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Trumpeter Swans: A Secure Future?

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PREFACE

Members of The Trumpeter Swan Society share a common mission - to assure the vitality and welfare of wild Trumpeter Swan populations and to restore the species to as much of its former range as possible. During the past century, Trumpeter Swans made a very welcome return from the brink of extinction. As North America's human population increases, finding ways to protect that progress and rebuild secure distributions will pose continued challenges. Over the past 32 years, our Conferences have periodically brought together wildlife managers, private sector partners, and interested citizens to discuss the issues, problems, and opportunities facing Trumpeter Swan restoration and management.

Our 17th Conference was held in Idaho Falls, Idaho, in September 1999, to highlight the problems facing Trumpeter Swans in the Rocky Mountains and the work that lies ahead to make their future secure. We were honored by the presence of representatives from Idaho's Governor and Congressional delegation, who shared our concerns about the vulnerability of trumpeters in eastern Idaho. We were particularly pleased to hear Agriculture and Natural Resources Director Don Dixon speak on behalf of Idaho Senator Mike Crapo. We also were honored by the participation of Paul Schmidt, Deputy Assistant Director for Refuges and Wildlife, who spoke on behalf of U.S. Fish and Wildlife Director Jamie Clark. Mr. Schmidt made clear that, despite the promising increase in Rocky Mountain trumpeters, until we restore their migrations and help them return to more suitable wintering areas, their recovery will remain questionable. We were heartened to hear that the top levels of the U.S. Fish and Wildlife Service (USFWS) comprehend the gravity of the current situation, and are committed to increasing Service leadership and the role of National Wildlife Refuges in range expansion efforts.

Speakers focused on the current status and trends of each management population, and discussed efforts to conserve and improve habitat, rebuild secure winter distributions, and expand migrations. Throughout the presentations and the field trip to Red Rock Lakes National Wildlife Refuge and Harriman State Park, the need to more effectively involve on-the-ground managers and private sector partners in Trumpeter Swan restoration was a prevalent theme. Speakers explored ways in which private citizens, land trusts, rehabilitators, and universities can work with habitat and wildlife managers to help restore the swans and their habitats.

The obstacle that Tundra Swan hunting has posed to southward expansion of Rocky Mountain trumpeters was discussed from various perspectives. Concerns that Tundra Swan hunting has derailed range expansion efforts by impeding translocations to important southern habitats and increasing the mortality of southward migrating trumpeters were discussed, as were concerns that southward expansion of trumpeters could lead to further reductions in the swan hunt. The USFWS reiterated its commitment to an open public process in the coming year to discuss and select a management alternative for future swan hunts in the Pacific Flyway.

Throughout the Conference, speakers highlighted the precarious status of the Tristate Trumpeter Swan nesting population, the only breeding population in the lower 48 states that escaped extirpation. The need to clearly differentiate between "management" populations and biological populations was also emphasized. In recent years, managers have broadly lumped most western Canadian and all western U.S. trumpeters into one "management" population (Rocky Mountain Population). Speakers emphasized the need to recognize the Tristate trumpeters as a distinct biological population in management plans and actions, and not allow its declining population trend, very low numbers, and difficult problems to be masked by lumping it with the increasing western Canadian population.

Beyond the exchange of information, the Conference brought together over 100 friends of the Trumpeter Swan to share their data, understanding, and enthusiasm. We hope the 17th Conference has helped make the trumpeter's future more secure, and that these *Proceedings* will make this information available to a much broader audience, for many years to come.

Ruth Shea
Conference Chair

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PACIFIC COAST POPULATION

THE 1995 CENSUS OF TRUMPETER SWANS ON ALASKAN NESTING HABITATS

Bruce Conant, John I. Hodges, Deborah J. Groves, and James G. King, U.S. Fish and Wildlife Service, 3000 Vintage Blvd., Suite 240, Juneau, AK 99801-7100

ABSTRACT

The sixth complete census of Trumpeter Swans (*Cygnus buccinator*) on their Alaska summering grounds was completed in 1995. Over 700 hours of flight time was expended by many survey crews to fly 90,726 km survey tracks (82,645 km in 1990) over all the potential swan habitat on 674 (625 in 1990) USGS, 1:63,360 scale maps. Compared to 1990, the population was comprised of: paired birds 7,946 (+13%); singles 859 (+33%); flocked birds 3,184 (+56%); total white swans 11,989 (+23%); cygnets 3,834 (+7%); and total swans 15,823 (+19%). Cygnets accounted for 24% of the population (27% in 1990) and 1,218 broods (+8% from 1,125 in 1990) were found with an average brood size of 3.1 (3.2 in 1990). Although the population of trumpeters summering in Alaska continues to follow a logistic growth curve, a comprehensive Alaska Trumpeter Swan Management Plan is still needed to ensure they remain an integral part of each geographical unit of their present distribution. The continual loss of Pacific Coast wintering habitat is of special concern. In Alaska, a combined program of complete censuses every 5 years and random sampling for interim years is recommended to provide the high quality data needed for the best management of this magnificent international resource.

Editors' note: Bruce Conant made a slide presentation of current Trumpeter Swan distribution in Alaska. The full text of this paper was previously published in the Proceedings and Papers of the 16th Trumpeter Swan Society Conference, pages 75-97.

ARE ALASKA'S WILD SWANS SAFE?

James G. King, 1700 Branta Road, Juneau, AK 99801-7918

Eighty percent of the world-wide population of Trumpeter Swans (*Cygnus buccinator*) build their nests in lakes of the boreal or rain forest regions of temperate Alaska, while two-thirds of North America's Tundra Swans (*C. columbianus*) nest on mounds on the treeless Arctic plains of northern and western Alaska. These swans, widely dispersed on their wilderness nesting grounds, form flocks of dozens to hundreds for migration and wintering. The natural estuarine habitat once favored by such flocks in winter is now largely gone and most wild swans have adapted to field feeding on farmland.

Wild swans were almost eliminated in North America during the 1800s as the human population grew from some 5 million to nearly 80 million. In the 1900s, swans have made a partial recovery as people, their primary enemy, approach 275 million strong. The swans' struggle to restore their numbers is succeeding only because within those millions, there are a few people dedicated to helping them.

The big questions are: Can mankind find a way to share enough valuable space for the swans' future winter needs? Can the swans prosper and reach safe population levels while the human population doubles again? These are political, as well as biological questions. The North American Waterfowl Management Plan has already set swan population goals at levels below the swan populations that exist at the end of the 20th century. Will the swans accept that? Will the swan advocates accept that?

Some of the questions swan advocates need to ask and get answers to include:

a) What is the effect of agricultural chemicals on the field-feeding swans? What are the benefits and the harms to the swans? Are some substances better or worse than others? Why has there been no research on this?

b) What is the cost to farmers? Most farmers don't mind feeding a few wild swans, but when dozens or hundreds settle into a field, that's another story. Swans arrive later and leave earlier in the year than most other field-feeding birds so that's a plus. Some root crop and grain farmers don't mind the swans as they clean up what is left in the field. Grass farmers particularly do not want swans cropping the first growth of spring. Ways to compensate farmers for doing a little swan management are needed. Ducks Unlimited (DU) has pioneered in this direction (Fowler and Wareham 1996, Fowler 1999). In British Columbia, DU Canada has paid farmers to sow rye grass in corn stubble to provide winter food for swans while they harass swans away from grass fields where the birds are not wanted. One particularly innovative effort is an attempt to actually communicate with the swans by placing black flags made from garbage bags where swans should not land and white flags where feeding is ok. In Washington, DU has a program called "Barley For Birds" that encourages farmers to plant barley to provide winter feed for swans, geese and other birds after harvesting other crops. Agencies and others have cooperated in these programs, but DU has been the lead instigator. These projects may be pointing the way for future swan management.

c) Are refuges for wintering swans needed? A "yes" answer is suggested by the recent purchase of the DeBay's Slough farm in Washington under the North American Waterfowl Management Plan and purchases of two farms on the Comox River delta in British Columbia by DU. Both are important for wintering trumpeters. They are not natural area refuges, but will be farmed to provide a high volume of food for swans. Benefits of such refuges include reduced conflict with farmers, high visibility for bird watchers, and keeping swans out of "natural wetlands" where pollutants such as lead shot are lethal to them. The swans are telling us that some of our farms are suitable for them, provided they can come in the big flocks that they prefer. How fortunate for swan managers of the future, as farming is something people do well. Experiments with clustering refuges near appropriate waters are needed so that the birds do not become too sedentary.

d) How many swans do we want to support? This is an important question if we must provide crops and refuges for them in winter. It has been suggested that half a million wild swans, half of each native species, should not be too many in a land of a half billion people. There would seem to be plenty of nesting habitat and additional winter habitat can be created. Both species could provide some hunting if there is still a demand for it. Hunting, the amount of winter habitat, and the fact that North American swans defend huge nesting territories will provide limits to growth so that swan numbers do not become the sort of problem some species of geese have become.

e) Could swans create wealth and become self-supporting? Theoretically, yes. Swan hunting fees today are set ridiculously low, designed to pay only the clerical costs of administering the hunt. A permit to take an alligator costs 20 times as much. Reasonable hunting fees could help compensate farmers or refuges that host wintering swans. In England and Japan, visitor facilities are located where wintering swans are lured close with crops and hand feeding. Heated observatories with all sorts of innovative lighting and audio equipment accommodate people of all ages in close proximity to the undisturbed birds as they feed and fly in and out, producing a grand show. Parking fees, entrance fees, lectures, restaurants, gift shops, and overnight accommodations pay the costs of providing for the swans. Are North Americans missing an attractive opportunity?

f) Are there moral and ethical questions involved in swan management? Certainly! Some people believe swans should not be hunted. Some people believe the wildness of swans should not be compromised by offering them feed and that they should learn to find it on their own. A great many people have other priorities and believe the use of public funds or dedication of public lands for swans is a foolish waste. Farmers, aircraft safety specialists, powerline managers, wetland managers, park managers, etc. have their own concerns. All of these will have to be dealt with in the next century.

We have to conclude that Alaska's wild swans are not now safe, but there is reason for hope. Wild swans may perhaps be the easiest of all our valued wild species to manage as the exploding human population continues to rebuild the ecological face of North America. The details of how we do that have yet to be determined. Leading that debate will be the finest thing The Trumpeter Swan Society could possibly do.

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ATLANTIC AND INTERIOR POPULATIONS

STATUS OF ATLANTIC FLYWAY TRUMPETER SWAN MANAGEMENT PLAN

Dennis Luszcz, North Carolina Wildlife Resources Commission, 701A North Broad Street, Edenton, NC 27932

[Editors' note: This update from the Atlantic Flyway Snow Goose, Swans, and Brant Committee was received in the form of a letter from Committee Chair Dennis Luszcz and was read at the Conference by David Weaver, TTSS Board Member].

August 30, 1999

Ruth Shea, President
The Trumpeter Swan Society
3800 County Road 24
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Dear Ruth:

Thank you for this opportunity to update The Trumpeter Swan Society on the Atlantic Flyway Council's ongoing attempt to develop management strategies and policies for Trumpeter Swans.

Two primary concerns have traditionally impeded efforts to implement Trumpeter Swan restoration and introduction in the Atlantic Flyway. The first is the anticipated conflicts with Tundra Swan hunt programs, primarily those arising from accidental shooting of Trumpeter Swans during Tundra Swan hunts. The other is the fear of adding another non-migratory waterfowl species to the flyway, resulting in additional problems similar to those usually associated with resident Canada Geese, tame Mallards and Mute Swans. In addition, there has been disagreement over the historical distribution of Trumpeter Swans within the flyway and most biologists were not interested in introducing the swans to areas where they were not previously found. There also is concern over use of artificial feeding programs to hold swans in selected sites.

These concerns have largely kept interest in "restoring" Trumpeter Swans to the Atlantic Flyway low. The Atlantic Flyway Council has not supported efforts to release the species into the Atlantic Flyway. The Council did not, however, oppose efforts to develop experimental techniques for developing migratory tendencies in juvenile Trumpeter Swans or Trumpeter Swan hybrids using such techniques as leading conditioned birds with ultra-light aircraft along predetermined routes. High probability of migration is considered to be prerequisite to supporting actual restoration activities.

In February 1997, The Migratory Bird Project (MBP), a group consisting of Defenders of Wildlife and Environmental Studies at Airlie, proposed experimentation to induce migration of Trumpeter Swans from Airlie, Virginia, to the eastern shore of Maryland. Ultra-light aircraft would be used to guide birds in the experiment. At the same time, the wildlife agencies of Maryland and New York expressed interest in restoration of migratory trumpeters to their states. A cooperative effort between MBP and the Atlantic Flyway's SNOBS Committee (Snow Goose, Brant, and Swan) was formed to prepare restoration guidelines for Trumpeter Swans under the auspices of a management plan. Several drafts of a plan were prepared, with Defenders taking responsibility for the writing and SNOBS and others providing review.

At this time, no restoration or management plan is completed. In 1998, Defenders decided to withdraw from the MBP and cease participation in Trumpeter Swan restoration in the Atlantic Flyway. Environmental Studies at Airlie continued the experimentation with ultra-light aircraft and the SNOBS Committee took responsibility for developing the plan. Preliminary results with the Atlantic Flyway ultra-light experiment have not met expectations, however preliminary results from a similar project conducted in the Mississippi Flyway provide some optimism. We will wait and see if this work will have practical application in our Flyway.

Another question that must be resolved if the Flyway Council is to accept the restoration of Trumpeter Swans is whether or not a general swan season can be used to deal with accidental take of Trumpeter Swans during Tundra Swan seasons. The U.S. Fish and Wildlife Service has not yet completed its review of such seasons in the Pacific Flyway. Until it does, and the repercussions of the approach are fully understood it is not likely that the Flyway Council's concerns over possible conflict with Tundra Swan hunting seasons will be resolved. Hopefully, the Service's review will be completed in the near future and the findings will remove or greatly reduce fears that trumpeter restoration will conflict with Tundra Swan hunting.

I am sorry to report that we have not made more progress towards developing a sustaining migratory population of Trumpeter Swans in U.S. portions of the Atlantic Flyway. We are aware that this would provide considerable positive benefits to the public. We are also aware that certain stumbling blocks must be removed if we are to provide these benefits without impacting existing resources and resource users. We want to take advantage of the hard work put into development of the draft management plan by Defenders of Wildlife biologists and others. There is disagreement, however, over whether this should be used in completion of a management plan, a restoration plan, or if we should merely prepare guidelines or policies for possible restoration. We are currently in the process of reassessing our options. In any event, the questions of suitable restoration techniques and the utility of general swan seasons must first be answered before we can proceed.

I hope that The Trumpeter Swan Society will see this ongoing process not as another setback, but as an opportunity. I believe that there is increasing support within the Atlantic Flyway for restoration of Trumpeter Swans. The Committee considers the Society as the most credible partner in any effort to make this so. We look forward to continued cooperation in the future.

Sincerely,

Dennis Luszcz, Chair
Snow Goose, Brant, and Swan Committee
Atlantic Flyway

THE TRUMPETER SWAN RESTORATION PROGRAM IN ONTARIO – 1999

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ABSTRACT

The main objective at present of the Ontario Trumpeter Swan Restoration Group is to restore the species to as much of its historic range as possible. Captive pairs cared for by cooperators produce release stock. In 1999, 18 pairs raised 57 cygnets. Loss of wild trumpeters from 1 September 1998 to 20 August 1999 was 42 or 22% of the 1998 population. Wild production and releases have increased the present population to 252 birds between Georgian Bay and Lake Ontario. Two small populations have colonized the Big Rideau Lake area in the east and the Kenora area in the west. A successful experiment to induce migration using an ultralight aircraft was carried out. Four trumpeters flew 1,085 km from Sudbury to the Muscatatuck National Wildlife Refuge in Indiana. Two of the swans are known to have returned to the Sudbury area.

INTRODUCTION

Currently, the main objective of The Trumpeter Swan Society and the Ontario Restoration Group is to restore the species to as much of its former range as possible. Prior to European settlement, trumpeters lived in the marshes of Ontario south of the Precambrian Shield in what is now agricultural land, as well as north of the shield in the Hudson Bay Lowlands. There was also a population in western Ontario adjacent to the Manitoba border.

The restoration effort has concentrated so far in southern Ontario, between Georgian Bay on Lake Huron and Lake Ontario. The population occupies only about 12% of southern Ontario and annual losses still exceed the production of wild cygnets. Therefore, the population is not yet self-sustaining.

At present, there seems to be little or no contact between the southern Ontario stock (Georgian Bay–Lake Ontario) and the Michigan–Wisconsin–Minnesota populations, which seem to have merged. This leaves the southern Ontario population somewhat isolated and we should continue with additional releases until it becomes self-sustaining.

In eastern Ontario north of Gananoque there is a nucleus of a population that probably originated from escaped captive trumpeters in New York State. Much good Trumpeter Swan habitat exists in this area, which lies about 280 km east of the Georgian Bay–Lake Ontario population. When stock is available, we should try to build this second population with links to the Atlantic Flyway through the New York population of trumpeters. At present, the Hudson Bay Lowlands have no trumpeters and any restoration effort there would be extraordinarily expensive. There is hope that the 260,000-km^2 Lowlands may be colonized one day from southern Ontario. If the Porcupine Forest in Saskatchewan can attract trumpeters from the Lacreek National Wildlife Refuge in South Dakota, 1,090 km away, there is little reason why the southern Ontario birds cannot pioneer 800 km to the Lowlands.

As long as we can protect and enhance the marshes in agricultural southern Ontario, there is a potential for well over 200 pairs of breeding trumpeters. We do not have enough data from the Hudson Bay Lowlands to make an estimate of potential there because the nesting habitat is not continuous. The good areas would probably support a similar density of pairs to that found in the Minto Flats of Alaska.

RESULTS AND DISCUSSION

1999 production by captive trumpeters

Twenty-three pairs of captive trumpeters were in the hands of cooperators through the 1999 breeding season. We welcome two new cooperators. At Storybook Gardens in London, Colin Springett will be caring for the birds. Stefan Foerster, at the Mac Johnston Wildlife Area near Brockville, will be looking after the other pair. During the year, we lost six breeding birds, but were able to replace all but one of them. Eighteen (78%) of the 23 pairs laid 120 eggs (mean = 6.7), hatched 79 (66%), and reared 57 (72%) cygnets. These results are very similar to those of earlier years.

An early genetic study by Joyce Marsolais and Brad White at McMaster University showed that all three stocks of wild trumpeters were very inbred but each of the wild stocks was distinct from one another. We have tried to use breeding stock from all three wild populations to broaden the genetic base of our released birds. We estimate that among our breeders 30% are Alaskan, 28% are Tristate, 10% are Grande Prairie, 5% are Alaska x Tristate and 27% are of unknown origin. It is too early yet to determine if this diversity has led to improved hatchability and fewer deformities due to inbreeding.

Survival and losses of wild trumpeters

We estimated there were 191 wild trumpeters in Ontario in 1998. Since 1 September 1998, we have lost 42 (22%) birds including 15 that have not been reported for over a year that we count as dead. This percent loss is a little higher than in previous years. Some of these birds are probably still alive, but have lost their wing tags. One swan missing for 2.5 years was reported again this year when its tags were read. Except for one cold spell, the winter of 1998-99 was mild. Between December and March, 12 swans died, which was about average for a winter.

An unusual number was lost to accidents. Four were found with broken wings and one with a broken leg; two flew into Hydro wires. Four were lost to predators including two that flew into the polar bear enclosure at Metro Toronto Zoo. As usual, lead poisoning claimed victims: seven died and others were treated and recovered. One trumpeter was shot, for which two hunters were fined $2,000 each. One swan died of disease and five of unknown causes. Two swans were injured, but survived for inclusion in the breeding program.

Birders and naturalists read the tag numbers on 142 swans. This contribution is valuable because it helps to estimate survival and to document movements. We know of two groups of trumpeters that moved to New York State this winter. Six birds, five of which were released at Mountsburg and one at Millgrove, wintered at Barcelona Harbour on the south shore of Lake Erie. Five additional swans were recorded in the Irondequoit Bay at Rochester, New York. Among them was No. 356 (hatched at Wye Marsh) and No. 308 (released at Wye Marsh) which spent its second winter near Rochester. Another marked swan, No. 448, unfortunately died in the Buffalo, New York, area. This may have been the bird reported earlier in the winter from Wilson on the south shore of Lake Ontario.

It is becoming increasingly difficult to keep track of unmarked trumpeters; they are now being reported from an ever-widening area. These include some 2-year-old wild-hatched cygnets from 1997 and some yearlings from the 41 wild cygnets produced in 1998. As many as 10 unmarked birds have been recorded in a single group; the Zoo has at least five and there are about 21 at Wye Marsh. It seems likely that there are at least 35 unmarked swans in southern Ontario at this time. During the past year, we have released 39 birds and the wild stock has produced 36 cygnets. We, therefore, have at least 252 wild trumpeters in southern Ontario. In addition, there are the two outlying stocks at Big Rideau Lake in the east and in the Kenora area of western Ontario (see below).

Production of wild trumpeters

Mature pairs of wild trumpeters are dispersing more widely each year. It is difficult now to say how many wild breeding pairs exist. At least 10 pairs laid eggs, although a predator destroyed one nest. Two other pairs that nested successfully in former years also built good nests. It is not known if they produced a clutch, however. In one case the marsh dried up and it was possible to walk to the nest. The other pair laid in 1998, but the eggs disappeared, and in 1999 the well-built nest attended by an anxious female was empty when visited. We recently discovered a pair with six cygnets that nested near Selkirk on Lake Erie. The 10 pairs that laid eggs hatched 48 cygnets, of which 36 survived to September.

Six additional pairs that were old enough to breed disappeared in the spring and we do not know at present if they nested. Some may appear at a winter concentration area with cygnets in October.

Trumpeter Swans in the Kenora District

Because of a logging strike, there have been few visitors in the English River system where trumpeters were first recorded nesting in 1989. On 27 May 1999, Neville Ward, Fred Zroback and Dave Anderson searched the swan nesting area from the air. Water levels had risen and were extremely high and any nests might have been flooded. No cygnets were seen but 13 (2, 2, 3, and 6) adult-plumaged swans were seen at various sites. The potential for trumpeter production in this area is very great with suitable range extending many kilometers to the west and north.

Trumpeter Swans in Eastern Ontario

In April 1996, a pair of Trumpeter Swans turned up on Lower Beverley Lake north of Gananoque and in May they were seen on Upper Beverley Lake. In

June probably the same pair, with a partially built nest, was seen by Jim and Winona Barker on nearby Big Rideau Lake. No eggs or shells were seen and it is probable that these birds were not fully mature. The birds were not marked in any way. In the late winter of 1997 a vandal shot the female. A new female was released in March 1997 and quickly formed a pair bond with the surviving male. They built a nest and raised two cygnets in 1997 and wintered on the open water at the Narrows near Portland. In 1998, the pair was again successful. They hatched three cygnets and raised two past flight stage. Unfortunately, the breeding female disappeared during the winter and one cygnet was frozen in the ice on 4 January 1999 and died. Kit Chubb determined the cause of death to be lead poisoning.

Four wild swans occupied Big Rideau Lake in the summer of 1999: one adult male, two subadults and one yearling. On 23 June, two pairs of captive-raised and wing-clipped trumpeters were released on Big Rideau Lake with the hope that these will boost the wild population.

The origin of the first two trumpeters to arrive in eastern Ontario is uncertain. Neither were banded and because most of the Ontario stock in 1996 were marked, it seems likely that they were from New York State. There have been trumpeters at the Perch River WMA north of Watertown, New York, since 1995. The Perch River WMA is only about 60 km south of Big Rideau Lake and cygnets have been raised there since 1995.

The Cataraqui Region Conservation Authority has joined the Trumpeter Swan Restoration Program and has reconstructed a holding pen and pond at the Mac Johnston Wildlife Area near Brockville. On 22 July a breeding pair was delivered to Stefan Foerster for care and perhaps breeding in 2000. There seems to be a good possibility that a self-sustaining wild population of trumpeters eventually can be established in eastern Ontario.

Induced migration research

In a restoration program such as that of migratory swans, one of the main problems has been that cygnets have no flying parents to lead them to suitable wintering grounds. Consequently, lacking guides, they cannot establish traditional migration routes and winter quarters. When frozen out of their release sites in the north, they wander in a southerly direction. If they find a suitable wintering ground, they seldom seem to form a tradition of returning to it in subsequent years. In 1965, Bill Carrick discovered that Canada Goose goslings would readily follow a jeep when they could first fly. Subsequent experiments showed that geese, and by implication swans and cranes, would follow many inappropriate models such as motorbikes, trucks, and boats soon after learning to fly. It occurred to us that this following response might be used to induce migration in restored flocks with the use of a surrogate parent in the form of an ultralight aircraft.

We learned from captive-raised cygnets in 1993 that the behavior of trumpeters varied depending on the type of rearing technique used. Among other behavior patterns, cygnets that were not imprinted to their caretakers flew more readily behind a fast boat than imprinted birds. It was desirable to explore factors influencing this following response more intensively with a view to possible development of a technique for inducing migration. We arranged with Professor Tom Nudds of the University of Guelph to meet Wayne Bezner-Kerr, whom he accepted as a graduate student, to work on the following response of trumpeters. Twenty cygnets from the Ontario Trumpeter Swan Restoration Group were provided in 1997 and 20 more in 1998 for Wayne's team, and in 1998 a second flock of 20 was given to Harry Hewick and Bill Carrick for this research.

Wayne Bezner-Kerr and his team worked extremely hard on raising and accustoming the birds to follow the ultralight aircraft. In 1998, only one group of cygnets, which had been left with their natural parents for 10 days after hatch and therefore were imprinted on them and not on caretakers, followed the ultralight with fidelity. Four out of this group of five flew 1,085 km from Sudbury, Ontario, to Muscatatuck National Wildlife Refuge (NWR) in Indiana, arriving on 23 December 1998. The remaining bird left the group at the end of the first leg at Monettville and has not been seen since.

At least two of the trumpeters that flew to Muscatatuck have returned to the Sudbury area. Their leg band numbers have been read twice. On one occasion, four swans in yearling plumage were seen together, so it is possible that all four Muscatatuck birds have returned. We await confirmation of the return of all four birds and hope that these swans will return to Muscatatuck NWR next winter.

The second group of 20 cygnets was under training with an ultralight in 1998. They hatched a month later than those used by Wayne Bezner-Kerr and were not well enough developed to undertake the flight in December.

ACKNOWLEDGMENTS

We are grateful to U.S. Fish and Wildlife Service Refuge Manager Lee Herzberger at the Muscatatuck NWR and the Indiana Department of Natural Resources for their cooperation and help in providing a winter terminus for the swans in the migration experiment. We thank the Falconbridge Nickel Company and the Canada Trust Friends of the Environment Foundation for financial assistance in this experiment.

The restoration program is entirely dependent on cooperators who raise cygnets for eventual release. We are indebted to the African Lion Safari and Rob Boyle, Peter Calverley, Gordon Cook, Gerry Donnelly, Al Dunford, John Gartshore, Tony Kostrich, Frank Lattarizio, Al Martin, Mrs. T. McColl, Tamara Rowbottom, Pat Semach, Colin Springett, Barbara Allen-Shaw, Norma Soul, George Vanner of The Wye Marsh Wildlife Centre, Michelle Knegt of The Grand River Conservation Authority, David Townsend of The Cataraqui Conservation Authority, Stefan Foerster of Midhurst District, MNR, and Bill Kroft. Harry Hewick and Bill Carrick continued to contribute eggs and birds to the program.

We are grateful to the Royal Botanical Gardens, Hamilton and Len Simiser, and Brian Pomfret for their care of sick swans and the use of Cootes Paradise as a release site; also the Halton Region Conservation Authority and Martin Wernaart for their release site at the Mountsburg Reservoir. The Grand River Conservation Authority provided holding pens and we are most appreciative of Ron Bauman and his family who fed the birds. The food was provided by the Corbit Seed Co.

Bev and Ray Kingdon and their friends continued to feed and watch over the trumpeters using the Burlington area both winter and summer. Food was supplied by David and Eleanor Wood of Wild Birds Unlimited. The Aurora IGA supplied lettuce trimmings all winter, which maintained the good condition of the Aurora swans.

Michelle Knegt carried out daily inventories of the swans at Wye Marsh, and followed up on pairs that left the marsh. Her conscientious care of the Wye Marsh population has saved the lives of many swans affected by ingested lead. We are most grateful.

Veterinary services were supplied by Metro Toronto Zoo and the Wild Bird Clinic at the University of Guelph. We particularly thank Dr. Kay Mehren and Dr. Graham Crawshaw at the Zoo and Dr. Douglas Whiteside, Dr. Michael Taylor and Becky Atkinson at Guelph. Dr. Campbell and Dr. Brojer of the Canadian Cooperative Wildlife Health Centre carried out necropsies providing valuable diagnostic information. The North Simcoe Veterinary Service in Midland run by Dr. Joel Rumney treated sick swans. Without the skill of these veterinarians, losses would have been much higher.

We thank Dick Rogers of Arbrux Ltd. for his servicing of ice-away equipment and donations to Wye Marsh. We are also most grateful to Mrs. Myrna Wagner of the Amhurst Wildlife Foundation who accepted donations, kept accounts and paid bills for the program.

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The Ontario Federation of Anglers and Hunters sponsors the restoration of trumpeters to Ontario.

INTERIOR POPULATION OF TRUMPETER SWANS: STATUS, TRENDS, MANAGEMENT AND RESEARCH PRIORITIES

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ABSTRACT

Trumpeter Swans (*Cygnus buccinator*) of the Interior Population (IP) were extirpated by 1900. The population now consists of 15 restored subpopulations located in eight states and two Canadian provinces. Initial restoration efforts began in the Central Flyway in the 1960s, followed by several projects in the Mississippi Flyway in the 1980s and 1990s. Techniques varied and source stock came from the Pacific Coast and Rocky Mountain Populations. Restoration of the IP is on the verge of becoming a major conservation success story as Trumpeter Swans return to a large portion of their ancestral breeding range and become common where they had been absent for a century.

INTRODUCTION

The Interior Population (IP) of Trumpeter Swans was extirpated by 1900 due to market and subsistence hunting (Matteson *et al.* 1995). The current population is comprised of several subpopulations, most of which are isolated and occur from Wyoming through the Great Lakes states to Ontario (Figure 1). The IP is the result of restoration efforts by federal, state, provincial, county and private agencies, and individuals.

Restoration efforts

Restoration efforts began in 1960 at Lacreek National Wildlife Refuge (NWR), South Dakota, in the Central Flyway. This subpopulation is now referred to as the High Plains. Mississippi Flyway programs began at Hennepin Parks, Minnesota, in 1966; Minnesota (State), Missouri, and Ontario in 1982; Michigan in 1986; Wisconsin in 1987; Iowa in 1994; and Ohio in 1995. Two small satellite populations were discovered in 1989 in eastern Saskatchewan and western Ontario (Kenora District). Based on observations of color-markers they likely originated from the Lacreek and Minnesota Department of Natural Resources programs, respectively.

Restoration techniques vary from program to program and include: collecting eggs from Alaska; captive-rearing cygnets to 1-2 years of age and releasing; decoy-rearing to 4 months of age; parent-rearing captive swans that are either allowed to fly free or are released on other sites; translocating cygnets and adults from other populations; and cross-fostering on to Mute Swans (*C. olor*). The majority of swans were released as 2-year-olds. More detailed descriptions of techniques are provided in the 1998 IP Management Plan, Appendix A.

Management Plans

During the past 16 years, considerable effort has been devoted to development of management plans for Trumpeter Swans. The 1984 draft North American Management Plan for Trumpeter Swans (NAMP) created a framework from which specific management plans for all populations evolved. The draft NAMP had an IP goal of 600 by the year 2000. By 1986, an ad-hoc Trumpeter Swan committee of the Mississippi Flyway Council Technical Section (MFCTS) revised the IP portion of the NAMP (section 5) and recommended approval of this section by the Mississippi Flyway Council. This document provided the framework for coordination within the Flyway Council system.

Individual state and provincial management plans were prepared to guide restoration efforts in the Mississippi Flyway. Council-endorsed plans allowed Mississippi Flyway programs to request eggs from Alaska in the Pacific Flyway 1986-98. The several hundred eggs collected were a major contribution to the restoration of IP of Trumpeter Swans. The Alaskan trumpeters are demonstrably the most genetically diverse population in North America and theoretically the most fit (Marsolais 1993). The IP section of the NAMP established a Mississippi Flyway goal of 1,000 swans in 10 populations, with a minimum of 15 nesting pairs in each by the year 2000. In 1994, The Trumpeter Swan Society (TTSS) hosted a meeting for interested parties to develop a consensus for future management of the IP. Both the Mississippi Flyway Council and Central Flyway

Council appointed members to the drafting committee. They, along with board members of TTSS and private citizens, created the Mississippi and Central Flyway Management Plan for the Interior Population of Trumpeter Swans (IPMP 1998).

The goal of the IPMP is "to restore a self-sustaining, migratory metapopulation of Trumpeter Swans in the Central and Mississippi Flyways." Two objectives relate to this paper: (1) "Develop a dispersed breeding population consisting of at least 2,000 birds and 180 successful breeding pairs by 2001"; and (2) "Encourage the development of migratory behavior south of 40°N latitude in response to suitable habitat and climatic conditions (IPMP 1998).

POPULATION ESTIMATES

Survey methods

IP Trumpeter Swans are currently surveyed annually throughout their summer range. According to management plan targets, annual population estimates will likely continue through 2000 in most states, through 2003 in Iowa, and through 2006 in Ohio. Population estimates for the High Plains subpopulation are made from late summer and winter aerial surveys. Partial aerial surveys are conducted in Minnesota, Michigan, and Wisconsin, but for most of the subpopulations a "cumulative" survey technique is utilized. Usually in September of each year, state coordinators compile swan sightings from a large network of federal, state, county, and provincial employees, and private citizens. Data gathering continues through the fall until freeze up, when migration significantly increases the likelihood of double counting. Historically the majority of the population was marked in some manner, thus double counting could be eliminated by identification of individuals. As the population increases, a smaller proportion is uniquely marked, thus significantly reducing the ability to detect double counting errors once migration begins.

Survey results

The Alaska connection

In the 1980s, when many restoration programs began, the demand for swans greatly exceeded supply. A few were available from the private sector and cooperating zoological parks. As the years passed, many private propagators and at least a dozen zoos enthusiastically formed partnerships with various programs and accelerated their efforts to produce swans for release. By 2000, a total of 1,629 captive reared swans will have been released in the IP range. Of this total, 584 (36%) were produced from eggs collected in central Alaska, a major production area for the Pacific Coast Population (PCP). Six programs participated in this process between 1986 and 1998. A total of 869 eggs were collected, 777 (89%) were successfully hatched by cooperating zoos, of which 661 (85%) were reared to 4 months of age or older. This resulted in the ultimate release of 584 (88%) swans (Table 1a,b). Thirty-two swans were retained in captivity to provide Alaskan bloodlines for future releases. Wisconsin decoy-reared 157 and released them at 4 months of age; Iowa released 23 1-year-olds, and Minnesota, Michigan, Wisconsin, Ontario and Ohio released a total of 404 2-year-olds.

Subpopulation summary (Table 2)

High Plains Flock (Lacreek NWR)
This flock began with release of 17 swans in 1963-65. The production of 114 wild cygnets in 1998 by 35 successful pairs brought the total cygnet production for this subpopulation to 1,563. The 1998-99 winter survey indexed this flock at 445 swans. A large portion of this group winters in Nebraska and the winter survey probably also includes birds from the Saskatchewan subpopulation.

Minnesota/Hennepin Parks (combined 1996)
This subpopulation developed from the release of 440 swans: Hennepin Parks released 159 swans 1979-85, and Minnesota DNR released 281 in 1987-98. Production of 162 cygnets in 1998 by 54 known successful pairs brought the total wild cygnet production in Minnesota 1979- 1998 to 874. The 1998 fall flight was estimated to exceed 600.

Iowa
The release of 135 swans between 1994-98, combined with the production of one wild cygnet in 1997 (first fledged in Iowa in a century) and three in 1998, produced a fall flight of 75 swans in 1998.

Wisconsin
A total of 387 swans were released in 1988-98. The production of 51 wild cygnets in 1998 by 15 successful pairs brought the total wild cygnet production in Wisconsin to 220. The 1998 fall flight was estimated to be 285.

Michigan
A total of 167 swans were released 1987-98. The production of 73 wild cygnets in 1998 by 23 successful pairs brought the total wild cygnet production to 255. The 1998 fall flight was estimated to be 245.

Table 1a. Results of Alaskan egg collections, 1986-98.

Location	Years	No. Collected	No. Hatched	No. Reared	No. Released	Kept in captivity
Minnesota	1986-88	150	123	73	73	0
Michigan	1989-91	92	88	80	67	12
Wisconsin	1989-97	397	370	347	157	Decoy cygnets
					164	2-year-olds
Ontario	1993	50	44	37	17	20
Iowa	1996-97	30	25	23	23	0
Ohio	1996-98	150	127	101	83	0
Total IP % of No. Collected			(89%)	(85%)	(88%)	(5%)

Table 1b. Swans released in Interior Population restoration efforts.

Subpopulation	Released Alaskans	Total Released	% Alaskans	Comments
High Plains	0	17	(0%)	
Hennepin Parks, MN	0	159	(0%)	
Minnesota DNR	73	430	(17%)	as 2-year-olds
Michigan	67	167	(40%)	as 2-year-olds
Wisconsin	321	387	(83%)	157 decoy cygnets, 164 2-year-olds
Iowa	23	135	(17%)	as 1-year-olds
Ohio	83	92	(90%)	includes through 2000
Ontario	17	242	(7%)	
Total IP	584	1,629	(36%)	

Table 2. Flyway Council approved Interior Population goals as indicated in restoration plans and status as of 1998.

Subpopulation (year began)	Flocks 1998	Successful Pair Goal	Successful Pairs 1998	Population Goal [a]	1998 Population Estimate	Total Released	Total Wild Cygnets Produced
High Plains (1963)	2	45	35	500	455 (winter survey)	17	1,563
Hennepin Parks (1979)	1	15		100		159	
Hennepin/MN DNR combined			54	Combined 1996	600		874
Minnesota (1987)	1	15				430	
Iowa (1994)	1	15	1		75	135	4
Wisconsin (1987)	3	20	15		285	387	220
Michigan (1986)	4	30	23	200	245	167	255
Ontario (1982)	2	15	13	 Kenora Dist.	191 18+	242 0	96 19
Ohio (1995)	1	15	2		36	92	8
TOTAL IP	15	170	143[b]	NA	1,905	1,629	3,039

[a] Most plans do not list population goal
[b] 79 % if breeding pair goal of year 2001
[c] 95% of population goal of year 2001

Ontario
A total of 242 swans were released in 1982-98. The production of 41 wild cygnets in 1998 by 13 successful pairs brought the total wild cygnet production in southern Ontario to 96. The 1998 fall flight was estimated to be 191.

Ohio
A total of 54 swans were released between 1996-98. The production of six wild cygnets in 1998 by two successful pairs brings the total wild cygnet production in Ohio to eight. The 1998 fall flight was estimated to be 36.

Missouri
A total of 16 color-marked swans were identified in Missouri during the winter of 1998-99. Origins were: Iowa (1), Michigan (1), Hennepin Parks/Minnesota (4), and Wisconsin (11). As in the past, the primary location for most of these swans was the U. S. Army Corps of Engineer's Riverlands Refuge, located along the Mississippi River north of St. Louis. Five additional unmarked swans were reported.

Illinois
A minimum of 76 Trumpeter Swans, including 35 that were banded, were observed in Illinois during the winter of 1998-99. In comparison, 30, 32 and 48 were observed in 1995-96, 1996-97 and 1997-98, respectively. Origins of marked swans were: Michigan (1), Minnesota (3), and Wisconsin (31). Swans are developing a late fall pattern of use of the Illinois River Valley. The birds then move south between St. Louis and Carbondale and many return to the Illinois River Valley in February.

Entire IP

Across the entire IP range, 1,629 swans were released between 1963-98. In addition, adult pairs resulting from those releases have fledged 3,000 wild cygnets. In 1998, 457 cygnets produced by 144 successful "wild pairs" and the surviving swans from previous years yielded an estimated fall flight of 1,905 Trumpeter Swans. The IP has attained 95% of the population goal and 79% of the successful breeding pair goal as stated in the IPMP (Table 2, Figure 2). Data for 1963-95 in Table 2 are a summation of that given in Appendix C, Tables 1 and 2, of the IPMP. Data for 1996 through 1998 were taken from annual program updates published in the Swan Committee reports of the Technical Section of the Mississippi Flyway Council, February 1997-99.

A 1998 request from the North American Waterfowl Management office for an estimated IP level for the year 2015 resulted in an estimation of 3,500 (Figure 3). This projection was based on an assumed growth rate of 17% to the year 2000 and then a doubling of the population by 2020. The growth rate is a calculated IP rate, which includes the annual release of captive-reared swans during the 1990s. The projected doubling in 20 years is based on actual population growth in the PCP as published in the PCP management plan. We assumed that suitable nesting habitat would not become a limiting factor. In reality, at some point in time it will become a limiting factor as many of our Midwest wetlands have been destroyed.

DISCUSSION

There is little doubt that restoration of the IP Trumpeter Swans is on the verge of becoming a conservation success story. As we move into the next millennium, we will surpass our goals of 2,000 swans and 180 successful nesting pairs. However, will the IP become a self-sustaining, migratory metapopulation?

Does self-sustaining mean no more releases and no supplemental feeding, or simply that births equal or exceed deaths? Is migration south of 40°N latitude critical to self-sustainability?

There are no new restoration efforts proposed for the IP. Current state restoration plans do not indicate releases into the next millennium, thus the large input of captive swans released in the 1990s will soon cease. Supplemental feeding presently occurs on a rather large scale by the public, however no agencies, excepting Lacreek NWR and Hennepin Parks are officially involved. We will never prevent supplemental feeding of ducks, geese and swans by the general public. From an ecological perspective, self-sustaining means that recruitment equals mortality and the population is stable. It seems more logical to strive for a population of swans that are at or near the carrying capacity of their habitat. The concept of a metapopulation is a relatively new one, conjured up by conservation biologists. In simple terms, it means that there are sufficient interactions between subpopulations so that losses in one are replaced by another and that genetic diversity is maintained. Interactions are occurring between Iowa, Minnesota, and Wisconsin. The development of a fourth subpopulation in the western portion of Michigan's Upper Peninsula should lead to interaction with northern Wisconsin swans. Considering the natural history of this species, the most logical time for subpopulation exchange should occur on wintering habitats, particularly in Ohio, Indiana, Illinois, Missouri, and Iowa. We will explore the feasibility of releasing swans in the southern portion of the aforementioned states within the next decade.

The availability of adequate winter habitat may well become a limiting factor for IP swans. A yet to be determined, but relatively small proportion of the IP swans has developed migratory traditions. It seems logical that staging and terminal habitat being developed for other migratory waterfowl will also serve swans. In the absence of quality winter habitat, swans may adapt and begin to field feed, however to expect swans to compete with several million field feeding ducks and geese may be at best wishful thinking. The adequacy of winter habitat remains a challenge to IP biologists.

A unique, totally unplanned "migrant experiment" will occur during the winter of 2000. In 1998-99 approximately 18 percent (360) of the entire IP wintered on the Mississippi River below a nuclear power plant near Monticello, Minnesota, where they are supplementally fed by citizens. If the 3-4 week shutdown of the Monticello Nuclear Power Plant in January results in the river freezing, several hundred swans will be forced to dispersed at a time when their biological clock indicates spring is coming. If this dispersal results in a southward migration, a coordinated program should be in place to ensure survival and hopefully encourage the development of migration traditions.

The protocol for monitoring and evaluating this "experiment" should include collecting accurate population data, provision for a targeted marking program to enhance our ability to locate dispersing swans, and documenting their association with alternate wintering sites. Development of an information alert system for reporting sightings of unusual concentrations in a timely and systematic manner is also needed. Biologists and the public need to be aware of the birds' presence. Supplemental feeding with state approval may be warranted to maximize survival. The state of Minnesota and TTSS, working with a number of states, are challenged to develop this protocol.

As an informational sidebar, in an attempt to study the use and quality of staging and wintering habitats of Wisconsin's swans, 10 satellite transmitters (collars) were placed on seven adult female and three adult male swans this summer. They represent 10 families of swans that Wisconsin has little or no migration information on. Data will be downloaded every 10 days this summer, every other day during migration, and every fourth day during the winter. Zoos throughout the country and private grants supported this space age, $40,000 project. Even more exciting than the natural history information is the educational opportunity this program presents. A web site (www.wildtracks.org) has been developed so that anyone on the internet can follow the birds. Sumner Matteson invites all of us to cross-link any of our web pages to Wisconsin's. Every kid in America should be tuned into this website!

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STATUS REPORT OF THE LACREEK TRUMPETER SWAN FLOCK FOR 1999

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ABSTRACT

A total of 455 Trumpeter Swans, including 101 cygnets, was observed during the mid-winter aerial survey following the 1998 summer/fall production season. This compares to 328 trumpeters, including 89 cygnets, in 1997, and 207 trumpeters, including 44 cygnets, in 1996. The late summer aerial production survey in 1998 recorded 298 Trumpeter Swans, including 62 nesting pairs, 35 broods with 91 cygnets, and 48 nonbreeders in nine flocks. This compared to 230 trumpeters, including 51 nesting pairs, 29 broods with 86 cygnets, and 41 nonbreeders in eight flocks in 1997. The surveys of the past several years indicate an expanding population. Refuge swan production has declined to almost nothing. The pair on Pool 7 hatched three cygnets in 1998, but only fledged one. The 1999 summer aerial production survey found 311 Trumpeter Swans, including 105 cygnets and 60 non-breeders. Winter migration to the Snake River and Blue Creek drainages in Nebraska is now well documented. A wintering population of over 140 swans was discovered in December 1996 along the Snake River in Cherry County, Nebraska, about 55 km south of the Refuge. Most of the High Plains Flock now winters in Nebraska. The Saskatchewan population also continues to winter in the area and Trumpeter Swans A03, A04, and A07 were seen on the Refuge during Winter 1998-99. Eleven Trumpeter Swans were banded and collared in 1999. Some collar icing was observed and ice removed. Current growth trends indicate that the population goal of 500 Trumpeter Swans in the High Plains Flock may be realized in the year 2000.

POPULATION REPORT

A total of 455 Trumpeter Swans, including 101 cygnets, was observed during the mid-winter aerial survey following the 1998 summer/fall production season. This compares to 328 trumpeters, including 89 cygnets in 1997, and 207 trumpeters, including 44 cygnets in 1996 (Table 1). The survey has been changed to include the new wintering areas discovered in Nebraska in 1996. Data prior to 1996 include only those birds returning to the Lacreek National Wildlife Refuge (NWR) area in South Dakota. The new winter aerial survey includes Bennett County, South Dakota, and Cherry, Sheridan, Garden, Keith, Lincoln, McPherson, Arthur, and Grant counties in Nebraska.

A total of 298 Trumpeter Swans was observed during the late summer aerial production survey in 1998, including 62 nesting pairs, 35 broods with 91 cygnets, and 48 nonbreeders in nine flocks. This compared to 230 trumpeters including 51 nesting pairs, 29 broods with 86 cygnets, and 41 non-breeders in eight flocks in 1997 (Table 2).

Production increased only 6% over 1997, but is recovering from a low of 46 cygnets in 1995. The number of nonbreeding birds increased by 17% in 1998 over 1997, demonstrating an overall population increase.

The 1999 summer production survey was completed in time to be included in this report: 311 Trumpeter Swans, including 69 nesting pairs, 36 broods with 105 cygnets, and 60 nonbreeders in 12 flocks were observed. The summer population increased 4%, while production increased 15% compared to 1998.

Due to mild temperatures, the 1998 fall Trumpeter Swan population count did not begin to increase until late November when 30 swans were counted on the Refuge. A severe cold snap with -25°F temperatures occurred on 20 December 1998 and brought 112 Trumpeter Swans, including 29 cygnets, to the Refuge. Most of the High Plains trumpeters remained in Nebraska on the Snake River Drainage in Cherry County and on the Blue Creek Drainage in Garden County.

Table 1. Peak population and production data for High Plains Trumpeter Swans based on the winter aerial surveys in South Dakota and Nebraska[a].

Calendar Year	Adults	Cygnets	Total
1998[b]	354	101	455
1997[b]	239	89	328
1996[c]	163	44	207
1995	118	34	152
1994	144	61	205
1993	122	42	164
1992	138	62	200
1991	105	45	150
1990	164	61	225
1989	221	61	282
1988	169	78	247
1987	182	86	268
1986	166	63	229
1985	144	43	187
1984	190	47	237
1983	206	57	263
1982	167	48	215
1981	172	58	230

[a] This table reflects the wintering population on Lacreek NWR through 1996. An off-Refuge wintering population in Nebraska was discovered in 1996.
[b] Includes new wintering areas found in the Nebraska Sandhills from the Snake River in Cherry County south to the North Platte River in Nebraska.
[c] Includes 58 adults and 7 cygnets observed on Lacreek NWR and 105 adults and 37 cygnets found on the Snake River in Cherry County, Nebraska.

PRODUCTION REPORT

The 1999 aerial production survey was conducted 31 August - 3 September 1999. The survey included Bennett, Shannon, Pennington, Meade, Butte, Perkins, Ziebach, Haakon, Jackson, Mellette, and Todd counties in South Dakota; Cherry, Sheridan, Garden, Grant, McPherson, Arthur, Hooker, and Logan counties in Nebraska; and Crook County in Wyoming. No swans were observed in Pennington, Perkins, Butte, Haakon, or Mellette counties in South Dakota, or in Crook County, Wyoming, this year. The swans normally associated with the Colony, Wyoming, site are apparently gone. Trumpeter Swans in northwestern South Dakota and in the South Dakota Badlands seem to be on a steady decline as the older pairs die out. No new nesting pairs have been observed. Trumpeter Swan nesting is expanding, however, in the Nebraska Sandhills, with Hooker and Logan Counties added to the survey. A total of 311 Trumpeter Swans was observed including 69 nesting pairs, 36 broods with 105 cygnets, and 48 non-breeders in 12 flocks. 1999 production exceeds the previous all-time high of 102 cygnets in 1992. Production in 1998 included 91 cygnets from 35 broods out of 62 nesting pairs, and 48 nonbreeders in nine flocks for a total of 298 swans. Summer production in the Sandhills is on a steady increase (Table 2).

Refuge production

Refuge swan production has declined to almost nothing (Table 3). The pair on Pool 7 hatched three cygnets in 1998, but only brought one to flight. The cob died in the fall of 1998, but the pen had a new mate for the 1999 breeding season. They developed a territory on Pool 7 again, but no young hatched in 1999. Another pair was observed on Pool 6 in the spring of 1999, but they did not establish a territory. The development of the wintering site in Nebraska has shifted production to the Sandhills.

MIGRATION ATTEMPTS

Winter migration to the Snake River and Blue Creek drainages in Nebraska is now well documented. Winter migration attempts were suspected during the early 1990s due to the declines in wintering swans at Lacreek NWR, combined with increasing numbers of adult swans on the summer breeding grounds. A wintering population of over 140 swans was discovered in December 1996 along the Snake River in Cherry County, Nebraska, about 55 km south of the Refuge (Table 1). The Snake River population and the Refuge population were counted on 30 and 31 December 1996, respectively, and their combined numbers accounted for the summer breeding population. Aerial surveys conducted in January 1998 and 1999 found an increasing population with 328 and 455 wintering Trumpeter Swans following the 1997 and 1998 breeding seasons, respectively (Tables 4 and 5). With the winter population now exceeding the summer population by over 140 birds, it appears that the eastern Saskatchewan trumpeters are also wintering in Nebraska, even though some of them are occasionally seen on the Refuge during the

Table 2. Breeding performance of Trumpeter Swans in South Dakota, Nebraska, and northeastern Wyoming, based upon summer surveys.

Year	Adults	Pairs	Broods	Cygnets	Total
1999[a]	206	69	36	105	311
1998	184	62	35	91	298
1997	171	51	29	86	230
1996	129	52	22	78	207
1995	168	48	17	46	214
1994	164	54	32	85	249
1993	115	42	21	58	173
1992	126	48	30	102	228
1991	117	44	24	89	206
1990	127	41	22	68	195
1989	152	51	30	79	231
1988[b]	-	-	-	-	-
1987	110	34	23	81	191
1986	103	41	21	74	177
1985	95	40	22	63	158
1984	116	42	28	65	181
1983[b]	-	-	-	-	-
1982[b]	-	-	-	-	-
1981	104	30	16	54	158

[a] No swan observations in northeast Wyoming.
[b] No data.

winter. Even though some swans may be migrating further south, no records are available.

The Snake River and Blue Creek drainages are shallow, young streams with rapid flows that keep them open during the winter. Both are extremely remote and produce abundant aquatic vegetation. With the Snake River discovery, hope for a more southern winter migration seems remote, but one must remember that the objective of migration is a self-sustaining population. If the High Plains flock can sustain itself over winter on the Snake River and Blue Creek in Nebraska, the objective is being met.

Three out of the seven trumpeters marked (collared A00–A07) by Rhys Beaulieu (Saskatchewan Environment and Resource Management) and Gerry Beyersbergen (Canadian Wildlife Service) in 1994, near Greenwater Lake Provincial Park, Saskatchewan, were observed sporadically on Lacreek NWR during December 1998 and January 1999. Observations included A03, A04, and A07. Local collared birds observed included S09, S13, and 99FA. The birds were seen during late December 1998 and January 1999. None of the Wyoming banded birds (01RC - 05RC) have been seen since January 1993.

BANDING AND MARKING

Summer banding and marking continues in late June–early July when subadults are flightless. Eleven Trumpeter Swans were banded and collared in 1999. Two swans were banded on the Refuge on 22 July (S28-29), two swans were banded on Square Lake, south of Merritt Reservoir, Nebraska, (R10 - 11) on 26 July, and seven swans were banded on South Cody Lake, Nebraska (R12-18) on 27 July.

Trumpeter Swans A03, S09, S13, and 99FA were found with iced collars on 20 December 1998. All of these swans were captured, de-iced, and released. The ice removed from collars averaged 2 kg per bird and the birds could barely keep their heads off the ground. The Refuge did not have a collar icing problem until we began to use a thicker,

Table 3. Production data for Trumpeter Swans on Lacreek National Wildlife Refuge.

Year	Nesting Pairs	Broods	Hatched	Fledged
1999	2	0	0	0
1998	2	1	3	1
1997	1	0	0	0
1996	2	2	2	1
1995	4	3	14	2
1994	3	3	13	2
1993	4	2	7	4
1992	5	3	11	5
1991	6	6	21	6
1990	5	4	18	8
1989	6	6	16	7
1988	6	5	15	8
1987	6	5	13	11
1986	6	6	19	19
1985	6	5	18	13
1984	5	5	15	7
1983	5	4	17	9

more rigid collar. Even though they may break off more readily, we need to go back to the lighter collars unless a heavy flexible collar material can be found.

Banding and collaring of subadults and adults will continue as funding and staff power dictate to provide an increasing pool of marked birds in the environment to aid in positive observations. Banding at remote sites more than 20 miles or so from the Refuge is becoming cost prohibitive. Although many Trumpeter Swans are seen during the aerial surveys, the remote locations and the difficulty of determining land ownership and access are very time-consuming. Also, physical access is difficult, as most of the wetlands used by nesting swans require off-road, cross-country travel. A second 4X4 vehicle is always required as the 4X4 pulling the boat trailer is always at risk of becoming stuck while trying to get the boat to the water. Many of the wetlands are not accessible to the airboat due to moist soil margins, shallow water, and dense cattails. The Nebraska banding effort in 1999 was conducted because the available birds were located close to paved roads.

The modified turkey trap employed to capture trumpeters in January 1997 continues to be used, but to a limited extent. With most of our birds now wintering in Nebraska, fewer swans are available for capture on the Refuge. The trap was used in January 1999 and 12 swans were caught, but seven escaped under the edge. The remaining birds were banded. Birds escaping under the edge continue to be a problem. Apparently, when several birds stand up together as a group, they lift the netting, and if they walk together towards the edge, the netting slides over their heads until they escape. Installing a lip on the bottom of the netting that swans would step on may solve this problem. However, with the decline in wintering birds, resolving the problem has been delayed. Overall, the drop-net appears to be a good trapping method that is much safer for swans than cannon or rocket nets used for ducks. The cannon and rocket nets can decapitate long-necked birds.

CONCLUSION

The High Plains Flock of Trumpeter Swans is becoming self-sufficient by the use of natural wintering sites, and with the current trend in population growth, the goal of 500 Trumpeter Swans by 1990 may be met in the year 2000.

Table 4. Winter peak population for the High Plains Trumpeter Swan Flock in South Dakota and Nebraska for 1997 (aerial survey 24 January 1998).

Location	Cygnets
Todd Pond	0
Trout Ponds	2
Pool 8	2
Pool 5	10
Lacreek Area Sub-Total	14
Cody Lake	9
Blue Creek[a]	8
Below McC Dam (Platte R)	3
Whitman Area[c]	8
North Loup River[b]	14
Snake River[c]	33
Sandhills Area Sub-Total	75
Total	89

[a] Various groups and families
[b] One dead swan observed
[c] Two locations

Table 5. Winter peak population for the High Plains Trumpeter Swan Flock in South Dakota and Nebraska 1998 (aerial survey 14 January 1999).

Location	Cygnets
Pool 5[a]	4
Pool 6[a]	1
Pool 8 [a]	0
Pool 9 [a]	3
Johnson	3
Micheel	1
Todd GMA	1
Lacreek Area Total	13
Snake River	40
Blue Creek	26
Keystone	1
Birdwood Creek	2
Whitman	0
North Loup River 1[b]	10
North Loup River 2[c]	9
Sandhills Area Total	88
Grand Total	101

[a] On Lacreek National Wildlife Refuge
[b] North Loup River 1 is located in Range 30 West.
[c] North Loup River 2 is located in Range 40 West.

WINTER SITE SELECTION CHARACTERISTICS, GENETIC COMPOSITION AND MORTALITY FACTORS OF THE HIGH PLAINS FLOCK OF TRUMPETER SWANS

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ABSTRACT

Biotic and abiotic characteristics of Trumpeter Swan (*Cygnus buccinator*) wintering sites in Nebraska's Sandhills and at Lacreek National Wildlife Refuge (NWR) are discussed. A potential population-level genetic marker and immigration between populations were detected. Collar ice build up and lead poisoning as mortality factors are also reviewed.

INTRODUCTION

Trumpeter Swans, once common throughout the northern United States, Canada, and Alaska, were extirpated from the Great Plains by 1900 (Matteson *et al.* 1995). By 1935, disturbance from European settlement and harvest for skins and meat reduced the population of the lower 48 states to 69 known birds (Mitchell 1994). Most of these birds were located in the Tristate area of Wyoming, Idaho, and Montana and have been designated the Tristate Subpopulation (TSP) of the Rocky Mountain Population (RMP). Hunting regulations, habitat protection, and reintroduction efforts led to an increase in the TSP. A Pacific Coast Population (PCP) is also recognized.

Reintroduction efforts have also reestablished an Interior Population (IP) comprised of small flocks scattered across the central and eastern portions of their historic range. One of the first reintroduction efforts began with release of 56 swans from Red Rock Lakes NWR, Montana, to Lacreek NWR in western South Dakota in 1960-62 (Leach 1977), thus establishing the High Plains Flock (HPF). The first successful nesting at Lacreek occurred in 1963. Since then, the HPF has grown to an estimated winter population of 455 in 1998 (Kraft 2000). In addition, a small flock of birds from Saskatchewan is known to winter with the HPF (Ad hoc 1998).

Management strategies for wintering swans at Lacreek NWR have included supplemental winter feeding and altering stream flows to increase open water areas. Until recently, wintering HPF swans were found primarily on Lacreek NWR. During the past few years, a shift to wintering sites in the Sandhills of Nebraska has been detected (Kraft 1997, Compton 1997). This shift in wintering sites is of interest and concern for Trumpeter Swan management at Lacreek NWR. In addition, management objectives for the IP identify the establishment of migratory patterns to wintering habitat south of 40^{o} latitude (Ad hoc 1998). However, little is known about wintering site characteristics and habitat availability for the IP (Mitchell 1994, Ad hoc 1998).

The genetic composition of the HPF and other populations has been the subject of previous research efforts (Barrett and Vyse 1982, Marsolais and White 1995). Maintaining the genetic integrity of reintroduction flocks and determining the most appropriate founder population for reintroductions has been the subject of differing opinion (Barrett and Vyse 1982, Marsolais and White 1995, Bill Long, Wyoming Game and Fish Dept., pers. comm.). Issues include whether: 1) a given population, such as the TSP or HPF is genetically distinct; 2) genetic differences are adaptive traits or the result of population bottlenecks or founder effects; 3) it is possible to maintain genetic integrity; and 4) it is more important to match habitat similarities between populations rather than genetic similarities. Although little genetic diversity has been detected in populations studied to date, a reevaluation is warranted to determine if changes in heterozygocity have occurred, or whether a genetic marker can be found to delineate different populations.

During winters 1997-98 and 1998-99, a study of Trumpeter Swan wintering habitat was conducted. The overall study was designed to identify site selection characteristics and habitat quality, site-specific differences in use, movement patterns between sites, and HPF genetic composition. Two mortality concerns also surfaced during the study.

First, lead poisoning is a known concern for Trumpeter Swan management in general (Mitchell 1994, Ad hoc 1998), and specifically at Lacreek NWR (Chris Franson, National Wildlife Health Laboratory, pers. comm.). Data collected during the study indicate that lead poisoning is still a concern. Second, the management plan for the IP (Ad hoc 1998) lists marking of swans through the use of auxiliary markers as a management tool. Extreme weather conditions during December 1998 led to the debilitation and death of several collared swans, thus raising concern for the use of collars as auxiliary markers for the HPF.

This paper will evaluate habitat criteria, genetic composition, and the two mortality factors. The primary objective of the portion of the study reported in this paper was to identify habitat characteristics of known wintering sites of the HPF, specifically as they relate to changes in distribution from Lacreek NWR to the Snake River and other Sandhill sites. A second objective was to evaluate the genetic composition of the HPF to determine if there has been a change in genetic diversity from earlier reports and if a suitable marker exists to identify the occurrence of immigration and genetic distinctiveness among various populations.

METHODS

Habitat analysis

Habitat data were collected in November 1997 - February 1998 and November 1998 - March 1999. Primary research sites were wetlands and stream habitat in and surrounding Lacreek NWR, Bennett County, South Dakota, and the Snake River, Cherry County, Nebraska. Other sites throughout the Sandhills of Nebraska were also assessed. Winter forage and loafing sites geographically overlap and were collectively considered as wintering sites. Wintering sites were identified by aerial and ground surveys. Ground surveys consisted of focal animal and scan sample observations (Altman 1974) to determine swan behavior and habitat use. Distribution and location of individually marked birds were also recorded. Aerial surveys were conducted to identify swan wintering sites and population distribution in inaccessible areas of the Sandhills. Vegetation sampling strategy and analysis modeled protocol described in Grant *et al.* (1994). Habitat variables described by Lockman (1987) were evaluated.

Vegetation samples were collected at the time of habitat use in both lentic and lotic systems. Once foraging activity was detected, swans were disturbed during or immediately following a foraging bout. Each identified wintering site was considered a single datum for analysis. A 0.3 m^2 sample frame (Natural Resource Conservation Service, unpubl.) was placed on the soil surface in areas with rooted aquatic vegetation. All vegetation suspended in the water column above the sample frame and contained within the substrate below the sample frame was collected. An Ekman grab benthic sampling tool was used to collect benthic substrate in areas devoid of vegetation. Five replicate samples per site were collected and samples were only collected in water depths <1.0 m. Samples were washed of soil particles, wet weighed, double bagged, frozen, and stored for later laboratory analysis. Suspended detrital matter within in-stream flows was also collected from lotic systems. A 0.6 m^2 kick screen was placed in the highest velocity portion of the stream and kept in place for 2-5 minutes depending upon the amount of detritus captured. Each site was sampled for a total of 5 minutes with a minimum of two replicate survey periods. Stream velocities were measured using a Marsh McBirney portable flow meter (Model 201). Distance, length and angle measurements of wintering sites were collected using tape measures, measured paces, and Leica Vector 1500 DAE/DAEF rangefinding binoculars.

Genetic analysis

Twenty Trumpeter Swans from the HPF were captured between January 1998 and January 1999. Capture techniques included drop nets, mid-winter evening airboat spotlight efforts (Drewien *et al.* 1999), summer airboat capture, and opportunistic capture of debilitated swans. Two additional swans were collected as fresh carcasses (within 12 hours of death) during periods of less than 0^oC temperatures. Four blood samples were also provided from swans known to be of Alaskan origin by The Raptor Center, St. Paul, Minnesota.

The preparation, storage, horizontal starch-gel electrophoresis and histological staining of blood samples (approximately 2.5 ml) from the 20 captured birds and four Alaskan birds, and muscle samples (approximately 3 gms) from the two carcasses followed standard methods (Vandeberg 1977, Utter *et al.* 1987, May 1992). Starch-gel electrophoresis laboratory analysis was conducted at the University of South Dakota, Vermillion.

Mortality factors

Approximately 2.5 ml of whole blood collected for genetic analysis from eight birds were sent to the National Wildlife Health Laboratory, Madison, Wisconsin, for lead level analysis. Livers from two carcasses and one entire carcass were also sent for analysis. Morphological measurements (Drewien 1994) and weights and measurements of ice accumulation from swans captured during icing events were also recorded.

RESULTS

Winter habitat

The null hypothesis was that there was no difference in forage availability, either in situ or within flow, between Lacreek NWR and other Sandhills sites. Significance levels for all tests were set at the 95% confidence level. The non-parametric Mann-Whitney rank sum statistical test (Zar 1996) was used for analysis of both sample frame data and in-stream flow data. The calculated sample frame U'=33. The critical value $U_{.05(2),2,8}=16$, thus the conclusion was to reject the null hypothesis and accept that there was a significant difference between the gross (wet weight) vegetative biomass at Lacreek and Sandhills sites. The in-stream flow data analysis supported a similar result. The calculated U=30 with a critical value of $U_{.05(2),3,8}=22$ also rejected the null hypothesis and accepted that there was a significant difference between the amount of gross vegetative biomass being transported in the water column at Lacreek vs. other Sandhills wintering sites. All Sandhill sites contained significantly more wet weight vegetative material than was present on Lacreek NWR. Only wet weight comparisons are currently available for analysis. Analyses of dry weight and nutritional values of forage are pending.

The mean distance from a swan wintering site to the nearest tree was 89.7 m $\pm$ 84.2 m (n = 17). The area of open water of a wintering site was measured as a mean linear distance of 222.5 m $\pm$176.3 m. The mean water body width was 76.8 m $\pm$35.5 m (n = 17). Bank slope mean angle was 2.2^o $\pm$1.8^o (n = 17). Barriers such as fences or power lines crossing wintering sites were not detected. The substrate at 12 of 17 sites was sand. Organic muck and vegetative matter to depths of 1 m dominated the remaining sites. Thirteen of 17 wintering sites had sandbars present. Maximum stream velocity in the vicinity of foraging sites was 70.7 cm/s $\pm$21.5 cm/s (n = 9). Stream velocities at foraging sites were not measured, but were always less than maximum stream velocities.

Genetics

Twenty-four of 25 presumptive allozyme loci examined showed no variation among the 26 individuals surveyed. Only one locus, ADA (adenosine deaminase), exhibited heterozygocity among the individuals as well as apparent fixed differences between two known populations. The four known Alaskan birds demonstrated a fixed difference as a slower migrating allele when compared with birds captured within the HPF geographic area. Seventeen birds from the HPF were fixed as the faster migrating allele. Of the five remaining birds from the HPF in the sample, one was fixed as the slower allele and four were heterozygous.

Mortality factors

Blood levels for 11 swans captured or collected during this study were analyzed for blood or tissue lead levels. Elevated blood lead levels were confirmed in nine of these 11 birds. Three birds demonstrated exposure to lead, five had elevated blood lead levels and one was diagnosed as mortality attributed to lead poisoning.

Mild climatic conditions dominated the Great Plains during the early winter of 1998-99. Until 18 December, temperatures were well above freezing, often reaching highs of 15-20^{o}C and most wetlands remained ice-free. A cold front began on 19 December and dropped temperatures to –29^{o}C. The accompanying strong winds averaged 48 km/hour. During this period, 10 collared swans were known to be present on Lacreek NWR. Rapid icing occurred during this period and nine of the 10 collars exhibited ice build-up. Three of these swans became incapable of flight and two succumbed to predation as a direct result of collar icing. The effects of collar icing have been well documented for other species, most notably Canada Geese (Greenwood 1974, Craven 1979, Zicus 1983). Individuals involved with Trumpeter Swan management (R. Shea, The Trumpeter Swan Society, J. Peterson, U.S. Fish and Wildlife Service, pers. comm.) have indicated that Trumpeter Swans are also subject to collar icing.

Swan weights from birds captured with iced collars (n = 2) fell within the reported ranges of normal adult birds (Mitchell 1994). Blood and liver lead level analysis determined that birds (n = 4) had trace or no detectable levels of lead present. Mean weight of ice accumulation was 1.5 kg $\pm$0.4 kg (n = 4).

Dimensions of ice accumulation averaged 19.8 x 19.1 x 11.7 cm (n = 3).

DISCUSSION

Habitat

The two winters of the study were mild in comparison with previous years, however, periods of extended cold occurred during each winter. Mild weather inhibited our ability to capture swans due to widespread availability of forage and open water during most of the winter.

Swan wintering sites in the Sandhills of Nebraska typically had more forage available than sites at Lacreek NWR. Consistent and moderate stream flows maintained open water and access to forage throughout the Sandhills region, whereas open water was artificially created at Lacreek in an area that would naturally freeze for extended periods during the winter. Swans extensively used lotic systems during winter periods when ice covered most wetland basins. However, any moderation in climate typically opened up wetland edges. Swans shifted from lotic to lentic systems depending upon ice cover and forage availability. Naturally occurring forage was available at Lacreek during ice-free periods, but was mostly nonexistent in those areas that were artificially maintained in open water conditions. The supplemental feeding program at Lacreek has typically supplemented this deficiency in forage availability. Having both lentic and lotic habitats in close proximity appeared to be a general characteristic of HPF wintering sites.

The presence of sandbars also appeared to be a critical component of HPF wintering sites. While the use of sandbars has been well documented (Banko 1960, Lockman 1987, Rogers and Hammer 1998), most references commonly refer to sandbars as loafing sites. Although sandbars were utilized as loafing sites, swans also showed two distinct foraging behaviors in these areas. Swans were often seen exhibiting a hunt and peck foraging behavior similar to that of plover species. The sandbars themselves were known to be devoid of rooted vegetation. Considerable flotsam in the form of vegetative plant material was found stranded in the shallow water areas. Birds were observed to glean this plant material from the sandbar surface. The in-stream flow measurements attempted to quantify the relative abundance of flotsam present.

Swans also actively fed in the backwater area of the sandbar. Eddies created by sandbars trapped organic material behind the sandbar. Swans then proceeded to consume bulk quantities of this forage, leaving behind depressions or “swan craters” in the organic material. Thus, sandbars appeared to provide suitable foraging sites as well as loafing sites for swans.

Length and width of open water was consistent with data from western Wyoming (Lockman 1987). However, swans of the HPF also utilized relatively narrow stream channels, sometimes barely wider than their wingspan. Stream velocities appeared to be greater than those reported for western Wyoming streams. This may simply have been an artifact of differences in data collection methodology. Velocity measurements for this study were based upon maximum flow and not stream flow at the actual forage site. Presence of trees was not a hindrance to swan use. Several sites were located in direct proximity to trees and tall woody vegetation. At three sites, swans were noted to forage and loaf underneath trees. In comparison with Wyoming data, this was probably a reflection of the increased abundance of trees as one travels east, rather than a requirement for a lack of tree cover for swan use.

Genetics

Generally, results from starch gel electrophoretic tests comparing earlier loci surveys (Barrett and Vyse 1982) with current data did not differ. The analysis of additional loci, however, led to documentation of one locus that may provide a genetic marker for certain populations of Trumpeter Swans. The presumptive locus, ADA, appears to offer the opportunity to identify whether a swan has originated from the Alaskan population or if it is from the HPF. Evidence for this capability lies in the fixed allelic differences between Alaskan birds and birds from the HPF. The four birds that are heterozygous may represent immigration and integration into the HPF from other reintroduction efforts such as those of Minnesota, Wisconsin, or Iowa, which utilize Alaskan stock. Summer breeding range of the HPF is about 670 km from Iowa and Minnesota releases. However, collar observations indicate that Trumpeter Swans from all reintroduction efforts overlap winter range from Minnesota and Nebraska south to Oklahoma and Missouri (Ad hoc 1998).

Natural immigration from Alaskan birds and the presence of this alternate Alaskan allele in the original founder flock are possible, but less likely, explanations for the noted genetic differences. Natural immigration of swans from Alaska has not been observed. The presence of the alternate allele in the founder flock is believed unlikely because 17 of

20 birds in the HPF demonstrate a fixed difference. This assumption is based upon the premise that if the original founder flock from Red Rock Lakes NWR shared this "Alaskan" allele, the HPF would not show fixed differences as a faster allele.

These results suggest that maintaining the genetic integrity of the HPF of Trumpeter Swan may not be possible since evidence suggests that immigration into this population has occurred. If the fixed differences prove to be conclusive, screening individual birds may assist other local reintroduction efforts in maintaining the genetic integrity of captive flocks. It should be recognized that these results are based upon a relatively small sample size, especially for Alaskan birds. Even with such a small sample, it is unlikely that four randomly collected Alaskan birds would demonstrate a fixed difference. Larger sample size and collection of baseline data from all populations at the ADA locus would help validate these conclusions.

Mortality factors

Lead poisoning continues to be a concern for the HPF. The source of lead shot is unclear, but is most likely a remnant of pre-steel shot regulations. Collar icing was documented as a cause of direct mortality and debilitation for 50% of the known collared birds present on Lacreek NWR during an extreme weather event. Blood and liver lead levels did not indicate lead exposure contributed to debilitation of birds with iced collars. It is therefore assumed that the weight of the iced collar, coupled with the shift in aerodynamic balance of the birds led to mortality and inability to fly. Conversations with U.S. Fish and Wildlife Service staff and others involved with Trumpeter Swan management indicated that similar incidents occurred previously. Thus, this mortality is not an isolated incident.

In summary, habitat conditions in the Sandhills provide suitable wintering habitat. Sandbar habitat provides both loafing and foraging sites and appears to be a critical component of swan wintering habitat. Lacreek NWR provides sparse naturally occurring forage during winter periods. However, water management can be modified to replicate habitat conditions found in the Sandhills. Moderate stream flows and low angles of adjacent shoreline are important for swan use, as are lack of obstructions for wintering site selection. Absence of trees is not a requisite for swan use.

Starch gel electrophoresis documented a potential genetic marker for the HPF and Alaskan populations of swans at the ADA locus. Additional genetic surveys would prove useful in determining the genetic composition of various populations. Heterozygocity at the ADA locus indicates that immigration, most likely from other reintroduction flocks, into the HPF has occurred.

Swan mortality due to lead poisoning continues to occur. Additional monitoring of blood lead levels of the HPF is warranted. Collar icing intermittently contributes to the mortality of the HPF. The risk of increased mortality to swans due to collar icing is unwarranted. Collar use should be discontinued as a marking tool in geographic locations with similar climatic conditions unless the collars are required to answer specific research questions.

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WHAT NEEDS TO BE DONE TO COMPLETE THE RESTORATION OF THE INTERIOR POPULATION OF TRUMPETER SWANS?

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Trumpeter Swan restoration has been underway in the Midwest for almost 40 years, since efforts began at Lacreek National Wildlife Refuge, South Dakota, in 1960. Goals and objectives have changed over time. Some obstacles have been overcome, but others remain or have developed. This paper looks at the present status of the Interior Population (IP) of Trumpeter Swans, and discusses actions needed to insure its future security and vitality.

Restoration efforts in South Dakota, Minnesota, Iowa, Wisconsin, Michigan, Ohio, and Ontario have created a Trumpeter Swan population in the Midwest that exceeded 1,900 birds in 1998 (Johnson 1999). In addition, there is a small flock in New York that is not considered to be part of the IP. The primary goal of each of these individual restorations was to restore a breeding flock of trumpeters. Birds were released on potential nesting marshes, or allowed to fly free within breeding range. On the surface, all these efforts appear to contribute to an overwhelming success story, and, to some degree, they have. The population is growing exponentially, and this growth shows no signs of slowing down (Figure 1).

In 1998, after 2 years of work, the Mississippi and Central Flyway Councils approved a revised "Management Plan for the Interior Population of Trumpeter Swans." The Plan's goal was "To develop a self-sustaining, migratory population (consisting of numerous overlapping flocks) of Trumpeter Swans in the Central and Mississippi Flyways" (Ad hoc 1998). The first three objectives of the Plan were to:

1. Develop a dispersed breeding population consisting of at least 2,000 birds and 180 successful breeding pairs by 2001.
2. Encourage the development of migratory behavior by IP swans in response to suitable habitat and climatic conditions.
3. Identify and manage nesting, migration, and wintering habitats in sufficient quantity and quality to meet population and distribution objectives by 2001.

Although the final population estimate has not been compiled for 1999, it is almost certain that the IP has surpassed the Plan's population objective of 2,000 birds. Most of these restorations were undertaken with the assumption that trumpeters would establish migratory traditions to southern locations on their own. While over a million dollars has been spent to accomplish the first objective, very little has been done to identify or develop winter habitat, or to encourage swans that have migrated to continue to do so.

Most swans have responded by staying in northern regions where they are supported by supplemental feeding. In Minnesota, where supplemental food has been provided in winter to increase survival, less than 10 percent of the swans migrate. A higher percentage migrates from Wisconsin than from Minnesota, in part because Wisconsin discourages feeding by the public. Their success has not been without cost, however. Mortality of Wisconsin's migrant trumpeters has been much higher than the mortality of swans that stay in Minnesota.

A Wisconsin study on mortality during migration concluded that the further trumpeters have to migrate, the higher the mortality (Sumner Matteson, Wisconsin Department of Natural Resources, pers. comm.). I would suggest that it is not merely the distance, as much as the number of stops that swans make on the trip, which increases mortality. Swans that know where they are going and stay at only a few locations have a much higher survival rate than those that wander from site to site in search of good winter habitat. Observations of swans that migrated successfully for years from Minnesota to Oklahoma and Arkansas support this conclusion. Exposure to lead poisoning, accidents, and disease were greater for birds that made frequent stops, than for those that flew directly to safe sites.

In 1990, Rolf Kraft (Kraft 1992) wrote in a status report on the Trumpeter Swans of Lacreek NWR, "We as a profession restored these magnificent birds to their former breeding ranges without adequate consideration for their winter survival. It is now incumbent upon us to find suitable wintering habitat and assist the species to find it." Most programs are still focusing on breeding range even though winter habitat is the most significant limiting factor. The swans can migrate, but managers must provide them with good places to go. Increasing the number of swans on their breeding range does not appear to solve the migration problem. In fact, it may compound the problem by putting more pressure on current winter habitat, which is already a limiting resource.

The behavior of trumpeters makes it difficult for them to establish a successful migratory tradition. Trumpeters in the Midwest migrate as family units and cygnets learn a migration route from their parents. They are much slower to locate and adapt to new sites than other waterfowl species that migrate in flocks. Trumpeters build subpopulations based on the survival of families that eventually find suitable wintering sites. It can take years to build a migratory tradition.

The difficulties created by trumpeter behavior are compounded by the lack of safe, high-quality aquatic wintering sites in the South. Most ponds and wetlands are devoid of aquatic vegetation, often intentionally removed to facilitate fish management. Rivers have been dredged and straightened. Water level fluctuations in reservoirs reduce vegetation establishment. Consequently, most dabbling ducks and geese that winter north of the Gulf Coast states have adapted to feeding in agricultural fields. Diving ducks must move on further south to find adequate resources.

There are few good historical records to document the full extent of Trumpeter Swan wintering range. Present conditions suggest that man has either degraded most of the winter habitat in the central Midwest or historically trumpeters migrated further south than any of the restored swans have done to date and wintered primarily in coastal marshes.

It can take years for trumpeters to learn to feed in agricultural fields, and most die before they can develop a successful strategy for migration. Ways must be found to increase the survival of migrant trumpeters so they can return to a site long enough to adapt to their new environments. Trumpeters will return to a wintering site only if it is more attractive than the alternatives, and obviously, only if they survive.

Waterfowl managers have been reluctant to aggressively pursue establishment of wintering flocks of trumpeters or to take actions to encourage their return to a site long enough to adapt to new habitats. Use of supplemental food and live decoy swans are two of the most effective and economical tools available. Unfortunately, these techniques have fallen into disfavor among waterfowl managers in recent years.

So far, it has been impossible to reach consensus on what needs to be done or how to proceed in the Midwest. The majority opinion expressed by the Flyways favors relying on the natural movements of trumpeters to get them to potential wintering areas. This strategy has proven to be slow and costly. I believe that present and future efforts in the Midwest must be directed toward aggressively encouraging swans that migrate and identifying and/or creating suitable winter habitat for them.

Assuming that "a migratory population" remains an objective for the IP, I consider the following list of actions necessary to achieve this objective:

- Management responsibilities should be better coordinated between the Flyway Councils and the state nongame programs. The latter often possess greater funding and interest.

- States within the two Flyways need to decide collectively what course of action to pursue. Northern states must make migration and winter habitat top priorities for their restoration programs, and they must become more active in promoting this agenda before funding runs out.

- Emphasis should be changed from releasing trumpeters in breeding areas to releasing them at wintering sites. Past experiences in Minnesota and Iowa show that trumpeters have a tendency to disperse northward to breed. By releasing them at potential wintering sites, they will have a familiarity with a wintering destination, which may increase the chances of their returning to it at some point in the future. Recently released swans could also serve as decoys to other swans.

- More effort needs to be made to determine what Trumpeter Swans are doing during migration in the Midwest. For example, managers don't know what their key foods are, how often they get handouts from people, how often they change locations, or how many swans feed in agricultural fields. Answering these questions may help in developing a management strategy.

- Managers must consider how trumpeters differ biologically from other waterfowl when developing management plans. Trumpeters are more aquatic than dabbling ducks and geese, and more susceptible to lead poisoning. Because of their strong family bonds, they are slower to learn new habits. Consequently, they may need additional help in adapting to modern environments.

- It appears that sufficient aquatic winter habitat cannot be identified in the areas where trumpeters have migrated to date. Therefore, it is time to either help the species adapt to the habitats that exist by providing additional temporary care at southern wintering sites, or create new habitat that will be suitable for wintering trumpeters and other species. Restoring aquatic vegetation by removing fish such as grass carp from existing impoundments serves the same function as creating new habitat.

- The National Wildlife Refuge System should be more effectively utilized to promote trumpeter migration. The U.S. Fish and Wildlife Service has maintained that restoration of Trumpeter Swans in the Midwest is a low priority, meaning they will cooperate where possible, but they do not expect to assume a leadership role in restoration efforts.

- Joint management plans should be prepared for Trumpeter and Tundra Swans to avoid future conflicts. The Eastern Population of Tundra Swans migrates across the upper Midwest, and winters on the East Coast. They are hunted in eastern Montana, North and South Dakota, and along the Atlantic Coast in Virginia and North Carolina. Tundra Swan hunts in the Midwest do not impact the availability of winter habitat for the IP of Trumpeter Swans, nor do they affect the viability of this population. However, as trumpeters continue to expand their range, the numbers venturing into areas open to Tundra Swan hunting will increase. The number of trumpeters shot will be insignificant in terms of overall IP viability, but the hunter liability issue needs to be addressed further. The problem could be much more significant on the East Coast, where hunting occurs on high quality winter habitat. A swan management plan is needed for both Tundra and Trumpeters Swans that will address the needs of both species.

- Additional public education and awareness are needed. Few people in the central and southern United States are aware that there is an opportunity to have trumpeters as winter visitors. It is hard to generate support for a program if few people know it exists.

- TTSS may need to commit more time and money toward establishing a migratory population in the Midwest to compensate for the lack of involvement by state programs.

Restoration of Trumpeter Swans in the Midwest is at a point where managers can no longer afford to ignore the winter distribution of the birds that have been restored. Until adequate winter habitat is available, and the swans have found it and adapted to it, the future will be uncertain for Midwestern trumpeters.

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ROCKY MOUNTAIN POPULATION

CHALLENGES IN CONSERVING SWANS AND OTHER MIGRATORY BIRDS INTO THE NEXT MILLENIUM

Paul Schmidt, USFWS, Deputy Assistant Director for Refuges and Wildlife, Arlington Square, Room 560, 4401 N. Fairfax Drive, Arlington, VA 22203

Thank you for inviting me to speak today on behalf of Director Jamie Rappaport Clark. She would have loved to have been here, but she is enjoying her first newborn baby on maternity leave. It's truly a special honor to speak to you today, and I'd like to thank the Board of Directors, and especially Ruth Shea and Larry Gillette, for giving me this opportunity. I think everyone in this room knows the dedication and passion they bring to the cause of Trumpeter Swan conservation. I'd also like to commend all of you for making the time to be here for this conference. It's heartening to be reminded of the phenomenal grass roots support that these birds enjoy, and I hope all of us in the Service and other professional wildlife agencies can find new ways to partner with you in the future. It is a great opportunity to focus on the big opportunities to work in harmony as a team for swan conservation and not dwell on the relatively small disagreements that might exist.

It is my pleasure to represent the U.S. Fish and Wildlife Service at the 17th Trumpeter Swan Society Conference. Ten years ago this month, Regional Director Jim Gritman presented the keynote address at the 12th Society Conference in Minneapolis. The Service's Trumpeter Swan Policy provided some of the elements of Mr. Gritman's talk in 1989. The intervening years have been very active ones for Trumpeter Swan restoration and management in North America. Indeed, the past decade has been a critical and active one for conservation and management of many species of migratory birds.

I'm here today to talk specifically about Trumpeter Swans, but I'd like to place swan conservation in the larger context of the challenges that the U.S. Fish and Wildlife Service, and the entire conservation community, are facing in the years ahead. I know it's fashionable this year to talk about the end of the millennium, and what the next thousand years may bring. Not having brought my crystal ball, I won't try to speculate that far into the future. But I do think it's worthwhile to look at how far we've come – and the new challenges we face.

As the largest North American waterfowl species, majestic Trumpeter Swans have always had a special place in bird conservation. As you know, trumpeters were at one time thought to be headed for extinction in the United States, decimated by unregulated market hunting and wetland drainage. In the early 20th century we thought that small nonmigratory populations in remote areas of the northern Rocky Mountains were all that remained. Had we had an endangered species act early in this century, there is little doubt that the trumpeter would have been on the list. By 1932, only 69 trumpeters were recorded in the Rocky Mountain region. From that precarious position, we have achieved remarkable successes in bringing the trumpeter back from the brink of extinction. Thanks in part to the establishment of Red Rocks Lake National Wildlife Refuge protecting some of the birds' remaining habitat, trumpeter populations increased in Montana, Idaho, and Wyoming. Estimates of trumpeter numbers in North America have increased from less than 1,000 40 years ago to nearly 20,000 in the 1995 range-wide census. Most of this remarkable recovery occurred in Alaska and Canada with little active management.

Along with growth in the trumpeter populations, migratory bird conservation has also produced encouraging results for other game and nongame species. Peregrine Falcons and Bald Eagles, once feared headed for extinction, have recovered sufficiently to be removed from threatened status or to be proposed for delisting. Other listed species, such as the Whooping Crane, continue on the long road to recovery. Significant accomplishments continue to be made in the protection of migratory bird habitats across North America by all of the partners of the North American Waterfowl Management Plan. Partners in Flight is focusing efforts on nongame migratory birds and new initiatives for the conservation of shorebirds and colonial waterbirds are being developed. The National Wildlife Refuge Improvement Act of 1997 helps provide a strong foundation for migratory bird management on the only system of federal land dedicated to the conservation of wildlife, fish and plants. Finally, Congress is beginning to recognize the importance of migratory birds and their habitats to the American people.

In contrast to some of the success stories in migratory bird conservation, the Service is faced with long term declines of many species. Habitat destruction and environmental contaminants continue to take a serious toll. On the other hand, we are confronted with serious overpopulation issues with mid-continent Snow Geese and resident Canada Geese. Like the population declines of other species, overpopulation appears to be linked to human activities such as changes in agriculture. These issues are very costly both in terms of staff-time and funding, and seriously impact our ability to deal with other conservation issues.

Although the long-term Trumpeter Swan population trend is very positive, we recognize that in order to sustain it, we will have to return Trumpeter Swans to greater areas of their historical range. We simply have too many birds for the limited habitat they currently use in the winter to support. Growth of the migratory Canadian segment of the Rocky Mountain Population (RMP) has created a severe “bottleneck” in eastern Idaho, southwestern Montana, and western Wyoming as increasing numbers of trumpeters arrive from Canadian nesting areas to spend the winter with the U.S. segment of the population.

At Harriman State Park (HSP) on the Henry's Fork of the Snake River in Idaho, which receives the greatest amount of swan use, the aquatic plants may no longer provide enough winter food to support the increasing flocks of swans, geese, and ducks. During recent mild winters hundreds of trumpeters have moved into other eastern Idaho sites—the Teton River, South Fork of the Snake River, and the lower Henry's Fork. When a severe winter strikes this region, mortality will likely be high among swans attempting to remain at HSP and these other sites. Despite the promising increase in RMP trumpeters, until we restore their migrations and help them return to more suitable wintering areas, their recovery will remain questionable. We are seeking ways to sustain growth of the RMP trumpeter population by encouraging wintering in more diverse and suitable habitats.

Now, we’re working to establish new migrations and to protect the habitat that sustains trumpeters and other populations that may be overabundant in their current habitats. It’s a management change that at times hasn’t been easy, and given the complexity of the situation facing these birds, will take time to reach a successful conclusion. I’d like to tell you where we stand on the existing management plans and agreements for Trumpeter and Tundra Swans.

The Service continues to be supportive of the concept of flyway management of waterfowl and of goals, objectives, and management strategies identified in flyway management plans for both Trumpeter Swans and Tundra Swans. We believe that cooperative, multi-partner, Flyway Council-endorsed projects offer the best opportunities for restoring migratory flocks of Trumpeter Swans within their historic range. Projects with objectives to maintain or enhance swan populations that have retained their migratory traditions or to establish new migratory traditions in sedentary flocks should be the highest priority, and we will strongly support them. Those projects that have the probable outcome of establishing nonmigratory or sedentary flocks will have a lower priority.

The Service also continues to support Flyway Council-endorsed hunting seasons on Tundra Swans, within prescribed guidelines to measure impacts of the harvest and meet overall objectives for Tundra Swan populations. We believe that ongoing or new waterfowl hunting opportunities that are meeting management objectives should not be curtailed or prohibited because of the chance killing of a Trumpeter Swan. However, the Service will strive to avoid Tundra Swan hunting at times of the season or in places where such activity would have impacts on the status of a particular population of Trumpeter Swans. If recent Trumpeter Swan population trends continue in North America, additional conflicts between Trumpeter Swan restoration and Tundra Swan hunting are anticipated. It is very important that all partners in swan management continue to work to minimize the conflicts and find workable solutions that benefit both goals.

We will continue to urge Flyway Councils to carefully examine the impacts of waterfowl hunting programs on Trumpeter Swan restoration efforts and the effects of restoration efforts on established Tundra Swan hunts. Flyway Councils should strive to seek input from all interested parties and to resolve conflicts prior to making recommendations to the Service. The Service, in turn, must give consideration to the broad interests of the public in management of all migratory bird resources. If there are irreconcilable differences among States, among Flyway Councils, or within the public regarding appropriate management for Trumpeter and Tundra Swans, the Service will deal with such conflicts on a case-by-case basis.

The National Wildlife Refuge System will continue to play an active role in Trumpeter Swan conservation as well as providing key habitats for many species of migratory birds. The role of individual refuges must be consistent with the purpose the refuge was established for and be consistent with the Refuge Improvement Act. We recognize that in order for our conservation strategy to succeed, refuges must develop management strategies in cooperation with other refuges and other public and private land managers in a broader ecological context.

The Service is committed to making management decisions based on the best available scientific information. We encourage improvements in swan monitoring programs and the utilization of the latest technology. There are significant gaps in our information for Trumpeter Swan biology and ecology. We urge all of the partners in swan conservation and management to contribute to improving our understanding of swans. For our Fiscal Year 2001 budget, the Migratory Bird Management Office and the Regions have cooperatively drafted project proposals that, if funded, will contribute to improving RMP swan monitoring protocols and understanding the similarities and differences between the Canadian and Tristate nesting swans. Too often in the past we have had to make choices based very little scientific evidence. We need your assistance with improving the knowledge base to support our decisions.

The RMP will always have a special place in Trumpeter Swan conservation. In the 1930s, a few of the RMP swans were the only known survivors of years of exploitation. During the 1999 mid-winter survey over 3,500 RMP Trumpeter Swans were recorded. We have known for a decade that we have too many trumpeters and other waterfowl trying to spend the winter in a relatively small area in Montana, Idaho, and Wyoming. They have exceeded the carrying capacity of this very small wintering area. The Service, other federal agencies, States, and private organizations initiated an unprecedented effort to reduce the number of trumpeters during the winter and to encourage them to develop new migration and wintering traditions.

The Trumpeter Swan Society and its members have been involved in this project from the beginning. Changing the learned behaviors of these non-migratory flocks and establishing new migration routes has been very difficult, as you know. Even though we have not fully achieved those goals, we have learned a great deal. Given the severe budget restrictions that the Service and other partners operated under during the project, the extreme winter working conditions, and the difficulty of coordinating with diverse partners, I am not surprised that difficult problems remain to be resolved.

The trumpeter is one of the birds receiving special emphasis in the concept plan for the Intermountain West Joint Venture. It would be appropriate for the Management Board to review the role of the joint venture in trumpeter habitat restoration and to review the several wetland focus area plans with that in mind. Joint ventures offer unique opportunities for partnerships for anyone who has an interest and a contribution to make for wetland and migratory bird conservation in the Intermountain West.

I expect the National Wildlife Refuges to continue to play important roles in the conservation of RMP swans. Red Rock Lakes National Wildlife Refuge was established for Trumpeter Swans, and as swans expand their range, it is appropriate that other National Wildlife Refuges play key roles as well. The Service is forming a cross-regional team to develop an integrated approach that links refuge management objectives with the goals for restoring RMP Trumpeter Swans. This team will also help define roles for other Service programs in RMP swan conservation. A strategy will be developed to address the role of individual refuges and establish strategies for working together to achieve broader swan management goals and objectives. The work of this group is intended to complement the efforts of the Pacific Flyway Council and other organizations.

As you know, in 1995 the Service approved an experimental swan season in parts of Montana, Utah, and Nevada that allows a limited quota on the take of Trumpeter Swans. This action was proposed to reconcile conflicting strategies for managing Tundra and Trumpeter Swans in the Pacific Flyway. The upcoming hunting season will be the final year of this experimental approach, and we believe that the experiment should run its course. This fall the Service will begin evaluating the experimental swan season to determine if the goals of the experiment have been met.

With these two working groups and potential funding increases, we will be able to better coordinate policy among refuges and administrative regions, while developing a scientific consensus for sound policy decisions. I won’t pretend that the process will be easy, and we need your support and your ideas. We can’t help these birds without the help of The Trumpeter Swan Society and our state, federal and conservation partners. We have daunting task ahead, but the effort must be made. Only by working together can we return the favor to birds that have contributed in so many ways to our lives. I hope I’ve answered some of your concerns, and I welcome your questions. Thanks again for giving me the chance to speak to you.

REMARKS ON BEHALF OF IDAHO'S SENATOR MIKE CRAPO

Don Dixon, State Director of Agriculture for Senator Mike Crapo, 490 Memorial Drive, Idaho Falls, Idaho 83402

Thank you for inviting Mike to speak at your 17th Conference. He would like to be with you, but his schedule would not allow it. As some of you know, Mike's family lives in the Idaho Falls area and he does commute back and forth between Washington D.C. as much as possible.

This aggressive travel plan allows Mike to be in the state relatively often, keeping him in touch with local issues and aware of constituent concerns. It also makes my job as a supplier of information much easier since Mike and his family experience the same everyday situations and problems that his constituents do in the State of Idaho.

I have worked for Mike for approximately 5 years, semi-retiring from a farming and ranching career in an attempt to get out of the way of my second son, who is now making the hard decisions of operating a farm and ranch in a time of transition to an increasing global marketing strategy and infrastructure consolidation.

Senator Crapo's family farms in the Parker area, north of Idaho Falls, about half way between Idaho Falls and the Island Park region. Although Mike's dad did leave the farm, Mike's uncles and cousins continue top work in agriculture. So, as a child and while growing up, Mike spent considerable time in the Island Park area, which you toured yesterday.

He has deep-rooted interest in preserving the distinct signature species of the Trumpeter Swan. While on your tour, I don't know if your tour guide pointed out to you the pond across the highway from the Pinehaven summer home area. The nesting swans that usually inhabit that pond have truly become a community ownership, which generates a great deal of interest and enjoyment. Passersby strain to see if the swans are nesting, when the hatch appears, and when the swans leave the pond. Trumpeter Swans, by the very nature of their magnificent, graceful stature, add a new dimension to the wildlife that we in Idaho, and those who visit Idaho, enjoy and sometimes take for granted.

May I pause in my remarks to recognize the dedication and commitment that Ruth Shea and Rod Drewien have shown in the work they have done to preserve and enhance the Trumpeter Swan population in this area. I remember on one occasion, when Mike was a dinner guest at Jan Brown's home in Island Park, Ruth and Rod invited him to accompany them, in sub-zero weather, to help in the capture and relocation of some swans. I don't recall Mike ever taking them up on the invitation!

When Senator Crapo was elected to the Senate in 1998, he was appointed to the Senate Committee on Environment and Public Works, and as a first term Senator, was appointed Chairman of the Subcommittee on Fisheries, Wildlife, and Safe Drinking Water, an appointment that was held by former Senator and now Governor Dirk Kempthorne. In that capacity he looks forward to representing Idaho, a state that has substantial amounts of public lands, is home for several threatened and endangered species, and because of its remoteness, affords opportunity for quality wildlife refuges.

The efforts of reestablishment and maintenance of an adequate population of Trumpeter Swans is very important to Senator Crapo. As you may know, Senator Crapo tried to get an appropriation of $75,000 for Trumpeter Swans this year. Like many of our appropriations requests, it didn't happen.

Earlier this year, Senator Crapo led an effort to increase the maintenance and operations account for the National Wildlife Refuge System. A coalition of wildlife groups estimates that there is presently a $800 million backlog of work. The FY2000 Maintenance & Operations account was increased by $27 million over the 1999 appropriation. The total appropriation for maintenance and operations of refuges is $264,337,000.

Proposed regulations published last week relating to the Refuge System deal with compatible uses and determinations, providing a framework for how refuge managers determine the ancillary uses of refuges, such as recreation, grazing, and hunting. Ancillary uses must not compromise the wildlife objectives of the refuge. Consideration of those regulations will continue during the 106th Congressional Session.

One of your Conference objectives is to lay a solid foundation for broader and effective involvement of the "on-the-ground" managers, private sector partners, and the public in future Trumpeter Swan management. I wanted to comment on that particular objective.

Senator Crapo has been supportive of local involvement and on-the-ground decision making, feeling that local people can best identify, prioritize, and implement needed responses to ensure the best possible success with a minimum of governmental involvement and regulations. Collaborative efforts should take into consideration all interests and identify all alternatives, and, at the same time, focus on the well being of the resource needs to be protected and enhanced.

Available federal money is usually best administered and put to maximum beneficial use by the cooperative efforts of federal, state, local, and private partnerships that arrive at best solutions through collaborative efforts. In some instances, federal seed money can generate matching funds, creating "dollar stretching" situations. And when local interests are served, and supplemental funds generated, local ownership and interest help spawn a successful program.

Public land and private land partnerships are usually necessary to accomplish the full results that are desirable. Wildlife knows no man-made, designated boundaries. Nesting, migration, and wintering all occur on private land as well as public. Cooperative easements, memorandums of understanding, can be tools, more easily agreed upon if all parties have shared in the discussion and development of the over all plan. Even the sanctuary of our National Wildlife Refuges, by necessity, still interact with adjacent lands. Our own Grays Lake National Wildlife Refuge in southeastern Idaho has attempted to include irrigators, sportsmen groups, and grazers in the development of refuge policy.

Senator Crapo supports your interest in obtaining a secure future for the Rocky Mountain Population of Trumpeter Swans and in so doing decreasing the possibility of a listing process under the Endangered Species Act. In some instances, listing negatively affects the cooperative spirit of multiple interest involvement in the problem-solving arena, reverting the activities to a more regulatory role and a resulting disenchantment in collaborative efforts, placing some in a defensive posture rather that a proactive position.

Realizing that the Trumpeter Swans have made a very welcome return from the brink of extinction, I commend you for your efforts and commitment to address the rebuilding of Trumpeter Swan distributions. Programs that will reestablish the migration habits of the Trumpeter Swans, in this area and to the south, will decrease mortality rates that result from the harsh winters that are experienced in the Greater Yellowstone area. Elimination of the feeding program in the Red Rock Lakes National Wildlife Refuge area has placed additional emphasis on the importance of providing additional winter habitat.

Opportunities should be afforded, through an open process, where concerns, including those of Eastern Idaho, should be considered in the regional scheme of migration patterns. Migration management plans should include needs of the swan population in the Greater Yellowstone area, including the Red Rock Lake Refuge, Harriman State Park, Camas Refuge, Grays Lake, and the entire Island Park area.

Once again let me thank you for the invitation for Senator Crapo to speak to you. It has been my privilege and pleasure to fill in for him today. Please feel free to contact our office at any time.

You have the envious job of working with a beautiful, magnificent species that stirs the heart of all spectators, whether they are novice or expert, sightseer or scientist. May I wish you the very best in your continuing work with the Trumpeter Swan.

HISTORY, ECOLOGY, AND MANAGEMENT OF THE ROCKY MOUNTAIN POPULATION OF TRUMPETER SWANS: IMPLICATIONS FOR RESTORATION

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ABSTRACT

A remnant group of Trumpeter Swans (*Cygnus buccinator)* from the Rocky Mountain Population (RMP) escaped overexploitation and extirpation because they wintered in the Tristate Area, near the intersection of Montana, Idaho, and Wyoming. This area was unique in that it provided reliable open water during severe cold periods, but was virtually uninhabited by humans during winter until near the end of the 19th century. This *de facto* winter refuge allowed a few family groups to avoid the fate of all other trumpeters that bred in Canada and the United States outside of Alaska. The survivors included the ancestors of the Interior Canada Subpopulation (ICSP) that bred in Canada and the Tristate Subpopulation (TSP) that bred in the Tristate Area. With aggressive protection and management, RMP trumpeters recovered numerically from less than 200 individuals in the early part of the century to over 1,600 by 1986. Nearly all tradition to winter in more southerly areas had died almost a century earlier, however, along with the families that followed those strategies. Trumpeters are long-lived and highly traditional, passing knowledge of migratory routes and destinations from parent to offspring, so recovery of lost traditions is extremely slow. This loss of access to wintering and spring staging habitats that are warmer, richer, more southerly, and at lower elevations appears to underlie most of the demographic and distributional problems affecting the RMP today. These problems appear to be most severe in TSP trumpeters because they often enter the breeding period with body reserves that are inadequate to allow successful egglaying, incubation, and broodrearing (the Spring Nutrition hypothesis). They also face growing winter competition from the rapidly increasing ICSP.

INTRODUCTION

Managers, researchers, and a diverse public share many common concerns over ongoing management challenges associated with RMP Trumpeter Swans. In 1987, we completed a comprehensive analysis of existing published and unpublished information on RMP trumpeters (Gale *et al.* 1987). Nearly 15 years have elapsed, but we suggest that our primary conclusions remain pertinent to current problems with RMP trumpeters and to the continuing efforts to find solutions. Consequently, here we provide a brief review of our earlier report and summarize the primary findings, with special emphasis on their implications for ongoing restoration of the TSP.

PRIMARY HISTORICAL AND ECOLOGICAL FINDINGS

The RMP consists of the TSP, which both breeds and winters primarily in the Tristate Area near the intersection of Montana, Idaho, and Wyoming, and the Interior Canada Subpopulation (ICSP), which also winters primarily in the Tristate Area, but breeds in Alberta, Saskatchewan, eastern British Columbia, Yukon, and Northwest Territories. By the early 1900s, the RMP had been reduced to fewer than 200 birds by exploitation and nearly extirpated. These few trumpeter families survived largely because they wintered in an area that provided reliable open water (albeit in small amounts), but was virtually free from human presence during winter until near the end of the 19th century.

This tradition to winter in the harsh and remote Tristate Area allowed some RMP trumpeters to escape the decimation suffered by all other trumpeters that bred outside Alaska. Ironically, however, it also tied them behaviorally to a strategy of wintering where suitable food and habitat were scarce and winters were prolonged and extremely cold. We suggest that this loss of tradition to use richer, lower, and warmer wintering areas persists today and, in fact, underlies most demographic and distribution problems of current concern.

Cessation of commercial hunting, establishment of Yellowstone National Park, and aggressive protection and management beginning in the 1920s and 1930s allowed the few surviving trumpeter families to recover numerically until, by the mid-1980s, RMP trumpeters numbered over 1,600. Most RMP trumpeters still winter in the Tristate Area today, however, presumably because trumpeters are long-lived and highly traditional, passing traditions and knowledge of migratory routes and destinations from parent to offspring (Hochbaum 1955).

Management strategies at Red Rock Lakes National Wildlife Refuge (RRLNWR) included impounding warm water at springs and feeding grain during winter to hold swans on the Refuge, reduce overwinter mortality, and improve nutritional condition of the birds. Before the impoundments were created and feeding began, winter habitat for swans at RRLNWR and in the rest of the Centennial Valley was extremely limited and food resources were inadequate for more than a few family groups. Under intensive protection and management, Centennial Valley trumpeters (including RRLNWR) increased from about 30 adults in the 1930s to about 400 in 1954. The flock then fluctuated erratically between about 250 and 400 for approximately 20 years, then declined by nearly 50% between 1978 and 1986. Similar trends in the TSP as a whole primarily reflected changes in the Centennial Valley component. Breeding populations in Yellowstone Park appeared to be supported by dispersal from the Centennial Valley Flock, and followed a similar pattern of increase and decline. Trumpeters breeding on lower-elevation territories in Wyoming and Idaho, however, generally increased in numbers between the 1930s and 1986. A wide variety of potential causes for the fluctuations and decline in the Centennial Valley Flock were proposed, including genetic problems, parasites and disease, lead poisoning, and carrying capacity of the summer habitat.

Our analysis of the 50-60 year records available on populations and other demographic data for the RRLNWR Flock identified several significant relationships between swan demography and fluctuations in management practices and environmental variables. Swan survival tended to be high when the amount of grain fed at RRLNWR was high and when winter releases of water from Island Park Dam were adequate to minimize ice formation on the Henry's Fork of the Snake River in the vicinity of Harriman State Park, Idaho. Survival in the RRLNWR Flock was unrelated to winter severity during the decades when grain was fed. Productivity (cygnets fledged/100 adults) tended to be high when populations were low, spring was early and warm, amounts of precipitation in April and July were low, and water levels were low. We concluded that much of the variation in population levels was attributable to management activities and weather conditions, both of which had varied much more than had been recognized previously. Grain fed at RRLNWR provided an important buffer against winter mortality in the Centennial Valley Flock, the demographic cornerstone of the entire TSP.

Demography of ICSP trumpeters, as reflected in surveys of the Grande Prairie (GP) Flock, did not vary with any of the management or environmental variables that we examined except for winter severity: mortality of GP trumpeters was relatively high when winters were severe in the Tristate Area. The lack of correlation between amount of grain fed at RRLNWR and mortality in the GP Flock was expected, because GP swans seldom used the feed ponds at RRLNWR. In contrast to the pattern of strong increase in the TSP in the 1930s through 1950s, the GP Flock remained low (50-100 adults) through the mid 1970s, then entered a phase of rapid increase and essentially doubled in number over the next 10 years. The phase of strong increase corresponded temporally with management changes at Island Park Dam; these changes in water release schedules improved conditions for trumpeters wintering on the Harriman State Park section of the Henry's Fork River compared to those that existed during the previous several decades. The same general pattern of population fluctuation seen in the GP Flock was reflected for the entire ICSP, as derived from winter counts in the Tristate Area with autumn populations of TSP swans subtracted.

This paradox of the ICSP increasing rapidly while the TSP declined was both puzzling and troubling but it also eventually led us toward improved understanding of the demographic differences between the flocks and hence toward discovery of their underlying causes. We reasoned that sharply differing demographic performance between TSP and ICSP trumpeters tended to weaken the case that declines in the TSP could result primarily from genetic problems, parasites, disease, and lethal or sublethal effects of lead ingestion. Both subpopulations had been through similar genetic bottlenecks with very low populations, and the ICSP had remained at these low levels considerably longer.

Hence, any genetic deficiencies should have been at least as serious in the ICSP as in the TSP. Furthermore, the successful restoration of a thriving flock of trumpeters at Lacreek NWR in South Dakota from a subset of swans translocated from RRLNWR further weakened the case for genetics as a primary cause. Overlap of ICSP and TSP swans on Tristate wintering areas was substantial, though it largely excluded the RRLNWR feed ponds. Hence we suspected that any problems with diseases or parasites, and to a lesser extent with lead poisoning, likely were similar between subpopulations. Potential explanations based on carrying capacity of breeding habitat or winter habitat (at least in the traditional sense) simply were not compatible with the biological record. Although we do not suggest that any of these potential problems are inconsequential to the RMP, none of them seem at all likely to explain the large differences in demographic performance between the two subpopulations.

Many hints of reproductive difficulties in the TSP had been noted, in some cases since decades earlier: small clutches, small eggs, low incubation constancy, low hatchability, stunted and deformed cygnets, high cygnet mortality, and pairs (or territories) that failed to produce cygnets year after year. We noted that declining productivity in the TSP during the 1970s and 1980s was related to an increasing proportion of pairs that fledged no cygnets, rather than to a general decline across all pairs in the numbers of cygnets fledged. Reproductive difficulties seemed to be relatively rare on ICSP breeding areas, and among trumpeters breeding at lower elevations in general. How then, if ICSP and TSP Trumpeters wintered in the same general region, with an important nutritional subsidy (grain) available primarily to the TSP, could any nutritional advantage accrue to the ICSP?

A plausible answer to this key question involves differences between the spring environment available to ICSP and TSP flocks and nutritional components of reproductive physiology. Swans, like geese, appear to be "capital breeders" (Thomas 1988) wherein a large proportion of the nutritional requirements of laying and incubation are derived from body reserves, rather than from resources obtained through foraging during the reproductive period. Canadian trumpeters typically depart the high and cold Tristate wintering areas in early March, migrating northward but dropping substantially in elevation. We suggest that in the crucial 4-6 weeks preceding nesting, ICSP trumpeters encounter a variety of ice-free habitats, rich feeding conditions, and relatively warm weather. Hence they are able to accumulate the nutritional reserves necessary to provision a clutch and to incubate successfully.

Conversely, TSP birds typically encounter harsh winter conditions during the same crucial period; they must attempt to nest immediately thereafter if they are to have any chance of fledging cygnets before fall freeze up. Furthermore, any pairs that attempt to nest on areas that also serve as wintering habitat could also face some degree of resource depletion caused by the food demands of other TSP swans and the rapidly growing ICSP.

The forgoing explanation, which we refer to as the Spring Nutrition hypothesis, is generally supported by observed differences between TSP and ICSP reproductive characteristics. A second and largely independent supporting line of evidence, mentioned earlier, is that reproductive output of the TSP tends to be high during early, warm, dry seasons. We surmise that in such years the food resources available to TSP birds more nearly approximate those available in most years to the ICSP and to trumpeters breeding on lower, warmer, and richer habitats in general. Clutch size, hatching success, and cygnet survival appear to be closely related to environmental conditions that allow breeding females to obtain adequate pre-breeding nutrition and cygnets to obtain necessary food resources. Such conditions were less common at RRLNWR after 1954 than earlier and likely contributed, along with changes in management practices, to population fluctuations and declines in the latter period. Conversely, ICSP trumpeters and TSP birds with territories at lower elevations in Wyoming and Idaho, which generally increased in the 1970s and 1980s, encounter more moderate spring and summer conditions during nearly all years.

THE CRUX OF THE PROBLEM

The loss of nearly all tradition for migration south of the Tristate area, though caused largely by events that occurred many decades earlier, has severe consequences for the RMP that are evident today. These consequences appear to be most serious for swans of the TSP, which face marginal winter and spring conditions in many years, depended heavily on grain subsidies for winter survival until feeding was terminated in 1992, and often begin the breeding period with nutritional reserves that are inadequate for successful reproduction.

Although the carrying capacity of Tristate wintering areas is unknown, growing concentrations of ICSP trumpeters presumably cause increased risk of habitat damage through overexploitation of food resources. Similarly, risk of catastrophic winter mortality during an extremely severe winter or in a disease outbreak likely increases as the overall RMP increases numerically without comparable pioneering of new wintering areas. Hence we suggest that the loss of access to warmer and richer wintering and spring staging habitats to the south and at lower elevations represents the ultimate problem faced by the RMP.

MANAGEMENT RECOMMENDATIONS

We proposed a primary long term management goal as follows: *Rebuild a predominantly migratory RMP that will use a diverse network of summer and winter habitats, and that will be able to maintain its stability without supplemental grain feeding*.

Managers faced the difficult quandary that supplemental feeding of grain at RRLNWR, although important to reducing winter mortality and hence to reversing population declines in the TSP over the short term, also likely conflict over the long term with the need to encourage migration. Hence, we suggested that supplemental feeding continue, with large amounts of high quality food, until progress was made at identifying alternate wintering areas and encouraging their use by TSP and ICSP trumpeters. Thereafter, we suggested, onset of feeding at RRLNWR should be delayed until a week after freeze up, then by several additional days each year until it reached 15 January or until regular movement patterns to "new" wintering areas were established. Finally, artificial feeding should be terminated completely, and consideration given to reducing the amount of open water to further encourage migration.

We also suggested short-term management goals and made recommendations for their accomplishment. The goals included halting and reversing the decline of the TSP, with specific target population levels and distributions. Management recommendations included: evaluating, protecting, and managing habitat; evaluating genetic issues and pursuing remediation if indicated, reducing disturbance on nesting areas, and a variety of related issues.

Several of the potential environmental and related biological events we mentioned as concerns in 1987 have subsequently occurred, as have several unforeseen events of major importance to conservation and restoration of RMP trumpeters. Furthermore, a major effort to actively redistribute RMP trumpeters was pursued between 1986 and 1997 (Shea and Drewien 1999). In the near future, we will update our original report and condense it substantially, integrate it with Shea and Drewien (1999), and submit the resultant manuscript for publication as a monograph.

ACKNOWLEDGMENTS

Primary financial support for our work on the RMP was provided on a sustained basis by the U.S. Fish and Wildlife Service, with additional support provided by Montana, Wyoming, and Idaho state wildlife agencies, and The Trumpeter Swan Society. Most of the data summarized in the 1987 report came from unpublished sources; the remarkable amount and quality of those data represent a tribute to the dedication of a multitude of individuals and organizations, far too numerous to list individually here. Chapter coauthors include B. Bortner, P. Brussard, D. Lockman, K. McCormick, D. Paullin, and L. Shandruk. To all we express our sincere appreciation for dedication, hard work, perseverance, generosity, and most of all, patience.

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1999 FALL SURVEY OF THE ROCKY MOUNTAIN POPULATION (RMP) OF TRUMPETER SWANS, U.S. FLOCKS

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ABSTRACT

The Fall Trumpeter Swan Survey is conducted annually in September. The survey is a cooperative effort between several entities and is intended to provide a total count of the U.S. Flocks of the Rocky Mountain Population (RMP) of Trumpeter Swans (*Cygnus buccinator*). We conducted the 1999 Fall Survey during the week of 7 September 1999. The 1999 survey found 417 Trumpeter Swans, a decrease from last year's 469 trumpeters and the lowest count since 1993. Most locations experienced high cygnet loss this summer. While cygnet losses are common, factors other than weather appear to be having an effect on cygnet survival and recruitment is low. The ratio of cygnets to adults (17%) remains consistent with historical trends, but more birds were present before the end of the winter feeding program. Although more widely distributed, Trumpeter Swan numbers remain lower than may have been anticipated since the end of winter feeding.

[Editors' note: The complete Trumpeter Swan Survey of the RMP/U.S. Flocks, Fall 1999, including all tables of specific swan locations and numbers, figures showing long term state-by-state trends, and other details is available from Red Rock Lakes National Wildlife Refuge at the above address.]

INTRODUCTION

The Fall Trumpeter Swan Survey is conducted annually in September. It is a cooperative effort between Red Rock Lakes National Wildlife Refuge (RRLNWR), Southeast Idaho Refuge Complex, National Elk Refuge, Harriman State Park, Idaho Department of Fish and Game, Grand Teton National Park, Yellowstone National Park, Wyoming Game and Fish Department, Malheur National Wildlife Refuge, Summer Lake Wildlife Area, Oregon Department of Fish and Wildlife, Ruby Lake National Wildlife Refuge, Shoshone-Bannock Tribes, and other parties.

The survey provides a total count of the core U.S. Flocks of RMP Trumpeter Swans, formerly known as the Tristate Subpopulation, and also includes disjunct flocks in Oregon and Nevada. It is a direct count, in that only birds observed are recorded. We do not use correction factors for birds not observed. At some locations, ground observers report sightings or may verify the number of cygnets or other details.

The RMP is comprised of two distinct subpopulations: the U.S. Flocks, which nest in Montana, Idaho, Wyoming, Oregon, and Nevada, and the Canadian Flocks. The Canadian Flocks summer in Canada and share common wintering areas with the U.S. Flocks in the Tristate area within the Greater Yellowstone Ecosystem. The Fall Survey is the best way to census the distribution of the U.S. Flocks and cygnets near fledgling stage. It provides essential data for waterfowl managers in five western states.

METHODS

We try to conduct the survey in as short a period as possible to reduce the chance of swans moving and being missed or counted more than once. Data are collected by single-engine, fixed-wing aircraft and ground surveys. Flying altitude varies according to terrain and surface winds, but generally averages 30-60 m AGL, at 135-155 kph. A pilot-observer and one to two other observers count and classify swans as adults/subadults (white birds) or cygnets (gray birds); "White birds" and "adults" are used interchangeably. New aerial observers are encouraged to join seasoned ones to increase the pool of observers who are familiar with trumpeter nesting areas. Data are tabulated at RRLNWR and a summary report is prepared and distributed.

We conducted the 1999 Fall Trumpeter Survey during the week of 7 September 1999. Weather was clear and mostly calm. We flew Montana on 7 September, Yellowstone National Park and Wyoming on 8 September, and Idaho on 9-10 September.

RESULTS AND DISCUSSION

This fall's survey found 417 Trumpeter Swans, a decrease from last year's 469 trumpeters and the lowest count since 1993 (Table 1). Flight conditions were good, and observers and pilots were experienced. It is unlikely the decrease was due to survey error.

Overall, some locations held fewer trumpeters while others had little change in white bird totals. The lack of increase in the adult segment despite above average cygnet production in recent years is cause for concern. Last winter was relatively mild. However, over-winter mortality appears to have equaled or exceeded last September's cygnet production. There is little evidence that dispersal outside of the survey area is accounting for the lack of increase in adults.

We counted 70 cygnets this fall (Table 2), which is lower than the 10-year average of 95 cygnets (since 1990). This year's 17% cygnet composition equals the average cygnet ratio observed over the last 10 years and is also similar to the historical trend (($p<.05$; $X^2=4.70$; S.D.=.057, T. Reed, pers. comm.). However, our concern is that we have less adult swans to support the flocks' viability. In spite of the consistent cygnet to white bird ratio, trends indicate that without improved cygnet recruitment, the overall number of Trumpeter Swans in the U.S. Flocks may continue to decrease as adults are lost.

In Montana, decreases in trumpeters in the Centennial Valley were offset by the increase of swans in the Paradise Valley (15 adults and six cygnets). Centennial Valley cygnet production was excellent during early July, when 51 were counted. However, by the fall survey the majority of cygnets had been lost to unknown causes. While we did not believe July or August weather to be severe, weather, disease (lead poisoning), predation, or other factors may account for the losses.

The RMP is generally increasing due to continued growth of Canadian flocks (Gomez 1999). The U.S. Flocks (Tristate) have continued to fluctuate since feeding ended, but at lower numbers (354–469 compared to 469–658). The flock has not maintained a stable adult segment since 1996. Most locations experienced high cygnet loss this summer. While cygnet losses are common, factors other than weather appear to be reducing cygnet survival. Unlike the spring and summer of 1998, where weather was believed to account for cygnet losses (Gomez 1998), weather this spring at RRLNWR was cold but summer was generally considered mild.

In Idaho and possibly elsewhere, a very late cold spring likely contributed to poor hatching and cygnet survival, even though summer weather was mild. Previous research has demonstrated this same relationship in the Tristate area prior to the termination of feeding. Cold springs are believed to delay the growth of invertebrate populations and aquatic macrophytes and possibly reduce food quantity or quality (Ruth Shea, pers. comm).

Other points to consider are that while some regional pioneering by dispersing trumpeters is evident, tenacity to a site may be a factor. In some areas, such as Henry's Lake or Island Park, Idaho, increasing human use of key wetlands has led to abandonment of historical Trumpeter Swan nesting territories. Additionally, over-winter survival is less than anticipated. Absent winter feeding or other available forage, the long winters may result in less than optimal body fat composition of nesting adults leading to lower nesting or brood rearing tenacity. Cygnet recruitment is slower than anticipated as the total number of trumpeters is not reflecting annual cygnet production. Depending on the site, factors such as chronic lead poisoning, infections, nasal leaches, predation, food availability, human disturbance, or other aspects which determine nesting and fledgling outcomes should be re-examined.

ACKNOWLEDGMENTS

All cooperators and contributors deserve thanks for working around scheduling issues and other survey difficulties and for helping to gather and summarize the data. In the core Tristate and adjacent areas, D. Gomez, T. Reed and pilot B. Twist (Western Montana Aviation - Cessna 206) flew the southwest Montana portion. Other Montana observations were provided by T. McEneaney. T. Reed, S. Bouffard and B. Twist flew Island Park and eastern Idaho, and south to Bear Lake NWR. T. McEneaney, T. Reed and pilot B. Twist flew the Yellowstone portion. S. Patla and pilot G. Lust (Mountain Air Research) flew the Wyoming portion. In the restoration areas, J. Mackay surveyed Ruby Lake NWR, Nevada, M. St. Louis surveyed Summer Lake WMA, Oregon and vicinity, and M. Laws and G. Ivey provided numbers for Malheur NWR. R. Shea provided consultation and helped to analyze trends. S. Bouffard and C. Bergren revised the spreadsheets. RRLNWR employees J. Vann, T. Reed, R. Gomez, and volunteers H. Woodward and B. Trussell helped to compile, edit, and distribute this report.

Volunteers H. Woodward and B. Trussell of RRLNWR, and C. Reckling of the USFWS Region 6 office, have worked together to assimilate data and incorporate it into our RRLNWR homepage. The site can be found at <http://www.r6.fws.gov/redrocks>

Table 1. Results of September surveys of the U.S. Flocks since 1990.

Year (Sept.)	White Birds	Cygnets	Total Swans
1990	432 (75%)	147 (25%)	579 (100%)
1991	463 (81%)	108 (19%)	570 (100%)
1992	473 (83%)	97 (17%)	570 (100%)
1993	303 (86%)	51 (14%)	354 (100%)
1994	302 (67%)	152 (33%)	454 (100%)
1995	372 (85%)	66 (15%)	438 (100%)
1996	381 (83%)	78 (17%)	459 (100%)
1997	360 (83%)	73 (17%)	433 (100%)
1998	364 (78%)	105 (22%)	469 (100%)
1999	347 (83%)	70 (17%)	417 (100%)

Table 2. State-by-state summary of September survey results, 1999.

State	White Birds	Cygnets	Total Swans
Montana	120	21	141
Idaho	103	23	126
Wyoming	89	12	101
Nevada	16	5	21
Oregon	19	9	28
Total RMP, U.S. Flocks	347	70	417

and contains significant Trumpeter Swan information. Eventually, we may be able to incorporate general survey results. Our homepage includes a link to The Trumpeter Swan Society homepage.

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RECENT CHANGES IN WINTER DISTRIBUTION OF RMP TRUMPETER SWANS

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ABSTRACT

In recent years, distribution of wintering Trumpeter Swans (*Cygnus buccinator*) has shifted south from traditional areas in Island Park, Idaho, and Yellowstone National Park, Wyoming. An increased number and percentage of the swans are using more southerly areas. However, because the overall number of swans in the Rocky Mountain Population (RMP) has increased, the number of swans wintering in the northerly areas is about the same as it was 10 years ago, even though it is a smaller percentage of the population. The shift southward is probably a result of several management actions, but it is not possible to attribute the shift to any particular action. The management actions often occurred simultaneously and without control treatments. These actions include trapping and relocation, hazing, cessation of supplemental feeding, differing water regimes, lowered water levels in several wintering ponds, and decreased aquatic vegetation. Increasing population pressure may also have had some effect. Limited hazing in the past few years has resulted in only short-term local movements of Trumpeter Swans, but has likely benefited the aquatic vegetation and fisheries.

INTRODUCTION

Winter distribution of RMP Trumpeter Swans has shifted since 1985 and several factors influencing distribution have also changed. These factors include winter relocations, hazing, termination of supplemental feeding at Red Rock Lakes National Wildlife Refuge (RRLNWR), differing water releases from Island Park Dam, reduced wintering habitat at RRLNWR and Harriman State Park (HSP), and aquatic vegetation changes in the Henry's Fork of the Snake River. Many factors changed simultaneously, making it difficult to separate effects of any particular factor on winter swan distribution. It is likely several factors had additive or interacting effects. None of these changes was designed as an experiment with treatment and control groups. Because of this and the interaction among factors, inferential statistics are not appropriate. This paper will first review swan distribution changes and then discuss some possible causes. See Shea and Drewien (1999) for a complete review of changes in management practices and factors affecting winter swan distribution through winter 1996-97. After 1996, relocations were discontinued and hazing was reduced. This discussion focuses on swans wintering in the Greater Yellowstone Core Area (Core Area) (Figure 1).

RESULTS AND DISCUSSION

Winter distribution

Overall, the percentage of swans wintering in the Core Area declined slightly from 100% to just over 90% during the past 15 years (Figure 2). Winter numbers appeared to increase in locations outside the Core Area, including the mid and lower Snake River in Idaho, as well as in Utah, Nevada, Oregon, Washington, and California. This apparent shift out of the Core Area is misleading, however, as Trumpeter Swans in these other states were not included in the Midwinter Swan Survey until 1992. Trumpeter Swans nesting at Malheur and Ruby Lake National Wildlife Refuges and other migrant swans have wintered at these locations for decades. By including them in the winter survey after 1992, the percentage of RMP swans wintering in the Core Area dropped slightly. Despite this question about numbers of swans in other states, there is at least one area, the Fort Hall Indian Reservation in southeast Idaho, where wintering Trumpeter Swans have increased.

Distribution within the Core Area has also changed. By breaking the Core Area into quadrants (Figure 1), it is evident there has been a shift of total numbers and percent of wintering swans from the higher and colder NW quadrant to the lower and warmer, SW and SE quadrants (Figures 2 and 3). The NW quadrant is the Island Park Area of Idaho and the

RRLNWR area. HSP encompasses several miles of the upper Henry's Fork within the Island Park Area. The NE quadrant is Yellowstone National Park (YNP) and vicinity. The SE quadrant includes the Jackson, Wyoming, area and other locations in Wyoming. The SW quadrant includes the lower Henry's Fork, the South Fork of the Snake River, Teton River and vicinity.

The decline in percentage of swans wintering in the NW quadrant, from over 60% in 1985 to 40% in 1999 (Figure 2), was likely due to several factors acting simultaneously and perhaps synergistically. In late winter 1990, swans and other waterfowl completely grazed the submerged vegetation in the Henry's Fork River within HSP, their primary wintering site in the NW quadrant. For the next few winters, substantially less food was available than during previous winters. The area of wintering habitat was also reduced because the ponds formerly used for supplemental feeding at RRLNWR have been lowered every winter since 1992 to reduce habitat for swans to winter there. Since fall 1996, water levels in Golden and Silver Lakes at HSP have also been lowered for the same reason.

Supplemental feeding was discontinued at RRLNWR in Winter 1992-93. This, coupled with lower water in the feed ponds and hazing, forced many local RRLNWR swans to move to other wintering areas. These events correlated with a lower resident population in the Tristate area in September 1993. Apparently, numerous swans were not able to survive without the supplemental food and those that survived had to have developed a tradition to use new wintering sites. In addition, the relocation program has affected winter swan distribution.

From Winter 1991-92 through Winter 1996-97, the relocation program affected distribution by physically moving birds out of the NW quadrant. Nearly 1,300 swans were moved during six winters (Shea and Drewien 1999) to locations out of the NW quadrant. In addition, harassment from night capture operations with motor and air boats encouraged swans that were not captured to leave. When capture operations ceased during the light phases of the moon, swans were hazed. At various times boats, ultralight aircraft, helicopters, snow machines, and pyrotechnic devices were used to haze swans from HSP. Capture and hazing operations usually ended by late December. Except for the activity of monitoring crews, swans were free from disturbance at HSP for the rest of the winter.

The relocation program started in response to events during February 1989 and winter 1989-90, and the increasing number of swans wintering in the NW quadrant. In February 1989, following months of unusually low flows from Island Park Reservoir, much of the Henry's Fork froze and prevented swans from reaching aquatic vegetation. Over 50 dead swans were picked up at HSP following a severe cold snap. Hundreds more were saved by increasing water releases from Island Park Dam and thawing the river.

While there was no apparent lasting effect on either the Canadian or Tristate flocks (both increased the following year), there was concern that future severe weather could cause additional high winter mortality. Representatives of the U. S. Fish and Wildlife Service (USFWS), Idaho Department of Fish and Game, and U. S. Bureau of Reclamation (USBOR) drafted a water release plan for Island Park Reservoir to prevent the Henry's Fork from icing in the future. The USBOR released more water the following winter and mild weather resulted in little ice formation. Record numbers of swans, over 800, wintered at HSP and by March 1990 no submergent vegetation remained. The swans then moved en masse to the RRLNWR feeding ponds. The loss of vegetation and the threat of disease outbreak among concentrated swans were incentives to start the relocation program. More swans were expected at HSP the following winter. There would be little natural food in the river, and the feeding ponds at RLLNWR were already near capacity. The lack of vegetation had direct and indirect effects on distribution: directly by forcing swans to move to find food and indirectly by triggering the relocation program.

The percentage of swans wintering in the SW quadrant increased from <20% in 1985 to 40% in 1999 (Figure 2), primarily influenced by the same factors. There was less habitat and food in the NW quadrant where most swans traditionally wintered. Moving downstream several miles, swans could winter on the lower Henry's Fork (from Ashton downstream to Idaho Falls). This area was lower elevation, somewhat warmer, and the water stayed open longer. Most of the increase in swans in the SW quadrant was in this stretch of river. Other areas where wintering swans increased included the South Fork of the Snake River, the lower Teton River, and further south, outside the core Tristate area, at Fort Hall Indian Reservation. No swans were relocated during winter to this quadrant, although some were released further south at Fort Hall.

Some of the additional swans in the SW quadrant could be attributed to a newly established breeding flock at Grays Lake NWR (GLNWR). This flock was established with summer transplants from RRLNWR to GLNWR in 1988-91. Some of the GLNWR swans wintered in the SW quadrant on the South Fork of the Snake River. While warmer than the NW quadrant, most areas in the SW quadrant where swans are now wintering could freeze during extreme cold.

The percentage of swans wintering in the SE quadrant increased from about 5% in 1985 to about 15% in 1999 (Figure 2). Increased numbers using the SE quadrant resulted from new breeding flocks at Seedskadee NWR, Wyoming, and other locations on the upper Green River, now wintering in those areas and from GLNWR swans wintering on the Salt River in Wyoming. Other increases resulted from more swans shifting from the NW quadrant to the Salt River and Jackson area of Wyoming.

The percentage of swans wintering in the NE quadrant has been relatively constant at about 5-10% from 1985 to 1999 (Figure 2). The NE and NW quadrants are both high elevation, colder areas than the southern quadrants. The amount of winter habitat and factors affecting winter distribution have not changed in the NE in recent times. Swans leaving the NW quadrant are more likely to move south rather than into the Yellowstone area (NE quadrant).

It is difficult to interpret changes in swan numbers wintering in other states (California, Nevada, Utah, Oregon, and Washington) from the Midwinter Survey data. Figure 2 shows an increased percentage of swans wintering in these states, but these swans were not included in the survey results until 1992, about the same time swans were relocated into some of these areas. It is difficult to conclude that this percentage increase actually represents more swans wintering in those areas, since some were present prior to 1992. While most of the swans in these states can be accounted for by resident breeding birds or recently released swans, there are some, albeit underdetermined numbers, that migrate to these other states for the winter. It is difficult to tell if they are there because they learned the site from being released there during previous years, learned the site from their parents, or whether factors in the Core Area encouraged them to move on their own.

Even though a higher percentage of Trumpeter Swans are wintering further south, the actual numbers wintering in the NW quadrant were about the same in 1999 as in 1990 (Figure 3), because of the increased total number of RMP swans. RMP swans have increased from about 1,600 in 1985 to over 3,500 in 1999 (Figure 3) although the Tristate Flock has remained around 500 (US Fish and Wildlife Service 1999). While more swans are wintering in somewhat warmer climates, the number of swans wintering in the NW quadrant is now about 1,200, nearly the same number as when the relocation program began.

Hazing Post-1997

During winters 1997-98 and 1998-99, only light to moderate hazing by two to four people with snow machines and pyrotechnics occurred at HSP. Hazing occurred on 4 days in Winter 1997-98 (December 1, 8, 18 and January 6) and 11 days in Winter 1998-99 (November 19, 23, 25, December 2, 3, 15, 16, 18, 29, 31, and January 5). No hazing occurred after early January. Sufficient staff were not available to monitor and haze at the same time, making it difficult to draw solid conclusions as to the efficacy of hazing. At this level of hazing, swans moved out of HSP temporarily, but did not appear to decline in HSP over the long-term. Swan numbers did not appear to change in other areas of Island Park or the lower Henry's Fork during hazing periods, even though these are the two places swans would most likely move to after being hazed from HSP.

While numbers exceeded the Flyway Management Plan objective (200 at HSP) (Subcommittee on Rocky Mountain Trumpeter Swans 1998), they never reached numbers (800+) that occurred at HSP prior to the relocation program. The maximum number in Winter 1998-99 was over 300. While numbers did increase over the winter despite hazing, there is no way to estimate numbers that might have occurred in the absence of hazing. Hazing also appeared to move ducks and geese out of HSP. Hazing of swans and other waterfowl probably reduces feeding on aquatic vegetation early in winter and probably reduces overall use for the entire winter. The vegetation is important not only for swan forage, but also as escape cover for young trout (Griffith and Smith 1995). The Henry's Fork is a world-renowned trout stream and fishery concerns must be considered while managing swan populations.

CONCLUSIONS

Greater percentages of swans are wintering in lower elevation, warmer sites in eastern Idaho, but because of increasing RMP numbers overall, large numbers are still wintering in high elevation, colder areas

HSP-RRLNWR vicinity. Many swans wintering in the lower elevation areas could still face problems in severe winters. This shift to lower wintering areas was probably a result of several factors acting in conjunction. These include less winter habitat in higher areas, discontinuance of supplemental feeding at RRLNWR, the relocation program, hazing, and the vegetation decline in the Henry's Fork in the early 1990s. Less intense hazing in the past 2 winters has lowered numbers of swans in HSP temporarily, but has not likely encouraged swans to move further south. Hazing has encouraged other waterfowl to leave and has had beneficial effects on the submergent vegetation in the Henry's Fork, upon which swans and trout depend. Present hazing efforts should be continued next winter and swan numbers monitored to see if present efforts are adequate to protect the submergent vegetation.

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U.S. FISH AND WILDLIFE SERVICE PERSPECTIVE ON RMP TRUMPETER SWAN RESTORATION

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INTRODUCTION

The Rocky Mountain Population (RMP) of Trumpeter Swans (*Cygnus buccinator*) is one of three populations of Trumpeter Swans recognized for management purposes in North America (Figure 1). The RMP breeds from northern Canada in a dispersed fashion southward to northern Nevada. Numbers of Trumpeter Swans in each population are inventoried by a cooperative breeding population survey conducted at 5-year intervals throughout North America (Caithamer 1996, Figure 2). Additional surveys are conducted annually that provide additional information about more local or regional aspects of population change and distribution (Gomez 1998, 1999). All surveys indicate that the total number of RMP Trumpeter Swans has increased since the surveys began. The most recent mid-winter survey suggests that the RMP now numbers in excess of 3,500 individuals (Gomez 1999).

There are at least three major issues facing Trumpeter Swan managers. The first two, which are specific to this population of Trumpeter Swans are: (1) the restrictive winter distribution and (2) the number of southern breeders, particularly those associated with the Tristate (ID, WY, and MT) area. The third issue is more general, and deals with the possible interaction between Tundra Swan (*C. columbianus*) hunting and Trumpeter Swan restoration. This issue is not solely restricted to RMP Trumpeter Swans, but it is most pronounced for this population. Our purpose in this presentation is to review past management actions directed at this population of Trumpeter Swans and to provide our perspectives on the three issues described above.

MANAGEMENT AGENCIES, RESPONSIBILITIES, AND AUTHORITIES

Trumpeter Swans are included in the species of migratory game birds covered by the Migratory Bird Treaty (1916) and the Migratory Bird Treaty Act (1918, as amended). Therefore, the management authority for these birds is considered a Federal responsibility. The U. S. Federal government has long recognized that migratory bird management is actually a shared responsibility with other governments both international and local that also have legislative mandates for various aspects of migratory bird management. In recognition of these shared responsibilities, waterfowl management in North America has evolved in a cooperative fashion based on the Flyway management concept that was first implemented in the late 1940s. North America is divided into four administrative Flyways for these purposes. Each Flyway has developed an administrative organization to facilitate communication and coordinate management activities between the various governmental organizations that share responsibility for waterfowl management at different administrative levels.

All four Flyways have organized themselves with both an administrative (Council) and a technical advisory committee. Flyways are organizations that bring together State, U.S. Federal, and International partners (both Federal and local governmental levels) in a formal process to annually consider aspects of migratory game bird management. An important point is that Flyways are primarily a means for State and local governments with migratory bird management authority to coordinate and communicate views on issues to the U.S. Federal government. The U.S. Federal government, the Canadian Federal government and, to some degree, the Mexican Federal Government participate in these organized meetings but only in an ad-hoc capacity. Private citizens and interested non-governmental organizations are also welcome and encouraged to participate in these meetings, but the decision making is restricted to those with specific legislative authority. Recommendations of the four Flyway Councils are formally communicated to the U.S. Fish and Wildlife Service's Regulation Committee at

specific times each year. The range of RMP Trumpeter Swans falls entirely within the Pacific Flyway and thus, the Pacific Flyway Council and the Pacific Flyway Study Committee are major contributors to RMP Trumpeter Swan management.

MANAGEMENT HISTORY

The subject of Service perspectives on RMP management has been an issue at TTSS conferences for a long time (Bartonek 1984, Hartwig 1989, Trost 1996). Two recent documents: (1) Pacific Flyway Management Plan - Rocky Mountain Population of Trumpeter Swans (Subcommittee on Rocky Mountain Trumpeter Swans 1998), and (2) Evaluation of efforts to redistribute the Rocky Mountain Population of Trumpeter Swans, 1986-97 (Shea and Drewien 1999) provide extensive detail concerning past management actions, distribution, and population status. Several other presentations at this Conference will also review the management history of RMP Trumpeter Swans. To avoid as much redundancy as possible, we will restrict our comments to the development and implementation of the 1995 Environmental Assessment (EA) that addressed the specific issue of Tundra Swan harvest management in relation to RMP Trumpeter Swan management. We will rely on our colleagues to present the background information on past management actions directed at the winter distribution and the status of southern nesting flocks within the RMP.

In 1995, the Service prepared an EA: Proposal to establish general swan hunting seasons in parts of the Pacific Flyway for the 1995-99 seasons (Bartonek *et al.* 1995). This EA was developed to reconcile conflicting strategies for managing the two swan populations in the Pacific Flyway as described above. It is important to note that the EA dealt primarily with harvest regulation and did not address many of the broader issues of management concern for RMP Trumpeter Swans. The section regarding Trumpeter Swan range-distribution efforts is fairly simple and the preferred alternative as adopted by the Service was:

a. <u>Active (preferred alternative)</u>. The Service would participate in cooperative efforts to achieve winter-distribution objectives, including translocate birds to more favorable wintering sites, haze birds from winter concentration areas, and stop feeding swans on Service managed lands. Funding and effort for these tasks would be relative to other migratory bird management matters.

Beyond this reference the EA deals with the specifics of when, where, and how hunting seasons would be conducted for Tundra Swans and most importantly, established a limited quota approach for the take of Trumpeter Swans within the Tundra Swan seasons in Montana, Utah, and Nevada. This action legalized the take of a limited number of Trumpeter Swans by hunters for the first time since the signing of the Migratory Bird Treaty Act (1918). It is important to note that the specific details were much debated at the time and that the Service clearly stated that it recognized that the preferred alternative was a compromise between the various advocacy groups that had offered positions on this issue. We note that the Service approach was based on its established policy as previously described by Hartwig (1989). This policy also clearly outlined Service support for cooperatively developed management plans to guide management activities of both populations of swans discussed in the EA. The development and use of management plans is the Service's general approach to on-the-ground management activities for migratory birds in general.

PERSPECTIVES ON POPULATION DELINEATION AND STATUS

The three populations of Trumpeter Swans recognized in North America are recognized for management purposes and not in recognition of reproductive isolation or genetic differentiation. As Trumpeter Swan populations continue to increase in North America, we expect there to be further assessment and revision of what populations should be recognized for management purposes, and that these definitions will likely change over time. At present, we do not believe that the Tristate breeding segment of the RMP Trumpeter Swan population constitutes a separate management entity. However, we do believe that maintenance and enhancement of a diverse breeding distribution is a sound strategy for the population as a whole. To that extent, we support the goals and objectives as identified in the Flyway management plan for this segment of the population, recognizing the important part that these swans play in the history of migratory bird management in North America.

Numbers of RMP Trumpeter Swans continue to increase as evidenced by the most recent midwinter index. As the population continues to grow, we expect increasing fluctuations in this annual index. An example illustrating this point is the change evidenced in the midwinter count of western Tundra Swans during the past 2 winters. Western Tundra Swans declined by approximately 70,000 birds in the

1998 index and recovered by a similar degree in the 1999 survey. We do not believe that this change was a result of actual changes in population, but rather a reflection of the type of uncertainty associated with midwinter surveys in general. We certainly endorse the continuation of these annual surveys to help guide management programs and serve as an early warning of potential management problems. However, we continue to view the 5-year continental breeding population survey as the official measure of the population status of all Trumpeter Swans in North America, including the RMP.

PERSPECTIVES ON EFFORTS TO CHANGE WINTER DISTRIBUTION

Despite heroic and intensive efforts to alter the winter distribution of the population as a whole, success must be considered limited. Apparently, the end result of translocating well in excess of 1,000 Trumpeter Swans from the winter concentration area in Idaho has been the death of most of these individuals. With the possible exception of Fort Hall, Idaho, Trumpeter Swans have not developed a new migratory tradition to any other location and even Fort Hall must be considered a limited success. Our perspective on this differs from some of the other principles involved. Our perspective is also influenced by past experience with other efforts to alter the winter distribution of migratory birds (Rusch *et al.* 1985). We believe that efforts to alter winter distributions of both geese and swans have generally failed, despite serious, expensive, and extensive efforts in a number of instances. Although our issue here today is swans, the concept of managing the winter distribution of geese has also been around for a long time, and has never been successfully achieved through management activities during the migration and/or the wintering period. Therefore, although we think such efforts should continue as part of the package of management activities we consider, we would choose to reduce our emphasis on this approach, given the track record in this population and with other similar efforts conducted for Canada Geese in the past.

It does seem that hazing swans at Harriman State Park (HSP) has affected a limited local redistribution in the Tristate area. Again, we draw the analogy to experiences at Horicon NWR directed at Canada Geese, where the same general result was achieved. Experience suggests that moving adult birds from traditional migratory patterns is a difficult, if not impossible task, that has yet to be successfully accomplished in any recognized population of migratory birds. However, winter distributions of populations do change, as evidenced by the recent shift in the wintering distribution of Cackling Canada Geese, and thus there is some hope that this could be accomplished by management agencies in a directed fashion. However, we believe that this would likely require landscape level changes to meet with a reasonable level of success.

This leads us to consideration of the second major issue facing this population. The status of the Tristate breeding segment of the RMP. The cessation of winter feeding programs at Red Rocks Lake NWR was expected to have some adverse impacts on the RMP. Additionally, trapping and translocating swans during winter was also recognized to harbor considerable risk for those swans being moved, including those that breed in the Tristate area. Therefore, the decline observed in the number of Trumpeter Swans associated with the Tristate area was not unexpected. Trends since 1992 suggest the population declined substantially (about 36%), and then has stabilized or has begun a slow recovery, with the most recent fall inventory data suggesting that the number in the Tristate region is within 100 of the pre-1992 totals.

The real issue is that a large-scale winter die-off might result in disproportionate losses and jeopardize the future existence of this segment. It seems to us that the two issues are therefore very related and the perception of risk is heightened because of the potential loss of Tristate breeding birds in a winter mortality event caused by weather in the Tristate wintering area. Most assessments would suggest the Canadian breeding segment of this population is healthy and growing, and likely could sustain winter losses of fairly significant magnitude. Our concern is therefore highest for the Tristate breeding birds that may be involved in such an event.

To us, this suggests that a change in emphasis to augmentation of Tristate breeding population should be considered a higher priority than in the past. We see several advantages to this approach. First, swans can be introduced into habitats where there is little probability of them wintering in the problem area within the Tristate, thus increasing the diversity and winter migratory traditions of the RMP in general. Additionally, there is some likelihood that these swans will attract Canadian migrants to new wintering locales and traditions, thus increasing the security of the population as a whole. For the immediate future, we see few alternatives to continuation of the winter hazing program. We believe this activity has served to help the local habitat situation at HSP. Additionally, the local redistribution that has resulted has increased the security of the population as a whole from a catastrophic winter weather mortality event.

PERSPECTIVES ON BALANCING DIFFERENT MANAGEMENT OBJECTIVES

The question of Tundra Swan hunter jeopardy is a larger issue than just RMP Trumpeter Swan management. One would logically expect that, as Trumpeter Swan populations expand, this has the potential to become a greater issue throughout the United States. We believe that the limited quota approach, combined with a required harvest monitoring program, is the best way to address this issue. The first application of this approach in RMP range made good sense, because we were actively engaged in trying to alter the winter distribution of RMP Trumpeter Swans and there was a real potential to place a significant portion of the population at risk in legal Tundra Swan seasons. The issue of specific ties between the redistribution program and the implementation of allowable harvest quotas for Trumpeter Swans within RMP range was never clearly established, as is illustrated by the ongoing discussion of this issue. We believe that this points out the need for improved communication and discussion between all agencies, organizations, and individuals that share the concern for this population. We are committed to work to improve the trust and understanding between all parties as our management program develops.

SUMMARY

We believe that there has been some improvement in the RMP during the last decade as a direct result of cooperative management efforts. We believe that the future of this population rests on our ability to maintain and enhance truly cooperative efforts that embody the goals and objectives of all affected constituencies. Without a doubt, arriving at an approach that meets this objective is our most difficult task of the immediate future. The elimination of artificial feeding without suffering large-scale population impacts has certainly been in the long-term best interests of restoring this population to a natural, self-sustaining population. Efforts to reduce swan use of HSP have also been relatively successful. Although the HSP still winters slightly higher numbers of swans than had been hoped, significant local reductions have been achieved in recent years and the proportion of the RMP wintering specifically at HSP has declined markedly. The so called "generic" swan season has shown that the harvest of Trumpeter Swans by Tundra Swan hunters in existing seasons is not great. Additionally, we believe that the method to monitor the species composition of the harvest in a cost effective fashion (Drewien *et al.* 1999a) developed as a result of this experiment has the potential to provide reliable information on the species composition of swan harvests in all swan seasons.

We view the efforts to establish new migratory traditions by winter translocations as the least successful of management activities attempted during the last decade (Shea and Drewien 1999, Drewien *et al.* 1999b). We believe that an approach that deserves serious consideration for the future is a shift in emphasis from winter translocations to augmentation of the Tristate breeding segment by introductions of flightless young. A number of details regarding such an effort need to be determined with all the involved constituencies. However, our perspective would be to encourage serious consideration of this approach as the next step in what we believe will be a continuing process to improve the status of the RMP and Trumpeter Swans in general throughout North America.

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PACIFIC FLYWAY STUDY COMMITTEE PERSPECTIVE ON RMP TRUMPETER SWAN RESTORATION

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INTRODUCTION

The Pacific Flyway Study Committee (PFSC) is a body of technical representatives from 11 states lying entirely or partially west of the Continental Divide. The draft charter of the PFSC is, "To implement the objectives of the Pacific Flyway Council (PFC), and support the goals of the National Flyway Council as created by the International Association of Fish and Wildlife Agencies, developing and implementing cooperative management programs throughout the Pacific Flyway ..." (Pacific Flyway Study Committee 1999).

The management focus of the PFSC includes the many migratory bird species that have supported rich traditions of consumptive and nonconsumptive recreation, and are also valued by society for their aesthetic, scientific, and ecological significance. Among those species are the many members of the family Anatidae, including the ducks, geese, and swans. The PFC and PFSC routinely invite representatives from universities, conservation organizations, and tribes, as well as individuals to participate in discussions about management programs affecting migratory game birds.

I have been requested to present the perspective of the PFSC regarding several management concerns affecting range expansion objectives for the Rocky Mountain Population (RMP) of Trumpeter Swans (*Cygnus buccinator*).

BACKGROUND

The RMP includes two primary breeding distributions of Trumpeter Swans, termed the "Tristate" and "Canadian" segments (Shea and Drewien 1999a). Swans from both breeding distributions winter primarily in the Tristate region, a 225 X 250 km area at the junction of Idaho, Montana, and Wyoming. In summer 1932, 57 adult Trumpeter Swans and 12 cygnets were documented in the Tristate region. In 1946, a breeding ground survey also documented 100 Trumpeter Swans in the vicinity of Grande Prairie, Alberta. These two breeding flocks comprised the seed birds for future management and recovery of the RMP. A winter feeding program was begun in the Centennial Valley of Montana in 1935 to assist recovery efforts. That program continued at Red Rock Lakes National Wildlife Refuge (RRLNWR) until winter 1992-93 (Shea and Drewien 1999a). The Tristate segment increased at an annual growth rate of about 10% until the early 1950s. Afterward, the numbers of adults counted in the September surveys fluctuated, but no definitive trend was evident. Relative maxima occurred in 1954 (548), 1964 (554), and 1989 (505). A linear regression fit to 1952-92 counts ($r = -0.44$) suggests a slightly declining trend of two birds per year (Figure 1). Oakleaf *et al.* (1996) determined the number of resident swans in the Tristate segment was significantly lower during the 1970s following changes in the feeding program at RRLNWR and removal of cygnets from the population; however, those two factors were ameliorated in the 1980s. It is unclear how resource limitations, climatic shifts, cygnet removal, changes in winter feeding, and changes in refuge management may have interacted to limit the growth of this population, but several of the human-caused influences were also operating on the population throughout the growth phase from the 1930s through the 1950s (Shea and Drewien 1999a). This suggests the population was limited by some aspect of resource availability, at least in the areas occupied by the birds. (David Lockman, pers. comm.) believed availability of winter habitat and breeding territories ultimately limited further growth.

The number of adults counted in the September survey declined 36% in 1993, the year after feeding was terminated, then increased during the subsequent 3-year period. The 1996-98 counts were similar (mean = 310), possibly indicating the population has reached a new equilibrium. This interpretation is speculative because it is based on only 6 years of data since feeding was discontinued.

The number of RMP swans documented in the mid-winter survey of the Tristate area has increased steadily and consistently since 1972 when 447 were counted (Subcommittee on RMP Trumpeter Swans 1998). The mid-winter counts exceeded 1,000 in 1981, 2,000 in 1990, and reached an all time record of >3,500 in 1999. The annual growth rate has been about 7.5% based on the beginning and end predictions of the regression equation fit to the survey data ($r = 0.95$) (Figure 2).

The growth of the RMP is attributed primarily to the Canadian segment of the population, which nests from west-central Alberta to northeast British Columbia, extending slightly into the adjoining territories. The majority of the Canadian birds winter in the same locations as the more sedentary Tristate swans. This has led to concerns that the increasing density of wintering swans may deplete aquatic vegetation at preferred feeding sites (e.g., Harriman State Park, Idaho), may increase the risks of disease outbreaks and large die-offs during a "severe" winter, and may reduce viability of the Tristate segment. The recovering RMP has been slow to pioneer into historic winter habitats outside the Tristate region, and its breeding distribution continues to be more restricted than in historic times.

A significant ecological alteration must be taken into account in our interpretation of the history of the RMP and of the management prescriptions that will be needed to achieve the population and distribution objectives contained in the Pacific Flyway Management Plan for RMP Trumpeter Swans (Subcommittee on RMP Trumpeter Swans 1998). The flow regime of the Henry's Fork of the Snake River was modified by construction of the Island Park Reservoir Dam in 1938 (Benjamin and Van Kirk 1999). The dam's long-term operation has improved winter habitat conditions for Trumpeter Swans (USFWS and USBOR 1994).

The favorable conditions at Harriman State Park (HSP) appear to have been enhanced by nutrient and sediment loading through dam operations, and the re-establishment of consistent winter flows in the early 1970s. In general, the Henry's Fork is nutrient poor. However a tributary, Sheridan Creek, transports nutrient-rich sediments originating from the Centennial Mountain Range into Island Park Reservoir (R. Van Kirk, pers. comm.). Primary production in the reservoir also adds nutrients through decomposition and settling of dead phytoplankton. Prior to reservoir construction, the nutrient load from Sheridan Creek would have passed through the system in smaller increments that would have had minor effect on aquatic productivity (R. Van Kirk, pers. comm.). However, the reservoir accumulates large volumes of sediments over time. Periodically, sediments are flushed from the reservoir and flow through a gorge below the dam. As the river widens at HSP, the current slows and nutrient rich sediments are deposited. This substrate has enhanced production of aquatic macrophytes and may have increased their nutrient content as well. Insert Tessman Figure 1 and Figure 2

The minimum flows during winter also reduce current and lower the stage of the river in relation to historic seasonal flows, possibly increasing the area of food items accessible to waterfowl. Benjamin and Van Kirk (1999) believe winter habitat conditions could be improved by increasing the present winter flows somewhat. Finally, septic systems from a community of cabins and summer homes at the mouth of the gorge once discharged into the river and undoubtedly added to the nutrient load. However, the community was hooked to a sewage line in the 1980s.

Prior to the early 1970s, winter flows from the dam were highly variable, often little or no discharge was released after 15 November (Benjamin and Van Kirk 1999). A change in dam operation in the early 1970s provided more consistent minimum flows through the winter period which, in concert with the nutrient rich sediment deposits at HSP, created a favorable feeding area for swans in the winter period. The area has also been closed to hunting and snowmobile disturbance further enhancing its attractiveness to waterfowl.

Human-created habitats have altered the distribution of many waterfowl species since the advent of mechanized agriculture, irrigation projects, large impoundments, and wildlife refuges. The winter feeding program at Red Rock Lakes and the flow alteration in the Henry's Fork have existed more or less throughout the recovery of the RMP. This does not mean those habitat alterations were bad or wrong. The motive for feeding at Red Rock Lakes was to prevent the extirpation of a species that was seriously threatened at the time, and society had no knowledge about the future effect of Island Park Dam during the era it was constructed. However, the birds have now developed a tradition of wintering on the Henry's Fork, and a few other suitable habitats within the Tristate region, which comprise a comparatively small percent of the historic distribution. A limited number of birds are known to winter outside the Tristate in Utah, Nevada, and California. The number migrating to those historic winter habitats does not appear to have increased commensurately with the recovery of the RMP, although data are sketchy. Several marked swans have been observed during fall migration each year, but are not seen in the Tristate region during winter months (Shea and Drewien 1999a). Stackhouse (1998 memo to Pacific Flyway RMP Subcommittee) indicated he has documented several Trumpeter Swans at Bear River Migratory Bird Refuge, Utah, during spring migrations since 1990.

IDENTIFICATION OF MANAGEMENT PROBLEMS

The PFSC recognizes that members of the conservation community and state and federal agency biologists have differing viewpoints about management issues for RMP Trumpeter Swans. However, in the absence of substantive documentation, the issues are really hypotheses, rather than problem statements, about what is wrong and what might be needed to fix it.

The PFSC believes the primary issues related to Trumpeter Swan management have been defined by conservation interests. Our interpretation of these issues is extracted from discussions in Shea and Drewien (1994, 1999a, 1999b). We have formulated the issues as questions rather than statements, because they are key points for discussion. They include:

1) How much risk to the population is inherent in the current winter distribution of the Canadian and Tristate segments of the RMP? Do we agree on the level of risk?

2) What are the most optimum management strategies needed to effectively address the risk and with what degree of urgency should those strategies be pursued? Do we agree on the best management strategies?

3) Is a winter translocation program an effective strategy in terms of developing alternative migration patterns outside the Tristate area?

4) Is incidental take of Trumpeter Swans during Tundra Swan (*C. columbianus*) hunts a significant impediment to range expansion through either natural pioneering behavior or translocation programs?

5) Can conflicts among resource users be avoided or minimized in an effective program to expand the range of RMP Trumpeter Swans?

6) Is the success of range expansion programs for the RMP contingent upon making swan restoration a dominant use of Bear River Refuge (Utah) and other National Wildlife Refuges?

The PFSC has made the following considerations in its evaluation of these management issues:

1) The Study Committee believes the RMP should be managed primarily as a single population with two breeding segments. The management plan for RMP Trumpeter Swans (Subcommittee on RMP Trumpeter Swans 1998) treats the Canadian and Tristate segments as one population. Some evidence suggesting possible interchange does exist. For example, a neck-collared yearling Canadian swan summered at Beula Lake in Yellowstone National Park in the late 1980s (David Lockman, pers. comm.). One instance of possible pairing was also reported by Shea and Drewien (1999a). Given these observations were based upon a small minority of marked Canadian swans, it is probable additional interchange has occurred.

2) The RMP has increased consistently since 1972 (Subcommittee on RMP Trumpeter Swans 1998). This increase has persisted despite high "missing" and mortality rates associated with a winter translocation program from 1990 through 1995 (Shea and Drewien 1999a).

3) Based on September surveys, the number of adults in the Tristate segment was comparatively stable from the early 1950s through 1992, and its geographic distribution has increased.

4) The September 1993 count of adults in the Tristate segment declined to 60% of the 3-year average prior to termination of feeding at Red Rock Lakes, but recovered to 75% of that average by 1996-1998 (Shea and Drewien 1999a). The increase from 1993-95 also coincided with the high "missing" and mortality rates associated with ongoing swan translocations. The growth of the RMP was apparently not impacted by the cessation of feeding. This recovery suggests at least some innate capacity for adaptation.

5) The states of Idaho, Montana, Oregon, and Wyoming, along with private conservation partners, have carried out successful, ongoing programs to restore nesting swans into suitable, vacant breeding habitats. Approximately seven occupied breeding territories have been established in Wyoming through human-assisted efforts (William Long, pers. comm.), and additional territories have been established at lower elevation sites in Idaho and Oregon. Swans that were established in the Upper Green River Basin of Wyoming have also migrated to winter habitats in southern Utah, well outside the Tristate region.

6) The number of Trumpeter Swans taken incidentally by Tundra Swan hunters has been insignificant to the population and is among the smallest sources of potential mortality to migrating swans. Since 1994, 11 Trumpeter Swans (excluding research birds in Utah in 1997) have been

documented in Tundra Swan harvests in three western states (Aldrich *et al.* 1999). An extrapolation based upon reporting and crippling rates yields a worst-case estimate of 18 Trumpeter Swans harvested, or 3.6 per year. From 1991-97, 62 Trumpeter Swan mortalities in Wyoming were attributed to the following causes: powerline and fence collisions (46%); illegal shooting (10%); predation (7%); disease (2%); incidental harvest in Tundra Swan hunt zones (2%); and unknown (33%) (Wyoming Game and Fish Dept. 1998, William Long, pers. comm.). Other mortality sources can include starvation, hypothermia, oiling, poisoning, and trapping and translocation casualties.

7) The PFSC finds it unlikely that the incidental take of Trumpeter Swans during Tundra Swan hunts in Utah is a significant obstacle to growth of the population segment that migrates outside the Tristate region. On average, 953 Tundra Swans were harvested per year from 1994-98 (Trost 1999). The number of Tundra Swans that migrate through Utah during the hunting season exceeds 75,000 (Tom Aldrich, pers. comm.). Consequently, the average harvest rate is about 1.27%. If we assume the vulnerability of Trumpeter Swans is comparable to that of Tundra Swans, this would mean 1.27% of the Trumpeter Swans that move through Utah are being taken by Tundra Swan hunters. Given an average annual take of 1.74 Trumpeter Swans per year, the number of Trumpeter Swans moving through Utah would be 1.74 / 0.0127 or 137. On the other hand, making the assumption all Trumpeter Swans that migrate through Utah are taken by hunters would mean they are 79 times more vulnerable, which seems untenable. Even if trumpeters are twice as vulnerable as tundras, this would mean there are about 68 trumpeters migrating through Utah during the Tundra Swan season, and they are incurring a 2.5% mortality rate due to incidental harvest.

8) The Tristate range expansion project evaluated by Shea and Drewien (1999a) documented high rates of attrition among winter-translocated swans. By the end of the study, 18% (199) were known dead, 52% (587) were missing (including substantial neckband loss) and 12% (131) continued to winter in the Tristate area (an undesirable migration pattern). Approximately 5% were documented to establish desirable migration patterns that persisted for at least 2 years. Fort Hall, the site with the best conditions, also sustained a low rate of return migrations that persisted at least 2 years (7.6%). The authors advocate use of juvenile swans to improve success (Shea and Drewien 1999b), but their evaluation did not provide any data regarding the numbers of juveniles (or yearlings) that persisted in desirable migration patterns to at least age 4, when Trumpeter Swans are known to reproduce successfully (Banko 1960). While noting the authors' criticisms about the poor quality and lack of adequate security at release sites, the PFSC believes winter translocations are very expensive, are associated with a very high rate of swan mortality, and, therefore, have a low prospect for success.

9) Bear River NWR, advocated as a crucial link for developing an expanded winter distribution for the RMP (Shea and Drewien 1994, 1999a, 1999b), does not contain substantial winter habitat for swans (Tom Aldrich, pers. comm.). It is primarily a migration staging area. The refuge typically freezes by 1 December. Available swan habitat is restricted to small areas of open water associated with current flowing through culverts in the dike system. Most of these are vulnerable to freezing in a severe winter. Therefore, a translocation to Bear River Refuge is complicated by the immediate need to link with other down range winter habitats in order to be successful.

10) The state of Wyoming, and to a lesser degree Idaho, have expressed concerns about capturing swans on Tristate wintering areas for use in translocation projects. Given the lower overall productivity of swans within the Tristate segment, accidental removal of one or both members of an experienced, successful breeding pair could significantly impact recruitment. Some swan managers consider the sedentary behavior of the Tristate segment maladaptive and advocate replacement of those birds with birds from stocks that express more vigorous migratory behavior. However, the Wyoming Game and Fish Department has established a management program that accepts only birds of appropriate genetic history for augmentation and range expansion of the resident breeding population (Oakleaf *et al.* 1996).

ANALYSIS

There are two hypotheses regarding what might happen to the RMP and to the Tristate segment in a severe winter. Both hypotheses presume mortality will increase. One hypothesis views climatic events and competition as ecological stressors that increase dispersal and pioneering behavior. As the RMP continues to grow and is subjected to winter conditions of varying severity, managers will have the opportunity to monitor how the population responds over time to the influences of these stressors. Selection will favor birds with fitness characteristics, including migration behavior, that enable them to make the most effective use of available resources. The second hypothesis presumes there is a high risk of catastrophic loss, because the majority of birds may not disperse into more favorable winter habitats in response to severe weather and competition. This hypothesis advocates aggressive intervention by managers to develop alternative migratory behavior within a segment of the population in order to enhance its survival during severe winters.

Through various ongoing management efforts, the RMP has increased and become more broadly distributed. However, the forecast of a catastrophic die-off, one that threatens the viability of the population, must be viewed as conjectural. The PFSC supports reasonable, cost-effective strategies to facilitate range expansion for the RMP. In view of management alternatives that appear to be making progress, the PFSC is reluctant to support specific, aggressive strategies that create user conflicts, are costly, or have a limited track record of success.

The PFSC does not believe the level of risk inherent at this time warrants drastic alterations of management programs at Bear River or other National Wildlife Refuges, or alterations of the Tundra Swan hunt programs throughout the western states. Swans that pioneer or disperse through natural, ecological mechanisms exhibit a fitness that is highly beneficial to the population. Accordingly, the PFSC supports an integrated approach of proven, effective techniques to achieve summer and winter range expansion, at the same time allowing the harvest quota system to work, and continuing to monitor the RMP as it grows and increases its distribution through both natural and human-assisted dispersal.

CONCLUSION AND RECOMMENDATIONS

The greatest single obstacle to swan range expansion is a lack of agreement on priorities among the Pacific Flyway member states and swan advocacy groups. The PFSC most certainly supports restoration of healthy Trumpeter Swan populations into suitable habitats that remain within the species' historic range. That ultimately is the objective of the conservation community also. However, the PFSC represents a broader cross-section of resource users and we must carefully balance the necessity and urgency of specific management recommendations with the needs of all resource users.

There is substantial consensus among the PFSC member states that we can move forward into a more cooperative, consensus-driven program for restoration of Trumpeter Swans. One alternative worth considering is an expanded program to introduce Trumpeter Swans into vacant breeding habitats. This program has been highly successful in Wyoming, Idaho, and Oregon, and also has produced migrations to alternative winter habitats outside the Tristate. With assurances that the inevitable short-term setbacks that may be encountered in such a program will not generate renewed calls to drastically alter state and federal management programs affecting other users, the PFSC believes this partnership approach has considerable merit and prospect for success.

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ROCKY MOUNTAIN TRUMPETER SWANS: CURRENT VULNERABILITY AND RESTORATION POTENTIAL

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INTRODUCTION

Throughout most of the 20th century, wildlife managers in the United States and Canada have worked to restore Rocky Mountain Trumpeters Swans from near extinction. However, despite current increased numbers and distribution, the swans remain vulnerable to high winter mortality that could erase decades of restoration progress. This paper discusses the current status, vulnerability, and potential for improving the security of U.S. and Canadian breeding populations.

Management and Biological Populations

For management purposes, the U.S. Fish and Wildlife Service (USFWS) recognizes three populations of Trumpeter Swans in North America: the Pacific Coast Population (PCP), the Rocky Mountain Population (RMP), and the Interior Population (IP) (Trost *et al.* 2000). The RMP has been defined to include most nesting flocks in western Canada (except those in the western Yukon Territory) and all nesting flocks in the western U.S. (USFWS 1986, 1994, 1996). The USFWS has not addressed the question of what biological populations should be recognized, based upon reproductive isolation or genetic differences.

Gale *et al.* (1987) concluded that the RMP contains at least two distinct reproductively isolated biological populations that share a common wintering area in the Tristate region of southwest Montana, eastern Idaho, and western Wyoming. Shea and Drewien (1999) suggested these breeding groups be referred to as the Western Canada Population and the Greater Yellowstone (or Tristate) Population. Based upon over 50 years of marking data, they found no evidence of successful interbreeding between these two populations. The small restoration flocks in Oregon and Nevada also appear to be reproductively isolated from each other, and disjunct from the two primary populations. The relationship between the Western Canada Population and the PCP is unclear; marking is needed to clarify population affiliation of trumpeters that summer in western and central Yukon Territory.

SURVEYS AND RECENT TRENDS

Entire RMP

Although U.S. nesting areas are surveyed annually in September, the Western Canada Population (and thus the entire RMP) is censused only every 5 years, during the summer Rangewide Survey (USFWS 1986, 1994, 1996). In 1985, the first complete RMP survey (USFWS 1986) counted 1,111 trumpeters and the most recent survey, in 1995, estimated 2,517 (USFWS 1996). Even though survey methods changed from direct counts to estimates in the Yukon and northern British Columbia, (James Hawkings, Canadian Wildlife Service, pers. comm.), the 5-year Rangewide Surveys indicate that the RMP more than doubled from 1985 to 1995.

Managers also use winter aerial surveys of the Tristate area, augmented by ground counts at a few sites, to annually monitor RMP trend (Pacific Flyway 1998). All swans counted during the survey are defined to be RMP trumpeters and the abundance of Canadian migrants is estimated by subtracting the previous September count of U.S. trumpeters from the Midwinter Survey total. Such interpretation of the data is problematic, however, because an unknown number of PCP trumpeters also visit the Tristate area and small numbers of Tundra Swans (*C. columbianus*) are frequently in the survey area in mixed flocks.

A December 1997 observation near Rexburg, Idaho, (Stephen Bouffard, USFWS, pers. comm.) of a trumpeter marked as a local cygnet at Tetlin NWR, Alaska, confirmed that PCP trumpeters have reached the Tristate region. Few PCP trumpeters have been recently marked, however, and managers have no way to estimate their total abundance in the Midwinter Survey area or to detect future changes. Migrants from the PCP could easily increase in the Tristate wintering area as the PCP breeding distribution expands eastward into the Yukon.

In 1986, 1991, and 1996, winter surveys of the Tristate area consistently found 400-450 more trumpeters than could be found during the previous summer rangewide surveys, and marked Alaskan trumpeters were observed in fall at Grande Prairie, Alberta, and Kooskia, Idaho, in the 1990s. As early as 1986, biologists suggested that some PCP trumpeters might be wintering in the Tristate area and inflating the winter count (McEneaney *et al.* 1986, Gale *et al.* 1987).

To reliably monitor the future trend of the Western Canada Population (and thus the total RMP), managers will need to further refine summer survey methods in Canada, where population affiliation can be determined with certainty. Summer surveys will also eliminate the problem of having to distinguish between Trumpeter and Tundra Swans during winter surveys, particularly in eastern Idaho.

The Midwinter Survey will continue to be useful to assess total swan abundance in the Tristate region and detect changing patterns of winter habitat use. If a future summer RMP survey finds more trumpeters than can be found in the Tristate wintering area, managers will also gain indirect evidence of RMP dispersal to additional wintering areas, even if their location is unknown.

Biological Populations

The two biological populations exhibit strongly contrasting trends, which are masked when they are lumped into one "management" population. The Western Canadian Population more than tripled from 604 swans in 1985 to an estimated 2,076 in 1995, while the Greater Yellowstone Population declined approximately 28%, from 507 swans in 1985 to 364 in 1995 (USFWS 1986, 1996). Annual cygnet production is highly variable and mortality of cygnets during their first winter can exceed 40% (Turner and Mackay 1982, Lockman *et al.* 1987). Thus, the trend of adults (white birds) provides a more meaningful measure of population trend than total numbers (adults plus fall cygnets).

Greater Yellowstone Population - After reaching peak levels in the 1960s, adults declined from 539 in 1965 to 331 in 1986 (Figure 1). This decline triggered substantial management concern and an intensive effort to identify causes (Gale *et al.* 1987, Ball *et al.* 2000). In 1986-89, the adult segment rebounded strongly, coincident with management changes to correct habitat problems at Red Rock Lakes (RRLNWR), increased winter feeding, and warmer, drier weather. Although adult numbers were similar in 1965 and 1989, the population was certainly not stable during that period. The rebound in 1986-89 was the direct result of milder weather and intensive management intervention to halt the decline.

Following that rebound, Greater Yellowstone adults again declined from 505 in 1989 to 248 in 1993. Approximately 45% of this decline (115 adults) occurred in 1989-1992 and was associated with translocations to potential nesting areas in Wyoming, Idaho, and Oregon to broaden population distribution and reduce possible mortality during the planned termination of winter feeding at RRLNWR. Despite this effort, during winter 1992-93 when supplemental feeding was terminated, the adult component lost an additional 142 birds and declined to the lowest level since 1946 (Shea and Drewien 1999).

High cygnet production and over-winter survival in 1994 helped the adult segment increase to slightly over 300 in 1995. However, unlike the rebound of the late 1980s, Greater Yellowstone adults have failed to increase since 1995, despite fledging 318 cygnets in 1995-99. There has been no evidence that Greater Yellowstone trumpeters are emigrating outside the survey area. Productivity has apparently not been adequate to exceed mortality, even though winters were exceptionally mild throughout these years and cygnets averaged 17.0% of the fall population.

WINTER SEVERITY AND VULNERABILITY

As the RMP declined to near-extinction by 1900, its migrations and use of diverse wintering areas were severely reduced and winter distribution became restricted almost entirely to the Tristate area (Banko 1960, Gale *et al.* 1987). During the 1990s, neckband sightings showed that most of the RMP wintered in the Tristate region at sites that will freeze during a severe winter. Although Greater Yellowstone as well as Western Canadian trumpeters have attempted to migrate south of Idaho, there is no evidence that they have been able to establish regular use of more southerly habitat. Consequently, despite its recent growth, most RMP trumpeters remain vulnerable to high mortality in the Tristate area during a severe winter (Pacific Flyway 1998, Shea and Drewien 1999, Schmidt 2000).

Gale *et al.* (1987) found that annual mortality of the Canadian trumpeters was strongly ($P<0.0001$) correlated with winter severity in the Tristate region. In contrast, annual mortality of the resident population was significantly correlated with the amount of grain fed at RRLNWR ($P< 0.02$) and the extent of ice-free water (and thus available macrophytes) in the Henry's Fork River, Idaho, below Island Park Dam ($P<0.01$), but not with winter severity ($P<0.83$). Their analysis concluded that during 1935-86, the resident swans had been substantially buffered from the impacts of winter severity by their heavy use of the supplemental grain and Henry's Fork habitat. In contrast, the Canadian swans made little use of the grain prior to 1986, were more widely distributed throughout the Tristate area, and were much more vulnerable to winter severity.

That situation has changed dramatically in recent years. Supplemental feeding has been terminated (1992), vegetation has declined in the Henry's Fork (1990), and swans have been hazed to reduce waterfowl use of the Henry's Fork (1990-99). The two key food sources that reduced the vulnerability of the Greater Yellowstone Population to winter severity during the first 5 decades of its recovery have recently been reduced or eliminated. Without these food sources, winter severity will have a much greater impact on the future survival of this population if they do not establish use of milder winter habitat. The recent growth of the Western Canada Population may also be causing increased competition for the limited available winter food and heightening the vulnerability of both populations.

The continued increase of wintering swans in the Tristate area has been possible because recent winters have been extraordinarily mild. A Winter Severity Index (WSI) was created by first calculating a monthly severity index (= 32^{o}F - monthly mean temperature) for each month (November–March) at Island Park, Idaho. The 5 monthly indices for November-March were summed to create a WSI for each year, 1937-1998. For the 62 years of record, WSIs ranged from 31.91 in 1939 (warmest) to 97.23 in 1978 (coldest). The mean WSI in 1990-98 (51.9) was significantly warmer ($P <0.01$) than the mean in 1937-89 (63.8). Five winters in the 1990s had indices <50.0; only 3 winters in the previous 53 years were as mild. (Figure 2).

During the 1990s, only the winter of 1992-93 was colder than the long-term average (WSI=70.61). During that winter, feeding also was terminated, and the Greater Yellowstone Population declined from 482 adults and cygnets in September 1992 to 248 adults the subsequent summer. Approximately 48% of the fall population was lost in 1 year, and their distribution has not improved substantially since then.

Managers should not be lulled into complacency by the recent series of mild winters or underestimate the continued vulnerability of the Greater Yellowstone Population. During 1937-89, 28% of all winters were more severe than Winter 1992-93. Without access to supplemental feeding and with reduced vegetation in the Henry's Fork, a return to pre-1990 weather patterns will devastate the Greater Yellowstone trumpeters and substantially increase mortality of the Western Canada Population if they do not establish secure use of milder winter habitat.

OTHER MANAGEMENT CONCERNS

The vulnerability of the Greater Yellowstone Population is furthered increased by deteriorating habitat quality and loss of nesting territories. Although vacant breeding habitat currently exists due to the decline in breeding pairs, loss of historic territories diminishes restoration potential. Recreational fishing and increasing human activity have destroyed the suitability of several territories in recent years. Nesting attempts have expanded in lower elevations of Idaho since 1990, but human activity, habitat problems, lead poisoning, and other unknown factors have reduced productivity at many territories.

Particularly acute problems exist at Grays Lake and Camas National Wildlife Refuges. Inadequate water and habitat deterioration at Grays Lake has effectively turned the refuge into a “black hole” or “sink habitat” (Pulliam 1988), which attracts about one-third of Idaho’s nesting pairs, but provides inadequate habitat for cygnet survival to fledging. At Camas NWR, strong cygnet production in the early 1990s has ceased and total nest failure, due to unknown causes, has become routine.

In addition to specific problems at certain nesting territories, productivity of the Greater Yellowstone Population appears to be depressed by lack of adequate spring pre-breeding habitat. Poor pre-breeding nutrition is suspected to contribute to reduced clutch size, cygnet hatching, and cygnet survival, particularly in cold, late springs (Spring Nutrition Hypothesis) (Gale *et al*. 1987).

RESTORATION POTENTIAL

Vulnerability of the RMP to winter mortality can be reduced and productivity of the Greater Yellowstone Population can be improved by 1) establishing secure use of diverse and more productive winter and early spring habitat, and 2) correcting problems at specific nesting territories.

To improve the security of the Greater Yellowstone Population, it is not sufficient to merely establish new nesting flocks elsewhere in the Pacific Flyway. It is crucial that restoration efforts expand distribution in a manner that allows adults to remain part of the breeding population, and not become so widely scattered that they become reproductively isolated from the swans nesting in the Tristate area. This potential pitfall has been illustrated by past efforts to establish new breeding flocks in the western U.S. (e.g. Malheur NWR, Ruby Lakes NWR, Turnbull NWR, Summer Lake). By 1999, these efforts had resulted in establishment of only about 10 nesting pairs despite over 40 years of effort (USFWS 1999). These small disjunct groups show little potential for long-term viability and contribute nothing to improving the status of the Greater Yellowstone Population.

The greatest potential for expanding the distribution of the Greater Yellowstone Population, continuous with their current distribution, lies within the 10 units of the National Wildlife Refuge system in southeast Idaho, south west Wyoming, and northern Utah (Figure 3.). These areas could all provide potential nesting habitat. Most also could provide significant fall habitat and security during the waterfowl hunting season. Seedskadee NWR, on Wyoming’s Green River, can provide additional habitat in most winters and serve as a migration stopover for swans moving along this river system.

Bear River Refuge, in the delta of the Bear River at the northeast edge of the Great Salt Lake, contains vast acreages of sego pondweed beds (Engelhardt 1997) and is less than 150 miles from current winter concentration areas. Bones in ancient Indian camps and observations during the early 20th Century confirm its past use by trumpeters (Shea and Drewien 1999). This NWR could provide additional nesting habitat for Greater Yellowstone trumpeters in close proximity to nesting areas in southeast Idaho. Additionally, it could provide spring/fall migration habitat for both populations. Potentially, it could become the major fall migration staging area for trumpeters moving south of Idaho, and provide excellent food and security during the waterfowl hunting season.

In many years trumpeters could also winter in and near the Refuge with the thousands of Tundra Swans (*C. columbianus*) that are frequently found there during USFWS Midwinter Waterfowl Surveys (Drut and Trost 2000). Although its winters are milder than in the Tristate region, in severe winters freshwater in the Refuge vicinity substantially freezes. Trumpeters would then have to utilize endogenous reserves during severe weather, feed on plants and invertebrates such as brine shrimp in nearby brackish waters, or move with other waterfowl to ice-free streams and wetlands further south in Utah, adjacent states, or California. Fortunately, the massive trumpeters are better adapted to utilize endogenous reserves for survival, if they enter stress periods well-nourished (Gale *et al.* 1987).

To achieve its potential in RMP restoration, however, changes in Refuge management priorities are needed. During the past decade, emphasis on Tundra Swan hunting on the Refuge prevented its effective use in range expansion efforts (Shea and Drewien 1999). Although the Refuge contains rest areas, their food quality is inferior and swan hunting is concentrated in units that contain the best food. Trumpeters are vulnerable to harvest when they leave rest units to forage in hunt units (Engelhardt 1997).

Because of potential conflicts with the swan hunt, trumpeter reintroductions to Bear River Refuge have so far been limited to a controversial research project that attempted to study their mortality during the hunt (Englehardt 1997). Past USFWS efforts to increase southward migration to Utah have primarily tried to divert trumpeters away from the Great Salt Lake swan hunt area, resulting in translocations to much less suitable habitat, such as Fish Springs NWR (Shea and Drewien 1999).

To reduce the vulnerability of RMP trumpeters, restoration efforts should focus on:

1) expanding the breeding distribution of the Greater Yellowstone Population in nearby areas where adults will not become isolated from the breeding population. Good potential exists on NWR habitat in western Wyoming, southern Idaho, and northern Utah (Figure 3).

2) increasing the productivity of Greater Yellowstone trumpeters by correcting habitat problems at specific territories. Particular emphasis should focus at Grays Lake NWR, due to its potential to support numerous pairs and proximity to more southerly winter habitat.

3) augmenting the Greater Yellowstone Population by salvaging eggs and cygnets that would otherwise be lost, captive rearing to yearlings, and releasing in target habitat in spring after northern migrant trumpeters have departed. Best release sites would be on NWRs and private lands in the southern portion of the suggested restoration areas (Figure 3) where swans can find dependable food and security and gradually explore beyond the Refuges.

4) expanding the winter distribution of the both the Greater Yellowstone and Western Canada populations by reestablishing use of the vast sego pondweed beds of northern Utah, and other smaller sites in southern Idaho, Utah and southwest Wyoming. As Greater Yellowstone trumpeters become familiar with more southerly habitats, they will serve as decoys for other migrant trumpeters.

5) encouraging southward pioneering by Western Canada trumpeters by annually capturing 20-50 cygnets at Harriman State Park in a one-week night-lighting effort, and releasing them among established decoy trumpeters in extreme southern Idaho and northern Utah, at sites where the birds will have good food and security from disturbance.

Managers can do little to reduce the concentration of swans using marginal winter habitat in the Tristate region or prevent their mortality in severe winters. Rather, the key to improving the security of the RMP is to increase the number of swans, particularly from the more vulnerable Greater Yellowstone Population, that winter securely outside the high-risk area. This can most realistically be accomplished by broadening their distribution southward through southeast Idaho and southwest Wyoming to the rich food resources of Utah's Bear River Delta to increase their winter habitat options or to fuel further dispersal.

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PERSPECTIVES OF THE TRUMPETER SWAN SOCIETY ON MANAGEMENT OF THE ROCKY MOUNTAIN POPULATION OF TRUMPETER SWANS

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The members of The Trumpeter Swan Society (TTSS) have listened to the arguments for and against Trumpeter Swan winter range expansion in the Rockies for over a decade, and we are frustrated. We are frustrated, because the situation is not much better today than it was 10 years ago. Certainly there are more Canadian Trumpeter Swans now, but their status is still precarious. Increasing numbers are stacking up in marginal habitat in eastern Idaho. Having more swans in a high-risk area does not make the population more secure. There is little evidence that any significant number of trumpeters is wintering outside the Tristate Region. Progress has been made in expanding the distribution of U.S. nesting flocks, but their numbers are very low and their winter distribution remains vulnerable.

This is the last year of a 5-year agreement on what we thought was supposed to be an experiment to evaluate the potential for moving trumpeters to the Great Salt Lake Basin. The project fell apart and there are persistent hard feelings as a result. The reasons vary depending upon whom you ask. The fact that the picture is so muddy points out the need for an open planning and review process.

Meanwhile, the situation has become increasingly precarious in the Tristate wintering area. Compared to a decade ago, winter feeding has been discontinued at Red Rock Lakes National Wildlife Refuge, and aquatic food resources have declined at Harriman State Park (although conditions improved in 1999), and appear to have declined at Teton Basin, while the number of wintering swans has increased. Wintering trumpeters have not suffered a catastrophic die-off yet in the Tristate Region, but only because the last decade has been one of the warmest on record and ice has been minimal.

Obviously we are dealing with complex biological problems, which are made more complex by over-riding political problems associated with Tundra Swan hunting. Swan managers can't guarantee that getting some of the Rocky Mountain Population (RMP) trumpeters to migrate to Utah will be the salvation of the population. However, we need to assess the role the Great Salt Lake Basin can play in the management of the RMP. However, this is made more difficult with continued Tundra Swan hunting, and the suspension imposed on the movement of trumpeters.

We keep hearing the argument that the Trumpeter Swan harvest in Utah is so small that it is insignificant relative to the overall population of trumpeters in the RMP. However, this comparison is meaningless. The number of trumpeters harvested must be compared to the total number of swans migrating to Utah, which is also very small. With this comparison, the harvest is very significant. Some way has to be found to allow these few migrants to survive long enough to start to develop a significant tradition, so that the value of the Great Salt Lake Basin can be assessed for trumpeters.

Based on decades of observation, TTSS believes that due to several behavioral and physical factors, trumpeters would be shot in a higher proportion than their numbers in a mixed flock if they were present in areas open to Tundra Swan hunting. TTSS has contended for years that trumpeters must be separated spatially or temporally from Tundra Swan hunts to survive. Unfortunately, Utah's solution has been to separate the two species spatially by keeping trumpeters out of Utah, even if that continues to risk the survival of the trumpeter population by forcing them to winter on marginal habitat elsewhere. TTSS believes that migrations southward from Idaho, and a secure winter distribution of both Canadian and Tristate trumpeters cannot be restored without rebuilding use of fall/winter habitat immediately south of Idaho in Utah. Additional changes in Tundra Swan hunting are necessary to allow effective restoration efforts to proceed and to protect trumpeters migrating southward.

TTSS questions the process by which decisions were made regarding the management of the RMP. The Pacific Flyway Council has a RMP Subcommittee, which prepares recommendations for the Study Committee and eventually the Council for the management of Trumpeter Swans. The Council functions in an advisory role to the U.S. Fish and Wildlife Service (USFWS), which has statutory authority over migratory bird management. The Subcommittee consists primarily of state waterfowl managers, who manage their state waterfowl hunting seasons and some wetland resources to provide for wildlife and hunting opportunities. The state representatives are knowledgeable and dedicated and do an excellent job managing resources for hunting, but to us, some of them have a very obvious conflict of interest when it comes to swan management, which may affect hunting.

Although Flyway meetings are open to the public, they are not announced widely outside of waterfowl hunting circles, and are poorly attended by other organizations and the public. Because of the managers' focus on hunting issues, the Subcommittee does not provide the proper open forum necessary for deciding the future of Trumpeter Swans in the RMP. There are too many stakeholders who are not included in the process, including some key Trumpeter Swan managers, other state and federal resource managers, conservation organizations, and other non-consumptive interests. While the RMP Subcommittee may be very helpful in implementing a plan, and should have input to a plan, they cannot be the only group to decide on what the plan should be if a broad perspective is desired.

The Trumpeter Swans nesting in the Tristate Region have a significance that is far greater than their numbers. From a historical perspective, this is where Trumpeter Swan management started. On a larger scale, this is where people come to see trumpeters in a natural environment. Trumpeters are expected to be a part of the Yellowstone Ecosystem. These 400-500 birds probably receive more attention and are seen by more people, who travel far to see them, than all the other Trumpeter Swans in North America.

TTSS offers the following thoughts regarding actions to help provide security for the RMP trumpeters:

1) The process for preparing management plans and the swan hunting frameworks for the RMP should be an inclusive and legal Federal decision making process that allows all interested parties to contribute and comment. The RMP trumpeters are a National treasure. As the concept plan of the North American Waterfowl Management Plan makes clear, "The tri-state subpopulation has historic and heritage values that make it one of the more important waterfowl breeding segments in the concept plan region." Obviously, based on the attendance at this conference, there are a lot of individuals and organizations interested in the management of this population of trumpeters.

2) Providing security for Trumpeter Swans in a highly variable and hostile winter environment entails providing the birds with the widest number of possible options. The more choices they have on where to spend the winter, and the more widely they are distributed, the greater the possibility of their surviving a major weather-induced catastrophe.

3) The most logical place to expand winter habitat is immediately south of Idaho, including the northern rim of the Great Salt Lake Basin, either as a final destination in mild winters or as a stepping-stone to other locations in severe winters.

4) As management strategies are developed for the 21st century, the National Wildlife Refuges should become some of the core units for winter range expansion of Trumpeter Swans. The mission of the United States Fish and Wildlife Service is "working with others, to conserve, protect and enhance fish, wildlife, and plants and their habitats for continuing benefit of the American public." Hunting, while an important recreational use of the refuges, is not the primary reason for their existence. If trumpeters cannot succeed in these refuges, which USFWS can control to a large extent, where in the Intermountain West can swans remain secure as our human populations continue to increase?

5) The Bear River Migratory Bird Refuge needs to be a central part of the National Wildlife Refuge System approach to reducing RMP vulnerability. This key refuge offers the best federally owned fall/winter habitat in the Rocky Mountain area. It is a stopping point during migration for millions of other birds, including Tundra Swans. For the past decade, Tundra Swan hunting has prevented Bear River Refuge from effectively participating in the efforts to reduce vulnerability of the RMP.

6) TTSS recommends that the USFWS close the Bear River Migratory Bird Refuge to Tundra Swan hunting, as it was for the first several decades of its existence. TTSS would prefer that Tundra Swan hunting in Utah be suspended or severely restricted for the next 5 years to allow more rigorous experimentation with trumpeters, but alternative solutions may be possible.

7) TTSS recommends that efforts be made to translocate trumpeters to the Refuge to assess their survival and fidelity to the site in

subsequent years. Various strategies, including both summer transplants of Tristate residents and fall and winter transplants of both population segments should be tried. Translocations to high-quality, secure habitat can be effective in expanding the winter distribution of trumpeters.

8) Translocations of trumpeters to Bear River Refuge will increase the possibility of trumpeters being shot on adjacent lands open to Tundra Swan hunting. Therefore, TTSS recommends that if the Refuge is closed to Tundra Swan hunting, and guarantees are in place to translocate trumpeters to the Refuge, the USFWS consider reauthorizing general swan hunting in areas that remain open to swan hunting to protect licensed hunters from liability for shooting a trumpeter. A mandatory check and registration of all swans is necessary to monitor the amount and location of Trumpeter Swan harvest. TTSS' tolerance of a general swan season should in no way be construed as an endorsement to expand swan hunting into new areas. It is meant solely to be a mechanism to remove hunter liability in the areas already open to Tundra Swan hunting.

9) The translocations, adjustments to swan seasons, and monitoring must be done as a well-documented, experimental 5-year program, which should be reviewed, evaluated, and discussed openly prior to continuation, modification, or abandonment.

10) In addition to expanding winter distribution, TTSS supports increased efforts to expand the Tristate breeding population. However, expanding the breeding population without addressing the wintering situation could make the present situation worse by putting additional pressure on limited and over-utilized winter habitat, and leave the resident swans at higher risk.

11) TTSS has concluded that suggestions to extend migration from the RMP into the Midwest are not advisable at this time. Sufficient winter habitat has not been identified to support the Interior Population of trumpeters, unless they adapt to feeding in agricultural fields.

TTSS' Board of Directors recognizes that these recommendations will not be popular with everyone, and if implemented, will require sacrifices on the part of the waterfowl hunting community in Utah. We believe these or similar steps are necessary to provide the security necessary to evaluate the potential for Trumpeter Swan range expansion into Utah, and we believe that range expansion is necessary. We welcome discussion of other options and are interested in your feedback.

INTERACTIONS AMONG WATERFOWL HERBIVORY, AQUATIC VEGETATION, FISHERIES AND FLOWS BELOW ISLAND PARK DAM, IDAHO

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ABSTRACT

We summarize the literature on the ecology of rooted aquatic plants (macrophytes) and the interactions among macrophytes, fisheries, flows and waterfowl in the Henry's Fork of the Snake River. Management of Island Park Reservoir has had significant impacts on the rainbow trout (*Oncorhynchus mykiss*) population and wintering Trumpeter Swan (*Cygnus buccinator*) numbers on the Henry's Fork. Trout and swan numbers both increased following dam management changes that increased winter flows during the 1970s. Declines in macrophyte community structure and abundance occurred throughout the 1980s and early 1990s due to increased waterfowl herbivory, low winter flows during drought years, and introduction of fine sediment into the river from drawdowns of Island Park Reservoir. Although fluctuations in the rainbow trout population cannot be tied directly to changes in the macrophyte community, the literature suggests that a robust and abundant macrophyte community benefits the fishery and associated angling opportunities through increased invertebrate abundance, water depth and trout habitat. We recommend managing Island Park Reservoir to minimize the probability of sediment transport into the river, maximize winter flows, and minimize abrupt flow increases during the spring. Furthermore, we recommend continuing the waterfowl hazing program at Harriman State Park and exploring different techniques for reducing waterfowl numbers on the Henry's Fork between Island Park Dam and Riverside during fall migration and winter.

INTRODUCTION

The Henry's Fork of the Snake River, Idaho, downstream of Island Park Dam and Reservoir supports one of the most popular rainbow trout fisheries in the United States (Van Kirk and Griffin 1997). The 15 river miles downstream of the dam include the Box Canyon, Last Chance, and Harriman State Park (HSP) reaches of the river (Figure 1), all of which have supported large amounts of angling pressure since the early 1970s (Jeppson 1973, Coon 1977, Rohrer 1983, Rohrer 1984, Angradi and Contor 1989, Van Kirk *et al.* 1999). The 9 miles of river from Last Chance to Pinehaven, including Harriman State Park, also provide important winter habitat for Trumpeter Swans (Snyder 1991, Vinson 1991, Shea *et al.* 1996). Between 1978 and 1991, the rainbow trout population declined 80 percent in Box Canyon (Figure 2), which is used as an indicator reach for the larger stretch from Island Park Dam to Riverside. Meanwhile, the number of Trumpeter Swans wintering between Island Park Dam and Pinehaven increased by a factor of four between 1972 and 1990 (Figure 3). During the winter of 1988-89, a large number of Trumpeter Swans died on the Henry's Fork as a result of cold temperatures and low flow releases from Island Park Dam (Vinson 1992). The following winter saw record numbers of trumpeters wintering on the Henry's Fork, which resulted in a severe decline in the abundance of macrophytes in the river between Last Chance and Pinehaven (Vinson 1992, Shea *et al.* 1996). Low flows and loss of macrophyte cover have been associated with poor over-winter survival of age-zero juvenile rainbow trout in the Henry's Fork below Island Park Dam (Griffith and Smith 1995), illustrating that management of swans, fisheries, and flows are inter-related in this reach of river. The common thread that ties these management issues together is the macrophyte community.

ECOLOGICAL ROLE OF MACROPHYTES AND THEIR IMPORTANCE TO TROUT

Macrophytes play an important ecological role in low-gradient streams such as the Henry's Fork between Last Chance and Pinehaven. In streams of the mid- to high-latitude regions of the world, seasonal variations in sunlight availability and discharge determine the growth potential of

macrophytes, which, in turn, affect trophic mechanisms, physical habitat characteristics, and flow hydraulics in the stream. Herbivory on macrophytes by a variety of vertebrates and invertebrates generally follows the seasonal growth patterns dictated by light and discharge and can have a significant impact on the characteristics of the macrophyte community. The greatest growth of macrophytes occurs during the late spring and early summer, when sunlight availability is greatest (Sand-Jensen *et al.* 1989). Maximum biomass generally occurs during summer or early fall and then decreases throughout fall and winter as the above-substrate portions of plants senesce. On the Henry's Fork, maximum biomass occurs in October (Angradi 1991, Vinson *et al.* 1992), and minimum biomass occurs in February or March (Angradi 1991, Vinson 1991, Griffith and Smith 1995).

As sunlight increases in the spring, new growth begins from tubers or rhizomes buried in the stream bottom. However, as flows increase during the spring, growth may be inhibited by decreased light availability due to turbid conditions (Sand-Jensen *et al.* 1989) or by bed scour (Shea *et al.* 1996). French and Chambers (1997) found that reducing summer flow velocity in the low-gradient reaches of a British Columbia stream increased macrophyte growth. The greatest increase in macrophyte growth to reduction in velocity occurred between channel speeds of 0.4 to 0.8 m/s. Vinson *et al.* (1992) measured velocities ranging from 0.30 to 0.40 m/s in the HSP section of the Henry's Fork during March 1990, during which time flows ranged from 431-554 cfs. Flows generally increase from March through May or June (Benjamin and Van Kirk 1999), and therefore, springtime velocities in the Henry's Fork are very likely to be in the range of 0.4 to 0.8 m/s, where French and Chambers (1997) found the greatest sensitivity of macrophyte biomass to velocity.

As macrophyte biomass increases during summer months, macrophyte beds slow water velocity (Gregg and Rose 1982, Sand-Jensen and Mebus 1996), trap fine sediment (Gregg and Rose 1982, Barko *et al.* 1991), and increase habitat for macroinvertebrates and fish (Dionne and Folt 1991, Wright 1992). Although conventional wisdom for many decades held that macrophytes are rarely consumed and therefore have little importance in food webs, recent work has demonstrated that significant herbivory occurs by crayfish, snails, fish, waterfowl and invertebrates (Lodge 1991, Jacobsen and Sand-Jensen 1992). Because macrophytes obtain most of their nutrients from sediments deposited on the stream bottom, they provide a mechanism for the introduction of sediment-derived nutrients into the aquatic food web (Barko *et al.* 1991). In addition to food provided by growing plants, macrophyte-derived detritus is an important food source for invertebrates after the plants begin to senesce (Gregg and Rose 1982, Wright 1992).

In the Henry's Fork, most particulate organic matter is derived from macrophytes and algae, and seasonal increases in the availability of macrophyte-derived organic matter occur after the growing season (Angradi 1991, Angradi 1993a, Angradi 1993b). Macrophytes also provide habitat to invertebrates in the form of shelter, colonization substrate, and oviposition sites (Gregg and Rose 1982). Studies on an English chalk stream showed that macroinvertebrate abundance, biomass, and taxon richness were all significantly higher in macrophyte beds than in unvegetated substrate (Wright 1992).

In the HSP reach of the Henry's Fork, Angradi and Griffith (1990) found that invertebrates of the orders *Trichoptera* (caddis flies), *Ephemeroptera* (may flies) and *Diptera* (midges and gnats) were the most important foods of rainbow trout during the summer months. These organisms benefit from abundant macrophytes, which were found at all study sites. Vertebrates and terrestrial invertebrates, whose abundance does not depend on the macrophyte community, were rare in the diet of Henry's Fork rainbow trout.

While the importance of macrophytes in providing habitat for invertebrates is well recognized, the role of macrophytes in providing direct cover for trout in the stream environment is less clear. In warm-water ponds and streams, it has been shown that macrophytes provide cover and foraging habitat for various sunfish species (Dionne and Folt 1991, Trebitz and Nibbelink 1996). Higher macrophyte densities lead to higher invertebrate prey densities but reduce foraging success in the interior of macrophyte beds. In the lake environment, bed edges provide increased foraging opportunities because of better visibility and maneuvering ability while still providing cover for foraging fish (Trebitz and Nibbelink 1996). The direct effects of macrophytes in providing summer cover and foraging habitat for trout in the Henry's Fork have not been studied. However, evidence from other studies suggests that trout could utilize channels along bed edges as optimal locations to forage in relative security (Sand-Jensen and Mebus 1996, Trebitz and Nibbelink 1996). Anecdotal observations of anglers suggests that this is indeed true in the Henry's Fork during late summer and fall. When combined with the role of macrophyte beds in providing cover and food for macroinvertebrates, the primary food for rainbow trout in the Henry's Fork, it is likely that the presence of dense macrophyte beds in the Henry's Fork provides increased foraging opportunities for rainbow trout and associated angling opportunities during the summer and early fall.

The role of macrophytes in providing cover for juvenile trout in the Henry's Fork during the winter has been studied extensively. When water temperatures fall below approximately 48ºF, age-0 trout seek daytime cover that will completely conceal them from predators (Smith and Griffith 1994) and emerge from the cover only at night to feed (Contor and Griffith 1994). Preferred concealment cover is provided by interstitial spaces within complex arrangements of cobbles and boulders on the stream bottom (Meyer and Griffith 1997a). When this cover type is limited, as it is in the Last Chance, Harriman and Pinehaven reaches of the Henry's Fork, competition among individual age-0 trout occurs for existing concealment spaces, and thus larger individuals are more likely to survive the winter than smaller ones (Meyer and Griffith 1997b). The limited availability of winter concealment habitat for age-0 fish in the Henry's Fork below Island Park Dam results in a trout population that is limited by survival of individuals through their first winter (Mitro and Zale 1998).

Macrophyte beds sufficient in density to provide concealment cover for age-0 fish are present in the Last Chance and Harriman reaches during early winter. However, sufficient macrophytes do not persist to provide concealment cover for significant numbers of fish throughout the entire winter, at least in conditions that have existed since the winter of 1989-90 (Griffith and Smith 1995, Mitro and Zale 1998). Between October 1994 and February 1995, Idaho Department of Fish and Game personnel captured age-0 trout in the Last Chance reach using electrofishing. Sampling yielded 302 fish during the 5-month period. Although 89 percent of the trout were caught further than 2 m from the shoreline where macrophytes provided the only cover, 78 percent of the total number of trout captured were caught during October and November. Equal sampling effort later in the winter failed to yield the numbers of fish that were captured during the fall.

During subsequent winters, Mitro and Zale (1998) found that few age-0 fish survived the winter at Last Chance, and essentially none survived between Last Chance and Pinehaven. For example, an estimated 162,833 juvenile rainbow trout were present between the mouth of Box Canyon and Pinehaven in the fall of 1996, but no juvenile trout were captured in this reach during the spring of 1997 (Mitro and Zale 1998). Most juvenile trout present in these areas during the fall emigrate during mid- to late-winter as macrophyte biomass approaches its minimum. While some of these fish migrate to better winter habitat in the Box Canyon and Riverside reaches, many die or leave the Island Park to Riverside reach altogether. Although it is possible that macrophytes persisted through the winter in sufficient densities to provide juvenile trout with concealment cover prior to the macrophyte decline of 1989-90, this has certainly not been the case during the 1990s.

Shea *et al.* (1996) noted that one of the most striking changes that has occurred in the Henry's Fork macrophyte community since Winter 1989-90 is a shift in community structure from dominance by the so-called "Group 1" species (tall, robust erect species that thrive in low velocity, silt-rich environments (*Potamogeton pectinatus, P. richardsonii, Elodea canadensis,* and *Myriophyllum exalbescens*)), to dominance by "Group 2" species (shorter, bottom-dwelling species more tolerant of higher water velocities and capable of colonizing disturbed sites (*Callitriche hermaphroditica, Ranunculus aquatilis* and *Zannichellia palustris*). Group 1 species *Elodea canadensi,* and *Myriophyllum exalbescens* are generally capable of persisting in greater densities throughout the winter, and, because of their growth forms, have a greater ability to slow current velocities and provide concealment cover.

This shift in community dominance provides additional evidence that prior to Winter 1989-90, macrophytes could have provided winter concealment cover for age-0 trout, and subsequent loss of this cover type may have resulted in lower recruitment of rainbow trout into the Island Park to Riverside population. However, Van Kirk and Gamblin (1999) provide evidence that decline in the Henry's Fork rainbow trout population between 1978 and 1991 was tied more to loss of recruitment from hatchery sources and Island Park Reservoir than to declines in recruitment of wild fish. It is clear that despite modest recovery in the Henry's Fork macrophyte community since 1989-90 (Shea 1996), macrophytes currently do not provide winter concealment cover for age-0 rainbow trout between Last Chance and Pinehaven. This results in a situation in which all juvenile fish recruited into the population from Island Park Dam to Riverside winter either in Box Canyon or between Pinehaven and Riverside, where cobble-boulder substrate and sufficient woody debris are present (Mitro and Zale 1998).

FLOW MANAGEMENT AT ISLAND PARK DAM

Flows in the Henry's Fork have been regulated by Island Park Dam since 1938. The hydrologic impacts of regulation and suggestions for improved dam management are discussed in Benjamin and Van Kirk (1999) and summarized here. Island Park Reservoir provides 135,000 acre-feet of storage for the Fremont-Madison Irrigation District. Prior to 1972, the reservoir was usually filled by reducing flows to near zero on November 15 and increasing them when the reservoir was nearly full in February or March. Under zero-flow conditions at Island Park Dam, the only discharge into the Henry's Fork in Box Canyon is provided by the Buffalo River, a spring-fed tributary with a winter flow of approximately 200 cubic feet per second (cfs) (Figure 1).

This management regime resulted in winter flows below the dam (above the Buffalo River) averaging 200 cfs, compared to a reservoir inflow (unregulated flow) of approximately 450 cfs. Furthermore, the pre-1972 management regime allowed significant increases in winter discharge over short periods of time to satisfy peak power demands downstream. Coefficients of variation in winter flows at Island Park were nearly an order of magnitude greater under the pre-1972 management regime than those observed in the relatively constant, spring-fed natural flow regime of the upper Henry's Fork.

Beginning in 1972, dam operations changed in response to hydroelectric needs downstream, resulting in winter flows averaging approximately 300 cfs above the Buffalo River. Higher winter flows under the modern flow regime are obtained in large part by commencing storage on 1 October rather than 15 November, as stipulated under the pre-1972 management protocol, thereby increasing the length of time over which the reservoir is filled. Reservoir storage that occurs prior to 15 November is termed "adverse storage," and is allowed by a formal agreement signed in 1984 by the Fremont Madison Irrigation District, the U. S. Bureau of Reclamation, Utah Power and Light, and the City of Idaho Falls, Idaho.

It is likely that improved winter flows at Island Park Dam allowed wintering Trumpeter Swan numbers to increase throughout the 1970s and 1980s (Figure 3). On the one hand, this increase in winter habitat allowed the Rocky Mountain Population to increase. However, during drought years such as 1988-89, winter flows out of Island Park Dam approached zero, and mortality of wintering swans increased as ice formation in the Henry's Fork increased.

The largest discrepancy between the managed and natural flow regimes at Island Park Dam is the decrease in winter flows under the managed regime. Low winter flows have two major impacts on wintering swans. If air temperatures are relatively mild and the river does not freeze, low winter flows reduce the amount of foraging habitat available to swans where dewatering occurs (Vinson 1991), but allow greater access to macrophytes in areas where water is present (Shea *et al.* 1996). When air temperatures are very cold, as occurred during the winter of 1988-89, the river can freeze, and wintering swans and other waterfowl lose access to the macrophyte food source. Furthermore, Vinson (1991) and Vinson *et al.* (1992) showed that under a given discharge, the amount of wetted habitat available to both fish and swans is greatly increased by the presence of abundant macrophytes due to the ability of dense macrophyte beds to slow current velocities and occupy volume in the stream channel. Vinson (1991) recommended a minimum discharge of 500 cfs below the Buffalo River and an optimum discharge of 700 cfs for maintenance of winter Trumpeter Swan habitat.

Benjamin and Van Kirk (1999) showed that under the constraints of fulfilling water rights, a winter discharge of 300 cfs at Island Park (equivalent to 500 cfs below the Buffalo) is attainable only during years when the reservoir is nearly full at the beginning of storage season. Flow in the range of 500 cfs at the dam (700 cfs below the Buffalo) exceed inflow during all but the wettest years and are therefore unattainable except during very wet years when the reservoir is essentially full at the beginning of storage season. Benjamin and Van Kirk (1999) recommended that to achieve maximum winter flows at Island Park Dam, the fill date target be designated as 1 May rather than 1 April as has been historical practice. This shift would allow a greater percent of the reservoir to be filled by higher springtime flows than by winter base flow. Additionally, this strategy results in slightly lower and more consistent flows during the springtime when new macrophyte growth is occurring.

In general, a flow regime at Island Park that results in higher winter flows and more consistent springtime flows will benefit the macrophyte community. Higher flows during the fall and early winter deter swans and other waterfowl from staying on the

Henry's Fork to winter, since access to macrophytes is more limited under high flows. Over the long term, fewer waterfowl wintering on the Henry's Fork will result in a more robust macrophyte community and in a lower probability of high winter mortality among wintering waterfowl in the event of an extremely cold winter. Higher winter flows also reduce the formation of anchor ice, which can cause considerable damage to macrophytes. Lower and more stable flows during the spring benefit the macrophyte community, particularly the Group 1 species, by reducing scouring and allowing new growth to become established.

From a fisheries perspective, the observation that age-0 trout begin requiring concealment cover when water temperatures drop below 48ºF early in the fall suggests that higher flows during the fall and early winter benefit the survival of age-0 trout by buffering the effects of rapidly decreasing atmospheric temperatures and by providing more available habitat during the stressful transition period between summer and winter. However, even under the current status of the Henry's Fork macrophyte community, sufficient macrophyte biomass is available to provide cover for trout during the fall and early winter (Griffith and Smith 1995, Mitro and Zale 1998).

Furthermore, in the fall when macrophytes are present at or near their maximum biomass, they act to increase water depth at a given discharge (Vinson 1991, Vinson *et al.* 1992), thereby providing adequate water depths at relatively low flows. Later in the winter when macrophyte biomass decreases, most age-0 trout leave areas such as Last Chance and Harriman where macrophytes provide the majority of the available cover and migrate to the narrower, deeper sections of the river in Box Canyon and Pinehaven to Riverside reaches, where cover is provided by cobble-boulder substrate and woody debris rather than by macrophytes. Because these reaches are relatively narrow compared to the Last Chance and Harriman reaches, small increases in discharge result in relatively larger increases in the amount of trout habitat, suggesting that higher flows during mid- to late-winter will benefit age-0 trout survival more than high flows during the fall.

Recent studies show that the number of age-0 trout surviving the winter between Island Park Dam and Riverside was higher during a winter in which flows were high between January and March than during winters in which flows were lower during this period (M. Mitro and A. Zale, Dept. of Biology, Montana State University, pers. comm., 1998). Because these observations were made over only 3 winters, further study is needed to quantify this relationship.

As a final comment regarding management of Island Park Reservoir, Shea *et al.* (1996) believe that large amounts of fine sediment introduced into the river by reservoir drawdowns during 1979 and 1992 negatively impacted the macrophyte community, in particular by creating substrate conditions that favored Group 2 species over the Group 1 species. Griffith and Smith (1995) noted negative impacts to wintering juvenile rainbow trout from the 1992 drawdown. Both the 1979 and 1992 drawdowns were conducted for the purpose of treating the reservoir to eliminate nongame fish. Benjamin and Van Kirk (1999) showed that winter flows below Island Park Dam are more sensitive to reservoir content at the beginning of storage season than to precipitation, and therefore recommended that management of all reservoir-related resources be conducted in such a manner to maximize storage at the beginning of the fall. To provide optimum benefits to the macrophyte community and wintering rainbow trout, drawdown of the reservoir should be avoided both to reduce the chance of mobilizing reservoir sediments and to increase allowable winter discharge under the constraints of satisfying irrigation rights.

IMPACTS OF WATERFOWL MANAGEMENT ON THE FISHERY

Following the winter of 1989-90, it became apparent that the winter swan carrying capacity of the Henry's Fork had likely been exceeded, and significant damage had occurred to the macrophyte community due to waterfowl herbivory and associated disturbance to plants and tubers (Vinson 1992, Shea *et al.* 1996). Although it has been shown that the macrophyte community that has remained since 1989-90 does not provide winter concealment cover for juvenile rainbow trout, it is clear that dense and abundant macrophyte beds are beneficial to the fishery through increased water elevation, increased habitat for macroinvertebrates, and increased summer foraging habitat for trout and associated angling opportunities, particularly during the late summer and early fall. It is also possible that if the present macrophyte community recovers to the point where biomass and species composition approach that of the 1970s, macrophytes could provide concealment cover for juvenile trout between Last Chance and Pinehaven, thus increasing the overall population.

Since large numbers of swans and other waterfowl wintering on the Henry's Fork result in significant macrophyte herbivory and damage, the fishery benefits from reduced numbers of wintering waterfowl, regardless of the techniques utilized to reduce waterfowl numbers and regardless of whether the hazing program is meeting desired waterfowl management objectives. Hazing implemented during Winter 1990-91 has reduced the number of swans wintering at HSP (Figure 3), which, along with higher winter flows since the end of the drought in 1994, has resulted in a modest recovery of the macrophyte community (Shea 1997). The Box Canyon rainbow trout population has also increased since 1996 (Figure 2), due in part to increased winter flows. How much of the increase in the trout population is due to improvements in the macrophyte community is uncertain, but it is certain that reduction in winter waterfowl numbers benefits the rainbow trout fishery via a healthier macrophyte community.

If flows in the Henry's Fork were unregulated, management actions taken to benefit swans and trout would be limited to those acting directly on the fish and wildlife populations themselves. However, flows are regulated by the dam, and regardless of the management scenario chosen for Island Park Reservoir, winter flows are subject to the constraints of meeting irrigation storage rights. Benjamin and Van Kirk (1999) offer methods for increasing winter flows while meeting these constraints, but the reality is that only a limited amount of water is available for winter flows in any given year.

As discussed above, it is not clear how best to release these flows to maximize benefits to age-0 trout. Higher releases in the fall and early winter buffer temperature changes, provide increased habitat for trout, and deter migrating waterfowl from staying on the Henry's Fork throughout the winter. However, during the fall and early winter, high macrophyte biomass maintains adequate channel depth to provide thermal buffering and fish habitat in the Last Chance to Pinehaven reach, even at relatively low flows. Furthermore, higher releases later in the winter provide increased habitat for age-0 trout in the Box Canyon and Pinehaven to Riverside reaches, where most fish are found during that time period. Higher flows later in the winter also reduce the occurrence of ice formation and provide more habitat for waterfowl that become committed to remaining on the Henry's Fork for the entire winter.

These observations suggest that a combination of: 1) hazing in the fall and early winter to deter waterfowl from staying on the Henry's Fork, and 2) utilizing available winter flow water to provide higher flows later in the winter, rather than earlier, will provide the maximum benefit to wintering swans, the macrophyte community and the fishery, given the constraints of satisfying irrigation rights.

SUMMARY AND RECOMMENDATIONS

History has shown that management of Island Park Reservoir has significantly impacted both the Henry's Fork rainbow trout fishery and RMP trumpeters. Increased winter flows beginning in the early 1970s allowed the fishery and the swan population to flourish. Although the trout population was limited by winter concealment habitat for juveniles, this limitation was circumvented by stocking of hatchery fish. Following cessation of stocking in 1978, drawdowns of Island Park Reservoir in 1977, 1979, 1981, and 1984 introduced large numbers of reservoir fish into the river, which compensated for low natural recruitment. The 1979 drawdown also introduced a large amount of sediment into the river, which likely initiated the shift in macrophyte community dominance from Group 1 to Group 2 species. Low winter flows during the drought of the late 1980s combined with increased waterfowl numbers to negatively impact the macrophyte community, which exacerbated what was probably already poor winter survival of age-0 rainbow trout between Last Chance and Pinehaven. The reservoir drawdown of 1992 revived the ailing fishery by introducing 10,000 adult reservoir trout into the river (Figure 2). However, release and deposition of reservoir sediment negatively impacted the macrophyte community and what little cobble-boulder juvenile trout concealment habitat existed along the banks in the Last Chance reach.

Since the end of the drought in 1994, the combination of increased winter flows and reduced wintering swan numbers has resulted in modest improvements in the macrophyte community. Improvements in the rainbow trout population are most likely due to the increased winter flows than to the macrophyte recovery, since the most important juvenile winter habitat occurs in the Box Canyon and Riverside reaches, where macrophytes are less important in maintaining channel depth. However, anecdotal observations suggest that angling opportunities and the overall quality of the angling experience from Last Chance to Pinehaven has increased since 1995, particularly during the late summer and early fall when macrophyte biomass is at its peak. The literature reviewed in this paper suggests that managing water flows at Island Park Dam and managing wintering waterfowl on the Henry's Fork to encourage an abundant macrophyte community dominated by the tall, robust Group 1 species will benefit the rainbow trout fishery.

Recommendations

1. Manage Island Park Reservoir to maximize winter discharge and minimize abrupt flow increases during the spring when new plants are beginning to grow. As detailed in Benjamin and Van Kirk (1999), winter flows can be maximized by maintaining a high reservoir level at the beginning of the storage season and by extending the fill date target to 1 May rather than the traditional 1 April.

2. Avoid excessive drawdown of Island Park Reservoir. This not only increases allowable winter discharge, but also reduces the probability of sediment deposition downstream, which negatively impacts both the macrophyte community and trout habitat.

3. Continue the existing waterfowl hazing program at HSP. Explore additional management techniques to minimize the number of waterfowl on the Henry's Fork between Island Park Dam and Riverside during fall and winter. Any decrease in waterfowl numbers will benefit the macrophyte community, which, in turn, benefits the fishery and associated angling experiences.

4. Continue monitoring of the Henry's Fork macrophyte community and juvenile trout survival. In particular, continue research into the relationship between winter flow regime and overwinter survival of age-0 trout so that water available for winter flows can be released in a manner that optimizes benefits to wintering waterfowl, the macrophyte community and juvenile trout survival.

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TRUMPETER SWAN NESTING HABITAT ON THE TARGHEE NATIONAL FOREST

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ABSTRACT

Trumpeter Swans (*Cygnus buccinator*) nesting in the Targhee National Forest (Targhee NF) in Idaho and Wyoming are part of the Tristate nesting population, and include approximately 40% of the nesting trumpeters in Idaho. In 1979-99, 8-19 territories have been occupied each year and 1-17 cygnets have fledged annually. Occupied territories and cygnet production have declined since 1990, likely due at least in part to termination of winter-feeding and efforts to disperse wintering swans from the Red Rock Lakes National Wildlife Refuge – Harriman State Park vicinity. Habitat changes at some lakes have also reduced cygnet production. The Targhee NF has implemented various projects to improve nesting habitat and has incorporated Trumpeter Swan habitat requirements in forest management guidelines. The Targhee NF has initiated a partnership with The Trumpeter Swan Society and others to identify site-specific problems and corrective measures at key swan nesting territories. The U.S. Forest Service is committed to doing the necessary habitat work to maintain this unique and historical breeding population.

INTRODUCTION

Trumpeter Swans on the Targhee NF in eastern Idaho and western Wyoming are part of the Rocky Mountain Population (RMP) of Trumpeter Swans (Shea 1994, Maj and Shea 1996). Although currently regarded as a single population for management purposes (Pacific Flyway Subcommittee on RMP Trumpeter Swans 1998), biologically the RMP includes two distinct breeding populations: 1) the migratory western Canadian breeding population from Alberta, British Columbia, Yukon, and Northwest Territories, and 2) the primarily non-migratory Tristate (Greater Yellowstone) breeding population in Idaho, Montana, and Wyoming, as well as two small disjunct flocks in Oregon and Nevada. Even though Canadian and Tristate trumpeters winter together in the Tristate area, over 50 years of marking records provide no evidence of successful interbreeding in the wild (Gale *et al*. 1987, Shea and Drewien 1999). The Tristate nesting population is the only breeding group in the lower 48 states that was not extirpated by 1900 (Banko 1960).

From less than 200 birds in 1930 (Gale *et al*. 1987), the RMP increased to about 3,500 by February 2000, the highest level in over a century. The February 2000 total included about 3,080 migratory trumpeters from Canada, about 370 Tristate summer residents, and about 50 trumpeters in Oregon and Nevada (U.S. Fish and Wildlife Service 1999, 2000). Since 1930, RMP growth and restoration efforts have gone through four somewhat distinct phases:

1) From 1930 to the mid-1970s, the RMP grew from a remnant of less than 200 birds (approximately 100 that summered near Grande Prairie, Alberta, and about 70 that summered in the Tristate area) to over 700 birds. Most of this growth occurred within the Tristate breeding population, which had increased to over 500 swans by 1951. While the Tristate population fluctuated between 450-650 birds (about 72% of the total RMP) during the next 25 years (1951-mid-1970s), the Canadian trumpeters increased to only 200 birds (about 28% of the RMP) by 1978 (Banko 1960, Gale *et al*. 1987).

2) During the mid-1970s, growth of Canadian flocks accelerated and they increased to about 1,450 birds (70% of the RMP) by 1989. During the 1970s-early 1980s, the Tristate population declined to a 35-year low of 392 by 1986; but rebounded to 550-600 in 1987-89 after changes in management at Red Rock Lakes National Wildlife Refuge (RRLNWR) and a period of warmer and drier spring weather. Substantial mortality in winter 1988-89 and massive decline of aquatic vegetation at Harriman State Park (HSP) in winter 1989-90 led to accelerated efforts to establish use of additional wintering areas (Shea and Drewien 1999).

3) In 1990-96, 1,476 swans were translocated in winter (1,279) and summer (197) from the Tristate area to other potential wintering areas in southern Oregon, western Wyoming, Utah, and

southern Idaho. In addition, winter-feeding at RRLNWR was terminated. Tristate swans were deliberately removed from the RRLNWR vicinity to reduce potential mortality associated with termination of feeding and to expand their distribution (Niethammer *et al.* 1993, Shea and Drewien 1999).

4) Due to translocations and mortality associated with termination of winter-feeding, the Tristate population declined to less than 300 swans in 1993 (248 adult birds counted in September 1993). Exceptional cygnet production in 1994 (130 cygnets fledged) led to an increase of Tristate adults in 1995. Since 1995, Tristate adults have failed to increase, despite a series of milder than average winters. In contrast, during the 1990s the Canadian trumpeters increased from about 1,500 to about 3,000 (U.S. Fish and Wildlife Service 2000).

SURVEYS AT TARGHEE NF NEST SITES

Approximately 40% of the active Trumpeter Swan nests in Idaho are located within the Targhee NF, where nesting habitat consists of scattered marshes, lakes, and ponds (Maj 1983). For 21 years (1979-99), the Targhee NF has annually surveyed 39 wetlands to document nesting and brood rearing use (Figure 1). The survey protocol generally involved two to three visits to each site during spring and summer. The first visit was made in the spring to document territory occupancy. A second visit documented active nests (incubation or eggs observed) and a third visit in August or early September recorded the number of cygnets present.

During 1979-99, 33 of the 39 sites have been occupied by pairs during 1 or more summers; 26 have had at least one nesting attempt; and 16 have successfully produced cygnets during 1 or more years. Seven sites have been occupied in $\geq$80% of the years surveyed and three sites have produced 54% of the fledged cygnets. The number of territories occupied each year has ranged from 8-19 and has declined since 1990 (Figure 2). Annual cygnet production has ranged from 1-17 and has also declined since 1990 (Figure 3).

The translocations of swans from HSP and RRLNWR, the termination of winter feeding at RRLNWR and the hazing of waterfowl from HSP have all been contributing factors in the recent declines in occupied territories and cygnet production on the Targhee .

RESEARCH ON NESTING HABITAT

Surveys have shown that swans do not use all potential suitable habitat annually and cygnet production is highly variable among sites. Trumpeter Swan habitat was studied on the Targhee NF in 1980-81 (Maj 1983) to determine if habitat parameters could help explain this variation. Comparative analysis of habitat parameters was performed on presently used, historically used, and non-used lakes in an effort to define nesting and brood rearing habitat. Key results were:

1) Clutch size averaged 4.4 eggs, and hatching success averaged 84%.

2) Analysis of egg composition, dimensional measurements, timing of cygnet mortality and the consistently poor production over many years on particular lakes indicated that mortality may be site specific.

3) Presently and historically used lakes had significantly greater shoreline irregularity.

4) Although the abundance of emergent or submergent vegetation was not significantly different among the three lake groups, presently used lakes had significantly more total vegetation.

5) The greatest species diversity in vegetation and invertebrates was found in presently and historically used lakes.

6) Swans preferred eutrophying lakes on the Targhee for nesting, while the non-used lakes were more oligotrophic.

Trumpeter Swan food habits were also studied in the Greater Yellowstone Ecosystem in 1989 (Squires and Anderson 1994). The primary food in summer was *Potamogeton* foliage, which accounted for 48.2% of the summer diet. Nesting Trumpeter Swans significantly prefered *Potamogeton spp*. when it was available at feeding sites within their territories. *Chara spp*. was eaten in proportion to its availability, and swans avoided eating *Ceratophyllum demersum* and *Myriophyllum exalbescens*.

Henson and Cooper (1993) evaluated Trumpeter Swan incubation behavior and nesting habitat quality,

and compared incubation behavior and habitat quality in Alaska with the Tristate region. They found that Alaskan swans incubated eggs for longer periods of time (higher incubation constancy) and had shorter feeding periods than Tristate swans. They concluded that the Tristate region is relatively poor swan habitat because it lacks the food resources necessary to allow females to maintain a high incubation constancy in an area with a short and harsh breeding season.

MANAGEMENT FOR TRUMPETER SWANS ON THE TARGHEE NF

The Trumpeter Swan is listed as a Forest Service sensitive species by the Regional Forester, and it is a management indicator species on the Targhee NF (US Forest Service 1997). The Forest Service is cooperating with many other agencies to maintain suitable habitat and securely restore the resident Tristate population.

Surveys and research have indicated that habitat conditions in the Targhee NF are changing over time at swan nest sites. The changes have included decreased productivity due to several decades-old outlet dikes that altered natural hydrology at some lakes, reductions in open water habitat at some territories, and increases in human activities. Past habitat improvement work has included: building nesting islands, reinforcing and elevating outlet dikes, fencing to exclude livestock, closing access roads, installing floating nest platforms, planting of riparian and aquatic plants, and dredging to maintain adequate water levels through the fledging period.

The Pacific Flyway has recommended a minimum objective of 101 nesting pairs in the Tristate region by 2002, including at least 10 pairs on the Targhee NF. Our surveys have indicated that to meet that objective, more than 10 sites need to be managed for Trumpeter Swan nesting habitat. Using the survey records, we identified 17 sites that will receive management emphasis for nesting swans. In the 1997 Revised Forest Plan (USDA Forest Service 1997), the following goals and management standards and guidelines were established:

Goals

1) Maintain habitat to support 10 breeding pairs or more on the Forest.

2) Protect emergent vegetation along shorelines. Maintain riparian vegetation in desired condition.

Standards and guidelines

1) Maintain suitable Trumpeter Swan nesting habitat conditions including (but not limited to) the following lakes and ponds: Boundary Pond, Swan Lake, Lily Pond, Hatchery Butte, Railroad Pond, Mesa Marsh, Bear Lake, Upper Goose Lake, Long Meadows, Thompson Hole, Twin Lakes, Chain Lakes, Widgit Lake, Rock Lake, Indian Lake, Putney Meadows, Unnamed Pond (Sec. 19, T9N, R46E).

2) Change livestock grazing through management or fencing when grazing is adversely affecting Trumpeter Swan use or productivity.

3) No vegetation management will occur within 300 feet of the lake or pond shoreline unless necessary to improve riparian habitat conditions favorable for Trumpeter Swans. Management may occur after the swans have left the lake or pond.

4) Maintain constant water levels; allow no drawdowns from 1 May to 30 September when not in conflict with preexisting water rights.

5) Do not take any recreation management actions that would encourage dispersed recreation activity at these lakes and ponds. Close these areas to recreation activity if this activity is adversely affecting Trumpeter Swan use or productivity.

6) Implement habitat improvement projects at these lakes and ponds, such as dredging, to maintain proper water depths and aquatic vegetation control.

In addition to the specific Trumpeter Swan management direction stated above, the 1997 Revised Forest Plan also established an aquatic influence zone management prescription that applies to all streams, lakes, ponds, marshes, and wetlands.

Aquatic influence zone management prescription

This prescription applies to the aquatic influence zone associated with lakes, reservoirs, ponds, perennial and intermittent streams, and other wetlands (such as wet meadows, springs, seeps, marshes and bogs). These areas control the hydraulic, geomorphic, and ecological processes that shape the various water types mentioned above and directly affect aquatic life. They also provide unique habitat characteristics which are important to those plant and animal species which rely on these systems for all or a portion of their life cycle. Many such habitats are locally rare or are sensitive to disturbance (such as fens and thermal springs). Overall, these areas serve as important reservoirs of biodiversity, critical linkages for the interchange of plant and animal genetic material, specialized areas of nutrient cycling and freshwater filtration, storage, and transport, and are important to water quality.

Management emphasis is directed at the application of ecological knowledge to restore and maintain the health of these areas in ways that also produce desired resource values, products, protection, restoration, enhancement, interpretation, and appreciation of these areas. The goals of the aquatic influence zone management prescription include the following:

1) Minimize adverse effects to aquatic and riparian dependent species from past, existing, and proposed management activities.

2) Allow endemic levels of insects and disease to play their natural role in ecological succession, compatible with other resource objectives.

3) Manage wood residue (natural and human-made), including fuelwood, to maintain or restore ecological health and function.

4) Coordinate with Idaho Fish and Game, Wyoming Game and Fish, and other interested individuals or groups, to identify and evaluate potential beaver reintroduction sites. Support reintroductions into areas that would benefit from beaver activity and where conflicts with other uses have been resolved.

Future surveys and habitat management

In 1999, a cooperative three-year project was initiated with The Trumpeter Swan Society to accomplish the following:

1) Locate all occupied territories and active nests on and adjacent to the Targhee NF.

2) Monitor all occupied territories to determine hatching and fledging success, determine chronology of nest failures, and identify causes.

3) Prepare documents for all active and historic territories summarizing basic territory habitat parameters, past nesting history, and habitat factors that may be detrimental to future swan use and production.

4) Conduct site-specific analysis and develop site-specific management actions for priority nesting territories.

5) Salvage eggs or cygnets from sites where they are otherwise likely to be lost due to flooding, inadequate water, or other factors. Raise these cygnets at a facility in Jackson, Wyoming, and then release back into Idaho.

Other cooperators in 1999 included: Idaho Department of Fish and Game, Mary Maj, Hornocker Wildlife Institute, Wyoming Game and Fish Department, U. S. Fish and Wildlife Service, and the Wyoming Wetland Society.

The nesting Trumpeter Swans on the Targhee NF are an important part of the Tristate population. The U.S. Forest Service is committed to doing the necessary habitat work to maintain this unique and historical breeding population.

ACKNOWLEDGMENTS

Many individuals have helped in the annual surveys and habitat improvement work for Trumpeter Swans. Without their dedication, this 21-year record would not exist. We would like to acknowledge the following individuals: Mary Maj, Gail Worden, Wayne Jenkins, Dave Grimes, Beth Towell, Ririe Godfrey, Delwyn Berret, Nancy Hoffman, Bryan Aber, Tom Gelatt, Paul Henson, Gavin Lovel, David Arthaud, and Blair Calloway. The Student Conservation Association also provided volunteers to help with survey efforts.

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TRUMPETER SWAN REINTRODUCTION ON THE FLATHEAD INDIAN RESERVATION

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ABSTRACT

The Confederated Salish and Kootenai Tribes, in a cooperative project with Montana Fish, Wildlife and Parks, the U. S. Fish and Wildlife Service, and the Mission Valley Community Foundation, commenced a project to reintroduce Trumpeter Swans on the Flathead Indian Reservation in 1996. The initial effort involved translocation of 19 Trumpeter Swans from Summer Lake, Oregon, to Pablo National Wildlife Refuge, Montana. Those swans proved that suitable summer habitat existed on the Reservation, but they returned to Canada after migrating from the area. A second effort in 1998, using 10 Trumpeter Swan cygnets from Grande Prairie, Alberta, again proved the suitability of the habitat at the Refuge. To date, only one trumpeter has returned to the area. Current and future efforts will involve obtaining additional swans from Alberta and other populations and initiation of a captive propagation project.

INTRODUCTION

The Flathead Indian Reservation (FIR) encompasses approximately 1.25 million acres in western Montana. The Reservation was established in 1855 by the Treaty of Hellgate between the United States and the Salish, Pend 0'Reille, and Kootenai Tribes, as the homeland of these tribes. The FIR was opened to homesteading by non-Indian settlers in 1910. Since that time, many changes have taken place, the most notable of which is conversion of much of the lower elevation valley habitat from grassland habitat to agriculture. A steady and, at times rapid, expansion of the human population has brought substantial changes to the habitat of the FIR and its native flora and fauna.

Trumpeter Swans (*Cygnus buccinator*) were apparently present as a breeding bird in western Montana prior to Anglo settlement of the area. The primary reference on Trumpeter Swans for western Montana and surrounding areas is Banko (1960). He noted a reference by Father Jean DeSmet in 1842, who observed that swan eggs were collected by an Indian hunting party near Flathead Lake (Thwaites 1906). Presumably, this reference deals with resident breeding Trumpeter Swans. Other references to swans in the area included observations by E. S. Cameron in 1881 (Coale 1915). No early detailed documentation of breeding Trumpeter Swans in western Montana exists.

Trumpeter Swans in the Flathead River Drainage were apparently extirpated as breeding birds in the early days of settlement, probably being utilized for food by settlers and Native Americans alike. The susceptibility of Trumpeter Swans to disturbance and changes in breeding habitat that occurred during the settlement period undoubtedly played a role in the demise of the species locally.

The Confederated Salish and Kootenai Tribes of the Flathead Indian Reservation (CSKT) have developed a strong environmental record over the past decades. The CSKT, through the Tribal Wildlife Management Program (TWMP), have taken a strong, proactive approach with regard to wildlife management issues. One aspect of this approach is the CSKT's efforts in rare species management. Tribal wildlife personnel have been active managers of rare species ranging from nongame birds to large carnivores.

Tribal wildlife management efforts have also focused on opportunities to reintroduce extirpated species of wildlife where current habitat and other conditions allow. These efforts have been successful for Peregrine Falcons (*Falco peregrinus*) thus far. Other projects to reestablish species assumed to be locally extirpated are in various stages of planning. These projects include examination of reintroduction or population augmentation potential for the Northern Leopard Frog (*Rana pipiens*), Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbainus*), and Burrowing Owl (*Athene cunicularia*). This paper is an overview of efforts by the CSKT and other cooperating entities to reestablish the Trumpeter Swan as a breeding bird on the FIR. The CSKT view these lost species as missing pieces of the natural environment, and the reintroduction project discussed here is a means to reestablish this lost piece of the environment.

PROJECT OVERVIEW

Interest in the reintroduction of Trumpeter Swans in western Montana has been increasing for years. The development and subsequent revisions of the Management Plan for the Rocky Mountain Population of Trumpeter Swans (Plan) provided a strategy for current reintroduction efforts (Pacific Flyway Council *et al.* 1984, 1992, 1998). Strong management actions by wildlife management agencies and private organizations have been undertaken in an effort to reestablish the species throughout its original breeding range. The Plan attempts to coordinate these efforts and to develop a comprehensive approach to population surveys, population management activities (including population augmentation and reintroduction activities), public education, and research needs. The Flathead River Drainage is included in the discussion of potential reintroduction sites.

CSKT efforts in the reintroduction of Trumpeter Swans on the FIR officially began with Tribal Council approval of a reintroduction proposal in 1995. The completion of an environmental assessment for the project by the TWMP and Montana Fish, Wildlife and Parks (MFWP) allowed for public review of the proposal. The proposed project met with an immediate and enthusiastic response from an interested public.

Initial efforts centered around the selection of suitable reintroduction sites on the FIR. Wetland habitat there is diverse. Wetlands range from small depressions with little or no seasonal water present to large reservoirs dedicated primarily to irrigation. These sites are owned and managed by the CSKT, state and federal agencies, and private landowners. In addition, concerns related to the potential for illegal shooting, hunter misidentification, fluctuating and unpredictable water levels, food availability, powerline and fence collisions, lead poisoning, landowner concerns or opposition, and other possible threats were evaluated as possible obstacles for the successful completion of the project.

Two sites on the FIR, Pablo National Wildlife Refuge (NWR) and Horte Reservoir were closely examined as initial potential reintroduction sites, and Pablo NWR was selected. The reasons for the selection of this site include seclusion, protection from excessive human activities, access to an adequate food supply, and the ability to control water levels. The lands within the Refuge are largely covered by water impounded by Pablo Reservoir and by smaller adjacent impoundments constructed by Ducks Unlimited in the late 1980s to maintain water during the irrigation season. Surrounding habitat is largely mixed grassland, interspersed with native and introduced tree species. The Refuge is situated on land owned by the CSKT and administered by the U. S. Fish and Wildlife Service (USFWS) under an easement. Wildlife management activities on the refuge are coordinated by the CSKT and the USFWS.

Initial reintroduction efforts commenced in 1996, with recapture of 19 Trumpeter Swans that had originally been captured at Harriman State Park in northeastern Idaho during the previous winter and relocated to the Summer Lake Wildlife Management Area in south central Oregon. All of the swans had previously been fitted with collars and tarsal bands for identification. These birds were recaptured by personnel of the Oregon Department of Fish and Wildlife (ODFW) and the TWMP and transported to the FIR.

All swans arrived at the Reservation in good physical condition and were released at Pablo NWR in May 1996. The release site was a wetland area on the western side of the Refuge. This site, where water levels could be controlled, provided seclusion from humans and other disturbance factors and adequate food resources. Status of the swans was monitored daily by TWMP staff. The birds acclimated to their new home immediately and thrived there throughout the summer.

Although the public was not allowed close access to the release site, swans were often visible from a public road located approximately .8 km to the west. Each evening and weekend, interested people were able to attempt to observe the swans from the road. Periodic progress reports to the local media and individual interested members of the public kept them apprised of the status of the birds.

Within 1 week of their release, two adult swans had moved from the release site to Pablo Reservoir. The other 17 swans moved onto the reservoir within the next month. All of the birds thrived throughout the summer, finding little disturbance and new feeding sites with ample food supplies as the water levels of the reservoir decreased.

In early October, the swans began to leave the area. Some apparently left immediately, but three ranged between the Refuge and a wetland area about 16 km northwest for several weeks before leaving the valley. Most of these swans apparently ranged northward. Later observations of other marked swans from the project indicated that most had moved into the migration path between northern Alberta and eastern Idaho. None of those swans have subsequently returned to the FIR.

Although the first reintroduction effort failed to successfully reestablish breeding Trumpeter Swans on the Reservation, it proved that the reintroduction site was a good location and could provide the factors needed for successful efforts in the future. However, the need to reevaluate the types of swans used in the project was obvious. Of the 19 swans released, 11 were adults, and the remaining eight were 1-year-olds. The presence of the adults probably proved to be a difficulty due to their apparent affinity to their natal area in northern Alberta. The younger swans were likely affected by the activities of the adults, i.e., they followed the adults and left the area. Additionally, the young swans probably had an affinity to the northern Alberta breeding area due to the fact that they had originally fledged from this location.

With the factors and experiences already discussed in mind, the methodology of the project was re-evaluated by the cooperating agencies. The decision was made to attempt to obtain pre-fledged Trumpeter Swan cygnets from the breeding population at Grande Prairie, Alberta. This strategy was based upon the assumption that, in subsequent years, the swans would tend to return to breed in the area from which they had fledged.

The reintroduction site at Pablo NWR was also re-evaluated. The Refuge had proven to be a good reintroduction site with regard to all factors involved. The decision was made to continue to utilize the location in future reintroduction efforts.

Discussions with the Canadian Wildlife Service (CWS) and the Alberta Department of Forestry, Lands and Wildlife, Fish and Wildlife Division were initiated in early 1997 in an attempt to obtain Trumpeter Swan cygnets from the Grande Prairie, Alberta, area in September of that year. Permits from the applicable state, federal, and provincial agencies were obtained, and logistical planning for the project continued. Unfortunately, reproduction surveys by CWS personnel in early September indicated depressed reproductive success, probably due to weather conditions that summer. As a result, no reintroduction activity took place in 1997.

Activity in 1998 again centered on obtaining cygnets from Grande Prairie. September flights by the CWS indicated improved reproductive success over that of 1997, and 10 cygnets were made available for translocation. With the assistance of CWS personnel and the Friends of Elk Island Society, TWMP personnel transported the 10 swans and released them at Pablo NWR.

From the time of the release until late October 1998, the 10 cygnets developed normally and thrived at the Refuge. Again, their progress was monitored each day by TWMP personnel. In early November, the cygnets began to leave the Refuge, but efforts to follow their movements proved unsuccessful. In late November, five were observed at the Lee Metcalf NWR in the Bitterroot Valley, approximately 145 km from the release site (S. Browder, pers. comm.). Collared swans were also reported from the lower Flathead River (approximately 60 km southwest of the release site), but the identity of these swans was not verified. No further observations of the other five cygnets were reported. One of the swans at Metcalf NWR was subsequently found dead there. Post-mortem results were inconclusive, but collision with a powerline was suspected.

No additional observations of the other nine swans were reported during the remainder of winter 1998-99. In May 1999, one of the swans that had been observed at Metcalf NWR was observed in the company of an unmarked swan near Bigfork, Montana (approximately 65 km northeast of Pablo NWR). No further observations of that bird or any of the others from the 1998 reintroduction project have been received.

Reintroduction efforts in 1999 again involved obtaining cygnets from the Grande Prairie population. Once again, however, the project received a setback due to low reproductive success there. As a result, no Trumpeter Swan reintroduction occurred in 1999.

The inability to obtain swans for the project in 1997 and 1999 proved to be an obstacle to the momentum and success of the project. Reevaluation of the entire project clearly indicated a continuing strong interest by all of the partners in the project and the public, but it also indicated a need to develop some means of insuring a more stable and reliable source of swans each year.

CURRENT AND FUTURE PLANS

In September 1999, the partners in the project agreed to develop a cooperative relationship with the Trumpeter Swan Fund (Fund) at Jackson, Wyoming. The Fund had a strong track record of captive reproduction of Trumpeter Swans at its facility and subsequent introduction of captive-reared swans to the wild. The Fund was able to locate 24 adult and subadult Trumpeter Swans at a waterfowl breeding facility in Montana that were for sale. These swans were desirable as breeding birds to supply cygnets for the FIR project.

Under a contract with the Fund, the CSKT were able to provide funding to purchase the birds and to assist the Fund in upgrading their facilities to expand their own captive breeding efforts. Initial indications are that up to four pairs may breed in spring 2000. As the captive propagation component of the project begins to produce cygnets, the number of swans available for release on the FIR should increase.

Progeny from the captive breeding effort will be held in captivity during their first winter and then transported to the release site, wing-clipped and banded, and then released and monitored until they fledge and hopefully after they fledge. This component of the project is aimed at increasing the number of swans that will be available for the reintroduction project each year. It will not replace efforts to obtain swans from other populations. Instead, it will provide an additional tool to use for the ultimate success of the project.

ACKNOWLEDGMENTS

The Flathead Indian Reservation Trumpeter Swan Reintroduction Project is a cooperative effort involving the CSKT, MFWP, USFWS, and the Mission Valley Community Foundation. The project is a component of the Wildlife Mitigation Plan for Kerr Dam, which is located on the Reservation.

Funding for the initial 1996 reintroduction activities was provided primarily by the CSKT, in cooperation with MFWP and the USFWS. The 1997 activities were funded by the CSKT, in cooperation with the National Fish and Wildlife Foundation, the Liz Claiborne-Art Ortenburg Foundation, and the Summerlee Foundation. Efforts in 1998 and 1999 were provided by the Tribes and derived from the Kerr Fish and Wildlife Mitigation Fund.

Jeff Herbert, MFWP Waterfowl Coordinator, secured all of the necessary permits to initiate and continue the project. Dr. Joe Ball, Montana Cooperative Wildlife Research Unit Leader, provided ideas and advice throughout the project. David Wiseman, Bill West, and Lindy Garner of the USFWS, provided logistical support and assisted with many aspects of the releases of the swans. Harold Knapp provided inspiration, ideas and valuable insight from his many years of interest in Trumpeter Swans and his experiences in the Flathead Valley. William Edelman, of the Mission Valley Community Foundation, provided moral support and unbridled enthusiasm for the project.

Other cooperators included Gerry Beyersbergen of the CWS, and the Staff of the Summer Lake Wildlife Management Area of the Oregon Department of Fish and Wildlife.

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ROLE OF SOUTHEAST IDAHO NATIONAL WILDLIFE REFUGE COMPLEX IN THE ROCKY MOUNTAIN POPULATION TRUMPETER SWAN PROJECT

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ABSTRACT

Southeast Idaho National Wildlife Refuge Complex includes Minidoka, Camas, Bear Lake, and Grays Lake National Wildlife Refuges, and Oxford Slough Waterfowl Production Area. All units are located in the southeast corner of Idaho and provide suitable nesting habitat for the Rocky Mountain Population (RMP) of the Trumpeter Swan (*Cygnus buccinator*). Habitat conditions and water management concerns are detailed. The role of the project leader as the Trumpeter Swan Coordinator to provide coordination for Service directed activities to reduce mortality of Trumpeter Swans wintering in the Tristate area is summarized.

INTRODUCTION

Southeast Idaho National Wildlife Refuge Complex (NWRC) includes Minidoka, Camas, Bear Lake, and Grays Lake National Wildlife Refuges, and Oxford Slough Waterfowl Production Area (WPA). Habitat on each unit contributes significantly to the distribution of Trumpeter Swans; however, water management concerns limit the potential. In addition to land management responsibilities, the project leader at Southeast Idaho NWRC has served as the Trumpeter Swan Coordinator since 1990.

SUMMARY OF THE TRUMPETER SWAN COORDINATION ROLE

Trumpeter Swan program coordination as a function of the Southeast Idaho National Wildlife Refuge Complex project leader position was initiated in 1990. The original purpose for this role was to coordinate Service-directed activities to reduce mortality of trumpeters wintering in the Tristate area of Idaho, Montana, and Wyoming. In recent years, the focus of this effort has been to haze swans from the Henry's Fork River at Harriman State Park (HSP) where about 30 percent of the RMP wintered in 1990.

A severe winter in 1989 resulted in mortality of Trumpeter Swans that wintered at HSP on the Henry's Fork River. This mortality, coupled with the impacts swans were having on aquatic vegetation, led manages to conclude that action was needed to encourage redistribution of swans to areas with milder winters. Management actions were taken by the Service and contractors to move birds away from HSP. In order to gauge the success of this effort, monitoring became a large part of the project. Objectives were:

1. Disperse Trumpeter Swans from HSP and expand winter distribution.
2. Increase the nesting range of Tristate Trumpeter Swans.
3. Monitor the results of hazing.
4. Document Trumpeter Swan nesting and productivity in Idaho.

OVERVIEW OF THE UNITS OF SOUTHEAST IDAHO NWRC

Minidoka NWR

Minidoka NWR is located along the Snake River Plain about 12 miles northeast of Rupert, Idaho. The Refuge is an overlay refuge, which means that primary jurisdiction over land and water is retained by the Bureau of Reclamation (BOR). Management options are limited to those compatible with the needs of the Minidoka Dam project, which was constructed to provide irrigation for farming. The dam resulted in the development of Lake Wolcott, which comprises the majority of the Refuge's 20,699 acres; effects of the dam influence 25 river miles. The BOR maintains a full pool in Lake Wolcott through the summer so that irrigation canals can be maintained at proper flows. The lake is then drawn down in mid-October so that ice does not damage the dam during winter. The Refuge provides important habitat for molting migratory birds during August. In addition, the area provides habitat for waterfowl during spring and fall migrations. The Refuge provides important swan habitat during migrations and has suitable nesting habitat that could support several nesting pairs.

Camas NWR

Camas NWR is located 36 miles north of Idaho Falls, Idaho, and is situated along the Camas Creek watershed. It contains 10,578 acres, of which about half are wetlands. The Refuge is highly dependent upon pumping and diversions of water from Camas Creek to maintain water levels. Increased pumping for agriculture in the surrounding area has lowered the water table in the refuge area substantially. Pumping costs have increased as well and this leaves the Refuge vulnerable to dry weather cycles and budgetary fluctuations. The Refuge ices up by late November so the area does not provide suitable winter habitat. Concentrations of 50-100 Trumpeter Swans during migrations are not uncommon and the Refuge provides suitable nesting habitat that could support up to 10 pairs. Currently, two – four nesting attempts are initiated each year.

Bear Lake NWR

Bear Lake NWR is located just outside of Montpelier, Idaho, at the north end of Bear Lake. The Refuge was established in 1968 and comprises about 18,000 acres of wetlands and grasslands. Water management is complicated by the fact that the Bear River has been diverted through Refuge wetlands to Bear Lake where it is stored for subsequent release during irrigation season through a canal that also bisects the Refuge. Siltation and carp have greatly impacted management. Water quality is compromised in areas of the marsh where water and fish control are limited. Impoundments have been constructed that exclude carp and thereby dramatically improve production of wetland plants. The positive influence on water-dependent species has been great. The Refuge is located at a relatively high elevation and typically ices up by mid-November, and, therefore, does not provide consistent wintering habitat. However, the Refuge is on line with a southerly migration flyway and could be important to future attempts to encourage distribution away from the Island Park area. Swans were transplanted to Bear Lake NWR in 1996, but none of the transplanted birds have returned to nest. However, a pair of Trumpeter Swans that probably dispersed from Grays Lake NWR during 1997 discovered the Refuge and successfully nested in 1998. Overall, nesting habitat found on Bear Lake NWR could potentially support up to 10 pairs.

Grays Lake NWR

Grays Lake NWR is located about 27 miles north of Soda Springs, Idaho, near the Wyoming border. The Refuge was established in 1965 under the auspices of cooperative agreements with local landowners and the Bureau of Indian Affairs. These agreements dealt with 22,000 acres of the lakebed area. Since this time, the Service has purchased about 5,300 acres of land adjacent to the lake that is comprised primarily of grasslands. The area has a long and complicated history of water management and land issues. Water levels in the lake are set by an agreement between local landowners, Bureau of Indian Affairs, and the Service that dictates drawdown to a prescribed water level by 25 June of each year. Water is diverted to Blackfoot Reservoir through a canal starting in May each year. Water rights are controlled by the Bureau of Indian Affairs and are used downstream for agriculture. Swans have been transplanted successfully into Grays Lake and the Refuge provides important nesting habitat for the Tristate population. However, during dry years the drawdown schedule negatively impacts brood rearing habitat. The Refuge is at a relatively high elevation and, therefore, does not provide suitable wintering habitat. However, up to 10-12 pairs of Trumpeter Swans have nested on Grays Lake in recent years and it potentially could support as many as 15 pairs.

Oxford Slough WPA

Oxford Slough WPA is located 50 miles south of Pocatello, Idaho. It contains 11,878 acres, of which 711 are wetlands. Ducks use the area extensively for nesting, however, no documentation of swan nesting has occurred to date. Maintaining water levels through the nesting period has been a problem in dry years. However, the area is very productive for a wide variety of water dependent birds. Future cooperation with neighboring private lands may increase the potential for maintenance of water levels through the brood rearing period. The area has potential to provide nesting habitat for two - three pairs of Trumpeter Swans.

In summary, Southeast Idaho NWRC provides excellent habitat for nesting swans although wintering habitat is limited. Two of the units, Grays Lake and Bear Lake NWRs, are located along a southerly path from the Island Park area to milder wintering areas. Current funding levels only allow for hazing and monitoring. If translocation and habitat modifications are deemed to be appropriate, increased funding will be necessary.

THE STATUS OF THE OREGON TRUMPETER SWAN PROGRAM

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ABSTRACT

Trumpeter swans (*Cygnus buccinator*) were moved from Red Rock Lakes National Wildlife Refuge (Red Rock Lakes), Montana, to Malheur National Wildlife Refuge (Malheur), Oregon, beginning in 1939, resulting in an established breeding flock at Malheur by the late 1950s. Following decline of the Malheur flock in the 1980s, a plan was proposed and initiated to increase Trumpeter Swan numbers and expand their breeding and wintering distribution in Oregon. The Oregon Trumpeter Swan Program (OTSP) was the result of this proposal. OTSP projects included moving Trumpeter Swans from Malheur to Summer Lake Wildlife Area (Summer Lake), moving swans from Red Rock Lakes to Malheur and Summer Lake, and moving swans from Harriman State Park, Idaho, to Summer Lake during 1991-96. The program successfully expanded the range of trumpeters in Oregon, however, additional effort is needed to achieve numerical goals for this flock. This paper details the results of this program and discusses future strategies for accomplishing program goals.

INTRODUCTION

Trumpeter Swans that breed in Oregon are considered part of the Rocky Mountain Population of Trumpeter Swans (RMP) for flyway management purposes and are included as a segment of the U.S. Flocks within the Pacific Flyway Plan for the population (Subcommittee on Rocky Mountain Trumpeter Swans 1998). Flyway Plan objectives relating to Oregon include: 25 nesting pairs and 100 adults and subadults by 2002.

HISTORY OF THE OTSP

Attempts to establish a breeding population of Trumpeter Swans in Oregon began in 1939 with initiation of a program that moved birds from Red Rock Lakes to Malheur. Cornely *et al*. (1985) summarized Trumpeter Swan production at Malheur through 1984. The first nesting occurred in 1958 and the Malheur flock slowly grew until its numbers peaked in the early 1980s at 19 breeding pairs and a total of 77 individuals (Ivey 1990). Flood conditions in the mid-1980s reduced swan productivity and allowed high numbers of carp (*Cyprinus carpio*) to invade traditional Malheur wintering sites and reduce aquatic food supplies, resulting in degraded wetland conditions and a declining trend in swan numbers. Low recruitment and shortage of winter food caused by degraded wetland conditions were the primary factors limiting the population (Ivey 1990) and these problems were compounded by the sedentary behavior of the flock.

Because of declining flock size, a proposal was developed to enhance conditions for Trumpeter Swans in Oregon by increasing the breeding population and expanding their breeding and wintering range in Oregon (Ivey and Carey 1991). The proposal included a goal to enhance habitat conditions at Malheur and other wetland habitats for Trumpeter Swans and also provided objectives for breeding and total flock size. Oregon Department of Fish and Wildlife's (ODFW's) Summer Lake Wildlife Area was proposed as the primary wintering area and release site for translocated swans. Klamath Forest National Wildlife Refuge was also proposed as a potential future breeding area.

The proposal was endorsed by ODFW and U.S. Fish and Wildlife Service (USFWS) and was presented to the Pacific Flyway Study Committee in March of 1989. A decision for approval was tabled because of concerns about potential conflicts between an expanded Oregon Trumpeter Swan flock and Tundra Swan (*C. columbianus*) hunting in Nevada. The proposal was presented to the Study Committee again during meetings in July 1989, March 1990, July

1990, and March 1991, and was finally approved at the July 1991 meeting because Oregon had suitable breeding and wintering habitat, and no conflicts with existing swan seasons.

Progress began in July 1991, when four subadult trumpeters were moved from Red Rock Lakes to Malheur and two subadults were also moved from Malheur to Summer Lake. The Red Rock Lake birds were brought in to enhance the genetic makeup of the Malheur flock and as insurance against the flock's decline in case the birds that were moved to Summer Lake did not return. Concurrently, Summer Lake was also selected by the Subcommittee on Rocky Mountain Trumpeter Swans as a site to release wintering birds captured at Harriman State Park (HSP), as part of RMP redistribution efforts. During late November 1991, 100 trumpeters were moved from HSP to Summer Lake. The results of the 1991 efforts were reported by St. Louis (1992).

In 1992, four subadult trumpeters were moved from Malheur to Summer Lake in July. To reduce the impact of the cessation of winter feeding at Red Rock Lakes, surplus subadults and cygnets were available for translocation to other sites. We moved 52 trumpeters from Red Rock Lakes to Summer Lake, including 26 molting subadults in July and 26 cygnets in September. An additional 101 Trumpeter Swans were moved to Summer Lake from HSP in Fall 1992. One adult female was captured at Malheur and moved to Summer Lake in January 1993. During summer 1993, two subadults and nine unfledged cygnets were moved from Malheur to Summer Lake, and in the fall, 152 Trumpeter Swans were moved from HSP to Summer Lake. In 1994, one subadult and one cygnet were moved from Malheur to Summer Lake in January; five Malheur subadults and seven unfledged cygnets were moved to Summer Lake during summer; and two additional cygnets were moved to Summer Lake in December. A total of 62 trumpeters were moved from HSP to Summer Lake during Fall 1994, and 18 of those were wing-clipped to force them to remain at Summer Lake until the summer molt. No swans were moved from Malheur to Summer Lake in 1995, but 169 were moved to Summer Lake from HSP and all were wing-clipped. In 1996, six cygnets were moved from Malheur to Summer Lake. No swans were moved in Oregon in 1997-99.

STATUS OF WETLAND HABITATS

Malheur staff have focused efforts on restoration of wetland habitats for Trumpeter Swans for the past 10 years. The historically important winter site at Refuge headquarters was restored by removal of carp in 1992. A 500-acre project to enhance wetlands near the mouth of the Blitzen River was completed in 1998. Most of the Refuge's water delivery system was rehabilitated and carp numbers were reduced to benign levels in managed refuge wetlands.

There have also been efforts at other wetlands within the current Trumpeter Swan range that will provide potential future habitat. At Klamath Forest NWR, a major acquisition added about 24,000 acres to the Refuge. The Nature Conservancy has accomplished a major wetland restoration project (19,000 acres) at Sycan Marsh Preserve in Lake County and is currently working on a large acquisition and wetland restoration project at the mouth of the Williamson River in Klamath County. The Bureau of Land Management completed a major wetland enhancement project at Warner Wetlands in Lake County and purchase and restored a large block of wetlands called the Wood River Wetlands in Klamath County. The private River's End Ranch created a large wetland along the Chewaucan River with funding from Ducks Unlimited, Inc., ODFW's Waterfowl Stamp Program, and USFWS' Partner's for Fish and Wildlife Program. Also, several smaller scale private wetland projects have been accomplished with combined funds from ODFW's Habitat and Access Program and USFWS' Partner's Program near Summer Lake.

The Intermountain West Joint Venture is also being actively applied in this region and several large wetland projects are on the horizon. These projects will increase habitat for Oregon Trumpeter Swans in the future. At this time, we do not believe that habitat deficiencies are limiting the Oregon flock. There appears to be a good supply of forage and winter habitat with open water available within the expanded trumpeter range and winter temperatures are not as harsh as in the HSP region.

STATUS OF OREGON TRUMPETER SWANS

Population data for Oregon Trumpeter Swans are summarized in Table 1. Unfortunately, we are no closer to our objectives for the breeding population than when the program began in 1991. In 1999, Malheur nesting pairs had declined to only two, partly because about half of Malheur trumpeters were moved to Summer Lake after 1991 and also because of tragic losses of breeding adults in recent years. Translocations did result in expansion of breeding range. Figure 1 shows locations of nests outside of Malheur since the program began. Thirteen nests have been recorded in central Oregon from 1994-99.

Table 1. Summary of Oregon Trumpeter Swan survey data including Malheur and central Oregon nests, cygnets fledged, and midwinter and fall counts, 1988-99.

Year	Malheur Nests	Central OR Nests	Cygnets Fledged	Midwinter Total	Fall Counts: Adult (Cygnet)
1988	5	0	8	24	37 (8)
1989	3	0	3	36	22 (3)
1990	4	0	7	23	27 (7)
1991	6	0	14	31	38 (14)
1992	7	0	6	123	75 (5)
1993	7	0	18	127	47 (17)
1994	5	2	11	210	48 (13)
1995	3	1	3	99	46 (6)
1996	5	2	11	189	49 (10)
1997	4	3	7	55	31 (9)
1998	3	2	8	39	39 (8)
1999	2	2	9	34	19 (9)

At least eight different pairs initiated these nests. Of these eight pairs, two swans were identified as originally from Malheur, three were from Red Rock Lakes translocations, and one was from HSP translocations. Several of these birds have returned to winter at Summer Lake with their cygnets, demonstrating another successful element of the program. Three of these new nesting pairs experienced a mate loss and have not re-paired as of 1999. The scattered distribution and relatively low numbers of Trumpeter Swans apparently make re-pairing difficult as there are limited opportunities for chance encounters. Due to open winter habitat conditions, single birds can remain isolated from each other and the primary problem appears to be the low numbers of swans available for re-pairing.

A total of 42 flightless cygnets was moved to Summer Lake as detailed above. Some of these have made striking migrations after they were taken from their parents (Figure 2). Three Red Rock Lakes cygnets migrated from Summer Lake and were observed near Independence, California, in December 1992 and then returned to Summer Lake in Spring 1993. A Red Rock Lakes cygnet was found at Lost River in south central Oregon in January 1993, then back at Summer Lake in May, then at Nelson, California, in December 1993. It was found near Forest Grove, Oregon, in December 1994 and at Mt. Vernon, Washington, in January 1995. Another Red Rock Lakes cygnet was found near Oroville, California, in March 1993 and then near Kamloops, British Columbia, in January 1994. One Malheur cygnet stayed at Summer Lake from September 1993 through April 1994 and was found dead near Mackenzie, British Columbia, in June 1994. Another Malheur cygnet, released at Summer Lake in September 1996, was found in the Sacramento Valley of California in January 1997. In February it was reported at Bear River National Wildlife Refuge near Brigham City, Utah. In December 1997, this bird was again found in the Sacramento Valley of California and was sighted in Utah again in southern Box Elder County in March 1998. These examples illustrate the extreme movements Trumpeter Swan cygnets are capable of if they don't remain with their parents during their first winter, and refute the theory that Red Rock Lakes swan stock have genetically induced non-migratory behavior.

Midwinter Trumpeter Swan counts were higher from 1992-96 because of the Harriman translocations, but declined after the RMP redistribution project ended (Table 1). Fall numbers were highest in 1992 when 52 Red Rock Lakes trumpeters were brought to Oregon, and remain higher than when the project first began. We suspect the actual numbers of Oregon swans are higher than these data indicate because complete counts are much more difficult now that swans are more widely distributed. The OTSP has resulted in expansion of summer and winter distribution of Trumpeter Swans. In 1991, trumpeters only summered in Harney County, whereas in 1999, trumpeters were summering in Harney, Lake, Klamath, Crook, Grant, and Baker counties.

Shea and Drewien (1999) evaluated the results of redistribution efforts for the RMP, including the 585 trumpeters moved from HSP to Summer Lake.

Figure 1. New Oregon Trumpeter Swan nesting sites, 1994-1999.

Of 383 flight-capable swans, 147 (38%) were known to have survived after redistribution, through May 1997. Of these survivors, 16 birds returned to Summer Lake in subsequent winters and eight returned to Summer Lake in at least 2 subsequent winters. Of the 174 wing-clipped trumpeters, 44% were known to have survived through May 1997 and 22 of these birds returned to Summer Lake in subsequent winters.

The greatest cause of mortality of Trumpeter Swans in Oregon since 1958 has been power line collisions (Figure 3). There are still some problem power lines at Malheur and Summer Lake that have killed trumpeters in recent years. Predation appears to be the second most important mortality factor. However, the importance of predators may be exaggerated because these data include four swans that were wing-clipped in 1995 and were more vulnerable to predators. Also, losses to predators increase during drought periods when drying wetlands expose flightless swans to predators. These losses can be reduced with improvements in water management capabilities on managed wetlands. Losses to shootings can hopefully be reduced with increased public awareness and hunter education programs.

LESSONS LEARNED

This project has been a learning experience for those of us involved. Lessons learned included:

- It is difficult to change the habits of adult swans and most will return to their old winter and summer sites, possibly leading younger swans away from our target areas.
- Pre-fledged cygnets taken from their parents will readily migrate, and this technique may prove useful in developing migration traditions to new wintering sites.
- Subadults are the best candidates for translocation as they are more likely to pioneer new nesting sites.
- Wing-clipping of adults only delays the inevitable return migration to their traditional areas.
- We need a larger base population to be successful and overcome problems with adult swans finding replacements for lost mates.
- We will need to sustain a higher level of additions of Trumpeter Swans into key wetland sites to build a viable Oregon flock.

FUTURE CHALLENGES

To achieve the goals of the OTSP, we need to initiate more proactive efforts to build the Oregon flock. We need to reduce mortality factors as much as possible and find innovative ways to acquire enough Trumpeter Swan stock to maintain a viable future population. Specific actions which need further attention include:

1. Rewrite the OTSP Plan to identify future strategies and specific goals for numbers of swans to be introduced over the next 5 years.

2. Acquire at least 25 Trumpeter Swans each year from a variety of sources. Consider using captive breeding pairs as a source of cygnets for introductions (Carey and Liedblad 2000). Consider salvaging wild cygnets from pairs where successful production is unlikely. Consider acquiring surplus subadults from summering areas where possible.

3. Identify and modify power lines that have a history of killing Trumpeter Swans. Problem power lines at Malheur and Summer Lake should be a priority for removal or modification.

CONCLUSION

Although the OTSP has made some successful strides in recent years, much more effort needs to be directed towards these birds to declare the project a success. We need to find innovative ways to obtain enough trumpeters to introduce into Oregon wetland systems to fill in the gaps in Oregon distribution and create a more interactive, viable flock in Oregon. Ideally, we would like to release at least 25 trumpeters into Oregon wetlands each year, until the flock reaches and sustains our long-term objectives.

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MUTE SWAN CONTROL AND TRUMPETER SWAN EXPERIMENTAL BREEDING PROJECT IN URBAN CENTRAL OREGON

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INTRODUCTION

The city of Bend, Oregon, was home to a rapidly expanding population of Mute Swans (*Cygnus olor*) that were released into an impoundment of the Deschutes River in the early 1960s. The original two pairs of mutes were the private property of the Bend Metro Park and Recreation District (BMPRD). The BMPRD did not actively manage these swans. By 1995 the population had expanded to 51 swans and was exceeding the carrying capacity of the area. Mute Swans were observed in areas away from the city as they sought out food and unoccupied territories. The Oregon Department of Fish and Wildlife and the Central Oregon Audubon Society became alarmed at the sudden expansion of this exotic species and the potential impacts that a feral Mute Swan population might have on recovery efforts for Trumpeter Swans (*C. buccinator*) in the state. This paper describes efforts to control and reduce the Mute Swan population, replace Mute Swans with Trumpeter Swans, and explore the possibility of developing an urban Trumpeter Swan breeding program to aid reestablishing wild populations in native habitats.

MUTE SWAN POPULATION CONTROL

Data were collected on the size, age composition, and distribution of the Mute Swan population. The midwinter population count from 1980-95 is shown in Figure 1. In 1995, there were six breeding pairs that hatched 25 cygnets. Another 19 swans were in the 1-3 year-old age classes. The distribution of nesting pairs indicated most of the suitable flat water habitat within city limits was occupied. The data confirmed field reports that the population was expanding rapidly and of sufficient size that subadult swans would be dispersing into new areas.

Swans are an important symbol for the local community. Citizens, civic groups and numerous businesses, including the Bend area Chamber of Commerce, have adopted the swan in their official logo. To accommodate the wide range of social concerns and values, in 1995 the BMPRD formed a Waterfowl Advisory Committee composed of a diverse assortment of environmental, wildlife, animal rights, and hunter groups, resource agencies, concerned citizens, and landowners. The purpose of this group was to prepare a plan for managing swans and other waterfowl in the city parks.

The Waterfowl Management Plan (BMPRD 1995) identified actions needed to control this fast growing population of Mute Swans while minimizing the potential for public opposition. The plan established a population objective of four to six pairs of swans, required all swans to be pinioned, initiated a program to control population growth, and recommended replacing the exotic Mute Swans with an equal number of native Trumpeter Swans. A special subcommittee was assigned to handle community education and public relations.

To reduce the population to the objectives set in the management plan, swans were segregated in neutered pairs or same sex pairs and relocated to private ponds. Three pairs of Mute Swans were relocated to Bend area golf courses to help with aquatic weed control and for aesthetic appreciation. As of August 1999, the Mute Swan population on the Deschutes River has been reduced to three pairs.

A wildlife veterinarian volunteered to work on the procedure to neuter or vasectomize the cobs and spay the pens. The surgical procedures took several years to complete because of the size of the population. During the interim, eggs laid by fertile swans were sprayed with mineral oil to prevent development.

The surgical procedures presented some difficult challenges. In the pens, the ovarian vasculature arises from the aorta and their removal resulted in hemorrhage, thus this procedure was discontinued. Most vasectomies were successful; however, one cob regenerated the vas deferens and became reproductively viable in 1999. Two cobs that were castrated regenerated the testes, possibly due to the epidmial attachment to the adrenal gland, and this procedure was dropped from the protocol. Uterine and infundibular removal in the pen is now being considered. More information on this aspect of the project can be found in Liedblad 1999 (in prep).

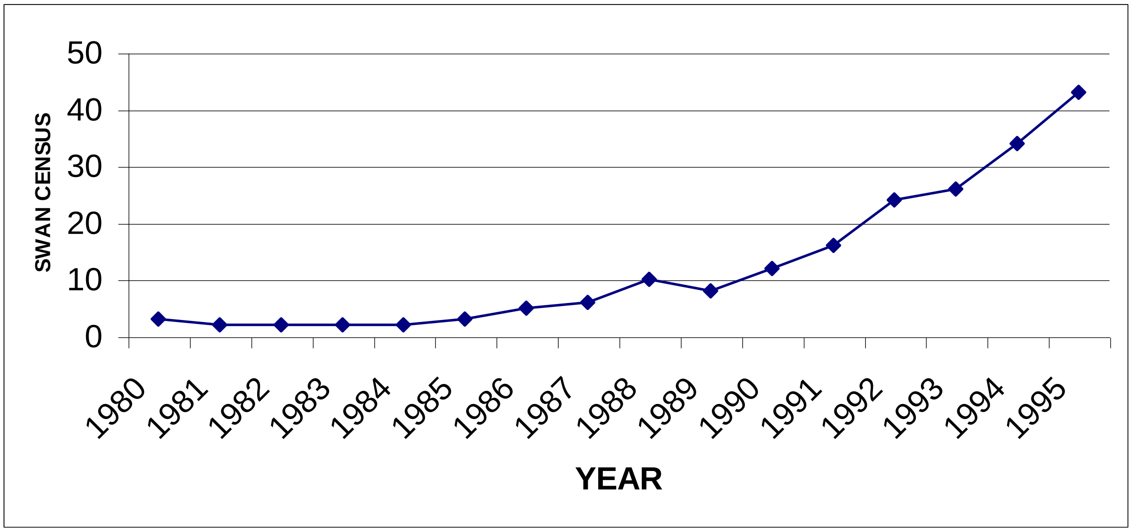

Figure 1. Mid-winter count of Mute Swans on the Deschutes River, Bend, Oregon, 1980–95.

Public response has been minimal to the swan population control and reduction activities. The public is most disappointed in not seeing cygnets every spring and a few individuals have concerns that pens incubating infertile eggs are under physical and emotional stress. Otherwise, the public appears unaware that the number of swans in the park is greatly reduced from the early 1990s.

TRUMPETER SWAN INTRODUCTION

The transition to Trumpeter Swans started in May 1998 when two yearling pairs were released on the North Unit impoundment. The birds were purchased from a private breeder in Wisconsin. Although the release site is within the city limits, the habitat in this area consists of well established riparian vegetation comprised of alder (*Alnus* spp.), cattails (*Typha* spp.), iris (*Iris* spp.), sedges (*Carex* spp.), rushes (*Juncus* spp.), an abundance of elodea (*Elodea canadensis*), and other aquatic plants. A half dozen homes border the river on the lower end of the pond and a ¾ mile long hiking trail, well screened with alders, runs the length of the western shore.

We purchased swans that had the best prospects for doing well in an urban environment. The cygnets we released were from stock raised by their parents, as opposed to those hatched from incubators and raised by humans, since parent-raised swans are reported to be less aggressive towards humans (Donna Compton pers. comm.). The domestically raised trumpeters had an association of food with people and it took less than a week before the cygnets were coming to a feed station.

The cygnets were routinely observed by several of the homeowners who reported any problem the swans encountered in adapting to their new environment. Most difficulties were from the swans spilling over the 25-foot high North Unit dam that creates the impoundment. The pinioned cygnets had to be repeatedly captured and returned to the pond. Another potentially serious problem from entanglement in fishing line was averted because of the public's vigilant monitoring of the health and activities of the birds.

TRUMPETER SWAN BREEDING PROGRAM

The swan objectives identified in the Waterfowl Management Plan for Bend set a goal of four to six breeding pairs of Trumpeter Swans. Public appeal for Trumpeter Swans has increased since 1997 when the State of Oregon adopted Wildlife Integrity Rules that prohibit ownership of reproductively viable Mute Swans. A local breeding population of Trumpeter Swans will provide the public an opportunity to see cygnets in the city parks.

In addition to the city of Bend, several local golf courses and some private estates with large ponds have expressed a desire to own Trumpeter Swans. The potential for numerous breeding pairs of swans sparked a new idea to create a cooperative Trumpeter Swan Breeding Program and link it to the Oregon

Trumpeter Swan Program. The Trumpeter Swan Breeding Program would develop an agreement between private entities with breeding pairs of swans and wildlife agencies for the disposition of the annual production of cygnets. The captive-raised cygnets would be available for release in the wild to help meet the State's recovery objective of 25 breeding pairs of Trumpeter Swans (Subcommittee on Rocky Mountain Trumpeter Swans 1998). Prior to fledging, the cygnets would be gathered and relocated to Summer Lake Wildlife Management Area, in south-central Oregon, where they would spend the winter mingling with wild swans. It is hoped the cygnets will learn a migratory tradition from the wild swans. Similar programs have been developed in Tulsa, Oklahoma, Camrose, Alberta, and southern Ontario.

The goal of the breeding project would be to have at least six pairs and preferably 10 pairs of captive-breeding swans. The managed pairs could conservatively produce between 15- 30 cygnets each year when all pairs are at full maturity and experienced at raising young.

Several elements of this plan need additional discussion before the project can move forward. Items to consider include:

- Ownership of the Trumpeter Swan breeding pairs
- Origin of breeding stock
- Budget and funding
- Composition of a management team
- Time line for full project implementation
- Disease transmission.

If details can be worked out and the necessary approvals and endorsements obtained, then a plan will be prepared later in 1999 or early 2000. Verbal commitments from the private parties wishing to possess Trumpeter Swans give this project a good chance of success. The annual release of captive raised cygnets into the wild will move Oregon towards its recovery goals for a self-sustaining population of wild Trumpeter Swans.

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ELK ISLAND NATIONAL PARK TRUMPETER SWAN REINTRODUCTION - 1999 UPDATE

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INTRODUCTION

The Elk Island National Park (EINP) Trumpeter Swan Reintroduction Program, initiated in 1987, is a partnership program to restore the Trumpeter Swan (*Cygnus buccinator*) as a breeding, migratory bird in EINP and surrounding area. The goal of expanding the summering and breeding range of Trumpeter Swans in Alberta has two objectives: (1) establishing a free-flying, breeding flock in EINP; (2) diversifying migration patterns and wintering areas of this group of swans (Kaye and Shandruk 1992). Trumpeter Swans are monitored in the Grande Prairie area (site of the host flock for cygnets to be relocated), EINP, and select habitats in the Lac La Biche area (initiated in 1999). The cygnet relocations occur after the Grande Prairie production surveys and are restricted to lakes in the forested or green zone that have a history as swan breeding lakes. Winter and migration monitoring of EINP swans is conducted through partnerships with other wildlife agencies and volunteers in Canada and the United States. This paper reviews the efforts, successes, and setbacks that were experienced, primarily during the past 5 years, in this ongoing project.

METHODS

Grande Prairie production surveys

Fixed wing aerial surveys, using a Cessna 210, were conducted in early September of 1990-99 on lakes in the Grande Prairie area. Severe weather affected flight conditions, resulting in variation in the number of lakes surveyed each year. Surveys were conducted along designated routes 100-150 m agl (above ground level) at 150-200 kph (Shandruk and Winkler 1988, and Beyersbergen and Kaye 1995). These surveys provided estimates of production success including number of broods, brood size, and total cygnets. Locations of broods of four or more cygnets were also identified for possible relocation.

Monitoring of swans in Elk Island National Park

Aerial surveys, using a Cessna 172, were conducted in early June to check for return of resident swans, distribution, and possible nesting. Fall surveys were flown in early September, prior to the cygnet relocation from Grande Prairie, and in early October prior to Tundra Swan arrival. The area monitored included EINP, Blackfoot Provincial Recreation and Grazing Area, and numerous lakes and wetlands within a couple of kilometers of the park boundaries.

Park staff conducted ground surveys of the lakes on a limited basis through spring and early summer, with effort focusing primarily on swan breeding lakes. Prior to cygnet relocation, Park staff checked area lakes used by nonbreeding swans daily to monitor use. After the relocation, the lake(s) with released cygnets were checked daily.

In addition, an active public relations program to reduce human disturbance of the swans was implemented by Park staff and the Friends of Elk Island Park Society. In 1995, Astotin Lake was closed to boating activity from early September through freeze-up to allow the transplanted cygnets and the nonbreeding adults to establish a close bond.

Potential northern expansion of swans released at EINP

Aerial surveys, using a Cessna 210, were conducted in the St. Paul/Lac La Biche area (approximately 200 km northeast of EINP) in June 1999. Ground observers checked all sites where swans were observed during aerial surveys and that were accessible by ATV or on foot to confirm numbers of swans (age classes and brood size) and to identify all collars and colored tarsal bands.

Trumpeter Swan cygnet capture and relocation

Trumpeter Swan cygnets, from broods of four or more, were captured during the first half of September when they were approximately 80-90 days of age. Cygnets were captured with a large fish dip-net, using a Jet Ranger 206B helicopter equipped with low skid gear following procedures described in Shandruk and Winkler (1988). The helicopter capture team consisted of the pilot and one individual who captured the cygnets.

After capture, the ground team, consisting of five persons assigned specific task(s), determined the sex, weight, length of 9^{th} primary of the cygnets, and banded them. To increase cygnet survival, minimum standards were set for selection of relocation individuals, including weight of 6.5 kg and 9th primary length of 160mm. When feasible, a higher number of females were selected, based on previous observations of greater fledge-site fidelity by females (Beyersbergen and Kaye 1995). At least two cygnets from each selected brood were returned to their respective lakes to be reunited with the adults. Those cygnets designated for relocation were administered an electrolyte solution and further processed as described in Beyersbergen and Kaye (1995), with the exception that the use of the red dye (rhodamine-b) was discontinued. The cygnets were transported in large plastic kennels in an enclosed horse trailer and released later that same day on selected lakes in the Park. Following the procedures established in 1992, only cygnets were moved and they were released near non-breeding adults in the Park in an attempt to establish these birds as their surrogate parents.

Migration and winter observation program

A cooperative program to locate, observe and report marked Trumpeter Swans was implemented in conjunction with the winter transplant program in the Tristate region (Montana, Wyoming, Idaho). A network of wildlife agency personnel and volunteer observers in Canada and the United States reported marked swans to the transplant project coordinator, who maintained the project database and forwarded reports to the appropriate agencies. The information on wintering and migrating EINP Trumpeter Swans was collected through this mechanism.

RESULTS AND DISCUSSION

Grande Prairie production surveys

Survey results (1990-99) are displayed in two tables. Table 1 shows the population dynamics for all lakes surveyed in the area. The number of lakes surveyed varied for logistical reasons (e.g. poor flying weather). In addition, swans occupied several new lakes in recent years. This variability in lake numbers and specific lakes surveyed annually makes it difficult to compare or detect trends in adult numbers and productivity. In 1995, as part of the International 5-year Survey for Trumpeter Swans, the survey area (number of lakes checked) was increased for that year only. Although the number of lakes increased in 1995, the occupancy rate declined and it is possible that a number of these new lakes were unsuitable for swans. Environmental conditions may also have affected hatch success, cygnet survivability, or the breeding pair may have abandoned the lake prior to surveys being conducted. Repeat surveys of the expanded area in future years could provide further information on the suitability of these lakes.

Table 2 shows adult and cygnet trends for the 98 lakes that were checked by aerial surveys each year during this 10-year period. Paired adults with cygnets increased during the first 3 years, peaked in 1992, and then showed a gradual decline until 1998 when numbers increased. These trends were noted in the corresponding changes in the number of paired adults without young. What remained somewhat constant was the total number of paired adults. Since the surveys are conducted in the fall, there is no indication of the number of paired birds attempting to nest. It is believed that poor environmental conditions (i.e. low mean temperatures, high levels of precipitation) around hatch or early post hatch period would result in losses of nests and/or young, thus changing the status of the adult pair observed during the fall production surveys. These same environmental conditions would affect mean brood size. Poor productivity and high cygnet loss in some years is further highlighted by the small number of "other" (flocked) adults observed in successive years (1997: 70 adults; 1998: 26 adults). High winter mortality may also play a role in the "other" adult numbers. The majority of suitable lakes (43-50%) appear to be occupied with little change over the years, so increases in swan production will force birds to expand into areas that are not being surveyed and will eliminate the potential for identifying overall population increases in the current survey area.

Elk Island National Park monitoring

Twelve adult swans returned to the Park area in spring 1995, including two known pairs (Yellow 33AC/Yellow 53AC and Yellow 20AC with an unmarked adult) (Table 3). Yellow 28AC, collared as a yearling in July 1994 on Flyingshot Lake, returned with two other EINP-released swans. Both were observed with metal tarsal bands. The origin of an unmarked adult observed on Astotin Lake in October is unknown.

The return of the two females (51AC and 27AC-1992 released cygnets) as paired birds, one with an unmarked swan, was another highlight for the year. This reaffirmed the point that female have a high release site fidelity (Beyersbergen and Kaye 1995), which results in additional birds following them from the wintering areas. The failure of these two pairs to return to the park in subsequent years (51AC & mate in 1996, and 27AC & mate in 1997) was a

Table 1. Summary of Trumpeter Swans observed at all lakes checked during aerial surveys in the Grande Prairie area, 1990-99.

	1990	1991	1992	1993	1994	1995	1996	1997	19998	1999
Paired Adults - no cygnets	60	34	48	50	52	90	70	62	56	68
Paired Adults with cygnets	52	70	106	76	64	82	54	42	72	92
Other Adults	97	57	98	140	196	207	143	75	26	117
Total Adults	209	161	252	266	312	379	267	179	154	277
Cygnet totals	79	99	214	130	107	141	90	69	123	136
Number of Broods	26	35	53	38	32	41	27	21	36	46
Mean Brood Size	3.04	2.83	4.04	3.42	3.34	3.44	3.33	3.29	3.42	2.96
Total Swans	288	243	466	396	419	520	357	245	277	413
Lakes Surveyed	175	193	180	153	150	234	176	128	138	182
Lakes Occupied	62	66	84	66	69	95	72	65	63	86
(% of Total Surveyed)	(35.4)	(34.2)	(46.7)	(43.1)	(46.0)	(40.6)	(50.8)	(50.8)	(45.7)	(47.3)

Table 2. Trumpeter Swans observed on 98 lakes checked each successive year during aerial surveys in the Grande Prairie area.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Mean	S.E.
Paired Adults - no cygnets	50	20	18	26	38	42	50	54	42	40	38	4.0111
Paired Adults with cygnets	30	52	74	56	46	46	42	34	60	58	49.8	4.1253
Other Adults	77	47	81	139	193	198	141	70	26	111	108.3	18.5479
Total Adults	157	119	173	221	277	286	233	158	128	209	196.1	18.5205
Cygnet totals	52	76	155	98	79	87	73	55	103	86	86.4	9.2065
Number of Broods	15	26	37	28	23	23	21	17	30	29	24.9	2.0626
Mean Brood Size	3.47	2.92	4.19	3.50	3.44	3.78	3.47	3.24	3.43	2.97	3.441	0.11618
Total Swans	209	195	328	319	356	373	306	213	231	295	282.5	20.6140
Lakes Occupied	43	45	49	44	50	51	55	54	52	53	49.6	1.3515
(% of Total Surveyed)	(43.9)	(45.9)	(50.0)	(44.9)	(51.0)	(52.0)	(56.1)	(55.1)	(53.1)	(54.1)		

Table 3. Trumpeter Swans observed in Elk Island National Park, Alberta, and surrounding area.

Year	Collar	Age	Sex	Lake Name	Comments
1995	Yellow 33AC Yellow 53AC	4 Ad.	F M	North Park Lake	Bred and hatched 5 cygnets. The female and all 5 cygnets disappeared within one month. Cause of mortality - unknown.
	Unmarked	Ad.		Astotin Lake	Observed briefly with #53 on Astotin Lake in October. No colored tarsal or metal bands.
	Yellow 20AC Unmarked	8 Ad.	M	Running Dog Lake	Observed on several other lakes in the area. #11 did not return or collar was lost. Unable to observe for metal leg bands.
	Yellow 51AC Unmarked	3 Ad.	F	Paul Lake	Returned from wintering area with unmarked swan. Observed on several lakes in the area.
	Yellow 27AC Yellow tarsal	3 2	F	Blackfoot Lake	Unmarked swan had a yellow tarsal band indicating a 1993 transplant.
	Yellow 28AC Unmarked Unmarked	2 Ad. Ad.	F	Jordan Lake	Observed on Tawayik and Astotin Lakes in the north park area. Both unmarked swans had metal leg bands.
1996	Yellow 53AC Unmarked	Ad. Ad.	M	North Park Lake	Observed using several lake in the north park including Tawayik and Astotin Lakes.
	Yellow 20AC Unmarked	9 Ad.	M	Running Dog Lake	Observed on several other lakes in the area.
	Yellow 27AC Unmarked	4 Ad.	F	Blackfoot Lake	Observed on other lakes including Tawayik Lake.
	Yellow 28AC Unmarked	3 Ad.	F	Unnamed Lake	Small lake in the north park area near the south gate.
1997	Yellow 53AC Unmarked Yellow 28AC	Ad. Ad. 4	M F	North Park Lake	Unmarked swan observed with Yellow 53 until mid May. Yellow 28 paired with Yellow 53 - end of May.
	Yellow 20AC Unmarked	10 Ad.	M	Running Dog Lake	Observed on Blackfoot Lake as well.
	Unmarked Unmarked	Ad. Ad.	M F	South Park Lake	Paired swans.
1998	Yellow 53AC Yellow 28AC	Ad. 5	M F	North Park Lake	Observed on several lakes in the north park area.
	Yellow 20AC Unmarked	11 Ad.	M	Running Dog Lake	Also observed on Blackfoot Lake.
	Unmarked Unmarked	Ad. Ad.	M F	South Park Lake	Bred and hatched 4 cygnets that fledged the lake in October. **First in over 100 years**.
1999	Yellow 53AC Yellow 28AC	Ad. 6	M F	North Park Lake	Bred and hatched two cygnets that perished within 24 hours during a severe storm.
	Yellow 20AC Unmarked	12 Ad.	M	Running Dog Lake	
	Unmarked Unmarked	Ad. Ad.	M F	South Park Lake	Bred and hatched 7 cygnets, observed on 1 July (1 week old) and 3 on 15 September.
	Red A23 tarsal Unmarked	Yr. Yr.	F	Astotin Lake	Unmarked yearling- possibly cygnet hatched in the south park area the previous year.

setback and has further delayed the build-up of the breeding flock in EINP.

Eight adults returned to the park in 1996, none of which had been released as cygnets in 1995. However, some of the 1995 cygnets were observed elsewhere as will be discussed later. Yellow 53AC, after the loss of its mate in 1995, returned with a new mate to set up territory on the same lake in 1996 and 1997. However, 53AC's unmarked female partner was only observed until mid-May 1997 at which time she disappeared from the park (status is unknown). A new pair bond, 53AC and 28AC, was established by the end of May. In addition, two unmarked adults were observed continually on a lake in the south part of EINP during the summer and fall 1997. Seven adults were observed in 1997 and only six adults in 1998 and 1999. Adult losses during migration and the winter period, in conjunction with the lack of recruitment either through cygnet relocation (1996 and 1997) or local breeding, continue to result in a decline in adult numbers in the park. However, the 1999 observation of two yearlings in the park, which had originated from breeding and relocation efforts, is encouraging. Such recruitment is critical for the growth of the breeding flock in EINP.

Breeding occurrences

The first breeding in the park in 1990 by 20AC and an unmarked female was unsuccessful and both young disappeared. Yellow 20AC and an unmarked adult have been annually observed on Running Dog Lake, but there have been no other observations of nesting in 1995-99. The second breeding occurrence, in 1995 by 53AC and 33AC, was also unsuccessful when all five of the cygnets and the female, 33AC, disappeared within a month of hatch. The loss of the breeding age female further delayed the building of a breeding flock in the park area.

No further breeding occurred in the park until 1998, when an unmarked pair nested in the southern area of the park and hatched four cygnets. All four young survived to fledging and departed the park with the two adults in late October. This was a milestone, in that it was the first successful breeding and fledging of Trumpeter Swans from Elk Island National Park in over 100 years. This same pair returned to their territorial breeding lake in 1999. This time they produced seven young, however only three survived to fledging. They were observed for 2 weeks with the adult pair on Astotin Lake, a staging lake, before their departure in late October. Yellow 53AC and 28AC hatched two young in 1999 on their first breeding attempt, but severe climatic conditions just after hatch resulted in loss of both young.

Potential expansion of relocated swans outside EINP

Survey results (Table 4) of summering swans are included with the wintering and migration observations because of the small number of individuals observed in the St. Paul/Lac La Biche area. Only one pair of swans was recorded during the international range-wide surveys in 1990 and 1995. This flock is increasing, however, there is currently no indication that any of these birds are EINP-released swans.

Trumpeter Swan cygnet relocation

The administration of the sugar/electrolyte solution prior to transport and the release of cygnets the same day as captured eliminated transport mortality and improved chances of long-term survival. Astotin Lake was identified as the primary release site in EINP (Beyersbergen and Kaye 1995) and on 8 September 1995, 10 cygnets (eight females and two males) with red tarsal bands (A04 - A15, excluding A10 and A12) were released on this site. All 10 cygnets fledged and were observed in the presence of the nonbreeding adults on Astotin Lake throughout the fall until they departed together for the wintering areas.

A second 1995 release site, Blackfoot Lake, received four cygnets (two females and two males) with red tarsal bands (A00-A03). Prior monitoring showed regular use of this wetland by Yellow 20AC and its mate. Restricted lake access resulted in the release of the cygnets on the opposite end of the lake, out of view of the pair. Cygnet A00 was found dead on the lakeshore on 12 October (mortality cause unknown). No observations were made of these cygnets in the presence of these two adults. The inaccessibility of the lake made observations difficult and it is not known if the cygnets actually bonded and/or departed with the two adults.

Severe environmental conditions and other unknown factors resulted in poor Trumpeter Swan productivity in 1996 and 1997. In addition, prospective EINP guide birds displayed a lack of consistency for staging or use of Astotin Lake during these 2 years. The combination of these two factors resulted in cancellation of relocation efforts for 1996 and 1997.

On 9 September 1998, four cygnets with red tarsal bands (A20-A23) were released on Running Dog Lake, which was occupied by Yellow 20AC and its

Table 4. Wintering, summering area*, and migration observations of Trumpeter Swans observed nesting in the Lac La Biche area and which may be associated with the releases in Elk Island National Park.

Collar Coding	Other Unmarked Swans	Observation Date	Observation Location
Yellow 02 Green 73V		March 15, 1997	Madison River, 1 mile above Highway 87 bridge, MO
Yellow 02		October 19, 1997	Taylorville Lake, AB
Yellow 02 Green 73V		November 4, 1998	Taylorville Lake, AB
Yellow 02 Green 73V		June 29, 1999*	Wetland 1 mile west Elinor Lake, AB
Green 4H8		May 2, 1997	Eagle Lake, Strathcona, AB
Green 4H8	Adult mate & 2 cygnets	October 26, 1998*	Shaw Lake, AB
Green 09H	Adult mate & 5 cygnets	June 29, 1999*	Wetland 2.5 kilometers west of Shaw Lake, AB
Green V74	Adult & unconfirmed nest	July 14, 1999*	6 miles north Lac La Biche Lake, AB.

mate. The pair aggressively attacked the cygnets when they approached them. Park staff tried to recover the cygnets, but were only able to locate two of the four. The other two were never observed again and were believed dead. The two cygnets recovered by Park staff were released on Astotin Lake. The remains of one, believed to have been killed by a coyote, were found along the shoreline in September. The remaining cygnet, Red A23, was observed alone throughout the fall until the arrival of Tundra Swans (*C. columbianus*) in the park. It was observed in their company on numerous occasions and was no longer observed after the Tundra Swans departed.

Migration and winter observations

Trumpeter Swan family groups relocated to EINP in 1987-91 migrated to the Greater Yellowstone region (Montana, Idaho, Wyoming), which is deemed an overcrowded wintering area. A number of EINP adults have still been observed in the area in recent years (Table 5). The observation of EINP swans, initially in Oregon in 1992 and finally in California opened the pioneering of new wintering areas for Trumpeter Swans (Beyersbergen and Kaye 1995). This start is tenuous because there are only a few birds to maintain the tradition. These pioneering birds, Yellow 27AC and 51AC, were believed to be leading others, such as 1995 release cygnets Red A07 and A15, to this new location. These cygnets were released on Astotin Lake in association with these adults. This new routing can be lost if it is not reinforced each year with the migration of swans to and from EINP. The observation of Yellow 27AC at Soda Springs, Idaho, (February 1996) and the failure of any of the 1995 release cygnets and Yellow 51AC to return to EINP has contributed to the breakdown of this migration route.

The role of Tundra Swans as guides for Trumpeter Swan cygnets has been addressed previously (Beyersbergen and Kaye 1995) and several recent observations at EINP are reinforcing this possibility. The observation of the three 1995 cygnets, released on Blackfoot Lake, in Oregon and California indicates that they did not bond with Yellow 20AC because its traditional wintering area is in the Rigby, Idaho, area. The 1998 cygnet, Red A23, was only observed with Tundra Swans on Astotin Lake, and it returned to EINP in the spring of 1999. Large

Table 5. Wintering and migration observations of Elk Island National Park Trumpeter Swans.

Marker Coding	Other swans	Observation Date	Observation Location
COLLAR			
Yellow 20AC		Feb, 1996	Texas slough, near Rigby, ID
Yellow 20AC		Dec. 1, 1996	Sheridan Reservoir, MT
Yellow 27AC		mid - Feb., 1996	Soda Springs, south of Gray's Lake, ID
Yellow 51AC	Green collared mate	March 17, 1995	Klamath NWR, OR
Yellow 51AC		Nov. 27 & Dec. 11, 1996	Hebgen Lake, MT
Yellow 53AC Yellow 33AC		April 14, 1995	Frank Lake, AB
Yellow 53AC Yellow 28AC	Yellow tarsal banded adult and 4 cygnets - red tarsal bands.	November 22, 1995	Red Rock Lakes NWR, MT
Yellow 53AC Yellow 28 AC		December 14, 1996	Red Rock Lakes NWR, MT
Yellow 53AC Yellow 28AC		October 19, 1997	Taylorville Lake, AB
TARSAL BAND			
Red A01		December 10, 1998	Harney Lake NWR, OR
Red A-- Red A03	 60 Tundra Swans	February 17 & 22, 1996	Marysville, Placer County, CA
Red A07	adult - metal leg band	December 4, 1996	Summer Lake NWR, OR
Red A11		May 4, 1996 (Dead)	Upper Madison River, MT
Red A15	Juvenile & 4 adults	December 09, 1996 & January 28, 1997	Ridgefield NWR, WA near Portland, OR

concentrations of Tundra Swans move through EINP in October and continue on their migration through Oregon to their final destination in the Sacramento Valley in northern California (Bellrose 1976, Ely *et al.* 1997). The failure of the 1995 cygnets to return to EINP is unexplained. Additionally, the observation of Red A15 in northwest Oregon could mean this swan has joined the Pacific Coast Population of Trumpeter Swans. The wintering area of Red A23 is unknown and this bird may be the last migration link between the new wintering areas and EINP.

CONCLUSIONS

1) The Grande Prairie area Trumpeter Swan flock appears to have a fairly stable number of paired adults and fluctuation in the flock size appears regulated by annual production and wintering area survival of young birds.

2) Recruitment is essential for building the EINP flock and the lack of cygnet relocation for several years, coupled with adult losses during the migration and wintering period, has resulted in the decline in the adult portion of the flock. The lack of relocation efforts was partially offset by the hatching and fledging of cygnets in the park. Therefore, the level of future relocation efforts will need to be adjusted according to the level of breeding success within the Park.

3) The loss of the adults observed wintering in California and Oregon and the failure of the 1995 release cygnets to return to the Park may have resulted in the breakdown of the migration tradition to these new wintering areas. Further release efforts or marking of individuals in the Park may be required to identify if this migration route still exists. With the small number of unmarked birds currently returning to the Park and the need to minimize disturbance, we may not be able to answer this question at this time.

4) The reaction of the Running Dog pair (20AC and mate) to the released cygnets was completely different from anything observed in all previous releases in which adults were used as foster parents. It is quite possible the pair may have left the lake before the cygnets came in contact them. The pair was likely defending its site as a potential nesting lake.

5) The failure to find any marked EINP birds outside the immediate area of the park in 1999 does not mean that they are not utilizing other areas. Rather, it will require a more concerted effort to determine where all the surviving EINP-release swans are spending the summer.

RECOMMENDATIONS

1) Future releases on EINP lakes should ensure that only staging lakes are used as release sites and that the conflict of territorial defence on potential nesting lakes by paired adult swans, as was observed on Running Dog Lake in 1998, does not occur again.

2) The level of relocation effort from the Grande Prairie flock should be regulated by level of breeding success in the Park and the availability and behaviour of foster parent guide birds on staging lakes.

3) A public information program and area closures, should continue to be implemented to minimize human disturbance during critical times for Trumpeter Swans in EINP.

4) To protect those swans nesting outside the Park on public and private land, a progressive information campaign may be helpful.

5) This type of campaign may also be required to gather information on the expansion of EINP-release swans outside the Park.

6) Aerial and ground surveys need to be conducted in partnership with other resource agencies to search for potential EINP swan expansion.

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ROCKY MOUNTAIN POPULATION OF TRUMPETER SWANS: HABITAT TRENDS IN THE GRANDE PRAIRIE REGION

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ABSTRACT

The scale, rate of growth, and changing nature of the economy of the Grande Prairie region is exerting unprecedented pressure upon Trumpeter Swan habitat in the form of residential, industrial, and recreational development. Climate instability is also an important factor to consider in that it widens the habitat needs of Trumpeter Swans relative to their needs during the now bygone era of climatic stability. The legal environment in Canada also impacts trumpeters negatively and needs change. A major effort should be launched to secure prompt protection of remaining Trumpeter Swan habitat if the RMP/Canadian flock is to survive into the future and flourish.

INTRODUCTION

As part of our current project to develop an educational presentation on the biodiversity and destruction of habitat along the Alberta Foothills, we have followed Canadian trumpeters to Harriman State Park, Idaho, in winter and north again in spring to their breeding grounds. We feel obliged to share our concerns with Society members about what is happening to trumpeter habitat in the Grande Prairie region.

Importance of Grande Prairie habitat

Of the 3,500 Rocky Mountain Population (RMP) Trumpeter Swans over-wintering in Greater Yellowstone, some 3,000 migrate to Canada to nest in spring. Once, the trumpeter bred across much of Canada but it was nearly extinct by the early 1900s. The only known Canadian survivors held on in the Grande Prairie region. Today, the largest flock within the RMP/Canadian subpopulation continues to nest in the Grande Prairie region.

The trumpeters' preferred historical habitat was the Parkland Bioregion, of which the Peace River Parkland is a subregion. Much of the latter lies mostly within the borders of the County of Grande Prairie, and comprises about 40% of the county. The Peace River Parkland is surrounded by the colder Mixedwood subregion of the Boreal Forest generally northward and by the colder, wetter Lower Foothills forest westward. Lakes of the Boreal and Foothills forests tend to be less productive and the Parkland continues as the trumpeters' preferred habitat.

However, some 95% or more of Canada's Parkland is no longer in its natural state, having long since been fragmented and converted to farmland, urban areas and highways. The Peace River Parkland, although likewise fragmented, remains the core breeding habitat for the Canadian trumpeters. Future breeding and restocking of trumpeters across Canada depends on it in two ways:

- it is a source of dispersing trumpeters that seek alternative breeding grounds (for example, along the northern edge of Waterton Lakes National Park in southern Alberta); and
- it is a source of trumpeters for reintroduction projects such as Elk Island National Park in east-central Alberta (Beyersbergen and Kaye 2000).

What little remains of the undisturbed wetlands of the Peace River Parkland is now under exceptional pressure and its trumpeters are rapidly being marginalized:

- physically, as disturbance displaces them out of preferred habitat into the Boreal or Foothills forest; and
- perceptually, as people who have traditionally protected the swan and its habitat age and die.

Thus, while statistics may indicate that RMP/Canadian trumpeter numbers are increasing, it is clear that serious trouble lies just around the corner for the Grande Prairie flock unless an immediate campaign is mounted to protect its habitat.

METHODS

We made five field trips to Grande Prairie between June 1997 and August 1999 and spent many days photographing swans, observing them, and recording our observations. We made various excursions within an area bounded by Wood Lake just east of the City of Grande Prairie, north to Sexsmith and Kleskun Lake, west to just north of La Glace and continuing west into the edge of the forested region; south to lakes and marshes south of the Beaverlodge area, and back east to the City of Grande Prairie.

We talked with business owners, the Grande Prairie Chamber of Commerce, City of Grande Prairie employees, County of Grande Prairie employees, Ducks Unlimited, the Canadian Wildlife Service in Edmonton, Alberta Fish and Wildlife, Provincial Park (Alberta Environmental Protection) personnel, local birdwatchers and naturalists, an ecologist, and "the man-in-the-street" in Grande Prairie.

PRESSURES UPON TRUMPETER SWAN HABITAT

Economic growth

Driving habitat decline is the rate and scale of economic growth in the Grande Prairie region, as well as the changing nature of it. The economy was and remains resource-based. Grande Prairie began as a Hudson's Bay trading post in 1881 and homesteaders began farming there in the 1930s. Even in 1956, 90% of those employed worked on farms. However, starting in the 1970s, capital-intensive industrialization has taken hold, resulting in a fall in farm employment to 25% by 1996, and corresponding spread of employment into resource extraction (primarily forestry, oil and gas) and related trades as well as the service sector. This industrialization process is accelerating as we enter the 21st century.

Population growth

Population growth compounds the growth stemming from industrialization. The population of the City of Grande Prairie has more than doubled in the last 30 years to 34,000. The County of Grande Prairie, including the three towns within it and the City of Grande Prairie, now totals about 47,000.

Residential development

The most obvious pressure upon habitat in the Grande Prairie region today is residential development. In general, the population of the County is growing within a 24-km radius of the City of Grande Prairie, stable within a 24-48 km radius, and declining beyond as an aging farming population leaves the land. The City manages land use within its boundaries. The same is true of each of the three towns within the County of Grande Prairie: Sexsmith, Beaverlodge, and Wembley. The County is responsible for land use decisions related to all land within the County except for that within city and town municipalities. Also, a concentric land-use planning area exists around the City, for which the City and County are jointly responsible.

Regarding the pace and scale of residential development, the Grande Prairie Chamber of Commerce told us that "new phases are now being developed in every subdivision – a phenomenon never seen before." There are four phenomena at work here:

First, the City of Grande Prairie is expanding and engulfing lakes used by trumpeters. For example, Crystal Lake, now within the northeast corner of the City, was until recent times a breeding lake, but is no more. Houses have been built to within a few meters of the water's edge. Similarly, Ivy Lake on the City's eastern edge has recently been engulfed by a new residential subdivision. A dike now separates Ivy Lake from the adjacent marshland. The latter was drained and used as the site for Swan City, a mobile home park developed a decade or 2 ago.

Second, small population centers around the City of Grande Prairie are expanding. Wembley on Wembley Lake, some 20 km west of the City is a case in point. Trumpeters bred on Wembley Lake until the mid-1970s, but as the town grew the trumpeters abandoned it. Likewise, the Hamlet of Clairmont, adjacent to Clairmont Lake, 7 km north of the City, is also growing rapidly. Trumpeter Swans bred here, too, until some 5-8 years ago when a sewage lagoon was constructed that interfered with the lake. Trumpeters have not bred there since. During the summer of 1998, a portion of a farmer's field adjacent to the west shore of Clairmont Lake was drained and built on. The new mobile home park there now, Countryview Estates, is one of numerous springing up around the City. Each spring the field sustained returning trumpeters until lake-thaw, but no more. This August (1999), we found another new mobile home park being built just to the south of

Countryview Estates, encroaching to the lakeshore. Will even nonbreeding trumpeters continue to use this lake in future?

Third, farmland is being converted to country residential estates with lots typically 2-5 acres in size – arguably the strongest immediate pressure on trumpeter habitat in the Grande Prairie region. The official County Municipal Map shows much agricultural land that has been earmarked for future residential use - and much of the latter borders or lies adjacent to wetlands in the region.

Fourth, the City of Grande Prairie to Wembley corridor is developing as a commuter belt. Here, the upscale mobile home park, Silver-pointe, is under construction near the Little Flying Shot Lake NW. Trumpeters used to breed on the marsh surrounding this lake, but since the Heritage Pointe country residential estate was built along its margin, they have abandoned the area.

Industrial development

Agriculture. The family farm has now largely been replaced by agribusiness and bottom-line agricultural economics. The trend is to let no land go unused, to plough to the very edge of sloughs and ponds, especially in drought years when wetlands shrink. In wet years, the farm manager is disinclined to allow the natural vegetation to recover. Furthermore, a farm manager recently filled in an entire 1,400-acre wetland and no government agency took any action.

Oil and gas. Development is booming. While Calgary is the industry's capital in Alberta, the City of Grande Prairie is the province's hub of oil and gas field services. The Alliance Gas Pipeline, the largest ever to be built in North America, is now being constructed across the region to move gas to Chicago. Such a project encourages development of oil and gas resources within easy reach and so this August (1999) we observed many new well-sites not there when we visited the region in April. Visitors to a large marsh north of the Hamlet of La Glace will see the result of this boom. Here, oil and gas installations surround the marsh, pump jacks nod up and down among the willow shrubs at the marsh edge, and another pump jack occupies a pad newly built right out onto the marsh itself.

Oil and gas development and gas flaring have become major issues in Alberta, adversely affecting human and livestock health and disturbing agricultural land. The mounting problems have been neglected by the Alberta government for decades now. As a result, this unchecked violence against the people and the land has been countered by reciprocal violence by civilians left unprotected by a government that is supposed to represent them. The result has been sabotage and murder.

Along with oil and gas development comes water contamination. A Grande Prairie farmer found that he could ignite the water flowing from his kitchen tap. What does all this air and water contamination do to trumpeter habitat and the swans themselves? The oil and gas industry is now seeking a toxic waste site for its unwanted byproducts. They had alighted upon a site at Kleskun Lakes, east of the town of Sexsmith, "because the slope of the land would hide it from public view". However, local residents found out and the public outcry has resulted in the industry's seeking a site elsewhere. Kleskun Lake, once extensive, was diked in the mid-1950s and most of it converted to agricultural land. Now abandoned by farming, the area is managed by Ducks Unlimited. It is still used by trumpeters as well as other waterfowl, now granted this reprieve. Where, now, will the toxic dump be located?

In August 1999 we rented a plane and overflew the Chinchaga forest, northwest of the Grande Prairie region, to do aerial photography for another project. Some 150 trumpeters have been seen in the Chinchaga. Considered the only largely intact Foothills bioregion landscape remaining in Alberta, the Chinchaga has been proposed as a candidate site to be protected via the Biodiversity Convention that Canada signed following the Rio environmental summit. We were shocked at how fragmented the Chinchaga has already become – slashed by roads, cutlines, power lines, oil and gas pads and wells, gas-gathering systems, and pipelines. This forest is the habitat into which the trumpeters are now being displaced from their preferred Parkland habitat. Looking down on the Grande Prairie region from the air, it was clear that it is no longer the sleepy backwater it once was; it is becoming one big industrial area.

Forestry. Forestry in the region – indeed throughout the length of the Rockies Eastern Slopes (the Foothills) – is also booming. It is not the traditional forestry that culls trees sustainably and maintains healthy forests. It is capital-intensive industrial clearcutting by multinational corporations who are inclined to make as much profit as they can during the 20-year term of their Forestry Management Agreements. This type of activity not only removes tree cover wholesale and can cause much undesirable ecological and erosion damage, but it is also notorious for the vast network of roads it creates, attracting ATV and other users. Furthermore, the forests are being liquidated for pulp as well as lumber. Another pulp mill, the Grande Alberta, costing an estimated $0.9 billion (Canadian), is proposed for the Grande Prairie area. At the present rate of cut, there will be no forest left in 20 years.

Other industrial pressures. On a smaller scale, at Flying Shot Lake NW an entrepreneur has now built a pad out onto the wetland, erected a mobile home upon it, and applied to extract organic matter from this former Trumpeter Swan breeding marsh.

Recreational development

Canadians like to make the most of their short summers, and landlocked Albertans especially enjoy lake-based recreation. That was compatible with the trumpeters' needs when the human population was small and unmechanized, but such is no longer the case. Saskatoon Island Provincial Park borders Saskatoon Lake – a designated lake under the Migratory Birds Convention Act of 1916. Trumpeters used to breed on the lake, but no longer do. The lake is still used by nonbreeders or staging birds. Powerboats abound and buoys now straddle the three bays in an attempt to protect at least part of this so-called "bird sanctuary" for the trumpeters and other waterfowl. Violations occur. This August the noise pollution day and night from powerboats was on occasion appalling. Harassment of waterfowl by increasing recreational use on lakes is a widespread problem in Alberta.

Climate change

While the average annual temperature of the Earth's envelope of ambient air has risen since the Industrial Revolution and the highest averages are being experienced in this last decade, the average affords no information at all as to the range and frequency of temperature events or associated weather phenomena. For the past 5,000 years, the Earth has experienced a period of climatic stability. This enabled the Agricultural Revolution and attendant human population explosion to take place. "Global warming" means this period has come to an end. We have now entered an era of climatic instability in which a wide range of weather conditions is occurring, including a growing number of extreme weather events.

Trumpeter scientists are undoubtedly cognizant of E. O. Wilson's seminal work on island biogeography. The need to keep intact and protect large landscapes of sufficient size to enable natural ecosystem processes to continue with integrity and to maintain biodiversity is beyond dispute. Protecting large landscapes – that is, large and (also important to note) contiguous arrays of habitat - is all the more critical within the context of climate change.

Take the Grande Prairie Trumpeter Swan habitat as an example. Alberta has experienced its two hottest and two wettest years on record – all during the 1990s. In the exceptionally wet June of 1997, trumpeter nests were flooded out, causing recruitment that year to plummet. The Grande Prairie summers of 1998 and 1999 have, by contrast, been exceptionally dry. Crops and natural vegetation were stunted, and marshes dried up. It must be a priority to ensure protection not only of lakes currently used by trumpeters, but also a far wider range of lakes such that, when lake levels fluctuate due to a wider range in weather, the trumpeter will continue to be accommodated. Tying species down to a few habitat islands in a sea of development will simply not serve to protect biodiversity.

Law and policy

Surely strict laws exist to protect the vital habitat of the world's rarest swan? Well, unfortunately, no – at least, not in Canada. All three levels of government have been preoccupied with deficit and debt cutting and the political consequences, hence the natural environment has not been a priority for a long time. Generally, then:

- legislation at all levels to protect species and habitat is weak, being rolled back, or non-existent;
- governments at all three levels are reluctant to put controls on private land;
- due to severe staff and budget cutbacks, data are relatively poor and, therefore, strong scientific argument for protection is hindered; and
- cutbacks mean law enforcement is weak.

Federal law and policy. Unlike the United States, which has had a federal Endangered Species Act for over 25 years now, Canada still has none. A bill has recently resurfaced, in very weakened form, which would protect species on federal lands only (a mere 4-12% of Canada and 9% of Alberta, comprised basically of the National Parks). Furthermore, in the case of birds, nesting sites would be protected, but not habitat required for other purposes such as feeding, staging or generally moving from one place to another.

Regarding federal policy, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has downgraded the Trumpeter Swan, Canada-wide, to Vulnerable (formerly termed Rare). Furthermore, the Government is now trying to tamper with COSEWIC decision-making: it wants to change the rules to allow votes on species listing and status to be cast only by the politician members of COSEWIC and no longer by scientist members as well.

Provincial law and policy. Under Alberta's Wildlife Act, Regulation 143, Revised 1997, Trumpeter Swans appear to be better off in that they are listed under Schedule 6 of the Act as Threatened. However, the Act protects individuals, not habitat. Policy of the Alberta Government, under current neo-Conservative ideology, can be summed as follows:

- "Alberta is Open for Business" (the Government's own phrase).
- Privatization of public (i.e., provincially managed Crown) lands.
- Multiple use of public lands.
- Promotion of a wide variety of recreational use of public lands.

These policies maximize industrial and commercial exploitation. Lakes, in particular, are seen as profit centers, and nowhere is sacrosanct – not even so-called ecological reserves.

Municipal bylaws and policy. The Grande Prairie region contains most of Alberta's known trumpeter breeding lakes. The only protection for these wetlands has been through land-use setbacks provided under the County of Grande Prairie's Municipal Development Plan of 1984. Under that Plan, 69 named lakes were listed as Trumpeter Swan habitat. Many unnamed lakes now known to be used by trumpeters were not listed. However, in compliance with a Provincial legal requirement, the County adopted a new Municipal Plan I, Bylaw #2360, in April 1998, from which the list of trumpeter lakes has been deleted. Thus, it removes the previously existing protection for Trumpeter Swan habitat. Instead, the protection of each lake must now be fought over on a case-by-case basis by a few paid (e.g., Ducks Unlimited) and mostly unpaid volunteer Trumpeter Swan defenders going up against development industry interests and the decision subject to the discretion of some government official.

Regarding municipal environmental policy (Section 10.0 of the new Bylaw), it must now reflect provincial land-use policy, which has three objectives, including the accommodation of "a wide range of recreational objectives". Thus subdivisions, powerboating, and jet-skiing are priorities and Trumpeter Swan habitat is not.

Perceptions and attitudes

What does the Grande Prairie public think about Trumpeter Swans and their habitat needs? So many people are newcomers that they either do not know of the swans' existence or are only vaguely aware due to the signage around town. Many are simply engaged in finding and training for local blue-collar jobs, queuing for homes, and then enjoying the good life. Protection of nature is not a high priority.

Demographics. The largest age group in Grande Prairie is 30-34. As evidenced from murals around town, the young men and new entrepreneurs are primarily engaged in resource extraction and related manufacturing and construction, and see themselves as movers and shakers wrestling wealth from the land. It is high-tech industry, not the swan, that is now being romanticized.

Industry. Industry's attitudes are self-evident. A sign boasts Grande Prairie as "The Forest Capital of Alberta", and another proclaims the next Petroleum Show (alternating annually between Calgary and its branch plant, Grande Prairie). This year's show in Grande Prairie was the largest petroleum show ever held. The Grande Prairie Chamber of Commerce received, not long ago, a proposal that the region sever its identity from that of the swan; that a dinosaur image would attract tourism (dinosaur fossils have been found in the region), and that the region's oil and gas installations could be promoted as tourist attractions. The latter sounds laughable, but it is already happening elsewhere in Alberta.

Now, the good news

There are now, however, some hopeful signs. Governments are paying off their deficits and starting to respond to a groundswell of public complaints regarding environmental issues generally. Both the federal and provincial environmental ministers have recently been replaced. International pressure and assistance is now being brought to bear on Canada's environmental problems, especially in Alberta.

Meanwhile, local people in Grande Prairie mounted a Swan Festival this April (1999). About a hundred attended, half of them children, despite poor weather. Although an embryonic event, this was a good start at public consciousness-raising and raising the profile of the Trumpeter Swan. Also, judging by their signage and murals, many local businesses continue to identify with, and value, the swan. There are also some older farming families who still care enough to leave swan habitat on their land intact and private.

What can be done to protect Grande Prairie Trumpeter Swan Habitat?

The handful of stalwart defenders of trumpeters and their Grande Prairie habitat urgently need all the support they can get. We will use this presentation as the basis for a public educational program that we shall present to groups when and wherever possible. In addition, we suggest that the Society:

- Write letters to the governments of Canada and Alberta urging them to protect Trumpeter Swan habitat in the Grande Prairie region and along their migratory route.
- Hold its year 2003 Conference in the City of Grande Prairie, with suitable fanfare to attract public attention and involvement and encourage related ecotourism.
- Assist with a strong pubic education campaign throughout the Grande Prairie region, including the local Swan Festival.
- Support (a) legislative protection of habitat, not just of the species; and (b) the building of a large public constituency for the appreciation and protection of the Trumpeter Swan and its habitat.

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HOW THE INTERMOUNTAIN WEST JOINT VENTURE CAN WORK FOR YOU

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ABSTRACT

The Intermountain West Joint Venture (IWJV) is the implementation arm of the North American Waterfowl Management Plan in portions of the 11 western states between the Sierras and the Cascades on the west, the Rocky Mountains on the east, and from Canada to Mexico. A public-private partnership, our purpose is to facilitate the conservation of wetlands and associated riparian and upland habitats within our boundaries. Since our origin in 1994, some 57 focus areas have been designated where we work on the "best of the best" wetland areas in the Intermountain area. Now, the Joint Venture is expanding our mission to include conservation of all migratory bird species in all habitats within the Joint Venture boundary and is joining with the emerging North American bird initiatives to accomplish this. We are in the process of reorganization and reconfiguration to accomplish this expansion and we invite all who perceive they have a stake in migratory bird habitat to join us in partnership.

INTRODUCTION

The IWJV was established in 1994 to facilitate wetland and associated upland habitat partnerships that implement habitat conservation practices on the ground. Before I explain how the Joint Venture can work for you, I will provide some background information that better describes our focus.

NORTH AMERICAN WATERFOWL MANAGEMENT PLAN

The North American Waterfowl Management Plan (NAWMP), an international management framework agreement, was established between the U.S. and Canada in 1986 and joined by Mexico in 1994. Its purpose was to halt the dramatic decline in waterfowl populations experienced in the 1980s through cooperative habitat conservation efforts. Joint Ventures, or regional partnerships, were established to become the implementation arm of the Plan.

In 1989, Congress passed the North American Wetlands Conservation Act (NAWCA) to provide federal funding on a non-federal matching basis to help meet the ambitious population and habitat goals that were established. Although population and habitat goals remain, the 1998 Update of the NAWMP provided for three new focal points:

- Strengthen the biological basis for the Plan
- Move toward a landscape level approach to planning and project implementation, and
- Expand partnerships to broaden the support base for our conservation efforts.

NORTH AMERICAN WETLANDS CONSERVATION ACT

NAWCA is a federal grant mechanism for wetland conservation projects located on both public and private ownerships, which requires a minimum 1:1 non-federal match. Approximately $40 million are provided annually for national competition and successful grants are normally developed through involvement in the Joint Venture process. Success in the grant process requires application in either April or August of each year by a broad-based partnership that has come together around common objectives for wetland and associated habitats in their local or regional area.

One of the most unique features of this grant is the period in which match for the grant proposal may be generated. The non-federal value of the work accomplished within the project area for the 2 years prior to grant application may be applied as match. In addition, non-federal values of cash or in-kind commitments which will be provided during the two-year period following the completion of a grant agreement may be used as match. Since there is usually a six to nine-month gap between the application and grant agreement completion, the period for which non-federal match can be generated is typically over 4.5 years. Also, federal funding may be used for project accomplishment, but it may not be used as matching funds.

The NAWCA fund is administered by the North American Wetlands Conservation Council, which provides initial approval for successful grants. The Council is composed of representatives from the four Flyways as well as representatives from various non-governmental conservation organizations. Final approval is given by the Migratory Bird Commission.

JOINT VENTURES

Originally six priority Joint Ventures were established to implement the Plan. Since then, the total has risen to ten and three more are now in various stages of development across the U.S. Joint Ventures focus on wetland habitat protection, restoration, and enhancement and are administered by a Management Board and a Coordinator.

Although sanctioned as a program and generally funded by the U.S. Fish and Wildlife Service, Joint Ventures are somewhat independent organizations. Management Boards set policy and general direction, although Board roles vary considerably between Joint Ventures. Joint Ventures vary in size. For example, the Intermountain West is one of the largest geographic areas involving portions of the 11 western states, while the Rainwater Basin in Nebraska involves only 17 counties.

INTERMOUNTAIN WEST JOINT VENTURE

IWJV was instituted in mid-1994 and our implementation plan was approved by the North American Waterfowl Plan Committee a year later. From the outset, the Joint Venture's purpose has centered on the conservation of wetland habitat, as well as associated riparian and upland habitats. The Joint Venture’s role has been to implement on-the-ground practices rather than research, education, or recreational programs.

The Management Board is composed of representatives of four federal agencies (which provide funding for the coordinator position through Ducks Unlimited, Inc.), four state wildlife agencies, five non-government conservation organizations, and eight private individuals who were asked to join the Board for their financial or political associations. The private citizen component differentiates the IWJV Management Board from others. State steering committees are loosely organized to provide technical and partnership support. All these organizational components are developed in support of the fundamental unit of the Joint Venture, the Focus Area Work Group. This group develops common habitat conservation objectives and project proposals, while the organizational components work to support the local technical expertise represented by the Focus Area Work Group.

NAWCA is key to the development of habitat conservation projects in the IWJV. Of course, key project funding is available through NAWCA, but we also follow the NAWCA philosophy of project development. Landscape perspectives underlie project design, multiple migratory bird values are recognized, and broad partnerships or public support are sought. Through FY 1999, over 107,000 acres of wetland and associated habitats have been conserved through NAWCA at a cost to the respective IWJV partners of over $37 million. The Joint Venture also facilitates Wetland Reserve Programs and National Fish and Wildlife Foundation grants, as well as funding from corporate or other private sources.

IWJV MISSION EXPANSION

In July 1999, the Management Board voted to expand the mission of the Joint Venture to include conservation of the habitat of all migratory birds within the Joint Venture boundary. We have invited Partners for Flight, the National Shorebird Conservation Plan, and the North American Colonial Waterbird Conservation Plan to integrate their objectives and to use and join our organization to implement their respective plans.

Mission expansion will require the Joint Venture to reorganize to include new partners and to reconfigure Focus Area boundaries to expand beyond wetlands and riparian zones. As we reconfigure we will change the Focus Area name to *Bird Conservation Areas*, which will include a wide array of habitats as they expand to include entire watersheds, ecosystems, or physiographic regions (depending on the consensus of local partners).

The Joint Venture cannot effectively expand our mission without participation of all of those who perceive themselves as stakeholders in migratory bird management. Thus, we invite all who wish to work together to conserve the migratory bird resources of the Intermountain area. Participation at the State Steering committee level, or better yet, at the Bird Conservation Area level, is critical to those of you who wish to include habitat needs of Trumpeter Swans in future Joint Venture projects. We will attempt to contact you and seek your help as we begin the transition to an expanded mission.

TECHNIQUES AND THEORY

CURRENT RESEARCH EFFORTS IN DECISION SUPPORT SYSTEM TECHNOLOGY AS APPLIED TO TRUMPETER SWAN MANAGEMENT

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ABSTRACT

A decision support system can be described as an interactive, computer-based system designed to help decision makers solve complex and loosely structured problems. Such a system is being developed to assist biologists who are managing habitats for the Rocky Mountain Population of Trumpeter Swans (*Cygnus buccinator*). Our approach is to apply advanced technologies to facilitate cooperative plan development using artificial intelligence methodologies. We are focused on providing decision support that allows managers to develop habitat management plans for local sites while recognizing that such decisions have ramifications not only at other sites but also at a population level within the migration corridor. Extensive empirical evaluation of the system is planned, but we will face many of the classic challenges of evaluating artificial intelligence based decision support. The system will be made available to swan managers through the world-wide web, using commercially available software that provides a common gateway interface between the web server software and an inference engine. Our initial focus has been on knowledge engineering for habitat needs, montane wetland management, migration chronologies and pathways, and principles of flyway management.

INTRODUCTION

The number of Trumpeter Swans breeding in the Tristate Region, where Montana, Idaho, and Wyoming come together, has always been limited, but has declined approximately 30 percent since the peak numbers of the 1960s, and now there are fewer than 400 total birds. In addition, they have abandoned to a large degree what were thought to be traditional migratory pathways. Swans, like most migratory birds in North America, travel along migration corridors that link northern breeding areas with more southern wintering grounds. National Wildlife Refuges such as Grays Lake, Red Rock Lakes, National Elk Refuge, and Bear River Migratory Bird Refuge; National Parks such as Yellowstone and Grand Teton; and other areas such as Harriman State Park (ID) share swans at different times of the year. Swan managers are interested in a decision support tool that will simulate and test management options for Trumpeter Swans throughout such corridors. The ultimate objective is to contribute to both population recovery and migration path development. Managers recognize that decision making is cyclic, and they wish to iteratively plan, implement, evaluate, and improve their management strategies. Biologists also are concerned by their lack of ability to objectively assess critical information gaps, identifying those that contribute the most uncertainty to the selection of management options. Unfortunately, optimizing management of migratory birds throughout a flyway with cyclic planning is so complex that it is often all but impossible to implement without computerized decision support (Sojda *et al*. 1994). Also, past conditions and future needs are ecological constraints to current decisions. Swan management is complex, requiring reasoning across time and space among geographically dispersed areas. Spatial interactions are inevitably intertwined with temporal components as swans migrate. This is further compounded by ecological issues that exist at specific wetlands in each location. Another component of complexity arises from local decisions having ramifications not only at other sites but also at a population level within the migration corridor.

Decision support systems use a combination of models, analytical techniques, and information retrieval to help develop and evaluate appropriate alternatives (Sprague and Carlson 1982, Adelman 1992). These systems should focus on strategic decisions, not operational ones. More specifically, they should contribute to reducing the uncertainty faced by managers when they need to make decisions regarding future options (Graham and Jones 1988). Distributed decision making approaches suit problems where the complexity prevents an individual decision maker from conceptualizing, or otherwise dealing with the entire problem (Brehmer 1991, Boland *et al*. 1992). It is in this light that we have chosen to develop a decision support system to assist biologists with swan management, especially related to habitat management. At this time, there are no such systems available for swan managers, nor any common databases for them to access. Furthermore, many managers are either located in relatively remote locations or simply distant from each other, making it difficult to meet frequently. On National Wildlife Refuges and some other areas, annual water management plans are prepared for individual wetlands. These are prepared manually, and often do not take into account conditions in other areas of the flyway except in a general sense. Plans are not usually updated during the course of the year. The past and current holistic situation for management of Trumpeter Swans, of which planning is only a part, has not yet resulted in population recovery.

A FRAMEWORK FOR SIMULATING MANAGEMENT OPTIONS

Based on input from swan managers, we have identified four management questions to address through decision support system simulations. Each of these simulations is a relatively coarse-grained approach to extrapolate possible future scenarios, while retaining the need to address the practicality of the fine-grained needs of individual managers. This is being tackled by paying close attention to knowledge engineering efforts and the use of expert systems to connect the relatively qualitative knowledge of the domain experts with the heuristic guidance needed by managers.

Simulation 1. If a particular management action is implemented at a particular site and particular time, what are the consequences for that site and for other sites in the flyway?

Simulation 2. Given an objective for spatial and temporal distribution of swans, what is the best set of management actions across all sites to achieve this? The decision support system will also have the capability for the manager to provide an alternative objective.

Simulation 3. Given some subset of management action(s) across all sites, and given an objective for spatial and temporal distributions of swans, what is the best complementary subset of management actions at other sites to achieve this?

Simulation 4. Given a satisfactory set of management actions across all sites to achieve an objective for swan distribution, if an alternative management action were to be implemented at a particular site, what are the consequences for that site and for other sites in the flyway in terms of reaching their respective objectives?

Four basic modules form the framework of the decision support system: 1) cooperative distributed problem solving, 2) knowledge bases (expert systems), 3) databases, and 4) web interface (Figure 1). The methods used are from a branch of computer science known as artificial intelligence. This approach, in its most simple form, encodes knowledge and problem solving techniques to address real problems. More specifically, cooperative distributed problem solving (Durfee *et al*. 1989, Carver *et al*. 1991) uses this approach to tackle problems that can only be solved by different modules and users jointly addressing the same problem, and building a solution as time unfolds. Searching for solutions utilizes encoded ecological knowledge and system constraints, including population objectives, on-the-ground management capabilities, wetland knowledge, and implementations of adaptive management. In addition, an area's past management history, as well as its future needs, represent further temporal constraints to forming recommendations in the present, particularly related to wetland manipulations.

The essence of the distributed nature of swan ecology stems from birds moving among areas as seasons and other ecological conditions change, especially habitat availability. Migration stimuli also are related to annual life cycle events and physiological condition in individual swans. Rules for handling the integration of all such spatial and temporal issues in the system will be developed and integrated at a high level in the system. It is clear to us that wetland ecology is a domain where the complexity of relationships, the interactions among ecological parameters, and the lack of empirical data make such programming of rule-bases and decision trees

Figure 1. The framework for the swan management decision support system.

complicated. By the same token, we are becoming increasingly convinced that the complexity of ecological systems is, in fact, what makes the application of expert systems, cooperative distributed problem solving, and other artificial intelligence methods so potentially useful.

PROBLEMS WITH PROPOSED VALIDATION

Validation is determining whether the system is providing a realistic and useful model of swan ecology and management. Sprague and Carlson (1982) recommend that an organization building their first decision support system recognize that it essentially is a research activity, and that evaluation should center on a general "value analysis". They state that iterative prototype development will ensure a quality product from the managers' perspectives, but recognize the qualitative nature of such evaluation. Our approach is an attempt to add analytic and quantitative rigor beyond that. Sensitivity analysis can be a powerful tool for validation, especially for heuristic-based systems, and for systems where few or no test cases are available for comparison (O'Keefe *et al.* 1987). Another issue reasons. Foremost are: (1) the lack of any gold standard, in an ecological sense, against which the system's performance can be evaluated; (2) the need to have a working system that is forward-looking, suggested by Rushby (1991) is that it is necessary to show not only how well a system performs, but also to show that it can avoid a catastrophic recommendation. This is important in a species like the Trumpeter Swan, where there is great concern for low population levels.

It is sometimes possible to test expert system performance against an independent panel of experts (O'Keefe *et al.* 1987). We do not plan to do so for two reasons. First, the panel of experts needed for such an evaluation would be the same people who will be closely connected to system development itself. This would add such confounding effects that no reasonable experimental design is feasible. Second, one of the basic tenets of distributed decision making is that the system is addressing questions that are beyond the capability of single persons to conceptualize and solve (Brehmer 1991, Boland *et al.* 1992).

The broad thesis proposed is that cooperative distributed problem solving can be used to implement a flyway approach to Trumpeter Swan management. Unfortunately, this is not directly testable for several simulating possible future scenarios as they are actually unfolding; and (3) the complications of verification and validation of any knowledge-based system that relies heavily on heuristics.

Validation of our system will ensure that the recommendations for timing of habitat availability will be sufficient to support the requisite number of birds. We also will examine whether recommended distributions of swans change when the system is not allowed to consider particular parameters such as population objectives, wetland habitat conditions, or disturbance. Again, validation will be an iterative process. The overall intent will be to determine whether cooperative distributed problem solving is an effective technique for imparting a flyway management approach to the Rocky Mountain Population of Trumpeter Swans. Additionally, we will query swan managers and experts about their satisfaction with the system.

KNOWLEDGE ENGINEERING EFFORTS AND OVERALL SYSTEM STATUS

The primary knowledge base developed, so far, has been related to breeding habitat needs for Trumpeter Swans. It was developed based on information provided during a knowledge engineering workshop, plus additional information from the scientific literature. Subsequently, this module was demonstrated to additional swan biologists and refined based on their qualitative critique. A knowledge base on montane wetland ecology is also nearing completion. Additional knowledge engineering efforts have been conducted regarding winter habitat of swans, migration paths and chronologies, and principles of flyway management. The assistance and expertise of people from several universities, federal agencies, and state wildlife agencies have all been utilized, and will expand as the project unfolds.

Typically, a 2-3 day workshop is held using standard techniques (Scott *et al.* 1991) to elicit knowledge from experts in a relatively narrow field of interest. Then, this knowledge is encoded using commercially available expert system development software. During this process, shortcomings of information and logic often become apparent, and additional probing of the experts occurs. Once an initial knowledge base is developed, it is posted to a web site and demonstrated to managers in the field for informal critique. New versions continue to be posted to the web site as additional information is uncovered or suggestions received. At this stage it is often difficult for people to visualize the complete system because they are only examining individual modules, specifically the knowledge bases represented in Figure 1. The process is relatively time consuming and currently involves only one staff person.

The knowledge bases are developed using a combination of individual rules and decision trees to encode the knowledge, the trees being converted to individual rules, albeit complex ones, at run time. An example of a simple rule is:

IF primary management should be targeted towards shallow water and mudflats for shorebirds
AND robust emergent vegetation currently does not dominate the wetland
THEN next spring's water levels should be kept low.

Such a rule does not stand on its own, it interacts with many others before a recommendation about a specific water level is made. Primarily, this is done through a process called backward-chaining, which is controlled by the inference engine of the expert system software shell. Trees used to encode ecological knowledge can be very complex because so many interactions, parameters, and variables are involved. Figure 2 shows the structure of such a tree related to assessing pre-laying food resources of a wetland for trumpeters. All this is transparent to the user who only will be answering questions regarding their own specific case, as shown in Figure 3.

The final system will be available to swan managers through the world wide web (Figure 3), using commercially available software that provides a common gateway interface between the web server software and an inference engine. The current web server is a UNIX workstation provided by the United States Department of the Interior's Geological Survey accessing the Internet through Montana State University. Access to the decision support system as it is being developed is available by contacting the senior author.

ACKNOWLEDGMENTS

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DESIGN AND EFFECTIVENESS OF THE 1995 YUKON/NORTHERN BRITISH COLUMBIA TRUMPETER SWAN SURVEY: AN APPROPRIATE TECHNIQUE FOR 2000 AND BEYOND?

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ABSTRACT

The 1995 Yukon/Northern British Columbia (BC) Trumpeter Swan survey was completely redesigned from the previous surveys conducted in 1985 and 1990. The 1985 and 1990 surveys consisted of counting birds along fixed flightlines that were somewhat arbitrarily located within the known range. The results were total counts of birds seen, but they could not be used to estimate the number of birds in unsurveyed areas, or the total population. The 1995 survey was a stratified random sample of 1:50,000 National Topographic Survey (NTS) mapsheets within the known or suspected Trumpeter Swan range. Maps were assigned to one of five strata according to the likely number of adult swans each would contain. A random sample of 55 maps was selected in the three strata, and these 55 were surveyed in their entirety using a Maule M7 aircraft on floats. Population estimates were generated for an area of 434,559 km^2. Separate estimates were generated within each stratum and within the ranges of the Rocky Mountain Population (RMP) and the Pacific Coast Population (PCP) units. The resulting estimates were much higher than the counts from 1985 and 1990, but had rather broad confidence limits (±41-60%). Despite this imprecision, this survey design has significant advantages over the previous design, including: fixed costs for the foreseeable future; ability to generate total population estimates; ability to document range expansion. This design can be readily employed in any jurisdiction that has appropriate maps, including virtually all of Canada and the USA. The appropriateness of this design in any jurisdiction will depend on the desired precision of the estimate, the size of the area to be surveyed, the amount and distribution of known and potential Trumpeter Swan habitat, and the practicability of alternative census methods such as ground-based surveys. As always, the resources (money and time) available to conduct the survey will be the most important factor to consider.

INTRODUCTION

Trumpeter Swans in the Yukon Territory (the Yukon) and northern British Columbia have been surveyed every 5 years beginning in 1985 (McKelvey 1986, McKelvey and Hawkings 1990) as part of a continent-wide survey effort that relies on hundreds of cooperators from federal, state, and provincial agencies as well as other groups such as The Trumpeter Swan Society. The goal of the continental survey is to estimate the post-breeding size of wild populations of Trumpeter Swans in North America.

The 1995 survey in the Yukon was completely redesigned from the 1985 and 1990 surveys which either followed previously established flightlines or created new ones in areas that were known to have swans, but had not previously been included in the survey (Figure 1). These flightlines were positioned to cover much of the occupied and potential Trumpeter Swan habitat, but there was no sampling scheme that would allow estimation of the total swan population in any particular area. This design also created an ongoing dilemma of how to incorporate new areas as trumpeters expand their range in the Yukon.

A new survey was designed for 1995 with the following objectives:

1. Allow estimation of the total number of Trumpeter Swans in the Yukon and adjacent northern British Columbia with 95% confidence limits of plus or minus 30%.
2. Determine the growth of the population at 5-year intervals.
3. Document the range expansion within the survey area.
4. Achieve these objectives with a relatively stable amount of resources (i.e. not require resources to greatly increase as the population increases).

METHODS

A stratified random sample design was chosen, using Canadian National Topographic Survey (NTS) 1:50,000 maps as the sample units. With the exception of some high elevation mountain areas, all

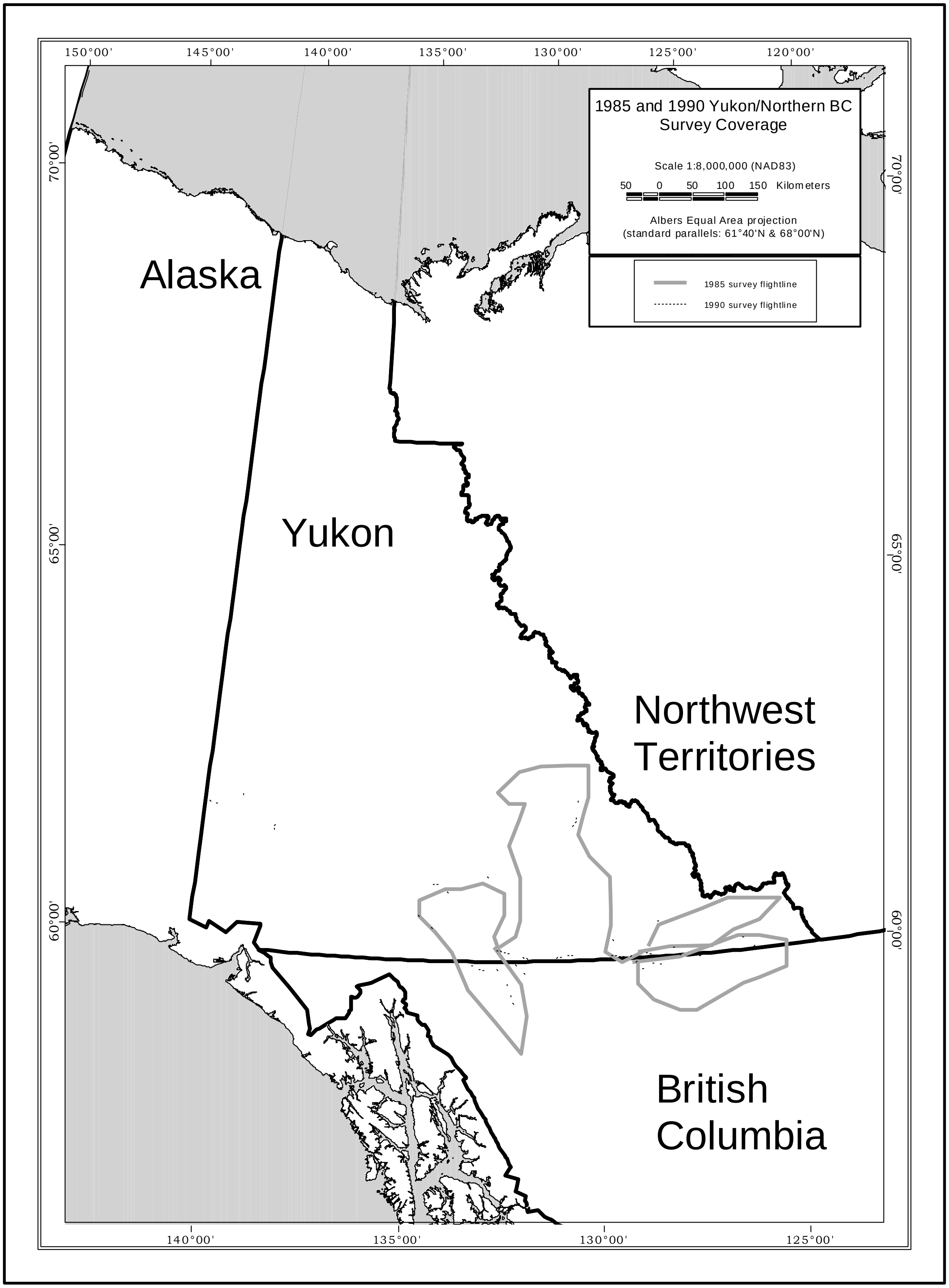

Figure 1. Location of aerial survey flightlines for the 1985 and 1990 Yukon/Northern British Columbia Trumpeter Swan Survey.

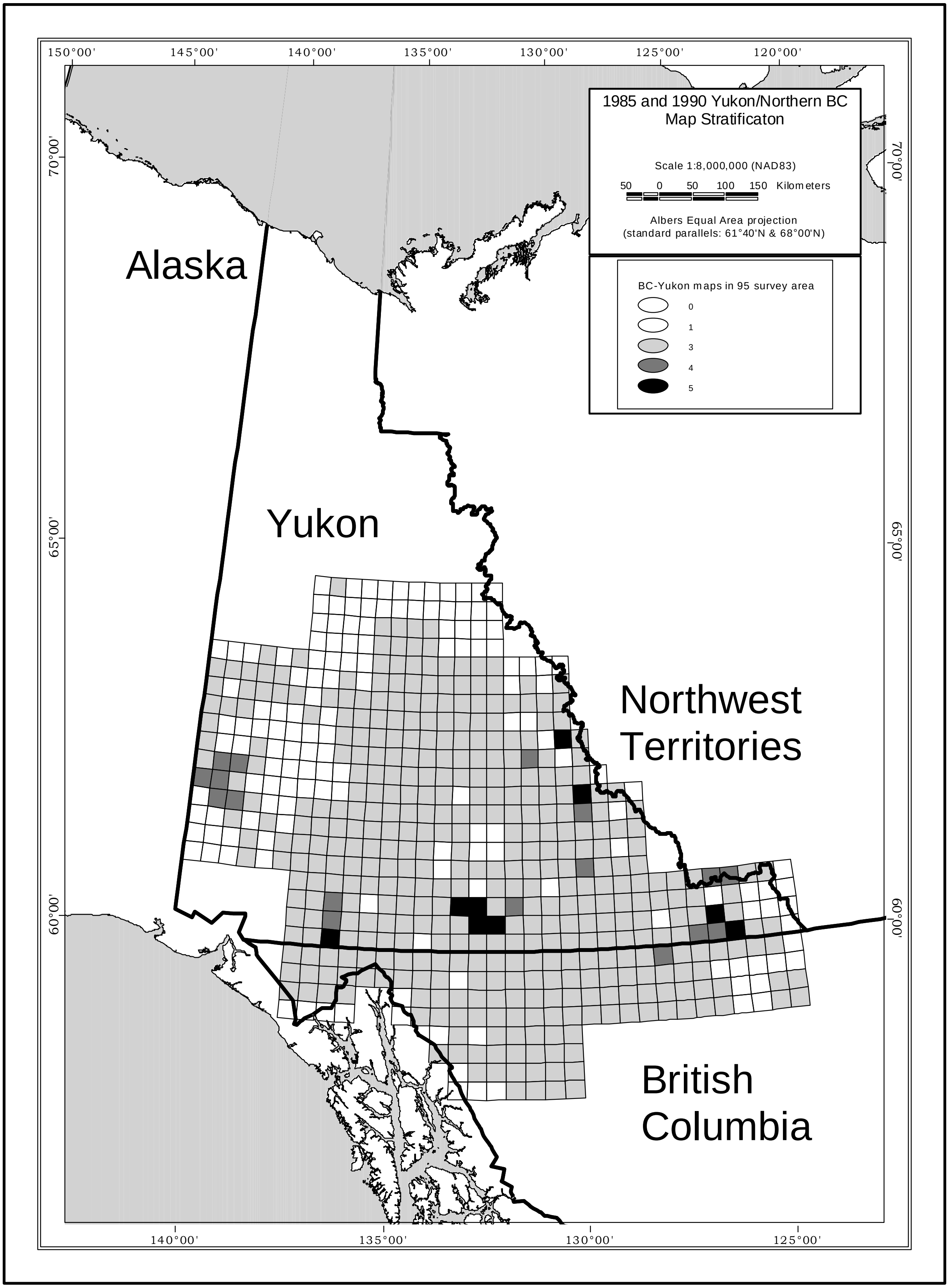

Figure 2. Distribution of 1:50,000 mapsheets among 5 survey strata for the 1995 Yukon/Northern British Columbia Trumpeter Swan Survey.

maps south of the Ogilvie Mountains (a total of 586 maps, or 434,559 km^2, Figure 2) were assigned to one of five strata based on the following criteria:

0 Apparently no possibility of suitable habitat (either no water or only fast-flowing streams and rivers with no floodplain wetlands and no lakes/ponds of suitable size with emergent vegetation). Includes much of the high-elevation areas of Kluane National Park, Mackenzie Mountains, Ogilvie Mountains.

1 Very little suitable habitat and where the chances of finding a swan seem to be virtually nil even though there is some habitat.

2 Some suitable habitat, but not likely to have birds in 1995 (possibly because outside current range).

3, 4, 5 Suitable habitat with previous swan breeding records or likely to have birds in 1995 based on probable range expansion:

- **3**. Likely to have one to six adults in 1995.
- **4**. Likely to have seven to 12 or more adults in 1995.
- **5**. Likely to have more than 12 adults in 1995.

As the cost and logistics of obtaining all the 1:50,000 maps were prohibitive, stratification was performed by examining each 1:50,000 map as outlined on the corresponding 1:250,000 map.

All sampling and estimation were based on strata 3, 4, and 5 only. I chose a total of 64 maps to survey, including all maps in strata 4(17) and 5(9). The remainder was a random sample of 38 from 406 maps in stratum 3 (Figure 3).

A pilot (Denny Denison) and one observer (Jim Hawkings) using a Maule M7 aircraft conducted the survey. We attempted to search all suitable habitat within each 1:50,000 maps on the survey. The aircraft was flown at varying altitudes depending on wind, cloud, visibility, and terrain, but usually between 100 and 200 m above the ground. The entire survey flightline, including ferrying between survey units, was marked on 1:250,000 topographic maps. Each swan sighting was marked with a small x and assigned sequential numbers within each map. Details of the sighting (number of pairs, lone adults, flocked birds, cygnets) were recorded on the margin of the map. We also recorded all incidental sightings obtained while ferrying between survey units or to and from bases and fuel stops.

In the office, UTM grid coordinates were recorded from all sightings, and all data were entered into a computer database using the Statistical Analysis System (SAS). Prior to generating a population estimate, each map was assigned to either the Rocky Mountain Population (RMP) or the Pacific Coast Population (PCP) based on the known and likely affinities of any swans breeding on that map (Figure 3). Estimates were then generated for each stratum within each population, and the final estimates for each population (RMP and PCP) were obtained by adding the three strata estimates for each. An overall estimate for the Yukon and northwestern BC was obtained by re-analyzing the data as a single population.

RESULTS AND DISCUSSION

The survey was conducted from 20 to 24 August 1995. Logistics prevented us from surveying 11 maps (two maps in stratum 5, two maps in stratum 4, and seven maps in stratum 3). However, two additional maps in the Tatshenshini River drainage of BC were surveyed by Bruce Conant of the U.S. Fish and Wildlife Service, and these were included in the sample of stratum 3. The resulting total was 55 maps surveyed (33, 15, and seven in strata 3, 4, and 5 respectively (Table 1, Figure 3).

Including incidental sightings, a total of 495 swans was seen including 335 adults and 160 cygnets in 42 broods (Table 2). The mean brood size was 3.8 and 32.3 percent of the birds counted were cygnets (47.8 cygnets per 100 adults). A total of 392 swans including 259 adults and 133 cygnets in 34 broods were sighted on the 55 maps that were formally surveyed in 1995. These 392 swans were the basis for the population estimates.

The resulting population estimates for the Yukon and northern BC are 1,265±517(95% CL) swans including 769±435 in the range of the Rocky Mountain Population, and 492±293 in the range of the Pacific Coast Population (Table 3). Estimates of the proportion of cygnets range from 35.8% for RMP to 38.7% for the PCP. This is slightly higher than that derived from observed birds (32.5% and 35.9% respectively) because of the larger proportion of cygnets found among birds in stratum 3, where

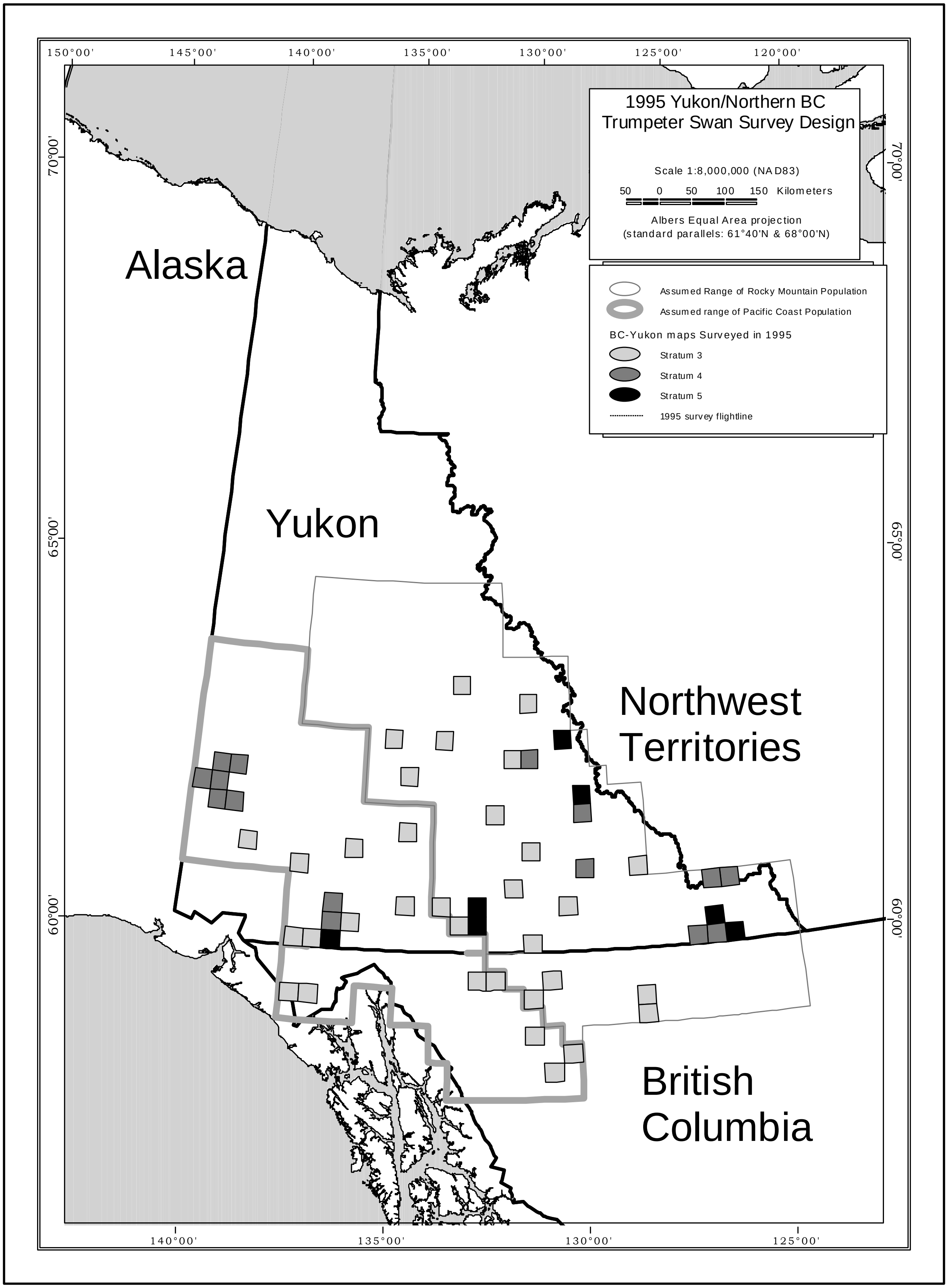

Figure 3. Aerial survey flightlines and distribution of 1:50,000 mapsheets actually surveyed during the 1995 Yukon/Northern British Columbia Trumpeter Swan Survey. Outlined areas show the presumed ranges of the Pacific Coast and Rocky Mountain populations.

virtually all the extrapolation occurs in generating the final estimates.

The 1995 estimates for the entire Yukon/northern BC are much larger than those from 1985 (141 swans, McKelvey 1986) and 1990 (271 swans, McKelvey and Hawkings 1990). I attribute most of this large (366%) increase since 1990 to the change in survey technique and coverage, and only part to an actual increase in the population. It appears that an increasing number of swans have been breeding since at least the mid to late 1980s in areas that were not covered by the 1985 or 1990 surveys. An exact comparison with previous years is not possible because of the different methods used. Productivity was higher in 1995 (32.3% based on all observed swans) than in the previous two surveys (15.6% and 24.7% respectively).

The population estimates generated in 1995 have relatively low precision overall, much lower than the objective of confidence limits of ±30%, primarily because of the high variance (i.e. large confidence limits) in stratum 3. Of the ±517 confidence limits on the total population, 460 (89%) came from this stratum. This problem stems from the large number of maps (21) with no swans (zero values). This will be addressed in future surveys by improving the stratification based on data from the 1995 survey. This will be done by using optimal allocation procedures to allocate higher sampling effort to strata that contribute most to the overall variance.

Table 4 shows the distribution of survey coverage between the Yukon and BC for the PCP and RMP. Swan density was similar for both PCP and RMP ranges within the survey. Costs for the 1995 survey are shown in Table 5. Most of the cost of the survey was for aircraft charter and personnel time for data analysis and write-up.

The new survey design of 1995 accomplished all but the first of its four objectives. The lack of precision is not critical for this population in this area as the population is still growing and it is not subject to intensive management that requires precise estimates. Precision should improve in future surveys, as more data becomes available to effectively stratify the area and optimally allocate sampling effort.

This survey design seems to be the most practical and appropriate one available for the Yukon Territory and adjacent northern British Columbia. It would also be appropriate for other areas having similar conditions:

- Large, remote, inaccessible breeding range that is not practical to survey entirely.
- Fixed resources available for the survey.
- Limited knowledge of the exact distribution within the probable breeding range.

AKNOWLEDGMENTS

I would like to thank pilot Denny Denison of Coyote Air Service in Teslin, Yukon, for putting in 5 long days of safe flying, throughout which he remained cheerful, and as always, keenly interested in the swan survey. Bruce Conant, U.S. Fish and Wildlife Service, kindly surveyed the lower Tatshenshini River and provided his data for inclusion. Paul Gort voluntarily prepared many of the GIS layers used in the maps. Nancy Hughes provided a valuable last minute review of the manuscript.

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Table 1. Number of maps in each of five strata for the 1995 Yukon/northern BC Trumpeter Swan Survey.

	Total Number In Stratum				Number Surveyed		
Stratum	RMP	PCP	**Total**		RMP	PCP	**Total**
0	25	34	**59**		0	0	**0**
1	66	29	**95**		0	0	**0**
2	0	0	**0**		0	0	**0**
3	247	159	**403**		18	15	**33**
4	9	8	**17**		7	8	**15**
5	8	1	**9**		6	1	**7**
Total	**355**	**231**	**586**		**31**	**24**	**55**

Table 2. Summary of all swan sightings (including incidental sightings) on the 1995 Yukon/northern BC Trumpeter Swan Survey.

Stratum	Population	No. of Sightings	No. of Pairs	Adults in Pairs	Lone Adults	Adults in Flocks	Cygnets	Broods	Total Adults	Total Swans	Percent Cygnets
0	PCP	1	0	0	0	4	0	0	4	4	0
1	PCP	1	0	0	0	3	0	0	3	3	0
3	PCP	24	16.5	33	6	17	38	10	56	94	40.4
4	PCP	28	22.5	45	5	25	39	11	75	114	34.2
5	PCP	2	2	4	0	0	3	1	4	7	42.9
	PCP Total	50	31	62	6	32	56	15	100	156	35.9
1	RMP	1	0	0	1	0	0	0	1	1	0
3	RMP	26	23	46	3	6	17	4	55	72	23.6
4	RMP	30	26	52	0	17	26	7	69	95	27.3
5	RMP	34	31	62	6	0	37	9	68	105	35.2
	RMP Total	87	65	130	7	23	77	19	160	237	32.5
0	Total	1	0	0	0	4	0	0	4	4	0
1	Total	2	0	0	1	3	0	0	4	4	0
3	Total	50	39.5	79	9	23	55	14	111	166	33.1
4	Total	58	48.5	97	5	42	65	18	144	209	31.1
5	Total	36	33	66	6	3	40	10	72	112	35.7
	Grand Totals	147	96	242	21	72	160	42	335	495	32.3

Table 3. Trumpeter Swan population estimates and 95 % confidence limits for the Yukon Territory/northern BC based Trumpeter Swan Survey.

				No. of Pairs			Adults in Pairs			Single Adults			Flocked Adults			Cygnets			Broods			Total Adults			Total Swans			Percent	per	Mean
Population	Stratum	N*	n*	Total	95% CL (#, %)		Total	95% CL (#, %)		Total	95% CL (#, %)		Total	95% CL (#, %)		Total	95% CL (#, %)		Total	95% CL (#, %)		Total	95% CL (#, %)		Total	95% CL (#, %)		Cygnets	100 Adults	Brood Size
Pacific Coast Population	3	159	15	69	64	93	138	138	100	11	18	168	74	129	175	148	176	119	32	38	121	221	148	67	371	293	79	40.0	67.1	
	4	8	8	23	0	0	45	0	0	5	0	0	25	0	0	39	0	0	11	0	0	75	0	0	114	0	0	34.2	52.0	
	5	1	1	2	0	0	4	0	0	0	0		0	0		3	0	0	1	0	0	4	0	0	7	0	0	42.9	75.0	
	Total	168	24	94	64	69	187	138	74	16	18	114	99	129	130	190	176	93	44	38	88	300	148	49	492	293	60	38.7	63.4	4.4
Rocky Mountain Population	3	247	18	123	95	78	247	191	77	27	31	115	41	191	467	192	229	119	41	50	122	313	207	66	508	382	75	37.8	61.4	
	4	9	7	33	9	26	67	17	26	0	0		22	17	79	33	12	37	9	3	35	86	13	15	122	23	19	27.4	38.8	
	5	8	6	41	6	15	83	13	15	7	4	66	4	13	319	49	19	38	12	5	38	93	13	14	139	30	22	35.6	52.9	
	Total	264	31	197	110	56	397	221	56	34	36	105	67	221	331	275	260	94	62	57	93	493	233	47	769	435	57	35.8	55.8	4.4
Entire Yukon/ n. BC	3	406	33	191	108	57	379	217	57	37	33	90	123	217	176	344	276	80	74	60	81	541	241	45	886	460	52	38.9	63.6	
	4	17	15	55	6	12	108	13	12	6	2	29	48	13	27	74	12	16	20	4	18	163	19	12	237	28	12	31.1	45.1	
	5	9	7	42	7	16	85	13	16	6	4	61	0	13		51	17	32	13	4	31	91	15	16	143	29	20	36.0	56.3	
	Total	**432**	**55**	**288**	**121**	**42**	**571**	**243**	**43**	**49**	**39**	**79**	**171**	**243**	**142**	**470**	**304**	**65**	**107**	**68**	**63**	**796**	**275**	**35**	**1265**	**517**	**41**	**37.1**	**59.0**	**4.4**

* N=number of 1:50,000 mapsheets in stratum, n=number of mapsheets surveyed in stratum

Table 4. Area coverage and swan density for the 1995 Yukon/northern BC Trumpeter Swan Survey.

	Area Covered by Estimate	**PCP**	**RMP**	**Total**
Yukon				
	No. of 1:50,000 mapsheets	156	292	448
	Total Area (sq. km)	114,510	210,546	325,056
B.C.				
	No. of 1:50,000 mapsheets	75	63	138
	Total Area (sq. km)	59,827	49,676	109,503
Total				
	No. of 1:50,000 mapsheets	231	355	586
	Total Area	174,337	260,222	434,559
	Swans per 100 sq. km	0.28	0.29	0.29

Table 5. Costs for the 1995 Yukon/Northern BC Trumpeter Swan Survey.

Personnel @$250 per day		Days	Cost (cdn)
	planning, map preparation	3	$750.00
	aerial survey	5	$1,250.00
	data entry, analysis, write up	21	$5,250.00
	subtotal	29	$7,250.00
Aircraft Charter (Maule M7)		hr	
	August 20	6.4	$1,995.55
	August 21	9.2	$2,805.54
	August 22	8.2	$2,510.86
	August 23	8.3	$2,596.10
	August 24	8.7	$2,508.14
		40.8	$12,416.19
	subtotal incl. GST		$12,591.76
Travel			$400.00
Materials			
	maps		$400.00
Total Cost			$20,641.76
Cost per counted swan			$41.78
Cost per estimated swan			$16.32
Cost per sq km			$0.048

NETGUNNING: A CAPTURE TECHNIQUE FOR TRUMPETER SWANS

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ABSTRACT

As Ohio's Trumpeter Swan (*Cygnus buccinator*) population increases, catching and collaring cygnets is necessary to determine range expansion and local movements. Using a netgun from a helicopter is an effective technique to capture cygnets with minimal disturbance or injury to the swans.

INTRODUCTION

The Ohio Division of Wildlife began a Trumpeter Swan reintroduction program in 1996 with the release of 15 swans. Since that time, 83 birds have been released and all have been marked with collars to monitor movements. The first wild trumpeter cygnets were hatched in 1997 and techniques to capture and collar cygnets were investigated.

Trumpeters have been caught by night-lighting on Idaho rivers (Drewien *et al.* 1999), but tall emergent vegetation and shallow (<1 m) water in Ohio's marshes prevented use of this technique. Portable cages positioned around a bait pile in winter have also been used successfully to capture swans in Michigan (J. Johnson, Kellogg Bird Sanctuary, pers. comm.), but Ohio swans did not regularly use the bait pile. In addition, attempts to "drive" flightless swans to a capture pen were unsuccessful.

Netguns have been used to capture ungulates (Scotton and Pletscher 1998), coyotes (*Canis latrans*) (Gese *et al*. 1987), Golden Eagles (*Aquila chrysaetos*) (O'Gara and Getz 1986) and Marbled Murrelets (*Brachyramphus marmoratus*) (Quinlan and Hughes 1992) with varying degrees of success. Drewien *et al.* (1992) had little success using the netgun on swans in Idaho, but they were operating under severe weather conditions in winter. The capture situation in Ohio was sufficiently different (late summer) to warrant a trial use of a four-barreled Coda netgun (Coda Enterprises, Mesa, Ariz.) and a Bell Jet-Ranger 206 helicopter (Bell Helicopter Textron, Fort Worth, TX) to capture cygnets.

METHODS

Swan cygnets were captured at Magee Marsh Wildlife Area (MMWA) and Ottawa National Wildlife Refuge (ONWR) along the western basin of Lake Erie in Ottawa County, Ohio. MMWA and ONWR are adjacent wetlands and contain 809 and 2350 ha, respectively. Both areas are comprised of freshwater marshes dominated by cattail (*Typha* spp.), burreed (*Sparganium eurycarpum*), rose mallow (*Hibiscus moscheutos*), water milfoil (*Myriophyllum* spp.), and pondweeds (*Potamogeton* spp).

A helicopter was used to locate the swans in the wetland complex. All doors except the pilot's were removed to give the gunner a clear field of fire, and to allow the two swan recovery personnel to quickly exit the helicopter when a swan was netted. The gunner and pilot were seated on the same side of the aircraft to aid in positioning the helicopter close to the swans. If swans remained in a tight group on the water when hazed by the helicopter, the ground crew used a shallow-draft boat to segregate the cygnets. If the swans flew, the helicopter stayed within 30 m of the group while they were in flight, and the helicopter kept the swans in either MMWA or ONWR airspace. The swans soon landed due to the short flight endurance of the cygnets.

When a cygnet was about 4 m away from another swan or emergent vegetation, the helicopter swung to within 8 m of the swan, and a 3.7 m x 3.7 m net (10.2 cm mesh) was fired from the netgun. The helicopter maintained forward movement while the shot was fired to prevent helicopter downdraft from affecting the trajectory of the net. After the swan was netted, the helicopter descended to within 1 m of the water surface, recovery personnel exited from the helicopter into the shallow water, and the helicopter went to pursue the next cygnet. The netted swan was caught and transferred into the boat while the gunner reloaded the netgun for the next shot. When all of the swans from a family unit were caught, they were taken to shore. Each swan was sexed, banded with a U.S. Fish and Wildlife Service band (size 9C) and a green plastic leg band (Spinner Plastics, Springfield, IL) with a white alphanumeric code (one letter and two numbers), and collared with a green plastic collar having the same code as the plastic leg band. All cygnets from a family unit were released together.

RESULTS AND DISCUSSION

On 29 September 1998, a total of 1.4 flight hours yielded six swans captured in seven attempts for a success rate of 86%. No swans were injured during capture, and all cygnets survived for at least three months after capture. The first family unit of 3 cygnets could not fly, and the entire process of locating the birds (4 minutes), separating the birds from the parents (6 minutes), and capturing the young (27 minutes) took 37 minutes. The majority of that time (23 minutes) was spent attempting to "drive" the third cygnet from a deep pool into shallow water. The actual shooting and recovery of the first two swans required <2 minutes each.

Although no time intervals were recorded, the capture of the second family of three cygnets took 10 minutes longer (47 minutes) than for the first family because the second set of cygnets could fly. When the helicopter attempted to separate the single adult from the cygnets, all the swans took flight. However, the swans landed three times and a cygnet was captured each time. All three cygnets were brought to a central location and were banded, collared, and released. Future capture attempts will be conducted in late August or early September so cygnets can be caught before fledging.

An attempt to net a 1-year-old swan was unsuccessful. The 1-year-old was more wary of the helicopter than the younger birds in family units, and the 1-year-old flew as the net was fired, causing a miss. The helicopter followed the swan into the air, but attempts to haze it to the ground were unsuccessful. Three subsequent attempts to get close to the swan after it landed were also unsuccessful.

The primary concern while using the netgun in the helicopter was the safety of the personnel. The gunner was securely fastened to the helicopter by a restraint harness (Coda Enterprises, Mesa, Ariz.) that enabled him to lean out of the helicopter without risk of falling. When the gunner prepared for a shot, he positioned himself so that he was facing 90^o from the centerline of the helicopter, raised the gun to his right shoulder, and rested his left elbow on his left knee. This position prevented him from shooting the net into the helicopter skid or rotor regardless of the helicopter's maneuvers. The gunner maintained this position, allowing the pilot to place the swan in the gunsight, and fired the net when the swan positioned itself for the shot. In prior uses of this technique, failure to comply with these safety rules has caused mishaps in which the gunner has fallen out of the helicopter or the helicopter was brought down by the net (M. Adkinson, The Wilds, pers. comm.).

Precautions were also taken to ensure the safety of the swans. Before practicing shots from the helicopter, the gunner practiced shooting the net from a two-tiered tower (6 and 9 m in height) at a mounted Tundra Swan. The swan was placed approximately 8, 11, and 14 m away from the tower so that the gunner could learn the effective range of the net and estimate distances to a swan. The gunner then practiced shooting the netgun at the mounted swan while the gunner was in the airborne helicopter. The practice allowed the gunner to become proficient in centering the swan in the net, thus quickly entangling the swan and minimizing any injuries the swans may suffer while struggling in the net. We also tried to minimize swan injuries by shooting at swans in water since the water seemed to cushion their struggles.

An additional concern was that capturing the cygnets on the nesting grounds might cause the parents to nest at a different location the following year. We tried to minimize this disturbance by quickly capturing and processing the birds. In both sets of captures, the adults reunited with the cygnets within 24 hours of capture. Capture did not seem to affect site affinity since both family units remained in the area after the cygnets had fledged and returned to the same areas the following spring.

Use of a netgun is an effective technique for capturing swans in the Lake Erie marshes. The helicopter allows for quick location and capture of the cygnets, and the shallow water in the marshes makes recovery quick and easy with only a boat needed for ground support. As the trumpeters expand their range in Ohio, and we attempt to capture cygnets on deeper bodies of water, further refinement of the technique will be needed.

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DETECTING TRUMPETER SWANS HARVESTED IN TUNDRA SWAN HUNTS

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ABSTRACT

Identifying the less numerous Trumpeter Swan (*Cygnus buccinator*) in Tundra Swan (*C. columbianus*) harvests is a management concern. As Trumpeter Swan ranges expand, their populations become more sympatric with Tundra Swans during fall and winter but the two species are difficult to separate in the field. Eight states currently allow limited permit hunting for Tundra Swans. Hunting of Trumpeter Swans is currently limited by experimental quota to three states in the Pacific Flyway. We compared bill measurements (tip to posterior edge of nares opening) for Trumpeter Swans captured in Idaho (n = 672), Tundra Swans harvested in Utah (n = 1,414), and measurements reported on postcards (n = 890) by hunters from swans harvested in Montana. Mean bill measurements for adult and cygnet Trumpeter Swans were 68.8 mm and 67.6 mm, and for Tundra Swans, 54.0 mm and 52.4 mm; differences were significant ($P<0.001$) between species and in each age class. Over 99% of Trumpeter Swan adults and cygnets measured >62 mm and >61 mm, respectively, while 99% of Tundra Swan adults and cygnets were <60 mm and <59 mm, respectively. Over 96% of adult Tundra Swans were also identifiable by yellow lore spots, which were rare (0.3%) in adult Trumpeter Swans. Utah data showed 10 (0.7%) of 1,424 swans checked during 1994-96 seasons were Trumpeter Swans. A Montana postcard survey was mailed to swan hunters during 1992-96 requesting bill measurements, presence or absence of yellow lore spot, and plumage color to assess age. Of 890 swans reported, 19 (2.1%) were judged to be Trumpeter Swans. The postcard survey identifies species with minimal error, is a useful and inexpensive technique to monitor minimal Trumpeter Swan harvest in Tundra Swan hunts, provides age composition of the harvest, and could be used in Tundra Swan hunting states. The utility of the technique is dependent on accurate measurements and a high compliance rate by hunters.

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INDUCED MIGRATION – ITS ORIGINS AND HISTORY

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ABSTRACT

In 1965, Bill Carrick discovered and subsequently demonstrated how to induce Canada Geese (*Branta canadensis*) to follow fast boats and ultralite aircraft. Successful migration, in which birds were led to a destination using ultralites and returned on their own, was first accomplished with Canada Geese by Bill Lishman in 1988; with Sandhill Cranes (*Grus canadensis*) in 1995 and with Whooping Cranes (*G. americana*) in 1997 by Kent Clegg and his team; and with Trumpeter Swans (*Cygnus buccinator*) in 1998 by Wayne Bezner-Kerr. Rearing methods have significant effects on the subsequent behavior of the birds. Geese, cranes, and swans have displays that signal intention to fly away. The drive to follow parents is very strong and offspring learn traditional migration routes and wintering grounds from their parents. So strong is this drive that artificially-reared young birds that have no flying parents will follow vehicles such as ultralite aircraft. These can be used as surrogate parents to induce migration. Restored populations of Trumpeter Swans sometimes pioneer long distances to the north to breed. Establishing breeding trumpeters in the southern part of their historic range could provide pioneers and help restore migratory traditions.

HISTORY OF INDUCED MIGRATION EFFORTS

Canada Geese

In 1965, Bill Carrick discovered that captive-raised Canada Geese, on reaching flight stage, would follow a Jeep. He realized that such close following would provide an ideal opportunity for flight photography. In 1971, Carrick supplied Dan Gibson with two Canada Geese and one Swan Goose (*Anser cygnoides),* which flew beside a fast boat. Gibson repeated this project in 1972 with Canadas supplied by Carrick, but also flew the birds with a camera-equipped remote-controlled model aircraft with a 7 foot wing span and made a movie of this project called "Wings in the Wilderness". Independently, in 1972, Des Bartlett trained Snow Geese (*Anser caerulescens)* and a Sandhill Crane to fly beside a truck and also used a remote-controlled model aircraft with a mounted camera for flight sequences. In 1980, Budge Crawley started to make a film with Colin Kirkby using Carrick's Canada Geese and a boat. Gerry Kirkby continued to fly Canadas in 1984 and made an IMAX film called "Skyward".

In 1986, David Mackay raised about 10 Canadas from eggs supplied by Carrick and made a 3D film of them flying beside a boat, which was shown at Expo in Vancouver. In 1987, Bill Lishman, with the assistance of Carrick, tried to fly Canadas behind an ultralite aircraft, but the birds could not follow because the aircraft was too fast. However, in 1989, with geese supplied by Carrick and a different ultralite, Lishman flew about a dozen Canadas and made a video called "C'mon Geese" (Lishman 1995). He continued with these experiments, again using goslings hatched by Carrick. In 1993, collaborating with William Sladen, Lishman and Joseph Duff flew 18 Canada Geese to Environmental Studies (ESA) at Airlie, Virginia. Thirteen of these geese returned on their own to their Blackstock, Ontario, natal area. This is the first occasion that an induced migration using Canada Geese and an ultralite was successfully completed. In October 1994, this flight was repeated when 38 geese left Nestleton, Ontario, and, after 5 days of flying, 35 geese arrived at Airlie. In December, these geese were led further to the Tom Yawkey Wildlife Center in South Carolina. Total distance flown was 1280 km. In April 1995, 33 of these geese returned to Nestleton on their own.

Sandhill Cranes

The first Sandhill Crane to be trained to follow a vehicle occurred in 1972 when Bartlett flew a Lesser Sandhill Crane raised at McConnell River, North West Territories. From 1990-92, Dave Ellis and his crew (USFWS) trained four to six Sandhill Cranes to follow a truck.

In 1994, Kent Clegg was first to lead six cranes behind an ultralite aircraft on local flights round his ranch in southern Idaho. These birds were not "costume raised". In 1995, Clegg led 11 radio tagged cranes 1,204 km (748 miles) from Grace, Idaho, to the Bosque del Apache National Wildlife Refuge in New Mexico by ultralite and released them among wild cranes. Four of these cranes migrated north in Spring 1996 and two returned to a point 53 km from their natal area (Clegg *et al.* 1997). In 1996 and 1997 this flight was repeated with the addition of four Whooping Cranes in 1997. These flights were plagued by attacks by Golden Eagles (*Aquila chrysaetos)* (Ellis *et al.* 1999).

At the same time in 1995, Ellis and his crew led Sandhill Cranes by truck on a low level flight over a 600 km (373 miles) route. The birds that completed the flight did not make the return trip on their own, but two returned 130 km (80 miles) to the starting point of the flight after the flock was scattered by Golden Eagle attacks (Ellis *et al.* 1997).

In 1995, Wayne Bezner-Kerr and Lishman persuaded Sandhill Cranes to fly with an ultralite. They undertook cross country flights with overnight stops before leading the cranes back to Nestleton. This test was followed in 1997 by Lishman and Duff leading seven Sandhill Cranes from Scugog Island, Ontario, to ESA in Virginia. These birds returned to Ontario in the spring. They apparently flew on the correct course to Nestleton until they reached Youngstown, New York, on the south shore of Lake Ontario. They then skirted west along the south shore of Lake Ontario, apparently unwilling to fly across the lake, and were next seen at St. Catharines, Ontario. They turned north and were recorded at Holland Landing on the same latitude but 56 km (35 miles) west of Scugog Island. They were seen at many localities up to 160 km (100 miles) west of Holland Landing. The birds had no fear of people, landing in school yards, golf courses, a prison, and a strawberry farm. They were finally led back by ultralite from Orangeville to Scugog Island (Lishman 1998). In spite of costume rearing and other precautions, there was a breakdown in wildness in these cranes (Duff 1998).

In 1998, greatly modified rearing and training procedures were developed to ensure and test the preservation of wildness in the cranes. The birds were trucked to Green Sea in South Carolina and were led by Lishman and Deke Clark with ultralites 174 km (108 miles) to the Tom Yawkey Wildlife Center, South Carolina. After a short period of confinement, they were released and spent the winter there. In spring, they moved north to Cedar Island in North Carolina. Half of the cranes were trapped there and moved to Batavia, Genessee County, New York, where they were released. They subsequently moved 402 km (250 miles) southeast to the Never Sink River State Wildlife Refuge, north of New York City. Wildness was apparently preserved successfully, which was the objective.

Trumpeter Swans

Carrick first experimented with flying Trumpeter Swans (*Cygnus buccinator)* with a boat in 1986. In succeeding years, improvements were made until several individuals flew beside the boat well enough to provide good photographs and videos. Carrick has flown trumpeters annually since.

Three female trumpeters, imprinted to their keepers, were led in 1997 by ultralite aircraft on a 166 km (103 miles) flight from ESA across Chesapeake Bay to a wintering site at Crapo, Maryland. In the spring, these three females left Crapo and one returned to within 10 miles of Airlie, while the other two did not complete the whole distance. Two males, which had been taken to Crapo by truck, did not leave in the spring and were retrapped and returned by truck (Sladen 1998, Sladen and Rininger 2000).

In 1998, Sladen's team trained imprinted trumpeter cygnets in northern New York State to fly with an ultralite aircraft. The plan called for leading them 530 km (330 miles) to Chesapeake Bay, Maryland, with four ultralites. This plan was abandoned when the cygnets failed to display adequate flight endurance and two were injured by collision with the planes. Ultimately, the cygnets were trucked to Maryland, with overnight stops along the route where they were flown locally to accustom them to the topography. Sladen and Rininger (2000) described the details of this experiment and the subsequent failure of these trucked birds to establish a New York to Chesapeake Bay migration.

In 1997, Bezner-Kerr, a graduate student under Professor Tom Nudds at the University of Guelph, Ontario, started work on induced migration of Trumpeter Swans. Previously, it had become apparent to Carrick and me in 1991, and from work done by Carrick, John Eadie, and his students in 1992 and 1993, that trumpeter behavior varied depending on rearing techniques (see below). We suspected that imprinting on keepers was not necessary when inducing birds to follow an ultralite. Bezner-Kerr's thesis study was to test the role of imprinting. Twenty cygnets from the Ontario Trumpeter Swan Restoration Program were given to him in 1997, but early freeze-up aborted the project. In 1998, Bezner-Kerr was given 18 more cygnets and a second flock of 20 cygnets was given to Harry Hewick and Carrick to use the same experimental protocol and join with Bezner-Kerr's birds for the flight south.

Bezner-Kerr imprinted some cygnets on human keepers and some on their parents. Although every effort was made to induce each group of cygnets to fly with the ultralite, only the cygnets imprinted on their parents for 10 days flew reliably enough with the ultralite to make the 1,085 km (674 miles direct line) flight from Sudbury, Ontario, to the Muscatatuck National Wildlife Refuge in Indiana. In the spring of 1999, at least two of the four birds that made the flight returned to Sudbury. This constituted the first successful induced migration of trumpeters.

The 20 cygnets that Hewick and Carrick worked with hatched a month later than Bezner-Kerr's birds and were not well enough developed to accompany the latter birds on the flight south. Bezner-Kerr's results raise the question of whether 10 days of imprinting on parents is the best period to use for inducing migration in trumpeters. This year, tests will be run with cygnets hatched by their own parents and removed for training at 14, 36, and 40 days of age.

Many of these attempts to persuade geese, cranes, and Trumpeter Swans to fly with machines have been based on the belief that imprinting on human keepers was necessary for success. Largely overlooked has been the fact that imprinting on people is not imprinting on boats, vehicles, and ultralite aircraft. There has been considerable misunderstanding of what constitutes filial imprinting.

BEHAVIORAL ASPECTS

Filial imprinting

The following behavior of newly hatched precocious species of birds was discovered by Spalding (1873). He found that newly hatched young would consistently follow the first moving object seen on leaving the nest. This filial imprinting behavior was studied in detail by Lorenz (1937) and more recently by many others. There is a limited time period immediately after hatch during which this following behavior develops. Ramsay and Hess (1954) found that Mallad (*Anas platyrhynchos*) ducklings were imprintable up to 32-36 hours after hatch, but the most sensitive period was 13-16 hours. However, Fabricius (1973) demonstrated that under certain experimental conditions the following behavior could be evoked up to an age of 72 hours post-hatch. Trumpeter Swans imprint in the same manner as other waterfowl although the period of greatest sensitivity does not seem to have been investigated. If imprinted on their keepers, they will follow with great fidelity. This has given rise to the idea that filial imprinting is somehow necessary for the development of the following response, which develops at fledging.

Cygnet behavior

The effects of rearing technique were investigated by Eadie and his students in 1992. Time budgets were carried out on incubator hatched cygnets to compare the behavior of those that were imprinted on, and would follow, their keepers (exposed) with those that had been screened from humans (unexposed) and would not follow anyone. The time budgets continued until the birds were 30 weeks of age. In 1993, these studies were repeated for 11 weeks with the inclusion of a brood hatched and raised by their own parents living in semi-natural surroundings. In both years, exposed birds fed at significantly ($P<.001$) higher rates and showed significantly lower levels of vigilance than unexposed birds and those naturally raised by their parents. Spacing behavior was significantly greater for exposed broods than those unexposed. These differences between exposed and unexposed cygnets disappeared by 26 weeks of age. In 1993, the brood that was hatched and raised by their own parents fed less, was more vigilant, swam more, and preened less than the other two groups. In spite of the difference in feeding rates, there was no effect on the rate of increase of mass among the three groups studied (Eadie *et al.* 1994a and 1995b). In the fall of 1993, 21 of the exposed group and five unexposed cygnets were moved to Lake Scugog to test their willingness to follow a fast boat. The five unexposed birds followed the boat more readily than the exposed imprinted birds. This suggested that imprinting to their keepers was unnecessary in development of the following response and might be detrimental.

The flying following response

Taking flight may be the time when offspring are most likely to become separated from their parents. Many species possess displays that signal intention to fly. In Canada Geese, this display consists of vertical and horizontal head-tossing accompanied by distinctive calls. Snow Geese use rapid lateral head-shaking and also calls (Raveling 1969). Swan Geese also use lateral head shaking accompanied by low ga-ga-ga-ga calls (Johnsgard 1965). Trumpeter Swans bob the head and neck up and down with neck feathers sleeked, utter one to three rapid short calls, and curve the neck with the head held low, then run or swim rapidly at takeoff (Lumsden and Carrick unpublished notes). Prior to flight, Sandhill Cranes have been described (Voss 1976, Tacha 1984) to stand on both legs and arch the neck forward with the body held upright at about 20-30° above horizontal. This pre-flight intention display may be augmented further by fully or partially spread wings.

Families of species that possess these flight intention signals are well bonded by the time the young reach flight stage. The parents fly to traditional wintering grounds leading the offspring. Lorenz (1988) found that the cohesion of Greyleg Goose (*Anser anser)* families seemed to increase when the goslings reached flying stage. Even captive-reared birds seem to become more attached to their human foster parents after fledging. In the spring journey north, the young may accompany their parents all or part of the way. That young birds can return to their natal area on their own, having once flown the route, has been shown for Canada Geese (Lishman), Sandhill Cranes (Lishman, Clegg), Whooping Cranes (Clegg), and Trumpeter Swans (Bezner-Kerr).

Intention movements do not evolve unless substantial selective forces pressure their development. The advantages of family bonding may be two-fold. Inexperienced young birds probably have a greater chance of survival if the family stays together through much of their first year of life. Secondly, at least with geese, larger families are more within their population (Raveling 1970). Therefore, they have advantages in the choice of safe loafing and roosting sites and the best food sources. Captive-raised birds have no flying parents to lead them on migration; nevertheless, when they fledge, they will follow inappropriate objects such as motor bikes, various motor vehicles, boats, and ultralite aircraft. Anyone can drive these vehicles, it does not need to be the individual to whom they might be imprinted.

Pioneering of restored populations of Trumpeter Swans

Some restored populations of Trumpeter Swans, such as the one at Lacreek National Wildlife Refuge (NWR), South Dakota, were established by transfer of cygnets that had no natural parents to follow. While they colonized and nested in the area surrounding Lacreek, for many years they returned to the Refuge where open water and food was provided in winter. In the 1980s, the population had built to an average of 240 birds (Kraft 1995a). Since 1991, the peak winter population on the Refuge has been lower than the number tallied in the surrounding area during the summer. The population appears to be expanding and up to 100 birds in some winters have left the refuge to wander south (Kraft 1995a). Whether this involves a true migration involving a traditional movement to and from a specific wintering area is not yet known. Some Lacreek trumpeters have also pioneered north (Kraft 1995b). Banding by Shandruk in 1991 and by Beaulieu and Beyersbergen in 1994 in Greenwater Provincial Park in east-central Saskatchewan has shown that some breeding swans there migrate 1,090 km (677 miles) south to Lacreek in winter.

A patagial marker seen on a breeding female on the English River system north of Kenora in western Ontario revealed that some of these birds winter on the Otter Tail River in western Minnesota. They are part of the Minnesota restoration program and travel 447 km (278 miles) between their breeding lake and wintering area. The unmarked trumpeters occupying Big Rideau Lake in eastern Ontario are probably pioneers from escaped captives in New York. The nearest known breeding locality is the Perch River WMA, 60 km to the south. These swans, however, are exceptional in that they have found open water at the Narrows on Big Rideau Lake and do not return to winter in their natal area in New York.

These examples of pioneering to the north to breed suggest that trumpeters may break their tradition of returning to the vicinity of their natal area to nest more readily than they break their wintering traditions. We have evidence in Ontario that as subadults they may wander substantial distances north of their normal summering area. Perhaps on these excursions they discover suitable nesting habitat. Much of the southerly movement of trumpeters in the Midwest, frozen out of their summer breeding range, appears to be non-traditional. We should make every effort to document those southerly movements that do become traditional and enquire if any special factors were at work. Rolf Kraft, manager of Lacreek NWR, has suggested that a realistic way to encourage natural migration would be to establish breeding populations in suitable habitat far enough south to ensure winter survival and allow those populations to expand and pioneer north on their own.

CONCLUSION

Induced migration using ultralite aircraft for Trumpeter Swans is now a workable technique. It is, however, very expensive, initially involving the purchase of at least two ultralite aircraft and an annual expense for raising cygnets, training them, and leading them to a suitable destination with paid staff or volunteers. When one considers the costs of the trapping and translocation program of trumpeters from the Tristate area, perhaps the costs of inducing migration with ultralite aircraft are not excessive.

We should seriously consider Rolf Kraft's idea of establishing breeding populations in suitable habitat in the south (Kraft 1992). This would restore trumpeters to their former range as well as provide an opportunity for them to pioneer north with subsequent migration to their original natal area.

This can be done with a minimum expenditure of taxpayers' money.

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TEACHING TRUMPETER SWANS PRE-SELECTED MIGRATION ROUTES USING ULTRALIGHT AIRCRAFT AS SURROGATE PARENTS - SECOND EXPERIMENT, 1998-1999

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INTRODUCTION

The objective of the Swan Research Program (SRP) is to develop methods to restore a flock of migratory Trumpeter Swans (*Cygnus bucccinator)* in the Atlantic Flyway, where this magnificent waterfowl species was extirpated almost 200 years ago. We are training young swans to follow an ultralight aircraft that will ultimately lead them on a pre-determined migration route from an area where trumpeters are believed to have once nested to a traditional wintering area in the Chesapeake Bay (Gillette and Shea 1995, Atlantic Flyway 1998).

METHODS AND RESULTS

In the SRP's first swan experiment (1997-98), three female and two male trumpeters were trained by pilot Gavin Shire to follow an ultralight. Alhough ultralights had previously flown with Canada Geese (*Branta canadensis*) (Lishman 1996), Sandhill Cranes (*Grus canadensis*) (Lishman *et al.* 1997), and in 1996 with swans (Wayne Bezner-Kerr, pers. comm.), this was the first time swans were successfully led over a pre-determined migration route. In December 1997, the three females were led by two ultralights from near Airlie, Virginia, to winter habitat on the Honga River on the eastern shore of Chesapeake Bay. Because the two males were not following well, they were trucked to join the females for the winter (Sladen and Shire 1998).

In Spring 1998, all three females returned halfway from their wintering site without deviating by more than 5 miles from the route that they had been shown by pilot Shire. One returned to within 10 miles of Airlie and another, though on course, was injured and therefore trucked back. The third was also trucked back from Cambridge, Maryland, after backtracking there, because our permits did not allow us to leave it there after the end of May. We do not know if it would have ultimately returned on its own. The males remained in the winter quarters and were subsequently trucked back to Airlie. In Fall 1998, all five trained swans remained at Airlie during the mild winter. We theorize that trumpeters need be "frozen out" to stimulate return to wintering grounds.

As in the first swan experiment, in our second experiment (1998-99) eggs were taken from captive birds after at least 10 days of incubation by their natural parents. Of 28 eggs taken from five nests, 26 hatched and produced 19 healthy cygnets. The other seven hatchlings developed congenital abnormalities and were thus excluded from the experiment. The second experiment differed from the first in several ways: 1) age range of cygnets was less; 2) handlers wore yellow ponchos during early training to differentiate handlers from strangers; 3) a trumpet-like bicycle horn was used for communication instead of voices of individual handlers; 4) the swans were led to and from a pond by a wingless ultralight rather than by a handler in early training; and 5) the birds flew in larger family-sized groups of up to five birds during flight training. These improvements resulted in swans bonding with and flying with the aircraft more quickly, consistently, and confidently. We learned little from the use of ponchos because they were abandoned halfway through the second experiment.

Flight training began at Airlie. In mid-September 1998, 19 swans were transported in a closed, climate-controlled van to continue their training at New York Department of Environmental Conservation's (NY-DEC) John White Management Area at Basom, near Buffalo. The grass airstrip proved excellent for early morning and pre-dusk training flights when wind was calm. However, bad weather reduced training time by almost 90%.

We also attempted to a create larger flock size than in the first experiment by dividing the birds into three training teams of about seven birds based upon physical strength, age, weight, and dominance. When attempts were subsequently made to amalgamate two teams to fly with the plane, as had been the practice in previous goose and crane experiments, the swans began to compete in the air for their respective positions in formation. This caused an extra hazard for both swans and pilots.

As migration time neared, some of the swans showed signs of stress during flight, perhaps due to insufficient flight-training time or health issues.

Nevertheless, fearing the onset of winter weather, we initiated the migration on 4 December 1998. With an accompanying ground crew, four planes started to lead the swans over a 305-mile pre-selected migration route to the eastern shore of Chesapeake Bay, Maryland. During the first two legs of the migration, however, two swans struck the ultralights. These non-fatal injuries were thought to result from "slow" wings on the ultralights.

Due to the injuries and the birds' inadequate flight endurance, we changed the protocol and trucked the swans between stops approximately 40 miles apart. At each location, birds were flown within a 5-mile radius at altitudes up to 1,000 feet and penned in the open overnight to orient them to the night sky. The goal was to teach the swans the topography at each stop and determine if the birds could piece together this disjunct information to complete a homeward migration in the spring. They gained strength and flying ability as they traveled south and arrived at their winter destination at the Wildfowl Trust of North America (WTNA), Grasonville, Maryland, on 16 December 1998.

These swans were marked with yellow plastic neck and tarsal bands engraved with one black alpha (R) and two numeral codes and a U.S. Fish and Wildlife Service metal tarsal band. A small transmitter attached to each neckband allowed tracking from ground or air. The antenna was incorporated in the neckband to eliminate protrusions. The range was thus somewhat diminished, but the resulting 10 mile range from the air proved adequate.

After a quarantine period of 1 month, the birds were released into Prospect Bay at WTNA. They adapted quickly to the wild, integrating with local Tundra (*C. columbianus*) and Mute Swans (*C. olor)* while remaining within a 5-mile radius of the release site.

Although the swans displayed migration intention behaviors and some disappeared for several days, none initiated migration in Spring 1999. The surviving flock of 13 was therefore relocated on 11 May 1999 to the NY-DEC's Oak Orchard Wildlife Management Area, 2.5 miles from their 1998 training facility. While in New York, the swans were monitored by volunteers. All adapted well and the radios were helpful in tracking local movements. Two swans died during the summer; one from aspergillosis and the other from a probable power line strike. During the hunting season, four of the remaining flock of 11 were confirmed (and one was suspected) to have been illegally shot.

DISCUSSION

SRP, in collaboration with Operation Migration (OM), has been involved in five experiments with Canada Geese (1993-96) (Sladen and Lishman 1994, Lishman 1996), two with Sandhill Cranes (1997-99) (Lishman *et al.* 1997), and two with Trumpeter Swans (1997-99). In three goose, one crane, and one swan experiment in which the birds followed ultralights the entire route, overall about 90% of the birds found their own way back to within 15 miles of where they were trained to fly (Sladen and Lishman 1994, Elliot 1998, NBC Television 1998, Sladen 1998, Sladen 1999). In all other experiments, including in part the second swan experiment, when these three species were trucked all or part of the way they failed to return on their own. We conclude these three species must be shown the entire pre-selected route from the air.

Additional evidence comes from another experiment by Wayne Bezner-Kerr (pers. comm.) who led four Trumpeter Swans on an epic 777-mile migration from Ontario to Indiana in 1998. All four are believed to have returned in Spring 1999 to the Ontario training area. However, confirmation was difficult as they were marked with metal bands only.

The ultralight technique has good potential and is the only method presently available for teaching pre-selected migration routes (Lumsden 2000). However, much still needs to be learned before it can become a management tool for the restoration of Trumpeter Swans. To restore a migration route, trumpeters not only have to return to the area where they were taught to fly, but subsequently also return to the wintering grounds. To date this has not been accomplished.

Tameness of the birds has also been a problem. Due to the imprinting process, the swans were fearless of humans although there was an enormous difference in individual behavior. Some birds kept away and presented no problems, while some would occasionally attack people. As with the experimental geese and cranes, the swans were often attracted to dwellings where the public would feed them. In our experience with a large swan collection at Airlie, we have found that imprinted swans and geese are most aggressive during the first 2 years as non-breeding juveniles and lose their aggression as they mature. This problem will be addressed by our third experiment (2000-01).

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THE SCIENCE OF MIGRATION AND NAVIGATION: CONSIDERATIONS FOR TRUMPETER SWAN (*Cygnus buccinator*) TRANSLOCATIONS

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ABSTRACT

This literature review provides a summary of avian migration and navigation research with practical application to Trumpeter Swan migration and translocations. Leading theories of avian orientation are summarized and the endogenous, environmental, and physiological controls that regulate the onset of migration are discussed.

INTRODUCTION

"If we are going to understand animal navigation, we must discover a new sensory channel. Existing ones are not sufficient to explain the behavior", so concluded avian migration specialist, M. L. Kreithen, after decades of research into the science of avian navigation (Kreithen 1931). The birds have kept their secret well.

That migratory Trumpeter Swans and other birds are capable of long-distance navigation from specific breeding areas to specific wintering areas is one of nature's most amazing, and least understood, behaviors. Designing and implementing empirical research to determine how birds accomplish their remarkable journeys is challenging, to understate. Aristotle was the first human to record observations and theories on avian migration. Over two thousand years later, we have made little progress in understanding this phenomenon.

Migration is studied with state of the art methods. Hormone and in vitro studies, satellite tracking of transmitters that record physiological data such as body temperature and heart rate, wind tunnel technology to test flight performance, captive breeding of many migratory species, and field studies all contribute important data to migration research. Frank Todd, avian biologist and photographer, wrote in *The Natural History of Waterfowl*, published in 1996, "Despite considerable effort by some of the most brilliant scientific minds for over a century, exactly how birds navigate has never been explained, and the uncanny ability remains one of the greatest mysteries of the animal world" (Todd 1996).

Migration is natural for migratory waterfowl. It is part of an annual cycle that includes five seasonal processes that must be precisely controlled: migration, courtship, breeding, molt, and migration. However, the exact genetic codes that control migration, and literally make the phenomena

possible, are neither known nor understood. Migration must be adapted to breeding cycles and wing molt must be adapted to migration. It is generally accepted in migration research that the desire to migrate is seasonal, as is the breeding season, with a beginning and an ending. This circannual cycle is controlled by three factors.

The first control is endogenous mechanisms, the biological clocks that provide birds with seasonal timing. The second is environmental cues, such as photoperiod; and the third is the physiological adaptations that regulate the onset of migration, such as building fat reserves and the integration of hormone systems (Berthold 1996).

Two endogenous, or internal, biological clocks provide birds with their seasonal timing. Circadian clocks control 24-hour day activities. Circannual clocks control molt, reproduction, and migratory activities, such as the desire to migrate and the length of time for the migratory phase. If we are attempting to teach swans to continue an established migration further south to better habitat, timing may be critical. Such movements may need to be accomplished within days of the swans' arrival to their traditional wintering areas. There is also evidence young waterfowl learn migration destinations by a process Dr. Frank Bellrose (pers. comm.) terms "delayed imprinting" that is operative only at a specific period in their development. The overall good health of waterfowl in migration is additional reason to move swans during their migratory period. This is an important consideration for relocation efforts because their survival depends upon an immediate recovery from the debilitating stresses of the capture and transport, and an expeditious, successful adaptation to unfamiliar habitat.

By September, most Trumpeter Swans have completed annual wing molt and cygnets have fledged. The swans become remarkably less territorial as their circannual clock changes over from breeding time to migration time. The individual families begin to move in relatively short flights, usually to other waters close to their breeding area. Although the primary objective may be to reach desirable feeding sites, such flights also refine the flying skills of the cygnets, and give them a familiarity with home habitat they may use as a reference on the return flight the following year.

Eventually the families begin to flock together at desirable staging areas offering large expanses of fresh water and abundant vegetation. Several families may concentrate at a particular site; however, the individual families retain autonomy. Yearlings may join their parents and this year's cygnets for the southbound migration flight to their wintering area. It is to their benefit to do so because the larger families are generally dominant, and this translates to greater access to the best food and resting areas. Unlike geese and Tundra Swans (*C. columbianus*), Trumpeter Swans seldom form large flocks that remain together for the migration flight.

Cygnets normally migrate guided by their parents, following traditional migratory routes. Orphaned or released subadults are usually unable to join Trumpeter Swan family groups. A cygnet attempting to migrate alone, or with a loose association of other subadults, is all too often unsuccessful possibly because its navigation abilities are not well developed. Without the traditions, the cygnet does not have the critical advantage of having flown the route before, and it has no memory of the geography of the wintering area.

The second control factor in migration is environmental cues and the most important cue is photoperiod. The changing hours of daylight and dark synchronize the two biological clocks, and may accelerate or retard individual migratory processes. Photoperiod also contributes to the physiological changes necessary to accelerate late-hatch birds to flight stage in fewer days than earlier clutches.

The third control of migration is physical adaptations, particularly the depositing of fat reserves and the strengthening of flight muscles. Migratory birds must have highly specialized flight muscles that very efficiently convert fat to energy. They must be able to maintain a balance between the dissipation of excess heat generated from flying and the critical conservation of water so they do not become dehydrated.

Birds also must be adapted for high altitude flight without suffering altitude sickness or hypoxia from oxygen deprivation. Waterfowl regularly fly at altitudes where oxygen availability may be only two-thirds that of sea level, yet the oxygen demands of flight muscles are enormous. Mammals could not maintain energy levels or normal brain functioning at altitudes where birds comfortably fly. Birds have a very unique respiratory system considered by biologists to be the most efficient in the animal kingdom. Through a complex arrangement of lungs and paired air sacs, fresh air passes through the lungs in a continuous supply. The varying oxygen demands at different altitudes are evidently met by specialized red blood cells, each form capable of different oxygen-binding capacities.

Over long distances, and maintaining a flight speed of 44 miles per hour (Mitchell 1994), swans may have abnormally high body temperatures. They must be able to rid their bodies of excess heat without the loss of water, and may accomplish this by flying at night or ascending to altitudes where air is cooler. An interesting research supposition is that critical hydration levels may be assisted by the release of water as a by-product when fats are metabolized for energy.

Like geese and cranes, swans also benefit from energy conservation measures. Extensive studies have demonstrated formation flying, such as the classic V formations, saves considerable energy over long distances (Berthol 1993). In flight, a wing creates a wake where there is less air resistance. The wake spreads outward from the wingtip of the leading bird. A bird following in this wake needs less energy to fly. Birds change positions in the formation to share the work and the savings. Ultralight pilots leading swans should be astute observers of the physical stresses of the flight, such as indications of hyperthermia or exhaustion, and adjust altitude or length of flight appropriately.

Stored fat deposits are the most efficient fuels for migration flights because fat has the highest concentration of metabolic energy; and most body tissues, especially flight muscles, oxidize fatty acids efficiently and completely. However, Trumpeter Swans, North America's heaviest flying native bird, are almost at maximum wingloading at normal body weight. There is evidence swans lose weight over winter, even with abundant food sources, presumably to minimize wingloading at the initiation of spring migration (Bortner 1985). Swans need safe stopovers along their migration route to feed, rest, and replenish energy reserves.

In the best of traditional Trumpeter Swan migration passages, the homeward flight to breeding areas follows the beginning of spring as they fly north. In effect, the new and protein-rich spring growth at every stopover provides swans with the nutritional resources to increase weight as they progress along established migration routes. Abundant and nutritious food is critical for meeting the high dual energy demands of migration and breeding, and should be a primary consideration for route selection. In fact, the quality and quantity of foods consumed during migration directly affects clutch size, incubation period, hatchling condition, and parenting commitments of waterfowl.

Swans with no migration traditions to good winter habitat, at Red Rock National Wildlife Refuge in Montana and Henry's Fork River in Idaho, for example, have died during severe winters (Shea 1998). They made no attempt to fly south where open water and food were available. Swans considered sedentary, or those with no traditions to carry them further south to better habitat, are unlikely to attempt pioneering flights during late winter when severe weather is life threatening. To suggest their individual intelligence level is the limiting factor when swans slowly die on frozen water is, in my opinion, wrong. More likely, the swans have no knowledge of the open water and abundant food available in another location because migration further south is not a part of their traditions, and arguably, their genetics.

In late winter, with fat reserves so depleted they are clinically emaciated, Trumpeter Swans should not be expected, encouraged, or forced to undertake long flights. Swans that winter in northern latitudes with insufficient resources cannot maintain the physical conditioning they need for flight. They must use the energy resources they possess to generate enough heat in those frigid conditions to maintain normal body temperature. Swans conserve energy by reducing physical activity. Flight muscles atrophy very quickly with decreased exercise and the birds cannot fly long distances without reconditioning. Hazing birds under these conditions puts already compromised Trumpeter Swans under critical stresses. Even if they used their remaining energy resources to attempt exploratory flights, the migration period is over and the swans are essentially being forced away from habitat they understand to fly into unknown, and potentially hazardous areas.

I really struggled with algebra class in the ninth grade. One night my wonderful dad became so exasperated with my inability to understand the value of "x" that he said, "Go to your room and don't come out until you understand algebra." I would not be here today, trying to speak for the swans, if he had not reconsidered. We may be making a similar ultimatum to Trumpeter Swans if we leave the swans in poor winter habitat until they understand migration. Swans, not unlike you and me, are limited to genetic and learned resources. Migratory behavior has nothing to do with I.Q. levels. Trumpeter Swans that stop short, or north, of good winter habitat, such as Trumpeter Swans that attempt to winter in Idaho rather than fly further south to Utah, do so, I believe, because they have no migratory traditions to lead them further south.

The concept of establishing wintering Trumpeter Swan populations in warmer latitudes, with good water and either natural aquatic plants or farmed crops, would give the swans the opportunity to establish their own migration traditions. At these carefully selected locations, swans could remain in good condition over winter and have the energy resources to make exploratory flights on their own, eventually establishing their own traditions. This may also be successfully accomplished in northern latitudes where valleys, warm springs, or dams keep water open during winter, if managers agree to provide supplemental food when necessary. That being said, I know the work involved in locating large tracks of available good habitat, determining the age group with the best prognosis for success, capturing and relocating many swans, and doing everything reasonable to safeguard their survival is very difficult.

Orientation mechanisms, considered by specialists to represent phylogenetically ancient mechanisms, are most likely basic equipment in birds (Berthol 1996), even in birds considered to be sedentary, or nonmigratory. Scientific research supports two fundamental orientation mechanisms: 1) genetically preprogrammed time and direction information and 2) the ability to navigate using data from several environmental compass references, such as the earth's magnetic field. However, to transfer the genetically encoded information to an actual migration route, and learn to effectively use compass references, Trumpeter Swans need to be guided by experienced adults. Trumpeter Swan cygnets need to follow their parents along traditional routes (Gillette 1989) to develop their own migratory traditions. In doing so, the cygnets learn to use the navigational tools, such as visual landmarks, they will eventually pass on to the next generation. Before we attempt to teach Trumpeter Swans a migration route, an understanding of the complex mechanisms that birds, including swans, evidently use to navigate should be a prerequisite.

Initial results of satellite tracking and field observation indicate long-distance flyers such as swans fly straight-line, direct routes. Trumpeter Swans typically fly below 500 feet (King 1991) and almost certainly use landmarks, such as lakes, mountain ranges and coastlines, for navigation cues. Actually, no where else in the world is there a continent better adapted for long-distant north-south migrations as North America. Our major mountain ranges, rivers, and coastlines run, roughly, north to south. Trumpeter Swans presumably use these obvious reference points for general direction guides, as well as to conserve energy by taking advantage of favorable winds generated along mountain ranges and seacoasts.

If we make a decision to assist swans to establish specific migration patterns by leading the swans with ultralight aircraft, the actual flight path should follow obvious landmarks. Departure should be on a day when the sun is clearly visible – not only for observation advantages, but also because the swans may be learning to use the sun compass. The flight speed should match that normally flown by adults leading cygnets, which usually is slower than flights of non-breeders. The selected flight path should be along leading edges of mountains, or follow a river. A change in direction should occur where there is a visual reference, such as a large lake.

However, swans and other waterfowl also fly great distances between cloud layers, at night, and across miles of land or ocean with no outstanding physical differences, and maintain a true course. Visual references are just one part of their complex orientation equipment. Three biological compass systems, the sun compass, the magnetic compass and the star compass, have been scientifically demonstrated in various avian species. It is reasonable to assume Trumpeter Swans have the same basic equipment.

Navigating by the sun compass would be complex, and learned details would have to be updated as the sun's course changed with the seasons. However, the movements of the sun are predictable. The navigation reference appears to be the azimuth, not the altitude, of the sun. The azimuth is the angle at which a great circle intersects a celestial body, usually measured in degrees clock-wise from due south. The sun is always due south at local noon. By adjusting flight direction counter to the movement of the sun, north-south navigation would be possible with an east-west sun movement. The sun also provides other navigation aids. Birds are able to see polarized light and ultra-violet rays. Sunlight is polarized when its rays scatter as they hit air molecules. The position of the sun can be determined by the angle at which sunlight strikes air molecules. Sunlight from behind clouds or at dusk or dawn could be a reference for determining the sun's position.

The earth's magnetic field provides the simplest and most reliable compass for basic navigation. The earth is a huge magnet and the core of the earth's center sends out immense arcs of force lines that curve back to the earth at specific angles, unchanged by season, time or weather. In Alaska, I was given a rain forest trail guide by the USDA Forest Service with this information: the angle of magnetic declination in the Sitka area is 27° east of true north. I certainly have no innate awareness of magnetic direction; however, birds are aware of the inclination angle as they fly. Neither the structure nor the receptor is known, although photoreceptors may be involved. The force lines are vertical at the magnetic poles and horizontal at the magnetic equator. Rather than north-south orientation, the geomagnetic field distinguishes pole or equator direction.

The North Star apparently is a learned visual compass point for birds capable of detecting the center of rotation of the stars (Terrill 1991). From the earth's position in space, the constellations rotate around the North Star in the constellation Ursa Minor, and the North Star appears to be directly overhead at the North Pole. In 15,000 years, give or take a few, the pole star will have moved by 47° because the earth's axis precesses. Birds will, perhaps, reorient to a different north compass marker. However, there is much more to exact navigation than just heading north – off by a degree over a long distance, and the birds would miss their destination. There are other navigation tools currently under scientific investigation.

One interesting and controversial study suggests mallard ducks may be capable of navigating by the moon's location in the night sky. Actually, there is a difference of opinion in the interpretation of the research as reported in various texts. Such an accomplishment would be impressive because the moon's relative position changes 12° eastward each day, rises an hour earlier each night, and is below the horizon some nights. It would be much more difficult than using a sun compass. We know, by observation, Trumpeter Swans occasionally migrate at night, presumably to take advantage of the light to fly further during full moon periods.

The sounds from earth, such as ocean waves crashing on the shore, provide orientation information. Perhaps even the calls of the birds themselves may be useful for echo sounding, from which they could judge altitude and the nature of the earth below their position. We assume the constant calling we hear, often before we see flocks of waterfowl, helps families and flocks stay together as they fly. Visibility is limited even on clear days – flying in clouds, rain, or snow makes it very difficult for birds to see each other. Wind shears may change the flight altitude by 1,000 feet or more in moments. For cygnets flying the route for the first time with their parents, the calling helps the young birds stay on course and with their parents.

Birds may receive navigational direction from the earth's smells, such as forests, ocean, or industrial centers. Wind could be a directional aid. We are unable to sense wind drift without instruments, however birds evidently are able to do so through feather follicles. Receptors near their feather follicles give birds information on flight speed, when flight is approaching stall, and airflow over the surface of the wing. A sensitivity to drift would be useful in selecting direction.

Birds may also use the Coriolis Force – as the earth spins through space, turning on its axis, the rain forests at the equator appear to spin much faster than for example, an iceberg in the Arctic Ocean. The effect is similar to watching several ice skaters holding hands and skating in a circle. Those on the outside of the circle skate much faster to keep a level line than those skating in the inner circle. Birds may be aware of the actual force or the changes in the apparent revolutions as they fly toward the poles.

DISCUSSION

Jim King, relating ultralight induced migration with Canada geese (*Branta canadensis*) to a similar effort with Trumpeter Swans said, "Their habits are very similar – the young learn to follow their parents, and stay with their parents for two migrations. But maybe there's something different that we can't see" (King, unpublished internet quote). My good friend, Joe Gabig, has taught me well that swans do what swans do for their own reasons. Maybe there is something different that we cannot see.

In this room are the people working to restore the ancient migration traditions that died with migratory Trumpeter Swans when this species was shot almost into extinction. Through trial and error we now attempt, and sometimes succeed, to teach migration to Trumpeter Swans with limited, or no, migration traditions. With every attempt, whether a success or a failure, we get closer to discovering how to work <u>with</u> the swans to change their migration traditions by shaping their natural behaviors. In so many ways we are the limited species, especially in our efforts to understand how swans learn. We should consider the orientation mechanisms and migration controls, basic equipment in Trumpeter Swans, as indicators of that something different that we cannot see.

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FIELD TRIAGE AND REHABILITATION OF SWANS

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ABSTRACT

Field triage and rehabilitation of individual swans is a useful conservation strategy when used to educate the public, return individuals to the wild population, or use nonreleasable birds as captive breeders or decoys to attract wild birds to desired locations. It is important for waterfowl biologists to be able to assess the seriousness of injuries and stabilize birds in the field so an injured bird has a better chance of recovering under the care of an experienced rehabilitator. Rehabilitation of swans is a sensitive process, and specific husbandry and management methods must be carried out for successful rehabilitation to occur.

INTRODUCTION

Waterfowl biologists are occasionally confronted with a situation involving orphaned or injured swans. Some choose not to interfere, allowing nature to "take its course". In the past, the "Do Nothing" conservation strategy was acceptable, as medical and rehabilitation expertise were not readily available for wild birds. But this strategy is counterproductive toward the goal of conservation of swan populations. In fact, in 1984 at the Ninth TTSS Conference, James King, Wildlife Biologist in Juneau, Alaska, said the "Do Nothing" strategy is "the course that resulted in the near extermination of trumpeters in the past…"

In today's world of modern technology, advanced medical science, and heightened awareness of the public to conservation issues and animal welfare, a modern conservation strategy has developed. It includes proactive care of injured swans – one at a time. After all, individual swans create the populations that conservationists are protecting.

Another conservation strategy in today's modern world is education of the public. The individual injured bird is an ambassador. The story of just one bird – its suffering as a result of negative human impact, the medical work required, the rehabilitation process, and finally its release - makes the entire conservation message a personal reality. Taxpayers want to believe that their tax dollars are supporting professionals who possess the knowledge base to manage wild populations while simultaneously demonstrating compassion for individual birds.

At the Fourteenth Trumpeter Swan Society Conference, Richard Howie of British Columbia reported, "A Trumpeter Swan was observed flying into a high voltage power line near Chase, but the bird was not killed immediately. Whether it survived the winter was not determined" (Howie 1993). This is one example of the ineffectiveness of the "Do Nothing" strategy. Nothing was done for this bird, but its suffering could have been, and should have been, prevented. If its injuries held a grave prognosis, a veterinarian could have humanely euthanized it. If the injuries were repairable, a veterinarian could have done so, and a trained, permitted rehabilitator could have cared for the bird until it was ready for reintroduction to the wild. Then, it could have been banded for identification and tracking purposes. Managers of populations have an obligation to assure that each bird makes a contribution to its species. Therefore, if the bird's injuries were repairable, but it could not survive in the wild, it could serve as a captive breeder. This bird may even be used as a decoy to teach migration routes that have been lost or to attract flying birds to desired locations. Individual birds and their injuries must receive attention for conservation purposes and because it is the humane thing to do.

Field biologists may feel they do not have the time and resources to invest in a single bird. Rehabilitators are the solution to the shortage of manpower and time when attempting to assist injured swans. Unfortunately, the rehabilitation profession carries with it years of well-intentioned but unprofessional and uneducated conduct. Modern rehabilitators have shed this stereotype. Today's rehabilitators are permitted and educated. Many have spent thousands of dollars and hours learning natural history, basic medicine, husbandry, and release criteria for virtually every wild species. Today's rehabilitator possesses vast knowledge about the natural history of a particular species, they have attended conferences and published professional papers, and they have read the latest publications on the subject. The modern rehabilitator may have even carried out the latest research on that particular topic. Rehabilitation is a science. It is taught in veterinary colleges, and hundreds of veterinarians are rehabilitating animals themselves, or are working with professional rehabilitators. Millions of dollars are going toward construction of rehabilitation centers all over the world. Animals are being returned to the wild, to breeding populations.

The process of caring for individual swans, however, cannot begin with the veterinarian or the rehabilitator. It must be initiated by the field biologists who discover injured animals. The resources to care for individual swans are available to waterfowl biologists, but it is necessary to be able to assess injuries and perform field triage in order to give the bird its best chance for recovery. Once time and resources are committed to capture the bird, there must be a plan in place to provide for its care. Taking a wild bird into captivity and not providing proper care is more inhumane than leaving it alone in the wild.

The goal of this paper is to demonstrate to waterfowl biologists their obligation, as stewards of swan populations, to capture and provide medical care and rehabilitation to individual swans. It provides waterfowl biologists with guidelines to assess an injured bird's probability for survival and repair. This paper also familiarizes waterfowl biologists with the rehabilitation process and provides contact information for trained, permitted rehabilitators that can take over the care of the bird once it is captured.

DISCUSSION

When an injured bird is rescued, it is important to remember that its chances of recovering from an injury or disease decrease exponentially with time. Therefore, identifying an injury or illness and capturing the bird early in the debilitating process is critical to successful recovery and return to the wild. Because birds mask signs of injury, astute observation, combined with familiarity of the natural history and normal behavior of swans, are critical in order to recognize when the life of a bird has been compromised. Waterfowl biologists have developed the skills necessary to recognize a bird that is in the early stages of trouble. Because swan populations are under the close observation of waterfowl biologists who have developed these skills, the injured bird can be captured early in the disease process and its chances for recovery increased.
Regardless of the type of injury, stress is the most life-threatening situation confronting the bird after capture. In order to reduce stress to the bird, place it in a box or travel kennel with windows and doors covered, on a bedding of clean straw or towels immediately after capture. Be certain the windows and door are covered. If you must hold the bird for any length of time, cover its head with a towel or other material to reduce visual input. This has a calming effect on the swan, and increases its chances of survival significantly. Make certain it is as quiet as possible. Loud human voices or music compounds the stress the bird is experiencing. Leave it alone as much as possible. The manner in which the bird is captured and handled enroute to the rehabilitator has a critical impact on its survival and recovery.

Once stress is reduced, dehydration is the next life-threatening situation confronting the bird. Physiologically, an injured bird's body cannot compensate for fluid loss. If blood loss has also occurred, dehydration is even more severe. Water in a deep bucket must be available to the bird at all times. However, if the bird is so debilitated that it is not alert and does not have control of its head, do not provide water, as it could drown. If the rescuer has the trained expertise, providing oral fluids (lactated ringer's solution is best, but even tap water will help) via feeding tube, or lactated ringer's solution subcutaneously will help counteract the negative effects of dehydration.

The life-threatening effects of dehydration cannot be overstated. Once an animal becomes dehydrated, it may die within hours. Since it may take hours or even days to make the necessary contacts and transfer the bird into a rehabilitation system, it is critical to reverse or at least slow the negative effects of dehydration. Always give appropriate attention to the treatment of dehydration, and address the bird's injury secondarily.

Injury categories

Fractures

Wing fractures are one of the most common fracture types seen in swans. Fractures at any location on the wing are often repairable. However, if bone is exposed, the fracture is far more serious than if no bone is exposed. Bone exposed to the air for even a few hours may turn brown as a result of a loss of blood supply and drying. The darker the bone, and the more dark bone there is, the poorer prognosis for adequate repair. Birds with fractures above the humero-ulnar joint or "elbow" should not be considered candidates for amputation because loss of this much of the wing compromises thermoregulation and balance.

Wild birds with fractured wings are easy targets for predators. Since they cannot fly, they often lose the protection of their flying flock. Only a small percentage of fractures repair themselves in the wild, and usually the repair is not adequate to support flight. In most cases, birds with fractured wings, if not killed by a predator, have a painful and lingering death from starvation or infection. Because wing fractures are so often repairable, birds that suffer from this injury are done a great injustice when left to suffer and die in the wild.

When waterfowl biologists capture birds with fractured wings in the field, it is critical to limit additional damage to the fractured bone. Any exposed bone should be replaced under muscle and soft tissue, and the wing should be held in normal folded position. The rule of thumb for fracture care is to stabilize the joint above and the joint below the fracture. In order to accomplish this, a figure eight wing wrap should be applied. Use three or four inch wide elastic bandage and wrap the "wrist" twice, then, using the same strip of bandage, incorporate the "elbow" joint into the wrap making a figure eight around the wing. The wing should now stay in normal, folded position. Because the wing is large and heavy on swans, several wraps around each joint will be necessary. White medical tape may be applied on top of the wrap to help keep the wing flexed. Do not allow the tape to contact the feathers.

If the fracture involves the humerus, a body wrap will be necessary to hold the wing against the body and limit any additional movement of the fractured bone. Use elastic bandage and wrap it around the body, under the normal wing, leaving it free, and over the wrapped wing. The wrap holds the broken wing against the body, thus helping to stabilize it. Use caution when applying the body wrap. If it is applied too tightly, the bird will not be able to expand its keel to breathe. Two fingers should fit comfortably under the wrap. Now the fractured wing should be stable enough that no additional damage will occur while the bird is transported.

Fractures involving the legs have a significantly poorer prognosis than wing fractures. If a bird has a leg fracture and takes even one step, the bone may be so badly damaged that recovery is not possible. Again, if the bone is exposed, the chance of repair is greatly decreased. Birds with leg fractures are often unable to fly, as they cannot use the leg to supply lift for take off. If left alone, these birds will die a slow and painful death in the wild, unless a predator kills them quickly.

The best prognosis for leg fractures occurs in cygnets because they are growing rapidly, laying down new bone quickly, and are lighter than adults. One cygnet in rehabilitation had a leg fracture that healed in 10 days despite the fact that the bird also had severe peritonitis from which it finally died.

In summary, wing fractures with no exposed bone have an excellent chance of healing with proper medical care, and wing fractures with exposed bone have a slightly poorer prognosis. Wing fractures with dark brown exposed bone and leg fractures in adult birds have a poor prognosis.

When transporting a bird with any type of fracture, keep the bird in a small space. A good rule of thumb is: the more severe the injury, the smaller the space required. Since there is no way to stabilize a leg fracture in the field, place the bird in a kennel or box that is small enough to discourage the bird from standing. In the case of a wing fracture, the box should be small enough that the bird will not try to open its wings. Limit movement of the fracture site as much as possible. Fractures are not normally life threatening, but can rapidly become irreparable if they are allowed to remain unstable.

Fishing line and hooks

Another common injury of swans includes damage from fishing line and fish hooks. These injuries vary greatly in severity and the outcome depends upon how long the line or hook has been in place as well as its location. Fishing line around the limbs tends to tighten as the bird struggles to free itself. This constricts the blood supply to the limb resulting in swelling of the limb distal to the line and eventually loss of the body part. Obviously, the bird's chances of survival in the wild are greatly reduced.

In most instances, the bird recovers completely once the line is removed. The field biologist, as the bird's rescuer, may wish to remove the line. In this case, there are three points to consider: 1) The line often wraps many times around the limb, and it is difficult to determine if every strand has been removed. 2) Severe hemorrhage may result if the line has severed major vessels. Large amounts of blood could be lost and the bird may die rapidly. 3) The bird is often more lame after the line is removed than before. It may be great at risk if not protected from predators. The recovery may take weeks. In summary, when removing fishing line from a swan, be prepared to control hemorrhage and the resulting dehydration, and be aware that a rehabilitator may be required to care for the bird during its long recovery period.

Lead poisoning

Laurence Gillette, Dr. Laurel Degernes, and Dr. Pat Redig, along with others have noted that lead poisoning has been a common and chronic problem in swans (Degernes and Frank 1988, Degernes 1988, Gillette 1989, Degernes *et al.* 1989, Degernes and Redig 1988). There is controversy about whether or not swans with lead poisoning should be addressed medically. Lead poisoning is a treatable, human caused condition, with a good prognosis in most cases. It is the authors' opinion that managers of swan populations have an obligation to provide treatment.

Birds suffering from lead poisoning show a variety of clinical signs that include emaciation, regurgitation, unusual "tameness" or tolerance of humans and predators, separation from the rest of the flock, abnormal wing posture, or central nervous signs. When working with swans that suffer from lead poisoning, it is important to remember that these birds are often severely debilitated. It is critical to maintain adequate hydration and nutrition, if possible, while transporting these animals to rehabilitators or veterinarians for care. Lead poisoning has a good prognosis for recovery, especially if treatment is initiated early in the disease process. However, birds that are seizuring from lead poisoning are in the late stages of the disease and are not good candidates for treatment. Most birds that are seizuring from lead poisoning will die within hours, even if the seizures are medically managed (Brown 1996).

Be aware that treatment for lead poisoning is a process that lasts weeks, and occasionally months. All the lead must be removed from the gastrointestinal tract, and treatment must occur for several weeks to be certain that lead stored in the kidneys and liver is also removed. Usually, lead poisoning is treated with CaEDTA injections. Two injections are required each day in the early stages of treatment, with the number of necessary injections decreasing with time. Of course, the bird must remain in captivity throughout the treatment period.

There is a possibility that the bird will suffer long term, irreversible liver or kidney damage, and there is some question regarding reproductive fertility after treatment for lead poisoning. These authors believe more studies need to be carried out with animals that have been treated for lead poisoning before conclusions can be drawn. Regardless, wild birds suspected of suffering from lead poisoning should not be ignored, as they will eventually die from the disease. If treatment is not elected, euthanasia should be chosen in order to alleviate the bird's suffering.

Oil

While oil and fuel spills may not be common in areas swans frequent, there is still the possibility that waterfowl biologists may discover one or more swans that have become oiled. Any type of oil or fuel is severely toxic – it causes skin burns, disrupts the gastrointestinal tract when birds preen and ingest it, and it destroys lung tissue through toxic fumes. But, the immediate, life-threatening problem that oiled swans face is hypothermia when the bird's waterproofing is destroyed by the oil.

Upon rescue of the oiled swan, DO NOT attempt to wash the bird. Removing oil from birds is a complicated, stressful process, and very specific, detailed protocols have been developed for that purpose. Extensive training is required to learn the protocol. Washing a bird incorrectly, even if well intentioned, greatly reduces its chance for survival.

In order to prepare a bird for a trip to an experienced rehabilitator or rehabilitation center that has the facilities to clean oiled birds, place it in a snug fitting burlap bag, and secure the bag around its neck. The purpose of the bag is to prevent the bird from preening the oil and ingesting it. Be certain the bird can stay warm through the entire trip from the field to the rehabilitation center. Hydration is critical, so at the very least provide water for the bird to drink while on the trip, or, better yet, provide oral or subcutaneous fluids. Transport the bird as quickly as possible to its destination. There, it will undergo the washing protocol and receive supportive care. If the bird survives the initial exposure to the oil, chances are very good that it can be returned to an uncontaminated area in the wild within days.

Soft tissue trauma

Soft tissue trauma is one of the most deceiving injuries that occur in swans and in waterfowl in general. Any wound that does not involve bone falls in the category of soft tissue trauma. These wounds may occur due to collisions, animal attacks, or a variety of other causes. It is important to remember huge, gaping wounds that appear grotesquely life threatening, are repairable. On the other hand, wounds that appear small, such as puncture wounds from a dog bite, are serious because much of the damage is not visible when looking at the wound.

The following guidelines may be used to determine whether or not to rescue a bird with soft tissue trauma: 1) If intestines or abdominal organs are exposed or are hanging out of the wound, it is life threatening. Rarely will a bird live for any length of time with its abdominal organs exposed, and if it does survive, the animal is a candidate for a severe infection. 2) If there is a large scab, it may cause the formation of scar tissue, which limits the mobility of the body part. Therefore, injuries with large scabs in very mobile areas, such as the joints of wings, should be examined by a veterinarian. 3) Wounds with large flaps of skin hanging from them appear very serious, but are often easily sutured, allowing the bird to return to the wild within days. 4) In the summer, wounds attract flies and quickly become infested with maggots. Maggots release toxins, and if not treated aggressively, the bird may die. 5) Swans are very resilient, and most soft tissue wounds will resolve by themselves over a long period of time without medical treatment. However, treating wounds, especially if the wound is fresh, usually results in a significantly shortened recovery time. Therefore, the length of time before migration or some other critical event in the bird's life can be used to determine whether or not a bird should be rescued. If the wound is not severe, and the bird has a long time to recover on its own, it may be appropriate to leave it in the wild.

The rehabilitation process

Locating rehabilitators

Once an injured swan has been rescued from the wild and stabilized, professional help must be located quickly. Two national organizations may be contacted to find the nearest qualified rehabilitator: The International Wildlife Rehabilitators Conference (800-419-4893) or the National Wildlife Rehabilitation Association (320-259-4086). Each state's wildlife commission may also have a list of qualified rehabilitators. All individual rehabilitators and wildlife rehabilitation centers, such as the Alaska Raptor Center in Sitka, Alaska, which rehabilitates all avian species, operate under the auspices of state and federal wildlife managers.

Wild swans are difficult to successfully rehabilitate and should only be trusted with rehabilitators who have experience with the medical and husbandry care of Trumpeter and Tundra Swans, a working relationship with an experienced avian veterinarian, and the proper physical equipment. If you cannot locate a rehabilitator who meets these criteria in the local area, one of the major airlines may agree to fly the swan at no cost to a rehabilitation center or an individual rehabilitator with proper facilities.

Rehabilitation requirements

Several criteria must be met in order to successfully rehabilitate swans. First, wild swans must be located away from human voices and traffic with no exposure to dogs, loud noises, or predators. Because recovery may take months, the rehabilitator must ensure the swan does not become habituated to humans or companion animals. The enclosure must be completely covered to reduce visual input to the swan, and in turn, reduce stress. However, good ventilation must be maintained in order to prevent the development of respiratory infections. Swans need large pens constructed of predator proof wire completely lined with nylon hardware cloth, or similar material, to eliminate damage to ceres, bills, eyes, feet, and feathers. Flooring must be designed to reduce the possibility of leg injuries and prevent foot infections known as bumblefoot, which is difficult to treat. Pools must be provided to allow the bird to care for its feathers, maintain waterproofing, reduce foot and leg injuries, and provide quality of life during rehabilitation.

In addition to the physical facilities, the rehabilitator must know the natural history of the particular swan species in hand, and must be able to access current information on that species' medical and husbandry management. It is the rehabilitator's responsibility to manage the medical and husbandry care of the bird after the veterinarian has prescribed appropriate treatment and performed surgery, if necessary. The rehabilitator must also understand the important role nutrition plays in recovery. Encouraging wild swans to eat in a captive situation can be very difficult. The diet must meet the needs of the swan for that particular season and provide the additional nutrients necessary to physically recover.

Release criteria

The definition of release as it relates to rehabilitation is: The reintroduction of healthy, wild, breeding animals, capable of continued survival, to their appropriate habitat. The bird's physical condition, natural history, and appropriate habitat must be evaluated before birds can be released into the wild. If a bird can no longer survive in the wild, many of the release criteria still apply, as they are critical to a good quality of life.

Together, the veterinarian and the rehabilitator assess the bird's physical condition:

1. Is the swan at normal body weight for its age, sex, and season of the year? Is it completely waterproof? Are the feathers in optimum condition, with primary wing feathers fully grown? Is the bird strong enough to escape predators and is it capable of accomplishing the necessary tasks to survive, including long-distance migration?

2. Is there any handicap? If so, does it significantly lessen the opportunity to re-enter the breeding population?

3. Is it a carrier of any pathogen that could be transmitted to healthy swans?

Once physical conditions are evaluated, the waterfowl biologist involved in the case is contacted, and may be able to provide information on the exact location of the injured swan's family or the current location of Trumpeter Swans near the rescue site. Trumpeter Swan managers may be contacted for migration routes and destinations, and band or neck collar data if the swan is individually identified. This information assists in addressing natural history factors important to release:

1. Swans are flocking birds. Have the other wild swans migrated during this recovery period? If so, it may need to be transported to winter-over or breeding areas to rejoin its family or flock.

2. Trumpeter Swans are very territorial during breeding, and there is a definite hierarchy system. A single bird is at the bottom of this social system. It must still be able to access safe feeding, resting and swimming areas.

3. The swan must be acclimated to outside temperatures, not imprinted on humans, and not habituated to the presence of dogs, cats, or other natural predators.

Finally, the rehabilitator must evaluate environmental factors:

1. Does the release site offer nutritious foods, safe resting places, expansive fresh, open water, and the company of other Trumpeter Swans?
2. Are weather conditions at the release site predicted to be fair for a few days after release?

3. Is hunting season closed?

CONCLUSIONS

It is the release of one healthy bird back into the wild that is the reward for many weeks of hard work. And, one bird at a time, individuals and centers rehabilitate thousands of waterfowl each year. Most rehabilitation, by rehabilitators and veterinarians, is volunteer – a gift of time, expertise, and medical care. Wildlife rehabilitators give so much because they believe in the contribution an individual animal makes to a population.

Waterfowl biologists should rescue injured swans. Unlike the "Do Nothing" strategy, rehabilitation is a useful tool for biologists managing populations in which each individual's contribution is critical to the population. Rehabilitation of swans is humane, provides public education, and impacts conservation of swans by either returning them to breeding populations or utilizing non-releasable birds to influence the success of wild populations. All that being said, rehabilitation of swans serves one more purpose. It helps begin to pay back a terrible debt that humans created by shooting a species almost to extinction, one bird at a time.

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SUMMARY OF TRUMPETER SWAN PRIORITIES IDENTIFIED DURING THE 17TH TRUMPETER SWAN SOCIETY CONFERENCE, SEPTEMBER 1999

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During the presentations and discussions at the 17th Trumpeter Swan Society Conference, many ideas for Trumpeter Swan (*Cygnus buccinator*) management and research priorities were discussed. The authors have summarized the points that were identified for each population, without attempting to prioritize them.

Pacific Coast Population (PCP)

- Increase winter habitat protection, including both wetlands and agricultural ground conservation.
- Improve understanding of how to keep farmers producing "wildlife friendly" crops and farming practices.
- Improve understanding of population dynamics. Write up and synthesize PCP survey data (summer and winter) and integrate with habitat data; make available to habitat and population managers.
- Maintain quality and consistency of summer surveys and improve winter surveys.
- Analyze all PCP color-marking and band return data.
- Use satellite telemetry on breeding grounds to better define migration and winter habitats. Winter distribution is poorly understood.
- Determine positive and negative aspects of winter use of agricultural lands vs. wetlands (energetics, pesticide residues, etc.).
- Develop a management program to prevent further expansion of Mute Swans (*C. olor*).
- Improve public education and outreach.

Atlantic and Interior Populations (IP)

- Shift emphasis from restoring breeding flocks to restoring migratory traditions to secure wintering sites. Releasing trumpeters further south so they can learn those habitats and then migrate north in spring is one possible management option.
- Clearly define "self-sustaining population" so that managers can better identify acceptable management practices and determine if a restoration program has been successful.
- The Atlantic Flyway Council insists on addressing two issues before they will proceed with trumpeter restoration in the Atlantic Flyway: 1) protection of the legal Tundra Swan hunter who accidentally shoots a Trumpeter Swan and assurance that trumpeter restoration will not impact existing Tundra Swan hunts, and 2) development of methods to ensure that restored flocks of trumpeters will be migratory rather than sedentary.
- Increase winter habitat options by creating or restoring habitat, encouraging adaptation to field feeding, and/or encouraging migration further south where aquatic food is more abundant.
- Collect more data on feeding behavior and habitat use at wintering locations being used by trumpeters.
- Evaluate the potential merits and drawbacks of managing Trumpeter Swans and other waterfowl in more of a "European" manner, with public viewing areas and supplemental feeding.

Rocky Mountain Population (RMP)

- Place greater emphasis on achieving growth and security of Tristate nesting population, not just the RMP as a whole.
- Emphasize expanding the winter distribution rather than trying to redistribute swans. Managers likely cannot reduce numbers wintering in high-risk wintering sites until a die-off occurs; better to focus on increasing the segment that goes further south.

- Improve monitoring of RMP winter distribution and mortality during swan hunts.
- Provide more southerly fall migration habitat with food and security from human disturbance/hunting.
- Include Bear River National Wildlife Refuge in range expansion efforts.
- Increase the involvement of local on-the-ground managers and private sector partners in development and implementation of the restoration program.
- Increase the use of more southerly wintering habitats by Canadian and Tristate trumpeters, primarily through summer transplants and salvage/captive rearing and release.
- Expand Tristate nesting distribution, particularly in locations where swans will winter further south.
- Focus on improving nesting and fall/winter habitat on National Wildlife Refuges where U. S. Fish and Wildlife Service can regulate conflicting uses.
- Restore U.S. flocks in Oregon, western Montana, and elsewhere.
- Use satellite tracking to better understand fall/winter movements and habitat use.
- Provide for greater public involvement in decisions regarding Trumpeter Swan hunting.

Conference participants generally suggested that reliance on hazing and winter translocations should be diminished, and were divided regarding possible modifications to existing Tundra Swan hunts and legalizing the harvest of RMP Trumpeter Swans.