SURVIVAL OF WISCONSIN INTERIOR POPULATION OF TRUMPETER SWANS

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ABSTRACT

Trumpeter Swan reintroduction efforts have concentrated on creating breeding populations, while work to encourage winter migration has been more limited. As a result, most populations cannot be considered self-sustaining. Migratory populations of Trumpeter Swans in the Midwest have not been well studied. In general, little is known about the importance of diet and nutrition in swan survival. To determine how migratory behavior and nutrient availability impact Trumpeter Swan mortality, we will compare survival estimates between migratory and non-migratory swans and among swans using different wintering areas. We will calculate annual and seasonal survival rates on the wintering and breeding grounds based on mark-resight data gathered since 1994. We will use activity-time budgets and habitat use surveys to determine the diets of at least two different wintering populations of trumpeters. We hope to determine what type of wintering habitat supports the highest survival rates for migratory swans and whether migratory swans survive at a different rate than nonmigratory swans.

INTRODUCTION

The historic breeding and wintering range of Trumpeter Swans (*Cygnus buccinator*) once covered much of North America (Banko 1960). By the early 1900s however, the species had been severely over-hunted and was considered to be doomed by many ornithologists (Banko 1960). In 1929, the National Park Service began a survey to determine the population status of Trumpeter Swans. By 1932, they had found that there were 31 individuals in Yellowstone Park in Wyoming, 26 on the Red Rock Lakes in the Centennial Valley of Montana, and 12 others in the surrounding region (Banko 1960). At the time, these were thought to be the only birds remaining for the entire species. In 1954, however, a large breeding population was discovered in Alaska (Banko 1960). By that time, the population of Trumpeter Swans in the lower 48 states was increasing, mainly due to supplemental feeding during the winter, protection of breeding habitat, and protection from hunting (Banko 1960). In the last continent-wide Trumpeter Swan survey in 2005, 34,803 swans were counted (Moser, in press).

RESTORATION BACKGROUND

There are three distinct populations of Trumpeter Swans in North America: the Pacific Coast Population, the Rocky Mountain Population, and the Interior Population (IP). Historically the IP bred throughout the upper Midwest and wintered along the Lower Mississippi River south to the Gulf Coast and along parts of the Atlantic Coast (Banko 1960). The IP, which once may have numbered more than 100,000 individuals, was extirpated by market hunting by the early 1900s (Banko 1960). In 1960, the first reintroduction of Trumpeter Swans to the IP was made on the Lacreek National Wildlife Refuge in South Dakota (Hansen 1973). The second transplant took place in 1966 in Carver County, Minnesota (Hansen 1973). Since that time, other states and the Province of Ontario have initiated reintroduction programs to restore Trumpeter Swans. In 1987 and 1988, the Wisconsin Department of Natural Resources (WDNR) used cross-fostering (using Mute Swans to incubate and raise trumpeter young), decoy rearing (a surrogate parent in the form of a decoy raised the decoy-reared birds), and captive-parent rearing (captive trumpeters were used to rear young) to re-introduce a wild population (Abel 1993). The original goal of the program was to have a minimum population of 20 breeding migratory pairs (Ad hoc Swan Committee 1998). The reintroduction was successful, and today the estimated population of Trumpeter Swans in Wisconsin is more than 500 individuals (Sumner Matteson, WDNR, pers. comm.). As early as 1993, a few trumpeters from Wisconsin began migrating to wintering areas in southern Illinois (Babineau 2004).

The lack of migratory behaviors and suitable wintering areas are considered the greatest obstacles to the complete recovery of the IP to a healthy, self-sustaining population (Mitchell 1994). Currently, only a fraction of the birds migrate to wintering sites below 40° N latitude (Gillette 1999). Some states with reintroduction programs have intentionally discouraged migration by failing to discourage supplemental feeding by private citizens during the winter to preclude high winter mortality rates. Swans that remain north during the winter often cannot survive without direct human intervention such as supplemental feeding or aerators to keep the water open. In some areas, people indirectly assist the swans in the form of power plants that release warm water and keep large stretches of river open throughout the winter. During exceptionally harsh winters, these areas may freeze over causing large die-offs in these nonmigratory groups of birds (Linck 1999, Drewien *et al.* 2002). If these swans migrated to more appropriate southern areas, they would not be exposed to this risk during the winter. There also are many dangers associated with long migrations, however, and anecdotal evidence suggests migratory Trumpeter Swans have lower survival than swans that do not migrate, but this premise has not been supported with empirical evidence. Additionally, there is some question whether good wintering areas are still available in the south (Mitchell 1994). Most wetlands in southern states have been drained and converted to agricultural fields (Dahl and Johnson 1991). Some populations of Trumpeter Swans field-feed, but some do not (McKelvey and Verbeek 1988, Hamer 1990, Beekman 1991, Squires 1991, Anderson 1993, Squires and Anderson 1995, Lamontagne *et al.* 2003, Babineau 2004). It is currently unknown if agricultural foods meet the energetic and nutritional requirements of Trumpeter Swans to allow for maximum population growth.

Swans are often the last species of waterfowl to leave the breeding grounds in the fall and the first to return in the spring (Banko 1960). IP swans appear on the wintering grounds toward the end of November and leave for the breeding grounds before mid-March (Babineau 2004). Trumpeter Swans are philopatric to both the breeding and wintering grounds each year. Young swans remain with their parents until the next spring, enabling them to learn the migration routes from their parents. Once the extirpation of a migratory population breaks the migratory tradition, it can be very difficult to reestablish (Ogilvie 1972). There are very few wintering grounds north of 40° latitude with adequate food and open water to support trumpeters throughout the winter. As populations grow and these northern wintering grounds become crowded, some swans may have to migrate randomly at first to search for a suitable wintering area. Gillette (1997) believes that these individuals have higher mortality rates than the swans that are sedentary or those that migrate to a known area. He states that searching may increase the risk of lead poisoning, shooting, and accidents when swans have to visit multiple, unfamiliar wetlands to find a good location (Gillette 1997). Some studies have shown that postfledging survival has a direct negative relationship with the length of the fall migration (Pienkowski and Evans 1985, Owen and Black 1991).

FORAGING BEHAVIOR

Many waterfowl species have adapted to a lack of good aquatic habitat by foraging in agricultural fields, usually to their benefit (Bellrose 1980, Baldassarre and Bolen 1994). Availability of food during winter is probably not a limiting factor for populations that use agricultural resources (Gates *et al.* 2001). Trumpeter Swans on the West Coast shifted from foraging exclusively on fresh water plants to grain and produce fields in the late 1970s (McKelvey 1981). There are multiple hypotheses that may explain why this switch occurred. Trumpeter Swans in the Skagit Valley of Washington may have begun field-feeding after seeing Tundra Swans grazing on croplands (Hamer 1990). Researchers have suggested that once the density of aquatic tuber stocks drop below a certain level, swans switch to feeding in agricultural fields for the remainder of the season (Beekman 1991, Squires and Anderson 1995). Eastern population Tundra Swans began feeding on crops because of a long-term decline in the quality and quantity of natural aquatic foods (Crawley and Bolen 2002). Flooding of the traditional aquatic habitat caused swans in one area of Europe to begin field-feeding. In subsequent winters, the swans returned to those fields even though there was no flooding (Owen and Cadbury 1975). During one study, Trumpeter Swans were observed feeding in pasturelands, even though their traditional habitat was still intact. Standing water in the fields may have attracted those swans to begin with (McKelvey and Verbeek 1988). They may have then continued feeding on the pastures because the grass was not only easier to eat, but was also much higher in protein than the estuary plants (McKelvey and Verbeek 1988). In southern Illinois, some groups of wintering IP Trumpeter Swans have been observed foraging solely on agricultural fields, while other groups may still use predominantly aquatic vegetation (Babineau 2004).

Among swans that forage on aquatic vegetation, the tubers of sago pondweed (*Potamogeton pectinatus*) seem to be strongly preferred (Owen and Kear 1972, Beekman 1991, Squires 1991, Squires and Anderson 1995, Lamontagne *et al.* 2003). Sago pondweed tubers are high in carbohydrates and protein and have a high digestive efficiency compared to other aquatic vegetation (Mitchell 1994, Squires and Anderson 1995). Tubers take a lot of time and effort to extract, so the swans will not use them unless the density of the tuber stocks is high (Beekman 1991, Lamontagne *et al.* 2003). Trumpeter Swans also favor muskgrass (*Chara spp.*), waterweed (*Elodea spp.*), and arrowhead (*Sagittaria spp.*), (Owen and Kear 1972, Mitchell 1994, Squires and Anderson 1995). Aquatic plants have less digestible protein and more fiber than many of the crops Trumpeter Swans use (Anderson 1993). To meet their daily energy requirements, swans have to spend more time feeding on aquatic plants than if they are eating soybeans and wheat (Bortner 1985). When the time and energy costs of feeding on aquatic vegetation become too high, swans shift to foraging on agricultural fields such as pastures and grain and produce crops (McKelvey and Verbeek 1988, Hamer 1990, Anderson 1993, Babineau 2004). Trumpeter Swans have been observed eating corn, soybeans, potatoes, carrots, winter wheat and pasture grasses (McKelvey and Verbeek 1988, Hamer 1990, Anderson 1993, Babineau 2004). Trumpeters in the Pacific Coast Population fed on corn in early winter, potatoes in mid-winter, and potatoes and grass in late winter, with potato fields receiving the highest use overall (Anderson 1993). IP Trumpeter Swans in southern Illinois ate both corn and winter wheat, with preferences among years associated with ambient temperature (Babineau 2004).

The best way to study waterfowl diets is to collect the birds and examine their esophageal contents (Baldassarre and Bolen 1994). Because of the population status of the Trumpeter Swan, however, this method is not possible. Fecal analysis is another method, but the results can be biased (Grant *et al.* 1994). To study the diets of Trumpeter Swans, some researchers have used activity-time budgets (McKelvey and Verbeek 1988, Hamer 1990, Grant *et al.* 1994, Lamontagne *et al.* 2001, Babineau 2004). One study found that Trumpeter Swans foraged on pastures only during daylight hours, but while on the estuary, they foraged almost as much at night (47.2%) as during the day (57.6%, McKelvey and Verbeek 1988). In an area where wintering trumpeters foraged on agricultural fields, both crop and pasture, they spent 28 percent of their diurnal activity budget foraging (Hamer 1990). Another study showed that field-feeding swans in southern Illinois spent 45 percent of their time foraging during the winter (Babineau 2004). Swans that forage on aquatic vegetation increased the amount of time they spend foraging from 30 percent during the winter to 45 percent in the spring (Squires and Anderson 1997).

SURVIVAL FACTORS

The abundance of a population is a balance between factors that lead to population increase such as productivity and immigration and factors that lead to population decline such as post-fledging mortality and emigration. Interior Population Trumpeter Swans appear to be isolated from the Pacific and Rocky Mountain populations (Caithamer 2001), thus, are unaffected by emigration and immigration. Therefore, productivity and post-fledging mortality exclusively influence the population abundance of IP Trumpeter Swans. Either an increase in mortality without a balancing increase in productivity, or decrease in productivity without a countering decrease in mortality could cause the population to decline. Alternatively, the opposite changes in these vital rates could lead to an increase in the population. Changes in productivity and mortality influence population dynamics of species to various extents and variation with average body size of individuals within a species correlates strongly with the degree of response (Jennings *et al.* 1999, Reznick *at al.* 2002). Change in productivity has a greater influence on population dynamics of smaller bodied species of waterfowl, while change in post-fledging survival has a greater influence on population growth rate of larger bodied species (Schmutz *et al.* 1997, Jennings *et al.* 1999, Hoekman *et al.* 2002). This is because smaller bodied species typically evolved a strategy of high reproductive rates, but low annual survival rates relative to larger bodied species (Eberhardt 1985, Lebreton and Clobert 1991). For example, smaller bodied species such as a Mallard Ducks tend to nest their first breeding season, lay clutches of 8 – 10 eggs, and re-nest up to six times when previous nests are destroyed, but have a low annual survival rate of about 65 percent relative to larger bodied species. Alternatively, larger bodied species such as Trumpeter Swans often delay nesting until their 3rd or 4th breeding season, lay four - six eggs, do not re-nest, and typically have about a 90 percent annual survival rate. Thus, larger bodied species rely more on having numerous years to successfully reproduce, whereas, smaller individuals rely more on successfully reproducing in any given year.

Swans have the highest survival rates of all waterfowl species (Nichols 1989, Johnson *et al.* 1992). Several studies have shown that survival does not vary between the sexes for adult swans and geese, because males stay with the females throughout the breeding season and the risks posed by nesting and brood-rearing are similar for both sexes (Nichols 1989, Johnson *et al.* 1992, Nichols *et al.* 1992, Schmutz *et al.* 1994, Ward *et al.* 1997). Survival does, however, vary with age. In general, researchers have observed reduced survival relative to adults during the 1st year after hatching, especially during the first fall migration (Ogilvie 1967, Coleman and Minton 1980, Owen and Black 1989, Perrins 1991, Schmutz *et al.* 1994, Menu *et al.* 2005). Coleman and Minton (1980) also observed reduced survival of young during the first spring migration in Mute Swans. Among swan species, migratory populations appear to have higher adult survival rates than those that are sedentary (Bart *et al.* 1991). It is unknown if this pattern also applies to Trumpeter Swans though, since migratory populations of this species have not been well-studied (Bart *et al.* 1991). Overall, annual survival rates for adult swans have been very high (Owen and Cadbury 1975, Anderson *et al.* 1986, Nichols *et al.* 1992, McCleery *et al.* 2002).

Lead poisoning, predators, adverse weather conditions, disease, parasites, flying accidents, birth deformities, pollution, and illegal shooting all cause mortality in Trumpeter Swans (Banko 1960, Mitchell 1994, Lagerquist *et al.* 1994). Collisions with overhead wires seem to be a major cause of death for some swan species. From 22-38 percent of reported deaths has been attributed to power lines in some studies (Owen and Cadbury 1975, Perrins 1991, Collins 2002). Cygnets on their first fall migration may be more vulnerable to collisions than adults (Ogilvie 1967, Owen and Cadbury 1975). There may be a bias toward reporting swans that hit power lines since power lines are usually located near people, an outage may result from a collision, and a swan will likely be found (Perrins 1991, Collins 2002). Because their method of feeding, which involves digging up large amounts of sediments, makes Trumpeter Swans more likely to ingest lead shot than other bottom-feeding waterfowl, lead poisoning causes 20-50 percent of swan deaths (Irwin 1975, Owen and Cadbury 1975, Blus *et al.* 1989, Lagerquist *et al.* 1994, Gillette 1996). Trumpeter Swans may also be more susceptible to lead poisoning than other species since low levels of lead seem to cause severe pathological changes in some birds (Blus *et al.* 1989).

MIGRATORY BEHAVIOR SOUTH OF 40° N LATITUDE

Two populations, totaling approximately 250 individuals of the 500 trumpeters in Wisconsin, have naturally established migratory behavior to more traditional wintering areas south of 40° latitude. One of these is at Burning Star # 5 (BS5), a reclaimed coal mine owned by Consolidation Coal Company in Jackson County, approximately 6 miles east of DeSoto, Illinois. The other site is the U.S. Army Corps of Engineers (USACE) Riverlands Refuge (Riverlands), a backwater area of the Mississippi River on the west side of the Mississippi River, West Alton, Missouri. Neck collar observations indicate little movement between these two winter locations suggesting they are separate winter populations (Babineau 2004). To determine habitat needs of wintering swans and determine if IP Trumpeter Swans have adapted to take advantage of agricultural habitats similar to other swan populations, Babineau (2004) conducted a study on the wintering population at BS5. She concluded this population of swans, which is increasing in abundance, uses primarily agricultural habitat as a food source. Although these results suggest the IP trumpeters can adapt to exploit agricultural habitat, agricultural foods may not supply all the nutritional requirements of free ranging geese (e.g., Buckley 1989, Amat *et al.* 1991). Thus, although swans using agricultural habitat may be meeting their minimal nutritional needs, use of this habitat type may not be allowing for maximum growth of the population. If swans are able to meet their nutritional requirements through the exploitation of agricultural habitat, it appears adequate wintering habitat exists throughout the historic wintering range of the IP of Trumpeter Swans to maintain the desired population. In contrast to the swans wintering at BS5, observations of the Riverlands winter population indicates those swans primarily use naturally occurring aquatic vegetation similar to historic food sources (Ed Zwicker, Illinois Department of Natural Resources, pers. comm.).

STUDY OBJECTIVES

To address the concern that habitat currently available is inadequate to properly support the population and that mortality during the migratory period may limit the growth of the population, we are initiating a study of IP Trumpeter Swan mortality with four primary objectives:

1. Verify that swans at Riverlands are depending more on natural submersed aquatic vegetation (SUV) for food than swans at BS5.
2. Identify the period of the life cycle (i.e., breeding, fall migration, winter, spring migration) in which most mortality occurs.
3. Determine if swans migrating below the 40° latitude have a different survival and reproductive rate than those swans that do not migrate.
4. Assuming the anecdotal evidence is correct that swans at Riverlands rely more on SUV,

determine if swans feeding on a more diverse diet at Riverlands have a different survival rate than those feeding almost exclusively on agricultural food sources at BS5.

METHODS

To determine if habitat use and diet differ between the two migratory swan populations, BS5 and Riverlands, we will estimate percent of daylight hours spent in each of two primary habitat types, aquatic and terrestrial, and five secondary terrestrial habitat types, corn, soybeans, winter wheat, milo, and other. To determine if these habitat types are used for feeding or roosting, we will conduct 72 hours of 1-hour activity-time budgets on focal birds, including 24 hours at BS5 and 48 hours at Riverlands. Babineau (2004) collected 66 hours of activity-time budget data at BS5 in a previous study; therefore, less data is needed for that site. We will distribute the time budgets among habitat types in proportion to the amount of time swans are observed using each habitat type. To verify that swans are foraging on foods representative of the habitat type they are seen in, we will estimate percent of forage cover on 0.5 m^2 plots randomly located within areas where swans are observed feeding. This will allow us to describe all types of forage swans may be consuming in each habitat type.

Approximately 50 percent of the swans wintering at BS5 and Riverlands have been fitted with neckbands. We will attempt to read and record all neckbands at both study sites weekly. Because most neckbanded swans seen in southern Illinois were banded in Wisconsin, we will also record neckbands of swans on the Wisconsin breeding grounds. We will record band resightings made at the start of the breeding season and again at the end of the breeding season, before the fall migration. We will use an information-theoretic approach with the Cormack-Jolly-Seber model in Program Mark to determine if the data indicates daily survival rate varies seasonally in adult and juvenile swans.

Wisconsin WDNR personnel will provide us with all previous records of neckband attachments and observations from that state. We will also acquire previous records of neck-banded swans wintering in southern Illinois from the Illinois Department of Natural Resources and the Cooperative Wildlife Research Lab at Southern Illinois University Carbondale. These data, as well as data collected during this study, will be used to estimate age, sex, and site-specific survival as well as annual survival.

We will consider swans observed north of 40° N latitude during December and January as nonmigratory, while we will identify swans observed during December or January south of that latitude as migratory. We will again use an information-theoretic approach with the Cormack-Jolly-Seber model in Program Mark to determine if the data indicate a difference in survival between migratory and nonmigratory swans.

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