; Korschgen and others, 1985; Morton and others, 1989a, 1989b, Sincock and others, 1966).

Habitat Suitability Index models (developed by the U.S. Fish and Wildlife Service) that incorporate disturbance as a parameter are based on the previous premise. Although some HSI models are built on unsubstantiated mathematical relationships, many do provide an excellent framework for conceptualizing constraints on a population. The HSI model for wintering American black ducks (Lewis and Garrison, 1984) requires the estimation of area and food value for subtidal water (V_1, V_3), intertidal zones (V_2, V_4), and creeks, ponds, and impoundments (V_5, V_6). This model does not specifically estimate estuarine emergent vegetation, although snail numbers are evaluated (V_7). Consequently, Morton and others (1989b) suggested including a new variable (V_8), that would credit the importance of salt marsh (*Spartina alterniflora*) to wintering black ducks, particularly along the mid-Atlantic coast. We also proposed that V_6 be generalized to reflect the abundance of common waterfowl forages in local ponds and impoundments; restricting this variable to *Ruppia* and *Potamogeton* tends to underestimate the value of this habitat type. Based on this retrospective analysis, I now suggest that the HSI model should include a variable to index human disturbance. Depending on the habitat, this could be measured by aerial counts of boat traffic, vehicle traffic counters, the number of hunting blinds, or some combination. The suitability index function would presumably decrease logarithmically as disturbance values increase.

Human populations and, consequently, disturbance levels in the Chesapeake Bay will almost certainly increase in the foreseeable future. American black ducks can be expected to seek habitats with less disturbance and/or extend feeding times to mitigate for the effects of disturbance (i.e., compensatory foraging). One predicted outcome is that a larger proportion of the black duck population wintering on the Bay may use the relatively undisturbed lands owned by public agencies, particularly NWRs. Mayhew (1988) showed that the longer a waterfowl species took to meet minimum daily energy requirements (as measured by feed time per 24 hrs), the greater the percentage of the population to be found wintering on British refuges and reserves. This likely scenario clearly argues for policies and regulations that maintain at least some public lands as true sanctuaries or "refugia" for at least some of the time. At Blackwater NWR, for example, public entry and boating are prohibited over most of the refuge from October 1 to March 31. Other strategies and techniques are available to mitigate the impacts of human disturbance on wintering American black ducks and other waterfowl (Morton, 1995).

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Mallards Replacing Black Ducks: Two Views

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Abstract: The population of the American black duck (*Anas rubripes)* has declined dramatically in recent decades. This decline has been attributed to many factors including overharvest, introgressive hybridization by mallards (*Anas platyrhynchos*), competitive superiority of mallards, and habitat degradation. Here we review evidence that refutes the theory that the decline of black ducks is directly due to competition with mallards. Alternatively, we propose that black ducks are more sensitive than mallards to human disturbance in their habitat, displaying greater levels of neophobia and/or wariness towards humans. Degree of neophobia was measured in captive populations of black ducks and mallards by measuring their latency to feed near familiar and novel objects. A significant difference was found between the two species; however, contrary to our prediction, mallards displayed greater levels of neophobia than black ducks.

Introduction

The population of the American black duck (*Anas rubripes*, hereafter black duck) has declined dramatically in recent decades, from approximately 800,000 in the 1950s to 300,000 in the 1990s (Longcore and others, 2000). This decline has been attributed to many factors including overharvest, introgressive hybridization by mallards (*Anas platyrhynchos*), the competitive superiority of mallards, and habitat degradation. Here we review two general theories regarding the decline of the black duck: (1) that the decline is directly due to the competitive superiority of mallards and (2) that the black duck decline and concurrent mallard increase is due to intrinsic behavioral differences in their response to human disturbance and not direct interaction of the two species. In addition, we present preliminary data highlighting an important behavioral difference between the two species.

One proposed explanation for the decline of the black duck is competitive exclusion from preferred breeding habitats by mallards (Merendino and Ankney, 1994). If mallards are causing black ducks to decline through direct competition for habitat, mallards must be more aggressive and competitively superior. However, studies have found that mallards are not socially dominant over black ducks in natural breeding (McAuley and others, 1998) or wintering (Morton, 1998) situations. Thus the hypothesis that mallards are more aggressive and competitively exclude black ducks is not supported.

Hybridization with mallards is often mentioned as a cause of black duck decline (Ankney and others, 1987, 1989; Seymour, 1990). If mallard males are preferred as mates by female black ducks, the demise of the black duck is assured due to its smaller gene pool. Rates of mixed pairing ranging from <1% to 14% (D'Eon and others, 1994; McAuley and others, 1998; Morton, 1998) for sympatric populations of mallards and black ducks have been reported. Hybrids may also arise from forced extra-pair matings. However hybridization is not likely to be a cause of black duck declines in the long term for two reasons: (1) hybrids are probably selected against and (2) they are less likely to form pair bonds than members of either parental species (Morton, 1998). The mechanism underlying this was described by Brodsky and others (1989) and is summarized here.

Early social experience results in assortative mating. In laboratory choice tests, black ducks and mallards preferred to pair with the species they were raised with since hatching. Since mallards and black ducks will only experience conspecifics in natural nests, because interspecific egg parasitism is unknown, the present low incidence of mixed pairing will remain low. F_1 hybrids that do occur either through mixed pairing or forced extra-pair matings have plumages intermediate to either parental species (Phillips, 1915; Morgan and others, 1976). This means that neither parental species will pair bond with them readily. Furthermore, when a hybrid mates with either parental species, the resultant offspring appear more like that parental species, either a mallard or a black duck, than their F_1 hybrid parent (Phillips, 1915; Morgan and others, 1976). These offspring, then, will prefer to pair with individuals of the parental species. This process will continually cull out hybrids or merge them into either the black duck or mallard gene pool.

It has also been suggested that mallards have higher intrinsic reproductive rates (Nichols and others, 1987). However, Petrie and others (2000) found no difference in reproductive rate between mallards and black ducks breeding sympatrically in New Brunswick. They rejected the hypothesis that divergent population trends of the two species result from differences in reproductive rates. However, Petrie and others (2000) accept the notion that mallards are competitively superior to black ducks. They suggest that black ducks have a lower propensity to breed when faced with mallard competition. However, as mentioned above, support for mallard competitive superiority does not exist, making it unlikely that this hypothesis will explain why black ducks are declining.

In addition, Morton (1998), Petrie and others (2000) and Ankney and others (1987) found it unlikely that habitat for breeding black ducks has been reduced sufficiently to cause their decline. What Morton (1998) suggested, and what we discuss here, is that mallards and black ducks differ in their ability to live with human disturbance, not land-use changes per se. Disturbance refers to recreational boating and jet skiing, fishing, cottage activity around lakes, dogs and human activities such as hiking. Krementz and others (1992) found these disturbances to affect breeding success in black ducks more than in mallards and was cited by Petrie and others (2000) to support their information that mallards and black ducks do not differ in nesting success in the absence of human disturbance. Thus, evidence does not support the idea that black ducks are declining because of direct interactions or competition with mallards.

We propose that the decline of the black duck is due, at least in part, to how the species responds to human disturbance, particularly the influx of novel objects and novel situations. Ecological plasticity, how flexible an animal is in the face of change, is an intrinsic feature of an animal, and species, even closely related ones, often differ strikingly in their ecological plasticity. This variation does not require morphological differences between the species but may be based on behavioral differences as well. We propose that a better understanding of the behavioral mechanisms underlying ecological plasticity may help to explain why the black duck population has declined, while the population of the very closely related and morphologically similar mallard has increased in past decades (reviewed in Heusmann, 1991).

Greenberg (1990a) has hypothesized that neophobia, the avoidance of an object or other aspect of the environment solely because it has never been experienced before and is dissimilar from anything that has been experienced, underlies differences in ecological plasticity. Neophobia is a concept associated with fear and is widespread throughout the animal kingdom (Greenberg, 1983; Beissinger and others, 1994; Coppinger, 1970; Raudensush and Frank, 1999). In 1990, Greenberg developed the Neophobia Threshold Hypothesis (NTH) based on studies of congeneric warblers (*Dendroica*) and sparrows (*Melospiza*). The NTH posits that birds can and do respond to novel stimuli with acute stress. Further, the greater the intensity of the original fear response the less likely an individual will be to explore or feed at novel stimuli. The fewer novel microhabitats or foods the bird approaches, the fewer new opportunities will be available for its foraging repertoire. The result is reduced ecological plasticity. However, novelty responses may be reduced through habituation. Finally, the NTH posits that neophilia, or attraction to novelty, in juvenile birds makes this period particularly important in shaping the foraging niche of a species. The more neophobic a species is as an adult, the more important its experience during the juvenile neophilia period will be. Early experience will determine the range of stimuli with which they are familiar, and strong neophobic responses as adults should make it less likely that their preferences will change.

The ability of neophobic responses to affect an animal's degree of ecological plasticity is clear. Differences in neophobia between laboratory and wild strain rats and among breeds of dogs, for example, suggest that enough heritable variation exists for artificial selection to shape major differences (Barnett, 1958; Barnett and Cowan, 1976; Mitchell, 1976). The costs and benefits of neophobia are predicted to vary with the age and condition of an individual and the foraging ecology and life history of the species (Greenberg and Mettke-Hofmann, 2001). For example, species living in relatively unsafe environments (high numbers of predators and/or toxic potential food items) might benefit more from high levels of neophobia than species living in safer environments where exploration of unfamiliar objects or habitats is less likely to lead to injury or death. Alternatively, species living in unpredictable environments where resources are highly variable might benefit more from low levels of neophobia since "familiar" resources may not be consistently present in the environment.

It should be noted that plasticity is not simply an alternative term for the concepts of generalist versus specialist. Specialization is a static concept involving a species' degree of ecological amplitude, while plasticity is a dynamic concept concerning a species' ability to respond to change (Morse, 1980). It is likely, however, that there is a strong correlation between specialization and plasticity in birds, as indicated by studies of congeneric species of *Dendroica* and *Melospiza* (Greenberg, 1983, 1984, 1989, 1990b).

We conducted a study to test the hypothesis that black ducks are more neophobic than mallards and thus less able to adapt to human disturbance of their habitat. The basis of this hypothesis is two-fold. First, mallards have a circumpolar distribution in the North Temperate Zone, occurring in a wide range of freshwater habitats and both open and wooded areas (Dwyer and Baldassarre, 1994). Black ducks, however, are restricted to eastern North America where they winter mostly in salt water habitats and use both fresh and salt water habitats for breeding (Longcore and others, 2000) but are more commonly associated with wooded areas than mallards. The restricted range of the black duck suggests it is more specialized than mallards. Second, black ducks are commonly considered to be much more wary than mallards (Pough, 1951; Krementz and others, 1992; Morton, 1998). Wariness or tameness is defined as the toleration by an animal to the physical presence of humans themselves, not just objects associated with humans. While it is unknown whether an animal's degree of neophobia is controlled by the same physiological system as wariness, degree of tameness has been found to be positively correlated with speed of habituation to novel objects in wild-type and domestic mallards (Desforges and Wood-Gush, 1975).

Methods

Mallard eggs were collected from the nests of wild birds in Egeland, North Dakota, while black duck eggs were collected from the nests of wild-type birds which had been in captivity at the USGS Patuxent Wildlife Research Center for several generations. All ducks were incubator-hatched and hand-reared. Ducklings were initially housed indoors in conspecific groups. At approximately 2 weeks of age, 8 groups of 7-12 conspecifics (totaling 37 black ducks and 39 mallards) were transferred to outdoor pens (6.1 m x 9.1 m) constructed of chicken wire and green canvas. Pens were adjacent to each other but were visually separated by canvas walls 0.9 m high. Substrate was stone and grass. Each pen contained a cement pond with continuously flowing water. Observation blinds were stationed approximately 5.5 m behind the pens.

Throughout the rearing and trials, an intense effort was made to limit the ducklings' exposure to bright colors (especially bright or neon shades of red, yellow, and blue) as well as shiny objects and manmade materials that they would be unlikely to encounter in pristine natural habitat. Beginning immediately posthatch, ducklings were routinely handled and in view of humans in order to reduce human-induced fear response during novelty trials because we wanted to determine the role of neophobia alone and not wariness. In addition, during the period of 2-6 weeks pretest, solitary and social tests were simulated without novel objects in order to familiarize the subjects with the test procedure. All ducks were raised with a "familiar" object in their pen, namely an orange pylon placed adjacent to each food bowl. Experimental trials did not begin until after ducklings had reached the age when they would typically fledge (approximately 8 weeks) in order to avoid testing during the juvenile period when birds have been proposed to be neophilic, or attracted to novel objects (Greenberg, 1990a).

The design of the experiment was straightforward. Ducks were deprived of food overnight. The next morning we measured the time it took them to feed (latency), comparing food presented next to either the familiar object or one of several novel objects. For each pen, we conducted multiple replicates of each of two different types of trials: solitary, where food is presented to one duck and alternating by day either the familiar object (four trials) or a novel object in its place (four trials); and social, where food is presented to a group of ducks and alternating by day either the familiar object (four trials) or a novel object in its place (four trials). Social as well as solitary trials were conducted because ducks are social and probably do not usually encounter novelty alone. Participation in flocks and response to the approach behavior of other individuals may play a critical role in allowing individuals to overcome neophobia (Greenberg and Mettke-Hofmann, 2001). The reason we used several novel objects is two-fold. First, a consistent response to a diversity of unusual objects is most easily explained by an overall response to novelty rather than as a reaction to a particular stimulus (color, shape, etc.) that the species finds inherently frightening. Second, any one object may be regarded as extremely frightening by both species and lead to a maximum display of stress, obscuring any difference that might typically occur between the species at more intermediate levels of stimuli (Suomi, 1983, 1987). As we cannot know the level of stress that will be caused by a particular object, we used a variety of items. Order of trials was counterbalanced across groups with each black duck group paired with a mallard group undergoing the trials in the same order and at the same age. Group-pairs 1 and 2 began trials at approximately 10 weeks of age, group-pair 3 at 15 weeks, and group-pair 4 at 18 weeks of age.

Results

Analysis of the social-familiar trials revealed no significant difference in median latency to feed between mallards and black ducks in three out of four experimental group-pairs ($P > 0.05$ Mann-Whitney U Test, fig. 1). Analysis of the social-novel trials revealed a significant difference between mallards and black ducks for three of the four group-pairs ($P < 0.05$ Mann-Whitney U Test, fig. 2). In all cases, mallards displayed longer mean latencies to feed at novel objects than did black ducks. In addition, age at first testing was positively correlated with latency to feed at the familiar object in mallards but not in black ducks (ducks in pairs three and four were older than those in pairs one and two at first testing). The role of group composition (sex and dominance rankings) remains to be analyzed.

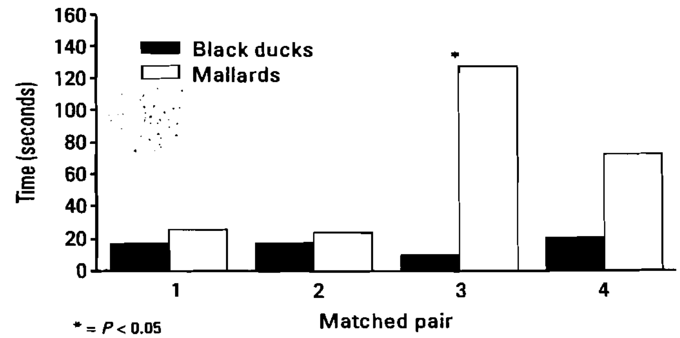

Fig. 1. Median latency to feed at familiar object.

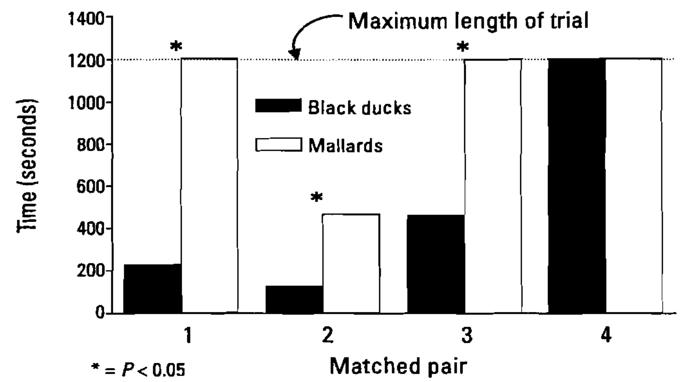

Fig. 2. Median latency to feed at novel object.

Solitary trials have also been completed on all eight groups of ducks. For both species, however, the majority of individuals did not feed within the allotted testing period for any novel object, making a comparison between the two species uninformative. The behavior of the ducks during individual trials suggests that motivation to return to the group may have conflicted with the motivation to feed.

Discussion

Preliminary results from our research on neophobia in captive black ducks and mallards indicates that there is a significant difference in neophobia between the two species. The relative levels of neophobia are opposite to those predicted by the NTH, however, as mallards show higher levels of neophobia than black ducks. Our research suggests that a relatively high level of neophobia either helps mallards cope better than black ducks with human disturbance, that black duck wariness rather than neophobia limits their ability to habituate to human disturbance, or that our experimental protocol did not produce natural levels of neophobia in the study birds.

The idea that relatively high levels of neophobia may help a species cope with human disturbance was proposed by Corey (1978) in response to a comparison of the level of neophobia observed in various species of rat (*Rattus* spp.). Corey proposed that the extreme wariness of wild *R. norvegicus* (a highly ecologically plastic species) is an adaptation to its commensal role with man and the attendant pressures of trapping and poisoning. Studies found that species of rat commensal with humans (*R. norvegicus* and *R. rattus*) are strongly neophobic, while the intensity of the neophobic response in noncommensal species (*R. fuscipes* and *R. villosissimus*) is greatly reduced (Cowan, 1976, 1977). These results suggest the possibility that the relatively low level of neophobia in black ducks compared to mallards may reduce their ability to survive and reproduce in areas of human disturbance.

Alternatively, the environment as well as genetics may play a critical role in determining the level of neophobia displayed by adults of a species. In this case, the restricted environment of our experimental design may not have allowed for the development of natural levels of neophobia. This conclusion is supported by studies on both wild-caught and captive-raised sparrows (Greenberg, 1989, 1990b, 1992). The song sparrow (*Melospiza melodia*) is a widespread species noted for its highly generalized habitat use and ecology, while the swamp sparrow (*M. georgiana*) is a specialist on marsh habitats. These species were tested in the wild by comparing visitation rates to feeders where both species occurred with and without associated novel objects (Greenberg, 1989). Consistent with the NTH, swamp sparrows showed a significantly longer latency to feed than song sparrows when a novel object was present. In the laboratory, however, when young birds of both species were reared under identical conditions and exposed to a similar environment during their postfledging exploratory period, the adult neophobic response was much greater in the song sparrow than the swamp sparrow. These results suggest that, contrary to the predictions of the NTH, the environment a juvenile is exposed to plays a key role in determining its adult level of neophobia. Even though song sparrows appear to be genetically predisposed to higher levels of neophobia than swamp sparrows, because they are generalists and frequently encounter novel objects and/or habitat, their cumulative experience may lead to a habituation to novelty in general, resulting in reduced levels of neophobia. As specialists, however, swamp sparrows do not have the same opportunity to habituate to novel stimuli, and levels of neophobia are not reduced in adults. Given these results and the preliminary results of our study, we believe data on the response of black ducks and mallards to novel objects under natural conditions are necessary before any conclusions can be made concerning the role of neophobia in the decline of the black duck.

Finally, studies on the differences in wariness between the two species and the effect of wariness on ecological plasticity may prove fruitful. Black ducks are commonly believed to be much more wary than mallards. However, the positive correlation between mallard age and latency to feed at the familiar object suggests that they may have been more disturbed by the experimental procedure (which included the presence of researchers immediately prior to the experiment) when testing was initiated at an older age.

Management Implications

If the black duck decline is found to be due to a relatively high level of neophobia, management strategies for wildlife areas set aside for black ducks may need to be changed in order to reduce all types of human disturbance, not just disturbance caused by hunting. The conservation implications of understanding the behavioral mechanisms of ecological plasticity, however, go beyond understanding the decline of the black duck. Given the rapidly increasing human population, it is more important than ever to understand why some animals seem better able to adapt to changes in their environment. Evidence supporting a correlation between level of neophobia and degree of ecological plasticity would support the idea that it is possible to devise a behavioral experiment that could be used to predict the ability of a species to adapt to rapid, human-induced habitat change. Such a finding could have significant impacts on the fields of conservation biology and wildlife management, allowing biologists to anticipate the effects of mild or moderate habitat change on a species before it occurs. A more thorough understanding of neophobia could also have a significant impact on captive breeding programs for threatened and endangered species. If levels of neophobia are found to be influenced by an animal's early environment, then it will become more important than ever to mimic a species' natural environment as closely as possible in captivity, especially if individuals are to be re-released into the wild.

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Breeding Productivity of Smith Island Black Ducks

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Abstract: We investigated the breeding performance of American black ducks (*Anas rubripes*) on Smith Island, Chesapeake Bay, to improve our understanding of island black duck breeding ecology and to make management recommendations to enhance productivity. During 1995-96, we implanted 56 female black ducks with 20-g radio transmitters and tracked 35 of the individuals through the breeding season to locate nests, determine nest fate, and identify brood habitat. We also increased preseason banding efforts and compared capture characteristics over 12 years with those from the Deal Island Wildlife Management Area, a banding site on the mainland of Tangier Sound. A low rate of nesting (37%), lack of renesting, and poor hatching success (31%) indicated that island salt marsh habitats present a harsh environment for breeding black ducks. Black ducks located 11 of 13 nests (85%) in black needlerush (*Juncus roemerianus*) marsh where they were vulnerable to flooding from extreme tides and to egg predators. No nests were found on forested tree hammocks, a feature that distinguishes Smith Island from nearby South Marsh and Bloodsworth Islands. Nest predators included red foxes (*Vulpes vulpes*), herring gulls (*Larus argentatus*), fish crows (*Corvus ossifragus*), and, potentially, Norway rats (*Rattus norvegicus*). Unlike mainland red foxes, foxes radio tracked on Smith Island were found to be capable swimmers and effective low marsh predators. We found shoreline

meadows of widgeon grass (*Ruppia maritima*) to be important foraging sites for black ducks and suspected that the virtual absence of fresh water in this high salinity environment (12-17+ ppt) to incur some cost in terms of growth and survival of ducklings. Preseason bandings revealed a high proportion of banded adults and a strong positive correlation in age ratios with the Deal Island banding site. This latter finding strongly suggests a negative universal effect of storm tides on nest success for Tangier Sound black ducks. Management to reduce nest predators, especially gulls and foxes, likely will have the greatest immediate benefit for island breeding black ducks.

Introduction

The American black duck (*Anas rubripes*) has long been an important wintering and prominent resident breeding waterfowl in the Chesapeake Bay (Stewart, 1958; Stotts and Davis, 1960; Krementz, 1991). Whereas numbers of wintering black ducks in the Atlantic Flyway have declined about 60% since the 1950s, the decline has been more severe and has approached 80% in the Maryland portion of the Bay (Midwinter Waterfowl Inventory, U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Laurel, Md., unpub. data). This marked decline in numbers of black ducks results from both a decline in use by northern migrants and a decline in the resident breeding population. That Chesapeake Bay once harbored one of the largest southern breeding black duck populations is best documented by the field study conducted by Stotts and Davis (1960) in the 1950s in the Kent Island area. During this study, 731 black duck nests were located, and large preseason bandings (1,256 bandings over two seasons, Stotts, 1957) substantiated black duck productivity.

In the lower eastern shore of Maryland, the vast marshes of the Tangier Sound region also have been recognized as a stronghold for breeding black ducks. This area differs markedly from the Eastern Bay region because of its higher salinity and extensively developed salt marsh. Nowhere else in the Chesapeake Bay does there exist such an extensive region of nearly continuous estuarine marsh. Although Stewart and Robbins (1958) reported high densities of black ducks (5.3 pairs per 40.5 ha) in the expansive marshes of the Fishing Bay area, no formal studies of black ducks have ever been conducted there. A second feature of the region is the presence of the 40-km island chain consisting of Bloodsworth, South Marsh, and Smith Islands, terminating in the smaller Tangier Island in Virginia. This series of large offshore islands remains some of the most remote wildlife habitat in the Chesapeake Bay and is perceived as one of the last strongholds for resident breeding black ducks in the Bay.

A 1994 initiative by the U.S. Department of Defense – Navy to include its 1,700 ha Bloodsworth Island Shore and Bombardment Range under cooperative management by the North American Waterfowl Management Plan identified the black duck as a species of special emphasis. Black ducks have never been studied on these remote islands, and the need for better management guidelines by the Navy for Bloodsworth Island, the Maryland Department of Natural Resources (MD-DNR) for South Marsh Island, and the U.S. Fish and Wildlife Service (USFWS) for Martin National Wildlife Refuge on Smith Island motivated our participation in a field study of insular breeding black ducks. The objective of our study was to document the ecology and breeding performance of island nesting black ducks and make recommendations for management.

Study Area

Because of the difficult logistics inherent to these remote islands and presence of live ordinance (bombs from aircraft) on Bloodsworth Island, we conducted our black duck studies on Smith Island, focusing on the 1,780-ha Martin National Wildlife Refuge. Smith Island is well isolated from the mainland, lying 21 km from the western shore of the Bay and 8 km from the nearest mainland marshes on the eastern shore of Tangier Sound. The habitat on Smith Island is nearly all low salt marsh dominated by black needlerush (*Juncus roemerianus*), lesser amounts of saltmarsh cordgrass (*Spartina alterniflora*), and a few meadows of saltmeadow cordgrass (*S. patens*) and salt grass (*Distichlis spicata*). The island is crisscrossed by numerous tidal creeks and unlike South Marsh and Bloodsworth Islands, still retains a small number of well forested tree hammocks. Most of these sites are rookeries for colonial nesting wading birds (Armistead, 1974). Other upland areas include limited dune development, mostly on the Bay side of the island, and several spoil sites that have been created from maintenance dredging of navigable canals.

Smith Island has been inhabited almost continuously since the late 1600s, at which time it was probably mostly forested (Dize, 1990). Since that time, and especially since the 1850s, the island has been experiencing submergence and rapid land loss attributed to the effects of sea-level rise (Kearney and Stevenson, 1991; Downs and others, 1994; Leatherman and others, 1995). From earliest settlement, livestock grazing was common on the island, and the last cattle were removed when the refuge was established in 1954. Aerial photographs reveal the extent of hand-dug linear ditch lines and stock ponds associated with former pasture sites. These disturbed sites are indelibly marked on the marsh surface by the presence of high tide and groundsel bush communities (*Iva frutescens* and *Baccharis halimifolia,* respectively) that now occupy elevated spoil lines adjacent to the ditches.

Black ducks are common on these islands, especially in winter where varying numbers ranging from 1,000 to 3,000 birds have been observed each year since the 1970s during the Midwinter Waterfowl Inventory (USFWS, Office of Migratory Bird Management, Laurel, Md., unpub. data). These few thousand are approximately 10% of the 15,000 to 30,000 black ducks reported on the midwinter survey for Maryland in the 1990s. Numbers of island black ducks decrease rapidly in March and April when migrants depart. Aerial surveys conducted in March by refuge personnel indicate that the islands harbor several hundred pairs of black ducks, usually with higher numbers on Smith Island (100-200 pairs) than on Bloodsworth or South Marsh Islands.

Methods

From mid-March through mid-April 1995-96, we captured black ducks in bait traps following procedures developed by Harrison and others (2000). Female black ducks were transported to refuge facilities at the island community of Ewell where they were banded and weighed before they underwent a 25-min aseptic surgical procedure to receive abdominally implanted radio transmitters (Olsen and others, 1992). Because we found that a high percentage of trapped black ducks had been previously banded during preseason on Smith Island (e.g., 37 of 80 [46%] in 1995 and 28 of 73 [38%] in 1996), we used local banding status to separate residents from migrants and gave preference to resident ducks for implanting. Typically, ducks trapped in early morning were implanted and released the same day (held 6 to 10 h); those trapped in late afternoon and evening were implanted and released the following day (held 12 to 18 h). All ducks were given postoperative, subcutaneous fluid injections to prevent dehydration. Implanted black ducks were marked with an identification leg band to alert the finder of an internal radio and provide a contact phone number.

Radio transmitters were 20-g implantable units designed with a temperature sensitive mortality circuit that would double the pulse rate when body temperature was $\leq 36^{\circ}$ C. Status of ducks was checked at least once a week. Particular effort was made to locate missing birds and identify sedentary individuals that might be nesting. An 18-m fire tower located near the center of the refuge was used to scan for radio-tagged ducks. We also tracked from boats with a portable mast and used a system of six fixed antennas that were located to provide systematic coverage of the island assuming a nominal transmitter range of 0.8 km. Tracking from aircraft was used sparingly to locate missing ducks only in the Smith-South Marsh Island area.

Nests of radio-tagged females were located by triangulation from a distance of about 50 m using a hand held null-peak antenna. We did not attempt to find or examine nests until they were terminated. We inspected terminated nests for evidence of hatching or cause of abandonment. We were alert to signs of nest predators that might inhabit the island. No evidence of raccoons (*Procyon lotor*) or mink (*Mustela vison*) was found; however, signs of river otter (*Lutra canadensis*), red foxes (*Vulpes vulpes*), and in some instances, Norway rats (*Rattus norvegicus*), were generally common on tree hammock, spoil, beach, and dune sites. After discovering red foxes on the island in 1995, we initiated a pilot telemetry study in 1996 to determine the extent of fox mobility in island marsh habitats.

Because we suspected that elevated salinity could affect black duck productivity, we surveyed island habitats during spring and summer to determine the range of salinity levels. We were interested particularly in sources of fresh water and whether such areas were used by black ducks. Finally, to enhance our knowledge of island black ducks, we increased preseason banding efforts and analyzed past banding records from Smith Island and at a mainland banding station operated by MD-DNR at the Deal Island Wildlife Management Area, about 20 km to the northeast.

Results

Spring Capture and Implants

Spring captures totaled 80 black ducks in 1995 and 73 in 1996 (table 1). Captures were characterized by a high percentage (42.5%) of returns (previously banded birds), most of which (95.4%) were from Smith Island bandings. Of three foreign returns (captured ducks banded elsewhere), two were from the Deal Island banding site and one was from New Brunswick, Canada. Captures were of relatively even sex ratio (table 1, 1.22 male:female).

We implanted radio transmitters between March 12 and April 11 each year: 33 females were implanted and released in 1995 and 23 in 1996. There was a greater proportion of females censored in 1996 than in 1995 (table 2, $P < 0.02$), with the difference resulting from a greater number of females being censored after April 14 ($P < 0.03$). The April 14 date

Table 1. Spring (March-April) bait-trap captures of black ducks on Smith Island, Maryland, 1995 and 1996.

Year	Total captures	Males	Females	Sex ratio[1]	Returns[2] (percent)	Foreign returns[3] (percent)
1995	80	44	36	1.22	37 (46.3%)	1 (1.3%)
1996	73	40	33	1.21	28 (38.4%)	2 (2.7%)
Totals	153	84	69	1.22	65 (42.5%)	3 (2.0%)

[1]Males to females.

[2]Recapture of ducks previously banded on Smith Island.

[3]Capture of ducks banded elsewhere.

Table 2. Fates of black ducks radio-tracked on Smith Island, Maryland, in 1995 and 1996.

Year	Number radio-marked	Number tracked	Censored[1]			Deaths
			Before 4/14	After 4/14	Total	
1995	33	25	7	0	7 (21.1%)	1[2]
1996	23	10	8	5	13 (56.5%)	1[3]
Totals	56	35	15	5	20 (35.7%)	2

[1]Number of females censored in 1996 was greater than in 1995 ($\chi^2 = 5.90$, $P < 0.02$, 1 df); number of females censored after April 14 was greater in 1996 than in 1995 ($\chi^2 = 4.94$, $P < 0.03$, 1 df), but number of females censored before April 14 was similar for both years ($\chi^2 = 0.67$, $P > 0.3$, 1 df).

[2]Killed by fox.

[3]Killed by peregrine falcon (*Falco peregrinus*).

was an arbitrary date by which most migrants were believed to have left the study area, thus leaving only resident breeding birds. Direct evidence from tracking confirmed that some poaching of black ducks was occurring on the island, and this might be responsible for the contrasting results in censorship of marked ducks between years. As a result, only 10 females were tracked through the nesting season in 1996. A single death was recorded each year to natural causes (table 2).

Nesting Performance

Only 37% of tracked hens nested during the 2-year study, and no difference existed in year-specific nesting response (nests produced per tracked female: $P = 0.44$, table 3). Hatching success was greater in 1996 (80%) versus 1995 when no nests hatched ($P = 0.01$). Although no year-specific difference was found in the proportion of nest losses to storm tides and predation ($P > 0.44$, table 3), two storm tides occurring a week apart (May 3 and May 10) destroyed five of six currently active nests in 1995. Three other nests were lost to predators in 1995 and one in 1996. Nests that had punctured eggs and/or egg fragments were attributed to gulls or crows; those with no sign of eggs or egg fragments were attributed to the distinct caching habit of red foxes (Rearden, 1951; Sargeant and others, 1998).

We recorded 13 females on nests between April 20 and May 25. We estimated the hatching dates of three of four successful nests as May 25, May 29, and June 11. Of the nine females that lost nests, none renested. We examined 5 of the 11 nests located in needlerush marsh and found them to be large elevated structures built of fragments of needlerush leaves to a height of 20-33 cm above the marsh floor. All had distinct ramps similar in structure to the overwater nests of North American diving ducks. Three nests had eggs buried within the nest material indicating that the females built up the nest in response to high water.

Although most black duck nests (11 of 13) were located in dense needlerush, only 2 of these 11 nests (18%) hatched successfully. In contrast, two nests heavily concealed in low woody and herbaceous ground vegetation at upland spoil sites hatched successfully. Although our sample sizes are small,

Table 3. Nesting effort and fate of nests of black ducks on Smith Island, Maryland, as determined by radio telemetry in 1995 and 1996.

Year	Number females tracked	Number nests[1]	Number hatches[2]	Nest losses[3]		
				Storm tide	Predators	Total (percent)
1995	25	8 (32%)	0 (0%)	5	3	8 (100%)
1996	10	5 (50%)	4 (80%)	0	1	1 (20%)
Totals	35	13 (37%)	4 (31%)	5	4	9 (69%)

[1]Nesting effort as measured by the number of nest attempts per radio-tracked female was similar for 1995 and 1996 (Fisher's exact test: $P = 0.44$).

[2]Proportion of nests hatching was greater between 1996 and 1995 (Fisher's exact test: $P = 0.01$).

[3]Nest losses to tides and predators were not different between 1995 and 1996 (Fisher's exact test: $P = 0.44$).

this difference might be biologically significant (Fisher's exact test, $P = 0.08$).

Observation of Females and Broods

During the nesting season we observed a general trend of pairs of black ducks foraging in aquatic bed habitats and mud flats around the perimeter of the island at low tide and moving into the interior tidal creeks at high tide. As the growing season progressed, black ducks were commonly observed at areas with submersed aquatic vegetation, mostly widgeon grass (*Ruppia maritima*). We tracked four females with broods during the month of June and found them generally sedentary. Remarkably, three of four broods used tidal ponds close behind beachheads on the west side of the island. Two of the broods used the same shallow tidal pond with interspersed clumps of needlerush and open water. The pond had abundant prostrate widgeon grass in several areas and salinities ranging from 11 to 14 ppt. It was impossible to approach and observe broods in heavy marsh vegetation, and, therefore, we did not obtain data on brood size and fledging success. Signal strength of transmitters declined after about 10 weeks, and tracking was terminated in early July.

Salinity

We measured salinity weekly between May 9 and July 11 at six fixed points in tidewater and at selected tidal ponds, stock ponds, ditches, and spoil sites around the refuge. As expected, salinity measurements (ppt) of tidal water had a lower mean and smaller deviation (12.51 ± 0.82 std. dev., $n = 53$) than measurements of tidal ponds (13.11 ± 1.56 std. dev., $n = 65$; test for variance, $F52, 64 = 3.55$, $P < 0.001$; t test with unequal variance, $t = 2.67$, $P < 0.01$). The difference in salinity, however, was not great, indicating that most ponds on Smith Island were regularly exposed to tide. This is not surprising because most of Smith Island is low needlerush marsh, and the only elevated ponds are those behind well developed beachheads typically on the western or Bay-side exposure of the island. Fresh water was virtually absent on the island except for three manmade sites: a small stock pond located on high ground on the forested Cherry Tree Island hammock and catchments at two elevated dredge spoil sites. We could identify no special use of these limited number of freshwater sources by black ducks. We did note that following heavy thunderstorms, salinities could drop sharply to below 10 ppt on the marsh surface until inundated on the next tide.

Preseason Bandings

Over 6,000 black ducks (average of 515/yr) were banded at Deal and Smith Islands in the 12-year period from 1984 to 1995 (table 4). These bandings are split 60:40% with slightly more than twice as many adult black ducks being banded at Deal Island. Numbers of black ducks banded annually at Smith Island were consistent over the 12 years, but 82% of Deal Island bandings occurred in the 6 years from 1990 to 1995 (average of 503/yr). Both locations recorded about the same numbers of hatching-year bandings (1,400+), but Smith Island exhibited a much lower sex ratio among young black ducks (about 48% male versus about 63% male at Deal Island). Sex ratios among adult captures were similar at both locations at about 60% male (table 4). The percent of hatching year (HY) black ducks captured each year was highly correlated between Smith Island and Deal Island banding sites (fig. 1: $r = +0.75$, $P < 0.01$, 10 df).

Deal Island had more returns than Smith Island (table 4, 21.6% versus 25.4%). Only 10 foreign recaptures (i.e., ducks banded outside the Tangier Sound region) were trapped at the two sites during the 12-year banding period. Two were trapped at Smith Island and eight at Deal Island. Deal Island bandings made up a larger proportion of Smith Island returns (17.6%) than vice versa (Smith bandings made up 6.8% of returns at Deal). Correcting for banding rate (1.46 times more black

Table 4. Numbers of black ducks banded preseason at Smith Island and Deal Island, Maryland, 1984-95.

	After-hatching year[1]		Hatching-year[2]				
Location	Number	Cumulative sex ratio[4]	Number	Cumulative sex ratio	Total (percent)	Hatching-year (percent)	Return[3] (percent)
Smith Island	1,051	0.602 A[5]	1,457	0.477 A	2,508 (40.6)	58.1	21.6
Deal Island	2,255	0.624 A	1,416	0.628 B	3,671 (59.4)	38.6	25.4
Totals	3,306		2,873		6,179 (100)		

[1]After-hatching-year, or adult.

[2]Hatching-year, or juvenile.

[3]Percent previously banded AHY ducks.

[4]Cumulative sex ratio as proportion male.

[5]Different letters (A and B) within columns indicate sex ratio differences by z-test of proportions ($P < 0.001$).

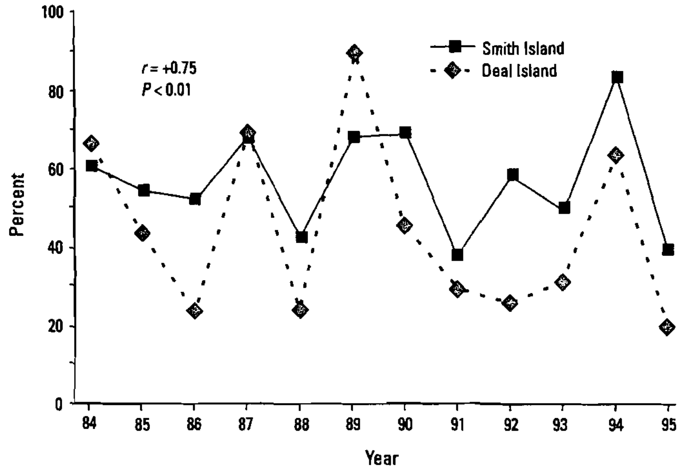

Fig. 1. Percent of hatching-year black ducks in July-September bait-trap captures at Smith Island and Deal Island, Maryland, 1984-95.

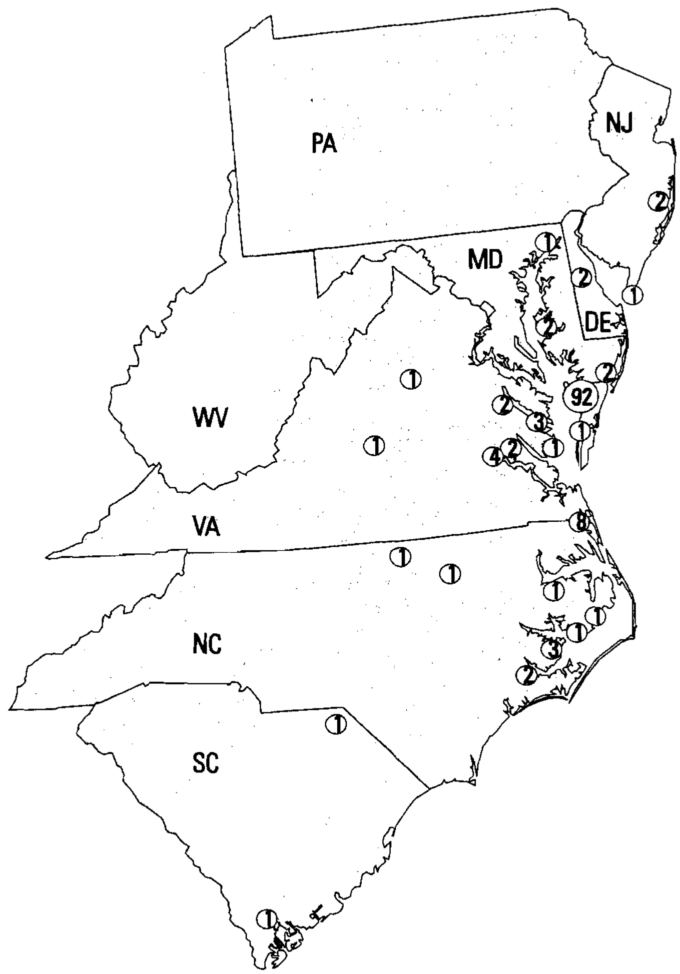

Fig. 2. Distribution of 137 direct recoveries of black ducks banded at Smith Island and Deal Island during July-September, 1980-95. Three other recoveries were from outside of map area.

ducks were banded at Deal than Smith) reveals that 1.7 times more ducks banded at Deal were recaptured at Smith. We examined direct recoveries (n = 140) of Smith and Deal Island preseason bandings and found two-thirds to occur in Tangier Sound, with the remaining one-third generally dispersed in the coastal mid-Atlantic area (fig. 2). Only a single duck was recovered north of Pennsylvania and two south of South Carolina.

Mallards

During the prenesting and nesting period, the number of mallards on Smith Island was very low; no mallards were captured during spring trapping in either year. A few semidomestic mallards (*Anas platychynchos*) nested in association with the waterman communities on the island, but none were known to nest in the marsh. About three mallard x black duck pairs were seen each year.

During the 1984-95 preseason banding period, about four times as many mallards (1,675 versus 412) were banded at Deal Island than at Smith Island. Mallards accounted for 31.3% of all mallard and black duck captures at Deal Island and 14.1% of captures on Smith Island. The percent of hatching-year captures was similar and highly correlated between black ducks and mallards at each banding location: Smith Island, $r = +0.75$, $P < 0.01$, 10 df (fig. 3); Deal Island, $r = +0.79$, $P < 0.01$, 10 df (fig. 4).

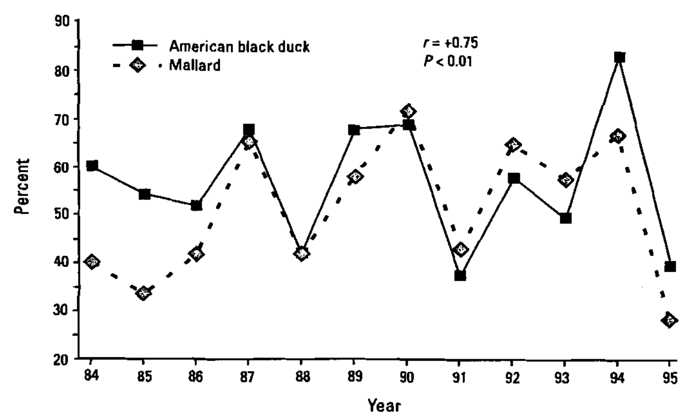

Fig. 3. Percent of hatching-year black ducks and hatching-year mallards captured July-September at Smith Island, Maryland, 1984-95.

Discussion

The low rate of nesting, lack of renesting, and poor hatching success indicates that island salt marsh habitats present a harsh environment for black ducks. The poor success is

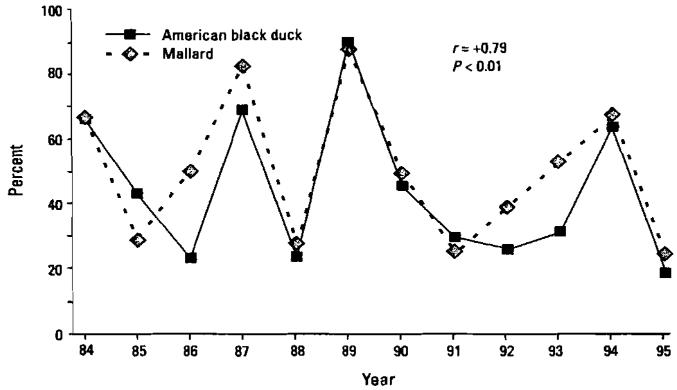

Fig. 4. Percent of hatching-year black ducks and hatching-year mallards captured July-September at Deal Island, Maryland, 1984-95.

further corroborated by the lack of observation of broods during the late brood rearing period. During the 2-year study, we observed only four black duck broods. Although low visibility might reflect the abundance of avian predators (i.e., gulls [*Larus* spp.] and crows [*Corvus* spp.]) that harry broods, it also is a strong indication that there are few broods present. This difference in visibility is in sharp contrast to the successful use of aircraft in the upper Bay in the 1950s to survey black duck broods (Stotts, 1957). Moreover, the presence of ground-based predators may also explain why black ducks favored dense cover in low needlerush marsh for nesting over more upland locations that are immune to tidal flooding.

In the upper Bay, Stotts and Davis (1960) found that black ducks prefer nest sites in upland woods, often on small islands and in association with honeysuckle (*Lonicera japonica*), poison ivy (*Rhus radicans*), or brush pile ground cover. They found only 14 (2.4%) of 593 black duck nests in low marsh emergent plants (i.e., needlerush or three-square bulrush [*Scirpus* sp.]) and another 14% in marsh grasses, especially saltmeadow cordgrass. We note, however, that salt marsh habitats are poorly represented in the Eastern Bay area whereas they dominate the landscape on Smith Island. None of our radio-tagged females nested in saltmeadow cordgrass. The premise that more black ducks might favor nesting on Smith Island because of their use of at least a small number of well developed tree islands, versus the treeless South Marsh or Bloodsworth Islands, was not substantiated. Although two of four hatching nests were in tangles of dense ground vegetation on manmade spoil sites, most nests (85%) were in needlerush marsh.

Storm tides had the greatest detrimental effect on black duck nest success in Smith Island salt marsh, followed by predators. The striking correlation between percent of HY black ducks in bait trap captures at both the divergent island and mainland banding sites underscores the generality of adverse tidal effects on nest success in the region.

Our small sample of nests was not sufficient to partition losses among predators. However, it is obvious that herring gull populations are large on Smith Island and together with fish crows seem to be placing increasing pressure on nesting black ducks and other nesting birds. In his surveys of island bird life in the early 1970s, Armistead (1974) noted that the herring gull colony on Smith Island was the largest in Maryland and likely the largest south of New York. He documented 543 nests there in 1973 and more than 1,000 nests in 1978 (H. Armistead, written comm.). We believe the large gull colonies result from commensalism with resident watermen. Discarded bait from crab pots and blue crabs (*Callinectes sapidus*) culled from shedding houses supplement the food base for gulls. Most watermen are now tending several hundred crab pots in which bait is changed every other day. This amounts to a massive food subsidy for gulls.

The effect of gulls and fish crows on nesting black ducks is likely an insidious pillaging of eggs and possibly ducklings. Because we could not detect black duck nesting until females were sedentary on nests (i.e., they reached late laying or incubation), it is likely that many black ducks had lost nests before we could detect their initiation. We commonly found black duck and clapper rail (*Rallus longirostris*) eggs under perches used by both gulls and fish crows. To illustrate the pervasiveness of gulls, their daytime vigilance at baited trap sites often restricted black duck access strictly to nighttime or the crepuscular hours of the day (Harrison and others, 2000). Baiting of potential trap sites was typically conducted at dusk to allow black ducks nighttime access to the bait. Another possible negative aspect of excessive gull numbers is their tendency to occupy small outlying marsh islands and therefore exclude black duck use of these potentially attractive nesting locations.

Our cursory tracking of radio-tagged red foxes also produced some additional insights. In a study of fox foraging behavior in upland prairie habitat, Sargeant and others (1998) noted that foxes avoided wet areas, seldom entered ponds even to retrieve accessible prey, and seldom depredated duck nests over water. In contrast, our radio tracking indicated foxes commonly hunt in salt marsh, swim tidal creeks and even on occasion cross large, navigable channels. We presumed that much of their access to tidal marsh was at low tide, although further study is needed to more thoroughly understand their tolerance to water. Their movements clearly were not constrained by tidal creeks. Foxes denned on any available high ground; especially important were manmade spoil sites which supported small mammal populations that might help sustain foxes in winter.

It is unclear how long foxes have been on the island. Our visits to Bloodsworth and South Marsh Islands found foxes there as well. Armistead (1974) did not report foxes on Smith Island in his 1973 survey, but he noted that residents reported them in 1978 (Armistead, 1978). It is probable that foxes crossed from the mainland during the severely cold winter of 1976-77 when Tangier Sound was frozen for more than 6 weeks.

Another potentially formidable predator to eggs and newly hatched ducklings is the Norway rat. Perhaps no better example of the effects of introduced rats to island bird colonies is the loss of 5 seabird species and a 90% reduction of ancient murrelets (*Synthliboramphus antiquus*) on Langara Island in the Queen Charlotte Islands of British Columbia (Bertram, 1995; Bertram and Nagorsen, 1995; Hobson and others, 1999). The presence of Norway rats on Smith Island is perhaps anticipated given the long period of human habitation there. However, the presence of rats at dune sites, spoil areas, and tree hammocks was unexpected and warrants further evaluation with regard to effects on island bird productivity. Not only are rats an additional potential predator of black duck nests, but they may be playing an important role in excluding black ducks from nesting at preferred upland sites on the island.

The virtual absence of fresh water on the island suggests a general adaptability of black ducks to this polyhaline environment. However, very young ducklings are known to have a limited tolerance to salinity. For instance, Barnes and Nudds (1991) found no survival of 7-day-old black duck ducklings exposed to 10 ppt salinity, and Moorman and others (1991) working with mottled ducks (*Anas fulvigula*) found the upper tolerance range for 1-day-old ducklings to be between 9 and 12 ppt. Clearly the high salinities on Smith Island could be incurring substantial costs in terms of growth or survival of black duck ducklings, yet the presence of flightless young observed in bait traps suggests that good numbers of black ducks are raised there at least in some years. Is it possible duckling survival is dependent on the vagaries of spring runoff to suppress salinity during the peak hatching period? Or is survival dependent on the ability of ducklings to utilize the limited habitat with tolerable salinities? A third scenario is the possibility that high salinities are being tolerated by ducklings obtaining enough "metabolic water" from the foods they ingest (Barnes and Nudds, 1991). Clearly, more information is needed to evaluate the effect of salinity on the survival of black duck ducklings on Smith Island adequately.

As a common response at duck traps, the presence of more adult ducks usually limits the capture of young and skews their sex ratio in favor of males. This competition, or density effect, likely explains the contrast in percent of HY captures and the observed difference in HY sex ratio between the Smith Island and Deal Island trap sites. It follows that there are higher numbers of black ducks and mallards responding to baited traps at the Deal Island site than at Smith Island. The low recapture rate between banding sites also suggests a generally high degree of isolation. Differences in recapture rates indicate that a slightly stronger dispersal over time is occurring from the Deal Island site, where a higher density of ducks exists to the lower density of the Smith Island site.

The striking positive correlation between percent of HY mallard and HY black duck captures at the two banding sites (figs. 3 and 4) suggests that the productivity of each species is remarkably similar at the mainland and island locations. We suggest, however, that this outcome might be tied to the great attractiveness of corn being offered over a lengthy preseason banding period that results in a broad sampling of Tangier Sound waterfowl. Thus both banding stations are sampling a larger, generally mobile population of ducks indigenous to Tangier Sound. Supportive evidence of this notion is the fact that many HY mallards are captured at Smith Island, where it is known that few mallards are produced. If mallards are highly mobile, then it is likely that black ducks are as well.

Conclusions

Given the remoteness and isolation of the islands and the general exclusion of breeding mallards, the island saltmarsh habitats seem ideal for black ducks. By all direct and indirect evidence, however, the reproductive success of black ducks is low. Clearly, a priority question is why has black duck nesting apparently been displaced from upland habitat to needlerush marsh? Is this in response to recently introduced foxes or possibly Norway rats? Or are black ducks simply using habitat with respect to its availability? Certainly the poor nesting effort and lack of renesting is cause for concern. However, there are possible explanations. For instance, as noted earlier, our telemetry provided only limited ability to detect nesting attempts by black ducks in an environment with high predatory losses of eggs. There is also the possibility that many of the black ducks tracked at Smith Island were only routinely loafing and feeding there and may have been nesting at more favorable locations such as small, predator-free islands as noted in a recent study in nearby Virginia (G. Costanzo, oral comm., 1999). Further, there is the remote possibility that a percentage of Smith Island black ducks are nonbreeding or have failed in nesting elsewhere and have sought sanctuary in the remote island chain. All of these possibilities could have contributed to our observed poor nesting effort of black ducks on Smith Island.

Despite these gaps in our knowledge, it is clear that black ducks are endemic to the islands, use the habitats in a variety of beneficial ways, and clearly produce significant young there at least in some years. We further add that the potential value of these islands for black ducks, as well as other shore and waterbird species, is exceptional. We cannot overemphasize that not only are island habitats a disappearing and rare commodity in the Bay (Leatherman and others, 1995), but those that are removed from land-based predators and large enough to offer a diversity of habitats to sustain wildlife are the most valuable wildlife habitats, and especially waterbird habitats, remaining in the Bay. Because of these qualities, these islands deserve the highest priority management concern and protection. Our evidence indicates that Smith Island black duck productivity is being overwhelmed by an imbalance of nest predators. Management efforts to mediate these effects will likely have the most immediate benefit for island breeding black ducks.

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The Midwinter Survey of Black Ducks, Locally and Regionally

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Abstract: The Midwinter Waterfowl Inventory (MWI) has been conducted consistently in Maryland since 1955 and in Virginia since 1957. Maryland currently focuses surveys in 30 segments along the Chesapeake Bay, Potomac River, and Atlantic Coast, whereas Virginia focuses on 22 segments centered over the eastern shore of Chesapeake Bay and along the tidewater areas of Back Bay and western shore tributaries. Until 1980, the survey along the Potomac River was shared and sometimes duplicated by Maryland and Virginia but now is flown entirely by Maryland. The MWI number of black ducks wintering in Maryland shows a decreasing trend until 1983 when the trend reversed, possibly in response to restrictive hunting regulations. In Virginia, the MWI index of black ducks reached its lowest point in 1965 at just under 4,000 ducks, steadily increased to a peak of 18,000 black ducks in 1981, then began a steady decline to the present. The number of black ducks on the Potomac River reached a low of 400 ducks in 1971, 1984, and 1985 but generally attracts 500-1,500 ducks each year. The distribution of black ducks in the Bay has also changed from upper Bay areas to mid-Bay eastern shore sites and the Potomac River. Whereas the decline in black ducks seems to be related to hunting, the redistribution of black ducks in Maryland seems to be associated with habitat changes in water quality and the decline of submerged aquatic vegetation.

Introduction to the Midwinter Waterfowl Inventory

The Midwinter Waterfowl Inventory (MWI) is an annual survey of waterfowl populations in some of the most important wintering waterfowl habitats in the United States. It is conducted during mid-January, but the exact dates of the inventory vary by state depending on weather conditions and the availability of aircraft and personnel. Most of the MWI is conducted from aircraft, but boats and automobiles are also used, depending on local conditions and accessibility. Because the MWI is a survey that is conducted fairly consistently over time, it is in essence a long-term monitoring program with the ability to detect changes in waterfowl numbers and distribution. The MWI also provides a useful index of these changes for management applications and decisions at various temporal and geographic scales. As with all long-term surveys, however, the MWI suffers from observer and methods bias and inconsistency of geographic areas surveyed.

In the United States, the MWI is organized and conducted separately within four flyways: Atlantic, Mississippi, Central, and Pacific Flyways. The 17 Atlantic Flyway states include: Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, North and South Carolina, Georgia, and Florida. Within the Atlantic Flyway, the MWI is primarily focused on coastal areas and on major rivers, lakes, and reservoirs. Each state is subdivided into zones and segments based on these general habitat types, and the MWI is conducted within these geographic units. Aircraft are flown along similar flight paths each year, and one or more observers record the species and number of waterfowl seen onto tape recorders, data sheets, maps, and/or laptop computers. When the MWI is completed, the data are entered into computer files, copied onto a diskette, and sent to the Atlantic Flyway representative, who is responsible for preparing reports and maintaining MWI computer records and access to MWI data.

Regional Summary of Black Duck Trends

Waterfowl populations in the United States had already started to decline before the turn of the 20th century, especially in coastal areas of the Atlantic seaboard. Hence it should be no surprise that the Atlantic Flyway MWI revealed a black duck decline already in progress not long after the survey was started in the early 1950s. Intense hunting pressure and extensive habitat loss throughout the entire range are believed to be the primary causes of this decline in Atlantic Flyway black ducks and other waterfowl species. The Atlantic Flyway MWI trends show that the overall decline in black ducks continued until the mid-1980s, when restrictive hunting regulations were implemented in the United States and Canada.

A more detailed look at MWI data reveals that the population trend has only started to reverse in the northern half of the Atlantic Flyway (fig. 1), whereas the number of

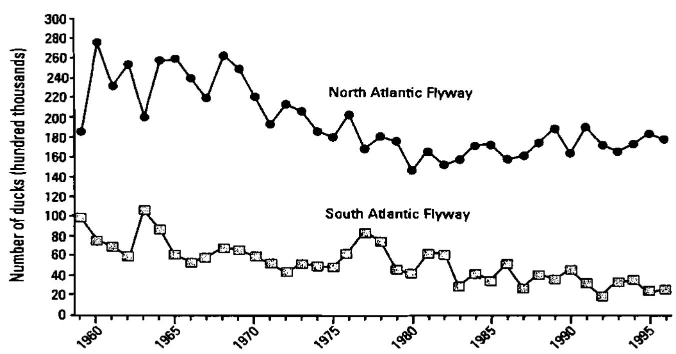

Fig. 1. Differences in Midwinter Waterfowl Inventory (MWI) black duck trends between the northern and southern Atlantic Flyway (1959-96).

black ducks in the southern half of the flyway has continued to decline. The transition zone for these two differing trends seems to be in Maryland and Virginia, which share a boundary near the middle of the Chesapeake Bay. North of the Chesapeake Bay, the numbers of black ducks are starting to increase, especially in New Jersey and Massachusetts, whereas south of Maryland, black ducks are continuing to decline. Not only have population trends in black ducks differed between the north and south, but also the relative distribution of black ducks is changing between the north and south. During the early years of the MWI in the Atlantic Flyway, the relative distribution of black ducks ranged from 20-30% for the southern half of the flyway (below the Maryland/Virginia border) but now has dropped to less than 15% and continues to decline (fig. 2).

Based on MWI State totals, the trend of black duck numbers in Maryland closely follows the trend for selected southern states in the Atlantic Flyway until 1983 (fig. 3). After 1983, the trend in black ducks for Maryland shows a small but steady increase, whereas the trend in black ducks continues to decline for other southern Atlantic Flyway states, including Virginia.

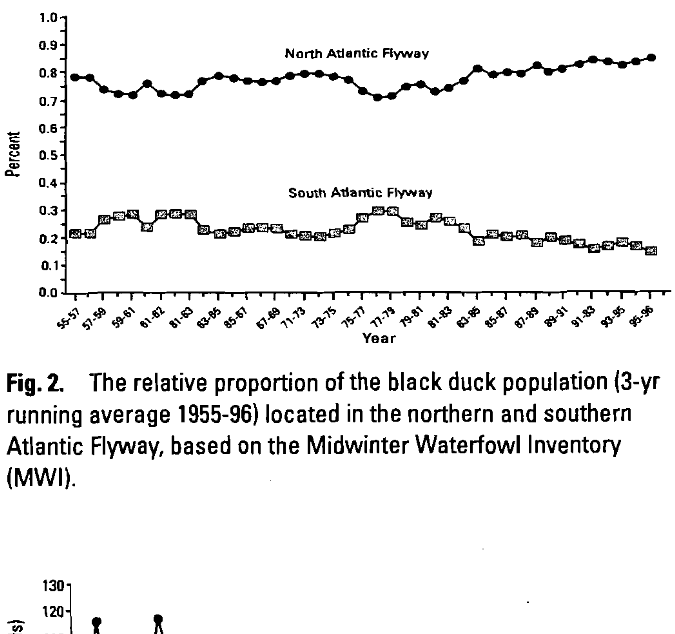

Fig. 2. The relative proportion of the black duck population (3-yr running average 1955-96) located in the northern and southern Atlantic Flyway, based on the Midwinter Waterfowl Inventory (MWI).

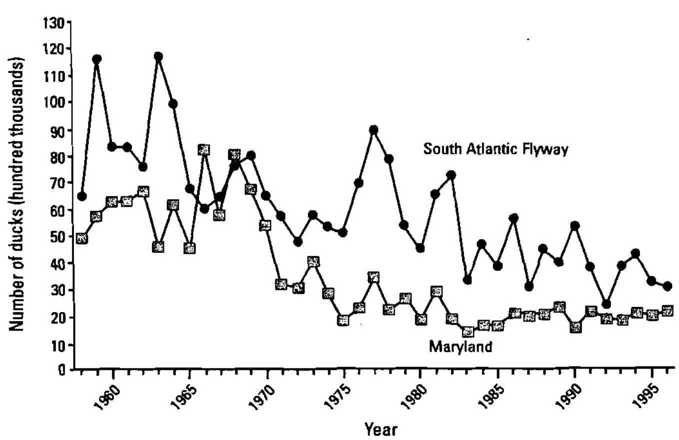

Fig. 3. Midwinter Waterfowl Inventory (MWI) black duck trends (State totals) in Maryland compared to the southern Atlantic Flyway, Virginia to Florida (1958-96).

Summary of Black Duck Trends in Chesapeake Bay

Focusing on the mainstem and tributaries of the Chesapeake Bay and adjacent coastal areas, the black duck MWI population trend is increasing in Maryland and decreasing in Virginia (fig. 4). For Virginia, the number of wintering black ducks seems to be somewhat equally distributed between the Bay and coast, whereas in Maryland the majority of black ducks winter in the Bay. If the current trend continues, a greater number of black ducks can be expected to winter in the upper tributaries and mainstem of the Bay (in Maryland) than in Virginia's coastal and Bay areas combined.

For selected geographic or "ecological" survey units of the Chesapeake Bay, the number of black ducks is steadily increasing in lower eastern habitats, with slight increases or steady numbers in the Potomac River and upper western habitats (fig. 5). These trends are in contrast to the steady decline of black ducks in lower western Bay and upper eastern habitats but similar to steady numbers of ducks using the Patuxent River (fig. 6). The differences are most likely associated with the long-term redistribution of black ducks to the mid-Bay and lower eastern shore habitats in response to significant losses of aquatic food plants in the upper Bay since the mid-1960s, intense shoreline development locally, and habitat losses and hunting pressure on a range-wide scale.

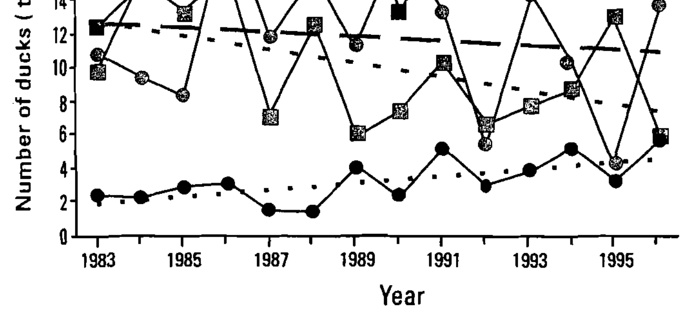

Fig. 4. Midwinter Waterfowl Inventory (MWI) black duck trends for the Chesapeake Bay and Atlantic Coast of Maryland and Virginia (1983-96).

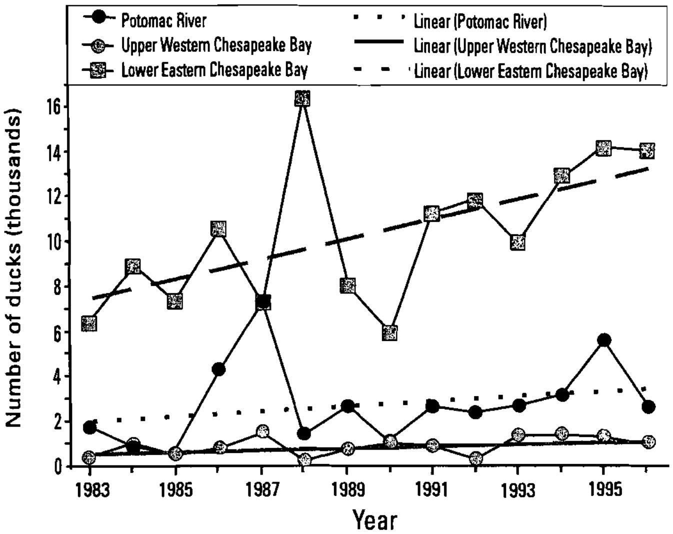

Fig. 5. Increasing Midwinter Waterfowl Inventory (MWI) black duck trends for selected "ecological" survey units (1983-96).

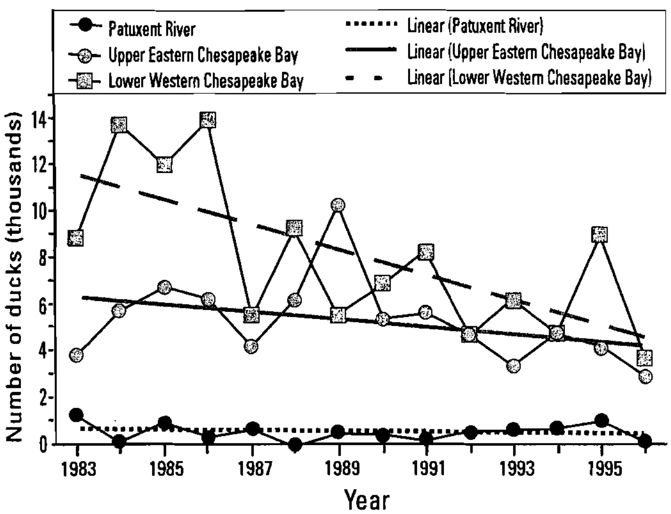

Fig. 6. Declining Midwinter Waterfowl Inventory (MWI) black duck trends for selected "ecological" survey units (1983-96).

Discussion

How much hunting has affected the migratory and resident populations of black ducks in the Bay is not known because these different populations are most likely mixed during winter and cannot be distinguished during the MWI. Also, the MWI is not a good index for establishing harvest regulations, which are more properly based on spring surveys of breeding areas. Considering the relatively small number of black ducks wintering on the Chesapeake Bay compared to the Atlantic Flyway, however, the issue of resident versus migratory black ducks could be important in the few localized areas that still support breeding populations in the Bay. A combination preseason and postseason banding program would be needed to estimate the number of resident and migratory black ducks wintering on Chesapeake Bay.

The impact of hunting on resident black ducks in the Bay depends on how hunting regulations might be established or modified based on information (especially from banding) about resident populations within the Bay region. If a significant proportion of the kill comprises resident black ducks, particularly in the early season before migrants arrive, then these birds may experience a harvest rate greater than local breeding populations can support (Stotts, 1959; Reed and Boyd, 1974; Blandin, 1982).

Subsequently, the overall population of black ducks recorded by the MWI could mask a decreasing trend for resident birds. Likewise, the resident component of the wintering black duck population could increase proportionately southward in its wintering range. If hunting regulations are not tailored to the management of specific subpopulations, then the disparity in hunting regulations and harvest for these two distinct populations might be a factor contributing to the continued decline of black ducks currently observed in MWI trends for the Virginia portion of the Bay and in southern states of the Atlantic Flyway.

Potential Research and Management Actions

Management of the black duck population in the Chesapeake Bay, which is composed of resident and migrant birds, depends upon appropriate population management throughout the species' range. The black duck continues to decline across the southern half of its wintering range, while the northern half shows an apparent increase. The black duck decline in the south may be due to a redistribution of birds to the north. However, since birds that have survived one complete migration cycle demonstrate fidelity to areas where they have previously wintered (Geis and others, 1971), particularly along the coast (Diefenbach and others, 1988), it is possible that the declines across the southern half of the range are due to slow attrition, caused by declining survival as birds migrate along a gradient from north to south. Though other hypotheses for the continuing decline are reasonable (i.e., the loss of breeding habitat in southwestern Ontario), population management through the use of hunting regulations still offers the greatest potential for the restoration of black duck populations on both local and range-wide scales.

Hunting season dates are set by individual political jurisdictions to take advantage of the peak fall flight, thereby offering the hunter the optimal opportunity for success. This strategy may result in substantial cumulative reductions in the migratory population as it proceeds on its journey to the southern limits of its wintering range. No comprehensive unifying strategy exists for population management over the complete black duck range. The 2000-01 black duck hunting season opened September 1 in Québec and Ontario and closed January 20 in the southern reaches of its wintering range. Some seasons ran as long as 60 days in the United States and 106 days in Canada. The flyway contains 23 individual State and provincial hunting seasons, compounded further within many political jurisdictions by season zoning. Consequently, migratory black ducks that wintered in the southern half of the wintering range may have potentially experienced up to 142 days (disregarding Sunday closures in some areas) of continuous hunting pressure, while those birds that hatched and wintered in Maine, for example, only experienced a 54-day season.

Based on the MWI, current population goals prescribe a combined total count of 385,000 black ducks for the Atlantic and Mississippi Flyways by the year 2000 (Canadian Wildlife Service and U.S. Fish and Wildlife Service, 1986). This population goal has not been met (Serie and Raftovich, 2000). Furthermore, the black duck management plan does not prescribe any range distribution goals within the flyways. Consideration should be given to maintaining the viability of populations across their historical breeding and wintering ranges. To that end, we suggest testing a strategy to redistribute the wintering black duck population over its range in the Atlantic Flyway to historical distribution levels. This geographic distribution goal would be to locate approximately 20%–30% of the flyway total (fig. 6) within the region from Florida through Virginia. We suggest that this may be accomplished by careful management of the opening season date, based upon the chronology of the peak passage of migrating black ducks along a latitudinal gradient. Black duck seasons in the southern Atlantic Flyway should remain closed (and perhaps, remain closed entirely in the Mississippi Flyway).

A similar strategy of delayed season openings was proposed in the 1960s by Florida to enhance the survival of migrant Canada geese and stem the population decline in the Southeast (Harmic, 1967). Maryland alone delayed the Canada goose season for 1 year (1968), resulting in a momentary increase in some southern populations (Stotts, 1983). Consequently, the southern Atlantic Flyway today is nearly devoid of migrant Canada geese (*Branta canadensis*) from Florida through the Carolinas, with little hope of ever recovering. Similar severe declines in mallard populations are also occurring in this region (Serie and Raftovich, 2000).

Delaying the black duck season opener along a latitudinal (or State/provincial) gradient may maintain a fall flight across the remaining range, reducing the threat of further range reductions and assuring a viable harvest in those states that still enjoy one. With proper management, the season in the southern range could hopefully be reopened to some minimal harvest at a future date.

Proper design and monitoring of what we have proposed here, of delaying the season along a latitudinal gradient, or other proposed study/management actions (Anderson and others, 1987; Nichols and Johnson, 1989; Nichols, 1991) would add useful insight for the black duck population model (Conroy, unpublished), and adaptive management (Williams and Johnson, 1995).

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Biographical Sketch: Dennis Jorde is a wildlife biologist (research) and currently serves as deputy chief of research, at the USGS Patuxent Wildlife Research Center. Dennis has been involved in waterfowl research since 1976, including studies of mallards breeding in North Dakota, mallards wintering in Nebraska, black ducks wintering along the coast of Maine, canvasbacks wintering on the Chesapeake Bay, and black ducks breeding on islands in the Chesapeake Bay. In addition, he has conducted nutrition and physiology studies of captive black ducks at the University of Maine and at Patuxent Wildlife Research Center.

Biographical Sketch: Daniel Stotts is a wildlife biologist working for the USGS Patuxent Wildlife Research Center. His work since 1982 has covered a range of black duck issues, including productivity of breeding black ducks and mallards on islands in Chesapeake Bay, and habitat use, movements, and survival during the postfledging, migratory, and wintering periods along the mid-Atlantic coastal and northeastern habitats. He is currently engaged in validating the Mid-Winter Inventory in the Atlantic Flyway for black ducks and comparing population trends to trends in wetland loss in the Atlantic Coast black duck wintering areas.

The North American Black Duck (*Anas rubripes*): a Demonstrated Failure in the Application of the Presumed Principles of Waterfowl Management

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The principles and ethics of wildlife management acknowledge the duty of managers to protect the "resource base," maintain or enhance populations, and use regulations to limit consumptive utilization accordingly. The author demonstrates, using an exhaustive review of literature spanning more than 40 years, that black duck populations have been allowed to decline dramatically, and that regulators and wildlife managers at the State and Federal level have consistently taken virtually no action to reverse the decline. From the late 1950s through the early 1980s, the decline was recognized and decried by essentially every knowledgeable and responsible waterfowl scientist or manager. Most of these people called for serious harvest restrictions or season closure, yet harvest regulations became more permissive.

In 1982 and 1983, relying in substantial part on the literature and government regulatory inaction, The Humane Society of the United States filed a lawsuit, and I published a monograph (Grandy, 1983) using black duck management from 1955 to 1983 as a case study of 28 years of failure in American wildlife management. Following the suit and the publication, three things immediately happened: (1) government scientists discontinued decrying the plight of the black duck and calling for harvest restrictions; (2) some minor harvest restrictions were instituted; and (3) research shifted to examine every possible cause of population decline other than hunting.

In 1986, the U.S. Fish and Wildlife Service (USFWS) and flyway councils, through the North American Waterfowl Management Plan, adopted the goal of achieving a winter inventory level of 385,000 black ducks by the year 2000. Given the fact that this level represented such a stark reduction from previous population levels (compare with >700,000, Barske, 1968), it was itself essentially an abdication of responsibility. Nonetheless, in the intervening years, the USFWS took no vigorous or effective regulatory steps to achieve even this modest goal, and in fact, harvest regulations have again become more permissive. Not surprisingly, the goal was not met.

In the earlier monograph (Grandy, 1983), I elucidated five reasons why the wildlife management community consistently failed to meet the needs of the black duck. These were, in brief: (1) a desire to keep hunters happy; (2) perceived political equity; (3) fear of giving in to antihunters; (4) protecting one's "professional reputation"; and (5) the fact that license fees and hunting license sales are critical to funding most State wildlife management programs. To this list I now add and discuss a sixth factor: the pervasive influence of having most black duck experts be employed by or organically tied to the agencies that are themselves dependent on license fees and hunter support. It is these six factors working synergistically at every level of the decision-making structure that have made the case of black duck management a demonstrated failure in the application of the principles of wildlife management. Because the wildlife management community has taken wholly inadequate steps to protect and restore the black duck, the liberalization of seasons occurring now will depress the black duck population further and further, making recovery ever more dubious. If the wildlife management community allows this to happen, the repercussions may be serious for black ducks and wildlife management alike.

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Biographical Sketch: John W. Grandy, IV, is the senior vice president for wildlife and habitat protection of The

Humane Society of the United States. A waterfowl biologist by training, his 1972 doctoral dissertation focused on black duck winter ecology. Concern about the long-term decline of black duck populations led to the publication in 1983 of "The North American Black Duck (*Anas rubripes*): A Case Study of 28 Years of Failure in American Wildlife Management."

Posters

Evaluation of Vegetative Response to Fire Exclusion and Prescribed Fire Rotation on Blackwater National Wildlife Refuge and Fishing Bay Wildlife Management Area

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Abstract: Fire has been used to facilitate the trapping of fur bearing animals, to reduce the risk of loss of human life and property due to wildfires, and to stimulate the growth of vegetation beneficial to waterfowl and other wildlife. Prescribed fire has been viewed as a technique to promote the growth of wetland vegetation and to enhance the long-term viability of wetlands. However, relatively little research has been conducted to quantify the effects of fire on marsh vegetation. The objectives of this study are to: (1) determine species composition and compare the species richness of vegetation in marsh habitats; (2) compare the vegetative response of three fire rotations and fire exclusion (no burn); and (3) compare vegetation sampling techniques including ocular estimation, stem densities, and biomass. In 1998, we initiated a fire evaluation study on Blackwater National Wildlife Refuge (NWR) and Fishing Bay Wildlife Management Area (WMA) to compare the vegetative response to three fire rotations and fire exclusion at six sites. The six marsh sites were divided into three treatment areas: annual burns, three 5-year burns, seven 10-year burns, and a control area (no burn or fire exclusion). We collected preburn vegetation data at all sites from September to December 1998. Prescribed burns were conducted on the annual burn treatment areas from January to March 1999. We collected postburn data in March 1999 and repeated our data collection in September–December 1999. We will continue collecting vegetation data through spring 2002 (after the first of the 3-year burns), and we will analyze vegetative response by comparing species composition, percent cover, average vegetative height, biomass, and stem density.

Biographical Sketch: Conception (Connie) Flores is originally from Arizona and received her bachelor of science degree from the University of Arizona. Her degree was in renewable natural resources with a major in watershed management. Flores is currently a graduate student working on a master of science degree at the University of Maryland Eastern Shore. She is also in the Student Career Experience Program working at Blackwater National Wildlife Refuge, where her fire management project is based.

Proposed Shallow Water Impoundment at Swan Harbor Farm—Ducks Unlimited, Inc.

Fred Gillotte, Jr., Michael Affleck, and Mark Gorham, Ducks Unlimited, Inc., 310 Goforth Drive, Havre de Grace, MD 21078, Gillotte: FreDu171@aol.com; Affleck: measuscon@erols.com; Gorham: magshooter@aol.com

Abstract: This Ducks Unlimited (DU) poster depicts the impoundment that is to be constructed in 2001 at Swan Harbor Farm in Havre de Grace, MD. Three Canada geese (*Branta canadensis*) and a pair of black ducks are shown vacating the shallow water impoundment. It is based on an original sketch that was used on the cover of the banquet program at a recent DU fund raiser for the R. Madison Mitchell Chapter DU, Havre de Grace, MD. The impoundment depicted is similar to that proposed for Swan Harbor Farm, which will provide excellent black duck habitat. The poster also serves to inform the viewer about the Ducks Unlimited's shallow wetlands enhancement program, which is in part funded by the Chesapeake Bay Foundation and the Conservation Reserve Program. Taxidermy mounts of black ducks, decoys, texts, and ephemera dealing with the black duck are also part of the display.

Biographical Sketches: The authors have held or currently hold positions of leadership within the Ducks Unlimited arena, including past Atlantic Flyway Chairmen posts within their local Chapters. All three men have interests in waterfowl, particularly the black duck, and their respective habitats that are found within the Mid-Atlantic area. Additionally, they have been involved as officers of the Izaak Walton League, Harford County Chapter. Their commitment to this conservation organization has led them to direct involvement with the Anita Leight Estuary, one of three such designated estuarine sites within the Maryland portion of the Chesapeake Bay. Fred Gillotte is the director, with Michael Affleck serving as deputy director of the Melvyn Boseley Conservancy, a core habitat area for waterfowl propagation within the Anita Leight Estuary.

Reconstruction of Anacostia Wetlands: Success?

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Abstract: Historically, the tidal Anacostia River in Washington, D.C. had been an extensive system of freshwater tidal marshes replete with a full array of wetland vegetation dominated by wild rice. The local Nacochtank Indians had

found the abundant fish and wildlife sufficient to sustain their daily lives. White man's intrusion upon the landscape gradually brought about deterioration of the natural (and associated cultural) system. Total demise followed mid-20th century dredge and fill channelization, which was conducted from the confluence of the Anacostia with the Potomac near the heart of Washington, D.C. to the terminus of the tidal regime at Bladensburg, Maryland. The National Park Service (NPS) became the manager for much of the land along the Anacostia, particularly the eastern bank. As part of its planning effort, the NPS envisioned returning portions of the Anacostia under its control to a natural system as a vignette. The concept was based on bringing back as comprehensive a collection of vegetation and wildlife as possible through the reestablishment of tidal marshes at Kenilworth and Kingman. The resultant wetlands were to be made accessible to the public both logistically and through a well designed interpretative program. In fact, this vision has been realized due to an impressive cooperative effort among a number of Federal and local agencies and organizations. In 1993, 32 acres of freshwater tidal marsh were reconstructed at Kenilworth. Based upon the 5-year monitoring program that has been in place since reconstruction, several generalizations may be made concerning the degree of success of the marsh reconstruction. Water quality in the marsh system and nearby tidal waters has not been noticeably improved. The poor quality may be due to the overwhelmingly high loads (e.g., sediment, nutrients, etc.) brought in on the twice daily tidal cycle from the Anacostia and to the relatively small volume of water which actually interacts with the emergent marsh. Revegetation, which is a product of direct plantings (16 species comprised of 350,000 plants) and by establishment of volunteer plants, must be considered successful. Remarkably, full vegetation cover was achieved by the end of the first year (1993). Species diversity is high with 100-130 wetland species occupying portions of the wetland. Good species differentiation (incipient plant communities) can be noted at areas of sediment elevation differences. There is a good range of predominant species (five to eight) with rice cutgrass (*Leersia oryzoides*) initially being dominant but in later years becoming codominant. Even the native wild rice (*Zizania aquatica*) is making a substantive comeback. Invasive plants such as purple loosestrife (*Lythrum salicaria*) and phragmites (*Phragmites australis*) are being watched and dealt with as appropriate. There has been important habitat creation, and a resulting increase in fauna can be expected, particularly as the acreage reconstructed at Kenilworth has more than doubled with similarly reconstructed wetlands at Kingman Lake (42 acres), which were completed during the summer of 2000, just a quarter of a mile down river. One of the challenges with the Kingman marsh reconstruction has been protecting against the grazing pressure of native Canada geese (*Branta canadensis*). In the long run, these revived Anacostia wetlands are bound to improve local conditions and will contribute to a rejuvenated Chesapeake Bay system.

Biographical Sketch: Dick Hammerschlag is currently a research biologist for the USGS Patuxent Wildlife Research Center. Recent research efforts have focused on the characterization of reconstructed wetlands in the Anacostia River, Washington, D.C. He retains a long-term interest in urban ecology and the management of urbanized landscapes. Considerable earlier experience involved work with the National Park Service's Center for Urban Ecology in Washington, D.C.

Pond Use by Wintering Waterfowl on the Northern Virginia Piedmont

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Abstract: Virtually nothing is known about wintering waterfowl on the Virginia Piedmont. The U.S. Fish and Wildlife Service Atlantic Flyway Mid-Winter Waterfowl Inventory (MWI) covers waterfowl found in coastal plain areas only. The same is true for the surveys performed by the Virginia Department of Game and Inland Fisheries. The MWI shows continually declining waterfowl populations in coastal areas. However, Virginia Christmas Bird Count (CBC) data show a large inland population of wintering waterfowl. For many reasons, environmental factors may be supporting the movement of waterfowl or short stopping to inland areas during the winter. My study focuses on this wintering population and involves two to three winters of weekly surveys, an analysis of CBC, MWI, and historical Piedmont waterfowl data, and finally, an analysis of environmental factors that may be supporting the wintering waterfowl population. The significance of the study of wintering waterfowl on the Virginia Piedmont lies in the continually declining numbers of waterfowl on the Coastal Plain and continued destruction of wetland habitats in relation to conservation efforts to reverse these trends.

Biographical Sketch: Susan Heath grew up in Houston, Texas, and received a bachelor of science degree in mathematics from the University of Southwestern Louisiana in 1982. She spent four years as a Naval Officer and traveled extensively throughout the world. After the Navy, she worked in the computer security field for 13 years and received a master of science degree in information systems from George Mason University in 1997. Heath was increasingly unhappy with a career that kept her inside all the time. When she was offered the opportunity to spend 6 months in Miami doing computer work, she jumped at the chance and explored the Everglades extensively. This experience prompted her to change careers. After completing several preparatory classes in biology, she left the computer field in January 1999 to pursue a master's degree in biology. Heath is currently conducting thesis research on wintering waterfowl in Fauquier County, Virginia, in association with the Environmental Studies Program at the International Academy for Preventative Medicine at Airlie. In March of 2000, she was awarded the J.J. Murray Award from the Virginia Society of Ornithology for her waterfowl research. She is currently attending George Mason University full time and expects to graduate in May of 2002.

Soil Development as a Functional Assessment of a Reconstructed Freshwater Tidal Marsh

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Abstract: In 1993, a challenging undertaking was initiated to restore 32 acres of the former 77 acre Kenilworth Marsh located along the Anacostia River in Washington, D.C. Previously part of an extensive network of freshwater tidal marshes, Kenilworth was dredged in the 1940s as part of an overall effort to improve navigation and create a recreational lake, consequently eliminating the functional value of the wetland. The values of wetlands of this area have only recently been emphasized and have arisen from an era of channelization projects such as the one that claimed thousands of acres of marshes along the Anacostia River. Recognizing Kenilworth's potential as a valuable habitat, the National Park Service collaborated with the U.S. Army Corps of Engineers and other agencies in an effort to restore the freshwater tidal marsh. The objective of this study was to compare the soil development of the now 7 year-old reconstructed Kenilworth Marsh with a nearby reference site, Dueling Creek, as a means of functionally assessing Kenilworth's progress. Using 10 sites within each marsh, the decomposition rate was measured with litter bags of *Typha angustifolia*. From these same sites, soil organic matter (OM) was estimated at depths of 0-3, 5-7 and 12-14 inches through ignition techniques. The results of these studies indicated a higher decomposition rate after 17 months at Kenilworth with 37% remaining biomass, as compared with 56% remaining biomass at Dueling Creek. Organic matter content was comparable between Kenilworth and Dueling Creek at the highest depth with 10.5% and 13.2% OM, respectively. However, Kenilworth demonstrated notably less OM at lower depths than Dueling Creek with 1.2% and 8.4% OM, respectively. These results suggest that the soil development of Kenilworth Marsh is continuing to progress towards the conditions of a less impacted freshwater tidal marsh, as evidenced by functional processes such as decomposition rates and organic matter accumulation.

Biographical Sketch: Stephanie Kassner is currently a graduate student working on a master of science degree in environmental science at the University of Maryland, College Park. She is also a research scientist for a biotechnology company working with marine algae. Kassner received her bachelor of science degree in biology from Dickinson College, Pennsylvania, in 1994.

Biographical Sketch: Patrick Kangas is a systems ecologist with interests in ecological engineering, tropical ecology and sustainable development, and the history of ecology. He received his bachelor of science degree from Kent State University in biology, his master of science degree from the University of Oklahoma in botany and geography, and his Ph.D. in environmental engineering sciences from the University of Florida. Kangas took a position in the Biology Department at Eastern Michigan University in 1979 and taught there for 11 years. In 1990, he moved to the University of Maryland where he is coordinator of the Natural Resources Management Program and an associate professor in the Biological Resources Engineering Department.

Understanding Food Webs in the Chesapeake Bay

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Abstract: Approaches to predictive modeling and to management of the Chesapeake Bay ecosystem are "bottom up" (i.e., approaches involve the control of nutrient inputs in attempts to manage plankton productivity) and "top down" (i.e., approaches involve controls on harvest of fisheries and wildlife in attempts to manage vertebrate populations). Both approaches are limited by a lack of understanding of trophic connections between nutrient inputs, primary producers, and higher trophic level consumers. This project is aimed at identifying trophic structure for the submersed aquatic vegetation habitat of the Chesapeake Bay. We are employing analysis of stable isotope ratios of plant and animal tissues to identify trophic levels and traditional food habits analysis to identify the foods of a number of species of waterfowl.

Biographical Sketches: Authors are research scientists with the USGS Patuxent Wildlife Research Center in Laurel, Maryland. Keough is an ecologist, Haramis is a wildlife biologist (see biographical sketch page 30), and Perry is a habitat management scientist (see biographical sketch below) with the Patuxent Wildlife Research Center.

The Exotic Mute Swan (*Cygnus olor*) in Chesapeake Bay, USA

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Abstract: The exotic mute swan (*Cygnus olor*) has increased its population size in Chesapeake Bay (Maryland and Virginia) to approximately 4,500 since 1962 when five swans were released in the Bay. The Bay population of mute swans now represents 30% of the total Atlantic Flyway population (12,600) and has had a phenomenal increase of 1,200% from 1986 to 1999. Unlike the tundra swans (*Cygnus columbianus*) that migrate to the Bay for the winter, the mute swan

is a year-long resident, and, therefore, reports of conflicts with nesting native waterbirds and the consumption of submerged aquatic vegetation (SAV) have raised concerns among resource managers. Populations of black skimmers (*Rynchops niger*) and least terns (*Sterna antillarum*) nesting on beaches and oyster shell bars have been eliminated by molting mute swans. Although data on the reduction of SAV by nesting mute swans and their offspring during the spring and summer are limited, food habits data show that mute swans rely heavily on SAV during these months. Widgeon grass (*Ruppia maritima*) constituted 56% and eel grass (*Zostera marina*) constituted 43% of the gullet food of mute swans. Other SAV and invertebrates (including bryozoans, shrimp, and amphipods) formed a much smaller amount of the food percentage (1%). Invertebrates are believed to have been selected accidently within the vegetation eaten by the swans. Corn (*Zea mays*) fed to swans by Bay residents during the winter probably supplement limited vegetative food resources in late winter. A program to control swan numbers by the addling of eggs and the killing of adult swans has been a contentious issue with some residents of the Bay area. A management plan is being prepared by a diverse group of citizens appointed by the Governor to advise the Maryland Department of Natural Resources on viable and optimum options to manage mute swans in the Maryland portion of Chesapeake Bay. Hopefully, the implementation of the plan will alleviate the existing conflicts to the betterment of all resources.

Biographical Sketch: Matthew Perry was born and raised in Bristol, Rhode Island, and received his bachelor of science degree from the University of Rhode Island in 1963 with a major in wildlife management/forestry. He served as a Naval Officer aboard the *USS Mount McKinley* for three years during the mid-1960s and spent many days cruising off the coast of Vietnam. After working for the Rhode Island Fish and Game for 2 years on an extensive study of mute swans, he went to Virginia Polytechnic Institute, where in 1970 he received his master of science degree with a major in wildlife management. His thesis was entitled "Studies of Deer-Related Dog Activity in Virginia." He then worked in Florida for a year at Lake Woodruff National Wildlife Refuge as the assistant refuge manager. He has worked for the last 31 years at the Patuxent Wildlife Research Center in Maryland, where he has conducted numerous research studies mainly in waterfowl nutrition and ecology and in the management, restoration, and creation of wildlife habitat. During this period, he received his Ph.D. at the University of Maryland. His dissertation was entitled "Seasonal Influence of Nutrients on the Physiology and Behavior of Captive Canvasbacks (*Aythya valisineria*)." Perry's current research deals with the evaluation of habitat management including wetland impoundments, powerline rights-of-way, compost amendments to soil, and the management of buffers in agriculture fields. Perry also recently initiated a study of seaducks in Chesapeake Bay.

Seasonal Dynamics of Waterbirds Using Freshwater Tidal Wetlands in the Nonbreeding Season

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Abstract: Chesapeake Bay wetlands support a high diversity of waterbirds. We examined how waterbird species used the changing microhabitats of a freshwater tidal wetland on a Bay tributary in the different periods of the nonbreeding season over a 10-year period. Habitats included bare mudflats, narrow tidal channels, open water, and dormant stands of herbaceous and woody plants. A total of 78 waterbird species was identified. Species richness was highest during fall and spring migratory periods and lowest in February. Maximum total numbers, however, occurred in winter. Canada geese (*Branta canadensis*), dabbling ducks (American black duck [*Anas rubripes*], green-winged teal [*Anas crecca*], mallards [*Anas platyrhynchos*]) and gulls (*Larus* spp.) constituted the bulk of the birds. Killdeer (*Charadrius vociferus*) numbers responded to daily tides. Numbers of American black ducks and mallards declined in the 1990s, and numbers of common snipe (*Gallinago gallinago*) and killdeer increased. These changes, while consistent with wider trends, may reflect in part human alteration of the local environment.

Biographical Sketch: Christopher Swarth is the director of the Jug Bay Wetlands Sanctuary, a wetland education center and ecological research station on the Patuxent River in Maryland. His current research interests include population assessment of waterbirds and the ecology of turtles. He has bachelor of arts and master of science degrees in zoology from the Humboldt State University and California State University, Hayward.

Biographical Sketch: Judy Burke is a naturalist at Jug Bay Wetlands Sanctuary and a news editor at *U.S. News & World Report*. She has a bachelor of arts in history from Harvard University and a master of science degree in wildlife biology from the State University of New York, College of Environmental Science and Forestry.

Marsh Periwinkles (*Littoraria irrorata*) as an Indicator of Mesocosm and Restored Ecosystem Quality

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Abstract: Salt marshes are among the most productive ecosystems on earth. They protect the shore against erosion, filter and assimilate pollutants, stabilize bottom sediments, and provide breeding habitat, protection, and nutrients for juvenile marine organisms, fueling the marine food chain. As

human development continues to encroach upon natural habitats, the need to restore and recreate functioning ecosystems becomes increasingly evident. Although much research has been conducted on restoration techniques, questions remain about the quality of restored and constructed ecosystems. Indicator organisms can be used to assess the overall value of the restoration by comparing the density and age structure of populations in analogous wild systems to those in restored systems. Gastropods are a particularly useful indicator organism because they play a vital role at the detrital interface where most eat living and decaying plants, although some are scavengers or predators. Grazing by gastropods will have obvious effects on the plants they are eating, but some positive effects for other species are more difficult to ascertain, such as clearing a suitable substrate for barnacles to settle on. Conversely, some species may require the habitat provided by plants for shelter and would be detrimentally affected by grazing and shredding behavior. This study compares marsh periwinkle (*Littoraria irrorata*) population density and age structure at three sites on Maryland's Eastern Shore near Cambridge: a natural reference marsh at a Taylor's Island tidal creek, a privately owned restored marsh that was created for erosion control in 1993, and salt marsh mesocosms at the Horn Point Laboratory. During the year 2000 growing season, surveys of density and individual size were performed at the reference and restored sites (20 1/4 m^2 plots per survey per site). Six of the 12 mesocosms were stocked with representative populations, selected for density and size distribution based on data from the Taylor's Island reference site and a 1997 mesocosm experiment. Average plot densities range from 8.85 to 11.65 per 1/4 m^2, and average lengths range from 14.6 to 16.4 mm. While these results confirm the expected similarity between the natural and restored sites, the size class histograms are significantly different. This discrepancy may be due to imperfect emulation of natural sites including edge effects, lower vegetation densities, or lack of accumulated marsh peat. Surveys will be performed through the end of this growing season at the Taylor's Island reference site and the restored site. The survival rate of populations in the mesocosms will be documented at the end of this growing season and at the beginning of the year 2001 growing season in order to assess the functional value of the mesocosms as habitat.

Biographical Sketch: Stacy Swartwood received a bachelor of arts in biology from the University of North Carolina at Chapel Hill in 1994. She worked for Washington area international public and environmental health organizations for 5 years, starting out with a family planning project then becoming a freelance information specialist providing editorial, layout, appropriate technology, and both online and print production services. She is currently pursuing a masters of science degree through the Marine Estuarine and Environmental Science (MEES) Program at the University of Maryland at College Park.

Public Policy and the Rocky Mountain Breeding Population of the Trumpeter Swan (*Cygnus buccinator*)

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Abstract: The trumpeter swan (*Cygnus buccinator*), nearly hunted to extinction by the early 1900s, found a refuge in the Yellowstone National Park area. From this small remnant population in the adjacent corners of three states (Montana, Wyoming, Idaho) a population of 500-600 resident birds developed. The tri-state population was so successful that the trumpeter has never been placed on the U.S. Fish and Wildlife Service Endangered Species List. The management of the tri-state population over the last few years has been influenced by questionable public policy decisions. Despite attempts to follow all applicable Federal and State laws, the population is declining. Most recently, the U.S. Fish and Wildlife Service released an Environmental Impact Statement that makes an experimental hunting season for tundra swans (*C. columbianus*) in Utah permanent. It is widely expected that this season will prevent the further southern expansion of wintering populations of the trumpeter. In August, the Biodiversity Legal Foundation petitioned the U.S. Fish and Wildlife Service to list the tri-state population of trumpeters under the Endangered Species Act. The biological factors, environmental constraints, and public policy affecting this population are discussed. Suggestions are made to avoid listing while protecting the social and economic values of the trumpeter swan to society.

Biographical Sketch: Jim Tate was born in Wisconsin and raised in Illinois. He has a bachelor's degree from Northern Illinois University, a masters degree from the University of the Pacific, and a Ph.D. from the University of Nebraska in animal behavior. Fresh out of college, Tate was appointed assistant director, Laboratory of Ornithology, and associate professor of natural resources at Cornell University. He served as graduate student advisor; managed a public education program; managed the Sapsucker Woods natural reserve; wrote, edited, and published; and taught a field ornithology course. Later, he worked as manager of environmental affairs for Atlantic Richfield Coal Company, Denver, Colorado. Among other places, this job took him to Wyoming where he studied sage grouse, pronghorn antelope, and shrub steppe habitats. After moving to Washington, D.C., Tate served as an endangered species wildlife biologist for the U.S. Fish and Wildlife Service, and he was a permitting manager for the U.S. Office of Surface Mining in eastern Tennessee. For 8 years, Tate served as professional staff to the U.S. Senate Committees on Environment and Public Works, and Energy and Natural Resources and executed major legislative initiatives on the Endangered Species Act, invasive species, and

Columbia/Snake River salmon. Presently, he works for the Idaho National Engineering and Environmental Laboratory (a U.S. Department of Energy facility). Stationed in Washington, D.C. and Idaho Falls, Idaho, Tate does research on conservation and habitat restoration biology and the interface between science and public policy.

Summary

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This symposium has brought together some of the most knowledgeable waterfowl biologists who are dealing with the black duck and its Chesapeake Bay habitat. At the beginning, the moderator, Gerald Winegrad, presented his 4-H concept in regard to problems facing the black duck, which included habitat, hunting, hybridization, and human disturbance. He described the problem as a mystery thriller that we have to solve.

Vernon Stotts started the technical session with a classic 1950s film of the black duck, which showed early management activities of the Maryland Game and Inland Fish Commission and their attempts to learn more about the biology of the black duck and techniques that would help restore their populations. Names of some of the pioneers in the Bay waterfowl scene, including Fran Uhler, John Steenis, Bill Nicholson, and Ed Addy, were mentioned and their accomplishments recognized.

Jerry Serie compared the black duck to the esteemed canvasback, as a duck whose sporting quality, wildness, and unique adaptiveness is treasured by sportsmen, naturalists, and avian ecologists. Serie traced the interesting history of the black duck in the mid-Atlantic area and credited early writers such as Bruce Wright (author of "High Tide and an East Wind") for their contributions to our present knowledge of this species. Serie presented the interesting progression of activities dealing with the black duck (and other waterfowl species), which culminated with the North American Waterfowl Management Plan and the subsequent Black Duck Joint Venture and the Atlantic Coast Joint Venture.

Serie also was quick to recognize the controversy that has characterized the management of this species and the lawsuit brought against the U.S. Fish and Wildlife Service (USFWS) by The Humane Society of the United States in 1982 to prohibit a hunting season on black ducks. Although the USFWS won this lawsuit, Serie and other waterfowl biologists recognized the problems with the black duck populations over the years, and drastic corrective measures were taken to reverse the downward population trend of this valuable species. However, in spite of all the focus and attention the black duck has received over the years, management efforts have made little progress toward increasing black duck numbers.

Jerry Longcore presented compelling evidence that linked much of the population problems that are seen in the Chesapeake Bay wintering grounds to the breeding habitat of the Northeast. Longcore questioned the name "American black duck" and suggested a more appropriate name would be the "North American black duck." He presented compelling arguments about the disparity in hunting restrictions between Canada and the United States, and that managers must transcend local, regional, and political boundaries to achieve a strategic management plan for the flyway.

John Morton presented data that demonstrated the role of human disturbance as a complex phenomenon that poses a management issue of concern. As human populations increase in the Chesapeake Bay, John predicted that more disturbance will be imposed on the black duck and that this species will seek habitats with less disturbance and/or extend feeding times to mitigate for the effects of disturbance. This disturbance could lead black duck populations to use relatively undisturbed lands such as refuges provided by State and Federal wildlife agencies. Human disturbance is restricted on these areas allowing the black duck and other wildlife to have adequate time for foraging.

Ginger Bolen and her colleagues presented an argument that the decline of black ducks is not due to competition from mallards as others have proposed but, rather, is a result of the possibility that black ducks display a greater level of neophobia and/or wariness to humans. Experiments were conducted with captive ducks, but contrary to the predictions of the authors, the data revealed that mallards demonstrated greater levels of neophobia than black ducks. It is possible that the higher level of neophobia that mallards display may help this species deal more successfully with human disturbance than the black duck.

Mike Haramis and his colleagues presented data on breeding productivity on Smith Island in the Chesapeake Bay. By tracking the movements and activities of female black ducks instrumented with internal transmitters, researchers were able to document the rate of nesting and cause of mortality. They found that nest success was low for Smith Island black ducks and that nests were subjected to high levels of predation, mainly from red foxes (*Vulpes vulpes*) and gulls (*Larus* spp.). Mike suggested that management to reduce nest predation would likely have the greatest immediate benefit for island breeding black ducks.

Dennis Jorde and Dan Stotts presented extensive survey data on the regional and local Bay black duck population trends based on aerial surveys. These data show the decline in black duck numbers in the southern states but an increase in the populations of black ducks in the Maryland portion of Chesapeake Bay. The authors also pointed out the need for more information, especially from banding, so hunting regulations can be established to lessen the kill of resident breeding ducks in the Bay.

John Grandy presented an argument that the management of the black duck is a demonstrated failure in the application of the presumed principles of waterfowl management. Grandy blamed hunting as the major cause of the black duck decline and suggested more restrictions in the regulations established by State and Federal wildlife agencies.

The issues presented by the authors of the symposium papers demonstrated a fairly strong agreement that the problems facing the black duck are complex, and that more should be done to assist the further recovery of this species. The role of habitat, predators, hunting, and competition were all discussed. One area that was not discussed was the role of contaminants or disease in negatively affecting black ducks in the Bay. Although most presenters argued for the need of greater amounts of quality habitat, John Grandy clearly favored less hunting to restore the populations in the Chesapeake Bay.

Although no grand plan was proposed on how to reverse the trend in the decline of black duck numbers, several persons suggested that managers representing State and Federal agencies work with private sectors such as Ducks Unlimited to preserve more habitat in the Bay and to better enhance the habitat that is presently available to black ducks.

At the beginning of the symposium, Gerald Winegrad stated that a high percentage of birds in North America were in trouble and that the black duck represented a species of special concern. Winegrad quoted the famous Yogi Berra, whose use of the English language and the twisting of metaphors has created many smiles; Yogi said "when you come to a fork in the road, take it!!" Winegrad suggested that we have come to a fork in the road, but that we should determine which road we will take to restore black duck populations. In later life, Yogi Berra explained that his home in the Bronx of New York City was at the end of a loop road so that both roads at the fork would lead to his house. With the black duck of Chesapeake Bay, we are not so fortunate to insure a positive outcome regardless of the road we take. Taking the wrong road may lead to reduced populations and degraded habitat conditions. The possibility of reversing these trends may be more limiting as human populations continue to increase in the Bay area. Managers and researchers have a challenge to assist this species of duck that represents Chesapeake Bay as much as the canvasback or the blue crab. To miss the opportunity to restore these populations would be a tragic loss, for which our descendants may not quickly forgive us. Hopefully, we will rise to the challenge and address the population and habitat issues of the black duck in a timely manner.

Attendees

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