Population Growth Parameters of a Reintroduced Trumpeter Swan Flock, Seney National Wildlife Refuge, Michigan, USA (1991-2004)

R. GREGORY CORACE, III[1], DAMON L. MCCORMICK[2] AND VINCENT CAVALIERI[3]

[1]Seney National Wildlife Refuge, 1674 Refuge Entrance Road, Seney, MI 49883
Internet: Greg_Corace@fws.gov

[2]Common Coast Research and Conservation, P.O. Box 123, Germfask, MI 49836

[3]311 4th Street, Iron Mountain, MI 49801

Abstract.—Once an abundant and conspicuous presence in wetlands across much of north-central North America, Trumpeter Swan (*Cygnus buccinator*) poplulations were decimated in the mid- to late 1800s by a combination of market hunting, subsistence hunting, and habitat loss. Since then, restoration has focused primarily on reintroduction efforts in which captive-reared birds are released and then monitored. From 1991 to 1993, 44 birds were released into Seney National Wildlife Refuge (Schoolcraft County, Michigan) in a multi-agency attempt to enhance the breeding population of this species in the Upper Great Lakes region. To provide information useful to swan restoration efforts elsewhere, this paper summarizes 14 years of Trumpeter Swan occupancy and productivity at Seney. In doing so, we document the first substantial inter-annual decline in swans on the Refuge and provide evidence that suggests birds may now be dispersing onto other lakes and wetlands in the eastern Upper Peninsula of Michigan. We also present information from which we infer processes regulating swan numbers and rates of productivity and discuss both the continued need for monitoring and the need for research to examine the effects swans might have on other components of aquatic ecosystems at the Refuge. Received 25 July 2005, accepted 29 August 2005.

Key words.—*Cygnus buccinator*, reintroduction, restoration, Seney National Wildlife Refuge, Trumpeter Swan, Upper Peninsula.

Waterbirds 29(1): 38-42, 2006

Guided in part by the recent National Wildlife Refuge Improvement Act (1997), restoration associated with ecosystems, communities, habitats, and species is an increasing priority for Seney National Wildlife Refuge (Schoolcraft County, Michigan) and the hundreds of other wildlife refuges across the United States. Although the term *restoration* has only in recent times come to describe efforts aimed at returning function to ecosystem and community-level patterns and processes (Society for Ecological Restoration 2002), it has long been the goal of land managers working with specific wildlife habitats and associated species (Leopold 1933; Curtin 1993). For instance, the present ubiquity of the Canada Goose (*Branta canadensis*) is the product of concerted restoration efforts that involved captive-release of birds or, as defined by Koford *et al.* (1994), reintroductions, in the 1930s and 1940s (Johnson 1947). More recently, attempts to restore the Whooping Crane (*Grus americana*) and the Trumpeter Swan (*Cygnus buccinator*) have also relied upon similar captive-release techniques, often using National Wildlife Refuges as project areas (Shea *et al.* 2002).

Once an abundant and conspicuous breeder in wetlands of north-central North America, the Trumpeter Swan (hereafter, also referred to as trumpeter or swan) is the largest waterfowl native to this continent (Bellrose 1976; Mitchell 1994). However, during the mid to late 1800s market hunting, subsistence hunting, and habitat loss acted in concert to cause the extirpation of this species from much of its historical range (Banko 1960; Mitchell 1994; Shea *et al.* 2002). By 1932 it was believed that the global population was represented by a mere 69 birds found high in the Rocky Mountains near Yellowstone National Park (Banko 1960; Shea *et al.* 2002). In 1935 Red Rock Lakes National Wildlife Refuge (RRLNWR, Montana) was established for the specific purpose of protecting breeding Trumpeter Swans (Banko 1960). Once enough birds were available from RRLNWR, efforts to restore extirpated populations were supported by providing surplus birds to captive propa-

gators and zoos (Shea *et al.* 2002). According to Nelson (1997) and Shea *et al.* (2002) attempts to restore breeding populations of trumpeters included reintroductions at Delta Waterfowl Research Station (Manitoba), Lacreek National Wildlife Refuge (South Dakota), Hennepin County Park Reserve District (now, Three Rivers Parks District, Minnesota), and in other sites in Iowa, Michigan, Minnesota, Missouri, Ohio, eastern Ontario, Canada, and Wisconsin. At present, the breeding distribution of this species is disjunct compared to historical times, with four main geographically-constrained breeding populations: Pacific Coast, Rocky Mountain (Canada), Rocky Mountain (U.S.), and Interior.

In Michigan, restoration of Trumpeter Swan has largely been the product of a multiagency attempt to establish a breeding population at Seney National Wildlife Refuge (hereafter, the Refuge or Seney) (Brewer *et al.* 1991). This relatively intact and isolated refuge lacks any history of waterfowl hunting and provides the chance for observing swans unaffected by urban influences (e.g., powerlines) or lead shot ingestion, both of which have been implicated as the leading causes of mortality for other Interior birds (Lumsden and Drever 2002). Moreover, because birds at Seney are readily observable and a nearly complete census is possible each year, patterns detailing population growth and rates of productivity of breeding groups at the Refuge provide baseline information for future research and restoration elsewhere. This paper summarizes 14 years of swan occupancy and productivity patterns at Seney. In doing so, we document the first substantial decline in swans on the Refuge and provide evidence that suggests that the population of birds at Seney may now dispersing onto other lakes and wetlands in the eastern Upper Peninsula of Michigan. Information is also presented from which processes regulating swan numbers and productivity are inferred. We close by discussing the continued need for monitoring of the swan population and the need for research to examine effects swans might have on other patterns and processes of aquatic ecosystems at the Refuge.

STUDY SITE AND METHODS

Seney National Wildlife Refuge is located in the east-central portion of the Upper Peninsula of Michigan, between Lake Superior and Lake Michigan. The Refuge encompasses 38,545 ha; approximately 2,832 ha are comprised of man-made impoundments (pools) of shallow open water and submergent vegetation interspersed by marsh and forests. Most of these pools were created in the 1930s and 1940s (Losey 2003) and are characterized by aquatic plant species such as *Najas guadalupensis*, *Vallisneria americana*, *Elodea canadensis*, *Chara* spp., and *Potamageton* spp. Many of these aquatic plant species have been identified as important food resources of swans elsewhere (Grant *et al.* 1994; Squires and Anderson 1995).

The climate of the Refuge is strongly influenced by the close proximity of Lake Huron, Lake Michigan, and Lake Superior. Precipitation is fairly evenly distributed over the year, with average annual precipitation of approximately 84 cm. Dominant soils at the Refuge are classified as mucks, peats, and sands (Albert 1995). No major municipality of >10,000 people exists within 129 km of the Refuge. Most lands immediately adjacent to Seney are state-owned and managed by the Michigan Department of Natural Resources.

Swans that were released at Seney originated from eggs collected in Alaska and subsequently hatched and hand-raised at the Kellogg Bird Sanctuary (Kalamazoo County, Michigan). A total of 44 two-year-olds were released between 1991 and 1993. Since swans establish pair bonds starting at 20 months (Mitchell 1994), these birds were assumed to have formed permanent pair bonds prior to release. Here, we term birds <1 yr as cygnets, 1-4 yr sub-adults and ≥4 yr adults. We use the term "whitebirds" for sub-adults and adults, collectively.

Since the release of the swans at the Refuge, monitoring of the population has occurred primarily during May to August when the numbers of whitebirds, the number of nests, and the number of cygnets on or near each of 21 officially designated pools in three pool management units are counted on a weekly basis by Refuge staff, interns, and volunteers as they drive along Refuge roads and dikes. Because both access and visibility are excellent, this sampling represents nearly a complete census of the population of swans at the Refuge on an annual basis.

Data showing productivity trends are graphically presented as both raw annual counts and as a 3-year moving average. Since the ability of surveyors and survey intensity may vary slightly from year to year, we believe that the moving average is an appropriate technique for smoothing results and thereby addressing survey variability. We also present data pertaining to productivity on a pool-by-pool basis. However during 2004, staff shortages precluded the following of all hatched birds. Thus, percent survival rates pertain to the period 1991-2003.

RESULTS

Since the initial release of swans in 1991, the number of whitebirds on the Refuge has increased 24% per year. In 2004, the highest breeding season count of these birds occurred on 28 June when 164 were counted.

This figure, markedly lower than the high of 191 whitebirds recorded in 2003, represented the first substantial inter-annual decline of trumpeters at the Refuge (Fig. 1).

During 2004, 25 nests were identified and 71 cygnets were hatched in 18 broods (72%). A large portion of cygnets (44%) hatched from just three pools (C-1, C-3, and Marsh Creek). The last weekly swan survey of 5 July indicated that 35 young (49%) had survived. This same number of cygnets was found during a subsequent 1-day survey on 19 October and apparently fledged.

During the initial year of the introduction (1991), no breeding was recorded at the Refuge (Fig. 2). In the following year four cygnets were observed and two of these birds fledged. In 1993, the lowest annual survival rate for cygnets was recorded at Seney as 17 cygnets were located, but only four (24%) fledged. After 1993, the number of cygnets hatched on the Refuge steadily increased through 2000, after which the number began to level off (Fig. 2). The highest number hatched (88) was in 2003. From 1992 to 2003, twelve pools had nesting swans during at least five years; eight pools had nesting swans in four or fewer years. We estimate that 348 cygnets have fledged at Seney, with yearly estimated survival rates of cygnets ranging from 24% in 1993 to 84% in 1996 ($\bar{x}$ ± SD = 57 ± 17%, Fig. 2).

Survival rates of cygnets varied by pool, ranging from a low of 27% (Lower Goose Pen) to a high of 82% on I Pool (the pool with the most fledged cygnets at 40). Swans never successfully bred on E-1 and M-2 in one and four attempts, respectively. Patterns of swan productivity from 1992-2003 suggest that those pools with occupancy of >4 years on average have a numerically higher success rate (60 ± 14%) than the other pools (41 ± 20%).

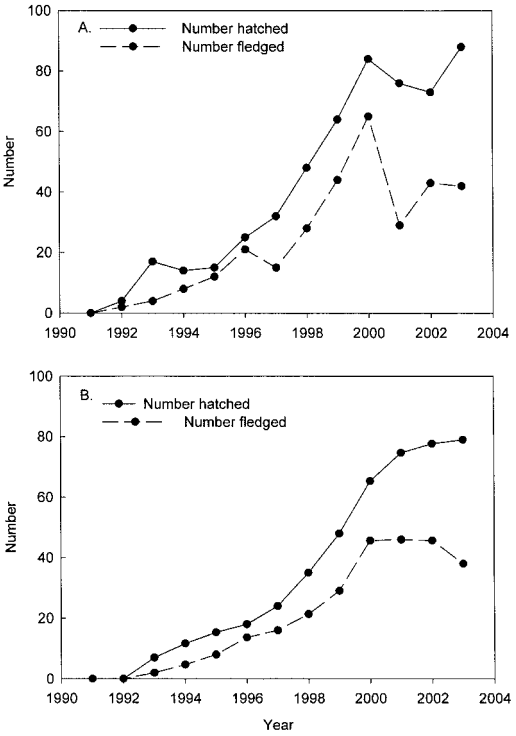

Figure 2. Number of cygnets hatched and fledged (a: raw data, b: 3-yr average) at Seney National Wildlife Refuge (1991-2003).

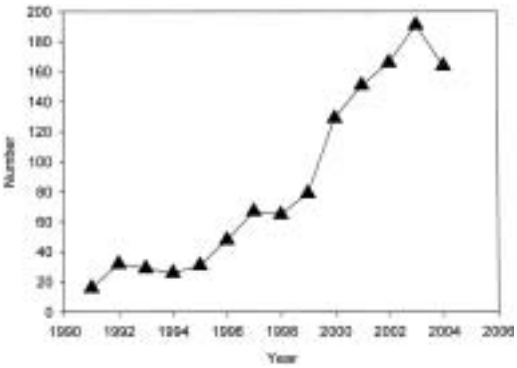

Figure 1. Number of Trumpeter Swan whitebirds recorded at Seney National Wildlife Refuge (1991-2004).

DISCUSSION

Despite various restoration efforts in North America, the Trumpeter Swan is still of significant conservation concern (USFWS 2002) for reasons including continued loss of wetland habitat, concentration of wintering flocks, and lead poisoning (Mitchell 1994). Since Trumpeter Swans at Seney represents a) the largest and best-monitored population in the State of Michigan (Johnson 1997) and b) an example of a population free from the effects of urbanization and lead shot (Lumsden and Drever 2002), our findings provide baseline information beneficial to those planning to further en-

hance the Interior Population. That said, since many studies have shown that geographical variances are associated with bird habitat availability and affinity (Collins 1983; O'Connor *et al.* 1999) population growth in future release sites should not be expected to mirror the patterns observed at Seney.

Several processes may be affecting the number of whitebirds and cygnets at Seney. Although mortality rates of whitebirds cannot be assessed at this time, we believe the substantial decline in their number observed in 2004 can partially be explained by dispersion of recently paired birds from the Refuge. Results from aerial surveys conducted by the Michigan Department of Natural Resources since 2002 suggest that an increasing number of nearby lakes are being colonized by breeding pairs of swans. In 2004, officials located six breeding pairs and 31 additional whitebirds off Refuge, the most ever observed (T. Weise and K. Sitar, pers. comm.). This observation, along with the data presented here, supports the hypothesis that the swan population at the Refuge may be at or near carrying capacity. If so, one would expect birds just forming pair bonds to be the most likely to disperse to other wetlands outside of the Refuge. However, more detailed study that includes continued monitoring of the swan population at the Refuge and elsewhere in the eastern Upper Peninsula is necessary to support this hypothesis.

Another possible process regulating swan numbers on the Refuge is predation. Decreased survival of cygnets noted over the last few years may be caused by increased predation from Snapping Turtle (*Chelydra serpentina*), Northern Pike (*Esox lucius*), Mink (*Mustela vison*), Coyote (*Canis latrans*), Gray Wolf (*C. lupus*), and especially Bald Eagle (*Haliaeetus leucocephalus*). In recent seasons, eagles have been observed taking cygnets, often snatching multiple young from broods that have been abandoned by parents. Mitchell (1994) noted that Golden Eagles (*Aquila chrysaetos*) were capable of predating adult trumpeters. We suggest that Bald Eagles at the Refuge may have identified young trumpeters as a reliable food source, and are now actively hunting them to a degree that has begun to influence cygnet survival rates. The fact that Seney's pools are relatively unproductive for fish, an alternate eagle prey, may further exacerbate this effect.

Patterns we present here can be compared to those observed with other trumpeter populations. For example, at Red Rock Lakes National Wildlife Refuge the number of swans peaked in the mid 1950s and then declined slightly and leveled off. This phenomenon was partially attributed to saturation of suitable nesting sites (Banko 1960). As the population reached its peak, additional territories were initiated in less optimal areas because swans holding prime sites did not decrease the size of their territories in response to increased swan numbers. It is possible that the lower quality of these new territories contributed to reduced swan productivity (Banko 1960; Bellrose 1976). At Seney, a group of >100 nonbreeding swans may congregate on a limited number of pools each year. In more recent years, these birds have encroached on established territories of breeding pairs, possibly reducing pair productivity. In 2004, for instance, the I Pool breeding pair did not fledge any cygnets, but for the first time spent considerable time defending their territory from a large number of nonbreeding adults and juvenile swans (D. McCormick and V. Cavalieri, pers. obs.). This total failure is in stark contrast with the 82% long-term fledging rate on this pool.

What effect swans may have on the food resources they exploit and the pool ecosystems in which they live is unknown (Belovsky 1986; Brown 1989; Squires and Anderson 1995). Similar to birds in the Greater Yellowstone area (Squires and Anderson 1995), swans at Seney feed almost entirely on aquatic macrophytes. Agriculture around Seney is comprised of low-intensity mixed grass hay production; row cropping, a land use that provides alternative food resources elsewhere, is rare. Consequently, since the primary diet of the birds at Seney includes many plant species also important to ducks and geese (Squires and Anderson 1995; LaMontagne *et al.* 2003), swans may be in direct competition for a limited resource growing on nutrient-poor soils. Although estimates of the

amount of food that can be consumed on a daily basis vary, McKelvey (1981) found that 4.5 to 5.5 kg (wet weight) of plant material may be consumed per day per bird. With swan populations apparently peaking, we suggest that a more detailed study is required to assess the roles swans may play as a potential keystone species of Refuge pool ecosystems.

ACKNOWLEDGMENTS

This work was made possible through the contributions of the staff, interns, and volunteers of Seney National Wildlife Refuge. Those involved with establishing swans at the Refuge include R. Hess (Michigan DNR-Retired), J. Johnson (Kellogg Bird Sanctuary), M. Tansy (USFWS-Retired), and T. Weise (Michigan DNR). Former Refuge Biologist, R. Urbanek, established the swan monitoring program. Other members of the present Refuge staff who have been instrumental in aspects of the Trumpeter Swan reintroduction efforts include T. Casselman, T. Papple, L. Tansy, and L. Zellar. The Seney Natural History Association provided financial support for interns over the years and it was often these young people who conducted the weekly surveys: M. Harless, J. Keffer, J. Martindale, T. McReynolds, T. Przybylski, N. Rein, D. Stasek, and A. Veine. We thank H. Adams, K. Henslee, and E. Losey for their helpful edits. This manuscript was greatly improved through the suggestions and comments of H. Burgess, J. Coulson, J. Johnson, H. Nelson, R. Shea, D. Weaver, and an anonymous reviewer. This paper does not necessarily reflect the position of the U.S. Fish and Wildlife Service or Seney National Wildlife Refuge.

LITERATURE CITED

Albert, D. A. 1995. Regional landscape ecosystems of Michigan, Minnesota and Wisconsin: a working map and classification. USDA Forest Service General Technical Report, Report NC-178. NorthCentral Research Station, St. Paul, MN.

Banko, W. E. 1960. The Trumpeter Swan. North American Fauna 63. U.S. Fish and Wildlife Service, Washington, DC.

Bellrose, F. C. 1976. Ducks, geese, and swans of North America, 2nd edition. Stackpole Books, Harrisburg, PA.

Belovsky, G. E. 1986. Generalist herbivore foraging and its role in competitive interactions. American Zoologist 26: 51-69.

Brewer, R., G. A. McPeek and R. J. Adams, Jr. 1991. The atlas of breeding birds of Michigan. Michigan State University Press, East Lansing.

Brown, J. S. 1989. Coexistence on a seasonal resource. American Naturalist 133: 168-182.

Collins, S. L. 1983. Geographic variation in habitat structure of the Black-throated Green Warbler (*Dendroica virens*). Auk 100: 382-389.

Curtin, C. G. 1993. The evolution of the U.S. National Wildlife Refuge System and the doctrine of compatibility. Conservation Biology 7: 29-37.

Grant, T. A., P. Henson and J. A. Cooper. 1994. Feeding ecology of Trumpeter Swans breeding in south central Alaska. Journal of Wildlife Management 58: 774-780.

Johnsgard, P. A. 1978. Ducks, geese, and swans of the world. University of Nebraska Press, Lincoln, NE.

Johnson, C. S. 1947. Canada Goose management, Seney National Wildlife Refuge. Journal of Wildlife Management 46: 21-24.

Johnson, W. C. 1997. Michigan 1996 Trumpeter Swan update. Pages 18-20 *in* J. R. Balcomb, M. H. Linck and A. L. Price, editors. Proceeding and Papers of the 16th Trumpeter Swan Society Conference. The Trumpeter Swan Society, Maple Plain, MN.

Koford, R. R., J. B. Dunning, Jr., C. A. Ribic and D. M. Finch. 1994. A glossary for avian conservation. Wilson Bulletin 106: 121-137.

LaMontagne, J. M., L. J. Jackson and R. M. R. Barclay. 2003. Characteristics of ponds used by Trumpeter Swans in a spring migration stopover area. Canadian Journal of Zoology 81: 1791-1798.

Leopold, A. 1933. Game management. Charles Scribner's Sons, New York, NY.

Losey, E. B. 2003. Seney National Wildlife Refuge: its story. Lake Superior Press, Marquette, MI.

Lueck, C. M. 1991. The agnostic behavior of nesting Trumpeter Swans toward other waterfowl. Pages 163-169 *in* J. Voigt-Englund, editor. Proceedings and Papers of the 12th Trumpeter Swan Conference. The Trumpeter Swan Society, Maple Plain, MN.

Lumsden, H. G. and M. C. Drever. 2002. Overview of the Trumpeter Swan reintroduction probram in Ontario, 1982-2000. Waterbirds 25 (Special Publication 1): 30-312.

McKelvey, R. W. 1981. Some aspects of the winter foraging ecology of Trumpeter Swans at Port Alberni and Comox Harbour, British Columbia. Unpublished Thesis. M.S. Simon Fraser University, Burnaby, British Columbia.

Mitchell, C. D. 1994. Trumpeter Swan (*Cygnus buccinator*). *In* The Birds of North America, No. 105 (A. Poole and F. Gill, Eds.). The Academy of Natural Sciences, Philadelphia; American Ornithologists' Union, Washington, DC.

National Wildlife Refuge System Improvement Act. 1997. Public Law 105-57.

Nelson, H. K. 1997. Development of a management plan for the Interior Population of Trumpeter Swans. Pages 27-29 *in* J. R. Balcomb, M. H. Linck and A. L. Price, Eds. Proceeding and Papers of the 16th Trumpeter Swan Society Conference. The Trumpeter Swan Society, Maple Plain, MN.

O'Connor, R. J., M. T. Jones, R. B. Boone and T. B. Lauber. 1999. Linking continental climate, land use, and land patterns with grassland bird distribution across the conterminous United States. Studies in Avian Biology 19: 45-49.

Shea, R. E., H. K. Nelson, L. N. Gillette, J. G. King and D. K. Weaver. 2002. Restoration of Trumpeter Swans in North America: a century of progress and challenges. Waterbirds 25 (Special Publication 1): 296-300.

Squires, J. R. and S. H. Anderson. 1995. Trumpeter Swan (*Cygnus buccinator*) food habits in the Greater Yellowstone Ecosystem. American Midland Naturalist 133: 274-282.

Society for Ecological Restoration. 2002. The SER primer on ecological restoration. Society for Ecological Restoration Science and Policy Working Group. www.ser./org

United States Fish and Wildlife Service. 2002. Fish and wildlife resource conservation priorities: Region 3. Fort Snelling, MN.