An Efficient Method of Capture and Field Euthanasia of Flightless Mute Swans

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ABSTRACT: Concerns surrounding the ecological impacts from increasing numbers of feral mute swans (*Cygnus olor*) have led some management agencies in the United States to implement control efforts directed at reducing populations of this invasive species. To remove large numbers of flightless mute swans from the Maryland portion of Chesapeake Bay, we developed a field live-capture technique using a modified design of the British swan pole. During the summers of 2005–2008, we captured and euthanized 1,396 mute swans from molting flocks in 24 operations. Swans culled per operation ranged from 6 to 199 with an average cull rate of 32 swans per hour. Our capture method frequently resulted in removal of all flightless mute swans in the area. Cost was $40,259 for the 24 field operations. Mean cost per swan culled (including disposal) was $28.84. We also describe an effective, humane method of field euthanasia for large birds, such as mute swans, using mechanical cervical dislocation with an emasculatome. We used these methods as part of an integrated control program that also included egg oiling to reduce swan recruitment and the humane shooting of adult swans (2002–2014) that resulted in a reduction of the State's mute swan population from 3,995 in 1999 to 41 in 2014. These techniques will benefit other state and provincial wildlife agencies in North America that are undertaking or considering implementation of mute swan control programs.

Key Words: capture, cull, *Cygnus olor*, emasculatome, field euthanasia, mute swan, swan pole.

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INTRODUCTION

Populations of local breeding mute swans (*Cygnus olor*) are widespread and increasing in certain regions of the United States and southern Ontario (Ciaranca et al. 1997, Petrie and Francis 2003, Baldassarre 2014). As these populations

have grown, so have concerns about their ecological impact on native bird populations and their habitats. Maryland's feral mute swan population originated from the escape of five captive birds in 1962 (Reese 1975). The population grew slowly through the 1960s and 1970s but then underwent rapid growth from 264 swans in 1986 to 3,955 in 1999 (Hindman and Harvey 2004). In Chesapeake Bay, mute swans have caused the abandonment of nesting areas by State-threatened waterbirds like the least tern (*Sternula antillarum*) and black skimmer (*Rynchops niger*) (Therres and Brinker 2004). Large flocks of nonbreeding swans have also reduced submerged aquatic vegetation (SAV) at the local level (Tatu et al. 2007).

The growth in mute swan numbers has also increased conflicts between people and swans, particularly swans defending their nest territory and young. Examples of conflicts with territorial swans include threat displays and direct attacks toward swimmers and people in small watercraft. The aggressive behavior of breeding swans can prevent people from using riparian shorelines (Hindman and Harvey 2004). Although no serious injuries to people have been reported in Maryland, there have been two recorded drownings caused by mute swans elsewhere (Indiana and Illinois) in the U.S. (Williams 1997, Golab 2012, Steckling 2012).

Because mute swans are considered invasive species by state and federal wildlife management agencies, some limited population control efforts have been aimed at slowing population growth (Ciaranca et al. 1997, Atlantic Flyway Council 2003). In 2003, the Maryland Department of Natural Resources (MDNR) adopted a mute swan management plan aimed at reducing the State's mute swan population to protect critical Chesapeake Bay living resources (e.g., native waterfowl, colonial waterbirds, and SAV). However, population control actions were delayed by negotiations with the Human Society of the United States and legal challenges from animal rights organizations (Tatu 2006). In 2004, the U.S. Congress provided clarification of the intent of the Migratory Bird Treaty Act (MBTA) by passage of the Migratory Bird Treaty Reform Act 2005 (Tatu 2006). The Reform Act stipulated that the MBTA only applies to migratory bird species that are native to the U.S. Congress also directed the U.S. Fish and Wildlife Service to prepare a list of nonnative species to which the act does not apply. The list was finalized on 15 March 2005 and mute swans were included, thereby returning management authority to the states. Thus, in July 2005, the MDNR initiated an integrated control strategy aimed at eliminating all mute swans from areas designated as "swan free areas" (e.g., colonial waterbird and black duck nesting habitats, SAV beds) and initially reducing the State's mute swan population to <500 by 2008 (MDNR 2003). The strategy used a combination of nest and egg destruction (Hindman et al. 2014) and the culling of adult swans using shooting and live capture with euthanasia. In 2011, the MDNR revised its mute swan management plan to include a population objective of reducing the swan population to as few as possible (MDNR 2011).

Because mute swans molt all their flight feathers simultaneously and are flightless for 4–7 weeks, they can be captured during the annual mid-summer molt (Ciaranca et al. 1997). In Britain, family groups of wild mute swans have been captured for centuries during a ceremonial activity known as swan-upping (Birkhead and Perrins 1986); swans are surrounded with several small boats or herded or driven towards shore and are captured either by hand, landing net, catch pole, or herded into temporary pens erected near the water's edge (Scott 1972, Birkhead and Perrins 1986). One of the largest single captures of mute swans occurred in 2011, when about 750 mute swans were captured for banding in The Fleet Lagoon near Abbotsbury, England, using about 90 canoeists and >150 people to form a human net to herd swans into onshore capture pens (The Independent 2011). Mute swans have also been captured in Britain for ringing (banding) studies by baiting them and then catching them by hand or with a capture pole known as a swan pole (Minton 1968, North West Swan Study 2007).

In the U.S., mute swan capture has been limited to small numbers of birds for marking studies (Reese 1975, Sousa 2005, New York Department of Environmental Conservation 2013), nuisance or escaped individuals, and removing birds to aid in reestablishing trumpeter

swan (*Cygnus buccinator*) populations (Ciaranca et al. 1997). In the U.S., flightless mute swans are normally captured by pursuing them with a boat and capturing them with a large fish-landing net (Gelston and Wood 1972, Sousa 2005). In 1995, we attempted (unsuccessfully) to capture 150–200 flightless mute swans by herding them with boats towards shore and into onshore capture pens. This method has been used to capture large numbers of flightless Canada geese (*Branta canadensis*) for banding studies (Costanzo et al. 1995). However, the escape behavior of flightless mute swans differs from geese in that swan flocks do not remain intact when being herded by 3–4 small boats. Rather, they avoid capture by dispersing as individuals or as small groups (3–10 birds).

Herein we describe an efficient capture technique using a modification of the British swan pole (Minton 1968) that was used in the large-scale control of mute swans in the Maryland portion of Chesapeake Bay. We also describe a rapid, effective, and humane field method of euthanasia for mute swans.

STUDY AREA

We conducted this work in the tidal estuarine waters of the Potomac River in St. Mary's County (centered at 38°12'09"N, 76°35'55"W) and along the Eastern Shore of Chesapeake Bay in Kent, Queen Annes, Talbot, Dorchester, and Somerset counties, Maryland (between 38° 55' 17"N, 76°15'11"W and 37°57' 16"N, 76°02'50"W). These areas supported concentrations (e.g., 25 – 250 birds per flock) of flightless, nonbreeding mute swans and smaller numbers of failed breeding pairs. These portions of the Potomac River and Chesapeake Bay contained an interspersion of SAV beds, open water, tidal estuarine wetlands, and irregular shorelines.

METHODS

Molting swans in Chesapeake Bay congregated in large tidal creeks and bays or narrow (1.5–2.4-m wide) tidal creeks lined with high tide bush (*Iva frutescens*) and Phragmites (*Phragmites sp.*). Molting sites typically had abundant SAV nearby and shallow waters that limited boat traffic. We observed as many as 75–200 swans hiding within the cover provided by these creeks.

Aerial surveys using fixed-wing aircraft were used to locate 10 swan molting sites along the Eastern Shore and 1 site in the lower Potomac River. We used live capture and euthanasia to remove molting swans at 6 of the 11 molting sites where culling by shooting using 12-gauge shotguns was inappropriate because of the proximity to waterfront residential homes.

We began capture operations between 1000 to 1300 hours when boating activity was lowest and about 1–2 hours prior to high tide to ensure adequate water for capture boat maneuverability. It was difficult to operate small boats powered with conventional outboard motors where swans congregated in shallow waters and creeks. We used a 4.2-m jon boat powered by a long-tail mud motor (Mud Buddy ®, West Jordan, UT) to drive flightless swans from the protective cover of these creeks. Once in the open, swans were slowly herded by 2–3 additional capture teams in jon boats to deeper offshore waters (1.2–3.7 m) where they were easier to capture and where the operation was less visible from waterfront homes.

Once swans were positioned offshore, we captured individuals with a swan pole after pursuit by boat. The swan pole was a modified aluminum, telescopic pole (approximately 2.4 m fully extended) that had a smooth, rounded hook or shepherd's crook at one end (Figure 1). The pole's crook was placed quickly around a swan’s neck so that the bird could be pulled toward the person making the capture. We captured most swans on the first attempt, but some required 2–3 capture attempts. A handler lifted each swan into the boat and restrained the bird on the boat floor below the gunwale where it was immediately euthanized by mechanical cervical dislocation) and the carcass placed in a plastic bag for transport and disposal.

We recorded staff hours, vehicle and boat costs, equipment purchases, and miscellaneous expenses for each of the live-capture culling operations. The duration of each culling operation was also recorded and began when capture teams arrived at a capture location and ended when each capture team had transferred bagged carcasses to onshore trucks for transport to disposal locations and began their return to nearby boat launch ramps. We determined the

mean number of swans culled per hour of an operation by dividing the total number of swans culled by the number of field operation hours required to complete the 24 culling operations (for example, 1,396 swans/44-culling hours = 31.88 swans culled per hour).

Figure 1. Distal end of telescopic, aluminum swan pole (3.2-cm crook gap) made of marine- grade aluminum rod (0.6-cm) used to capture flightless mute swans in the lower Potomac River and upper Chesapeake Bay, Maryland, USA, 2005–2008.

Field Euthanasia

Cervical dislocation can be applied manually, which involves stretching and separating the vertebrae by hand, or mechanically, which involves the use of a tool such as bovine castration forceps (emasculatome) to sever or crush the vertebrae (Galvin et al. 2005). For mute swans we used a 48-cm emasculatome (Jeffers, Dothan, AL) to mechanically perform the cervical dislocation. Mechanical cervical dislocation using this tool has been recommended as a field method of euthanasia and farm culling for large birds (U.S. Department of Interior and U.S. Geological Survey 1999, Canadian Council on Animal Care 2009). We used the American Veterinary Medical Association (AVMA) guidelines for the euthanasia of wildlife and consulted with veterinarians to ensure that the field techniques used for culling swans was humane (AVMA 2000).

We used mechanical cervical dislocation to humanely euthanize all captured mute swans. Each member of our capture teams received training in the proper use of the emasculatome to perform the cervical dislocation. We restrained each captured swan by laying the bird on its

sternum with its neck outstretched on the boat floor while holding the base of the wings next to the body. We found mechanical cervical dislocation could be performed rapidly and humanely by placing the open emasculatome forceps about 3-cm below the base of the skull and clamping the forceps tips shut firmly for 2–5 seconds. Following luxation of the cervical vertebrae and coincident severing of the spinal cord, and cessation of reflex muscle spasms, we immediately placed each swan carcass in a plastic 3-mil 182–227 liter contractor bag. The entire process from time of capture until a single bird was humanely killed and then stored for transport averaged about 30 seconds.

Swan Pole Construction

We constructed swan poles patterned from the Abbotsbury Swannery in the Britain (Birkhead and Perrins 1987). To construct our swan poles we modified a 1.47- to 2.43-m telescopic aluminum boat hook (West Marine, Watsonville, CA) by removing the hook portion of the tool and welding a 1.5-cm diameter, marine-grade, aircraft aluminum rod to the distal end of the pole. The aluminum rod was heated and bent into the shape of a hook or shepherd's crook (Fig. 1). The rod extended 43.2 cm from the end of the pole and was bent and extended 27.3 cm in the opposite direction and parallel to the portion of the rod extended from pole. The inside dimension of the gap between the rods that formed the crook was 5.1 cm.

In the spring and summer of 2002 and 2003, we tested the swan pole design in capturing and marking about 100 mute swans including incubating swans, adult swans with cygnets that were either flightless or reluctant to fly, and flightless swans associated with a swan research project (see Sousa 2005). Although successful, we noted that the original swan pole design enabled some swans to escape from the pole's crook. We modified the original pole design by first bending the outward tip (8.25 cm) about 45º to help guide a swan's neck into the crook, and second, reducing the gap of the crook from the original 5.1 cm to 3.2 cm. The weight of the distal end of the swan pole was also reduced by using a smaller gauge marine-grade aluminum rod (1.27-cm diameter) to form the crook. These modifications, especially the smaller gap distance, resulted in an improved capture rate with reduced effort (i.e., fewer capture attempts).

Project Costs

For each of the 25 live-capture culling operations we recorded the manpower (person hours and salary), vehicle- and boat-use expenses, and cost of field equipment and supplies. We included the cost required for disposal (i.e., burial). However, some carcasses were incinerated at Maryland Department of Agriculture (MDA) Animal Health Diagnostic Laboratories. Incineration costs were not included in the operation costs as our swan carcasses were added to MDA's weekly incineration of commercial poultry carcasses as an integral part of their poultry health surveillance program. We used the total operation costs to calculate the mean cost required to cull an individual swan.

RESULTS

Between 11 August 2005 and 21 September 2008, we culled 1,396 flightless mute swans on public waters during 24 live-capture culling operations (Table 1). Most flightless (n = 1,020; 74%) swans were culled during the last 2 weeks in August (Fig. 2). The number of swans removed was greatest in 2005 (n = 721) when molting flocks were largest and declined each successive summer thereafter as swan population size declined (Table 1). Mean cull size was 58 swans per operation (range 6–199) for the 4-year period (2005–2008). Mean cull size per operation was also highest (120 swans) the first year (2005) and declined steadily each year thereafter (Table 1). Culling operations lasted between 1.0–3.5 hrs for all 4 years combined (44 hours total) and cull success averaged 32 swans per hour. This culling method frequently resulted in removal of all flightless mute swans in the area.

Other flightless, molting flocks of mute swans on public waters in remote locations were culled by shooting during this same 4-year period. After 2008, molting flocks of swans were rare and only flightless individual and paired swans were live-captured in subsequent years (2009–2014). Live capture was used in combination with the culling of adult swans by

shooting throughout the spring, summer, and fall and egg oiling of nests during the spring (Hindman et al. 2014) to reduce the State's mute swan population.

Interactions with the public occurred during only 1 of the 24 live-capture operations. No press or media coverage resulted from any of the culling operations (live capture or shooting). Public reaction to the control of mute swans was mixed, but opposition was less than expected. Results of a random telephone survey of Maryland citizens in 2005 indicated that nearly all respondents (n = 539; 86%) would support mute swan population control after they were provided evidence that this species was harmful to the Chesapeake Bay ecosystem; they felt the health of Chesapeake Bay was more important than sustaining a non-native swan population (Hindman and Tjaden 2014). Of the respondents that supported aggressive control measures, 62% supported the use of lethal methods of control, including hunting.

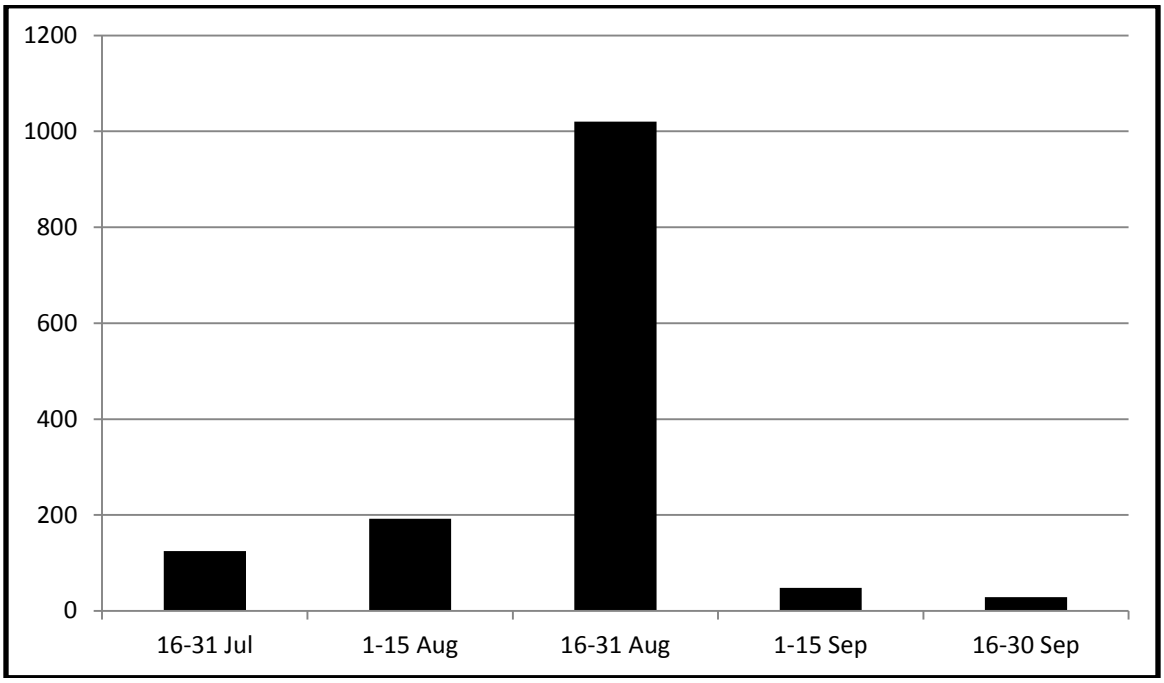

Figure 2. Temporal distribution of flightless mute swans captured during 24 live-capture operations in the lower Potomac River and upper Chesapeake Bay, Maryland, USA, 2005–2008.

Table 1. Population size and number of flightless mute swans live captured and euthanized, with number and dates of cull operations, mean and range of swans culled per operation in the lower Potomac River and upper Chesapeake Bay, Maryland, USA, 2005–2008.

Year	Population size[a]	No. swans culled	No. of operations	Mean no. swans culled per operation	Range of swans culled per operation	Cull dates
2005	3,624	721	6	120	58–199	11–30 Aug
2006	2,174	453	11	41	6–139	26 Jul–28 Sep
2007	1,455	158	5	32	9–60	8 Aug–6 Sep
2008	927	64	2	32	17–47	11 Aug–21 Sep
Total		1,396	24	58	6–199	26 Jul–28 Sep

[a] Population size from annual September survey prior to implementation of swan cull operations the following summer. Population size used for 2005 was count from 2002; no surveys were available for 2003 and 2004.

Project Costs

Total cost incurred during the 24 live-capture cull operations was $40,259.74 (Table 2). As expected, staff hours was the most expensive part of cull operations. Salaries of MDNR staff ($29,699) composed 74% of the total project costs. Operation costs declined over the 4-year period as fewer molting swans were encountered. Costs were highest the first year (2005; $25,541) when 721 birds were culled during 6 field operations, and lowest the fourth year (2008; $2,319) when only 64 birds were culled during 2 operations. Mean cost per swan culled was $28.84 for the 24 operations and ranged from $25.92 in 2006 to $36.24 in 2008.

Table 2. Estimated cost of culling flightless mute swans by live capture and euthanasia in the lower Potomac River and upper Chesapeake Bay, Maryland, USA, 2005–2008.

Year	No. culled	Staff Hours	Salaries	Vehicle costs	Boat costs	Misc. costs	Total costs	Mean cost per swan culled
2005	721	623	$15,928	$2,088	$2,467	$1,057	$21,541	$29.88
2006	453	354	$8,756	$1,367	$1,620	$229	$11,743	$25.92
2007	158	144	$3,382	$833	$320	$120	$4,655	$29.65
2008	64	60	$1,633	$341	$280	$75	$2,319	$36.24
Total	1,396	1,181	$29,699	$4,629	$4,687	$1,481	$40,259	$28.84

DISCUSSION

We captured mute swans by herding flightless birds offshore to deeper waters which increased capture effectiveness and efficiency. This technique reduced capture time by maximizing boat maneuverability, resulting in fewer attempts to catch individual swans. Capture in shallow waters compromises boat maneuverability and increases capture time unnecessarily by having to adjust outboard motor propeller position and clear the propeller fouled by SAV. Herding of flightless swans offshore for culling also minimized potential conflicts with onshore property owners. Our control method also allowed us to conduct swan control when fewer people were engaged in commercial and recreational fishing and boating. This technique allowed us to remove swans in highly developed areas where shooting would not have been appropriate.

Our method was also more efficient than the methods used in Britain where large numbers of canoeists and volunteers forming a human pen are used to herd flightless swans into onshore capture pens (The Independent 2011). Further, our method did not require us to secure property owner permission to herd swans onto a private beachhead near locations where flightless swans congregated to molt. However, in some instances we obtained landowner permission to offload bagged carcasses at a private beachhead for transport.

The use of the modified swan pole was more effective and efficient than using a fish-landing net. The swan pole was far more maneuverable than a bulky landing net. Also, it is more difficult to get a landing net around a swan's body on the water. We found that a swan captured in a landing net took longer to remove because its wings and feet often became entangled in the netting. The use of the swan pole also enabled us to capture swans without causing physical injury (e.g., broken wing).

Captured swans were killed quickly and humanely using mechanical cervical dislocation, consistent with the guidelines for euthanasia of free-ranging wildlife (AVMA 2000). Cervical dislocation humanely kills waterfowl and poultry by causing instant loss of central nervous system activity, resulting in simultaneous anesthesia and death. Cervical dislocation can be applied manually in the field and is typically used on small to medium-sized birds, such as ducks (New York Department of Environmental Conservation 2004). However, manual cervical dislocation of large birds, like mute swans, is physically difficult to conduct and may not result in a rapid and painless death (U.S. Department of Interior and U.S. Geological Survey 1999).

Mechanical cervical dislocation is sometimes recommended for the euthanasia of large birds when manual means are difficult to apply (Canadian Food Inspection Agency 2007, Saif 2008, CCAC 2009). Both manual and mechanical cervical dislocation are listed as killing methods for poultry by the World Organization for Animal Health for the purposes of disease control (Galvin et al. 2005). Cervical dislocation and blunt trauma are the methods most commonly used on commercial turkey farms and are thought to be humane (Erasmus et al. 2010). However, there is little scientific evidence to confirm this observation (AVMA 2007).

We chose to use mechanical cervical dislocation as the preferred method of field euthanasia for captured mute swans because it (1) was considered efficient and humane by consulting veterinarians given the field conditions; (2) was consistent with the guidelines for euthanasia of free-ranging wildlife (AVMA 2000); (3) minimized distress to captured swans associated with alternative methods of euthanasia; (4) was practical under field conditions (marine habitat from boats), (5) reduced worker safety risks; and (6) allowed for burial of tissues free of chemical contamination.

MANAGEMENT IMPLICATIONS

In 2011, the MDNR updated its 2003 mute swan management plan by revising the primary management objective to reducing the mute swan population to as few birds as possible (MDNR 2011). Our live capture and field euthanasia techniques were part of an integrated population control strategy aimed at reducing Maryland's mute swan population (MDNR 2003, 2011). We reduced the State's mute swan population from 3,995 in 1999 to 41 in 2014. Our work demonstrates that the use of these control methods can be used to reduce a jurisdiction's mute swan population. These techniques can be especially effective in eliminating flightless swans during the annual feather molt in areas where culling by shooting is not appropriate. Our work will benefit other state and provincial wildlife agencies in North America that are considering or undertaking the implementation of mute swan control programs.

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