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Mute Swans and Their Chesapeake Bay Habitats:Proceedings of a Symposium

Matthew C. Perry
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Preface

The Wildfowl Trust of North America, located at Horsehead Wetlands Center in Grasonville, Md., was the major sponsor of this one-day symposium held on June 7, 2001. The symposium on "Mute Swans and Their Chesapeake Bay Habitats" was intended to provide an understanding of the complex issues relating to the growing numbers of mute swans on the Chesapeake Bay.

The symposium was cosponsored by Chesapeake College and the USGS Patuxent Wildlife Research Center and was held at Chesapeake College, Wye Mills, Md. A late-afternoon reception and poster session were held at the Wildfowl Trust's Horsehead Wetlands Center (now Chesapeake Bay Environmental Center). This symposium was the second in a series sponsored by Wildfowl Trust of North America, following the symposium on "Black Ducks and Their Chesapeake Bay Habitats" that was held on October 4, 2000.

The exotic mute swan (*Cygnus olor*) has increased its population size in the Chesapeake Bay (Md. and Va.) to approximately 4500 since 1962, when 5 swans were released in the Bay. The Bay population of mute swans now represents 30 percent of the total Atlantic Flyway population (12,600) and has had a phenomenal increase of 1200 percent from 1986 to 1999. Unlike tundra swans (*Cygnus columbianus*) that migrate to the Bay for the winter, the mute swan is a year-long resident. Reports of conflicts with nesting native water birds and the consumption of submerged aquatic vegetation (SAV) have raised concerns among resource managers.

Mute swans have historically been classified as a wetland game bird in Maryland and were protected under state law. They have not been protected in Virginia. In addition, mute swans have not been protected by the Federal government under the Migratory Bird Treaty Act (MBTA) of 1916, because they were considered nonmigratory and exotic. Several years ago, Maryland initiated a limited program to control mute swan numbers by addling eggs and by some euthanasia of adult swans. Some residents of the Bay area opposed these control methods, and they successfully appealed to the Governor to stop all mute swan management in Maryland.

In 2000, the Governor appointed a Mute Swan Task Force to advise Maryland Department of Natural Resources (DNR) on viable management for mute swans in the Maryland portion of the Chesapeake Bay. Some who are opposed to any control of swan numbers have criticized the Task Force Report. Subsequent to this symposium, the Maryland DNR produced a Mute Swan Management Plan, which was designed to alleviate existing conflicts, while not excessively diverting limited wildlife management resources. The management plan was posted on the Maryland DNR Website and received numerous comments from the public and from professional natural resource managers. In 2003, subsequent to the symposium, a Federal court ruled that the mute swan should be considered under the MBTA and, therefore, should receive protection. Hunting regulations may be promulgated for the mute swan under the MBTA.

This symposium was designed to provide an overview of the available information about the mute swan so that the public has a better understanding of the complex issues concerning this species and its growing presence on the Chesapeake Bay. Invited papers were presented during the day at Chesapeake College, and posters were displayed at an evening reception at the Horsehead Wetlands Center. All technical aspects of the symposium were the responsibility of my staff and myself at USGS Patuxent Wildlife Research Center. It was our goal to present a balanced assessment of the mute swan status 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 primarily responsible for all logistical planning of 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 all these persons and others was greatly appreciated.

Other persons who assisted on the publication of the proceedings include Scott Altmann, Caroline Bond, Tammy Charron, Marcia Holmes, Lynda Garrett, Susan Lauritzen, Edward Lohnes, Beth Vairin, and Alicia Wells. The formatting of these proceedings with the use of desktop publishing software was conducted by Edward Lohnes.

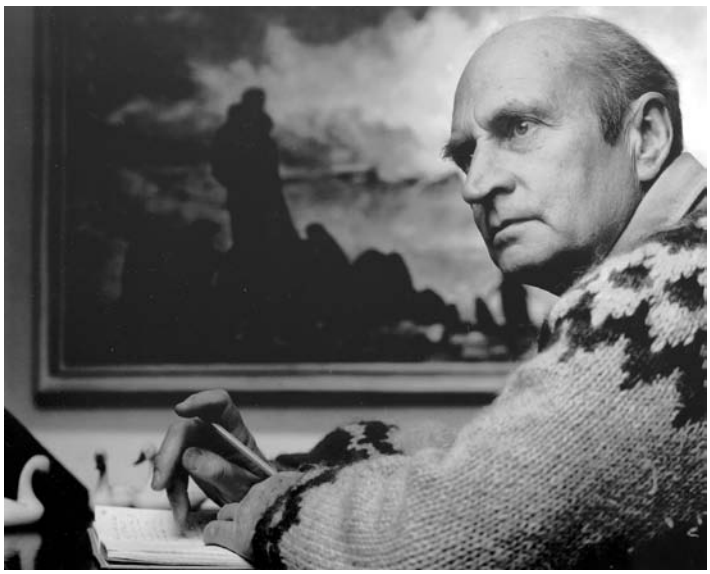
Matthew C. Perry
USGS Patuxent Wildlife Research Center

Symposium Dedication

This symposium is dedicated to Dr. William Sladen, a long-time expert and researcher of polar birds (especially penguins, swans, and geese), amateur botanist, photographer, and filmmaker. Dr. Sladen has been a major advocate for management of waterfowl in the Chesapeake Bay and its watershed for 40 years. Born and educated in England, Dr. Sladen earned his medical degree during World War II. His career in biology began in 1947 when, as a medical officer, biologist, and photographer with the Falkland Islands Dependencies Survey (British Antarctic Survey), he traveled to Antarctica. In 1956, Dr. Sladen received the Rockefeller Foundation post-doctoral fellowship, which brought him to Johns Hopkins University (JHU), where he began working in the School of Hygiene and Public Health. During his tenure at JHU, he headed up the field ecology program, which included extensive studies of waterfowl in the Chesapeake Bay. Numerous graduate students conducted their research with waterfowl in the Chesapeake Bay under his tutelage. Dr. Sladen earned his U.S. citizenship in 1962.

Dr. Sladen's discovery of DDT residues in Antarctic penguins was the first to demonstrate global pollution. His long-term ornithological research, involving the banding of some 50,000 penguins and 60,000 albatrosses, was the first of its kind. His pioneering banding and radio-telemetry techniques for bird studies have taken him to such far-flung places as Antarctica, Lapland, Alaska, Chile, and Iceland. In 1975, he was the first westerner to visit Siberia's Wrangel Island to study the snow geese.

Dr. Sladen was instrumental in the creation of the Wildfowl Trust of North America located at the Horsehead Wetlands Center in Grasonville, Md. He had the ambitious goal to create a collection of all the indigenous waterfowl of North America. This program was modeled after the very successful waterfowl sanctuary at Slimbridge that was created by Dr. Sladen's good friend Sir Peter Scott. Sir Peter and Lady Scott visited the Wildfowl Trust of North America in the 1970s and were impressed by the outstanding work that Dr. Sladen had done to display and study native waterfowl.



Dr. Sladen has always maintained a high standard for native wildlife. He opposed the introduction of farm-game mallards that were being released by the state of Maryland in the 1970s-80s. He has been and continues to be opposed to the proliferation of mute swans in the Bay. However, because he is opposed to killing swans, he pressured managers to consider more humane techniques, such as same-sex pairing, a technique he continues to promote for swans today.

Dr. Sladen is presently director of the Environmental Studies at Airlie's - Swan Research Program (SRP) and guides the education and research at its facility, located in Fauquier County, Virginia, at the Airlie Center. SRP maintains a collection of over 160 swans (9 taxa, including breeding trumpeter swans). Dr. Sladen and sculptor Bill Lishman originated and developed the technique of using ultralight aircraft to teach birds a predetermined migration route with the goal of reestablishing a migratory tradition. This technique is now being used successfully with whooping cranes. Dr. Sladen and his team have continued to test new and innovative methods with recent experiments to test "passive migration" by carrying geese below a gas balloon over a migration route.

In addition to publishing over 120 scientific papers, he has also made TV films to illustrate his research, which have been shown on all major USA networks, NOVA, and BBC. His awards include Member of the British Empire, the Polar Medal (U.K.), and the 1991 Explorer's

Medal (Explorer's Club, N.Y.) for research in the polar regions. Two Antarctic mountains are named in his honor.

Dr. Sladen has been a popular lecturer and leader on small study voyages to the Polar Regions. Most recently, he returned to Antarctica as a guest lecturer on the Kapitan Khlebnikov in December 2000, qualifying him as a seven-decade Antarctican! Dr. Sladen lives in Warrenton, Va., with his wife, Jocelyn, at the 550-acre field station of Environmental Studies at Airlie, which they have personally managed for the benefit of native flora and fauna. In recognizing his long and productive career dealing with the conservation and research of wildife resources, especially swans, we are pleased and honored to dedicate these proceedings to Dr. William J.L. Sladen.

Contents

Mute Swans and Their Chesapeake Bay Habitats: Proceedings of a Symposium

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Abstract

The symposium "Mute Swans and their Chesapeake Bay Habitats," held on June 7, 2001, provided a forum for biologists and managers to share research findings and management ideas concerning the exotic and invasive mute swan (*Cygnus olor*). This species has been increasing in population size and is considered by many to be a problem in regard to natural food resources in the Bay that are used by native waterfowl during the winter months. Other persons, however, feel that resource managers are attempting to create a problem to justify more killing of waterfowl by hunters. Some persons also believe that managers should focus on the larger issues causing the decline of native food resources, such as the unabated human population increase in the Bay watershed and in the immediate coastal areas of the Bay. The symposium, sponsored by the Wildfowl Trust of North America and the U.S. Geological Survey, provided the atmosphere for presentation of mute swan data and opinions in a collegial setting where discussion was welcomed and was often informative and enthusiastic. An interesting historic review of the swan in regard to the history of mankind was presented, followed by a discussion on the positive and negative effects of invasive species. Biologists from different parts of the continent discussed the population status of the species in several states in the east and in the Great Lakes area. Data on the food habits of this species were presented in regard to submerged aquatic vegetation, and an interesting discussion on the role that the food habits of Canada geese in regard to native vegetation was presented. Findings and recommendations of the Mute Swan Task Force were presented. Finally, a representative of the Friends of Animals gave a thought-provoking presentation in defense of the mute swan. The presentations, in general, provided the necessary information and recommendations to allow managers to proceed with management of this controversial species with new and valuable perspectives.

Welcome

Dr. Edward L. Delaney, Executive Director, Wildfowl Trust of North America, P.O. Box 519, Grasonville, MD 21638 USA, director@wildfowltrust.org

Welcome to the Mute Swans and Their Chesapeake Bay Habitats Symposium.

The purpose of this symposium is to bring together some of the finest experts on mute swan biology and habitat needs and to share this information with you, the symposium participants. We hope that the symposium will be stimulating and challenging, causing each of us to reflect, plan and undertake research on habitat conservation efforts with the ultimate goal of managing this species in a biologically sound manner. Thank you for the part you are already playing in these efforts.

Biographical sketch: Edward Delaney was executive director/CEO of the Wildfowl Trust of North America (WTNA) at Horsehead Wetlands Center (now the Chesapeake Bay Environmental Center) in Grasonville, Md. from 1997-2002 and remains on the WTNA Board as a vice president. Dr. Delaney has more than 25 years of experience as an administrator and educator. He received his Ph.D. in Administrative and Organizational Studies and his Masters Degree in Human Relations and Social Policy from New York University. Before coming to WTNA, he was a senior fellow and professor at George Mason University in Fairfax, Va., and served as President of the Association for Institutional Research, an international society of researchers and planners. He also served as a board member for the Environmental Fund for Maryland and the Kent Narrows Development Foundation and as 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 for policy of the American Bird Conservancy, acted as moderator for the symposium and introduced all speakers.

Mr. Gerald W. Winegrad, Vice President, American Bird Conservancy, 1834 Jefferson Place, NW, Washington, D.C. 20036 USA, gww@abcbirds.org

Biographical Sketch: Gerald Winegrad is an attorney who 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 eight years, he wrote, sponsored, or managed nearly all environmental legislation passing the Senate during that

period. Mr. Winegrad was called the "environmental conscience" of the Senate by the Washington Post, and regional writer Tom Horton wrote that "he is the person who more than any other set Maryland's environmental agenda over the past 16 years." Mr. Winegrad has taught graduate courses in environmental policy at the Johns Hopkins University in Baltimore and at the University of Maryland, College Park. Mr. Winegrad is currently Vice President for Policy for the American Bird Conservancy in Washington, D.C., and is a leader in national efforts to conserve avian species.

Presentations

Mute Testimony: Some Dialog About Swans and Humankind Through History

Kent Mountford, Estuarine Ecologist and Environmental Historian, c/o Cove Corporation, 10200 Breeden Road, Lusby, MD 20657 USA, kentmountford@chesapeake.net

Abstract: The swan as figure and reality has intertwined with humans at least as far back as Greek mythology can relate stories of the past. Its symbolism and actuality has combined beauty, sexuality, song, the written word, culinary delight, weapons of war, and the hunt. One of many related species, the Eurasian "mute" or "tame" swan assumed significance in English culture. Humans, fascinated and long associated with them, brought them to the New World, as nonnative species. The track record for hundreds of other introduced nonnative species is largely one of tragic and unintended consequences. In North America, the two species of native swans were temporary, though noteworthy, visitors to temperate latitudes only during winter months. One species, the trumpeter, was mercilessly hunted into the past century and its population was nearly extinguished. Here and in Europe, there is increasing potential for conflict as both mute swan and human populations overgrow available space and their uses overlap. On the eastern seaboard, regional populations of mute swans are in the thousands, and, when densely aggregated, they can consume large amounts of already stressed submerged aquatic vegetation. Their large and well-defended nesting territories bring many mated pairs into disturbing contact with coastal residents. A multifaceted dialog on the virtues and problems posed by this beautiful but difficult bird is provided.

Introduction

The mute swan, *Cygnus olor*, was introduced to North America from Europe, where it has lived together with man for centuries. Its natural origins are Eurasian, and this large bird has been widely considered an object of beauty. At the same time, once escaped from ornamental captivity, the mute swan is a challenge to wildlife managers all over eastern North America and, in our region is a ravenous year-round consumer of the Chesapeake Bay's limited submerged aquatic vegetation.

Laying 6, 7, or rarely 10 eggs and with few natural predators who will brave attack by the "cob" or male, the probability of rapid population increase is high. Over 4000 swans now range the Bay, and wherever they are concentrated, controversy follows. As background, this presentation considers some aspects of their interweaving relationship with human history.

The Oxford English Dictionary (OED) says that, in Greek mythology, the swan was sacred to Apollo, one of the Olympian gods who succeeded the Titans. Classical scholar Joel Skidmore disagrees, and he can't understand why OED says this. Zeus, he says, is a much more plausible candidate. There are a couple of variations to the tale, but both of them involve some really hard sex. These mythic characters could change shape and form at will, and they did so often. Zeus assumed the form of a swan and came to cohabit Leda, who'd already slept with her partner Tyndareus that night. From two unions, she bore two sons, Castor and Pollux, the famous Hero Twins.

Among the constellations, you can find Castor and Pollux (to the right of the Big Dipper as Gemini, the twins) and Cygnus, the swan, (well to the left of the Big Dipper) as seasonal constellations in our Northern Hemisphere skies. A poet said:

> "The silvered swan that dying sweetly sings,
> Adorns with twelve stars her beautiful wings"

This couplet reveals another myth about swans. The word itself derives from the old English words "geswin" = "melody" and "swinsian"= "to make melody," in the actually mistaken belief that on dying the swan sings its "swan song," which is continued by our language in metaphor today.

Also in the time of the myths, Cronus castrated his father, the god Uranus, in an act of typical youthful independence and tossed his severed genitals in the sea. A bit of leakage occurred, and apparently spawned Aphrodite, who subsequently arose from the sea foam on a giant scallop to be the goddess of love, desire, and beauty. The birds that are sacred to her are the dove, the sparrow, and the swan.

These Greek myths allowed a creative priesthood to assign cause and lend meaning to almost any event in society, and the opportunity was not missed by subsequent cultures. In Rome, the poet Horace, (that is, Quintus Horatius Flaccus, who lived from 65 until 8 BC), wrote of the swan as "Dircaeus cycnus." In the later Byzantium Empire (the Empire in the East), Edward McNall Burns in his book on Western Civilization tells us that, Theodora, a popular actress of the 6th century AD, was wife and consort to Emperor Justinian, 527-565.

From my student days, I recall that Theodora reenacted "Leda and the Swan," performing in a public tableau where a swan (or swans) gobbled up grain piled around her and exposed her nakedness. This tale sticks in the mind, but I've not been able to trace my memory in print yet. Theodora, in a wider ranging role, was a member of the sect of Monophysites,

which survives today as a branch of Christiandom in Egypt, Syria, and Armenia."

Swans appear very early in European writings; in the Norse tales and in Teutonic mythology, "Brynhilde and the Valkyries became swan maidens, receiving into their arms the souls of heroes (and) into Vedic Heaven," according to the Oxford.

In English literature, the swan appears in the years 700 AD, 1000 (in time for the Y-1K problem), 1050, 1300, and, in 1386, Goeffrey Chaucer wrote "...a fat swan loved he best of any roost (i.e., roast)." In another source we see: "The mute swan, or that which we call Tame, is found in a wild state in some parts of Russia." The swan, with its pure white plumage, was taken as a symbol of "faultlessness or excellence, as opposed to the use of 'crow' or 'goose,'" old crow or silly goose to us.

They were nonetheless hunted by the royals, often in the time of molting, when they could not fly away. It was said that one could also decoy them with a white shirt thrown over a pile of brush. On this popular diet item, we read "My wife gives your Lordship her humble thanks for the swan pie." Another remarks to us across centuries: "Was't not an excellent swan pie?"

A selection of medieval chants and poems were discovered decades ago and immortalized by Carl Orff in the moving chorale "Carmina Burana." One piece tells the lament of a swan destined for table. The tenor sings:

"Olim lacus coluerum,
Olim pulchar exiteram
dom cignus ego sueram.
Miser, miser! Modo niger aet ustus fortiter."

Once I lived on lakes
Once I looked beautiful
When I was a swan.
(Refrain) Misery me! Now black and roasting fiercely.

Swans on England's Thames River were always coveted, and their ownership, that of the new cygnets each year, has been determined at least since 1570 through a process of capture and marking called "swan-upping." This obscure term comes from Old English "ypping," making known or manifest. The upping is overseen by a swan warden and conducted jointly by the Crown and the Companies of swan masters.

A last testament filed in Lincoln Diocese, 1451, discusses the swan as owned property: "I will (leave to) my nevew Robert, Constabull, half all my gwhite swannes." Repeated references appear not to the wild migrating swan but to tame or domestic animals.

Swans were a poignant resource in war and the hunt. Arrows fletched with their strong pristine feathers, like the wings of the mute swan, sang as they flew to their doomed targets. The stiff feathers, either directly harvested or taken during molt, also served quite an opposite role and were trimmed as excellent quill pens. Perhaps it is not so opposite after all, if we accept that the pen ultimately is mightier than the sword.

When guns supplanted the long- and cross-bow, surgeons, extracting a musket ball embedded in human flesh, used an instrument called a "swan's bill," a type of speculum, to spread the wound, without anesthetic of course, and this permitted forceps to grasp the projectile for withdrawal.

In the parlance of hunting in which the terms "buck shot" and "bird shot" have entered vernacular usage, there was a particularly heavy lead shot developed called, variously, "swan shot," "swan post," or "swan drops," for its ability to fell these heavy birds.

Let's speak of swans in North America, the New World. The first depiction from this side of the Atlantic is a watercolor drawing by John White in 1585, done in the Carolinas and later published in Europe. If you look closely at this picture there is no prominent knob above the bill. This is the tundra or whistling swan, *Olor columbianus*, not the mute swan, *Cygnus olor*, which was not in North America then. Tundras had clearly reached south of the Chesapeake to the Carolinas, where White saw them.

A couple of decades later, John Smith and other chroniclers after 1607 include the swan among an inventory of wildfowl available for hunting. "In winter there are great plenty of swans, ...But in summer not any..." Charles Calvert used one of the Bay's "swan points" in 1674 to set a boundary for Cecil County. On New Year's Day, 1610, Governor Thomas Gates, later of Virginia, (but at that time shipwrecked for some months on the then so-called "Devil's Isles" of Bermuda), was walking with a friend, and they each killed a wild swan in one of the saltwater bays there.

The Native American hunters of Powhatan's Confederation also took swans. Nemattanew, who the colonists called "Jack the Feather" was an aggressive, flamboyant warrior who "used to come into the felde all covered (with) feathers and swans wings fastened unto his shoulders as thowghe he meante to flye." Archaeologist Fred Fausz recites an early Spanish account that the Powhatan's god appeared to them as a bird, which this warrior may have sought to emulate. By1621 Nemattanew had ascended to something of a charismatic religious figure, but it's thought that his feathers were only a way to be noticed.

The 1953 edition of John James Audubon's "The Birds of America," with its wonderful images painted from 1827-38, is also very clear about who's who, showing *Cygnus columbianus* (*C. Americana* to Audubon) with the same little ripple that White showed at the juncture of beak and head and a diagnostic "yellow" spot just ahead of the eye. Maryland waters, the Virginia Bay, and southward to Currituck Sound were prime winter swan habitat, and these swans all clearly left to go beyond the Arctic Circle in breeding seasons.

There was another swan in North America, the trumpeter, *C. buccinator*. It was a midcontinent species and was almost exterminated by hunters. It does not have the yellow spot ahead of the eye. By the 1950s, enough mute swans were introduced to have William Vogt's annotations comment that these indigenous birds were sometimes confused with whistlers (tundras today) but that the latter usually swims with its

head erect, where the mutes hold a graceful curve. Both White and Audubon have the neck bent, of which tundra swans are quite capable, to make a detailed painting of all features fit on the limited size of the folio page!

It is ironic that, with all the mute swan controversy, the U.S. Postal Service, in its wisdom, chose two mute swans facing with arched necks to grace a recent Valentine's Day stamp. More stamps than swans were thus proliferated in the blink of an eye!

Male mute swans, or "cobs," usually engage in "busking," a display of puffery that increases apparent size and shows displeasure to warn off those approaching a nest before attacking. The term "buskers" is also used to describe, in a sense, the puffery of performing street musicians in England.

But sometimes the cobs don't stop at busking. A colleague sent me an item from Reuters News Service dated May 7, 2001. At Kristiansand Nature Center, a Norwegian swan named Oscar, noted for his aggressiveness, flew all the way across a lake to attack an elderly lady, biting her in the buttocks and dragging her five meters into the water, where she was submerged twice before rescue. She spent the night in the area hospital. I simply report what Reuters says, a service with no swan agenda, pro- or con-.

My own experience with swans began in the late 1960s on Barnegat Bay, N.J., just below Swan Point (so named in the 19th century) one foggy morning when, as a young researcher, I headed out in my skiff to sample the Bay and found my bow crossed just yards ahead by a skein of massive tundra swans, who had been feeding on Barnegat's then-abundant widgeon grass beds as they had for millennia. I will never forget the sight.

Since coming to the Chesapeake I thrill each autumn at the cries of tundras "trumpeting" aloft as they arrive from boreal America. They used to enter my cove each winter in stately fleet, looking for bay grasses. In the 1970s, we began regularly exploring Tar Bay on the Eastern Shore by boat, and watched with interest in spring as a mixed colony of terns, oystercatchers, and my favorite bird, the black skimmer, began developing there on offshore shell banks and sandbars. This was as far north as skimmers had ever nested. In my logbooks for those years around 1987, the terns were always there, circling to keep us clear of their breeding area, but no swans were seen. Tar Bay was also one of the Chesapeake Bay Program's success stories because of the strong resurgence of underwater bay grasses in the late 1980s. Our bay program aerial imagery showed that these beds were expanding rapidly in a regrowth so dramatic that a display with sliding panels showing the positive changes from year to year was set up by National Geographic as part of a Chesapeake Bay exhibition in Explorers' Hall.

In 1990, three decades after the mute swan's escape from that Eastern Shore Maryland estate, we saw the first three dozen, then about 160 mute swans in Tar Bay. This was at the outset a remarkable sight.... these big, dramatic birds, brilliant in the sunlight and a symphony of sound charging off the water with their wings singing. I videotaped these first encounters as a rare and memorable event, and so it remains. Even then, however, I estimated by quick calculation that they could consume some 66,000 pounds of bay grasses during the growing season. Sampling Tar Bay's bottom then, on October 20, we found no evidence of the formerly abundant grasses.

I've watched this flock wax and wane for a dozen years now (there were about 370 in September 2000) as they move about, disperse, and reaggregate on the Bay, but many of the more sensitive birds, terns especially, have been pushed off. In recent years, I've seen no more than a dozen pairs, and, in May 2001, only 8 pairs. With the bulk of their competing population off nesting, just 56 swans were seen, but they were enough to accidentally trample many nest sites of the smaller species as they march around on these low beaches. The mute swans in winter eat algae in the absence of SAV, the widgeon grass not being grown yet, which results in large oozy cow pie droppings.

When the grasses are abundant, the swans' stools are well formed, and on sandbars used as a loafing area, beaches are often strewn with hundreds of swan feces. It's hard to walk on a sand strip like this and keep one's feet clean. Considering nutrients and fecal coliform contamination, how 'bout these big birds? Any volunteer pooper-scoopers? When groups like this become food and space-limited, they emigrate elsewhere, and many moved to the Western Shore.

One of my true joys in living on my home creek for 27 years has been to swim along the shoreline, reflecting on the beauty of this land and water. As the Patuxent River's nutrient loads reduced in the late nineties, the grasses in my cove increased dramatically. In spring 1997 the grass beds in my cove were very dense. This was not wasted on the arriving mute swans and one day when I went down to swim there were over 40 of them waiting for me to leave so they could come in and feed.

A few years ago a mute swan pair decided to nest on the tip of the sand bar where I swim, and the males made me the target of repeated attacks. Believe me, something like this 7-foot wingspan coming at you at 20 miles an hour is frightening. The first time I was really terrified, literally shaking and my heart pounding like I'd have a heart attack. Swimming, you feel pretty small with just head and hands above the water. I'm an adult; imagine how my neighbor's little ten-year-old daughter felt when a swan attacked her kayak.

My friend Frank, a waterman who poles around this cove looking for soft-shelled crabs, says a swan came right up on his boat and chased his dog overboard while he tried to fend it off with a piece of PVC pipe. This is my own land, and has been so for decades before mute swans came here, and I have shared this cove with a great variety of wildlife, including the tundra swans in winter with no problem. There are no grasses this year down to "swan neck depth," except (ironically) under my tied up rowboat and beneath the dock. What to do?

They are at the same time lovely birds. Sixteen of them were feeding in front of my neighbor's property recently as we had a picnic a few Sundays ago, and their grace was unmistakable. These 16 have, however, the probability of becoming 40

next year and 80 the following. A single pair can sometimes produce six cygnets, so without predators, the potential for increase is astronomical.

People, of course, are at the same time crowding these same shores with serious environmental impacts of their own. We are certainly overall more of a problem than the swans, but two separate problems don't admit to a single solution...or might they?

The final mute swan solution may be staring us in the face. The Easton Star Democrat, a 200-year-old Eastern Shore newspaper, reported on April 5 of this year that a 6-foot-long caiman, a Central and South American alligator-like reptile introduced to and now widespread in Florida, was found by two preteen boys on the bank of Kent Island's Northwest Creek. It was April Fool's Day and nobody would believe them, so they got a camcorder and videotaped the beast. It had reportedly escaped LAST YEAR from a neighbor who kept it as a pet. "I think the only reason," said the boys, "that it didn't go after us is because it is cold and they aren't used to the weather." "There was a bunch of swans out there and now there is only one and they blamed it on the alligator," said nine year-old Joey Adams.

Now, with global warming, it's not too much of a stretch to imagine caimans prospering all over the Chesapeake and enough of them may provide an interesting population control for humans as well as mute swans. Just let the balance develop between people population and our mute swans. End of problem!

Biographical Sketch: Kent Mountford is an estuarine ecologist with 38 years experience focused on North America's mid-Atlantic temperate estuaries. He has spent 32 years of that time in the Chesapeake Bay area. As a working scientist, he spent a decade and a half studying productivity and ecology of coastal plankton systems. Leaving fieldwork to join the District of Columbia Government in 1980, he looked at the then-polluted Potomac and began investigating the region's early colonial literature to understand the Bay's past as a key to understanding today's problems. As Chairman and project officer for the ad-hoc Potomac Estuary Modeling Committee, he helped set foundations for using ecosystem models to manage the Chesapeake. These models were among the first to simulate the Bay's precolonial state and forecast the importance of nitrogen pollution. When the Chesapeake Bay Program concluded its six-year research phase in 1984, he joined the U.S. Environmental Protection Agency's (EPA) new Bay Program Office to coordinate its estuary-wide monitoring program. Dr. Mountford spent the balance of his 16 years at EPA as Bay Program Senior Environmental Scientist. He managed a number of university research grants and administered EPA's multimillion-dollar contributions to nonpoint pollution control in Virginia for six years. Since 1997 he has written "Past as Prologue," a popular column on Chesapeake environmental history, which is in the Alliance for Chesapeake Bay's Bay Journal. His book Closed Sea, written long ago about the Barnegat (New Jersey) Estuary, was published in May 2002.

Figure 1. The mute swan *Cygnus olor* was featured for Valentine's Day 2000 on a popular U.S. postage stamp; they were chosen because of the species' tendency to hold their necks in a graceful curve. Two swans facing suggest a heart.

Figure 2. Primary feathers from a swan's wings made prime quills for writing instruments. Our term "pen" comes from the Latin word 'penne' for feather. Quills sliced diagonally with a knife and dipped in an inkwell were the principal writing instrument in an era before metal nibs and ballpoint pens.

Figure 3. Mute swans are commonly used as images in household ornaments such as this planter.

He has many publications on Chesapeake Bay resources and gives numerous lectures about the environmental history of this Bay.

The Role of Invasive Species in a Complex Ecosystem: Mute Swans in the Chesapeake Bay

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Abstract: The mute swan (*Cygnus olor*) issue is an example of a larger problem of the increase of invasive species in ecosystems. Some of these species are exotic (those that evolved in a different region than where they have become invasive), while others are native to the region where they have become invasive. Concern about invasive species is great because of the impacts that may be caused by their increasing dominance. In this presentation, ecological roles of invasive species are discussed. Objectively viewed, an increase of invasive species simply represents change at the ecosystem level. Decisions about whether or not the change is positive or negative are subjective and depend on what humans want. Ideas about mute swans in the Chesapeake Bay ecosystem are presented within the context of ecological theory and the history of the Bay.

Introduction

Invasive exotic species are now a widely recognized environmental problem. They are believed to disrupt ecosystems by out-competing or preying upon native species to the extent of altering relative abundances or even causing local extinctions. They also can impact human land uses by excessive growth, as with weeds, or excessive feeding, as with herbivorous insects. A common quality of the worst exotics is their ability to dominate the systems they invade by being very successful within their ecological niche. This quality has led them to be called "biological pollutants" within ecosystems. For all of the reasons listed above, exotics are considered to be unwanted pests by ecologists and environmental managers, and new funding has been allocated to either keep exotics out of ecosystems or to control their abundances once they invade.

The purpose of this paper is to explore the role of exotic species in ecosystems. The paper will take an ecosystem perspective and contrast it with the human perspective. Some conventional ideas will be challenged and some alternative ideas will be offered. These challenges and alternatives are important because the conventional thinking about exotics has been narrow and dogmatic. Also, there is the practical matter of new funding directed at control of exotics. Monies available for environmental management are limited, and we need to make the best use of this type of funding. Are monies spent on exotic control a wise use of scarce funding resources?

The focus of this paper is on the mute swan in the Chesapeake Bay, though the discussion will apply more broadly to other exotics. The mute swan is a perfect pest: a large, aggressive bird that consumes huge amounts of submerged aquatic vegetation (SAV). Since SAV is highly valued by Chesapeake Bay environmentalists, anything that destroys this type of plants is considered a serious public enemy. Therefore, the question of mute swan control is an important public policy issue currently being examined by the Mute Swan Task Force (2001).

What are Exotic Species?

Elton (1958) defined exotic species as those that have evolved in one biogeographic province but successfully invade another biogeographic province. The conventional thinking is that invasive exotics escape their ecological control factors (that is, abiotic limiting factors, predators, parasites, etc.) through dispersal into a new area. A corollary of this reasoning is the idea that species that are native to a biogeographic province have their ecological control factors intact, and these factors regulate populations so that growth is never excessive.

This logic of distinguishing between natives and exotics rests on defining species in terms of geographic location. However, species can only be understood in terms of the ecosystems in which they are found. Ecosystems provide habitat, resources, and positive feedback circuits for species to exist. The problem with the natives-vs.-exotics logic is that ecosystems change, while place or location does not. Thus, when an ecosystem changes, the species that were native to it may no longer be adaptive to the new conditions, while exotics may be. To illustrate this line of reasoning, consider the Chesapeake Bay as a place and as an ecosystem. Obviously, the Bay has changed dramatically over time from an ecosystem perspective. Table 1 lists some important changes, using the pre-Columbian Bay as a contrast to the present Bay.

The pre-Columbian setting is often used as a relatively undisturbed reference point for thinking about restoration

Table 1. Comparisons of the ecology of the Chesapeake Bay under pre-Columbian and present day conditions (based on ideas from Walter Adey of the Smithsonian Institution).

Parameter	Pre-Columbian	Present Bay
Forest cover of watershed	Nearly 100%	Less than 50%
Emergent wetland area	Extensive	Significantly reduced
Turbidity	Relatively low	Increased
Phytoplankton production	Relatively low	Increased
Oyster abundance	Extensive	Loss of >95%
SAV	Extensive	Loss of >85%
Exotic species	None?	100s

or preservation. Thus, we might ideally want to restore an ecosystem to its pre-Columbian conditions or, if an ecosystem is still in pre-Columbian conditions, then it might receive high priority for preservation. For the Chesapeake Bay, the pre-Columbian reference is more or less equivalent to the Bay that Captain John Smith saw and described in the early 1600s. All true Chesapeake Bay environmentalists love to think about Captain John Smith's Bay because of the wonderful descriptions he wrote about the abundant and diverse biota. For example, one observation made by Smith was that the fish were so abundant you only had to reach out with a frying pan to catch them!

As an aside, there is an ironic twist to the pre-Columbian setting as an environmental reference. Pre-Columbian was pre-renaissance. Do we really want to go back to the dark ages? No Leonardo, no Galileo, no Copernicus, no Michelangelo... We might want the pre-Columbian landscape but few would want to give up the knowledge, culture, and technology that arose from this great period of world history.

Of course, any reference point to past conditions is arbitrary (Egan and Howell, 2001), and the pre-Columbian works as well as any to illustrate how much the Chesapeake Bay ecosystem has changed over time. The changes have occurred with human development: forests and wetlands have been converted to housing and agriculture; oysters and other species have been harvested for food; water quality has declined due to eutrophication; and exotics have increased dramatically because of accelerated disturbance and dispersal. All of this is well known. The point of the comparison is that the present day Chesapeake Bay is not the Bay that Captain John Smith saw. The geography is basically similar, but the ecosystem is very different.

In fact, the present-day Chesapeake Bay is a new system that has never existed before. The present Bay has a very different set of driving forces compared with the pre-Columbian Bay and has a very different ecological structure and function. It is in this sense that the concept of native species breaks down. Native species are those that existed in the pre-Columbian Bay and their roles were adaptive in that environment. In the new Bay the native species may or may not have ecological roles. Moreover, the Bay has changed so much since the Renaissance that it is a wonder that there are very many native species left at all! On the other hand, some exotic species have ecological roles to play in the new Chesapeake Bay ecosystem. They have niches, they transform energy and they recycle nutrients. They are successful because their ecological roles match the conditions of the new ecosystem.

A new perspective is required to understand the new ecosystems that exist in the present day and to value the species that make up the new ecosystems. This new perspective is generally lacking, and some of the old notions, such as the value system associated with native versus exotic species, are no longer sufficient for environmental education or management.

The Chesapeake Bay: an Ecosystem Out of Balance?

The subheading of this section of the paper came from a publication about the Chesapeake Bay that was written for the public (Greer, no date). Wennersten's (2001) chapter entitled "Is the Chesapeake Dying?" relates similar sentiments. The notion is that the Bay is in trouble, and its ecology is dysfunctional. We learn of this position from such pronouncements as "report cards" (Horton and Eichbaum, 1991) and assessments of "ecosystem health" (Reshetiloff, 1995). Table 1 is consistent with the notion because the changes that have occurred in the Bay are thought by many to be from a healthy condition (pre-Columbian Bay) to an unhealthy condition (present Bay). All of these interpretations are true from a human perspective, especially because given that the Bay does not provide the benefits to humans that it once did.

But is the Bay in trouble or unhealthy from an ecosystem perspective? In other words, from a purely ecological perspective, without regard to human values, is the current Chesapeake Bay unhealthy? The answer is, in fact, that it is a fine ecosystem with a fully functioning biota. It is perfectly "healthy," given its signature of external inputs, which include high nutrient concentrations, intense harvesting efforts, and increased dispersal of exotic species. What has happened is that the pre-Columbian Bay reorganized itself by shuffling relative abundances of available species through the selection process of succession, and new combinations of natives and exotics that function effectively under current conditions have emerged. From the human perspective, this change represents degradation. However, value-free interpretations of this kind of change also exist and are worthy of consideration. For example, H.T. Odum (1967) wrote the following quote in regard to his experiences in the Texas coastal zone in the 1960s:

> Man's new systems are removing things from the old Bay systems and, in return, exporting wastes and work to them. Desirable or not, the old systems and the new systems are being joined into an overall network including factories and towns, reefs and grass flats, and the flows between them. Some call this pollution since the phenomenal rates, energy involvements, and chemical aspects are something new on this planet, but from the overview this is a case of system evolution.

Furthermore, Mitsch and Jorgensen (1989) wrote in general about pollution:

> We may even go so far as to say that the concept of a polluted ecosystem is an anthropogenic view, one that may not recognize the beauty of natural systems shifting, substituting species, reorganizing food chains, adapting as individual species, and ultimately designing a system that is ideally suited to the environment that is superimposed on it.

Thus, we can take the position, from an ecosystem perspective, that the present Chesapeake Bay is healthy but different from pre-Columbian conditions, and that the change was a natural ecological process rather than a kind of degradation.

One way to think about the changes that have occurred is to use alternative stable state theory. This theory basically holds that ecosystems possess the ability to exist in two or more alternative states depending on their energy signature of forcing functions. Ecosystems shift between alternative stable states when significant changes occur in the forcing functions. Sometimes large changes in forcing functions are required to cause a shift between two states of an ecosystem, but in other cases small changes in a key variable can cause the shift. A good example of the latter situation has recently been documented for Lake Erie. Here the introduction of zebra mussels caused a dramatic shift from a pelagic state, with high nutrients and plankton concentrations and turbid waters, to a benthic state, with high densities of zebra mussels and clear waters. The reason for the shift was the increased filtration rates of the zebra mussels. This shift has been described in terms of nonlinear dynamics (Kay, 2000; Kay and Regier, 1999) as shown in fig. 1. In this mathematical theory, the alternative stable states are considered to be attractors, which are domains of stability to which the systems return after small perturbations. The shift between attractors in fig. 1 is described by a discontinuous function, which generates fast and dramatic dynamics.

This same kind of theory seems to apply to what has happened to the Chesapeake Bay. Here the shift was from a benthic system in pre-Columbian times, with dominance of benthic organisms such as SAV and oysters in clear water, to the current pelagic system, with dominance of plankton food webs in turbid water. Thus, the pre-Columbian Bay was a benthic attractor and a shift occurred to the present pelagic attractor with changes caused by human development. Scheffer (1998) provides detail on this theory for changes in lake ecosystems caused by nutrient additions, which may have direct applicability to the Chesapeake Bay.

Ultimately, the theory of alternative stable states is just a theory. It may or may not be correct, but it certainly seems to provide an interesting line of thinking about what has happened in the Bay. Ecological theory in general has much to offer to both environmental education and management, which can enrich our understanding of the changes occurring in the environment. From a parochial point of view, it is somewhat discouraging to think that in the Chesapeake Bay we might become stuck on simplistic notions of ecosystem "health" and "report cards" of the Bay, while in Lake Erie they are applying exciting theory. With all of the knowledge that exists about the Bay, it would be a shame to think that there is more theory applied per cubic meter to Lake Erie as compared with the Chesapeake Bay!

An Ecology of Mute Swans

The theory of alternative stable states provides an alternative way of thinking about the role of mute swans in the Chesapeake Bay. Mute swans are an issue of great concern, not just because they are exotic, but also because they eat large amounts of SAV, which has been called a "barometer" of the Bay's health (Orth and Moore, 1988). Mute swan grazing pressure can even cause "eat-outs" of small scale patches of SAV (Perry, 1987). A general description of the interaction of grazing in Chesapeake Bay habitats is given in fig. 2.

Effects of problem species such as Canada geese (*Branta canadensis*) and nutria (*Myocastor coypus*) are shown in the marsh portions of the graph. Mute swan activity applies to the extreme left-hand side of the graph in subtidal areas. The representation shows that increasing grazing pressure, associated with increasing numbers of mute swans, causes the subtidal habitat to shift from SAV-dominated to bare bottom. While this situation is of great concern to environmentalists who are using SAV as a barometer of Bay health, mute swan grazing can be thought of as a natural result of the alternative stable state theory given earlier. That theory suggests that the present

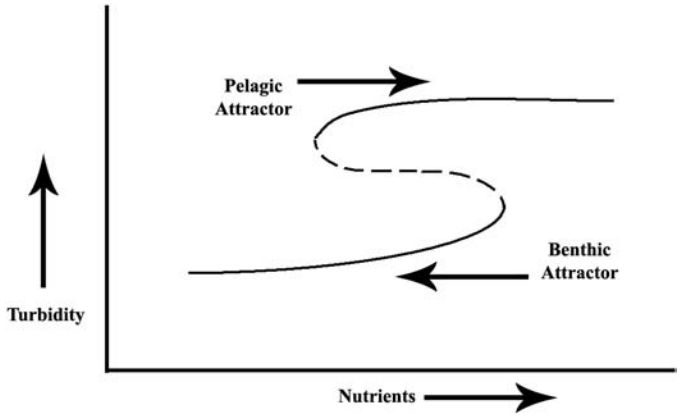

Figure 1. The two-phase attractor used to describe Lake Erie ecology. Redrawn from Kay and Regier (1999).

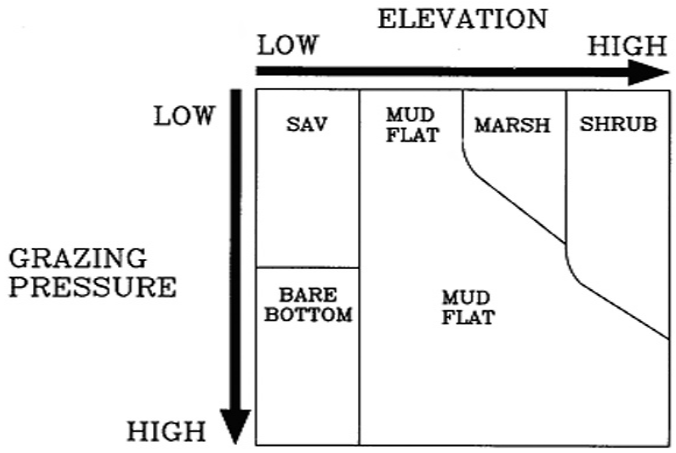

Figure 2. Hypothetical causal basis for the distribution of tidal habitats in the Chesapeake Bay.

Bay is a pelagic attractor where SAV are nonadaptive. Mute swans are removing SAV through their grazing; therefore, they are helping to keep the Bay in the pelagic attractor. From this ecosystem perspective, mute swans make perfect sense for the Bay, and they represent a natural response of the Bay to maintain itself in the pelagic attractor.

The argument given above is a view of the ecological role of mute swans in the Chesapeake Bay. It is an alternative to the conventional view of the mute swan as a dysfunctional, rogue species that needs to be controlled. Of course, it would be interesting to learn of other ecosystem perspectives on mute swans. The potential seems to exist because several ecosystem-scale models of SAV have been developed (Kemp and others, 1995; Madden and Kemp, 1996; Wetzel and Neckles, 1986). However, these models lack mute swans. They focus on nutrient levels and photosynthesis and do not include grazing by waterfowl. This missing link brings to mind the unfortunate story (Lugo, 1995) of a now-well-respected marine ecologist who, as a student, panicked just before a class presentation when he noticed that he had left turtles out of his turtle grass (*Thalassia* sp.) model! In general, there seems to be little discussion from ecosystem ecologists about the role of exotic species, but this paper suggests that opportunities exist for alternative views to the convention of thinking of them as biological pollution.

Conclusions

To some extent, much of this paper is really irrelevant to the question of what we should do about mute swans in the Chesapeake Bay. The ecosystem perspective is a luxury of academics, and what really matters is the human perspective. The Chesapeake Bay is managed by humans for humans. This means that reality is better described as political ecology than by the ecosystem perspective outlined in this paper. Thus, if humans want a pre-Columbian Bay, then managers will try to restore it to that reference condition. This consensus doesn't mean that the pre-Columbian Bay was any better, or that it was ecologically healthier, than the present Bay, it just means that the pre-Columbian Bay has more value to humans than the present Bay. In other words, the pre-Columbian Bay is more politically correct than the present Bay ecosystem. By the same reasoning, it doesn't matter whether or not mute swans are well adapted to the present Bay. If humans don't want mute swans, then managers will try to control them.

This kind of political ecology substitutes for a well-articulated worldview of ecosystems where humans are considered to be part of the system. This kind of ecological, rather than political, world view is lacking, but it can be imagined. The current question of what to do about mute swans points in this direction. We now know that to understand the ecology of mute swans, we must include animal rights groups as part of the system! The recent legal decision in favor of animal rights has determined that mute swans will not be controlled, at least in the short run (Dewar, 2002)! This is ironic, because mute swans are one of the few exotic species that actually could be controlled with a reasonable amount of funding. Many, if not most, exotics cannot be controlled after they invade, because the costs of eradication are just too high. This is probably true of plant species such as common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and tree-of-heaven (*Ailanthus altissima*) and animal species such as the zebra mussels (*Dreissena polymorpha*). However, the animal-rights groups have created a feedback into the Bay that protects the mute swans!

Thus, to really understand the Chesapeake Bay, we must extend the boundaries of our models. Humans are directly a part of the Bay, and the system is even more complex than we thought. In the sense of the theory described earlier, the animal rights groups who defend mute swans are part of the pelagic attractor, whereas, the environmentalists with their report cards and ecosystem health metaphors are part of the benthic attractor. An aggregated diagram of the two attractors is shown using the energy circuit language in fig. 3. The pelagic attractor is shown above (including phytoplankton, mute swans and the animal rights group) whereas the benthic attractor is shown below including SAV and DNR. In the diagram, mute swans directly or indirectly cause interactions between the two attractors, and, thus, they are a keystone species for understanding the extended Chesapeake Bay system.

All of this presents new challenges for environmental education and management, which require our best thinking about the roles of exotic species, such as the mute swan, in ecosystems.

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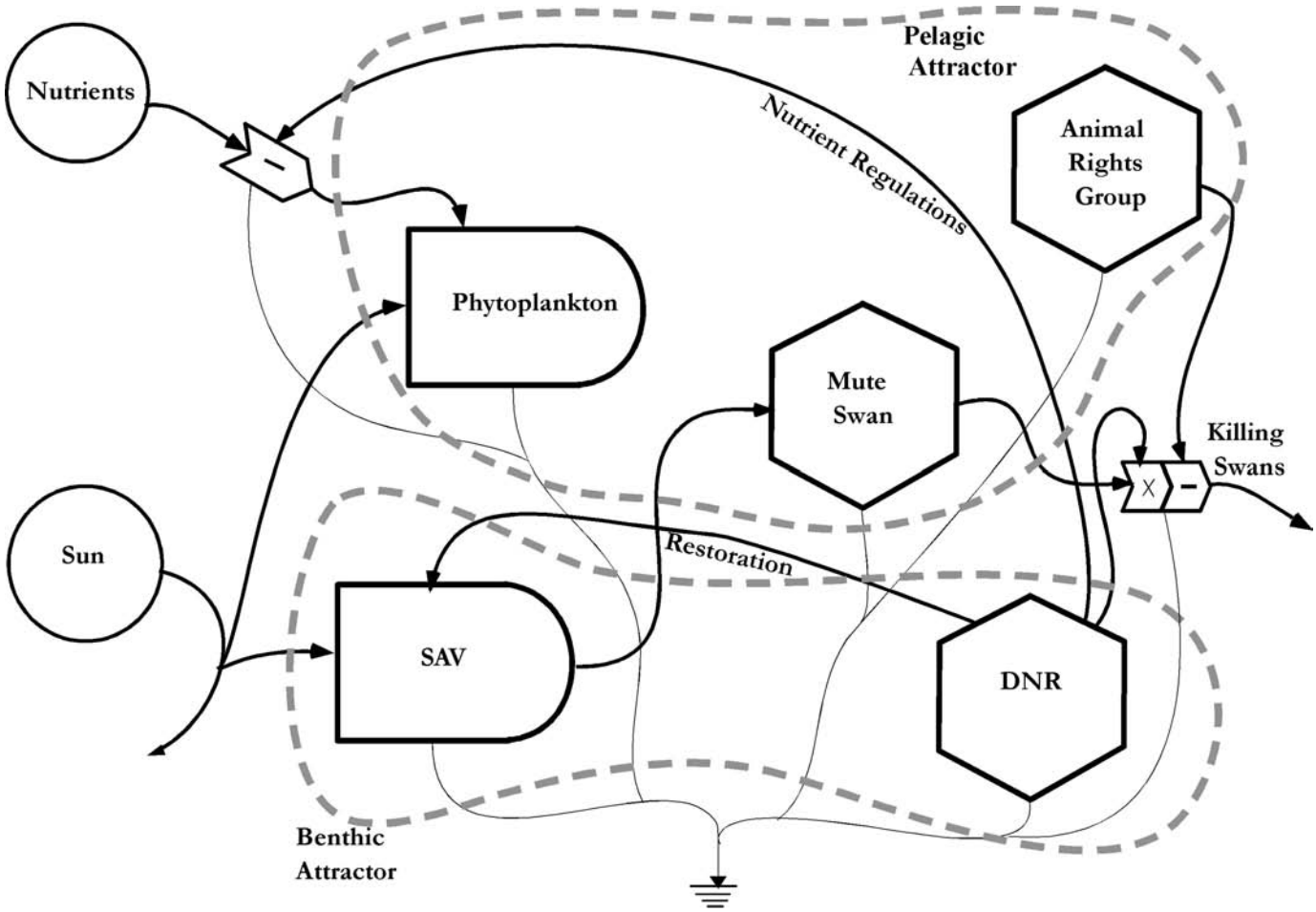

Figure 3. An aggregated view of the dominant components and interactions in the two-phase attractor model for Chesapeake Bay.

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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 B.S. in biology, from Kent State University his M.S. in Botany and Geography, from the University of Oklahoma and his Ph.D. in environmental engineering sciences from the University of Florida. Dr. 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 associate professor in the biological resources engineering department.

Status and Management of Mute Swans in Maryland

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Abstract: Since the escape of five mute swans from captivity in 1962, the feral mute swan population in the Maryland portion of Chesapeake Bay has increased to about 4,000 birds by 1999. The swan population increased at an annual rate of about 23 percent between 1986-92 and 10 percent between 1993-99. If these growth rates continue, the population may reach 11,300 (at 10 percent) to 38,500 (at 23 percent) by 2010. Mute swan pairs have become a nuisance, preventing some people from using their riparian waters where swans vigorously defend their nests and young during the breeding season. Since 1986, conflicts with native wildlife have increased, including the displacement of colonial waterbirds from nesting areas. Furthermore, mute swan grazing on submerged aquatic vegetation (SAV) has reduced the carrying capacity of wetlands for native waterfowl and other fish and wildlife. Although the impacts upon SAV are not well quantified, maintaining a large mute swan population is inconsistent with the 2000 Chesapeake Bay Agreement objective of restoring 114,000 acres of SAV. This overabundant, invasive swan population poses a challenge to Maryland resource managers. Population modeling suggests that it would be necessary to reduce recruitment by 80 percent merely to stabilize the mute swan population. A combination of reducing recruitment and adult annual survival is the most effective means of reducing the population to a level that minimizes the impacts of mute swans upon Chesapeake Bay resources and people.

Population Trend and Distribution

Mute swans are not native to Maryland or North America (Bellrose, 1980). The first recorded observations of mute swans in the tidewater areas of Maryland occurred when three birds were observed near Ocean City in February 1954 and then again when three swans were seen near Gibson Island, Anne Arundel County, in January 1955 (Stewart and Robbins, 1958). These were likely transient birds that were forced south by severe winter weather.

The mute swan population in Maryland's portion of the Chesapeake Bay has been attributed to the escape of five captive birds along the Miles River in Talbot County during a storm in March 1962 (Reese, 1996). Following this accidental introduction, the mute swan population grew slowly for two decades (Reese, 1975). However, after the mid-1980s, the swan population underwent dramatic growth and range expansion, rising to about 4,000 birds by 1999 (fig. 1).

A number of factors could have led to this increase, including milder winters and reduced mortality from lead poisoning. During the period 1986-92, the mute swan population increased at an annual rate of about 23 percent. Between 1993-99, the growth rate slowed to about 10 percent, probably in response to limited population control by the Maryland Department of Natural Resources (DNR) on state-owned lands and waters and the removal of swans from Federal national wildlife refuges. At these observed growth rates, the swan population could reach 11,300 (at 10 percent) to 38,500 (at 23 percent) by 2010.

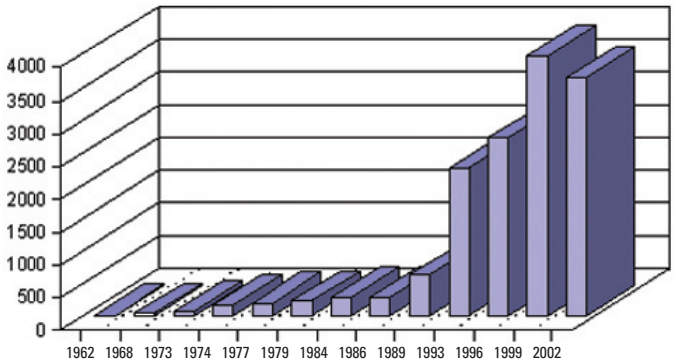

Figure 1. Number of Mute Swans in Maryland 1962-2002.

A Bay-wide survey of mute swans conducted in summer 1999 showed that the largest numbers of mute swans were located in the mid-Bay, from Taylor's Island (Dorchester County) to Rock Hall (Kent County) on the Eastern Shore (fig. 2). Large concentrations also occur in the vicinity of Hoopers and Bloodsworth Islands. However, swan pairs have now established breeding territories in nearly all Maryland tidal tributaries. Although most swans nest along tidal river shorelines at the edge of tidal wetlands, the population has expanded to the point at which swans are now nesting on inland reservoirs, ponds, managed impoundments, canals, and dredge spoil ponds.

Room for Population Growth

Considering the availability of unoccupied swan breeding habitat, the potential for the mute swan population to increase its numbers and expand its range is high. Territory size of mute swans has been reported to vary between less than 1 ha in high quality areas to about 6 ha on large bodies of water and open rivers (Ciaranca and others, 1997). The upper Chesapeake Bay includes about 101,762 ha of coastal estuarine wetlands (Tiner and Burke, 1995). Even assuming that territories are at the upper limit of this range (6 ha), these wetlands may provide nesting territories for about 16,960 pairs of mute swans.

Maryland's coastal zone includes 2,706 km of shoreline along the Chesapeake Bay and coastal bays (State of Maryland, 2000). During a 2001 survey of mute swans along the Talbot County shoreline, DNR observers recorded 119 nesting mute swan pairs, about 0.43 nesting pairs per km of shoreline. Assuming this density, coastal shorelines of all 16 tidewater counties may provide nesting territory for an additional 1,174 pairs of mute swans. Thus, considering the availability of unoccupied coastal wetlands and shoreline, there is the potential in the State to provide nesting territories for about 18,134 nesting mute swan pairs. Including nonbreeders, this could represent a population of about 100,000 mute swans. Furthermore, this estimate does not account for mute swans that occupy inland freshwater wetlands, ponds, impoundments, or reservoirs. Therefore, unless there are widespread disease outbreaks or serious degradation of the quality of remaining wetlands, the size of the mute swan population will likely increase dramatically, and impacts to native species will increase, unless growth is limited by population control.

Legal Status

Prior to a recent court ruling (http://www.II.georgetown.edu/Fed-Ct/Circuit/dc/opinions/00-5432a.html), mute swans were not regulated by the U.S. Fish and Wildlife Service (USFWS). Primary management

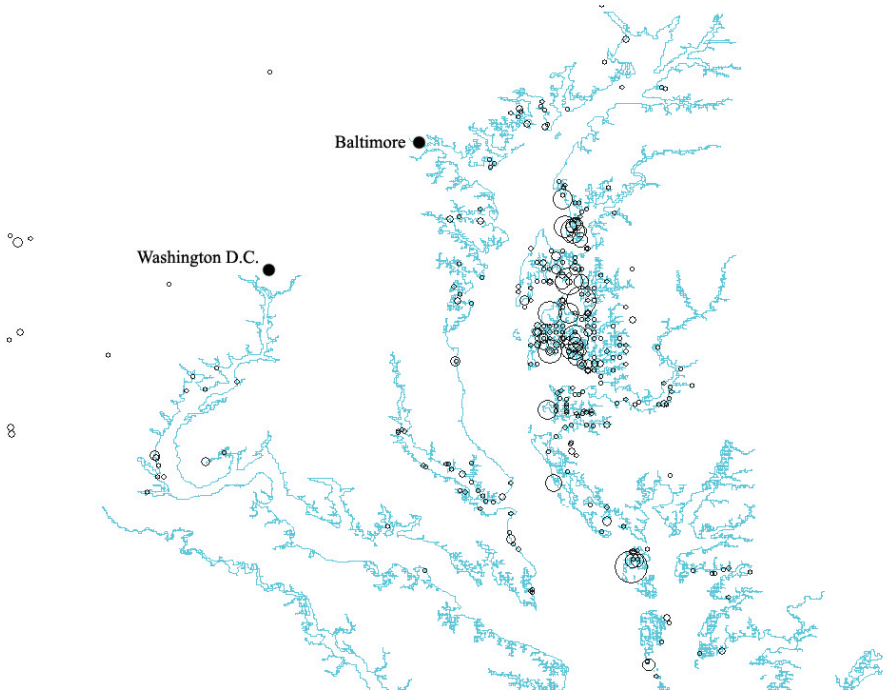

Figure 2. The distribution and abundance of Mute Swans in the Chesapeake Bay (largest circle = 400 birds), 1999.

authority was held by individual States. The USFWS based its exclusion of the mute swan from the Migratory Bird Treaty Act (MBTA) on its argument that the mute swan was exotic to the United States and was nonmigratory. However, on December 28, 2001, the U.S. District Court of Appeals for the District of Columbia, ruling in the case of Hill vs. Norton, found that this was not legally supportable and that the mute swan should not be excluded from the List of Migratory Birds (Title 50 Code of Federal Regulations Part 10.13).

In Maryland, mute swans are included in the statutory definition of Wetland Game Birds (Natural Resources [NR] Article, Section 10-101). This law does not list the specific names of native species of waterfowl that winter in Maryland but only identifies ducks, mergansers, brant, geese, and swans as wetland game birds. The state law was promulgated prior to the accidental introduction of mute swans in Maryland. The law gives DNR the authority to allow the taking of wetland game birds during an open hunting season, although no swan season has been opened in the state since 1918. Further, it gives the DNR the authority to regulate the possession, sale, trade, exportation, and importation of mute swans in Maryland (NR Article Section 10-903).

With the inclusion of the mute swan in the MBTA and Federal List of Migratory Birds, a Federal permit is now required for all activities directly involving the mute swan, their eggs, and their young. These activities include take, possession, transportation, sale, purchase, barter, importation, exportation, banding, and marking mute swans. The MBTA does not necessarily afford strict protection or preservation of any species. Rather, appropriate management of migratory bird populations is provided for in the MBTA. Thus, mute swan management activities that are conducted in Maryland can be implemented, but are now subject to Federal permit requirements. Currently, there is no open hunting season for mute swans in the U.S. Thus, a hunting season for mute swans in Maryland is not a management option until the USFWS completes an Environmental Impact Statement and proposes regulations that offer State wildlife agencies mute swan hunting season frameworks.

Public Policies Pertaining to Mute Swans

Several Federal, regional, and State public policies address the concerns associated with invasive species and are specifically directed at the management of mute swans. The Chesapeake 2000 Agreement is a cooperative agreement signed by the Governors of Maryland, Pennsylvania, and Virginia, the Mayor of the District of Columbia, the Chesapeake Bay Commission, and the Environmental Protection Agency representing the Federal government. The Agreement requires the jurisdictions to develop and implement management plans for nonnative, invasive species deemed problematic to the restoration and integrity of the Bay ecosystem. The mute swan was identified as one of the priority species requiring regional management.

In 2001, the Maryland General Assembly directed the DNR to establish a program to control the population of mute swans and to include the managed harvest of adult mute swans in this program (NR Article, Section 10-211). In response to shift primary legal responsibility for mute swans, the State legislature urged the USFWS to act with expediency to develop regulatory processes which will allow Maryland to establish a method of controlling the mute swan population and to mitigate the mute swan population's impact permanently (Maryland General Assembly, 2001).

Impacts to Public Safety and Use of Private Property

Despite their aesthetic appeal, mute swans can be a problem for people. Some birds may threaten or directly attack humans who get too close to their nest or young. The Environmental Protection Agency has listed mute swans as a pest species of significant public health importance because of their ability to cause injury to people (EPA, 2000). The aggressive behavior exhibited by these large birds poses a safety risk, especially to small children, swimmers, or people in small watercraft. Although the potential for injury is low, many people who experience this display of aggressive behavior are frightened by mute swans. This behavior prevents some shoreline landowners from using their shoreline property and adjacent waters during the nesting and brood-rearing seasons.

Grazing Impacts upon SAV

Unlike the native tundra swans (*Cygnus columbianus*) that only spend winter months in the Bay, the nonnative mute swans inhabit the Bay year-round. Mute swans utilize large amounts of emergent vegetation (for example, *Juncus roemerianus*, *Phragmites communis*, *Spartina alterniflora*, *Typha latifolia*) in Maryland for nest building. They also feed exclusively in shallow wetlands, where they consume large amounts of SAV (Berglund and others, 1963; Owen and Kear, 1972; Birkhead and Perrins, 1986). In Maryland, mute swans feed almost exclusively on widgeon grass (*Ruppia maritima*) and eelgrass (*Zostera marina*) in higher salinities (Perry and others, 2004). A small proportion of invertebrates (including bryozoans, shrimp, and amphipods), algae, and emergent and terrestrial plants are consumed as well (Fenwick 1983; Perry and others, 2004).

While foraging, adult mute swans consume about 4-8 pounds of SAV each day (Willey and Halla, 1972). Because adult mute swans tend to paddle and rake the substrate to dislodge SAV and invertebrates for themselves and their cygnets, additional SAV which is not eaten is destroyed and uprooted (Owen and Kear, 1972; Birkhead and Perrins, 1986). At high densities, mute swans can overgraze an area, causing a substantial decline in SAV at the local level (Cobb and Harlan, 1980; Mountford, 2004). This consumption of SAV is

the primary complaint received from Maryland citizens about mute swans.

The grazing upon SAV by concentrations of mute swans has also raised serious concerns among resource managers (Naylor, 2004). SAV is critical to the health and well being of a myriad of Bay organisms. Not only does SAV protect water quality and prevent erosion, it also provides food and shelter for fish, shellfish, invertebrates, and waterfowl (Hurley, 1991). For example, research has shown that the density of juvenile blue crabs is 30 times greater in SAV beds than in unvegetated areas of the Bay (Naylor, 2004).

The dramatic Bay-wide decline of all SAV species in the late 1960s and 1970s was correlated with increasing nutrient and sediment inputs from development of the surrounding watershed (Kemp and others, 1983; Hurley, 1991). Only about 10% of the historic levels of SAV (or about 69,126 acres) remain in the Bay (Orth and others, 2001). Grazing upon SAV by large numbers of mute swans places additional pressure on this already stressed yet vital resource. The removal of large quantities of SAV and the physical impact of the grazing upon SAV by mute swans reduce the capacity of the remaining SAV beds in the Bay to support wintering waterfowl and other fish and wildlife populations.

Although data on the reduction of SAV by mute swans is limited, there is sufficient information to conclude that these birds are having a deleterious impact on SAV in the Bay. The efforts of Citizen tributary organizations in the form of new SAV and emergent transplantings have been damaged by mute swans, thwarting efforts to improve water quality (J. Flood, South River Federation, oral. commun.). Mute swans forage on SAV shoots before they can mature. This grazing during the spring and summer growing season has been shown to reduce plant survival and reproduction, reducing SAV abundance in subsequent years (Sondergaard and others, 1996; Bortolus and others, 1998; Allin and Husband, 2003). Over time, areas with high densities of mute swans exhibit a decrease in plant diversity and abundance, sometimes becoming devoid of SAV (Naylor, 2003).

The presence of a large mute swan population in the Bay is in conflict with public policies aimed at restoring the Chesapeake Bay. A simple mathematical extrapolation of SAV consumption by mute swans suggests that 4,000 mute swans may consume up to 12 million pounds of SAV annually, equal to about 12 percent of the SAV biomass in the Bay (Perry and others, 2004). This level of impact is greatest on the mid-Eastern Shore, where high numbers of mute swans concentrate and acreage of SAV is small. This level of grazing, especially during spring and fall SAV growth and reproductive periods and in SAV restoration plantings, is an impediment to achieving the objectives of the Chesapeake 2000 Agreement, specifically the restoration of 114,000 acres of SAV by 2010.

Impacts to Property

Few instances of property damage by mute swans have been reported. However, citizen complaints have reported the fouling of beaches and pond berms by mute swan droppings and feathers. Mute swans have damaged SAV and emergent vegetative plantings that were made by the private sector and government to restore wetlands. The cost of replanting one 0.06-ha restoration site that was damaged by mute swans in the South River, Maryland, exceeded $4,000 (J. Flood, South river Federation, oral. commun.). Today, physical barriers protect nearly all transplant sites (M. Naylor, Maryland DNR, oral. commun.).

Direct Impacts to Native Wildlife

Observations in Maryland and findings reported in scientific literature support the fact that territorial mute swans can be very aggressive towards other waterfowl, displacing native species from their breeding and foraging habitats (Willey, 1968; Stone and Masters, 1970; Kania and Smith, 1986; Ciaranca, 1990). Mute swans occupy and defend relatively large territories of wetland habitat during nesting, brood rearing, and foraging. Not only do they displace native waterfowl from breeding and staging habitats, they have been reported to attack, injure, or kill other wetland birds (Willey, 1968; Stone and Masters, 1970; Kania and Smith, 1986; Ciaranca, 1990). In Maryland, mute swans have been observed killing mallard ducklings (*Anas platyrhynchos*), Canada goose goslings (*Branta canadensis*), and other mute swan cygnets.

The most serious instance of conflict between native wildlife and mute swans occurred in the early 1990s when a large flock of mute swans (600-1,000 swans) caused the abandonment of nesting sites for State-threatened colonial nesting birds at Tar Bay in Dorchester County. These colonial nesting birds nested on oyster shell bars and beaches that were used by swans as loafing sites. Tar Bay was the only area in the Maryland portion of the Bay where black skimmers (*Rynchops niger*) and least terns (*Sterna antillarum*) nested on natural sites (Therres and Brinker, 2004).

Maryland has the largest population of mute swans in the Atlantic Flyway (Atlantic Flyway Council, 2000). There is growing concern among wildlife managers that the increase in mute swans may be playing a role in the failure of tundra swans to increase, as they have done in other areas of the Atlantic Flyway. Mute swan pairs have been observed exhibiting aggression toward wintering tundra swans in Maryland, driving them from foraging areas and protected coves that are used for winter shelter. Food habit studies show that tundra swans and mute swans do compete for limited SAV food resources, but tundra swans feed on invertebrates and agricultural foods to a greater extent (Perry and others, 2004). The extent to which aggressive behavior and competition from mute swans is related to the inability of the State's wintering tundra swan population to increase is unknown.

The large mute swan population in Maryland consumes SAV that might otherwise be available to native waterfowl. This competition for space and food that is imposed by mute swans reduces the carrying capacity of breeding, staging, and wintering habitats for native species of migratory

waterfowl in Chesapeake Bay, where mute swans are established. Populations of several waterfowl species (for example, redhead [*Aythya americana*], canvasback [*Aythya valisineria*], American wigeon [*Anas americana*], and black duck [*Anas rubripes*], that are dependent upon SAV have declined in the Bay (Serie and Raftovich, 2002). However, except for black ducks and wigeon, the continental populations of these species are healthy and remain at or near North American Waterfowl Management Plan objectives. The Chesapeake Bay population declines are attributed to the reduced abundance of SAV (Haramis, 1991a; Haramis, 1991b; Krementz, 1991).

Population Management and Resource Protection

Since the early 1970s, the DNR has monitored changes in mute swan population size and distribution with periodic aerial surveys (Hindman, 1980; Allin, and others, 1987). During the early and mid-1990s, the DNR and USFWS national wildlife refuges in Maryland used egg addling and the removal of adult swans to prevent the establishment of mute swans on State and Federal properties. In the mid-1990s, these agencies reduced a flock of about 800 mute swans in the vicinity of Tar Bay, Dorchester County, where mute swans were found to be trampling the nests of State-threatened water bird species on a coastal island. As part of this reduction, 250 swans were captured and exported to Asia by a New Mexico game breeder. Others were removed by shooting.

Limited mute swan control by landowners has also been authorized by the DNR (for example, issuance of permits) to resolve nuisance, safety, and depredation problems. This has included egg addling, nest destruction, and removal of adults by shooting. These methods satisfactorily resolved problems of property owners caused by mute swans at these sites. However, since 1998, permit conditions have only allowed egg addling and nest destruction. No lethal removal of swans has been authorized by the DNR, pending development of a statewide mute swan management plan. Permits limiting landowner action to egg addling have been ineffective in resolving nuisance, public safety, and depredation problems caused by swans. Furthermore, permits for capturing and relocating mute swans to other areas of the state are not issued. Relocation is considered a method that may accelerate both distribution and population growth of this deleterious species in Maryland.

Management Plan Development

In 1999, a Mute Swan Task Force (MSTF) was appointed by the secretary of DNR to develop recommendations for addressing basic mute swan issues including known and potential impacts on native habitats and species, conflicts with people, and the bird's legal status in Maryland. To assist the MSTF in evaluating the effects of different management strategies, the DNR developed a mathematical model of the Maryland mute swan population using the most current demographic information (Harvey, 2000). The model was used as a tool to compare the relative effects of different management strategies on population growth rate.

Most wildlife population management falls into two main categories: (1) affecting reproductive output or recruitment and (2) affecting the survival rate of adult birds. Addling swan eggs reduces the proportion of nests that successfully produce cygnets (for example, hatching success). The model was run at different levels of hatching success to simulate various levels of egg-addling effort. The simulations indicated that it is necessary to reduce hatching success by 80 percent just to stabilize the population.

In contrast, when annual adult survival rates in the model were reduced, it took just a 20% reduction to result in a population that will slowly decline over time. While egg removal/destruction can reduce the production of cygnets, merely destroying eggs does not reduce a population as quickly as removing immature or breeding adult swans. The comparisons showed that the mute swan population is much more sensitive to changes in adult survival than to changes in hatching success. These findings are very similar to other modeling exercises for long-lived waterfowl species (Schmutz and others, 1997; Gauthier and Brault, 1998).

The MSTF recommended that the DNR maintain some population of mute swans in the Chesapeake Bay while also maintaining specific "Swan-free Zones" to help control local impacts on Bay grasses and other native fish and wildlife habitats. Further, the MSTF recommended that the DNR develop a program to increase public understanding of the impact of mute swans on our aquatic ecosystems and to educate the public on how to avoid human/mute swan conflicts. The DNR Waterfowl Advisory Committee (WAC) endorsed the MSTF recommendations, but further advised the DNR to reduce the mute swan population to less than 500 birds over the next five years and remove legal protection for the species by removing mute swans from the Wetland Game Birds definition and designate it as an "unprotected bird."

Utilizing the MSTF and WAC recommendations, and public input, in 2002, the DNR released a draft statewide management plan for public comment. In the interim, the DNR has launched an extensive effort to limit mute swan reproduction and to slow population growth. In 2001, DNR personnel and volunteers treated eggs in more than 200 mute swan nests on public and private lands where property-owner permission had been obtained. Treatment consisted of coating swan eggs with corn oil to terminate embryo development (L. Hindman, Maryland DNR, unpubl.data).

Conclusions and Management Recommendations

The mute swan is an invasive, nonnative species that inhabits Chesapeake Bay in large numbers. Such a large mute swan population threatens the protection and restoration of SAV beds of critical importance to the Bay's living resources.

Furthermore, the foraging of mute swans reduces the likelihood of achieving the Chesapeake 2000 Agreement objective of protecting and restoring 114,000 acres of SAV. Mute swans reduce the carrying capacity of habitat for native species and can cause conflicts with people.

The large mute swan population in the Bay is causing adverse ecological effects, and these impacts will increase if the population continues to grow. The DNR believes that the mute swan population must be managed at a level that will protect critically important SAV beds, will allow for the restoration of SAV, and will minimize swan impacts on native wildlife and habitats. Accomplishing this goal will require reducing the size of the mute swan population. The population level at which key natural resources will be adequately protected is unknown. However, when the State's mute swan population was less than 500 birds, adverse ecological impacts and conflicts between people and mute swans were negligible. The management of mute swans in the Bay compliments other efforts to protect and restore these habitats and should be viewed as part of a more comprehensive Bay restoration effort.

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Mute Swan Population in the Virginia Portion of Chesapeake Bay

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Abstract: Mute swans were reported in Virginia in the 1950s and 1960s. Most of these swans were in private collections and a feral breeding population of mute swans was probably not present until the late 1960s or early 1970s. A survey conducted in the summer of 1986 counted 60 mute swans in Virginia. Mute swan numbers have increased substantially over the past 10-15 years and the most recent survey, conducted in 1999, indicated that there were over 500 mute swans in Virginia. Because of their detrimental effects, mute swans should be removed or their numbers reduced wherever conflicts with wildlife, native habitats, or human populations occur in Virginia. The statewide population objective, as identified in the Atlantic Flyway mute swan management plan, is 100 or less mute swans in Virginia. Public desires to view swans can be met by observing captive mute swans or the larger number of native tundra swans that spend the fall an winter in Virginia.

Introduction and Population Status

The mute swan (*Cygnus olor*) is indigenous to Europe and Asia, but has been introduced into various parts of North America in the past century. Mute swans were first reported in Virginia in the 1950s and 1960s. Most were in private waterfowl collections, although some were released into the wild. A feral breeding population of mute swans in Virginia was probably not present until the late 1960s or early 1970s, and mute swan numbers remained low until the 1980s. The first population survey of mute swans in Virginia was conducted in 1986 as part of a cooperative project with the other Atlantic flyway states. Sixty mute swans were counted in Virginia, and most were still associated with private collections.

Mute swan numbers have increased substantially in Virginia (813 percent) during the past 10-15 years. The most recent survey, conducted in 1999, indicated that there were over 500 mute swans in the State (Table 1).

Table 1. Number of mute swans (plus private [p] swans) counted on periodic surveys conducted in Virginia, 1986-99.

	YEAR					
	1986	1989	1993	1996	1999	% Change 86-99
Number of mute swans	60	145(+94p)	231(+88p)	419	504	813

This increase has come from a number of sources, including escapees from private collections, progeny of these and other feral breeding swans, recent release by private landowners (collectors, homeowners, golf courses, etc.), and movement of birds into the state from other areas, most notably from further north in the Chesapeake Bay. The number of mute swans in the Chesapeake Bay States (Maryland and Virginia) has increased at a greater rate than in the rest of the flyway (Atlantic Flyway Mute Swan Management Plan 2003).

Distribution

The greatest numbers of swans are located in northern Virginia and in the Tidewater area, where most of the releases have occurred. Fewer swans are located in the central and western parts of the State. However, the mute swan range is expanding, and their numbers are increasing throughout the State. Most of the swans are located on inland waters and on private ponds where they have been released. These birds often move into public parks, ponds, and reservoirs to set up breeding territories. At the present time, there are relatively few birds located on the larger tidal marshes or tidal river systems. One exception, however, is a fast growing segment of the population that is located on the islands and marshes in the Chesapeake Bay near the Maryland border. Groups of 30-50 nonbreeding mute swans have been counted in the past few years, and the number of nesting swans has increased substantially in this area.

Mute swans in Virginia are generally nonmigratory, although some birds have been found to make short-range movements to seek new habitats or to disperse from breeding locations.

Management

The impacts that mute swans have on native wildlife (Maryland Report 2001), aquatic vegetation (Chasko, 1986; Ryley and Bowler, 1994), human populations have led to concerns about their numbers and distribution in the State. The presence of mute swans in Virginia is in conflict with public policies aimed at restoring the Chesapeake Bay and other wetland habitats throughout the state. Prior to December 2001, the U.S. Fish and Wildlife Service (USFWS) considered the mute swan an exotic species, and State wildlife agencies were the primary management authority for mute swan populations. In Virginia, mute swans were included in the list of nuisance species. Under this designation, mute swans and their nests and eggs could be destroyed at any time. A limited amount of control, including egg addling and removal of adult birds, had been conducted on national wildlife refuges, State wildlife management areas, military installations, and private lands. Hunters also took some mute swans during the migratory waterfowl seasons in the fall and winter.

However, in a decision rendered in December 2001, the U.S. Court of Appeals for the District of Columbia ruled that mute swans should be afforded protection under the Migratory Bird Treaty Act. The USFWS notified State wildlife agencies that they would not challenge this ruling and that mute swans will now be afforded the same protection as native migratory bird species. Because of this ruling, the Virginia Department of Game and Inland Fisheries recently (August 2002) changed the State regulations to remove mute swans from the nuisance species list. States and private landowners will now be required to obtain a Federal permit to control mute swan populations. The Virginia Department of Game and Inland Fisheries will likely apply for such a permit. However, it is unlikely that many private landowners will put forth the effort to obtain a federal permit, and this form of mute swan control will likely be reduced.

Future Considerations

Mute swans provide aesthetic benefits to some of the citizens of Virginia, but also have adverse impacts on native wildlife species and habitats. These detrimental impacts include destruction of emergent wetland vegetation and submerged aquatic habitats, competition with or displacement of other waterfowl and native breeding bird species, and potential human health and safety issues. These impacts will become more severe if the mute swan population continues to grow. We have seen this with other species, and we are currently trying to manage similar problems with nonmigratory (resident) Canada geese and urban mallard populations.

The population objective for Virginia, as identified in the Atlantic Flyway Mute Swan Management Plan (2003) is to reduce the number of mute swans in the state to 100 or less. Efforts should be made to prevent mute swans from expanding their range in the State. In addition, mute swans should be removed or their numbers reduced where conflicts with wildlife populations, native habitats, or human populations may occur in Virginia. Control activities will include egg addling and removal of adult birds. Other techniques may be used (Sladen and Rininger, 2004) if proven effective in controlling mute swans. Public desires to observe swans can be met by observing captive mute swans or the larger number of native tundra swans that spend the fall and winter in Virginia. Information and outreach programs must be enhanced to educate the public about mute swans and their impacts on the environment. Virginia will work with other States and organizations to monitor, evaluate, and control mute swan populations where necessary.

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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 the Patuxent Wildlife Research Center, Laurel, Maryland, and the Northern Prairie Wildlife Research Center, Jamestown, North Dakota, as well as work for other state agencies and in private industry. Gary received his M.S. in wildlife biology from Clemson University and a Ph.D. in wildlife biology from Cornell University. His master's work focused on the habitat use of wood ducks, and his doctoral research addressed the wintering ecology of black ducks along the East Coast.

An Evaluation of 22 Years of Mute Swan Management in Rhode Island

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Abstract: An evaluation of efforts to manage Rhode Island's mute swan (*Cygnus olor*) population is discussed, including a previous prediction of growth rates in the Atlantic flyway. Rhode Island Department of Environmental Management's Division of Fish and Wildlife has maintained a mute swan egg-addling project between 1979 and 2000 that destroyed 9,474 eggs from 1,636 nests. The Rhode Island mute swan population continues to grow at about 5.6%, well below that of the 9.1% in the Atlantic flyway. Although the Rhode Island program has been successful in reducing the growth within the state, we suggest that a flyway-wide effort must be implemented to control this invasive species.

Introduction

Mute swans (*Cygnus olor*) are indigenous to Europe and parts of Asia. Initially introduced into North America as a decorative waterfowl for parks, zoos, and private estates during the 1880s, this species escaped captivity and became established in the Atlantic flyway (AF) by the mid-1900s (Allin and others, 1987). The earliest record of nesting by wild mute swans in Rhode Island was in 1948 on Briggs Marsh, Little Compton (Allin and others, 1987). A population dynamic study on mute swans was conducted in the State during the 1960s, resulting in a recommendation to manage this invasive species population at 300 birds (Willey, 1968).

A management program was not initiated for another six years, at which time biologists in the Rhode Island Department of Environmental Management's Division of Fish and Wildlife (DFW) began a mute swan roundup and euthanasia program. After two seasons, the project was ordered to stop because of the negative response from the public after the publication of a story in local newspapers. In 1978 and 1979, the DFW implemented a program of capturing and pinioning birds for adoption by local residents. After reports of birds escaping back into the wild, as well as an inability to find enough residents with adequate facilities to adopt the birds, the program was ended by the DFW in 1980.

Although the humane treatment of animals must be a primary concern when establishing wildlife management programs, effectiveness is also a key issue. DFW biologists decided to attempt management of Rhode Island's mute swan population through an egg-addling program (EAP) beginning in 1979. Egg addling is an acceptable, humane means of managing bird populations. Public relations that were associated with the program included personal contact with residents who lived adjacent to swan nesting sites, television news stories, and newspaper articles initiated by the DFW. Many people accepted the program once they were educated to the reasons and methods of controlling this invasive species. A vocal portion of the public, however, remains opposed to management efforts. We review and evaluate 22 years of mute swan management efforts in Rhode Island.

Methods

Mute swan counts are included in the annual January Mid-Winter Waterfowl Survey (MWS) that is coordinated by the U.S. Fish and Wildlife Service (USFWS). In addition, Mid-Summer Mute Swan Surveys (MSMSS), coordinated by the Snow Goose, Brant, and Swan Committee, Atlantic Flyway Technical Section (AFTS), have been conducted every third year since 1986. The latter survey was established to provide more accurate population counts of the birds during their summer molt, when no migratory swans are present. We reviewed both surveys to estimate the mute swan population growth rate for Rhode Island and the Atlantic Flyway.

During the 1970s, DFW biologists addled 50 percent of eggs in nests found while doing unrelated fieldwork. A management policy established in 1979 prescribed that all mute swan eggs found would be addled. Although mute swans are repetitive users of nesting mounds (Ciaranca and others, 1997), they do occasionally move their nest within a wetland or to an adjacent wetland site; thus, maintaining accurate records of nest locations and activities requires intensive fieldwork.

Since 1985, the DFW has conducted an April helicopter survey to augment the ground search for nests. Data recorded for each nest included date, clutch size, number of cygnets and adults, and the need for rechecking the nest. Personnel reached nests by motorboat, by canoe, or on foot. A direct approach usually caused females to move off the nest but occasionally resulted in an attack by one of the adults. Older pairs tended to be more aggressive in their defense of the nest. Canoe paddles, carried to repel aggressive swans, were held above a bird's head as a threat or used to physically push the bird off the nest.

Some nest locations were noted only after the appearance of swans with cygnets. This information was added to the next year's control list and provided data for the year's nest estimate. Some nests were inaccessible and were not managed.

Egg shaking physically ruptures the yolk, halting embryonic development. In recent years, a small hole was drilled at one end of the egg and a sliver of vegetation or wire was inserted to destroy the embryo. If a nest's egg count appeared low, the eggs were difficult to shake, or if the eggs appeared to be recently laid, a recheck of the nest was scheduled.

We constructed a population model to illustrate the possible growth between 1979 and 2000 of Rhode Island's mute swan population if management efforts not been implemented. For comparability, this model was fashioned after a previous model of mute swan growth in the Atlantic Flyway (Allin and others, 1987). The number of eggs that were shaken was a factor in the model in order to estimate the annual increase of mute swans in the Rhode Island population. The male:female sex ratios for eggs and for fledged swans were assumed to be 1:1 and 1:1.16 (Willey, 1968). We used a 45% survival rate from egg to age one, as in our previous model (Allin and others, 1987). Other studies have reported similar survival rates of 49 percent (Willey, 1968), 48 percent (Reynolds, 1965), 46 percent (Reese, 1975), and 40 percent (Reese, 1980). Although MSMSS counts are considered to be the most accurate, only five counts were done between 1986 and 1999; thus, annual MWS data were used to construct our model. MSMSS and MWS data were compared for years when both were collected.

The MSMSS data suggest a higher survival rate of 56 percent. We entered this higher rate into the model to examine the potential number of swans that would have been added to the population under this scenario. We used a t-test ($P=<0.05$) to compare the differences between the actual mute swan population and the estimated population without control that would have resulted from each of the two survival rates. Also, comparisons were made between our 1987 model's predicted (Allin and others, 1987) mute swan population in the flyway, and the population estimate from the MWS and MSMSS flyway surveys.

Results

Early nest counts (1962-70) ranged from 29 to 75 (fig. 1). No data were collected for 1969, 1971, and 1975 through 1978. Fewer nests were noted from 1972 to 1974 when birds were removed from the population. During the 22 years of the EAP (1979-2000), nest numbers continued to increase. In 1979, of 43 nests observed (likely to be the total for the state), eggs were shaken in 34 nests. By 2000, the eggs from 85 of 118 known nests were addled (fig. 1). During the duration of the EAP, 9,474 eggs from 1,636 nests were addled. Overall, eggs from 79 percent of the estimated 2,076 nests received control measures through the EAP.

Between 1986 and 1999, the MWS and MSMSS surveys showed population increases of 117 percent and 118 percent for the AF, respectively (fig. 2). Midsummer counts in Rhode Island for the period rose from 880 to nearly 1,600 birds (Allin, 2000).

The nesting dynamics of Rhode Island's mute swan population are similar to those of the AF. Previous short-term studies in the flyway noted average clutch sizes of 5.9 (Willey, 1968) and 6.1 (Reese, 1975) eggs. The annual clutch size for the 22 years of the EAP varied from 3.7 (1982) to 6.6 (1988), with an average of 5.7 $\pm$ 0.03 (SE) eggs. An examination of the MSMSS data revealed a similar average brood size for Rhode Island, with 3.2 cygnets in unmanaged nests and 3.3 cygnets in the AF (Allin, 2000). Annual nest counts indicated a substantial growth in nesting activities (fig. 1). Although the number of nests under management has remained relatively constant, the total number of nests has increased resulting in continuous growth of the population.

The model that used a 45 percent survival rate indicated that, during the period 1979-2000, if unmanaged, the mute swan population might have swelled by an additional 571 (fig. 3) to approximately 1,243 birds. However, in 1999 the population that was estimated by the model was considerably higher, 1,969 birds. The lower estimated number in 2000 was possibly the result of swans emigrating outside of the area that was examined by the MWS. If the model's survival rate was based on 56 percent, then there might have been an increase of 711 birds to a total population of 1,383 by 2000. Again, the population was estimated to be 2,105 in 1999. Although there is no apparent significant difference between the populations based on the two survival rates, both models show that either survival rate would have increased Rhode Island's swan population (P= 0.000) and added more substantially to the mute swan population of the Atlantic Flyway.

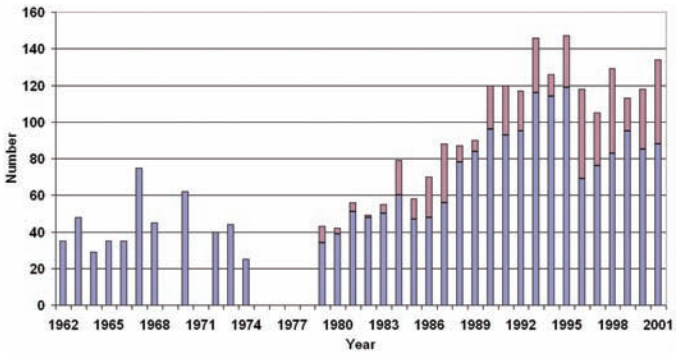

Figure 1. Estimated number of mute swan nests in Rhode Island since 1962 and the number of nests that were managed or unmanaged (cross hatch) from 1979 to 2000.

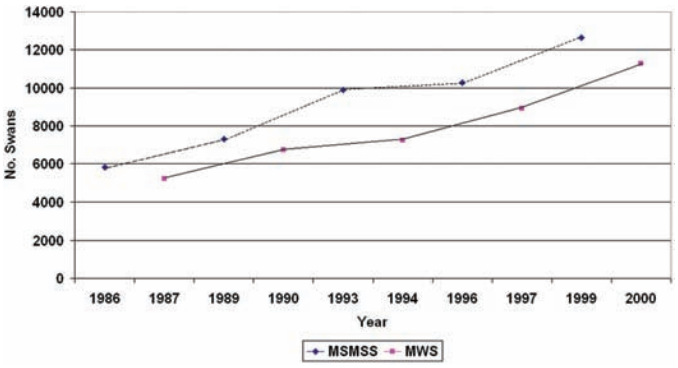

Figure 2. Mid-summer Mute Swan Surveys (MSMSS, August) and the following Mid-Winter Waterfowl Surveys (MWS, January) at 3 year intervals, 1986-87 through 1999-00 (Allin 2000).

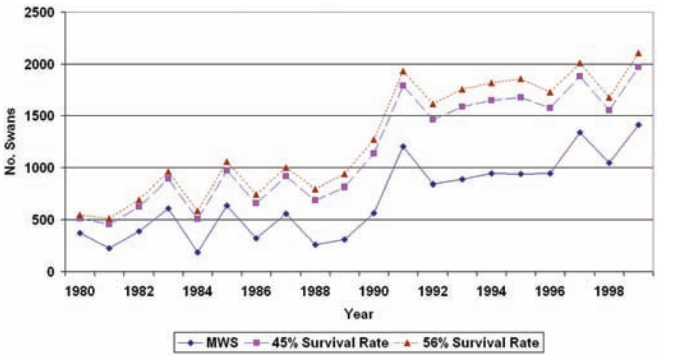

Figure 3. Mute swan population estimates at 45% and 56% survival rates based on the actual MWS counts of mute swans in Rhode Island, 1980-2000.

Discussion

An earlier review (Allin and others, 1987) of the history of mute swans in the AF predicted, based on the then-5.6 percent annual growth rate of the MWS, that the population would double itself by the year 2000. By 1999, the population had actually increased by more than 2.2 times to over 12,650 birds (Allin, 2000). The MSMSS showed an annual growth rate of 5.8 percent. If this level of growth is maintained, the

AF mute swan population may double again in 12 years. By 2025, the population may be nearly 52,000 birds (fig. 4).

Rhode Island's success in managing this invasive species has been limited. Although the DFW has reduced the mute swan's growth rate, a greater effort is needed to stabilize the population. Mute swans have spread throughout our coastal ponds and, in recent years, to inland wetland habitats. Nesting now occurs in residential areas, industrial parks, and even in downtown Providence. During 2001, our survey revealed 134 nests located in 27 of 39: state's cities and towns. Since 1979, the estimated number of nests has increased 174%, whereas the number of nests controlled only increased by 150%. The Rhode Island population continues to grow at 5.6% annually (based on the MWS growth rate), and potentially could double again in only 13 years.

Only a few states in the Atlantic Flyway attempt to manage their mute swan populations. General laws and perceived political incorrectness block most states from establishing a mute swan management program. Although our State's efforts have helped to slow the population's growth in the flyway, without a broader effort, the Rhode Island program will have little overall effect. Without a sincere effort to control this invasive species throughout the flyway, the mute swan population will continue to grow and likely have an impact on our native waterfowl. It also may impact human health and use of wetlands. The longer we delay management, the larger the problem becomes.

Control of this species is not without cost. In Rhode Island alone, the estimated annual cost in person-hours (184 hours at about $30 per hour), operating expenses ($700), and helicopter surveys (5 hours at $350 per hour) to conduct the management program is approximately $8,000. The size of the mute swan population in Rhode Island is now so large that the DFW EAP is limited by current staffing levels. The State of Rhode Island now faces many difficult decisions about the future of its mute swan control program. These decisions become more difficult if there are no flyway-wide management programs.

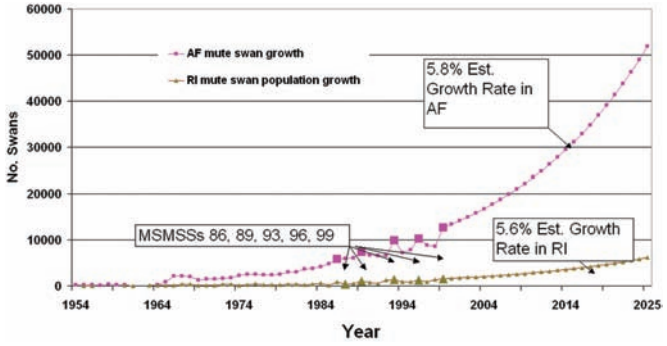

Figure 4. Mute swan population growth in the Atlantic Flyway and Rhode Island from MWSs (1954-99) and predicted annual growth rate of 5.8% (AF) and 5.6% (RI) based on MSMSSs (1986, 89, 93, 96 and 99) for 2000-2025.

Acknowledgments

The Rhode Island Department of Environmental Management's Division of Fish and Wildlife has many dedicated staff members who have contributed to this program over the years. Wildlife biologists C. Brown, B. Tefft, L. Gibson, T. Silvia, and staff members J. Simmons, M. Talbot, and D. DeBerardino have been the mainstay of these efforts.

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Biographical Sketch: Charles Allin is a principal wildlife biologist with the Rhode Island Department of Environmental Management, Division of Fish and Wildlife. He has been with this agency since 1968, after receiving a B.S. in Agricultural Technology from the University of Rhode Island, Kingston. His areas of expertise include population dynamics and management of mute swans and Canada geese. Mr. Allin has headed the Rhode Island mute swan population management program since 1978 and is active with the Atlantic Flyway Technical Section, promoting the control of this invasive species in the Atlantic coastal states. He has completed a long-term study on the effects of mute swan concentrations on submerged aquatic vegetation in a shallow Rhode Island

coastal pond. Charles is a native Rhode Islander and lives with his wife Mary and their son Eric in Coventry, Rhode Island.

Biographical Sketch: Thomas Husband is a researcher and educator at the University of Rhode Island. He earned his B.A. at University of Michigan and his M.S. and Ph.D. in wildlife ecology at Michigan State University. Dr. Husband has been at the University of Rhode Island since 1977 and is a professor and current chair of the Natural Resources Science Department. His research addresses contemporary, important scientific problems of State, regional, and international scope. Dr. Husband has conducted basic and applied research on a wide variety of topics: forest productivity and management; impacts of gypsy moth defoliation on forests; fuelwood management; habitat use by wild turkeys; position-finding radio telemetry; bird and mammal use of wetland buffers; and the effects of mute swan herbivory. Most recently his research has included: the conservation genetics and systematics of New England and eastern cottontail rabbits; a first-ever faunal inventory of the Atlantic forest in Sergipe, Brazil; the measurement of edge effects on small mammals in Brazil's Atlantic forest; the population ecology of the banded bog haunter, an endangered dragonfly (*Williamsonia lintneri*); and a study of the conservation genetics of the endangered Cretan wild goat. In addition, he has received grant funding for a three-year project that employed teams of undergraduate students to monitor the production of wood ducks in Rhode Island. He presently teaches the department's introductory course and three advanced undergraduate/graduate courses: 1. natural resources conservation, 2. wildlife biometrics, 3. biology of mammals, and 4. advanced techniques in wildlife biology.

Review of the Status of Mute Swans on the Canadian Side of the Lower Great Lakes

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Introduction

Lower Great Lakes coastal wetlands provide important staging habitat for numerous native species of ducks, geese, and swans (Dennis and Chandler, 1974; Crowder and Bristow, 1988, Prince and others, 1992; Petrie, 1998). Unfortunately, these coastal wetlands have been affected severely by drainage and development (Crowder and Bristow, 1988; Smith and others, 1991; Prince and others, 1992); only about 20–25 percent of the original wetland area of western Lake Ontario (Whillans, 1982) and less than 5 percent of western Lake Erie's original wetlands remain (Herdendorf, 1987). This wetland loss has concentrated birds on a reduced habitat base, which has probably increased the importance of remaining lower Great Lakes wetlands for staging waterfowl. Although rates of wetland loss have probably declined over the last half century, the introduction of exotic plants and animals to the lower Great Lakes system is now the primary threat to the ecological integrity of remaining wetlands (see Mills and others, 1993).

Mute swans (*Cygnus olor*), endemic to Eurasia, were transported to North America for captive and semicaptive collections in the late 1800s and early 1900s (Bellrose, 1980). The intentional release and accidental escape of these birds and their progeny resulted in the establishment of wild populations along the northeastern Atlantic Coast of the United States, portions of the Pacific Coast, and the lower Great Lakes basin. Since the mid-to-late portion of the twentieth century, mute swan populations have been rapidly expanding, particularly along the Atlantic coast. For example, the Chesapeake Bay (Maryland and Virginia) populations have grown from 5 birds that were released in 1962, to over 4,000 birds today (Allin, 2003). Despite efforts to control them, the Atlantic flyway population is now close to 15,000 birds (Allin, 2003). More recently, mute swan populations have been increasing in the Great Lakes watershed, and the population is probably close to 10,000 birds.

It is well known that exotic waterfowl can have negative ecological impacts on native species, particularly if the introduced species is aggressive, competes with other waterfowl for food or habitat, and/or hybridizes with native species (Weller, 1969). The species' size, aggressive disposition, and voracious appetite make mute swans a strong competitor that causes substantial regional impacts on native waterfowl and their habitats (Cobb and Harlan, 1980; Allin and others, 1987; Ciaranca and others, 1997). Mute swans have also recently been reported to hybridize with native trumpeter swans in the wild (Ruth Shea, oral commun.).

Southern Ontario Population Status

The first free-flying mute swan that was observed in Ontario was seen in 1934 at Long Point (Kathy Dickson, oral commun.). The first breeding pair in Ontario was recorded in 1958 at a golf course near Georgetown, but larger scale colonization began in the lower Great Lakes in the mid-1960s and 1970s. Since that time, breeding and wintering populations have become well established throughout Ontario's lower Great Lakes coastal regions (Petrie and Francis, 2003). Based on data from the Ontario Breeding Bird Atlas from 1981-85 and anecdotal evidence since then, mute swans breeding in southern Ontario are still concentrated in coastal wetlands associated with the Great Lakes, especially lakes St. Clair, Erie, and Ontario. While it is not known how many birds emigrate from Canadian waters during winter, large numbers of mute swan are counted on the Niagara and Detroit Rivers during the annual Mid-Winter Waterfowl Survey. During a 2002 mid-winter waterfowl survey of the Canadian lakeshore, 1369 mute swans were counted between the St. Lawrence River and Lake St. Clair (Petrie, unpub data.). Because not all habitats

were thoroughly surveyed and winter emigration rates to the U.S. are unknown, this number can be considered a conservative estimate of Ontario's summer population.

Petrie and Francis (2003) performed a population analysis to determine the rate of mute swan population growth on the lower Great Lakes to predict how big the population may become and to make recommendations for future management of swans in the region. Three independent historical data sets (Canada Christmas Bird Counts, 1980-2000; Mid-winter Waterfowl Inventory of the Canadian side of Lake Ontario, 1980-2000; and Long Point, Lake Erie spring and fall aerial surveys, 1971-2000) were used to estimate the rate of mute swan population change on the Canadian side of the lower Great Lakes. Christmas Bird Count data from the U.S. side of the lower Great Lakes (1980-2000) were also analyzed for comparative purposes (Petrie and Francis, 2003).

All four data sets indicated rapid growth of the mute swan population around the lower Great Lakes. Christmas Bird Counts on the Ontario side of the lower Great Lakes (Lakes Ontario, Erie, (fig.1), and St. Clair) increased by about 14% from 1980-2000, whereas those on the U.S. side increased by about 18 during the same time period (fig.2). The number of swan recorded during the Lake Ontario midwinter survey increased from 49 birds in 1980 to 327 in 2000 (fig.3); the average rate of population growth during this period was 10 percent per year. The overall average rate of mute swan population increase between 1971 and 2000 at Long Point was 16 percent, based on spring data and 12 percent, based on fall data (fig.4). However, during the period 1980-92, the growth rate was about 30 percent per year.

The most conservative growth-rate estimate of 10 percent per year would result in a doubling of the lower Great Lakes mute swan population every 7-8 years. Petrie and Francis (2003) further predicted that, if the carrying capacity of the lower Great Lakes for mute swans is similar to portions of

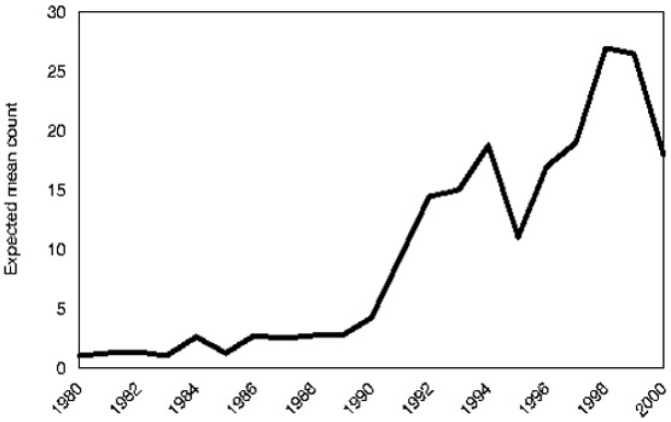


Figure 2. Annual indices for mute swans based on Christmas Bird Count data for the United States side of the lower Great Lakes, 1980-2000 (Petrie and Francis, 2003).

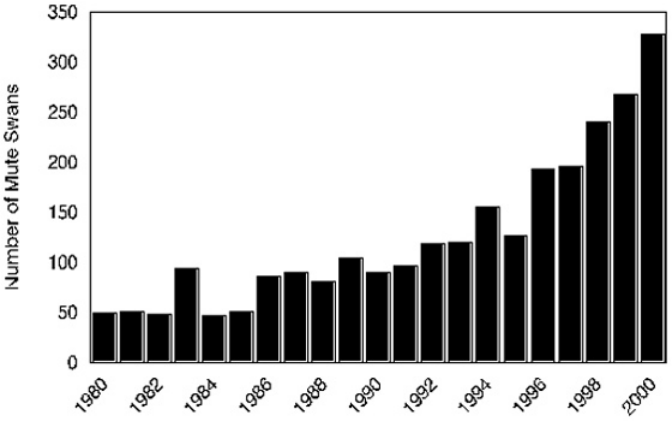
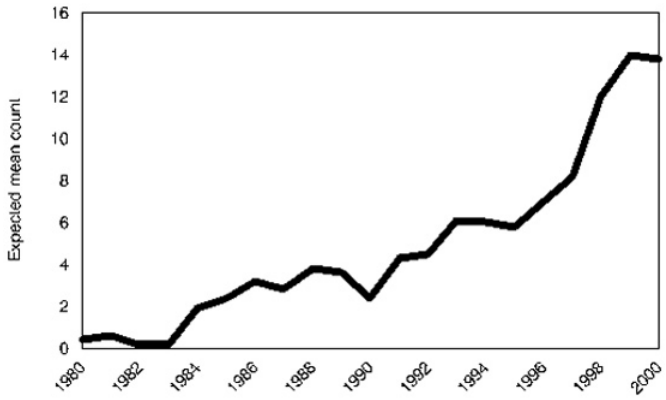


Figure 3. Mid-winter inventory of mute swans on the Canadian side of Lake Ontario, 1980-2000.



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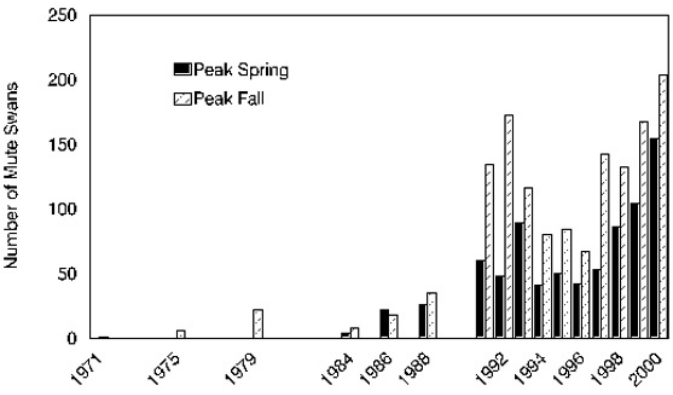

Figure 4. Peak spring and fall mute swan counts at Long Point, Lake Erie, 1971-2000.

the species native European range, it could be expected that, at present growth rates, the southern Ontario population can reach 30,000 birds within 30 years or less. If mute swan populations expand to the point at which they begin nesting on inland wetlands and manmade waterbodies, (as they have in Poland and along the Atlantic coast of the United States), we can expect that the southern Ontario population may even surpass 30,000 birds (Petrie, 2002).

The rapid growth rate of southern Ontario's feral mute swans can probably be attributed to a number of factors. The lower Great Lakes is climatically similar to the native Eurasian range of mute swans. There are few natural predators of mute swan nests, cygnets, or adults on the Great Lakes (Perrins and Reynolds, 1967; Wieloch, 1991; Ciaranca and others, 1997). Mute swans are dominant over all other members of the lower Great Lakes waterfowl community. There has been minimal interference by humans; in Ontario, mute swans have been protected under the Migratory Bird Treaty Act since 1974 (Environment Canada, 1991). Reduced availability of lead artifacts in the environment has probably also helped this species; mute swans are highly susceptible to lead artifact ingestion (O'Halloran and others, 1991; MacDonald and others, 1990; Brown and others, 1992; Pennycott, 1999). The recent warming trend has been beneficial, because as cold winters result in reduced overwinter survival and future reproductive output (Esselink and Beekman, 1991; Perrins, 1991; Walter and others, 1991). Finally, mute swans have large clutch sizes and are capable of laying replacement clutches (Wieloch, 1991; Ciaranca and others, 1997).

Ecological Concerns

This rapidly growing mute swan population is of a concern for numerous reasons. Mute swans are one of the most aggressive species of waterfowl in the world; they regularly attack other species of waterfowl, as well as other wetland-dependant birds (Willey, 1968a; Reese, 1975; Ciaranca, 1990; Ciaranca and others, 1997). They also are known to attack humans. Mute swans maintain large territories (>15 acres) during mating, nesting, brood rearing, and foraging; they have even been reported to occupy territories throughout the year (Birkhead and Perrins, 1986; Ciaranca, 1990; Ciaranca and others, 1997). During incubation and brooding, cobs actively patrol the perimeter of their territory and aggressively defend it, thereby forcing native species to nest and feed in less preferred areas.

By displacing other waterfowl from their territories, the amount of staging and breeding habitat available to native species of ducks, geese, and swans on the lower Great Lakes is effectively reduced. This probably reduces the carrying capacity of (with respect to number of birds and capability of birds to acquire body fat) coastal wetlands for staging and breeding waterfowl. Mute swans have also been reported to kill ducks, Canada geese, pied-billed grebes, and herons and to cause nest abandonment in least terns, black skimmers, Forster's terns, and common terns (Reese, 1975; Ciaranca, 1990; Ciaranca and others, 1997). Therefore, while the quality and quantity of wetland habitat continues to decline in North America, increasing populations of aggressive mute swans serve to further reduce the carrying capacity of remaining habitats for wintering, staging, and breeding waterfowl, as well as for other wetland-dependant avifauna (see Cobb and Harlan, 1980; Allin, 1981; Allin and others, 1987).

Competition in waterfowl will most likely occur on wintering and/or spring staging areas where food is most limiting. Whereas coastal Great Lakes wetlands are most important as staging habitat for native waterfowl, these habitats are now being used year round by mute swans (Petrie and Francis, 2003). Being primarily herbivorous aquatic foragers, mute swans daily consume at least 6 to 8 pounds (wet weight) of submerged aquatic plants, including leaves, stems, roots, stolons, and rhizomes (Willey, 1968a; Mathiasson, 1973; Owen and Cadbury, 1975; Allin, 1981; Fenwick, 1983). Because adults also tend to paddle and rake the substrate to dislodge food for themselves and their cygnets, additional vegetation is destroyed and uprooted, further decreasing the availability of food for native waterfowl (Gillham, 1956; Willey, 1968b; Ciaranca and others, 1997). At high densities, mute swans can overgraze an area, causing a substantial decline in the availability of submerged aquatic vegetation, before they move to a new area (Cobb and Harlan, 1980; Allin, 1981; Allin and others, 1987). In extreme cases, mute swans can even eliminate some plant species from an ecosystem (Mathiasson, 1973).

Mute swans increase their feeding rate during spring and summer because more food is required before feather molt and egg laying, which probably influences the availability of submerged aquatic vegetation (SAV) to fall migrant waterfowl. During winter, mute swans may also consume nutrient storage and overwintering structures such as tubers, which could reduce the future availability of perennial species such as wild celery (*Vallisneria americana*) and American bulrush (*Scirpus americanus*), both important food sources for native waterfowl on the lower Great Lakes (Petrie, 1998; Knapton and Petrie, 1999). Therefore, feral mute swan populations directly reduce the carrying capacity of lower Great Lakes wetlands for native waterfowl via aggressive interactions (reduced space), as well as indirectly through resource depletion (reduced food).

Management Considerations

Given the similarity of climate between Eurasia and North America, the unparalleled competitive abilities of mute swans, and the almost total lack of predators, it seems highly probable that mute swans will continue to increase exponentially in the lower Great Lakes. Because natural causes are unlikely to limit the population in the near future, it seems prudent to control the species in the Great Lakes region (and elsewhere) before the population becomes much larger.

Presently, the Canadian Wildlife Service (CWS) issues permits to CWS staff to control mute swans on national wildlife areas as well as to landowners that can demonstrate a need to control mute swans on their property. However, Ontario

does not yet have a management goal with respect to mute swan numbers on the lower Great Lakes. Unfortunately, mute swans are protected in Canada and the United States under the Migratory Birds Convention of 1916, despite the fact that they are a nonnative species and that "Federal law does not generally protect species or families that were introduced to North America by humans, i.e., not native to this continent" (Environment Canada, 1991). This protection from hunting and harassment has allowed the population to grow unchecked. Therefore, the first step that should be taken is to remove any legal protection for the species; this removal would allow hunters and other private individuals to participate in control programs without a need for special permits.

Control programs have been implemented in a number of eastern U.S. States with varying degrees of effectiveness. Rhode Island began a control program of egg addling and pricking in 1979; despite the fact that 9,378 eggs were destroyed in 1,629 nests over a period of 22 years, the population increased by over 500 percent (C. Allin, oral commun.). Vermont, in contrast, reported no mute swans in 2000, apparently as a result of a lethal control program. This is supported by the fact that population models indicate that the most effective way to reduce population growth for a long-lived species such as the mute swan is to reduce adult survival rates (e.g., Schmutz and others, 1996). This can be done through capture and removal programs or through culling. Swan capture and removal during wing molt may be an appropriate solution in some situations, such as along the Toronto Waterfront where human populations are high. However, this is a costly alternative and it is doubtful that a sufficient number of repositories exist for these birds once they are removed from the wild. Several hundred birds would have to be captured and removed annually, and measures would have to be taken to ensure that captured birds are never released back into the wild.

Therefore, a simple and effective solution is to remove any protected status for the species and to encourage hunters and managers of refuges and other waterfowl management areas to control their numbers. If it was determined that these measures were not sufficient, then professional culling programs could be implemented. Given the present rate of increase, whatever control measures are selected should be undertaken as soon as possible, before the population becomes too large to control. However, mute swans are conspicuous, attractive birds that appeal to many members of the general public, many of whom are unaware of the swans' potential adverse ecological impacts. Attempts to control this species in the U.S. have often been thwarted by well-meaning, but poorly informed citizens. Education and discretion must, therefore, be an integral component of any well coordinated mute swan management program.

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Biographical Sketch: Scott Petrie received a B.S. from the University of Guelph in 1990 and a Ph.D. from the University of the Witwatersrand, South Africa in 1998. His work has focused primarily on the ecology of waterfowl in semiarid environments and the staging ecology of north-temperate occurring waterfowl. Scott is the research director of the Long Point Waterfowl and Wetlands Research Fund and is an Assistant Professor at the University of Western Ontario, where he teaches wildlife ecology and management. Scott is presently studying numerous aspects of the staging ecology of mute swans, tundra swans, and lesser and greater scaup on the lower Great Lakes.

A Nonlethal Method for Reducing the Mute Swan Population by Same-Sex, Non-Breeding Pairs, 1987-2000

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Abstract: The Swan Research Program (SRP) is headquartered at Environmental Studies at Airlie in Warrenton, Virginia and manages the largest known collection of swans including 84 non-breeding, pinioned mute swans. The mute swan should be energetically and humanely dealt with and removed as a feral species. At the time of presentation, the philosophy of SRP is that however undesirable mute swans are in the Chesapeake Bay region, they should not be killed.

Author's note: In the time that has elapsed between presentation and publication, SRP has updated its position as follows: SRP maintains that all free-flying, feral, mute swans should ultimately be removed from the wild, but believes that as many mutes as possible should be brought back into captivity (from where they have escaped) as same-sex, non-breeding, pinioned birds for private or public display. Due to the continued exponential growth of mute swan populations in Atlantic Flyway, SRP regrettably acknowledges that government agencies will now need to use lethal methods to control the several thousand mutes in the Flyway. We believe that our non-lethal same-sex method has merit and should be employed for smaller populations of up to 400 mutes and that any lethal methods must be humane. We urge animal rights groups to cooperate with government agencies, SRP and other swan experts to ensure that the best humane methods are used. SRP opposes an experimental hunt, as approved for tundra swans in 1984, because of the inevitable crippling and suffering that results even if by the most skillful hunters (Sladen and Rininger, 2004).

We believe the best non-lethal method is to catch feral mute swans, pinion them to render them flightless, and redistribute them on inland ponds of marginal habitat as same-sex pairs. During the past twelve years, we have released into a captive environment a total of 262 flightless, non-breeders mostly into farmland or ornamental ponds between 0.5 - 2.0 acres. Marginal habitat was judged by the absence of migratory ducks in winter. Through this program SRP not only maintains a no-growth population, but also provides a good home for the swans, promoting a public awareness of wetland environments. Further, cooperators better understand the mute swan problem and pass it on to others, usually altering their behaviors and/or land management practices to benefit the swans. This in turn attracts other wetland species including herons and migratory ducks to their property.

The Swan Research Program (SRP) was founded in 1969 and it is now headquartered at Environmental Studies at Airlie. SRP was formerly associated with the Chesapeake Bay Foundation, Johns Hopkins University, and the Wildfowl Trust of North America. Its goals include: 1) creating an awareness of the importance of wetlands, using swans as elegant ambassadors; 2) discouraging the spread of the alien mute swan by relocating feral birds as pinioned, nonbreeding same-sexed pairs; 3) opposing the sport hunt of North American swans (Sladen, 1991); 4) testing the effect of neckbands, radios, and harnesses on swans, geese, and other waterfowl, especially by flying imprinted birds with ultralight aircraft; 5) studying hybridization in the northern swans; 6) providing a sanctuary for crippled and rehabilitated wild swans; and 7) restore the trumpeter swan back to the Atlantic Flyway.

Accomplishments have included scientific and popular publications; pioneering of circumpolar marking schemes (Sladen and Kistchinski, 1977); defining migration routes of the tundra swan (*Cygnus columbianus*) and trumpeter swan (*Cygnus buccinator*) by neckbands and radio-telemetry in the 1970s (Sladen, 1973, 1975); and developing techniques for teaching migration routes to geese, swans, and cranes by ultralight aircraft (Sladen and others, 2002).

At Airlie Center and its surrounds, the SRP holds the largest known collection of free-swimming swans, comprising approximately 150 individuals in nine different taxa. Eighty-four are nonbreeding pinioned mute swans; others include rehabilitated tundra and trumpeter swans. The mission of Environmental Studies at Airlie is:

> Provide guidance in land stewardship that encourages, preserves, and restores diverse wildlife habitats emphasizing native flora and fauna.

Thus, like the need to control (may, eliminate) the invasive multiflora rose (*Rosa multiflora*) and Oriental bittersweet (*Celastrus orbiculatus*) which from our study areas at Airlie, that are so severely smothering and endangering our native plants, we believe that the mute swan (also an alien to North America that has become invasive) should be energetically and humanely dealt with and removed as a feral species from the Chesapeake Bay area.

In 1962, five mute swans escaped into the Bay from a captive collection (Reese, 1975, 1980). After a slow start, there are now nearly 4,000 mute swans (Allin, 2000). Our native tundra swan, visiting the Bay each winter after its 4,000-mile migration across the continent from its arctic breeding grounds, is increasingly finding its habitat occupied by the larger and more aggressive mute swan. Moreover, the mute swan is a year-round resident, feeding voraciously on the food on which our wintering ducks and tundra swans are dependent.

The philosophy of SRP is that, however undesirable mute swans may be in the Chesapeake Bay region, they should not be killed, see Abstract. Swans are very special birds that stir positive emotions of the natural world. They have in fact been listed, after dog and horse, as the third most popular animal in America, sharing this distinguished place with the robin and the butterfly (Kellert, 1980).

We believe the best nonlethal method is to catch feral mute swans in Virginia (Costazo, 2004), pinion them to render

them flightless, and redistribute them on inland ponds of marginal habitat as same-sex pairs (i.e., male with male or female with female). During the past twelve years, we have released a total of 262 flightless, nonbreeders into marginal habitat, mostly farmland or ornamental ponds between 0.5-2 acres. For example, of the 81 mute swans under SRP's care in 1999, 68 (84 percent) were located in rural areas, whereas 13 (18 percent) were located in urban areas (fig. 1). The majority of the swans (54 percent, n=44) were located on small rural ponds, with the fewest birds (n=2) being located on medium sized urban ponds. Marginal habitat was judged by the absence of migratory ducks in winter.

If we suppose that these 81 birds were of breeding age and had the annual growth potential similar to Maryland's (up to 23 percent) (MD DNR, 2001), then, with no management, the number (if still feral) would have increased to an estimated 790 birds by 2010. Instead, these 81 birds have been in captivity, enhancing wetland habitats and giving people enjoyment, with zero production.

From 1987-2000, SRP has handled 262, birds of which 114 (44 percent) have died. Sixty-two (24 percent) died from natural causes, for example, old age. Thirty-nine (15 percent) were killed either with positive or suspected evidence by predators, mostly dogs. Eleven (4 percent) were lost from aspergillosis or bacterial infections, and two were lost after ingesting fish hooks (<1 percent).

Through this program, SRP not only maintains a no-growth population but also provides a good home for the swans, promoting a public awareness of wetland environments. As part of this ongoing study and as a result of our outreach efforts, cooperators better understand the mute swan problem and pass this understanding on to others, usually altering their behaviors and/or land management practices to benefit the swans. This in turn attracts other wetland species, including herons and migratory ducks, to their property. Moreover, through frequent tours to Environmental Studies at Airlie's headquarters at Clifton Farm, school children, eco-groups, and Airlie Center's many national and international conferees have a chance to appreciate our native migratory swans yet still admire the beauty of our nonbreeding mute swans.

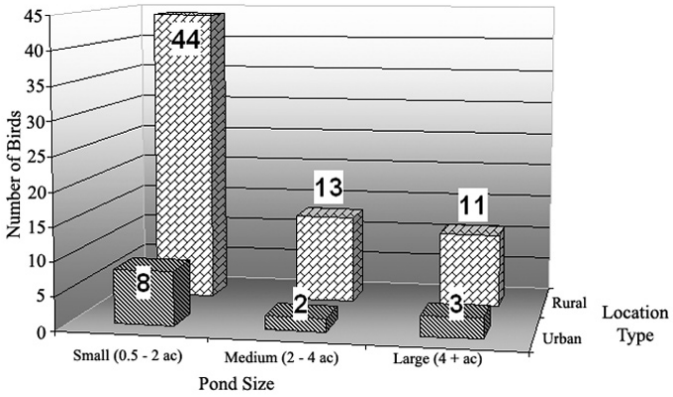

Figure 1. Locations of non-breeding mutes in relation to pond size, 1999.

Critics have opposed our program because of the notion that the birds will adversely affect other wildlife in the ponds where they have been released. But we are dealing with small numbers of nonbreeding birds in comparison to the large congregations of mute swans that have shown a negative impact in the Chesapeake Bay. On the contrary, evidence from our twelve-year program has shown that a small number of swans enhance the habitat. For example, in SRP's collection at Airlie, we display a pair of captive trumpeter swans in a 9 acres wetland area. They and their offspring share this habitat with up to 400-500 individuals of 20 wintering waterfowl species; 8 of which are seen daily (Heath, 2002). In fact, we are more concerned about the effect on the resources of these two ponds caused by the roosting, defecating, and foraging of often as many as 600 wintering resident Canada geese (*Branta canadensis*), which is equal to a biomass of approximately 250 swans.

We strongly believe that all feral mute swans must be removed from the wild in the Chesapeake Bay area, and, in this respect, we fully support the American Bird Conservancy's recommendations (Fenwick and Winegrad, 2001). Mute swans can still be admired in captivity. SRP has circulated its position paper (Sladen, 2001) on the mute swan problem, similar to the views expressed in this paper over the years, but to no avail. For example, the Maryland Mute Swan Task Force (MD DNR, 2001) dismissed this method without discussion with SRP. Fifteen years ago, when SRP first recommended this nonlethal method of control to the Maryland Department of Natural Resources, there were only 264 mutes recorded from Maryland and 60 from Virginia (Allin, 2000). The mute swans could then have easily been eliminated as feral birds; now it is almost too late.

However, we still believe our nonlethal method can contribute significantly to the solution. It took 60 years for the feral mute swan to reach its present rapidly increasing population. Maybe it would take the same time to remove all feral birds by solely nonlethal methods. Surely, if on a small scale, nonlethal methods have has been responsible for preventing a possible population of 790 birds, these methods certainly have merit on a larger scale. There are thousands of small marginal ponds in Virginia that can be used for our plan.

All swans distributed remain the property of the Swan Research Program and are covered by SRP's permits. SRP therefore maintains control over the management and care of the birds. Cooperators sign a contract in order to participate in the program and to meet the following requirements:

1. Provision of electricity for an aerator to prevent the pond from freezing in winter
2. Presence of an island or raft for roosting

3. Provision of a feeder with whole corn for supplemental feeding
4. Regular correspondence with our staff, especially to report any unusual happenings or the loss of identifying plastic bands
5. Preservation of carcasses for necropsy. We maintain records on all losses

The Swan Research Program also makes the following recommendations:

1. Promotion of talks by videos, internet, radio, and TV should be encouraged. Educating the public about the important
2. Prevention of the selling of breeding pairs of mute swans by dealers and private citizens. Steps must be taken to curtail this practice immediately throughout North America. Further, Maryland and Virginia need to be encouraged by U.S. Fish and Wildlife Service to pass legislation to list the mute as a nuisance species
3. No release of mute swans by rehabilitators, but instead birds should be pinioned and placed in a nonbreeding environment
4. Encourage zoos or education organizations to display captive (pinioned) mute swans, provided that a swan education program accompanies them
5. Encourage continued research on mute swan biology. Research must be the foundation for sound management

In conclusion, we believe that all mute swans should be removed from the Chesapeake Bay region. It is important to think ahead ecologically. No one could have imagined in 1962, when the five mute swans escaped into the Bay, that there would now be over 4,000 of their progeny swimming in and occupying almost every tributary!

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Biographical Sketch: William Sladen, Professor emeritus, Johns Hopkins University, and Director, Environmental Studies at Airlie, guides the programs of education and research at Airlie Center, which maintains a collection of over 160 swans (9 taxa, including breeding trumpeter swans). His long-term Antarctic ornithological research, involving the banding of some 50,000 penguins and 60,000 albatrosses, was the first of its kind. He has completed over 50 years of waterfowl research in North America (including Alaska), Lapland, Iceland, and Wrangel Island, Siberia, and has pioneered techniques in capture, circumpolar neck banding, radio-telemetry, and, recently, with his team at Airlie, teaching geese migration

routes with ultralight aircraft. In addition to publishing over 120 scientific papers, he has also made television films which have been shown on all major U.S. networks, NOVA, and BBC, to illustrate his research. Sladen's awards include Member of the British Empire, the Polar Medal (United Kingdom), and the 1991 Explorers Medal (Explorer's Club, New York) for research in the Polar Regions. A U.S. citizen since 1962, he was educated in the United Kingdom, receiving his M.D. in (London) and his D. Phil. in Zoology at (Oxford).

Biographical Sketch: Donielle Rininger, research biologist at Environmental Studies at Airlie, received her B.S. from Virginia Polytechnic Institute in Wildlife Science (1994). Working with the goose and swan projects since 1996, Donielle has assisted with post-experimental monitoring of the ultralight-led geese and with the hatching, rearing, and training of the experimental trumpeter swans. Donielle is working on a master's degree in Environmental Science and Public Policy at George Mason University and is also an avid naturalist, participating in bird and butterfly counts, including banding migrating raptors, at Cape May, New Jersey.

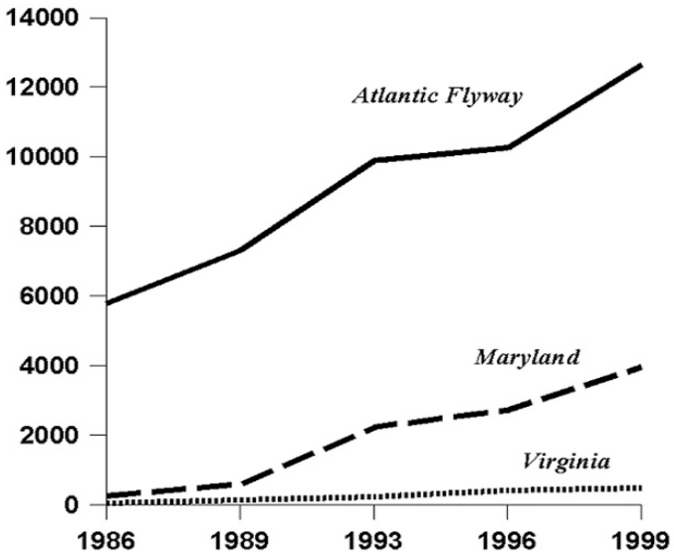

Figure 1. Total Atlantic Flyway mute swan populations and Maryland and Virginia segments.

Food Habits of Mute Swans in the Chesapeake Bay

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Abstract: Unlike the tundra swan (*Cygnus columbianus*) that migrate to the Bay for the winter, the mute swan (*Cygnus olor*) is a year long resident and therefore has raised concerns among research managers over reports of conflicts with nesting native water birds and the consumption of submerged aquatic vegetation (SAV). 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. Analyses of the gullet and gizzard of mute swans indicate that widgeon grass (*Ruppia maritima*) and eelgrass (*Zostera marina*) were the most important food items to mute swans during the winter and spring. Other organisms were eaten by mute swans, but represent small percentages of food. Corn (*Zea mays*) fed to the swans by Bay residents in late winter probably supplements their limited vegetative food resources at that time of year.

Introduction

The exotic mute swan (*Cygnus olor*) has increased its population size in the Chesapeake Bay in Maryland and Virginia to approximately 4500 since 1962, when five swans were released in the Bay (fig. 1). The Bay population increased by 1200% from 1986 to 1999 and now represents 30 percent of the total Atlantic Flyway mute swan population (12,600). Demographic studies that were conducted on the mute swan population in Chesapeake Bay (Reese, 1975, 1980, 1996) suggest that the population will continue to increase.

Unlike tundra swans (*Cygnus columbianus*) that migrate to the Bay for the winter, mute swans are year long residents. Reports of conflicts with nesting native water birds and of the consumption of submerged aquatic vegetation (SAV) have raised concerns among resource managers (Allin, 1981; Allin and others, 1987). SAV is a key component of the Chesapeake Bay ecosystem; it performs a number of valuable ecological roles within the Bay and provides a major food source for native Bay waterfowl (Martin and Uhler, 1951; Stewart, 1962; Munro and Perry, 1982; Perry and Deller, 1996).

Mute swans are highly territorial during the breeding season, which leads to localized depletions (eat-outs) of SAV during the growing period (Cobb and Harlan, 1980). Data on the reduction of SAV by nesting mute swans and their offspring during the spring and summer are limited, however. The cumulative effect of their yearlong foraging on aquatic plants and the implications to SAV restoration efforts are unknown. Mute swans have also been blamed for direct effects on other wildlife of the Bay. 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 (D. Brinker, MD DNR, oral commun.).

Mute swans have historically been classified as a wetland game bird in Maryland and were protected under current State law. They were not historically protected in Virginia. Mute swans were also not protected by the Federal government under the Migratory Bird Treaty Act of 1916, because they are

considered nonmigratory and exotic. Maryland had a special program to control swan numbers by the addling of eggs and the killing of adult swans, but it was a contentious program with some residents of the Bay area.

In 2000, the Governor appointed a Mute Swan Task Force to advise Maryland Department of Natural Resources (MD DNR) on viable management for mute swans in the Maryland portion of Chesapeake Bay and to begin development of a management plan. The recommendations that were given in the Task Force Report (http://www.dnr.state.md.us/wildlife/mstfpc.html) were criticized by some who were opposed to the control of swan numbers. Development of a Mute Swan Management Plan by the MD DNR will attempt to alleviate existing conflicts while not excessively diverting limited wildlife management resources. The objective of this paper is to present data on the food preferences of mute swans in all seasons of the year and to discuss the impact mute swans have on the flora of the Bay.

Methods

Mute swan populations are being studied by aerial surveys in the Chesapeake Bay and throughout the Atlantic flyway to learn more about population status and habitat uses, particularly feeding and resting areas during all seasons of the year. The Atlantic Flyway Council has sponsored a total flyway survey of mute swans every three years since 1986. Additional aerial and ground surveys are conducted to gather habitat information.

Food-habits analyses have been conducted on the gullets and gizzards of mute swans that were collected as part of another study dealing with food web characterization using stable isotopes (J.Keough, pers. commun.) Food habits analysis follow techniques established in other larger studies (Martin and Uhler, 1951; Perry and Uhler, 1985). Attempts were made to determine the amount of corn (*Zea mays*) being fed to mute swans and the influence of corn on the status of mute swans in the Bay. We established exclosures 12ft x12ft in three areas (Bay Bridge, Kent Narrows, and Horsehead Wetlands Center) to measure the impact of mute swans on SAV and other vegetation. The wire fencing that was used for exclosures was a vinyl - coated 2 in x 2 in mesh that was supported in each of the four corners with 8 ft metal stakes. The exclosure was open on the top to allow use by ducks and was raised approximately 10in above the bottom to allow entrance by fish, crabs, and other nontarget Bay species.

Results

Analyses of the gullet (esophagus and proventriculus) and the gizzard of 29 mute swans from the Chesapeake Bay indicated that they were primarily herbivorous during all seasons of the year and relied heavily on SAV during these months. Widgeon grass (*Ruppia maritima*) constituted 76 percent and eelgrass (*Zostera marina*) constituted 9 percent of the gullet food of mute swans. Corn was found in some mute swan gullets and gizzards but made up less than 2 percent of the volume. Invertebrates (including bryozoans, shrimp, isopods, and amphipods) formed a much smaller amount of the consumed food and were believed to have been ingested accidentally as part of the consumed vegetation. Average food volume in the gullets of the swans was 67 cc with a maximum of 173 cc.

When the various areas of the Bay where mute swans were collected were compared, there appeared to be similar findings (except for birds from Eastern Neck that were feeding primarily on algae) (fig. 2). Leaves of widgeon grass predominated as food for mute swans from Eastern Bay (fig. 3), Smith Island (fig. 4), and South Marsh Island (fig. 5). Sea lettuce (*Ulva lactuca*) was used as food by swans from Eastern Bay (fig. 3) and South Marsh Island (fig. 5) whereas, eelgrass was an important food at Smith Island (fig. 4). Soft-shelled clams (*Mya arenaria*) were eaten by tundra swans from the Eastern Neck area (fig. 6).

Preliminary results of exclosure studies revealed degraded habitats as a result of mute swans. Cover of the bottom within the exclosures at the Bay Bridge site averaged approximately 90 percent, whereas outside the exclosures in the reference plots, the cover of SAV was less than 10 percent. At the Kent Island site, the average SAV cover within the exclosures was approximately 80 percent, and outside it was less than 5 percent. Exclosures at the Horsehead site were destroyed by waves, and therefore no estimate of cover could be made.

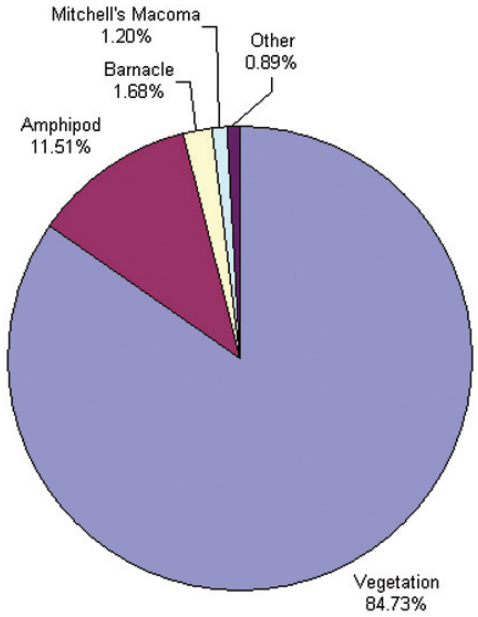

Figure 2. Food habits of mute swans (n=6) from Chesapeake Bay Eastern Neck, April 2001.

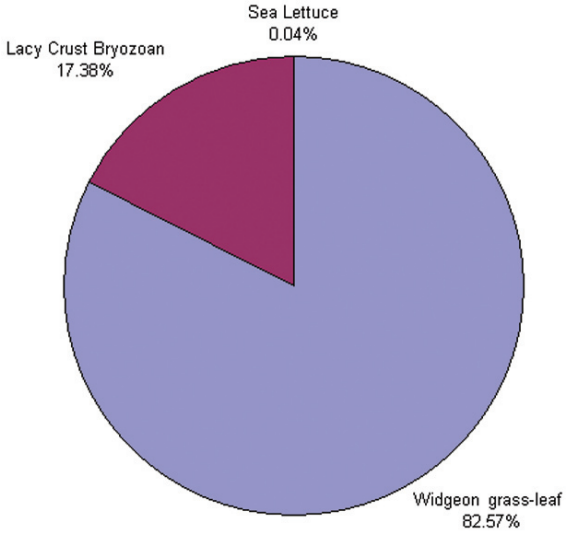

Figure 3. Food habits of mute swan (n=2) from Eastern Bay, February 2000.

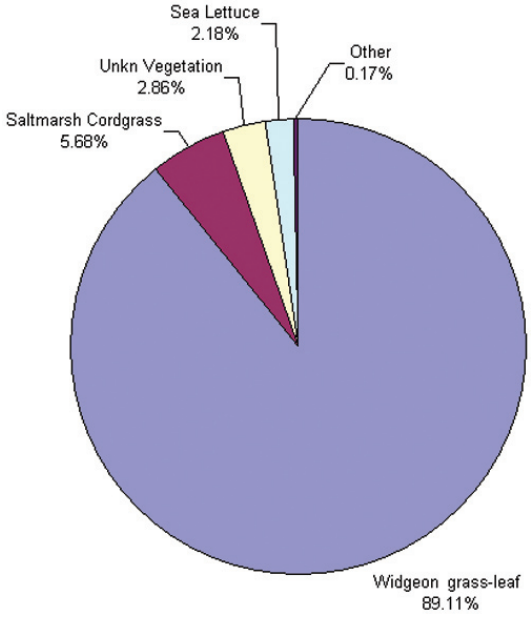

Figure 5. Food habits of mute swans (n=6) from Chesaepake Bay South Marsh, April 2001.

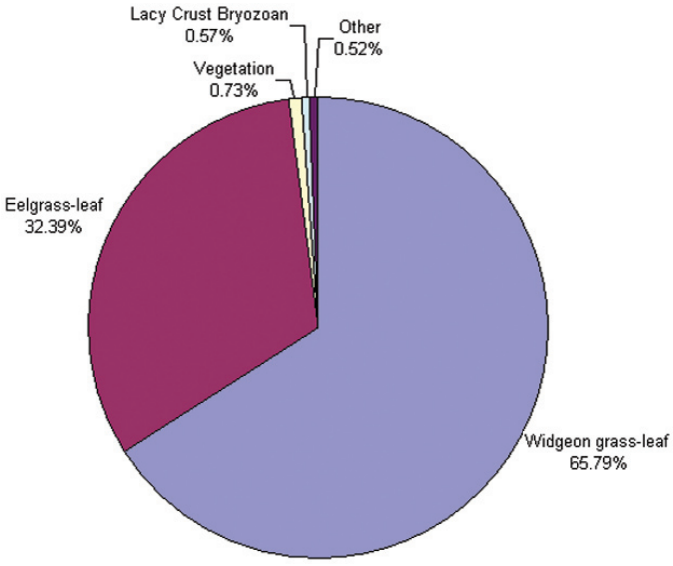

Figure 4. Food habits of mute swan (n=15) from Chesapeake Bay Smith Island, winter and spring of 2000.

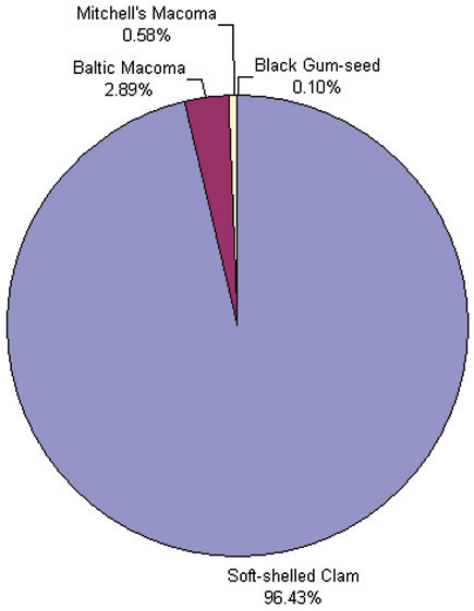

Figure 6. Food habits of tundra swans (n=4) from Eastern Neck, February 2000 and April 2001.

Discussion

The expanding mute swan population needs to, and should be, continually monitored to determine its population status and seasonal distribution. More research is needed within the Chesapeake Bay to determine the impact of mute swans on other species caused by habitat degradation or by aggressive territorial behavior that causes direct mortality. The preliminary results of exclosure studies reveal degraded habitats from mute swans, which is similar to findings in other areas (Willey, 1968; Cobb and Harlan, 1980; Allin 1981, 1987; Sondergaard and others, 1996; Idestam-Almquist, 1998).

Although more information is needed to understand the impact of mute swans on SAV beds, it is known that mute swans consume large amounts of SAV (Berglund and others, 1963; Willey, 1968). Fenwick (1983) determined that male swans in Chesapeake Bay consumed 34.6 percent (±10.8 Standard Deviation) of their body weight per day and females consumed 43.4 percent (±12.9 Standard Deviation) per day. Assuming that an adult/sub-adult mute swan consumes an average of 3.789 kg wet weight of SAV per day (Willey and Halla, 1972), a population of 4,000 swans has the potential to consume more than 5.5 million kg of SAV annually.

There are other estimates of the biomass of SAV in the Bay (fig.7 and 8). Other estimates indicate 44 million m² of SAV in the Upper Bay. If a square meter of SAV weighed 1 kg, then this would amount to 44 million kg of SAV. Therefore, if mute swans consume approximately 5.5 million kg of SAV over a period of a year, this consumption would amount to approximately 13 percent of total SAV biomass in the Upper Bay. In addition, consumption of immature seeds, removal of biomass before plant maturation, and uprooting of whole plants may have a substantial negative effect on SAV with even minimal consumption (Neirheus and Van Ireland, 1978; Bortolus and others, 1998).

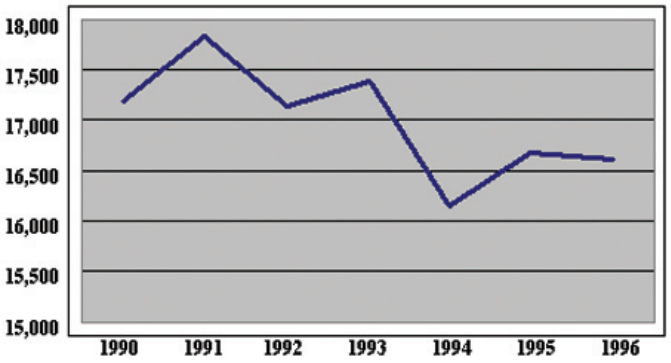

Figure 7. Total biomass (tons) of Zostera (July) in Chesapeake Bay (Moore and others 2000).

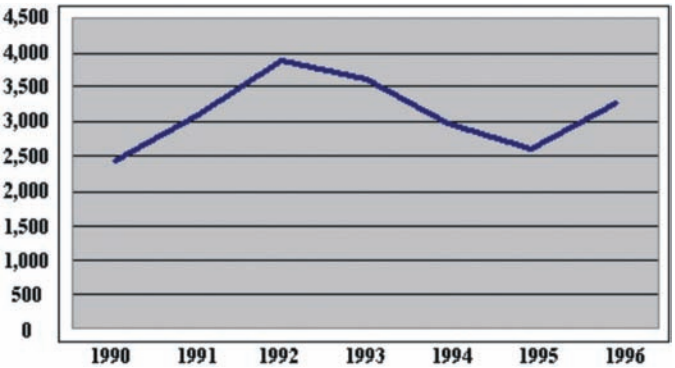

Figure 8. Total biomass (tons) of Ruppia in Chesapeake Bay, August 2000 (Moore and others, 2000).

Analysis of fecal content of Chesapeake Bay mute swans showed similar results with 81.8 percent being SAV, 8.4 percent algae, 8.3 percent emergent and terrestrial plants, and 0.3 percent animal matter (Fenwick, 1983). Insects, crustaceans, and fish may be important for young and molting birds (Ciaranca and others, 1997). Mute swans can graze at the surface of the water and can uproot underwater plants in water up to 1m deep. Some birds find areas where food is provided by waterfront property owners or by visitors to public waterfronts. In particular, corn is often used by people to feed waterfowl, and feeding may enable many mute swans to survive extreme winter conditions (Bellrose, 1980).

The food-habits data are different from those of tundra swans who commonly feed in agricultural fields and also feed heavily on clams in late winter. Food habits of four tundra swans revealed that soft-shelled clam formed 96 percent of the diet in the Bay. The major difference, however, between the food habits of tundra and mute swans is that the tundra swan does not occur in the Bay during the summer when SAV is growing.

More information about the mute swan population in the Chesapeake Bay is needed. If attempts to reduce the mute swan population are made, data on changes in population size and productivity should be collected. Researchers must continue to investigate the diet and influence of mute swan populations on the growth and biomass of SAV and its availability to other waterfowl using the Chesapeake Bay. Food-habits analyses should continue to further document the use of SAV and other food items, including corn, by mute swans.

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Biographical Sketch: Matthew Perry was raised in Rhode Island and received his B.S. from the University of Rhode Island in 1963 with a major in Wildlife Management/ Forestry. From 1966-68 he worked for the Rhode Island Fish and Game Department on an extensive study of mute swans. He then went to Virginia Polytechnic Institute, where in 1970 he received his M.S. with a major in Wildlife Management. His thesis was titled "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 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 titled "Seasonal influence of nutrients on the physiology and behavior of captive canvasbacks (*Aythya valisineria*)." Dr. Perry's current research deals with the evaluation of the creation and management of wetlands to improve habitat for wildlife. Other studies of habitat management include research on powerline rights-of-way, compost amendments to soil, and the management of buffer zones in agriculture fields. Dr. Perry also recently initiated a study of seaducks in the Chesapeake Bay, which includes satellite telemetry tracking of scoters.

Biographical Sketch: Peter Osenton is a biologist at Patuxent Wildlife Research Center, where he conducts

research on a variety of wildlife and habitat issues. Recent study areas include mitigated forested wetlands, powerline rights-of-way, stable isotope analyses with shorebirds, satellite telemetry with scoters, and food habits of water birds. Before coming to Patuxent, Peter worked for the USDA Animal and Plant Inspection Services in Louisiana and the U.S. Forest Service in Wyoming. He has a B.S. from the University of Rhode Island.

Biographical Sketch: Edward Lohnes was born in the county of Norfolk, on the east coast of England. In 1995 he began a summer job position, working at Abbotsbury Swannery, a mute swan colony located on the south coast of England. In the summer of 1996 Edward began a degree in "Coastal Zone and Marine Environment Studies" at the University of Glamorgan in Pembrokeshire, Wales. He graduated with a B.S. in the summer of 1999, during which time he completed a variety of field work in England, Wales, Ireland, and Iceland. His seasonal work at Abbotsbury Swannery, 1995-2000, led to an interest in mute swans, and he sought out work overseas following the completion of his degree. In October 1999, he came to the United States and began working for Dr. Matthew Perry at the USGS Patuxent Wildlife Research Center. This job involved a number of habitat restoration projects and Chesapeake Bay Research with seaducks. Since then he has worked full time at Patuxent as a visiting scientist, with several trips back to the U.K. to assist with activities at the Abbotsbury Swannery, such as the management of mute swans' annual nesting.

Potential Impacts of Mute Swans to SAV in Chesapeake Bay

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Abstract: There are a number of specific concerns about the potential effects of swans on recovering submerged aquatic vegetation (SAV) populations in Chesapeake Bay, in addition to the simple loss of biomass of eaten SAV. This paper reviews these concerns and the implications for restoration of SAV.

Introduction

Estimates of consumption indicate that mute swans consume up to 4 kg of submerged aquatic vegetation (SAV) daily (Sondergaard and others, 1996). Four kilograms of vegetation per day per bird sounds insignificant when compared to the vast quantities of SAV in the Chesapeake Bay, and the population of mute swans is certainly small compared to the multitude of SAV-eating ducks that descend on the Chesapeake Bay each winter. However, studies have shown that waterfowl can and do have substantial impacts upon the number of plants and plant height in SAV beds (Mitchell and Wass, 1996; Sondergaard and others, 1996; Weisner and others, 1997; Idestam-Almquist, 1998), which in turn has a negative impact on water quality which can result in a feedback mechanism with severe implications for the long- term health of this resource (Weisner and others, 1997). This is particularly true for resources that are stressed, and this is the case with SAV in the Chesapeake Bay; 35 percent of Bay program segments (27 of 78) still have no SAV at all, and only 18 percent (14 of 78) have met the Tier I (1971-90) goal.

Even specific areas that sometimes contain vast beds of SAV sometimes experience severe diebacks. For example, Eastern Bay's SAV acreage declined from 1,982 hectares in 1999 to 0 hectares in 2000. Likewise, the Chester River SAV area declined from 294 hectares in 1999 to 0 hectares in 2000.

Several species of swans have been found to have different, more destructive feeding habits than other species of waterfowl. This behavior involves disturbing the sediment to loosen it, then feeding on subterranean tubers that are used in asexual reproduction by SAV. Mute swans have also been observed pulling and consuming intact plants rather than feeding on only parts of plants, as do native waterfowl (Fox, 1996). Through the partial or complete destruction of individual SAV beds, this feeding behavior may impact future SAV growth, resulting in reduced food stocks for both native waterfowl and the increasing mute swan population.

In addition to the amount of food that is consumed and the manner of its consumption, the timing of the feeding activity is another factor that causes concern for biologists. Native species of SAV have evolved concurrently with native waterfowl, and the timing of feeding does not overlap temporally with SAV reproduction. In fact, it is believed that waterfowl act as a vector for distribution of SAV seeds within and between areas along waterfowl flyways (Fore and Mohlenbrock, 1966). Some proportion of the seeds of SAV that are consumed pass through the digestive tract of waterfowl intact and are deposited with feces in locations that may be hundreds of kilometers from where the waterfowl had fed. This could be an effective strategy for recolonizing areas from which SAV has disappeared or for colonizing areas that have seen water quality improvements. Mute swans feed on SAV year round (Allin and others, 1987), and selective feeding behavior may have a significant impact on SAV populations, particularly in areas with low density patches of SAV and high numbers of mute swans. The destructiveness of this feeding impact is greatly increased by the consumption of intact plants themselves before reproductive activities of the plant have been completed, possibly altering SAV community structure by selectively removing the most palatable species (Barrat-Segretain, 1998).

For example, one of the most significant food sources for the canvasback (*Aythya valisineria*) is the native SAV wild celery (*Vallisneria americana*). A quote from the February 10, 1866 edition of Frank Leslie's Illustrated Newspaper:

> It is only in the Chesapeake Bay... where it (the canvasback duck) becomes itself the king of all wild fowl. This excellence is attributable solely to the peculiar food which it finds in that estuary, a plant commonly known as wild celery... This plant, of which the canvasback duck is so fond that it derives from it its specific name... grows on shoals where the water is from eight to nine feet in depth, which are never wholly bare...

Canvasbacks eat tubers, seeds, and vegetative matter of wild celery plants when they arrive from the north to overwinter in the Chesapeake Bay. As the population of wild celery has declined in the Chesapeake Bay, so too has the canvasback population. Mute swans also feed preferentially on wild celery; however, they do so long before the canvasbacks begin their migration, giving mute swans a substantial temporal feeding advantage. Probably more significant than the actual food removal implications, mute swans consume wild celery seed pods before the seeds inside have completed their development, resulting in the systematic loss of entire crops of seeds from wild celery beds. This phenomenon has been recorded in the Gunpowder River (Mike Weldon, Aberdeen Proving Grounds, oral commun.) and the Potomac River, Md. (personal observation). Researchers who collect seeds for artificial propagation have experienced considerable difficulty in locating mature seed pods for this reason.

In addition, because of the sedentary nature of mute swans, it is unlikely that they would serve as a significant inter-waterway vector even if seeds had time to fully develop. Mute swans also feed extensively on above-ground biomass before tubers have begun to form (Sondergaard and others, 1996), thus preventing the plants from forming these important reproductive structures and potentially eliminating the resource from some areas.

It was the consensus of the SAV Task Group that continued expansion of the mute swan population runs counter to the Vital Habitat Protection and Restoration Section of the Chesapeake Bay Agreement, in particular, the goal to "Preserve, Protect and Restore those habitats and natural areas vital to the survival and diversity of the living resources of the Bay and its rivers."

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Biographical Sketch: Mike Naylor, a natural resources biologist with the Maryland Department of Natural Resources, has been studying various aspects of submerged aquatic vegetation (SAV) propagation, transplanting, and ecology for the past 7 years. Mr. Naylor is the chairperson of the Chesapeake Bay Program's SAV Task Group.

Invasive Herbivory: Resident Canada Geese and the Decline of Wild Rice Along the Tidal Patuxent River

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Abstract: While concern grows over the increasing numbers of exotic mute swans (*Cygnus olor*) on the Chesapeake Bay, less attention seems to be given to the highly familiar and native Canada goose (*Branta canadensis*) which has over time developed unprecedented nonmigratory, or resident, populations. Although nuisance flocks of Canada geese have been

well advertised at city parks, athletic fields, and golf courses over the past three decades, recent expansion of populations to an estimated one million birds in the Atlantic Flyway, and to over 100,000 in Maryland, carries a threat of broader ecological consequences.

Our research began over concern for the mysterious widespread decline of annual wild rice (*Zizania aquatica* var. *aquatica*) in an historic rail hunting marsh of the tidal Patuxent River, Maryland, the Jug Bay component of the Chesapeake Bay National Estuarine Research Reserve. Suspecting an unusual source of herbivory, in April 1999 we placed replicate sets of 1 m^2 fenced exclosures constructed of small (1.3 cm), medium (2.5 cm), and large (5.1 x 10.2 cm) mesh wire at six locations on river-bordering tidal mudflats where an even distribution of naturally germinating rice occurred. Two unfenced control plots accompanied each set of exclosures. In April 2000, the experiment was repeated using only the large 5.1 x 10.2 cm mesh wire. We also used an 80 m-long fenced plot to protect naturally occurring river-bordering rice and two 5 x 20 m exclosures planted with rice seed on tidal mud flats to demonstrate restoration. We estimated rice production by sampling seed yield per panicle and panicle density in a natural stand. Panicles were bagged during the seed development stage to capture all seed produced. Depredation of rice by red-winged blackbirds (*Agelaius phoeniceus*) was estimated by subtracting rice fall captured in staked buckets from total panicle production.

In both years, results of exclosures presented an extreme contrast: wild rice grew abundantly inside fenced plots, regardless of wire mesh size, while outside the plots rice was virtually eliminated by grazing by resident Canada geese (*Branta canadensis)*. Damage began at germination (mid-April), when geese uprooted rice seedlings on exposed mud flats. Thereafter, grazing continued until the plants were either eliminated or were too high to be reached. Creches of flightless goslings were believed to be especially damaging to developing rice because the rice reached the floating-leaf stage in May and remained accessible at the water's surface at normal flood tide. Rice grew luxuriantly wherever it was protected by fencing both within exclosures and within the larger natural and planted plots. Within exclosures, rice achieved greater size, higher density, and greater numbers of panicles per plant than rice occurring in natural stands. Production of rice was estimated (dry weight of seed) at 1,350 kg/ha in 1999 and 1,995 kg/ha in 2000. In 1998, we estimated that 72 percent of rice was consumed by blackbirds before shattering. This still left an estimated 2,600 seeds/m^2 reaching the marsh surface.

The devastating effects of Canada geese on wild rice along the Patuxent were surprising, because large numbers of geese were not commonly visible on the marsh during the day (although greater numbers were likely amassing there to roost at night). It became clear that a moderate number of birds could have devastating effects on the rice because of the long, nearly 3-month, early growing phase of the plant. We estimate that the observed loss of rice has been the result of the grazing pressure of 500 or more geese that are clearly time-sharing the marsh with nearby residential and agricultural lands. We suggest that grazing pressure from a growing population overwhelmed the wild rice along the Patuxent in the 1990s, reducing it from monotypic stands to isolated patches. Clearly these large numbers of resident geese are presenting a threat to our natural marshes that, if left unabated, portends radical changes in vegetative composition. Wild rice is viewed as a critical stopover food resource for many migratory birds, and the loss of rice could have deleterious effects on migration and ultimately populations. A major reduction in geese will be required to restore wild rice to its former abundance along the Patuxent River.

Biographical Sketch: Michael Haramis is a research wildlife biologist with the USGS Patuxent Wildlife Research Center near Laurel, Maryland. He earned his M.S. degree in wildlife science at Cornell University and has spent 26 years conducting a variety of field studies of waterfowl and waterbirds mostly in Chesapeake Bay habitats. His career focused for many years on the ecology of wintering diving ducks on the Bay, especially canvasbacks (*Aythya valisineria*). His current research includes studies of the effects of nutria on marsh loss along the Blackwater River, stopover and migrational ecology of sora rails (*Porzana carolina*) on the Patuxent River, and the importance of horseshoe crab (*Merostomata sp.*) eggs to migrant shorebirds, especially red knots (*Calidris canutus*) in Delaware Bay. In cooperation with his colleague Greg Kearns, Mr. Haramis continues study of the stopover and migrational ecology of sora rails on the Patuxent River.

Biographical Sketch: Greg Kearns is resident naturalist at the Maryland-National Capital Park and Planning Commission's Patuxent River Park, located near Upper Marlboro, Prince Georges County, Maryland. Greg's avid interest in wildlife is reflected in his pioneer field investigations with sora rails that began in the mid-1980s, and more recent work with colleague Mike Haramis in investigating sora migration ecology and the cause of the decline in wild rice along the Patuxent River. He is currently engaged in developing management plans to control numbers of resident Canada geese on the Patuxent and leading in an effort to restore wild rice through a large-scale fencing and planting program.

The Mute Swan, Its Status, Behavior, and History in the U. K.

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Abstract: For many years the mute swan has been considered a royal bird. It is a prominent resident throughout the United Kingdom (U.K.), often found on the inland waterways. Some people consider it to be a nonmigratory native bird because it doesn't tend to move large distances and

doesn't often venture far from freshwater. A mute swan may often live out its life cycle in the same river valley in which it hatched. Over the last 30-40 years, a large amount of research has been carried out on their life cycle, behavior, and mortality caused by such factors as lead poisoning from fishing weights. Throughout the U.K., there are a number of areas where mute swans may be found in large numbers, including (1) the River Thames (which passes through London), (2) Slimbridge Wetlands Center, (3) Berwick-upon-Tweed (the second largest mute swan colony in Britain), and (4) Abbotsbury Swannery (the worlds only managed swan colony). This last site is a truly unique area, and each year it often has over 150 nesting pairs producing between 2-12 eggs per nest. The management is minimal, and the site is ideal for their requirements because it is close to a number of freshwater sources, and has good nesting sites and large quantities of eelgrass *Zostera marina* and widgeon grass *Ruppia maritima*, their preferred food sources. The Swannery is located on the south coast of England at the western end of the Fleet Lagoon, a micro-tidal estuary, which borders the English Channel.

Population Status

Some people believe that mute swans were in fact an introduced species. This introduction was perhaps by the Roman Empire or by Richard I after returning from the Crusades. However, there is little evidence to back up these claims. After the last ice age, there was no English Channel separating the U.K. from France. With no sea barrier until later, entry by the birds would have been easier. In addition, following the melting of the ice caps, there would have been extensive exposed wetlands, providing suitable habitat for the swans. It would seem logical that mute swans are indeed native to the U.K.; many believe that they were established before their supposed introduction (Birkhead and Perrins, 1986).

Mute swan distribution is fragmented, and they breed throughout north-central Europe. Only since the early 1900s have mute swans been considered wild birds. They were semi-captive during medieval times and were owned by many local dignitaries; thus they were considered valuable. Swans in the U.K. do not tend to move large distances, and flights across the North Sea, or south across the English Channel, tend to be infrequent. Swan movements over 50 kilometers are rare, and movements over 100 kilometers would represent only 3 percent of the population. However, seasonal movements may exist and tend to be linked to food availability, the search for new territories, and climatic variation. For instance, in Scotland many mute swans may move down the coast for the winter, prior to or following their annual molt; these would be both nonbreeders and failed breeders. The movement would be towards a safe haven for molting and from small rivers to larger water bodies such as lakes, estuaries, and reservoirs (Birkhead and Perrins, 1986).

In Great Britain (England, Wales, and Scotland), the mute swan population has been estimated at 30,000. The following graph (fig. 1) shows data from the wetlands bird survey that was carried out by the Wildfowl and Wetland Trust (WWT). It only represents a sub-sample of the U.K. mute swan population, but it does highlight the rate of population change. The data are presented as a percent of the results from the last survey year. Thus, the population in 1999 would be 100 percent because this is the graph's final survey year, and everything else would be a percent of this figure.

Mute swans occupy a range of lowland wetland habitats. They tend to prefer rivers and shallow slow-flowing freshwater marsh areas and show a preference of being close to fresh water and, subsequently, do not move far away. Mute swans will occasionally nest in coastal settings, such as rocky mounds, a phenomenon that has been recorded in Scotland. They also frequent shallow coastal waters with a micro-tidal setting and moderately saline/brackish water. Artificial habitats (such as gravel pits which possess a rich perimeter of flora and small islands) are also used, because they are valuable for nesting ground. Mute swans may often move to a new habitat during the winter months, and a depletion in aquatic vegetation tends to force the birds to become more dependent on foods such as bread that is supplied by people in urban areas (Birkhead and Perrins, 1986).

Food Habits

Mute swans in the U.K. feed upon submerged leaves and stems of aquatic plants, including crowfoots (*Ranunculus* sp.) and pondweeds (*Potamogeton* sp.). Roots, tubers, and stolons of salt marsh plants such as the asters and species of *Plantago* tend to be fed upon in marsh habitats. In 1956, B. Gillham studied the food habits of 200 mute swans along the river Exe in Devon, southwest England. He found that there were

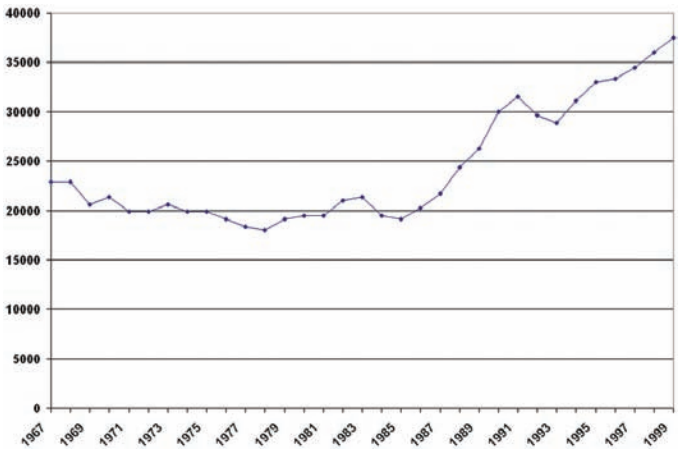

Figure 1. Population of mute swans in Great Britain (1967-1999) (Wildfowl and Wetlands Trust).

seasonal variations in food consumption and that as the birds changed their habitat during the year, they would consume different species of flora. A summary (fig. 2), shows the results.

The volume of food that a mute swan requires may often vary with the time of year. In adults, the food volume increases prior to breeding. Females are at their heaviest just before egg laying and they may put on as much as 2 kg during this period. The cob (male) also tends to become heavier during nesting to enable him to defend his territory more efficiently. Egg production by the pen (female) is extremely demanding, and large amounts of energy are expended in producing eggs, each weighing 300 g. During incubation, the pen will rarely feed at all and is dependent upon fat reserves, which she strategically lays down prior to nesting. During the 5-week incubation period, the female may lose up to 1 kg in weight (Birkhead and Perrins, 1986).

Behavior

Most birds will not begin to breed until they are 3 years or older. Throughout the U.K., nest building tends to take place between March and May. Females tend to lay between 2 and 12 eggs, although between 3 and 7 is most common. The pen will lay an egg every other day, with the last egg laid being the first to hatch (David Wheeler, Abbotsbury Swannery, oral commun). Parents will protect their offspring for the initial few months, although it is uncommon for the young to remain with their parents for longer than 1 year. During the summer molt, July-August, the cygnets will join the flock. Over the next two seasons, the immature swans will bond with a mate, and begin to seek out territory. In general, well-established pairs tend to be better at raising their young. A cob and pen may be successful year after year because of such factors as territory selection. Their ability to defend an area from other mute swans and from predators such as badgers and foxes is also important (Birkhead and Perrins, 1986).

A mute swan's aggression is very often one of its most characteristic traits. Cobs are known to extend a large perimeter surrounding their family. Their behavior may often be unpredictable during nesting time, and they may attack persons on land or in water. One documented account of mute swan behavior from the 1930s relates a cob repeatedly attacking a cow! Swans tend to do little damage with their beak; their wings, however, are a different matter. The birds use their carpal joint (to a human the equivalent would be the wrist), and a strike tends to be powerful. Swans will also fight with other swans over territory when defending their mate or young. One technique used by the cob is to fluff his feathers up to make him look more aggressive and larger than the opposing mute. Fights may lead to the death of one of the swans, and when fighting on the water, they often appear to attempt to drown one another.

Mute swans will not always pair for life and will only on occasion appear concerned for a lost mate. Some swans have been known to have as many as four different mates during their lifetime. In certain situations, a mute swan may "divorce" a mate and then take up with a new one. This has been documented at Abbotsbury Swannery, where each year around 30 percent do not remain faithful to their original mate (Perrins and others, 1995). To sum up their behavior with a quote:

> *"The habits of the swan are extremely peaceful, except in the defense of the female, or her young, or when a rival intrudes on the possession of his mistress. He then forgets his mildness, becomes ferocious, and fights with an obstinate rancor; and a whole day is often insufficient to terminate the quarrel" (Hunt, 1815).*

Mortality Factors

Causes of death may be quite varied. In the U.K., the British Trust of Ornithology maintains a series of records, as does the Northwest England Study Group. However, the reason behind the swan's death is not often clear. The known causes of death among mute swans include:

- Collision (most common examples include trees, powerlines, buildings, etc.)
- Vandalism and shooting
- Predation
- Natural causes (e.g., bacterial infections, digestive disorders, airsacculitis, and starvation).

During the 1960s, the mute swan population within Great Britain dropped significantly (www.northwestswanstudy.org .uk). Many birds were dying from lead poisoning caused by the ingestion of lead. Birds were picking it up as they searched out grit for grinding up their food. Lead is ground down by the gizzard and subsequently enters the blood stream. Muscular weakness is experienced by the birds; a swan's drooping neck

Spring / early summer

Sea arrowgrass	*Triglochin maritima*
Sea plantain	*Plantago maritime*
Common Saltmarsh grass	*Puccinellia maritima*

July / August

Eelgrass	*Zostera marina*
Green algae	*Enteromorpha* sp.

Late fall / winter

Swans fed on nearby marshes and bread provided by the public

Figure 2. Mute swan food consumption habits of 200 birds in the river Exe, 1956 (Birkhead & Perrins, 1986).

giving it a kinked appearance, is indicative of this (www.northwestswanstudy.org.uk). So one question was, "Why did it take such a long time before the mute swans became symptomatic of the lead poisoning?" Two theories were put forward:

1. The lead levels had to reach a critical level of bio-accumulation before the bird would become symptomatic
2. Fishing habits had changed.

The first of these theories was discredited; however, the second was deemed very plausible. Prior to the 1950s, cotton line, a hook, and catgut were used and reused. Following the 1950s, new nylon monofilament was used, and anglers began discarding the line between the float and hook, i.e., the section with the lead weight (Perrins and Birkhead, 1986).

Shot becomes entwined with the aquatic vegetation and later ingested by the swans during their feeding. During the 1980s, mute swan lead levels were investigated by Perrins and Birkhead. Some of the results tended to show increased lead levels with closer proximity to urban areas such as London (Birkhead and Perrins, 1986).

There is a strong relationship between lead concentration and fishing season. These findings resulted in a lead weight fishing ban, which is still in effect today. In 1987, it became illegal to use small lead fishing weights in England. The ban on lead was also extended to wildfowlers who were prohibited from using lead in September 1999. It is illegal to shoot with lead pellets over England wetlands designated as SSSIs, (Special Site of Scientific Interest), and now lead cannot be used to shoot coot, moorhen, plover, snipe, ducks, or geese (www.northwestswanstudy.org.uk).

Deaths caused by direct lead poisoning have since declined, and this has been evident in the North West Study Group sample, which saw only six cases of lead poisoning between 1988 and 1994. The North West Study was founded in 1988 and is concerned with mute swan research. They are affiliated with the WWT who assist with the study, and their work covers such areas as northwest population dynamics, distribution, breeding sites, and movements of mute swans.

Swan Upping

The mute swan has been a prized bird for many years. It acquiring royal status in the 12th Century and, thus, escaped swans became property of the Crown. The Crown claimed ownership of all mute swans during a period when they were considered an important food source for banquets and feasts. In 1378, a keeper of the King's swans was appointed. Swan upping takes place along the River Thames in London, when all new cygnets are given the same mark as their parents. This tradition dates back to medieval times (www.thamesweb.co.uk).

Swan upping is an annual event, and the journey up the river lasts for 5 days. The Crown retains the right to own their own mute swans in open water, but the current Queen of England only exercises this right along certain stretches of the River Thames and some of its numerous tributaries. However, there are three companies that also have the right to own mute swans; these are:

- The Worshipful Vintners Company (on the River Thames, London)
- The Worshipful Dyers Company (on the River Thames, London)
- Abbotsbury Swannery (Dorset, on the south coast of England)

Swan upping involves the Queen's Swan Marker and Swan Uppers, who are accompanied by the two companies, the Vintners and Dyers. Six traditional Thames rowing skiffs are used over the 5 days. Both companies wear traditional scarlet uniforms, and their boats fly the relevant flags and pennants. During swan upping, mute swan families are rounded up, the parents have their beaks examined, and ownership is determined (www.thamesweb.co.uk).

The cygnets are then marked according to ownership. In previous years, the Worshipful Company of the Dyers has made a nick on one side of the bird's beak, and the Worshipful Company of the Vintners has made a nick on both sides of the beak. Royal swan beaks are left unmarked. Once the families are rounded up, the Queen's swan warden is responsible for marking the royal birds' cygnets with rings (bands). In addition, the cygnets are weighed, their growth is assessed, and they are given a brief medical examination. Following the annual swan upping, a report is produced by the swan marker, which provides information on swan counts, brood sizes, and other information on the cygnets (www.thamesweb.co.uk).

Abbotsbury Swannery

Abbotsbury Swannery conserves the world's only managed colony of nesting mute swans. The records date back over 600 years, to a time when Benedictine Monks from the Monastery of St. Peter took advantage of the unique setting in order to harvest the birds for meat, and use their quills for writing. The first written record of the swannery is in the court roll, written in gothic lettering, dating back to 1393. However, some claim it may be even older, perhaps dating back to 1320.

The monks used the swannery until 1539, when it was dissolved by King Henry VIII. The swannery, along with over 80 hectares (200 acres), came into private ownership in 1543 and is still owned by the same family to this day, the Strangways. This family was also granted ownership privileges to all swans hatching at Abbotsbury. Today the nesting is managed as a tourist attraction, and the emphasis is on nature conservation as opposed to farming the birds for food and feathers. Each year over 100,000 people visit the swannery to witness the nesting and hatching of the birds. The 0.3 hectare (0.8 acre) nesting site is prepared annually by staff, and the swans will mostly arrive from feeding areas further down the Fleet Lagoon (Fair and Moxom, 1993).

As larger numbers of mute swans arrive at the nest site it becomes necessary to provide them with a food supplement, and initially they are fed wheat. Common reed is harvested each year from an area close to 20 hectares (50 acres). This helps to provide nesting material for the swans, which may often number 150 pairs. Mounds of reed are positioned at established sites, and willow sticks help to elevate the bundles. Other site preparation includes water level adjustment in the adjacent streams and ponds because many birds will continually return to the same territories (Fair and Moxom, 1993).

March and April tend to be one of the more interesting times of the year, as nest construction is continually interrupted by territorial disputes. Very soon after mating, egg laying begins, and for the swannery, average clutches may be slightly lower than the rest of the UK, usually 5-6 eggs per nest. Hatching takes place from mid-May, and in 2001, the first eggs hatched on May 16, and 163 pairs of mute swans nested during the season, a swannery record.

Once cygnets have dried out after hatching, each receives a numbered metal tag, which is clipped to the end of its web, the left for males, the right for females. In addition, the opposite web to the one tagged has a small incision made at the tip of the web. This is a mark of ownership for Abbotsbury birds called the "Hive of Ilchester". The tag information is recorded, along with the parents' band-code and number. This technique allows lost cygnets to be reunited with their parents very quickly (Fair and Moxom, 1993).

Each of the families is fed wheat mixed with high protein crumbles at the nest three times a day. While they are fed, the nonbreeders are enticed to the water, by rolling a wheelbarrow laden with wheat through the nest site, and down to the water's edge. It is certainly not difficult to gain the attention of 400 swans, and wheeling the food down through the nest site will gain the interest of many individuals. Feeding nonbreeders is not really necessary but it does help thin out the nest site, and allows the parents and their cygnets to feed undisturbed. From late August onwards, the cygnet survivors each receive two leg bands. The first of these is a larger plastic ring called a darvic, which has three letters; an example would be BHS, and the next in the sequence would be BHT, etc. In addition, they also receive a metal ring, which is called a BTO for (British Trust of Ornithology). The BTO has a Z, followed by 5-numbers engraved upon it; an example would be Z54264. Quite often, some of the Queen's birds may arrive at the Swannery from elsewhere, and many will stay. Their ownership is denoted by a yellow band. If any of the Queen's birds nest at the Swannery, then the cygnets instantly become property of the estate owner, the honorable Mrs. Charlotte Townshend (David Wheeler, Abbotsbury Swannery, oral commun).

All the nesting details are recorded and sent to Dr. Christopher Perrins at the Edward Grey Institute of Field Ornithology at Oxford University. The swannery also has five rearing pens on the edge of the lagoon. In these are placed swan families from unsuitable nesting locations. Extra cygnets are also fostered from large families on the nest site, which helps to increase their survival. The survival of mute swan offspring is particularly poor in a colonial nesting situation. On average, 66 percent of all cygnets that hatch perish before the end of the nesting season. In 2000, over 80 percent of all cygnets failed to reach maturity. This was attributed to fox and badger predation and attacks by other nesting cobs and pens (David Wheeler, Abbotsbury Swannery, oral commun).

Every two years the Swannery holds a "swan roundup." The aim is to capture as many mute swans as possible from the Fleet Lagoon which lies adjacent to the swannery. Timing is very important, and roundups tend to take place during the mute swans' annual molt in July. On day one, a canoe team paddles from the far eastern end of the lagoon in a westerly direction for 14.4 km (9 miles); this usually takes most of the day. At the end of day one, an air-filled boom is placed across the lagoon at the far western end. This prevents all the rounded -up birds from swimming eastwards overnight. Day two involves the capture of the birds: the herd of mute swans are pushed onto land by boats, and are driven into a large prebuilt pen. Each of the swans is then caught, weighed, and banded. Swans with bands are given replacements if the band is excessively worn. Finally, each swan is given a brief medical examination prior to release. All the data are recorded by hand throughout day two. It is then transferred to a database and sent to Oxford University for population analysis (David Wheeler, Abbotsbury Swannery, oral commun).

Research of the mute swan colony has taken place for nearly 30 years by scientists from Oxford University and it would appear that this will continue for many years. The research undertaken will allow more comparisons to be made between a colonial mute swan setting, and more secluded locations within the British Isles.

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Biographical Sketch: Edward Lohnes was born on April 5, 1975, in the county of Norfolk, on the east coast of England. In 1995 he began a summer job position working at Abbotsbury Swannery, a mute swan colony located on the south coast of England. In the summer of 1996 Edward began a degree in "Coastal Zone and Marine Environment Studies" at the University of Glamorgan, in Pembrokeshire, Wales. He graduated with a B.S. in the summer of 1999, during which time he completed a variety of field work in England, Wales, Ireland, and Iceland. His seasonal work at Abbotsbury Swannery, 1995-2000, led to an interest in mute swans, and he sought out work overseas following the completion of his degree. In October 1999, he came to the United States, and began working for Dr. Matthew Perry at the USGS Patuxent Wildlife Research Center. This work involved a number of habitat restoration projects, and Chesapeake Bay research with seaducks. He has worked full time at Patuxent since then as a visiting scientist, with several trips back to the U.K. to assist with activities at the Abbotsbury Swannery, including the management of their annual nesting.

Mute Swan Interactions with Other Birds in Chesapeake Bay

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Abstract: The mute swan (*Cygnus olor*) is an exotic species that became established in the Chesapeake Bay area as a result of captive birds escaping in 1962 and then successfully breeding in the wild. Mute swans exhibit aggressive behavior towards other waterfowl, displacing native nesting and wintering species and killing ducklings and goslings. In Maryland, the presence of a molting flock of mute swans led to the abandonment of nesting colonies of least terns (*Sterna antillarum*) and black skimmers (*Rynchops niger*), both state-listed threatened species, in the Tar Bay area of Dorchester County. The molting flock of mute swans, numbering over 600 individuals, used the oyster shell bars and beaches as loafing areas and disturbed the nesting terns and skimmers. Mute swans may indirectly impact wintering waterfowl by reducing the availability of submerged aquatic vegetation as food for the native species.

Introduction

The mute swan (*Cygnus olor*) is a relatively recent addition to the avifauna of the Chesapeake Bay. The species is native to Eurasia (Ciaranca and others, 1997). The Chesapeake Bay population originated when five pinioned birds escaped from a private waterfront estate along the Miles River in Talbot County, Maryland, in 1962 and then successfully bred in the wild (Reese, 1969). The population increased to more than 400 birds by 1980 (Reese, 1996) and was concentrated mainly in the tidal waters of Talbot County. During the mid-1980s, the breeding population was distributed primarily in the mid-Eastern Shore section of Maryland, especially in Eastern Bay, the Choptank River, and the mouth of the Chester River. Some breeding was documented along the Bay shoreline in Dorchester County, and some observations were made on the western side of the Bay in Maryland (Reese, 1996). Maryland Department of Natural Resources (MD DNR; unpub. data) surveys in 1999 documented the mute swan population at 3,955 birds.

Introduced exotic species can cause problems with native birds and other wildlife. The European starling (*Sturnus vulgaris*) is a classic example of an introduced species that has impacted native species. It has had a detrimental effect on many North American cavity-nesting birds (Cade, 1993), nearly eliminating the red-headed woodpecker (*Melanerpes erythrocephalus*) from east of the Appalachian Mountains and drastically reducing the eastern bluebird (*Sialia sialis*) population (Terborgh, 1989). Introduced species have been identified as the second leading cause of biodiversity loss on the planet (Myers, 1997).

Will the introduction of mute swans to the Chesapeake Bay cause declines or losses of native birds? The answer to this question remains to be determined. Fofonoff and others (1998) classified the mute swan as an exotic species with serious, but localized, impacts to native species in the Bay watershed. This paper summarizes the known interactions of mute swans with other birds in the Chesapeake Bay and the impacts of such interactions.

Interactions with Waterfowl

Mute swans occupy the same aquatic habitats as with many native waterfowl species; thus, the opportunity for interactions exists. Waterfowl using shallow water areas, either tidal or nontidal, or impoundments are most likely to interact with mute swans. Such native waterfowl include dabbling ducks, Canada geese (*Branta canadensis*), and tundra swans (*Cygnus columbianus*). Mute swans are larger than all species of waterfowl that are native to the Chesapeake Bay and, therefore, have an advantage during aggressive interactions.

Mute swans are territorial during the nesting seasons (Ciaranca and others, 1997), with some pairs exhibiting intense aggression (Stone and Masters, 1970; Anderson and Titman, 1992). This is the time of the year when aggressive behavior is exhibited by mute swans towards other waterfowl. Males are particularly territorial during the egg-laying and incubation periods (Ciaranca and others, 1997). Antagonism with other waterfowl does vary among mute swan pairs, with some exhibiting complete tolerance to other species while other pairs aggressively attack waterfowl intruding within their nesting territory (Ciaranca, 1990).

Aggressive behavior towards other waterfowl involves the mute swan, typically the male, moving directly at the intruding species and chasing it away. The swan will pursue the intruder

by swimming, flying, or even running on land (Ciaranca and others, 1997) until the other species leaves the nesting territory. Several accounts of such behavior have been reported by members of the public to the MD DNR (unpub. data).

In instances where the intruding waterfowl has been a female with young, mute swans have been documented as attacking and killing the flightless juveniles. Mallards (*Anas platyrhynchos*) nest in the same habitats as mute swans, and several reports of young mallards being attacked and killed by mute swans have been received by the MD DNR (unpub. data). Most of these observations have been in suburban and residential waterfront areas. Black ducks (*Anas rubripes*) nest in the same tidal marshes as mute swans and may be subjected to similar attacks by swans, but the attacks have gone undetected due to the remoteness of the nesting areas. In Connecticut, the killing of a blue-winged teal (*Anas discors*) by a mute swan was documented (Allin and others, 1987). This duck also nests in the marshes of the Chesapeake Bay. Canada goose goslings have also been attacked and killed by aggressive mute swans in Maryland (MD DNR, unpubl. data).

Displacement of breeding waterfowl by mute swans has also been documented (Allin and others, 1987). Kania and Smith (1986) observed a pair of mute swans build their nest atop an active mallard nest, causing the female mallard to renest elsewhere. However, displacement of other nesting waterfowl does not always occur. In Maryland, two MD DNR biologists found an active mallard nest within 5 m of an active mute swan nest with no apparent adverse impacts to the mallard's nesting attempt.

Mute swans may also displace native waterfowl outside of the breeding season. During the first seven years of mute swan population growth in Maryland, three waterfront landowners reported that wintering tundra swans (*Cygnus columbianus*) and Canada geese were seldom tolerated in the home range of paired mute swans (Reese, 1975).

Interactions with Threatened Species

In Maryland, least terns (*Sterna antillarum*) and black skimmers (*Rynchops niger*) are listed as threatened species (Md DNR, 2001). Both are colonial nesting waterbirds that nest on bare beaches in the tidal portions of the state. In Maryland, the number of least tern colonies ranged from 10-15 during the 1980s and 1990s; for black skimmers, the number of colonies was 5-6 (Gates and others, 1992; Brinker and others, 1996). Their colony sizes range from a few pairs to several hundred, and natural sites are usually on islands that are inaccessible to mammalian predators.

Two such colony sites were in the Tar Bay area of Dorchester County. Tar Bay is located between Barren Island to the west and Hooper and Upper Hooper islands to the east. It is a shallow tidal bay with extensive dense beds of submerged aquatic vegetation (SAV). A series of sand and oyster shell bars and beaches provided ideal nesting habitat for two colonies of least terns and black skimmers. The two colony sites were referred to as Tar Bay and Oyster Bar.

The Tar Bay colony ranged from 40 to 247 nesting pairs of least terns during 1985 through 1987 (Gates and others, 1992; MD DNR, unpub. data). In 1987, this was the largest colony of nesting least terns in the State and accounted for 49 percent of the total nesting population statewide. Oyster Bar supported far fewer nesting least terns: 22 pairs in 1985 and 2 pairs in 1987. Thirteen pairs of black skimmers nested on Oyster Bar in 1985. This was one of only two small colonies of nesting skimmers in the Maryland portion of the Chesapeake Bay. Small numbers of common terns (*Sterna hirundo*) also nested in these colonies: eight pairs on Oyster Bar in 1985 and seven pairs on Tar Bay in 1987.

By the late 1980s, a molting flock of mute swans started congregating in the Tar Bay area. Such flocks have also been documented in Sweden (Mathiasson, 1973). The combination of protected open waters, abundant SAV (upon which the swans feed), and loafing areas attract such flocks of molting birds. During the molt, mute swans are flightless for eight weeks (Palmer, 1976), which, for the flock of prebreeders in the Tar Bay area, coincided with the peak nesting period of least terns and black skimmers. By the early 1990s, the number of mute swans in the molting flock was over 600 (Brinker, pers. observ.).

The flightless swans made extensive use of the shell bars and beaches as loafing areas. While monitoring tern and skimmer nests, we observed swan tracks throughout the colonies. On most visits, mute swan tracks completely covered tern and skimmer nesting areas, as well as most other open spaces. No eggs or young were found crushed, all remnants having been trampled into the sand. Loss of eggs and young was assumed to be caused by mute swans, based on the tremendous amount of surface area on which swan tracks occurred. During our visits to the colonies, loafing mute swans departed from colony sites as our boat approached. Therefore, we have no observations of direct agonistic behavior of mute swans towards the nesting terns and skimmers.

Colonial nesting waterbirds are susceptible to disturbance (Gochfeld, 1983; Mueller and Glass, 1988; Erwin, 1989) and will abandon colonies if disturbance is too frequent or of an extreme nature. The regular occurrence of hundreds of flightless mute swans loafing amongst the least tern and black skimmer colonies in the Tar Bay area in the early 1990s disturbed these nesting waterbirds to the point that the number of pairs declined and the colonies were abandoned by 1993 (fig. 1). Habitat conditions at the colony sites were still suitable for nesting, so loss or alteration of habitat was not a factor.

Since the MD DNR and U.S. Fish and Wildlife Service reduced the size of the molting flock of mute swans in the mid-1990s, some least terns have returned to the area for nesting (fig. 1), though not in numbers comparable to the mid 1980s. Even though the mute swan molting flock was reduced to fewer than 100 individuals, these flightless birds still use the shell bars and beaches for loafing.

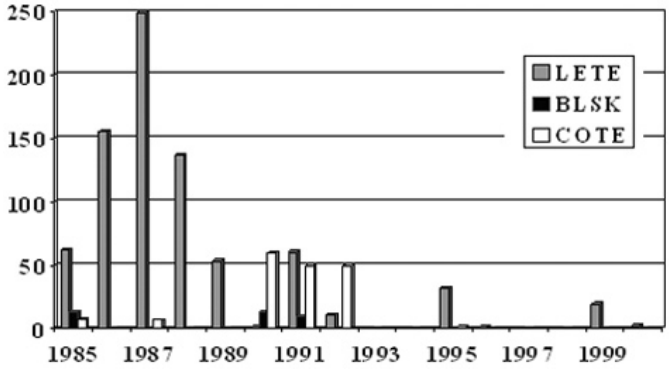

Figure 1. Number of nesting pairs of least terns (LETE), black skimmers (BLSK), and common terns (COTE) in the Tar Bar area of the Dorchester County, Maryland.

Indirect Interactions

Because mute swans feed primarily on SAV (Ciaranca and others, 1997; Perry and others, 2004), their consumption may reduce SAV availability to other waterfowl. Several species of wintering waterfowl feed primarily on SAV (Stewart, 1962) and their populations could be impacted by any reduction in their food supply caused by consumption by mute swans. Declines in SAV abundance in the 1970s and 1980s shifted the distribution of tundra swans and geese in the Chesapeake Bay (Munro and Perry, 1981; Perry and Deller, 1996). Though the reduction in SAV during that time period was not caused by mute swans, losses of recovered SAV to mute swans could have similar results on native waterfowl that feed on aquatic grasses.

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Biographical Sketch: Glenn Therres holds a B.S. degree in zoology from the University of Maryland and an M.S. degree in wildlife management from Pennsylvania State University. He has been employed as a wildlife biologist by the Maryland Department of Natural Resources for 20 years. Mr. Therres has supervised the State's conservation of nongame wildlife and endangered species since 1986, including overseeing MD DNR's colonial waterbird project.

Biographical Sketch: David Brinker holds a B.S. degree in ecosystems analysis from the University of Wisconsin - Green Bay. He has been employed as a wildlife ecologist by the Maryland Department of Natural Resources for 13 years. Mr. Brinker has served as the State's colonial waterbird biologist and technical expert since 1989.

Mute Swans: Natural (?) Environmental Indicators

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Abstract: The rapid expansion of the Chesapeake Bay's population of feral mute swans (*Cygnus olor*), coupled with a dramatic Bay-wide decline in submerged aquatic vegetation (SAV), has fueled much of the current debate surrounding the need for a management plan to protect the aquatic food resources that are critical to many species native to the Bay. Crucial to this decision process is a sound understanding of the ecological ramifications of having the year-round presence of a large, nonnative, aquatic herbivore on the Bay. Ultimately, this will require a quantitative assessment of the ecological harm currently posed by mute swans before a biologically defensible management strategy can be developed. Unfortunately, very little new information specific to the Bay's mute swan population has been gathered since Reese first studied them in the late 1960s and 1970s. While the debate over what to do about the rapidly expanding mute swan population continues, there is much that can be gained from study of this beautiful intruder.

Several recent studies of the feeding habits of mute swans have shown that mutes can provide a unique barometer, or indicator, of environmental conditions. Because of their reliance on SAV as a primary food source, monitoring the density of swans utilizing a particular area can give some indication of the status of the area's grass beds. This phenomenon was clearly demonstrated during the summer of 1999 when there was a dramatic decline in the number of swans observed around the Eastern Neck NWR, a traditional population stronghold. The shift in bird use was precipitated by a rapid, large-scale collapse of the area's aquatic grass beds, possibly the result of a prolonged drought. During the winter of 2000/2001, a similar ecological assessment was conducted by comparing body weights of swans collected from Tangier Sound, an area with relatively abundant grass beds, and swans from the waters adjacent to Eastern Neck Island. Swans weights tended to reflect the conditions of their surroundings, with the Tangier Sound birds being slightly heavier at the onset of the breeding season. Interestingly, the birds at Eastern Neck showed a 1 kg decline in weight after dispersal from their wintering locations and entered the breeding season with noticeably less subcutaneous fat than the birds sampled in Tangier Sound.

The fact that mute swans are nonmigratory and feed exclusively on benthic food items makes them an ideal organism to monitor the degree of contamination of sediments within the Bay. In 1995, we compared the accumulation of metals by mute swans and other waterfowl and related it to metal concentrations in the sediments from the areas where the birds were collected. This study led to the development of an exposure model that more accurately assesses the risk of exposure to environmental contaminants through incidental ingestion of sediments, as opposed to the traditional assessment of contaminant accumulation through the food chain. This sediment exposure pathway was subsequently shown to be the primary route of exposure of swans to metals in risk assessments conducted at two Superfund sites.

Biographical Sketch: Daniel Day is a wildlife biologist with the USGS Patuxent Wildlife Research Center in Laurel, Maryland. He has been involved in waterfowl and waterbird research since 1990, including extensive work with swans since 1995. Much of this research has focused on the toxicological effects of dietary exposure to environmental contaminants to various waterfowl, including mute and tundra swans (*Cygnus columbianus*), through study of their natural diets. This work has involved feeding trials under controlled conditions, as well as study of wild waterfowl throughout the Chesapeake Bay region. His work has included toxicological studies investigating the effects of dietary exposure of various metals, such as arsenic (Aberdeen Proving Grounds, Maryland), white phosphorus (Eagle River Flats, Alaska), and lead (Coeur d'Alene, Idaho) to mute swans through incidental ingestion of contaminated sediments. Current research examines potential seasonal shifts in mute swan diets and degree of foraging overlap with wintering tundra swans.

Mute Swan Task Force

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Abstract: The purpose of the Mute Swan Task Force was to provide the Maryland Department of Natural Resources (DNR) with recommendations that the DNR would consider in the formation of a statewide mute swan (*Cygnus olor*) management plan. Members of the Task Force were drawn from the Maryland Waterfowl Advisory Committee and included representatives from animal welfare and national exotic species management efforts. The Task Force worked for about two years, drafting an extensive report on existing information about the biology and history of mute swans in the Chesapeake Bay and on species management in Maryland and other states. Recommendations of the Task Force were drafted through a consensus-building process which resulted in both broad and specific recommendations regarding the management of impacts that mute swans may have on rare species and on submerged aquatic vegetation, as well as management of conflicts between humans and mute swans on the Chesapeake Bay shoreline. The Task Force's consensus on its goals and objectives, issues, and specific recommendations will be discussed. In addition, the status of the Maryland Mute Swan Management plan and management efforts to date will be briefly reviewed.

The following is the outline of the major components of the Mute Swan Task Force:

Purpose:

To provide recommendations to the Maryland Department of Natural Resources (DNR) on the management of mute swans in the State through the review of mute swan:

- Population status
- Existing information on mute swan impacts on other living resources
- Existing information on mute swan conflicts with humans

DNR is considering Task Force recommendations in the drafting of its Mute Swan Management Plan. DNR values Task Force consensus because of: Diverse interests represented Consensus represents framework for management options that may be acceptable to a diversity of constituent interests.

Members:

Waterfowl Advisory Committee Existing Members

Federal Wildlife Biologist

Refuge Manager

Chesapeake Bay Ecologist

Eastern Shore Waterfowl Hunting Interest Ornithologist

Maryland General Assembly Member Environmental Matters Committee

State Veterinarian

Wildlife Advisory Commission

SPCA

Humane Society

Defenders of Wildlife

Citizen Mute Swan Advocate

Goals:

1) To summarize population status of mute swans and their impacts on habitat, native species, and the public
2) To generate recommendations for resolutions to problems presented by mute swans, specifically, potential/documented problems and site-specific/ecosystem-wide problems, and detailing responses to these problems

Context:

1) Task Force purpose is to provide recommendations, not to set policy
2) DNR will consider recommendations with scientific information and public input and will use them to make final policy
3) Task Force reports to the Waterfowl Advisory Committee
4) Task Force is obligated to work within legal mandates and limitations of the DNR
5) Task Force can agree to specific statute or regulation changes

6) Members bear a responsibility to other members, including treating them with respect and fulfilling all obligations made through the Task Force

7) Members have a responsibility to actively participate in the work of the Task Force

Consensus on Issues:

1) Mute swans are inherently valuable

2) Mute swans impact native wildfowl habitat (SAV) species, and state-listed species

3) Mute swans impact water quality

4) There is a lack of public education on mute swans

5) Mute swans can conflict with humans

6) The population of mute swans is a contested issue

7) The legal status of mute swans is a contested issue

Process Goals:

1) Collaboration among members' knowledge and expertise

2) Conflict Management

3) Consensus Building

Process:

1) Build trust and respect by setting safe boundaries (ground rules/goals/i.d. roles)

2) Bridge isolation of members (issue identification/pros and cons)

3) Develop consensus on how to use information to reach final recommendations

4) Use information to critique issues and develop agreement on them

5) Use information to develop agreement on recommendations

6) Develop protocol for management of information generated by group

Role of Participants:

1) Facilitator: Process guide
Helps committee get from where it is to where it wants to be

2) Committee Members: Content
(Members provide input on the final product of the committee from their individual perspectives)

3) Expert Commentator:
Provides expertise on issue when needed by committee to make decisions; drafts Task Force white paper

Ground Rules:

1) Respect each other

2) One person speaks at a time

3) Only accountable input is allowed; each member must have a proposed solution for each problem he or she raises during the discussion

4) Committee decisions are made at meetings; committee meetings will go forward in the process

5) Committee members are expected to share information affecting the mute swan with all other members

6) Only committee members may participate in committee discussions

Issues, Possible Research, and Recommendations: Issue 1: Mute Swans are Inherently Valuable

1. Mute swans are beautiful and pleasing to many Maryland citizens

2. Mute swans can represent positive emotions to those who feel a special connection to them

Possible research: DNR should consider conducting a survey on public perception, values, and knowledge about mute swans to assist in education and outreach efforts. This survey could assist the department in identifying target audiences so that effective communication strategies can be developed.

Recommendation: Maintain some population of mute swans in the Chesapeake Bay and its tributaries for public enjoyment in select areas.

Issue 2: Mute Swans Impact Native Wildfowl Habitats (SAV) and Species, As Well As State-Listed Species

1. DNR priority: to protect and enhance habitat for native species, especially listed ones.

2. Task Force agreed (one dissenting) that removal of mute swans from rare nesting habitat of listed water birds was/is reasonable when mute swans negatively impact them.

3. Task Force agreed (one dissenting) that mute swan competition with a state-threatened and other colonial waterbirds for open sandy beach should be addressed to

ensure that this habitat is available for colonial waterbirds during their nesting period.

4. SAV has declined in the Chesapeake Bay in the past 40 years and is currently at 58 percent of the biomass and distribution goals for SAV set by the DNR. SAV is a limiting factor for some waterfowl species. Mute swans exert additional pressure on SAV. Mute swans could exert local pressure on SAV that could affect SAV regeneration, based on exclosure studies.

Possible research:

1. Measure the extent of Bay-wide and local impacts of mute swans feeding on SAV in the Bay, especially where SAV is most vulnerable.
2. Measure the extent to which mute swans have or can contribute to loss of SAV and other habitat and how this can affect native populations of aquatic species and waterfowl.
3. Monitor interactions between mute swans and tundra swans, as well as other native waterfowl.
4. Measure how well or how poorly SAV beds in the Chesapeake Bay recover from grazing by mute swans.

Recommendations:

1. Develop criteria to designate "swan-free zones" to protect sensitive habitats and Bay resources, including:
   a. maintain the zones seasonally or year-round
   b. include areas where SAV is most sensitive
   c. SAV restoration plantings
   d. rare nesting habitat for state-listed water birds
   e. preference given to nonlethal options
   f. monitor zones for mute swan activity
2. Swans should be killed only after nonlethal options are exhausted and in situations where it is necessary as a last resort. Criteria for killing swans should be as restricted as it is for killing resident Canada geese (*Branta canadensis*).
3. Local government agencies and private land managers should be able to implement appropriate options on properties under their jurisdiction or care.
4. If mute swans repopulate "swan-free zones" after removal, strategies for excluding or removing them again will be based on the set of guidelines that were used to determine the appropriate option for initial exclusion or removal.
5. Consider restricting artificial feeding of mute swans in environmentally sensitive areas.

Issue 3: Mute Swans Impact Water Quality

1. Mute swans may impact water quality by dislodging sediment while feeding. They may also contribute to an increase in coliform counts where mute swan flocks congregate. This is of particular concern in areas of beds of shellfish beds used for human consumption
2. Very little is known about this issue. Research is needed to determine its occurrence in Bay waters.

Recommendation:

Areas identified by DNR as being environmentally sensitive to coliform counts from mute swan flocks should be designated as "swan-free zones." Criteria for this designation in Issue 2 should be developed for water quality issues.

Issue 4: There is a Lack of Public Information on Mute Swans

1. Most people know very little about mute swans
2. Educating people about their biology and interaction with Chesapeake Bay habitats and native wildlife could help increase public support for their management and could help shoreline landowners and recreationists learn to avoid conflict with them

Possible Research:

1. Survey on public perception, values and knowledge about mute swans
2. Could assist the Department in identifying target audiences.
3. To Develop effective communication strategies

Recommendations:

1. Develop an education effort for shoreline landowners about mute swans, their behavior, and how to manage conflicts, including information on egg addling and on how feeding may contribute to future conflicts
2. Develop information for shoreline landowners about fencing to exclude mute swans

Issue 5: Mute Swans Can Conflict with Humans

1. Nesting mute swan pairs have been known to be aggressive toward humans and pets
2. Mute swans may defend a territory of 10-13 acres
3. Mute swans may impact SAV beds in impoundments that are designed to shelter fishery resources

Recommendations:

1. Develop criteria and guidelines; nonlethal actions preferred
2. Require that each complaint is investigated by Wildlife Services (USDA)
3. Killing of swans as a last resort
4. Require a historical record of the problem and past use of nonlethal techniques only by professionals in most humane manner. (One member felt that swans should not be killed under any circumstances.)

5. Allow local government agencies and private land managers to implement appropriate options on properties under their jurisdiction or care under the law
6. If mute swans repopulate an area after removal because of conflicts, base strategies for excluding or removing them again on the set of guidelines that were used to determine the appropriate option for initial exclusion or removal

Issue 6: The Population of Mute Swans in Maryland Is an Issue

1. Population of mute swans has increased from about 100 birds in the mid-1970s to nearly 4000 birds in 1999
2. Population could reach 20,000 birds in 10 years
3. Percent of sub-adult mute swans dominates the population
4. There are impacts on SAV and native species (sub-adults)
5. The increase in mute swan population will lead to an increase in potential human/mute swan conflicts (nesting pairs/sub-adults)

Possible research:

1. Continue monitoring research on immuno-contraceptives that are being developed for geese; investigate potential for use with mute swans
2. Monitor population of mute swans in Maryland's Chesapeake Bay annually for numbers and expansion of distribution around the Bay

Recommendations:

1. Mute swans should not be eradicated in Maryland
2. DNR should move with caution toward providing people with pet swans
3. The Task Force did not set a maximum or minimum number on the Maryland Chesapeake Bay mute swan population

Issue 7: The Legal Status of Mute Swans Is an Issue

1. Determine the scope of authority for DNR to set regulations to manage the mute swan population
2. Current status is "wetland game bird" in Maryland statute
3. DNR has authority to set regulation regarding their captivity, breeding, transport, import, hunting, or destruction as well as to set population limits locally or Bay-wide.

Recommendations:

1. Mute swans should remain "wetland game birds."
2. No hunting season should be set in the foreseeable future. Hunting should be considered in view of public preferences and how hunting would contribute to populations, management goals locally or Bay-wide.
3. Regulations for mute swan captivity, sale, transport, import, and breeding should be developed and enforced in a manner similar to regulations affecting other wetland game birds
4. Permits to transport mute swans to other states should require written permission of the wildlife agency of the recipient state

The Task Force further recommends that the State should allocate appropriate funds for mute swan education, research, and management needs.

Recommendations regarding management options:

1. Exclusion (i.e., fencing)
   -Should be attempted wherever possible
   -Provide information to landowners
   -Develop for "swan free zones" where possible
2. Harassment
   -Investigate and develop effective harassment strategies for "swan-free zones" or other areas as appropriate
3. Chemical repellents should not be used to exclude mute swans
4. Immuno-contraception
   -Investigate potential for use with swans as an option for distant future
5. Sterilization
   -Caponization (the removal of testicles) should not be used
   -Vasectomy only under general anesthesia by veterinarian when birds are young
6. Capture and relocation
   -Should be captured and relocated where possible
   -Care given to not create increase distribution of mute swan in new, viable populations
   -Caution over providing wild mute swans as pets
7. Prohibit feeding
   -Unenforceable, except possibly in "swan-free zones."
8. Regulate importation
   -In conjunction with the development of regulation regarding mute swan captivity, breeding, sale, and translocation
9. Egg addling/replacement
   -Should continue on public and private properties; private properties by permit. (One member wanted to leave two eggs in each nest untouched.)
10. Capture and removal for human consumption not an acceptable management option

11. Removal by shooting
    -Acceptable option where criteria (including historic problems and attempted us of nonlethal management options) show that the killing of swans is necessary in the establishment or maintenance of "swan-free zones" and where capture and euthanasia are considered inhumane options (one dissension)
12. Establishment of swan hunting season
    -Not recommended for the foreseeable future
    -Information is needed about:
        a. How Maryland citizens perceive the value of mute swans
        b. How hunting may contribute to a reduction of mute swans in the Bay or to the growth rate of this population

Time Line:

January 2001: Mute Swan Task Force finalizes the white paper. White paper is, including the Task Force, publicly released. Written public comment will be solicited by the DNR in an official public comment period.

February 2001: Maryland Waterfowl Advisory Committee reviews Task Force findings and recommendations. Maryland Wildlife Advisory Commission reviews Task Force findings and recommendations. March 2001: Public comment period ends after Wildlife Advisory Commission finishes its consideration. DNR reviews Task Force findings and recommendations, Waterfowl Advisory Committee, Wildlife Advisory Commission, and public comments to develop a final mute swan management plan. Fall 2001 Maryland Mute Swan Management Plan released for public comment.

Biographical Sketch: Edith Thompson is currently Exotic/Invasive Species Policy Coordinator for Maryland Department of Natural Resources (DNR). She has worked for DNR for 13 years as urban wildlife program manager, dealing with wildlife habitat issues raised by land development, urban habitat conservation through park planning, etc., then went on to work on DNR-wide Bay education. From there, she started coordinating Maryland's Teaming With Wildlife Coalition, working with the U.S. Congress and national environmental organizations, as well as with State businesses and organizations, to promote long-term, consistent funding for State fish and wildlife programs in the Conservation and Reinvestment Act. Prior to working with the DNR, she worked with the U.S. Fish and Wildlife Service's Breeding Bird Survey and Rare and Endangered Species propagation project at Patuxent Wildlife Research Center and in the Department of Ornithology at the National Zoological Park. Edith has a B.S. in natural resource management and a B.S. in paralegal studies from the University of Maryland.

Waterfowl Advisory Committee

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Abstract: In 1998, the Waterfowl Advisory Committee approved a motion to advise the Department of Natural Resources on the increasing population of mute swan in Maryland and to begin a population control policy for this population (thus, the formation of the Mute Swan Task Force.) You have heard the findings of that Task Force. Following the recommendations and findings of the Task Force, the Waterfowl Advisory Committee unanimously approved a motion to recommend to the Department that the Maryland mute swan population be reduced from the present 4000 birds to a population of 500, all this to be accomplished in five years. It was also recommended, but not voted on, that these reductions begin in the environmentally sensitive areas where high populations of mute swan are creating extreme damage to SAV. Also recommended was that mute swan should be made unprotected, whereby, if anyone has problems with mute swan on private property, control can be at their discretion and without permission from the Department. The recommended population of 500 swan was the result of a review of this population over the last 15 years. During the 1980s this population remained at about 500 birds, which indicated that a number of controlled birds could be reached. This, coupled with being unprotected, indicated to the committee that a sustainable population could be maintained to provide the aesthetic value to the recreational public. It was also the recommendation of the Waterfowl Advisory Committee that any management of mute swan in Maryland should be based solely upon science and that emotions should not become an element in the population management program for mute swan.

Biographical Sketch: Ladd Johnson is president of Resource Management, Inc. (RMI). RMI is a worldwide wildlife-habitat consulting firm based in Maryland. RMI has designed over 2 million acres combined in the United States, Ukraine, Russia, Mexico, South Africa, and Argentina. RMI also administers the "Conservation Seed Program," a food-plot program that exceeds 1 million acres annually. Mr. Johnson is also chair of the Waterfowl Advisory Committee and a member of many conservation and sport-hunting organizations. He is a graduate of the University of Maryland. Mr. Johnson has served as a lobbyist at Federal and State levels on habitat issues. He resides in Cambridge, Maryland.

Nonlethal Techniques to Reduce Animal Problems

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Abstract: To the disappointment of some game biologists, it is clear that mute swans (*Cygnus olor*) are not among the most serious threats to the ecological integrity of the Chesapeake Bay. Rather, empirical data, collected and analyzed by qualified and competent scientists working under the auspices of prestigious institutions, have identified other sources of ecological havoc. Nevertheless, there have been no suggestions from these game biologists for lethal control of persons responsible for aquatic pollution from the livestock industry, agricultural fertilizer run-off, quarries, manufacturing plants, and other sources of offensive effluent. Further, the impact of the U.S. Fish and Wildlife Service's issuance of 8,895 permits for hunting tundra swans (*Cygnus columbianus*) has been inadequately explored, particularly as it relates to the populations and distributions of that species on Chesapeake Bay. Despite the balance of available and credible evidence and indicators, State agencies seem reluctant to pursue the known threats to the Bay's ecological integrity and instead are creating unreasonable commotions that suggest mute swans be targeted as a scapegoat. We propose that one nonlethal technique to reduce animal problems would be for the State agencies 1. to cooperate with scientifically credible and practical initiatives that identify the individual polluters and others who are principally responsible for the ecological degradation of the Chesapeake Bay and 2. to take action that will suppress further environmental damage. This will provide opportunity for the Bay to recover and improve ecological viability, and it will then provide a more wholesome habitat for the animals who live there.

The mute swan (*Cygnus olor*) is one of the most attractive and widely appreciated inhabitants of Chesapeake Bay. But, despite its celebrated beauty and legions of admirers, there are those who want to repress this bird, and there are those who seek to kill it. The principal rationales used to justify repression of mute swans are:

1. they are a nonnative species, and
2. they are responsible for the ecological degradation of the Chesapeake Bay.

Accepted: Mute swans are immigrants. But there is no empirical evidence to justify any allegations that the species is making a substantive contribution to the ecological dysfunction of the Chesapeake Bay. They are exotics, but they are not invasive. Mute swans are indeed a nonnative species that did not coevolve with the Chesapeake Bay ecosystem. But, for that matter, neither did the motorboats and water-skiers now found on the Bay. Nor did house sparrows, or pigeons, or ring-necked pheasants. Nor did the starlings, or suburban cats and dogs. Nor did humans of Asian, African, and European descent, all of whom cluster in and around the beautiful Bay in numbers far greater than those of the mute swans.

The nonnative species of suburbia have overwhelmed so much natural habitat and have replaced it. Current planning for the Chesapeake Bay watershed estimates that the present human population of 15 million will become 18 million by the year 2025. Land-use planning seeks to protect only 20 percent of the watershed's area in a natural state. The remaining 80 percent is doomed to be planted with lawns composed of well-fertilized European grasses and exotic vegetation such as Japanese cherry, Chinese ginkgos, English roses, Scotch pines, Irish yews, Norway spruces, and many other introduced trees and ornamental shrubs. That's the fortunate acreage.

Less fortunate acreage will be paved if it hasn't been so already. Commercial and industrial zones are paved with asphalt and concrete. Agricultural zones are paved with tons of fertilizer. Of the two, it appears that contemporary agricultural methods are the greater hazard for the Chesapeake Bay. Chesapeake Bay and its 64,000-square-mile watershed harbor hundreds of introduced species. But among all these, the mute swans are being singled out for persecution. The various arguments supporting such persecution are, at best, inadequate.

Some persons claim that the Chesapeake Bay's mute swans are crowding out other waterfowl, especially the smaller and less aggressive tundra swans. But the mid-winter waterfowl survey conducted in Maryland this year estimated 20,800 tundra swans (*Cygnus columbianus*), up by 5,200 since last year's count of 15,600. The increase in tundra swans alone is more than the total population of mute swans. Furthermore, there is no scientific documentation of mute swans crowding out any other species—although there is abundant documentation of other waterfowl species nesting in close proximity to mute swans, sometimes within 16 feet. Mute swans are aggressive toward perceived threats during nesting season. But other waterfowl are not perceived as threats, and, therefore, they are tolerated.

Some persons suggest that mute swans may be crowding out species that are classified as threatened or endangered. Again, there is no empirical data documenting these allegations. There are no substantive studies to support such allegations. Do responsible conservationists pursue lethal control methods based on hearsay? There are those who raise incredible Malthusian predictions based upon current growth rates and forecast a plague of mute swans descending upon the Chesapeake Bay. But honest wildlife biologists will acknowledge that impressive growth rates are perfectly natural for species with low populations. Once the swans start to fill their ecological niche, the growth rate will taper off and stabilize within its dynamic limits. The eventual maximum population will likely be quite modest because mute swans require rather large nesting territories from which they will exclude conspecifics. Mute swans are naturally thinly distributed.

Yet other people complain that the mute swans eat submerged aquatic vegetation (SAV). But there are barely 4,000 mute swans. They constitute less than one-half of one percent of the 879,000 waterfowl counted in Maryland this

past January. And most of those nearly one million waterfowl also consume aquatic vegetation. Let's take a closer look at the SAV issue, because it touches the heart of the Chesapeake Bay's tragic ecological condition. Chesapeake Bay naturally should have approximately 600,000 acres of SAV. Of this, only about 72,000 acres remain. More than a half million acres disappeared long before the mute swans started nibbling. And people in authority know very well the reasons for the loss of that vegetation.

A perceptive study conducted by Brush and Hilgartner of Johns Hopkins University documents a gradual, but accelerating, loss of SAV in the Chesapeake Bay over the past two centuries. They identify nutrient overloading particularly run-off containing significant concentrations of nitrogen and phosphorus, as the main culprit. These nutrient overloadings have exceeded SAV tolerance capacities, precipitated eutrophication, and resulted in the extermination of many SAV colonies around the Bay.

Although there have been various attempts to control the discharge of nutrients into the Chesapeake Bay, such as by decreasing the amount of fertilizers used on agricultural land within the Bay's watershed, (as well as removal of nitrogen and phosphorus from point sources, control of animal wastes, and reduction of atmospheric nitrogen emissions), Brush and Hilgartner nevertheless found that "over the past 10 years there is no general trend in reduction of either nitrogen or phosphorous, and in many cases, an increase."

This disturbing trend continues. The recently released 2000 Chesapeake Bay Health Index provides documentation of this distressing situation: The Bay's current Health Index says the amount of toxins entering the Bay have not been reduced. The index says that sediments entering the Bay has increased, and the Bay's water is characterized as "turbid." Turbid water restricts the penetration of sunlight to underwater vegetation. Without sunlight, there is no photosynthesis. Without photosynthesis, plants—including SAV—die.

The Bay's Health Index reports that nutrient overloadings of nitrogen and phosphorus remain essentially unchanged this year, despite the targeted reductions and deadlines, which have been missed. Nutrient overloadings contribute to algae blooms, some of which are toxic, and all of which contribute to eutrophication. They have especially been linked to the blooms of *Pfiesteria piscicida*, the toxic dinoflagellate implicated for large fish kills in the Chesapeake Bay.

The Bay's Health Index notes that dissolved oxygen levels in the Bay are very low, another indicator of eutrophication. By coincidence, extremely low levels of dissolved oxygen normally follow the *Pfiesteria* blooms. Without dissolved oxygen, aquatic animals such as fish cannot breath, and that likely is one of the reasons why the Chesapeake Bay's fish population is very low. Fish that venture into those waters are suffocated.

The Bay's Health Index reports "no change" to any conservation initiatives including wetlands, forest buffers, resource lands, and underwater grasses. Curiously, the decline in underwater grasses in Gunpowder, Chester, and Potomac Rivers has not been attributed to grazing by mute swans. These losses are partially offset by impressive gains in underwater grass recovery in Tangier Sound, which is attributed to local reductions in nutrient overloading and sediment pollution.

The Bay's Health Index says aquatic animal populations are much the same, with rockfish and oysters registering "no change" in their depressingly low population levels. Blue crab populations have declined. The only increase involves transient shad, and this is attributed mostly to the reopening of the Susquehanna River to fish migration for the first time in a century.

The only "plus" in the entire 2000 Chesapeake Bay Health Index relates to the restoration of a natural process that was interrupted one hundred years ago. Does that tell us something? Mute swans have nothing to do with the tragic state of the Chesapeake Bay, and shooting one of them or all 4,000 will not contribute to the Bay's recovery. The swans are being used as scapegoats to divert attention from what really needs to be done if Chesapeake Bay is to be saved. And it can be saved.

There are many very useful guides toward fostering recovery, and it is likely that the $8.5-billion recovery program being championed by the Chesapeake Bay Foundation is a good way to go. It will be expensive. There long has been an axiom among educators: "Education is very expensive. But the alternative is even more so." The same concept can be applied to conservation. The consequences of letting the Chesapeake Bay die will be painfully expensive—financially expensive, ecologically expensive, socially expensive. Ask the Europeans.

Countries of Western Europe faced similar challenges some decades ago. Europe started dumping wastes into rivers and destroying habitats, while America was still pristine. So the consequences caught up with the Europeans sooner. In the 1960s, the Thames River in England was declared "biologically dead." The Waal/Rhine estuary was in a similar situation, as were other estuarine ecosystems throughout Western Europe.

Recovery work on the Thames started in 1963, and other projects followed soon thereafter. Research indicated that the Thames suffered essentially the same problems experienced in the Chesapeake Bay—toxins from industry, suspended sediments, and nutrient overloads from both agriculture and residential communities. Water in Dutch estuaries was so turbid that anything deeper than eight inches could not be seen from the surface.

Today, the Dutch water is much clearer. Objects at depths of 2.1-2.7 m (7-9 feet) can be clearly seen from the surface. As a consequence, sunlight can penetrate better, and that's a key first step to restoration of SAV. The Europeans pumped enormous amounts of money into clean-up projects. The Dutch passed laws forbidding the opening of new factory farms and encouraging the closure of existing facilities. A strong alliance of animal protection and environmental conservation reversed industrialized cruelty that was responsible for massive point-source nutrient overloads. Other projects targeted sewage processing, industrial wastes, and even the holiest of Holland's

cows, the Dutch dairy industry. Strict controls prevented toxins and excess nutrients from entering rivers and estuaries, and pumping projects removed nearly all of the run-off sediments that had fouled the Dutch waters. Shortly after this was accomplished, the SAV colonies that had collapsed through previous decades made dramatic recoveries.

And they didn't have to kill any mute swans to do it! In England, the Thames underwent a similar resuscitation. The river, which in the 1960s was so polluted that it caught fire several times, after three decades of devoted work became the cleanest metropolitan estuary in Europe. Ichthyologists will confirm that sea bass, salmon, and flounder are fish species that are very sensitive to pollution. Yet these species are today found in the Thames, and in good numbers. Mute swans are found there as well.

The British have learned their lesson and are vigilant in keeping their river and its estuary clean. The entire European Community has adopted the "Polluter Pays" principle. Aggressive environmental protection units track down those responsible for environmental damage and haul them into court. So far, they haven't arrested a single mute swan.

But they have prosecuted farmers, municipalities, and industries that have been remiss in their obligations to protect water quality. Even Thames Water Ltd., a major utility responsible for the river's water management, was dragged in to court a year ago and fined 43,935 British pounds—about $60,000—because they weren't quick enough to repair a leak. The Crown Court acknowledged that vandals had broken a sewer pipe, but it also found that Thames Water, in taking five hours to get a repair crew to the scene, did not act fast enough to protect the precious river.

Similar stories may be told about France and Denmark, and about Belgium, Germany, and Sweden. The European Union has taken a lead in developing techniques—a mix of voluntary, regulatory, incentive, and disincentive-based measures to curb the pollution of their waterways. They have taken a technological lead in developing systems for purging toxins, sediments, and nutrient overloads out of the water.

They have done a lot of homework, paid an enormous price, and achieved a lot of success. European estuaries are today much cleaner than those found in the United States. It would be worthwhile for those concerned with the future of the Chesapeake Bay to review European policy and technological achievements, and then consider how they might be applied on this side of the ocean.

The mute swans of the Chesapeake Bay are the offspring of naturalized Americans, just like the vast majority of this country's citizens. They too are the children of immigrants. They are not invasive. They harm no one. They contribute beauty and grace to our landscapes and our lives. The least we can do in return is to provide them with peace and security while we cooperate in identifying and addressing the real problems that are causing ecological dysfunction in the Chesapeake Bay.

Biographical Sketch: Since 1987, Priscilla Feral has served as president and executive director of the United States-based Friends of Animals, an international, nonprofit membership organization that works to protect animals from cruelty, abuse, and institutionalized exploitation. Her affiliation with Friends of Animals started in 1974, when she served as the group's public information director. As president, Ms. Feral participates in many international meetings which involve practical and technical aspects of wildlife protection. As general policy, Friends of Animals seeks to protect the full expression of biological diversity and ecological dynamics of any natural habitat. As such, FoA is generally opposed to artificial manipulations of either habitat or wildlife populations.

Summary

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One of the issues regarding mute swans (*Cygnus olor*) that was raised by the Maryland Mute Swan Task Force in its recent report to the Governor was lack of public information about the bird. I think today's symposium helps to address this public education need, and I applaud the sponsors for making it happen. I think it has been an excellent meeting. We have heard firsthand from knowledgeable researchers and managers in the field who are involved with mute swans.

Kent Mountford started us off this morning with some historical information about mute swans. He pointed out that the bird is native to Europe and Asia. It was transported to North America in the late 19th Century by European immigrants, and some birds escaped captivity or were released to the wild, where they are now reproducing.

Pat Kangas next discussed the issue of invasive species in ecosystems. He challenged our thinking about ecological theory and the issue of native versus exotic species. From an ecological perspective, Pat argued that the Bay ecosystem is different now than it was in pre-Columbian times. Whether or not it is "out of balance," "healthy," or "unhealthy" relates to human values, not to ecosystem structure and function. What people want and will support (political ecology) will define the kind of Bay ecosystem that managers will be charged to sustain.

We next learned something about the mute swan in its native range. Edward Lohnes reviewed the bird's status and behavior in the United Kingdom. We learned that the mute swan is considered a royal bird in the U.K. where, like here, it is largely nonmigratory. A bird may live its entire life in the same river valley in which it hatched. Another behavioral trait of the bird in its native range, as here, is its aggressive nature during the nesting season. We learned that foxes (*Vulpes vulpes*) and badgers (*Taxidea taxus*) are significant predators of the bird at Abbotsbury Swannery. Edward also gave us a good overview of "swan upping," which, with great ceremony, involves annual roundups of swan families along the River

Thames in London and marking of all cygnets according to ownership (they either belong to the crown, two private companies, or Abbotsbury Swannery).

The bulk of the presentations focused on the Chesapeake Bay. Six speakers discussed mute swan populations, food habits, and interspecific competition between mute swans and other birds. Larry Hindman and Gary Costanzo discussed the current population status of the bird. We learned that the Maryland Bay population began in 1962, when five swans were released from an aviculture collection along the Miles River in Talbot County. In the Virginia portion of the Bay, a breeding population probably became established during the late 1960s to early 1970s. Both states have seen rapid population increases in the last 10-15 years. The Baywide population is now some 4,500 birds, a figure representing 30 percent of the Atlantic flyway population.

Matthew Perry and Michael Naylor discussed food habits of the birds in the Chesapeake Bay. We learned that mute swans feed largely on submerged aquatic vegetation (SAV), primarily widgeon grass (*Ruppia maritima*) and eelgrass (*Zostera marina*), and rely heavily on this vegetation during spring and summer. The birds are not migratory and feed on SAV year-round. A single bird can consume some 4 kilograms of SAV per day. Bay-wide, this is estimated at more than 5 million kilograms per year. As Bill Sladen would say, mute swans are pigs! Mute swans can overgraze an area, reducing biomass as much as 95 percent. This is not helpful to the Bay restoration program of restoring SAV.

We learned of the impact of year-round feeding on aquatic vegetation by another species of waterfowl. Mike Haramis presented striking evidence of such feeding by nonmigratory Canada geese (*Branta canadensis*) on wild rice (*Zizania aquatica*) in the Patuxent River. Mike pointed out that a management plan to control numbers of resident geese is needed if wild rice is to be reestablished to its former abundance.

Daniel Day discussed the value of using mute swans as biological indicators for monitoring SAV beds and sediment contamination in the Bay.

Glenn Therres and David Brinker discussed the interaction between mute swans and other birds in the Bay. We learned that in the early 1990s, mute swans excluded black skimmers (*Rynchops niger*) and least terns (*Sterna antillarum*), two threatened species, from nesting sites in Tar Bay, in Dorchester County. Mute swans also have displaced Forster's tern (*Sterna forsteri*) and common tern (*Sterna hirundo*), two declining species in Maryland. Mute swans are aggressive toward tundra swans (*Cygnus columbianus*) and other waterfowl, driving them from protected coves and feeding areas. Tundra swan numbers have declined about 30 percent since the mid-1970s, but the cause of this decline is unclear. Mute swans sometimes kill the young of other waterfowl.

Two speakers addressed mute swans in other regions of the United States, Charles Allin reported on the status and management of mute swans in Rhode Island. There, an aggressive egg addling program reached some 79 percent of active nests between 1979 and 1998. Even so, the mute swan population continued to grow, with a 79 percent increase noted from 1986 to 1999.

Scott Petrie discussed the status and management of mute swans in the Great Lakes region. He reported that the bird was introduced in the region around the mid-1900s. Its rate of increase since 1971 is estimated between 10-21 percent per year. This high rate of increase suggests a favorable environment, which is, in fact, climatically similar to the bird's native range in Europe. In the Great Lakes region, the birds experience low natural predation and minimal human interference. Scott recommends that control measures be implemented before the population grows much larger.

Also with regard to management, William Sladen and Donielle Rininger discussed their experience with redistribution of same-sexed pairs to inland ponds. These birds are rendered permanently flightless and have been placed mostly on small, rural ponds. Bill reported that he has been advocating this practice for 12 years and thinks it still has value.

Priscilla Feral reminded us that there are other impacts to the Bay in addition to mute swans. She argued that various polluting activities of humans are largely responsible for the current plight of the Bay, and the human population in the Bay watershed is expected to increase from 15 million currently to 18 million by the year 2025. Over 200,000 hectares of SAV have disappeared from the Bay and some 29,000 hectares remain. Nutrient overloading (mainly nitrogen and phosphorus) is the primary factor responsible for SAV loss. Increased sediment loads entering the Bay contribute as well. Feral called for greater cooperation among State agencies and others in addressing these pollution threats to the Bay.

Edith Thompson and Ladd Johnson summarized the report of the Maryland Mute Swan Task Force. This body was formed in late 1998 to provide a report of findings and recommendations to the Governor. The Task Force documented seven primary issues involving mute swans in the Bay:

Issue no. 1: Swans have aesthetic appeal to many residents. The Task Force recommended that this be better documented through a survey of public perceptions, values, and knowledge of the birds.

Issue no. 2: Interspecific competition between the mute swan and other birds, and their consumption of SAV. The Task Force recommended that "swan-free zones" be designated and that methods be established to keep swans out of these areas. In this regard, preference should be given to nonlethal methods of control, with lethal removal as a last resort.

Issue no. 3: Mute swans impact water quality. The Task Force recommended further research on this issue to better document such impact.

Issue no. 4: Lack of public information on mute swans. The Task Force called for better public education concerning mute

swans, and as I indicated earlier, I think this symposium helps in this regard.

Issue no. 5: Conflict with humans. Where this occurs, the Task Force recommended that preference should be given to nonlethal methods of control, with lethal control as a last resort.

Issue no. 6: The mute swan population in the Bay should not be eradicated. However, the Task Force did not recommend either a maximum or minimum population size.

Issue no. 7: Legal status. The Task Force recommended that the mute swan should remain classified as a "wetland game bird" but that no hunting season should be set for it.

The Task Force reviewed a number of possible nonlethal approaches to managing the mute swan in the Bay including exclusion, harassment, immuno-contraception, sterilization, capture/relocation, and egg addling, noting the potential and limits of each approach. As I indicated earlier, if the birds cannot be kept out of "swan-free zones" by nonlethal approaches, the Task Force recommended lethal removal of the birds as a last resort.

Ladd Johnson chairs the State's waterfowl advisory committee and was a member of the Task Force. He reported that his committee does not agree with some of the findings of the Task Force. Specifically, his committee recommended that the Maryland mute swan population be reduced from the present 4,000 birds to a population of 500 within the next 5 years. His committee also recommended that Maryland remove the bird from protected status.

I think it is clear that there is a lot of concern on the part of biologists and much of the public at large about the impact, and potential for impact, of mute swans in the Chesapeake Bay. Biologists point out that the mute swan did not coevolve with other species in the Bay. One result of this is that widgeon grass, eelgrass, and other SAV have not evolved defense mechanisms to cope with year-round feeding by the birds. In addition, native birds of the Bay may be impacted through competition with mute swans for resources and by the aggressive nature of the bird.

The significance of mute swan impact is hard to measure at this point. Nonetheless there are many examples to draw from with regard to exotic-species introductions. The problems caused by invasive alien species are receiving increased worldwide attention. The World Conservation Union has established the Invasive Species Specialist Group, a global body of 146 scientific and policy experts on invasive species from 41 countries (IUCN, 2001). The group's aim is to reduce threats to natural ecosystems and the native species they contain by increasing awareness of invasive species and of ways to prevent, control, or eradicate them.

To draw attention to the problems caused by exotic introductions, the group has published a list of the World's 100 Worst Invasive Alien Species. One of these is the Nile perch (*Lates niloticus*), which was introduced to Lake Victoria, Africa, in 1954. The Nile perch contributed to the extinction of more than 200 endemic fish species through predation and competition for food. Another species on the list is the brown tree snake (*Boiga irregularis*), which was introduced to Guam (probably accidentally) and has caused almost complete extermination of that island's native forest birds. Other species on the list include the European starling (*Sturnus vulgaris*), the nutria (*Myocastor coypus*), and our own eastern gray squirrel (*Sciurus carolinensis*).

I think most of us are familiar with the impact of exotic house sparrows (*Passer domesticus*) and European starlings on the native eastern bluebird (*Sialia sialis*) in this country. Like the mute swan, house sparrows and starlings are aggressive birds who out-compete bluebirds for nesting cavities. The result has been a drastic decline in the bluebird population. Humans now assist the bluebird by building and erecting artificial cavities in the form of bluebird boxes. But even these are not foolproof. This fact became quite clear to me a few years ago when I participated in a bluebird box project sponsored by the Central Maryland Chapter of the National Audubon Society.

The project involved placing and maintaining bluebird boxes along the right-of-way of Interstate 70 in Howard County, Maryland. Following the year of placement, boxes were annually cleaned prior to the nesting season and were then weekly monitored to document production of young throughout the nesting season. On one occasion, I recall arriving at a box that I knew was being used by bluebirds only to find it had been taken over by house sparrows. As I removed the house sparrow nest material, I found the dead female bluebird still sitting on her eggs with a hole punctured in her skull. I have no doubt that this was done by the invading house sparrows, which, after killing the female and driving off the male, simply built their own nest on top of the dead bluebird and her nest. Other workers have recorded similar observations.

Nutria is also infamous in Maryland. This large South American rodent was introduced in the State in the late 1930s or early 1940s. It impacts wetland vegetation and competes with muskrats (*Ondatra zibethicus*) and waterfowl in this regard. Our own generally well-liked eastern gray squirrel is not so well liked in England, where it was introduced and is now implicated in the decline of that country's own native red squirrel (*Sciurus vulgaris*). We could mention many other examples regarding the problem of exotic introductions, but I think the point has been made.

In closing, I hope we can manage the mute swan population in the Chesapeake Bay before it gets out of hand and perhaps winds up on the list of the World's 100 Worst Invasive Alien Species.

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Biographical Sketch: Lowell Adams obtained his B.S. degree in Forestry and Wildlife from Virginia Tech and his M.S. and Ph.D. degrees in zoology from Ohio State University. For 20 years he served as wildlife biologist, research director, and vice president of the National Institute for Urban Wildlife. Currently he is an adjunct associate professor in the Natural Resources Management Program of the University of Maryland and a member of the graduate faculty of that institution. His interests focus on urban wildlife ecology and management and human-wildlife interactions in the metropolitan environment. In 1994, Dr. Adams was appointed by the Governor to the Maryland Wildlife Advisory Commission, where he maintains an active interest in wildlife issues throughout the state, including mute swans of Chesapeake Bay. He has served as vice-chair of that body since 1996.

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