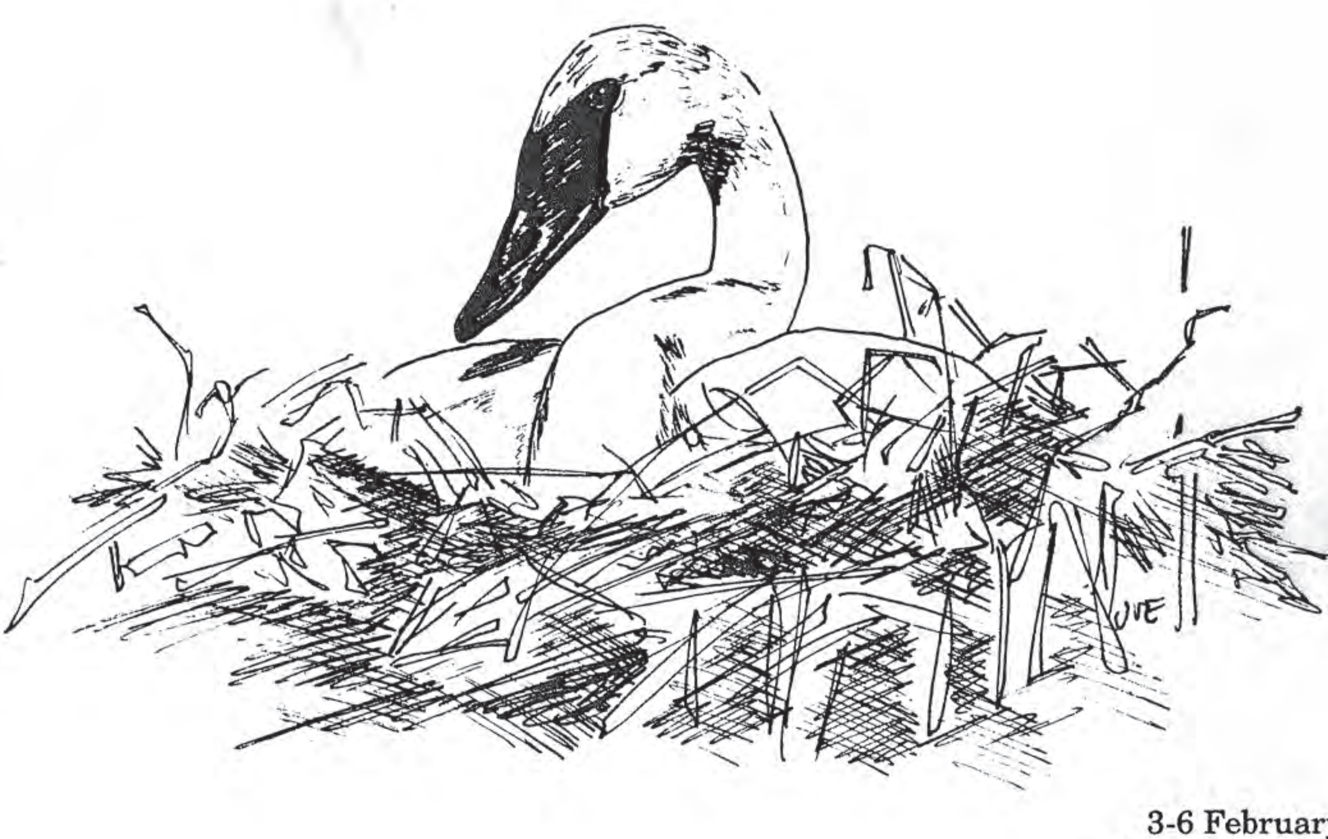
PROCEEDINGS AND PAPERS OF THE ELEVENTH TRUMPETER SWAN SOCIETY CONFERENCE

Donna Compton
Editor



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Everett, Washington

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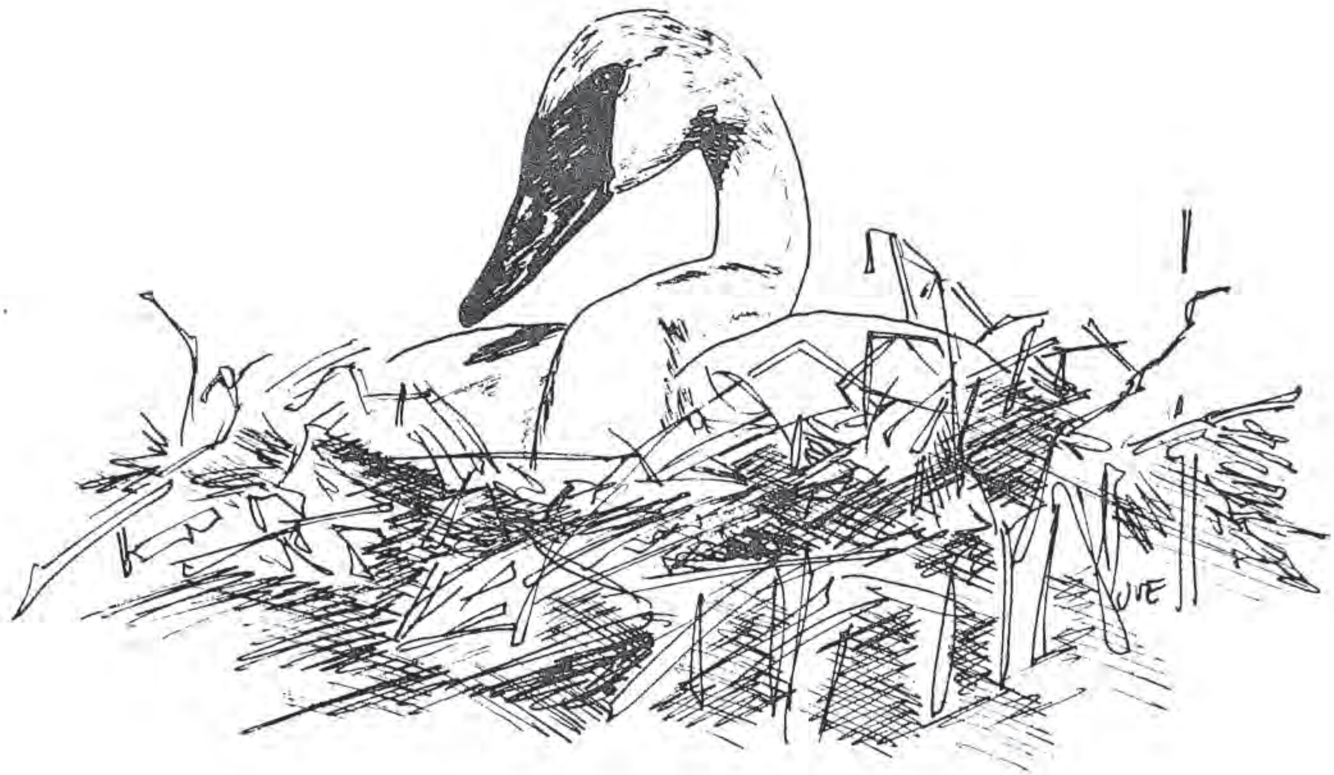

Conference Chair
Martha Jordan

Program Chair
Dave Paullin

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PREFACE

The Pacific Northwest is well known for its bountiful and beautiful natural resources. This includes the Skagit Valley, which provides wintering habitat for one of the largest concentrations of Trumpeters Swans in the lower 48 states. Everett, Washington, was chosen as our Conference site because of its proximity to the Skagit Valley and other swan wintering areas. The theme of the Conference was "The Pacific Coast Population of Trumpeter Swans: Its Past, Present and Future."

The objectives of the Eleventh Conference were to:

1. Review the status of Trumpeter Swans in the Pacific Coast Population.

2. Discuss Trumpeter and Tundra Swan interactions on the wintering areas of the Pacific Coast.

3. Improve the working relationships between The Trumpeter Swan Society and regional government agencies responsible for swan management.

4. Provide an opportunity to view winter habitats of Trumpeter and Tundra Swans of the Skagit Valley, Washington.

Participants from all over the continent participated in the learning and sharing of information about Trumpeter Swans. Many private citizens provided insightful information on swans from their volunteer efforts. Old friendships were renewed, and new friendships were made. The papers presented and the general environment of the Conference stimulated many interesting discussions.

Let us continue to dedicate ourselves to helping the Trumpeter Swan expand its range on the Pacific Coast and throughout the continent.

Martha Jordan, Conference Chair
Board Member, The Trumpeter Swan Society

ACKNOWLEDGMENTS

The Eleventh Trumpeter Swan Society Conference was co-sponsored by the Washington Department of Wildlife and The Trumpeter Swan Society. It was hosted by The Washington State Trumpeter Swan Working Group and chaired by myself. We wish to thank all those who participated in the Conference by presenting papers or by taking part in the panel discussions. The Conference was a success only because the support of the agencies these people represent and the strong personal interest in Trumpeter Swan conservation by those who attended unsponsored.

A special thank you goes to Secretary of State Ralph Munro for serving as Honorary Chairman and supporting swan efforts in the Northwest.

We thank Contel Telephone Company for sponsoring our field trip and lunch in the beautiful Skagit Valley, Riverside Beverage Company for its donation for our social event and hospitality suite beverages, and all other corporate and private sponsors.

The art auction was very successful, thanks to the hard work of several dedicated volunteers. Shirley Goll, Sue and Mike Murphy, and many others provided invaluable assistance on auction night to keep things running smoothly. Thanks also goes to all the artists and galleries that contributed their works to help further the efforts of the Society. Special thanks go to Johnny Walker of the Washington Sportsmen Council who provided assistance and coordination of the auction, to Sea Wind Gallery for its creative framing and assistance in the auction, and to auctioneer Don Britton for bringing out the wallets of so many of us.

Dave Paullin was responsible for the program content. He arranged for speakers and chaired the technical session portion of the Conference.

Donna Compton spent countless in the editing, preparation, and organization of these proceedings. The U. S. Fish and Wildlife Service contributed a portion of the preparation costs and the Washington Department of Wildlife printed the document.

Special commendation goes to my husband, Michael Kyte, who worked continually behind the scenes to make sure everything ran smoothly and who provided support and assistance to me for many months before and after the Conference.

Martha Jordan, Conference Chair
Board Member, The Trumpeter Swan Society

SPEAKERS

Theodore N. Bailey
U. S. Fish and Wildlife Service
Kenai NWR
P. O. Box 2139
Soldotna, AK 99669

June Bergquist
U. S. Fish and Wildlife Service
Turnbull NWR
Route 3, Box 385
Cheney, WA 99004

Lawrence J. Blus
U. S. Fish and Wildlife Service
480 SW Airport Road
Corvallis, OR 97333

Sara Brown
U. S. Fish and Wildlife Service
Ruby Lake NWR
Ruby Valley, NV 89833

Russell S. Canniff
430 Avenue I
Snohomish, WA 98290

Brian A. Cooper
Alaska Biological Research
P. O. Box 81934
Fairbanks, AK 99708

James A. Cooper
Dept. Fisheries and Wildlife
University of Minnesota
St. Paul, MN 55108

Mike Davison
Washington Dept. Wildlife
2105 Hwy. 20
Sedro Woolley, WA 98284

Laurel A. Degernes, DVM
Raptor Research and Rehab. Progr.
University of Minnesota
St. Paul, MN 55108

James Franzel
U. S. Forest Service
Tongass National Forest
P. O. Box 1328
Petersburg, AK 99833

Ruth Gale
Idaho Dept. Fish and Game
1515 Lincoln Rd.
Idaho Falls, ID 83401

Laurence N. Gillette
Hennepin Parks
3800 County Road 24
Maple Plain, MN 55359

James S. Hawkings
Canadian Wildlife Service
202-204 Range Road
Whitehorse, Yukon Y1A 3V1
Canada

John I. Hodges, Jr.
U. S. Fish and Wildlife Service
P. O. Box 1287
Juneau, AK 99802

Gary L. Ivey
U. S. Fish and Wildlife Service
Malheur NWR, HC 72, Box 245
Princeton, OR 97721

Clay Jobes
Dept. Fisheries and Wildlife
University of Minnesota
St. Paul, MN 55108

Joe Johnson
W. K. Kellogg Bird Sanctuary
Michigan State University
12685 East C. Avenue
Hickory Corners, MI 49060

Martha Jordan
11025 44th St. SE
Snohomish, WA 98290

Ken Kalenak
240 Spencer Road
Saginaw, MI 48603

Jim King
U. S. Fish and Wildlife Service (Retired)
1700 Branta Road
Juneau, AK 99801

Rodney J. King
U. S. Fish and Wildlife Service
1412 Airport Way
Fairbanks, AK 99701

Steven M. Kittelson
Minnesota Dept. Natural Resources
Carlos Avery Game Farm
5436 W. Broadway
Forest Lake, MN 55025

Rolf H. Kraft
U. S. Fish and Wildlife Service
Lacreek NWR
HWC 3, Box 14
Martin, SD 57551

Dave C. Lockman
Wyoming Game and Fish Dept.
Box 96
Smoot, WY 83126

Andy Loranger
U. S. Fish and Wildlife Service
Nowitna NWR
P. O. Box 287
Galena, AK 99741

Harry G. Lumsden
Ontario Ministry of Natural Resources
Box 50
Maple, Ontario L0J 1E0
Canada

Carl Mitchell
U. S. Fish and Wildlife Service
Red Rock Lakes NWR
Monida Star Route, Box 15
Lima, MT 59739

Karen F. Morrison
Ministry of Environment and Parks
2569 Kenworth Road
Nanaimo, British Columbia V9T 4P7
Canada

Michael J. Mossman
Wisconsin Dept. Natural Resources
Box 7921
Madison, WI 53707

Dave Paullin
U. S. Fish and Wildlife Service
Malheur NWR, HC 72, Box 245
Princeton, OR 97721

Jimmy Pichner
Minnesota Zoological Garden
12101 Johnny Cake Ridge Road
Apple Valley, MN 55124

Barry Reiswig
U. S. Fish and Wildlife Service
Red Rock Lakes NWR
Monida Star Route, Box 15
Lima, MT 59739

Tom Rothe
Alaska Dept. Fish and Game
P. O. Box 3-2000
Anchorage, AK 99502

Leonard J. Shandruk
Canadian Wildlife Service
2nd Floor, 4999-98th Avenue
Edmonton, Alberta T6B 2X3
Canada

John W. Smith
Missouri Dept. Conservation
1110 College Avenue
Columbia, MO 65201

Jeffrey W. Snyder
Idaho State University
Dept. Biological Sciences
Box 8007
Pocatello, ID 83209

F. David Stearns
U. S. Fish and Wildlife Service
Arrowwood NWR
Rural Route 1
Pingree, ND 58476

David K. Weaver
Hennepin Parks
3800 County Road 24
Maple Plain, MN 55359

ROCKY MOUNTAIN POPULATION OF TRUMPETER SWANS

TRUMPETER SWAN MANAGEMENT - MONTANA OVERVIEW

Barry Reiswig

TRISTATE MIDWINTER SURVEY

The 1987 winter survey was conducted from 4-6 February 1987 by the U. S. Fish and Wildlife Service (USFWS) and a host of cooperators (Reiswig 1987). A total of 1582 swans was counted, 1196 white birds and 386 cygnets. This is down approximately 1 percent from the 1986 survey. In Montana, a total of 377 Trumpeters was counted, 314 white birds and 63 cygnets. This figure is approximately 6 percent below the 5-year average. We experienced a very mild winter in the Tristate during 1986-87, and, as a result, a great deal of open water was observed throughout the area, especially in southeast Idaho. As a result, some birds that normally winter in Montana may have moved outside of the count area to open water sites further south.

WINTER FEEDING

Based on research conducted by Gale et al. (1987), we stepped up the winter feeding program significantly in 1987. The program ran from 11 November 1986 to 7 April 1987. A total of 964 bushels of wheat and 2,100 pounds of commercial feed were put out during the winter. The numbers of birds fed ranged from 101 to 325 Trumpeter Swans. Carl Mitchell, Assistant Refuge Manager, did exhaustive observations of the winter feeding program. His work has given us additional information to better manage the program over the short-term (Mitchell 1987b).

The mild winter conditions allowed the birds to move off-feed earlier than normal. We feel the birds came through the winter in top condition.

PRODUCTION

Swan production in the Centennial Valley was excellent for the year. When based on the number of nesting attempts, we had the best year since record keeping began. A total of 96 cygnets was fledged from 34 nests on the Refuge, and an additional 37 cygnets were fledged from 18 nests in the remainder of the Centennial Valley (Mitchell et al. 1988). Nearly all suitable Refuge waters produced broods. Weather and runoff conditions were ideal in the Centennial Valley. When this was combined with the mild winter and the increased winter feeding rates, things worked together to give us an outstanding production year.

Population levels in the Centennial Valley were roughly stable as compared to the 1983-87 average. A total of 211 were counted in April and 198 were counted in August. The big drop in numbers experienced from May to June of 1986 did not occur during 1987 (Mitchell et al. 1988).

PROPAGATION

Assistant Manager Carl Mitchell took the eggs from two nests in the valley below the Refuge because the nests were doomed for a variety of reasons. The clutches were incubated in an incubation unit provided by Rod Drewien of the Whooping Crane Project. None of the three eggs in the first clutch hatched. However, four of the five eggs from the second clutch hatched and were raised successfully (Mitchell et al. 1988). The cygnets were transferred to the Wyoming Game and Fish Department for release in the Salt River drainage.

A great deal was learned from this project. Plans are underway to expand this effort.

TRISTATE SURVEY

The Tristate Survey was conducted from 14-17 September 1987 by the USFWS and cooperators. A total of 540 Trumpeters was counted, 365 white birds and 175 cygnets (Mitchell 1987a). This represents the highest number of swans counted since the 1968 survey and is the second highest number of cygnets ever recorded in the Survey's history. This undoubtedly reflects the high production in the Centennial Valley.

LEAD POISONING

A total of five swan carcasses was retrieved for analysis during the year. Only one of these has been analyzed to date. This bird, an adult female, had mildly elevated lead levels (Mitchell et al. 1988). Roughly 30 percent of Centennial Valley Trumpeters analyzed in the past has shown lead poisoning as a cause of death.

Extensive sampling of Refuge biological systems was conducted by USFWS Enhancement in Billings, Montana, and Refuge staff. A host of contaminants is under examination by chemists in Refuge fish, birds, soils, invertebrates, and water. The study was prompted by the finding of high selenium levels in several swan blood samples collected by researchers from the Patuxent Wildlife Research Center. Final results of the detailed analyses are not yet available.

WATER MANAGEMENT

The long-awaited rehabilitation of the Lower Lake water control structure was completed by Ducks Unlimited at a cost of $255,000. The structure allows variable water level control of the major wetlands of the Refuge for the first time. It also conforms to dam safety requirements of the Department of the Interior. The gates were opened as soon as permitting requirements were completed by the State of Montana. Intensive drawdowns were initiated on several manageable wetlands based on work completed by Assistant Manager Kurtenbach. It is hoped that these efforts will increase the productivity of these wetlands.

LAND ACQUISITION

Three tracts have been acquired since late 1986 which will have a very positive impact on swans and other wildlife on the Refuge. The Companeros tract, 1674 acres, was acquired in 1986 at a cost of $1,000,000. This tract, which contains more than a mile of Odell Creek, has caused significant siltation of the Lower Lake over the years. The USFWS will assume control of the property in 1989 when a land use reservation expires. The 120-acre Kinard tract, immediately adjacent to Culver Pond, was acquired in January 1988 at a cost of $102,000. This acquisition will greatly increase the security for a major Trumpeter Swan wintering site and a Bald Eagle nest site. The 431-acre Saier tract, also acquired in January at a cost of $237,000, will greatly aid in the management of a number of Refuge species. Thus far, we have acquired a total of 2,225 acres at a cost of $1,339,000. This is 74 percent of acres targeted for acquisition under the current program.

CONCLUSION

We have had a very productive year at Red Rock Lakes NWR in a number of ways. Cooperation between agencies in the Tristate area is better than ever. This will become increasingly important in the future because of the difficult and time-consuming projects that await us under the guidance of the Trumpeter Swan Subcommittee.

The continuing support of The Trumpeter Swan Society is greatly appreciated.

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STATUS OF TRUMPETER SWANS IN IDAHO

Ruth Gale

The State of Idaho provides important habitat for Trumpeter Swans of the Rocky Mountain Population (RMP). Swans from the Tristate Subpopulation nest and spend the summer in eastern Idaho, as well as in Montana and Wyoming. From late October to early April, these Tristate Trumpeters are joined by wintering migrants from the Interior Canada Subpopulation. Trumpeters in Idaho are managed by the Idaho Fish and Game Department (IFGD) in close cooperation with Harriman State Park, Wyoming Department of Game and Fish, Red Rock Lakes National Wildlife Refuge (RRLNWR), and other Federal agencies whose actions affect swan habitat. To understand the current status of Trumpeters in Idaho, it is necessary to separately discuss the summer and winter conditions.

SUMMER

Surveys by IFGD located 23 occupied territories, of which 19 contained active nests in 1987. Since 1984, the number of known active nests in Idaho has increased from 13 to 19. Most of this increase is probably due to intensified survey effort.

Most nesting territories occur within a 40-mile radius of the southwestern corner of Yellowstone National Park, at elevations ranging from 4,600 to 6,600 feet. Eight nests were on U. S. Forest Service lands, eight were on State of Idaho lands, two were on private lands, and one was on Camas National Wildlife Refuge.

Despite exceptionally mild and dry weather during the prenesting and nesting period in 1987, only 12 broods, totaling at least 33 cygnets, were observed in June. However, the unusually advanced development of emergent vegetation in June made cygnet observations extremely difficult this year. Due to my illness in June and July, IFGD did not have the manpower to make nest visits or to closely follow cygnet mortality. The aerial U. S. Fish and Wildlife Service Tristate Trumpeter Swan Survey on 14-17 September found only six broods, totaling 15 cygnets in Idaho. These results were consistent with observations made from the ground in late August and September. At least one cygnet died in September, shortly after the aerial survey.

Nest flooding was not a problem in 1987, and we detected no specific causes for the poor cygnet production. Brood sizes were small, and several territories which have consistently produced cygnets in past years raised none this year. Cygnet production in Idaho in 1987 could be categorized as "below normal," in marked contrast to the outstanding cygnet production experienced by swans at RRLNWR and in the adjacent Centennial Valley, some 25 miles west of the Idaho nesting areas. Other papers later in this Conference will speak more directly to the factors that may underlie these production differences.

WINTER

Trumpeter Swans from the Canadian nesting flocks in Alberta, British Columbia, Saskatchewan, Yukon, and Northwest Territories usually begin arriving in the Tristate Region by 20 October and remain intermixed with the resident Tristate Trumpeters throughout the winter. In Idaho, swans winter primarily on the headwaters of the Henry's Fork of the Snake River and on the Teton River between the towns of Victor and Driggs, Idaho.

The amount of available habitat fluctuates widely in response to changing ice conditions. On the Teton River, inflow from springs keeps at least an acre of water ice-free during even the coldest periods. When air temperatures moderate to above 0°F, about 4 miles of river opens up and provides habitat for up to 470 swans. In the Henry's Fork drainage, scattered springs provide a variety of wintering sites for groups of 10 to 150 swans at Sheridan Reservoir, Big Springs, and the Buffalo River. Most wintering swans, however, can be found downstream from Island Park Dam in the vicinity of Harriman State Park. In most years, water released from the bottom of the Reservoir warms the river and minimizes ice formation downstream at Harriman State Park.

Since 1985, the total number of swans wintering in the Tristate Region has ranged between 1500 and 1600. During this same period, between 850 and 950 swans have wintered in Idaho. If we subtract the approximately 300 to 500 swans that are grain-fed at RRLNWR and consider only those that are dependent upon the available aquatic vegetation, the importance of ice-free aquatic food sources in Idaho becomes more apparent. Throughout the Tristate Region, some 1100 wintering Trumpeters are primarily dependent upon the existence of ice-free habitats with adequate aquatic vegetation. Roughly 75 percent of these swans depend upon Idaho habitats.

As the RMP has increased during the past decade, record numbers of wintering swans have become dependent upon the habitat at Harriman State Park and Teton Basin. On 4 January 1988, IDGD flew an aerial survey and located 553 swans below Island Park Dam. These birds represented about 1/3 of the entire RMP, and, in the winter of 1987-88, their food supplies were largely unavailable due to extensive ice formation.

Due to the current drought in Idaho, the flows of the Teton River and tributaries of the Henry's Fork were very low. In flow into Island Park Reservoir was about 1/3 below normal (375 cfs vs. 550 cfs), and releases at Island Park Dam were reduced from a normal winter flow of 400-500 cfs to 150-250 cfs. As a result, ice formed over 50-75 percent of the river below Island Park Dam in Harriman State Park for much of the winter. Alternate wintering sites were also less available due to the low regional flows. Near record numbers of swans congregated in the remaining open areas at Harriman State Park.

In an attempt to avoid a crisis on the Henry's Fork, IFGD developed and implemented a contingency plan. The plan called for accelerated autumn storage of water in Island Park Reservoir and the release of this water during periods of winter ice formation. However, the fall of 1987 was extremely dry, however, and the amount of water stored was only adequate to provide for two pulses of higher flows to break out ice in late November and December. IFGD was closely coordinating with the Bureau of Reclamation in order to release as much water as possible without violating the existing water rights of irrigators and power companies.

On 18 January, IFGD attempted to haze and disperse swans and 1000+ Canada Geese out of the Harriman State Park area with the hope that at least a portion of these birds would move to other ice-free habitats in Island Park and downstream below Ashton, Idaho. Skiers moved along the river from north to south at 15-minute intervals and all waterfowl took to flight. Although it appeared that some ducks and geese dispersed from the area, most of the swans had returned to the area by the following day.

In coordination with Jeff Snyder who is monitoring ice conditions and swan distribution on the Henry's Fork, IFGD is continuing to budget the available water flows to best meet the swans' needs. Contingency plans have been made to feed grain at Harriman State Park only as a last resort, if it becomes obvious that the swans have depleted the available aquatic vegetation and no other management options exist. IFGD wants to avoid feeding grain if at all possible to avoid further concentrating the stressed swans and attracting additional ducks and geese to the area.

The vulnerability of Trumpeters wintering in Idaho has been recognized for over a decade. The situation is more precarious this year due to the drought and low water flows. However, the future of the RMP will not be reasonably secure until their winter distribution is expanded and the swans regain access to milder and more diverse winter habitats. Long-term efforts to rebuild migratory traditions and create alternate wintering areas will be discussed later in this Conference.

THE WINTERING AND FORAGING ECOLOGY OF THE TRUMPETER SWAN, HARRIMAN STATE PARK, IDAHO

Jeffrey W. Snyder

ABSTRACT

A study is currently underway to quantify important aspects of wintering habitat available for Trumpeter Swans at Harriman State Park (HSP) in Idaho. Objectives of the study are to: (1) quantify the relative distribution and abundance of aquatic macrophytes in the Henry's Fork of the Snake River through HSP and to develop methods for long-term monitoring, (2) determine the reduction in standing stock attributable to swan foraging, (3) determine if swans are foraging with aquatic macrophyte preference, (4) identify areas of high swan use along the study area and describe foraging locations relative to aquatic macrophyte distribution and abundance, and (5) monitor water levels, river discharge rates, and icing along the Henry's Fork through HSP. The overall objective of the study is to develop a computer model that will adequately forecast flow rates necessary from the Island Park Reservoir to maintain open, ice-free, swan-use areas.

JUSTIFICATION AND BACKGROUND

The Trumpeter Swan (Cygnus buccinator) is the largest member of the waterfowl family Anatidae. Once common over most of the American continent, these largest of waterfowl now reside in a fraction of their former range (Rogers and Hammer 1978). Settlement and expansion of the white man across the continent during the 17 and 1800's were the primary causes of their range reduction. Farming and commercial hunting reduced both available Trumpeter Swan habitat and swan numbers. By the early 20th century, Trumpeter Swans were sighted only in the Tristate area around Montana, Wyoming, and Idaho. Once considered to be on the verge of extinction, the Trumpeter has made a comeback due only in part to habitat preservation and hunting controls. A Pacific Coast Trumpeter Swan Population, breeding in Alaska and western Canada numbering 4,000-5,000 individuals, was discovered and verified in the 1950's. Combined with 400-500 Tristate Trumpeter Swans and several hundred in restoration populations, the current world population of Trumpeter Swans is approximately 9,000-10,000 individuals.

Scientific investigations of the Pacific Coast (PCP) and Rocky Mountain Populations (RMP) revealed the PCP to be large and expanding and the Tristate Subpopulation to be slowly declining (Banko 1960). The Tristate Subpopulation is joined on their wintering grounds by Interior Canada Trumpeter Swans. The Tristate Subpopulation exhibited a higher cygnet mortality rate (Page 1976, Shea 1979) than their Alaskan or Canadian counterparts. Pre-fledging cygnet mortality for the Tristate Subpopulation was found to be 76 percent. Both Shea (1979) and Page (1976) hypothesized that the harsh winter conditions of the Tristate Region, the sedentary nature of the Subpopulation, and the restricted availability and quality of winter foods combined to place the swans in a weakened condition as they approached the breeding season.

The hypothesis that winter nutrition affects cygnet production and cygnet mortality should be addressed. Shea's (1979) and Hampton's (1981) studies on selected Trumpeter Swan wintering sites along the Madison River within Yellowstone National Park and the Henry's Fork of the Snake River were among the first to document which aquatic macrophytes were available in what quantities to wintering swans. Shea (1979) compared her samples of the Henry's Fork swan feeding areas against Hansen's (1959) data collected two decades earlier and found that the composition of the macrophyte community along the Henry's Fork had changed. The relative abundance of Elodea canadensis, a reportedly favored swan food (Paullin 1973), had either decreased from 35 percent to 4 percent. Plant species diversity was reduced and 95 percent of the samples collected consisted of only three species. Additionally, other important tuberous swan foods had decreased in abundance or were not among the samples. Hampton (1981) sampled 10 transects in the fall of 1980 and seven additional transects in the fall of 1981. He hypothesized that winter foods were available in quantity, but that the limited quality and availability of foods due to icing during cold spells placed the swans in stressful physiological states. This led, in turn, to poorly conditioned adults going into the breeding season. These studies were instrumental in identifying and protecting important Tristate Trumpeter Swan wintering sites. However, sample design, sample sites selection and procedural differences between Hansen's, Shea's, and Hampton's work that did not allow for adequate statistical comparisons. As a result of these inconsistencies, knowledge of Trumpeter Swan wintering and foraging ecology on the Henry's Fork is still not fully understood and remains inadequate for sound management.

The Henry's Fork of the Snake River, which flows through Harriman State Park (HSP) of Idaho, has long been recognized as one of the most important river sections for wintering Trumpeter Swans in the lower 48 states. Idaho Department of Parks and Recreation personnel have conducted annual winter swan censuses since HSP was established in 1977. Approximately 450-500 Trumpeter Swans winter along the "Harriman stretch" throughout the winter. Roughly 80-90 percent of the Tristate Subpopulation is suspected to winter here. Both Shea (1979) and Hampton (1981) conducted their macrophyte studies in this area. During periods of extremely cold weather, much of the Henry's Fork freezes, and the availability of winter foods to swans is limited. The Bureau of Reclamation now increases outflows from the Island Park Reservoir during cold spells to maintain open water. Optimal reservoir outflows to maintain ice-free conditions have never been determined. Recent flow increases ranged from 100-200 cubic feet per second (cfs) during cold spells. It was observed that even these flow increases did not always open up some of the preferred feeding areas (pers. obs.).

In addition to the discharge management information needed, an upstream sewer district has been proposed for the Island Park region. Little is known about the effects of effluent upon nutrient levels in the Henry's Fork and the possible effects it might have upon the macrophyte community.

The purpose of this study will be to quantify factors important to the wintering ecology of the Tristate Trumpeter Swan Subpopulation. It will determine their habitat and food requirements, and how these requirements relate to current habitat and wildlife management practices in the area.

OBJECTIVES

A. Quantify the distribution and abundance of aquatic macrophytes in the Henry's Fork of the Snake River through HSP. Compare the results with past investigations (Hansen 1959, Shea 1979, Hampton 1981). Develop methods for long-term vegetation monitoring. Determine if swans are foraging with preference.

B. Identify areas of high winter Trumpeter Swan use along the study area by means of a weekly HSP swan census. Describe foraging locations with respect to known aquatic macrophyte distribution, abundance, river flows, and iced, and ice-free river sections.

C. Monitor water levels and river discharge rates within the study area. Develop a computer model for the Henry's Fork to forecast flow rates needed to provide sufficient ice-free areas for foraging Trumpeter Swans, given air and water temperatures, and weather data.

METHODS

Aquatic vegetation

A paired exclosure design will be used to determine swan feeding effects. At each of three sites in HSP, five exclosures will be installed. Two sites will be in sections of the river that traditionally receive heavy use by wintering swans. The third site will be in a section of the river traditionally receiving little or no use by wintering swans. All sites will be as similar as possible with respect to velocity, depth, and percent macrophyte cover. They will be constructed of chicken wire fencing fastened to steel posts driven into the river bottom. Exclosures will measure 4 m on a side and will extend above the surface approximately 0.3 m. The wire fence material will not extend below the water surface.

Above-surface plant stems and (where possible) benthic plant parts will be collected with a standard Hess sampler (0.083 m^2). At each sampling period, five samples will be collected from within the exclosures, and five samples will be collected from an area equal to that of the exclosure and immediately adjacent to, but outside of the exclosure. Sample sites will be chosen without replacement from a grid of 36, 0.25 m^2 sample positions within and adjacent to the exclosure. Samples were collected in October 1987 and will be collected in April 1988, and semimonthly through spring and summer, 1988. Once collected, samples will be sorted to species and wet-weighed. The paired design with an unused (by swans) control section will allow testing the following hypothesis: Winter swan foraging accounts for a measurable reduction in vegetation biomass beyond normal winter senescence and export.

Swan census

Trumpeter Swans on the Henry's Fork of the Snake River flowing through HSP will be censused during the wintering period (November-March). The census system currently used by HSP personnel will be used during the study period. Data on total swan numbers, swan distribution among river sections, cygnet-to-adult ratios, and occurrence of collared Trumpeter Swans, and Tundra Swans (Cygnus columbianus) will be collected. Surveys will be conducted at least once a week, twice if possible. Methods developed by LeMaster (1981) to assign a relative zone-importance value will be developed and combined with previously standardized HSP census data to create a functional zone-importance value for each river section. Data will be compared to see what correlations exist between known macrophyte abundances and functional zone-importance values. This will test if swans are foraging with preference.

River flow

Flow rates, water temperatures, and air temperatures will be monitored through the HSP wintering area. Records on river flow rates will be obtained from the Bureau of Reclamation gauge stations near the Island Park Dam. Weekly temperatures will be read at each selected station throughout the study period (November-March) in conjunction with the weekly swan survey. River ice buildup, over time, will be measured as the percent area covered by ice, the type of ice, and estimated ice thickness (cm). The computer model originally developed by George Ashton, physical scientist, for the Missouri River, will be altered to fit the configurations of the Henry's Fork. The icing model will test the effects of various environmental factors on ice buildup and breakup and will recommend the flow rates needed to keep important swan-use areas (as defined by the functional zone-important values) open.

RESULTS

The results of this study will be presented in thesis form to cooperating agencies upon completion of the study and associated University requirements. Reports of census data will be forwarded to personnel of the U. S. Fish and Wildlife Service, Idaho Fish and Game Department (IFGD), and HSP for use in their respective annual reports, as needed.

COOPERATORS

Contributors for the project include Idaho State University, HSP, IFGD, U. S. Fish and Wildlife Service, Bureau of Reclamation, Water District Users One, Utah Power and Light Company, Fall River Rural Electric Cooperative, and the Henry's Fork Foundation, Inc.

SCHEDULE

Vegetation sampling will commence in the fall prior to the swans' arrival and will be repeated the following summer. River flow, icing, and swan census data will be taken during the winter. The schedule will be repeated the following year.

PRINCIPAL INVESTIGATORS

Dr. Charles Trost
Professor of Biology
Department of Biological Sciences
Idaho State University
Pocatello, Idaho 83209

Jeffrey W. Snyder
M.S. Candidate
Department of Biological Sciences
Idaho State University
Pocatello, Idaho 83209

Mr. Ted Angradi
Ph.D. Candidate
Department of Biological Sciences
Idaho State University
Pocatello, Idaho 83209

PRINCIPAL CONSULTANTS

Ruth Shea Gale
Wildlife Biologist
Idaho Fish and Game Department
1515 Lincoln Road
Idaho Falls, Idaho 83401

George D. Ashton
Research Physical Scientist
Snow and Ice Branch
Cold Region Research and Engineering Lab
Corp of Engineers
Hanover, New Hampshire

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WYOMING TRUMPETER SWAN PROGRAM STATUS

Dave C. Lockman

In 1982, the Wyoming Game and Fish Department (WGFD) initiated a vigorous Trumpeter Swan management program for Wyoming. The Wyoming program is a cooperative effort of the WGFD, Grand Teton National Park, Bridger-Teton National Forest, Rock Springs District of the Bureau of Land Management, and many private landowners. Many volunteers, both individuals and groups, have contributed time, materials, and habitat improvements toward the effort.

I have represented Wyoming on the Rocky Mountain Trumpeter Swan Population Subcommittee and have served as coordinator for the Wyoming Swan Program. It has been my responsibility to work with the agencies and landowners in western Wyoming, coordinating an effort to achieve program objectives. Most of the in-state coordination is conducted on a one-on-one basis, with a coordination meeting held each March, prior to the spring nesting period.

Objectives, strategies, and tasks for Wyoming's swan program were defined in the North American Management Plan for Trumpeter Swans (1984), a 1984 Wyoming Trumpeter Swan progress report (Lockman et al. 1986), and Wyoming's Nongame Bird and Mammal Strategic Plan (October 1987). In a nutshell, Wyoming's objectives are to achieve 80 breeding pairs by the year 2005 and to expand the State's breeding and wintering Trumpeter distribution.

In Wyoming's Nongame Strategic Plan, the Trumpeter Swan is regarded as a "Priority 1" species, along with 12 other species of avifauna. This designation ensures that the Trumpeter will receive "special management attention" toward accomplishment of program objectives. Current Wyoming Trumpeter Swan projects are described below.

MONITORING AND RESEARCH

Intensive monitoring of Wyoming flock size, composition, productivity, mortality, movements, and habitat use, initiated in 1982, will be resumed.

In 1988-89, the Wyoming Cooperative Wildlife Research Unit will conduct a research project to identify factors that influence the reproductive performance of Trumpeter Swans in Wyoming.

HABITAT EVALUATION

Winter habitat

We have completed an evaluation of swan winter habitat use in the Snake River drainage of Wyoming and plan to have the report completed by June 1988. An evaluation of winter habitat potential within the Salt River drainage, a tributary of the Snake River, will also be completed by June.

The North Platte River near Casper is currently being evaluated for potential swan wintering habitat. On Bighorn River, a 25-mile stretch between Thermopolis and Kirby appears to have great potential for a large number of swans. However, before continuing the survey we must meet with the local power utility company and determine the cost and feasibility of marking over 50 power lines which cross the river. Also, increasing numbers of waterfowl hunters are floating the river and as a consequence, the area is supporting decreasing numbers of waterfowl each season. Waterfowl hunters have suggested that we close a stretch of the river as a method of holding more waterfowl through the hunting season. If such a closure was implemented, it would tie into the development of a wintering area for Trumpeters very nicely.

To encourage and maintain public support for Trumpeter range expansion in Wyoming, we feel we must fulfill the needs of both the consumptive and nonconsumptive users of wildlife. We make a concerted effort to integrate management programs for hunted and nonhunted wildlife.

Other potential wintering areas we hope to evaluate include the lower Green River and the Wind River.

Summer habitat

We have identified at least 84 marsh, pond, and shallow lake areas within the current summer swan range in Wyoming, but outside of Yellowstone National Park with potential for Trumpeter Swans. At least 67 of these sites would require habitat modification and/or management of human activity levels to become production areas or subadult summering habitat. We have identified at least 42 sites immediately outside and peripheral to the current range which have Trumpeter Swan nesting habitat. We anticipate that our ability to evaluate some of the finer aspects of Trumpeter Swan winter and production habitat will be increased with the knowledge gained from the research project being initiated this spring.

HABITAT MODIFICATION

In 1985, management efforts were initiated to: 1) increase the annual egg production and cygnet survival on occupied territories, 2) increase annual adult and subadult survival, 3) provide additional wetlands for seasonal use by Trumpeters, and 4) maintain security from excessive human activity as new areas were occupied by territorial pairs.

Habitat improvements

About 40 percent of the known subadult and adult mortality has been due to power line collisions in major movement corridors. The Lower Valley and Utah Power and Light Companies responded to the problem by marking their lines in six major movement corridors in 1987. These companies have been more than willing to help the swans and other avifauna on the Green, Salt, and Snake Rivers. We maintain their trust by only asking for assistance in problem areas or predictable high risk zones for species of special concern.

Fences crossing important wintering sites have accounted for about 20 percent of our subadult and adult mortality. Most of these fences occur on private lands. As a result of our efforts, most fences on wintering areas are now marked with orange surveyor's flagging, making the fences more visible to the swans and some are being let down for the winter by landowners.

We are currently designing projects to increase the number of wetlands available to subadult and adult swans at the National Elk Refuge, on private lands, and U. S. Forest Service lands in the Buffalo Valley, and in the Gros Ventre drainage. We hope to get these projects funded through Jackson Lake Dam mitigation funds or agency enhancement monies. We are also investigating potential winter habitat improvement projects in the Jackson and Salt River areas on private lands.

In the summer of 1988, two wetland projects funded by the WGFD will be built. The projects, a 21-acre and a 28-acre wetland, were designed to accommodate the habitat needs of nesting Trumpeter Swans. They will be located within current swan summer range.

We have provided technical assistance to private landowners that are developing wetlands in the Jackson area. The results have been the development and improvement of about 40 acres of wetlands which are capable of supporting swans throughout the fall, winter, and spring.

Habitat protection

The Jackson Hole Land Trust, a private group based in Jackson, has been actively acquiring scenic and conservation easements in the Jackson area. The Trust utilizes our mapped, quantitative data as criteria for prioritizing easement acquisitions. We estimate that since 1981, they have acquired open-space easements on about 20 percent of the swan winter habitat occurring on private lands in the Snake River drainage. They actively seek our consultation and recommendations on wetland protection and enhancement to benefit the Trumpeter Swan on many private land projects. Recently, the Trust has expanded its efforts to include some private land areas important for swan production and prenest conditioning habitat.

Managing human disturbance levels

In 1986 and 1987, three pairs were brought into production by managing human activity on production areas. Signing of important shoreline zones and placement of artificial nest sites in emergent cover away from shoreline disturbance zones was effective. Within the current Wyoming swan range (outside of Yellowstone National Park), 40 of 84 available swan production areas require some level of human activity management to sustain swan production. As currently unoccupied sites become occupied by new pairs establishing territories, we will implement human activity management.

Learning to live compatibly with swans that we might enjoy their presence, is commonly referred to as public education. The WGFD has provided lectures and programs throughout the State to all types of groups and individuals in order that they can better understand the swan in today's world.

Generally, landowners are interested in ways of increasing swan and other waterfowl use on their lands. At their request, Department biologists provide assistance in habituating resident Trumpeters to human activities. We carefully explain to landowners how swans and people can coexist without severely limiting human activities. If swans are allowed to slowly habituate to routine human disturbance, they will tolerate man's presence very well. We do warn them about approaching swans without surprising them and to always leave an available escape route for the birds. We have found that landowners appreciate our attitude of not trying to be overly protective of the swans and of not "shoving things down their throats," and they are quite cooperative. We are also spending more time with waterfowl hunters, young and old, to ensure that they understand the needs of the Trumpeter.

By involving the general public in the Wyoming Swan Program, we have instilled a personal interest in the Trumpeter Swan. We try to use positive approaches toward swan protection, when managing the public. For example, we do not like to say, "You can't do this or you can't do that," but, instead, say, "In order that you can continue to enjoy the presence of the Trumpeter Swan at this site, we ask your cooperation in observing the swans from here." In the future, as swan numbers and human development increase, this program will likely become a very important part of swan management.

In 1987, two hunting closure areas were implemented in the Salt River drainage. These closures were implemented to provide nonviolate resting areas for ducks, geese, and swans during the hunting season. Intensive hunting pressure in recent years has forced waterfowl out of the valley, thereby decreasing the number of waterfowl available to the hunter. The closures were designed to hold more waterfowl in the valley during the waterfowl season. One of the closures was in an area with the potential to support overwintering Trumpeter Swans and past observations indicate that swans have not overwintered in the Salt River valley because of the hunting activity. Swans observed wintering in the valley in recent years seemed to be late migrants, arriving toward the end of the waterfowl season.

The second closure area was implemented by a private landowner in the valley. The property has some of the best wintering habitat in the valley. Three Trumpeter/Tundra Swans have wintered there in past years. This closure was the most effective because it did provide good habitat and because the surrounding lands received only light to moderate hunting pressure. It held large numbers of waterfowl in the valley throughout the season and, thus, provided better hunting conditions outside of the refuge area.

RANGE EXPANSION PROJECT

Currently, the Rocky Mountain Population Subcommittee is developing a 5-year range expansion project. Wyoming's expansion program will be integrated into the population project.

Wyoming's short-term emphasis will be on maintaining the core production flocks in the Snake and upper Green River areas and the wintering flock in the Snake River drainage. Our long-term objectives in Wyoming are to facilitate winter and breeding range expansion to the maximum degree feasible in coordination with the Rocky Mountain Population project.

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TRUMPETER SWAN MORTALITY IN WYOMING 1982-1987

Dave C. Lockman

Studies of mortality and survival rates conducted on components of the Rocky Mountain Trumpeter Swan Population were summarized by Gale et al. (1987). An important task in the Wyoming swan program has been the identification of mortality rates and mortality factors (Lockman et al. 1985). The maintenance of the Wyoming swan flock as a contributor to the Tristate Subpopulation will require management measures which increase survival and productivity, and minimize mortality.

METHODS

Between 1982 and 1987, Wyoming Game and Fish Department (WGFD) and cooperators collared and leg-banded 39 swans in the Snake and Green River drainages in western Wyoming. This report covers data collected, to date, but the project will continue through 1990.

The fates of eight marked swans representing six nesting pairs, 13 marked subadults representing seven subadult (nonbreeding) pairs, four marked subadults with no known mate associations, one marked 13-year-old bachelor, and 13 marked yearlings representing five sibling groups of known origin were followed 1 August 1982 through 1 December 1987[1]. Collars were replaced on four breeding adults which had lost their collars during the study period. Collars were not replaced on four other individuals known to have lost their collars. Four individuals were banded with U. S. Fish and Wildlife Service (USFWS) metal leg bands only.

Annual cygnet production, fledging success, and molting-yearling (age class 2) counts were tabulated to assess mortality through age class 1 (hatch to 1-year-old). Marking and observation methods were described in Lockman et al. (1987).

All dead or injured swans found within the study area were collected by the WGFD. The investigator visited each site and recorded information which might be pertinent to cause of death if the cause of death was not apparent by necropsy or laboratory analysis. The WGFD's research lab and the State of Wyoming Veterinary Laboratory conducted pathological and heavy-metal analysis on seven swans. The Madison Wildlife Research Laboratory (USFWS) in Madison, Wisconsin, analyzed two swans for lead poisoning.

[1] Status or age class at time of banding and color marking: two swans were captured in 1982, 21 in 1983, 12 in 1984, five in 1985, and two in 1986.

We thank those individuals who assisted in reporting and retrieving dead swans: Fred Herbal, Kent Schmidlin, Tom Toman, Carol Campbell, Duke Early, and Bert Raynes, and Dr. Tom Thorne (Veterinarian, WGFD) and Dr. Beth Williams (Pathologist, State of Wyoming Veterinary Laboratory) for conducting necropsy and pathological examinations.

RESULTS

Within the Wyoming Trumpeter flock, annual mortality was highest in age classes 1 and 2, 54 and 31 percent, respectively (Table 1).

Table 1. Trumpeter Swan mortality, Wyoming, 1982-87.

Age class (years-of-age)	Number alive at beginning July 1,198n	Number alive at end June 30,198(n+1)	Mean annual mortality(%)	Annual mortality range(%)
1 (0-1)	107	49	54	40-88
2 (1-2)	16	11	31	0-60
3-5 (2-6)	49	45	8	0-19
6+	49	46	6	0-18

Age class 1 exhibited the highest mortality every year. Thirty-four percent of the hatched birds died before fledging. Seventeen percent of the remaining birds died between the production area and the fall staging area, and another 17 percent of those reaching the wintering area died before spring. The cumulative mortality throughout the first year for the three periods described was 34, 45, and 54 percent (Table 2).

Table 2. Cygnet mortality through the first year-of-age, 1982-87.

Number alive per period	Percent mortality	Annual mortality range for period (%)
At hatch = 107		
At fledging = 71	34	0-51
At fledging = 71		
At pre-winter = 59	17	0-40
At pre-winter = 59		
At first adult molt = 49	17	0-80

Birds in age class 2 were sampled in 4 of the 5 years. We believe the recorded mortality (31 percent) is higher than the actual average for the flock due to the small sample size. Two age class 2 birds were presumed dead when they disappeared after their second winter. They may, instead, have left the area. Two sibling age class 2 birds died in 1983, one from a power line collision and one from coyote predation. The fifth mortality of this age class was due to a collision with a fence.

The lowest mortality observed was in the 6+ age class (six percent, the 3-5 age class mortality was only slightly higher at 8 percent.) Between 1982 and 1987, only three mortalities were recorded in the 6+ age class. Two of the three occurred during the harsh winter of 1984-85. Other age classes showed high mortality during that winter, as well. The third bird disappeared during the summer of 1987.

About 61 percent of recorded mortality was attributable to accidental death from power line or fenceline collisions (Table 3). Wire fences crossing wintering sites and power lines crossing major flight lanes on favored seasonal use areas caused most of the problems. Investigations, to date, indicate that these accidental deaths were most prevalent in the younger age class birds which lack experience with such obstacles. Older-aged swans were susceptible to accidental collisions when human disturbance or food shortages forced them to pioneer areas outside their traditional use areas.

Table 3. Causes of recorded swan mortality, Wyoming, 1982-87.

Cause of mortality	Number of swans by age class 1/2-1	2	3-5	6+	Total
Power line collision	4	1	2	1	8
Fence collision	1	1	1	0	3
Winter starvation	2	0	0	1	3
Lead poisoning	0	0	1	0	1
Predation	0	1	0	0	1
Illegal killing	0	0	0	2	2
Unknown	2	1	0	0	3
Total	9	4	4	4	21

The only accidental or malicious shooting of swans was recorded in the Salt and Snake River drainages in fall 1987. We believe that the expansion of breeding and wintering swans into other parts of Wyoming could result in a substantial illegal harvest without an intensive hunter education effort. Between 1982 and 1987, no illegal swan harvest had been documented in the Snake River drainage.

Although high lead levels were detected in at least three live adult swans (Lockman et al., 1987), only one fatality had toxic levels of lead in tissues analyzed. None of the other carcasses analysed had high lead levels in the tissues.

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TRUMPETER SWAN SEASONAL HABITAT USE IN WESTERN WYOMING

Dave C. Lockman, Robert Wood, Harold Burgess, Ruth Burgess, and Hanna Smith

ABSTRACT

Since 1982, Wyoming Game and Fish Department (WGFD), the National Park Service, and cooperators have monitored seasonal habitat use and movements by 39 marked swans and their unmarked associates in western Wyoming. Data on seasonal habitat use by all age classes are herein summarized, as are the seasonal swan movements. The characteristics of production and winter habitats used by Trumpeters are identified.

Studies of seasonal habitats used and movements by the Tristate and Canadian components of the Rocky Mountain Trumpeter Swan Population were summarized by Gale et al. (1987). The Wyoming swan program has focused on the identification of seasonal habitats, understanding why and how swans use these habitats, and the development of a habitat management program which will ensure the maintenance of the Wyoming flock (Lockman et al. 1986). The State of Wyoming long-range Trumpeter Swan management plan requires a habitat maintenance and improvement program (Wyoming Game and Fish Department 1987).

METHODS

Between 1982 and 1987, the Wyoming Game and Fish Department (WGFD), the National Park Service, and cooperators collared and leg-banded 39 molting, flightless swans on the Snake and Green River drainages in western Wyoming. Although our studies will be continued through 1990, data collected to date have been compiled for this report.

Aerial surveys were conducted 1982-87 in the following periods: 15 April - 5 May, 1-15 June, 4-12 July, 1-15 September, 1-15 December, 1-15 January, and 5-20 February with occasional follow-up flights. Surveys were conducted throughout the range of swans in the southern 1/3 of Yellowstone National Park and the Snake, Green, Wind, and Salt River drainages of Wyoming. On several occasions, searches for marked swans were conducted by air in Idaho. Wildlife biologists in Montana, Idaho, and Yellowstone National Park often assisted in ground searches for marked swans. Information collected on aerial surveys included: location, numbers of adults and immatures, numbers of marked swans, open water and ice conditions, nest location, number of eggs or cygnets, and other relevant information. Follow-up ground surveys were made when required to identify marked individuals, determine the status of production, or other pertinent information. At more accessible sites, direct observations were made at seven 15-day intervals through the prenesting, nesting, early brood rearing, and wintering periods. General behavioral traits related to the Trumpeter's life cycle were determined from seasonal data collected from marked individuals. Specific behavioral traits relating to habitat use were investigated using a timed activity budget study (Lockman et al. 1987).

RESULTS AND DISCUSSION

Movements and habitat use

Motivated by the need for open water, food, and nesting habitat, migration and seasonal Trumpeter Swan movements tend to become traditional, established by learning experiences and annual repetition. The intracontinental movements of Canadian swans to and from the Tristate wintering areas constitute migration. Movements between summering and wintering areas by Wyoming swans might also be regarded as a short, annual migration. Wanderings of subadults and young pairs tend to function in population dispersal and range expansion. The following are the preliminary findings of the Wyoming studies, 1982-87.

Seasonal movements and migration

Of 13 identifiable territorial pairs, all but one pair wintered in the Jackson area. That pair wintered in Idaho and summered on the Targhee National Forest along the Wyoming/Idaho border. (It is interesting to note that another pair summering on the Targhee wintered in the Jackson area. Also, two pairs that wintered in Jackson, were observed in the Teton Valley, Idaho, in early March of 1986 and 1987 prior to arrival on their breeding territories.) All other marked adult swans summering in the upper Green and Snake River drainages and along the south boundary of Yellowstone National Park wintered in the Snake River drainage near Jackson, Wyoming.

Circumstantial evidence indicates that increasing numbers of wintering swans in Wyoming may be due to increasing numbers of Canadian migrants. Prior to 1981, winter swan numbers in Wyoming were about equal to Wyoming summer numbers. However, increases in winter swan numbers since 1981 were coincidental to increases in Canadian swan numbers occupying Tristate winter areas. Between the molt and mid-September, 42-60 subadult and adult swans occupied the Wyoming study area annually, 1982-87. Over those same years, the Wyoming wintering areas wintered 78-91 subadult and adult Trumpeters, annually. Therefore, 33-55 percent of the winter numbers were migrants from other summer areas. A Grande Prairie Trumpeter was observed in December 1982 on the National Elk Refuge (NER) (Lockman et al. 1987). In December 1987, 10 marked Trumpeters from the Yukon were observed in the Jackson area

Movements and habitat use, early March-early June

Swans departed from the wintering areas as soon as warm temperatures created open water on nearby ponds. Canadian migrants have usually left the area by 20 March. Wyoming breeding pairs and family groups depart about the same time or slightly later if the spring thaw is slow. Breeding pairs, family groups, and territorial pairs without nesting experience move to "prenest conditioning areas" within a few kilometers of their nesting marshes. The same sites are used each spring, unless the sites are not available. Pairs nesting at higher elevations that cannot find open water close to their territories in early spring, use open water at lower elevations and greater than a few kilometers distance from their territories, and again use the same "prenest conditioning areas" year after year.

Pairs of swans tended to limit their movements from the "prenest conditioning area" to occasional visits to the nesting territory. Constant territorial occupancy does not occur until territories are partially or completely ice-free (one productive pair did not occupy its territory until 5-10 days prior to initiation of laying each year).

Cygnets remained associated with the parents in two instances, until after the adults occupied the nesting territories full-time. In one instance, upon arriving on the spring-use area, the cygnet group (three siblings, one of which was leucistic) and adults separated. These siblings were observed on three occasions about 10 km from the sites being used by the adults. In late May, about 50 days after the family group had split up, the family group was observed together again on a stream outlet of the nesting territory. The pair began incubating about 10 June. The siblings left the area and were not seen with the adult pair the remainder of the summer. In the second instance, four yearlings were tolerated by the nesting pair on Christian Pond through the molt in 1986. The yearlings were believed to be the pair's previous year's progeny.

In four other instances, sibling groups separated from the parents and began wandering around soon after leaving the wintering area. Quite often two sibling groups were observed traveling together. Unmarked yearlings in recently independent sibling groups could be identified with reasonable certainty because of the number of sibling groups, group sizes, areas occupied by each group, occasional reunions with parents, and, as mentioned previously, by the presence of a leucistic cygnet. Preliminary observations indicated that some yearlings tended to move out of the breeding range of the flock by mid-June. Their summer locations usually could not be determined. Counts of cygnet/yearling groups in the spring and through the molt each year within the Wyoming flock's range indicated that in 1984, three yearlings left the area in a mid-June premolt migration, and, in 1986, 11 yearlings left. At least one sibling group, the one including the leucistic yearling, returned to the NER in November.

It appeared that in those years with late ice-off and a lack of available spring foraging areas, experienced breeding pairs monopolized the spring-use sites. In those years, nonbreeding swans including young pairs and subadult birds seemed to remain on wetlands near the wintering areas longer. However, eventually they wandered farther afield (out of the study area) than in other years. Young pairs without established territories were wide-ranging after leaving the wintering area. Newly-occupied territories were widely dispersed and mostly peripheral to previously occupied breeding range.

Subadult 2- and 3-year-olds (age classes 3 and 4, respectively) that were not paired remained near the wintering area, often until mid- to late May. These swans, in the early stages of pair bonding, focused their spring activity on the NER ponds where courtship activity was intense each spring. Since 1982, at least two solid pair bonds were formed on the Refuge involving marked subadult birds.

Nesting habitat availability and dispersal

The Snake River drainage was the core production area for Wyoming swans. During the study period (1982-86), there were 10 productive and two unproductive sites. Seven additional sites were determined to be adequate for nesting swans. In 1985, subadults intensively used these sites, and, in 1986, two of the sites were occupied by territorial pairs.

Eleven historical nesting sites were determined to be currently inadequate for nesting due to excessive human disturbance and/or missing habitat components. True to the evaluation results, these sites were unoccupied from 1982-86. Fifty-five additional unoccupied sites were found to be in need of habitat management and/or protection from disturbance to be useable by nesting swans. Two of these sites became productive in 1987 after human disturbances were decreased and artificial nest sites in secure locations were provided.

The number of territorial pairs in the Snake and Green River drainages has increased since 1982, and few suitable territories were unoccupied in the core production area by 1987. Several observed strategies of different age/breeding status birds indicate that the core breeding area has reached its carrying capacity. The core area, in 1987, was 75 percent territorial pairs as a result of the limited availability of suitable habitat for subordinate birds. A portion of the pairs present were "floating pairs," or birds temporarily occupying marginal habitat until a quality territory was vacated. In one instance, a marked pair occupied an inadequate territory for 2 consecutive years. A nearby productive territory became vacant during the third year and was immediately filled by the pair from the unsuitable territory. Since 1984, three new pairs have established territories, one of which was within the core area and the other two outside of the core area. Limited availability of quality habitat within the core area has forced young pairs and unpaired birds to peripheral habitats or to disperse from the core nesting area.

Subadult pair dispersal has been documented in Wyoming. A subadult male, produced in 1983 on the NER, was observed in courtship activities on the Refuge, spring 1985. He was last seen on the Refuge 20 May accompanied by an unmarked swan. He was subsequently found during the summer molt on Sheridan Reservoir, Idaho, approximately 128 km (80 mi.) to the northwest of the NER and observed the following winter at Harriman State Park. In both instances, he was accompanied by an unmarked swan.

Yearling dispersal has also occurred from the core nesting area. In the summer of 1986, a group of five swans summered and molted near Farson, Wyoming (a group of five swans suggests a yearling - sibling association). This area was about 120 km south of the known southern extent of the current swan range in the Green River basin. Although these birds were not marked, it is reasonable to assume they originated from the Snake/Green River area. In fact, there was a yearling group of five siblings that wintered in the Jackson area that could not be found during the summer of 1986. The occurrence of yearling and subadult premolt dispersal is further documented by the annual concentrations of yearling and subadult Trumpeters in the molting flocks on Sheridan, Island Park, and Lima Reservoirs.

Although sample sizes were small, the Wyoming studies suggest that two dispersal periods exist: 1) a premolt yearling dispersal, and 2) a dispersal of 2- and 3-year-old swans following the courtship period in late winter and early spring. Similar premolt movement occurs in Canada Geese among subadults, nonbreeding pairs, and failed breeders (Krohn and Bizeau 1980). It also appeared that young males were the dispersers, while young females remained within the flock's range, guiding new mates to vacant territories near their natal area.

Summer movements and habitat use

Young pairs without an established territory, unpaired subadults, yearling sibling groups, and single birds were quite mobile before and after molt. Yearling sibling groups generally molted within 4 km of their nesting parents with the exception of those groups that left the core area completely. In the five sibling groups studied, some disruption of the sibling association was noted for brief periods after their first adult molt. After molting, young swans generally remained on a site, feeding and loafing for 1 to several days. Movements to new sites or searches for new sites appeared to be promoted by human disturbance, inadequate food resources, strife between individuals or groups, or an inexplicable desire to move. In addition, territorial pairs defending a nest or brood tended to keep young pairs, singles, and yearling or 3-year-old sibling groups on the move through the spring and summer. This mobility in younger age classes (which were not a part of the family group) is believed to be an important strategy to population dispersal and pioneering. This strategy forces young birds to seek unoccupied habitats for feeding and nesting. It also increases the probability of young, unmated swans finding a suitable mate.

Young pairs without established territories remained very mobile until they settled into a territory. If a young pair occupied a territory premolt through early September, that pair was likely to return to that site the following spring and remain until late September. Young pairs tended to have a stronger attachment to a site after their first year of occupancy. Two of eight possible pairs found and established a territory during their second year.

Territorial pairs and family groups were relatively sedentary, remaining on their territories until mid- to late September. Most movements by these swans were within their territories. Flight was generally induced, sometimes by other swans, occasionally by other waterfowl species, but, most often, by humans. These flights were generally short in distance and duration. If cygnets were present, only rarely did both adults fly, even after the molt was complete. Following the July molt, territorial birds were much more tolerant of other swans in their territory than they were earlier in the summer. Failed breeders often vacated their territories for extended periods of time, and in two instances molted off of the nesting area although in close proximity (3 km).

Family group movements

The movement of adults and young 3-5 days after hatching to brooding sites away from the nesting territory has been documented by numerous investigators (Shea 1979, Hansen et al. 1981, Banko 1959). In most of the documented cases, these movements were attributed to human disturbances. The influence of predator intrusion on brood movements has been alluded to, but not investigated. Movements were over land through forested areas for distances up to a mile or between marsh areas via open water and emergent vegetation routes. On many sites in the Tristate area, nesting territories consist of isolated ponds and lakes with no alternative sites within several miles for displaced broods. Many of these isolated sites in Yellowstone National Park and the Targhee National Forest have a history of poor fledging success. Maj (1983) hypothesized that cygnet mortality may be site specific. Widget Lake, a back-country lake in Wyoming, has had a consistent history of nesting activity, but has never been known to fledge cygnets. This site also does not have any unoccupied brood-rearing areas within reasonable proximity. In 1985, three or four viable eggs within 3 days of hatching were removed from the nest at this site. The eggs were hatched in an incubator and the young brooded and fed in captivity. The three young were then released at 5 days-of-age on a high quality marsh with a wild pair and their 1- to 2-day-old brood of two. Two of the three young were raised to fledging. The results of this experiment suggest that the high early cygnet mortality associated with this site was not solely related to adult prenesting energetics nor adult congenital anomalies, but more likely related to food availability and abundance through the brooding period. Complete loss of cygnets due to predation every year in the period of 1982-87 was believed unlikely.

In Wyoming, outside of Yellowstone Park, from 1981 to 1985, movement of broods to areas disassociated with the nesting territory only occurred on one of 13 isolated production areas. This was an annual occurrence within 3-5 days after the last egg was hatched. An analysis of invertebrate concentrations and aquatic vegetation qualities on the site indicated poor invertebrate supply and a monotypic aquatic vegetation community. The lack of adequate food for rapidly growing cygnets probably induced the adults to move the brood to an area about 1.8 km away. At 6 weeks-of-age, the family group returned temporarily to the nesting pond. From that time until fledging, they were quite mobile within a 324-hectare area.

Brood movements in Wyoming within the first 4-6 weeks posthatch appeared to be induced by nutritional need. Alaskan (Hansen et al. 1971) and Wyoming studies indicate that such movements often result in increased cygnet mortality. Shea (1979) determined that cygnets that moved cross-country tended to get lost, become entangled in barriers, and were more vulnerable to predators.

Fall movements and habitat use

After fledging, family groups stayed on the summering areas, feeding on sites familiar to the adults. These sites were often the same ones used by the adults in the early spring. Where sufficient food was available, the family remained on the nesting areas until iced over.

By late September, 1- and 2-year-old (age classes 2 and 3) sibling groups moved to the fall staging area at the NER.

Young pairs, single swans, and failed breeders moved in throughout the month of October. Family groups were the last to arrive, generally by 15 November.

The presence of migrating/staging Tundra Swans has influenced the length of time and the number of Wyoming Trumpeters wintering on the Refuge. Between 15 October and 15 November every year, about 90 percent of the marked Wyoming Trumpeters could be observed on the Refuge. During the winters of 1981-82, and 1982-83, about 50 percent of the Wyoming flock wintered on the Refuge. In the fall of 1984, about 200 Tundra Swans spent 25 days staging on the Refuge, severely impacting the food resource available for wintering Trumpeters. Only 15 percent of the Wyoming flock wintered on the Refuge for the next 2 years. By the fall and winter of 1986-87, use by both species was similar to that of 1981-83. Evidently, the aquatic food resource had recovered.

Adult pairs utilized about the same travel corridors on fall flights to winter range as on spring flights to summer range. Trumpeter movements were documented along major drainage courses, and crossing hydrographic divides in passes with gradual gradients and mild relief. Swans moved as family groups, pairs, sibling groups, singles, or rarely in mixed flocks.

Prior to the drawdown of Jackson Lake to repair the dam in 1985, 11-31 Trumpeters utilized the shallow zones for feeding immediately above the dam to Hermitage Point from mid-October through freeze-up (early to mid-December). An additional two to 22 swans fed in the Lizard Point area from mid-November through freeze-up, each year. The Lizard Point area, at the river inlet, generally thawed by late February to mid-March and hosted up to 50 swans annually in early spring.

Winter movements and habitat use

By late November, with freeze-up of some of the marsh areas, swans dispersed to winter sites within the drainage. Adults with young used the same sites each winter, segregating themselves from other swans and apparently defending a feeding territory. Progeny from previous years also tended to winter in the same sites as their parents and were the only associates of the family groups. Adults with young did not move around as frequently as did other age classes and pair associations. In two cases, an adult pair with young in two different winters was found in the same areas and same sites throughout each winter. In contrast, a pair without cygnets fed on several sites throughout the winter, including areas where they had never been observed before.

Subadults and pairs without young often loafed and rested on creeks or river banks, 1-8 km from a feeding area. Often, midday loafing concentrations of 26-60 swans were observed on a Snake River gravel bar or on a sand bar of Fish Creek ponds. These loafing swans on Fish Creek dispersed to as many as eight different locations within a 2.5 km radius to feed in the mornings and evenings.

During extended sub-zero °F periods, many of the wintering areas froze up. The larger feeding areas on slow-moving streams, and small ponds all tended to freeze. Only a few small sites could be kept open by intermittent swan feeding and swimming activities. Swans were forced to disperse to warm, spring-fed creeks, fast moving channels, and sites close to human habitation. During the extremely cold winter of 1984-85, swans were documented using sites they had never used before or since.

Swans moved around more frequently during the mild winter of 1985-86, than was observed the previous three winters. Waters that stayed open and were used in the extreme cold of 1984-85 were not used at all. It is suspected that when a multitude of wintering sites are available, the factors of forage availability and swan density determine movements and habitat usage.

Bioenergetics

The importance of winter habitat quantity and quality was summarized for Tristate swans by Gale (1987). Lockman et al. (1988) evaluated swan winter habitats and forage availability in Wyoming.

The most productive breeding pairs moved to creeks or ponds in close proximity to their territories by late March or early April most years. Pairs used the same spring areas each year. These sites supported diverse stands of aquatics which appeared to have an abundance of invertebrates. The adults remained on these sites feeding voraciously until or even after their nesting ponds opened up. We noted that after the harsh winter of 1984-85, there was an unusually early ice-off within the core nesting areas. We attributed the good production in 1985 to the unusually early ice-off, enabling the breeding adults to achieve almost 6 weeks of good forage intake and preconditioning prior to egg laying. Based on the movement and habitat investigations, it is believed that the transitional spring feeding areas are very important in preparing the female physiologically for egg production.

In recognition of the importance of the preconditioning feeding periods and the availability of quality sites near the nesting area, it was surprising that one of the most productive Wyoming pairs nested on Enos Lake, an isolated lake which consistently has very late ice-off (late May-early June). The male of this pair was marked, and it was determined that the pair spent all of April and May feeding on six different sites in the Buffalo Valley about 400 meters lower in elevation and about 20 km from their Enos Lake territory.

Based on our knowledge of other waterfowl species needs, it has been assumed that young cygnets need large amounts of protein to support their fast, early growth. In 1985, invertebrate abundance on a pond site from which the adults move their young (at 3-4 days-of-age) every year was compared with a site on the NER used by a family group for feeding in their early brood life. Both pairs had a history of consistent production and fledging success. There were about eight times the abundance of invertebrates on the NER cygnet feeding site as on the site from which the pair moved their young (1.97 as opposed 15.60 invertebrates/ft^2 of aquatic vegetation). A study was then made of sites with a consistent history of hatching, no available optional brooding areas within close proximity, and poor (little or no) cygnet survival beyond 4 weeks-of-age. These sites had monotypic and/or poor aquatic plant production in water depths of less than 18 inches, poor interspersion of shallow water aquatic vegetation, few aquatic invertebrates associated with shallow water rooted aquatic macrophytes, and relatively constant water levels between and within years. Many of these sites had greater than 75 percent lily pad (Nuphar sp.) coverage. In contrast, sites which consistently fledged young had diverse and abundant shallow water (less than 18 inches) aquatic plant communities. At these sites, broods were feeding in diverse communities with what appeared to be good available invertebrate supplies attached to the vegetation.

There were one and sometimes two feeding strategies available. In standing water of less than 18 inches and oftentimes less than 12 inches, the adults puddled macrophytes and invertebrates to the surface to make the food available to the cygnets. This strategy required a tremendous energy expenditure by the adults. The second strategy was available in slow-moving streams (velocity less than 33 cm/sec.), downstream from the previously described aquatic beds. The current moving through the beds coupled with a little adult energy expenditure was sufficient to provide good plant and animal food for the cygnets.

The adults with cygnets at Christian Pond, NER ponds, and the Pinto Ranch ponds selected the same feeding sites every day until the cygnets were 4-6 weeks old. It is quite likely that the sites selected supported the best or most accessible supply of protein-rich invertebrates. At 4-6 weeks-of-age, the cygnets were more mobile, more independent of adult aid in obtaining food, and may have a decreasing demand for protein. Consequently, feeding site selection was more diverse.

In summary:

1. On sites with a good egg production history and poor survival beyond 4 weeks-of-age, water levels were relatively stable.

2. On good production sites, water levels fluctuated more dramatically between and within years. This fluctuation exposes shallow water soils to increased temperatures and light, promoting oxidation of detritus and nutrient recycling. Upon reflooding the increased nutrients available promotes aquatic plant production and supports a more diverse aquatic invertebrate population. Brood behavioral studies conducted by Smith (1985), suggest that aquatic invertebrates and vegetation must be abundant, as well as available, to ensure survival of young, rapidly-growing cygnets, when their nutrient demand is high.

Production habitat characteristics and territory selection

When a young inexperienced pair first establishes a territory (which later becomes a nesting and brood rearing area), their immediate needs are food and security. Because swans generally establish a territory and do not nest until subsequent years, the selected territory may meet their immediate needs but will not necessarily fulfill their needs for production of flighted young. The area may lack nesting sites, concealment cover for adults with broods and/or adequate food for the brood. The Wyoming studies found that of 14 sites used by nesting pairs from 1981 to 1986, only four were consistent producers of flighted young. The common habitat features of those sites included:

1. Security from excessive human disturbance.
2. Early spring feeding areas a short flight distance from the territory with early ice-off and sufficient food for prenesting adults.
3. More than one site available for nesting.
4. Nesting materials available immediately adjacent to the nest site.
5. Brood-rearing areas available.
6. Good interspersion of emergent vegetation within site to provide cover and limit disturbance.
7. Adult experience in nesting and adaptability to disturbance.

Since 1981, territories have been established on six additional wetland areas; however, to date, no nesting has occurred. Of 17 territories occupied in 1986, all were on sites which received relatively minimal human disturbance, were relatively large or had sufficient emergent cover to provide security to the occupants.

Characteristics of winter habitat - preliminary findings

An evaluation of Wyoming winter swan habitats was made. Sites in use during the study period (1982-86) were carefully examined, and additional potential sites were identified (Lockman et al. 1988 unpub.). The attributes of swan winter-use sites included (Lockman et al. 1987):

1. Soft substrates greater than 5 cm in depth.
2. Winter water depths less than 1.3 m.
3. Channel width 15 m or greater.
4. Pond or stream banks with sparse or no tree or canopy cover to facilitate greater visual range.
5. Stream banks gradually sloping on at least one shoreline.
6. Loafing sites of shallow water less than 10 cm in depth or sand/gravel bars interspersed with or in close proximity to feeding areas.
7. Linear stretches or ponded areas of open water greater than 100 m in length or width.
8. No physical barriers such as fences or power lines bisecting feeding and loafing areas, or bisecting travel corridors used for flights, swimming, and walking.
9. Beds of diverse aquatic macrophytes in shallow water zones having the preceding physical and biological characteristics.
10. Aquatic macrophyte (vegetation) beds in water areas that are open for at least 75 percent of the winter period or, if frozen, then only intermittently and generally not for periods longer than 2 or 3 days.
11. Water velocities in fast-flowing feeding areas generally not exceeding 45 cm/second.

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IDENTIFYING POTENTIAL WINTER HABITAT FOR TRUMPETER SWANS

Dave C. Lockman, Carl Mitchell, Barry Reiswig, and Ruth Gale

ABSTRACT

Using observations of wintering Trumpeter Swans and habitat measurements, we have identified habitat components that characterize good quality winter habitat. These are: areas of open water greater than 100 m in length or width, stream channel widths greater than 15 m, water velocities less than 45 cm/sec., banks with little or no shrub cover, water depths greater than 0.6 m and less than 1.3 m, shallow water less than 10 cm deep and/or sand or gravel bars for loafing, gradually sloping banks (less than 1:2 slope), soft substrates greater than 5 cm deep, beds of diverse aquatic vegetation, open water more than 75 percent of the winter with freezing only intermittently and less than 2 consecutive days, no fences or power lines that bisect the habitat or flight paths to or from it, pollutant-free waters, and little or no human disturbance. Identifying suitable habitats is an important first step in range expansion programs.

INTRODUCTION

Expanding winter ranges of Trumpeter Swans is an important part of this species' management. This paper is part of an ongoing project of the Pacific Flyway Council's Subcommittee on the Rocky Mountain Population of Trumpeter Swans to identify potential winter habitats. As part of this project, a narrated slide program is being developed. The program (with accompanying handouts on swan identification, important habitat characteristics, forms for reporting swan sightings, the location of potential habitat sites, and a list of agency phone numbers and addresses) will be sent to various private groups, agencies, and professional meetings, to expose the greatest number of interested individuals to the information herein. Our current target areas are Idaho, Wyoming, Colorado, Utah, Arizona, and New Mexico.

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HISTORY

The Rocky Mountain Population of Trumpeter Swans consists of birds that nest in the United States and Canada. Swans in the United States nest in Montana, Idaho, and Wyoming, primarily in the Tristate Region where all three states share boundaries. The Canadian segment of the Population nests at localized sites in Alberta, Saskatchewan, British Columbia, the Northwest Territories, and the Yukon. Although the breeding flocks are widely scattered, nearly all of these swans winter on a few bodies of water in the Tristate Region. This remote, high-elevation area experiences long, cold, extremely harsh winters.

Historically, Trumpeter Swans migrated south to wherever ice-free waters were available, including the Mississippi Valley, and the coastal waters of the Atlantic, Pacific, and Gulf Coasts. As continental populations declined, primarily due to overharvest and habitat destruction, some of the migration routes were lost as the swans that knew these paths died. The remaining breeding flocks in Canada and the United States continued to use their traditional wintering areas in the Tristate, because here they were isolated from the effects of settlement by man.

As wildlife biologists became aware of the existence of these populations, they began to manage them and their habitats. This management has been largely successful. The Tristate Subpopulation has increased from about 69 to over 500, while the Canadian breeding flocks have grown from about 100 to over 1,000. In recent years, however, the Tristate Subpopulation has declined to about 400 swans, while the Interior Canada Subpopulation has continued to grow. Currently, approximately 1,500 to 1,600 Trumpeter Swans migrate to and winter on the limited ice-free waters found in the Tristate Region.

The current lack of extensive wintering habitat creates several major problems for the swans. Population growth may be inhibited by stresses caused by overcrowding on the wintering areas. Swans must also compete for the sometimes limited food resources, and the areas' severe winter climate imposes maximum demands on their energy reserves. Although Red Rock Lakes National Wildlife Refuge provides supplemental food for the swans that use its ponds, the swans that winter on other Tristate waters rely completely on natural foods. Aquatic vegetation on some wintering areas is being over-used and depleted. Evidence suggests that Tristate winter habitats are at or very near their carrying capacity for swans. Large numbers of swans occurring in such limited habitat also increases the potential for catastrophic losses to diseases, water pollution from sewage, lead shot, or fishing sinkers, or curtailment of critical water flows which affect ice formation and limits the swans' access to aquatic vegetation.

Currently, wintering waters in the Tristate Region consist of two warm water impoundments on Red Rock Lakes National Wildlife Refuge, and small portions of Ennis and Hebgen Lakes in Montana; parts of Sheriden and Island Park Reservoirs, several miles of the Henry's Fork near Harriman State Park, the Teton River and Teton Basin areas of Idaho; and the Flat Creek, Snake River, Yellowstone River, and associated warm springs in Wyoming and Yellowstone National Park. The availability of winter habitat is extremely variable, and depends upon air and water temperatures, as well as water flows.

One of the management goals for the Rocky Mountain Population calls for having 2,000 Trumpeter Swans on adequate winter habitat by the year 2010, as stated in the North American Management Plan for Trumpeter Swans (U. S. Fish and Wildlife Service 1984). At least 1,000 of these swans will need to winter on waters outside of the current Tristate range. In order to reach these goals, we must first complete several tasks. We need to identify areas that are currently being used by swans of which we are not aware. We must identify potential new winter habitat that is not presently being used by Trumpeters. And, we must identify areas where management could create suitable winter habitat.

IDENTIFICATION OF WINTERING SWANS

Habitats that are being used by wintering Trumpeter or Tundra (Whistling) Swans are of interest. However, it is important to know which species is involved. Trumpeters are somewhat larger than Tundra Swans, averaging 60 inches in length, and 21 to 26 pounds in weight, with wingspans of 6 to 8 feet (Bellrose 1976). Tundra Swans average 52 inches in length, and 13 to 16 pounds in weight, with a wingspan of about 5 feet (Bellrose 1976). Trumpeter Swans have a straight bill profile, resembling that of a Canvasback. The eye is not distinct from the bill. The bill is solid black on the white-plumaged adult swans, and mottled pink and black on the gray-plumaged cygnets. Trumpeters have longer necks in proportion to their bodies than do Tundra Swans. Although this is not a reliable characteristic to use on flying swans, it is a noticeable characteristic when the birds are swimming or standing. Tundra Swans have a more concave bill profile, and the bill is smaller in proportion to the head. The lore commonly shows a yellow spot, and the eye is distinct from the base of the bill. Adults are colored as are Trumpeters; however cygnets are generally a lighter gray than are Trumpeter cygnets.

Trumpeter Swans have a loud, low-pitched, bugle-like call. Tundra Swans possess a high-pitched, quavering call (Canadian Wildlife Service 1987).

Body movements and behavior can also be used to distinguish between the two species. Trumpeters frequently bob their heads and necks up and down, often while vocalizing. These activities increase in intensity when the birds are disturbed. Tundra Swans do not bob their heads and necks and call, although they will occasionally nod only their heads. When not alarmed, Trumpeter Swans generally have the neck kinked back at the base, so that it appears to rise from the forepart of the back. Tundra Swans do not hold their necks in a kinked position like Trumpeters. When they are alerted, Trumpeters draw their heads and necks straight up. If standing, an alarmed Trumpeter Swan also holds its body in a closer-to-vertical angle, while Tundras hold the body in a more horizontal position. In general, the body postures of Trumpeters are more angular, and Tundra Swans are more rounded (Canadian Wildlife Service 1987). Without vocalizations, it is not always possible to tell these two species apart under field conditions.

WINTER HABITAT CHARACTERISTICS

Identifying potential winter habitat is somewhat complex, but it is a major component of Trumpeter Swan management plans. It requires finding sites that possess a number of specific physical characteristics outlined below. The characteristics listed below were derived from investigations of the Wyoming flock (Lockman, unpub.).

Because Trumpeters are large birds, they require relatively long stretches of water while taking off and landing. Therefore, Trumpeters need linear stretches or ponded areas of open water greater than 100 m in length and/or width.

Most of the streams that wintering Trumpeters have been observed on are also 15 m or more in width. The swans probably prefer these rather wide waters because they are able to see farther, and the space provides them with a sense of security.

Similarly, the banks of the stream or pond should have little or no tree or shrub cover. Thick shoreline vegetation acts as a screen, provides potential cover for predators, and prevents swans from feeling secure.

The stream or pond banks should be gently sloping, as well, with a slope of not more than 1:2. This provides an additional measure of visual security and provides access to the shore for loafing.

The water should also contain loafing sites of shallow water less than 10 cm deep, or sand and gravel bars interspersed within, or in close proximity to feeding areas.

Water velocities in the fast flowing areas should not exceed 45 cm/sec. (1.5 ft./sec.). Fast water makes it more difficult for swans to swim about while feeding or moving from place to place, and causes them to expend more energy than desirable. Fast water can also affect the formation of sand and gravel bars used as loafing sites.

Trumpeter Swans feed on aquatic vegetation, primarily the fine-leaved pondweeds, waterweed, milfoils and muskgrass, by "tipping up," much like puddle ducks do. Because of this, feeding area water depths should be between 0.6 and 1.3 m deep to allow access to these plants and their rootstocks.

These beds of rooted aquatic plants should be located in waters that are open at least 75 percent of the winter period. Freezing should occur only intermittently, and should not last longer than 2 consecutive days. If the water remains frozen for longer periods and prevents the swans from feeding, important body fat reserves may be depleted.

In addition to the leafy plant parts, swans also consume the tuberous roots of some plants. The pond or stream bottom should have at least some soft substrates 5 cm deep, as a seedbed and substrate for root growth, to ensure annual production and proliferation of submerged, rooted vegetation.

There are additional considerations which can be corrected by proper management. Some problems that have been encountered in Tristate wintering waters include flight hazards, such as wire fences crossing streams, or power lines crossing wintering waters, pollution, especially in the form of lead shot or lead fishing sinkers, and disturbance from people boating or snowmobiling. Flight hazards can be conspicuously marked or removed, the use of lead can be curtailed, and recreational uses can be managed in a variety of ways.

While the identification of suitable new winter habitats is proceeding, the Pacific Flyway Council Rocky Mountain Trumpeter Swan Subcommittee is preparing proposals to expedite the winter range expansion of the swans that are currently wintering in the Tristate Region. The identification of new habitats will complement the Subcommitte's efforts to reestablish Trumpeters in former habitats and expand their range into new habitats.

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STATUS OF TRUMPETER SWANS IN THE SOUTHERN MACKENZIE DISTRICT, NORTHWEST TERRITORIES: 1986 AND 1987

Leonard J. Shandruk and Kevin J. McCormick

ABSTRACT

The occurrence of breeding Trumpeter Swans (Cygnus buccinator) in the southern Mackenzie District, Northwest Territories (NWT), is a relatively recent phenomenon. The first bird was observed in 1970, but breeding was not recorded until 1977. The Canadian Wildlife Service has undertaken surveys of Trumpeters in the NWT since 1984. Most of the birds were concentrated in the area between the South Nahanni-Liard Rivers junction and Camsell Bend on the Mackenzie River. Seventy-seven percent of the adults and 93 percent of the broods were observed in this area in 1986. In 1986, 20 adults were collared within this concentration area in an effort to delineate their migration route and wintering areas. The purpose of this paper is to report on our 1987 surveys and collaring efforts.

INTRODUCTION

The occurrence of breeding Trumpeter Swans (Cygnus buccinator) in the southern Mackenzie District, Northwest Territories (NWT), is a relatively recent phenomenon. The first bird was observed in 1970, but breeding was not recorded until 1977 (McCormick 1986). Subsequent studies have resulted in additional observations, primarily within Nahanni National Park Reserve where Park personnel have compiled records since 1977.

The Canadian Wildlife Service has undertaken surveys of Trumpeter Swans in the southern Mackenzie District since 1984. Progressively more extensive surveys (McCormick 1986, McCormick and Shandruk 1986, McCormick and Shandruk 1987) have yielded larger numbers on each occasion. The increasing numbers stemmed both from the discovery of new breeding sites and the occupation of new breeding ponds at known breeding sites. Despite the extensive distribution of Trumpeter Swans in this region (McCormick and Shandruk 1987), most of the birds were concentrated in the area between the South Nahanni-Liard Rivers junction and Camsell Bend (Figure 1). Seventy-seven percent of the adults and 93 percent of the broods were observed in this area in 1986 (McCormick and Shandruk 1987).

In 1986, 20 adult Trumpeter Swans were collared within this area of concentration in an effort to delineate their migration route and wintering areas. We collared additional birds in 1987 and surveyed the entire area of concentration on two occasions. The purpose of this paper is to report our 1987 observations and to discuss the current status of Trumpeter Swans in the southern Mackenzie District.

STUDY AREA

The study area includes the flood plains that occur between the Nahanni and Camsell ranges and the Mackenzie Mountains to the west (Figure 1). This flood plain extends eastward to the Mackenzie River in the vicinity of Camsell Bend. The northern and southern extremities of the study area are the Root River and Sawmill Mountain, respectively. Important riverine systems include: Liard River, South Nahanni River, Fishtrap Creek, Tetcela River, Ram River, Carlson Creek, and Root River.

Important Trumpeter Swan habitats, adjacent to the above rivers, include oxbow lakes, ponds, and pond complexes. Yohin Lake and Mid Lake are also significant sites. All wetlands are characterized by significant emergent vegetation growth along portions or all of their margins. Typical emergent species include cattail (Typha latifolia), bogrush (Juncus sp.) and horsetail (Equisetum sp.). The latter is a particularly common feature of site where swans are observed. Waterlily (Nuphar variegatum) is a common submergent species at many sites. Further site-specific details are included in McCormick and Shandruk (1986) and McCormick and Shandruk (1987).

METHODS

An aerial survey was flown from 27-31 July 1986 in a Cessna 185 at approximately 150 m agl and at about 225 km/h. Two observers accompanied the pilot. All waterbodies within sight of the survey route were examined. Upon sighting one or more swans, flight altitude and speed were reduced to determine the number of adults present, the breeding status of the birds, and the number of cygnets present. Habitat information was also recorded. Habitat quality was subjectively rated on the basis of physical and vegetative features of the wetlands. Observations were also recorded on wetland type, submergent vegetation, emergent vegetation, width of emergent vegetation, and water turbidity. Many of the wetlands were photographed to aid in their evaluation and for future reference.

Moulting swans were captured, from 1-2 August 1986, with the aid of a Bell 206L helicopter and a large dip net. Captured birds were fitted with plastic collars (white alphanumeric code on a red base) and stainless steel legbands. They were also weighed and measured before being returned to the waterbody

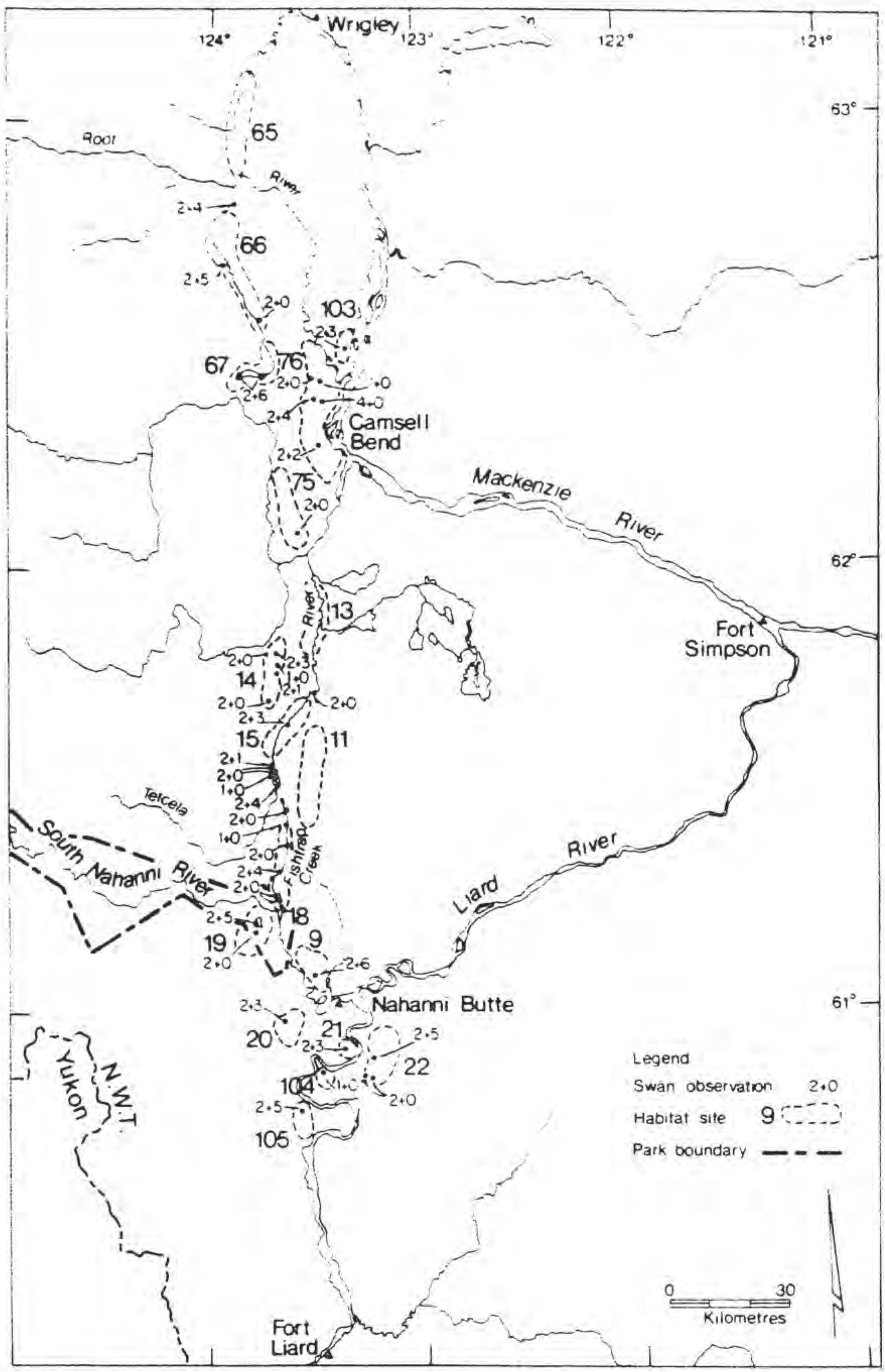

Figure 1. Location of 1987 Northwest Territories Trumpeter Swan study site.

where they were captured. Detailed information regarding specific methods and observations on the 1986 surveys can be found in McCormick and Shandruk (1987). Fecal samples were also collected, when possible, for diet analysis.

On 28-29 July 1987, all wetlands within the study area were surveyed, while collaring moulting adult swans. The survey was flown in a Bell 206L helicopter at approximately 150 m agl and 100 kph. Two observers accompanied the pilot. Upon sighting one or more swans, flight altitude and speed were reduced to determine the number of adults present, their collar numbers, if present, the breeding status of the birds, and the number of cygnets present. Data were recorded directly onto 1:250,000 topographic maps of the study area.

The study area was surveyed, again, on 1 September while collaring cygnets. The observers and survey methods were identical to those of the earlier survey.

RESULTS AND DISCUSSION

The results of the 1986 and 1987 surveys of the study area are presented in Table 1. The 1986 survey yielded 65 adults (26 pairs) and 55 cygnets in 13 broods, whereas the 1987 survey revealed 78 adults (34 pairs), 69 cygnets, and 19 broods. The increase in each of the above categories is: number of adults - 17 percent, number of cygnets - 35 percent, and number of broods - 46 percent. The 1987 results represents a composite of the two surveys. An additional brood was observed at Site 67 during the September survey, despite an intensive search of the site in July. Many of the nonbreeding birds were not encountered during the September survey (Table 1). They apparently had abandoned the area after completing their moult. Similarly, several broods were not observed during the September survey (Table 1). Intensive surveys at these sites failed to reveal either the young or the adults. However, the brood at Site 105 was discovered, minus the adults. It appears that the adult swans may be reacting to the sound of the helicopter and taking cover among the dense vegetation. Similar behaviour has been reported from Red Rock Lakes NWR (R. Gale, pers. comm.). Accordingly, we have assumed that the broods were present but not observed.

Average brood size in 1986, which was 3.9 cygnets, declined slightly to 3.6 cygnets in 1987. This decline may be attributed to two factors. Seven new breeding locations were documented during this survey, suggesting that a number of pairs bred for the first time. Average brood size at these locations was 3.3 cygnets. However, there was also a decline at the six breeding sites where birds were collared in 1986 (Table 1). The mean brood size at these sites was 5.2 cygnets in 1986, but only 3.4 cygnets in 1987. One 1986 breeding pair (#19 and mate) was not discovered in 1987.

Twenty adult swans were collared in 1986. Sixteen of these swans were observed during the 1987 survey. Swan #23 was found dead on 23 January 1987 at Key Pittman Wildlife Area, Alamo, Nevada (T. Redderer, pers. comm). Its mate (#30) was not observed during the 1987 survey. Similarly, #19 (above) and #29, which was part of a nonbreeding pair, were not located. It is possible, however, that the birds were present but were not observed (McCormick and Shandruk, in press). All of the birds, except #20, were observed on the ponds where they were originally collared. Bird #20 was collared in 1986 as part of a nonbreeding pair, on Site 16. It had relocated in July 1987 with a mate and a brood of three cygnets to Site 14, approximately 27 km to the north.

In 1986, a male (#24) was collared in association with a female (#27) at Site 16. Bird #27 was seen alone, near Coeur D'Alene, Idaho, on 27 November 1986, and #24 was observed on 29 December 1986 with a flock of swans near Driggs, Idaho. In July 1987, #27 was observed alone at Site 15, whereas #24 was seen again at Site 16, in association with another swan. It is possible that #24 and #27 were brood mates rather than paired birds when first encountered. If such occurrences are common, we may be overestimating the numbers of paired birds. Further observations on collared known-age birds should clarify this issue.

To confirm that the breeding swans of the southern Mackenzie District are Trumpeter Swans, we took selected body measurements while banding and collaring the birds. These observations are summarized and presented in Table 2. Appropriate measurements for determining species of swans are culmen length, tarsus length, distance from bill tip to the anterior of the nares, and weight (Banko 1960). All measurements for Trumpeter Swans, except for the tarsus length of females, exceeded those presented by Banko (1960). Scott (1972) presented mean weights for adult Trumpeter Swan males (11.9 kg) and females (9.4 kg) and Tundra Swan (Cygnus columbianus) males (7.1 kg) and females (6.2 kg). These Tundra Swan weights are well below the average weights recorded in the present study. Hansen et al. (1971) recorded a mean "bill nail to nostril" measurement of 54.1 mm for 59 adult Trumpeter Swans on the Copper River, Alaska. Data from adults in the present study indicated mean length of 54.07 mm (95% C.I. = $\pm$ 0.88, n = 58). Banko (1960) stated that swans over 1 year-of-age, of either sex, are probably Trumpeters if the "bill nail to nostril" measurement exceeded 50 mm. If this measurement was less than 50 mm, the swan could be considered to be a Tundra. The majority of measurements of NWT Trumpeter Swans exceeded 50 mm and the mean for females (n = 30) was 53.52 mm $\pm$ 0.67. Thus, we believe that all adult birds banded and collared were Trumpeter Swans.

A female white colour-phase cygnet was discovered at Site 66 during the July 1987 survey. Although white-phase birds constitute approximately 1 percent of the cygnets in the Tristate area, (R. Gale, pers. comm.), this is the first observation reported from the NWT. The adult pair (#65 and mate) merits further observation to determine if additional white-phase cygnets are produced.

A total of 35 adults was collared in July 1987, where as 43 cygnets and two additional adults were collared in September. Details on the collared adults are summarized in Table 1. On 18 November 1987, USFWS biologists flew an aerial survey of the Tristate swan wintering concentrations and observed 24 adults and 31 red-collared cygnets. This accounted for 45 percent of the adults and 72 percent of the cygnets collared in the NWT in 1986 and 1987.

Table 1. Observations of Trumpeter Swans in the Nahanni Butte-Camsell Bend area; 1986 and 1987.

Site no.	1986 Collar no. M	1986 Collar no. F	1986 Number of Adults	1986 Number of Young	1987 Collar no. M	1987 Collar no. F	1987 Number of Adults	1987 Number of Young
9			2	0	49	40	2	6
10			1	0				
14					39	33	2	0
14	-[a]	19	2	5				
14	17	22	2	5	17	22	2	1*
14		26	1	0	66	26	2	0*
14			1	0				
14						55	1	0*
14			2	0				
14					34	20[b]	2	3*
15	15	14	2	5	15	14	2	3
15	23	30	2	0				
15						27	1	0
15					57	47	2	0
16					-	37	2	0
16					-	51	2	4
16	24	27	2	0	56[c]	-	2	0
16			1	0				
16					42		1	0
16			2	0				
16	-	20	2	0				
16	29	-	2	0				
16					31	62	2	0
16					45	46	2	1
18			2	0				
18					44	53	2	0*
18			2	2				
18					48	54	2	4
18			2	4				
18					34	41	2	0*
18					52	36	2	0
18						50	1	0
19			2	0			2	0
19			1	0				
19			2	5			2	5
20			2	2	38	30	2	3
21			2	0			1	0
21	25	21	2	4	25	21	2	3*
22	16	13	2	7	16	13	2	5*
22	18	11	2	0	18	11	2	0
22			2	0	32	-	2	0
66			2	0	68	61	2	0
66					64	67	2	5*
66					-	65	2	4*
67			2	0	31	43	2	6*
67			2	4			2	6*

Table 1. (Continued)

Site no.	1986 Collar no. M	F	Number of Adults	Young	1987 Collar no. M	F	Number of Adults	Young
75			3	0				
75					35	59	2	0
75			1	0				
76							1	0*
76							2	0*
76			2	2			2	2*
76							4	0
76			2	0			2	2*
103			2	1	-	63	2	1*
105	12	28	2	5	12	28	2	5*

* Numbers confirmed on the 1 September survey.
[a] _ indicates that mate was present, but not collared.
[b] This bird was collared in 1986, as part of a nonbreeding pair at site 16.
[c] This bird was collared as #24 in 1986. Collar #56 is a replacement for collar #24 which was lost.

Table 2. Mean body measurements and confidence limits for adult Trumpeter Swans, southern Mackenzie District, NWT, 1986 and 1987.

	Males (n=28)	Females (n=30)
Culmen	117.60 mm ± 3.10	117.00 mm ± 1.70
Tarsus	125.88 mm ± 5.29	121.03 mm ± 1.70
Bill to nares	54.66 mm ± 1.70	53.52 mm ± 0.67
Weight	11.87 kg ± 0.68	10.28 kg ± 0.31

CONCLUSIONS

It is apparent that the southern Mackenzie District flock is continuing to expand at a significant rate. Similar concentrations of breeding birds are not encountered in other parts of the Interior Canada Subpopulation breeding range. Earlier surveys suggested that there is plenty of unoccupied habitat available in the southern Mackenzie District. This premise is reinforced by the repeated, incidental observations of swans in other parts of the District. Continued expansion of the flock is expected, subject to favourable conditions on the wintering areas.

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ELK ISLAND NATIONAL PARK TRUMPETER SWAN REINTRODUCTION, 1987 PROGRESS REPORT

Leonard J. Shandruk and Terry Winkler

ABSTRACT

This project was designed to restore the Trumpeter Swan (Cygnus buccinator) as a free-flying, migratory, breeding bird in Elk Island National Park (EINP), Alberta. A pilot transplant project was conducted in 1983 and in 1984 to test and evaluate methods and techniques. The suitability of Park habitat was evaluated in 1983 and again in 1986. As a Wildlife '87 initiative, Parks Canada and the Canadian Wildlife Service transplanted four family groups from the Grande Prairie, Alberta, area to EINP. This paper discusses the techniques and results of this effort.

INTRODUCTION

A 3-year reintroduction project was designed to restore the Trumpeter Swan (Cygnus buccinator) as a free-flying migratory breeding bird in Elk Island National Park (EINP), Alberta. A pilot transplant project which tested and evaluated methods and techniques was conducted in 1983 and 1984 (Shandruk 1988). The suitability of Park habitat for the Trumpeter Swan has been evaluated by Graham (1983) and Burgess and Burgess (1986). As a Wildlife '87 initiative, the Canadian Wildlife Service (CWS), Parks Canada, the University of Alberta - Forestry Department, and the Friends of Elk Island Society requested and obtained support for a Trumpeter Swan restoration project from World Wildlife Fund (WWF), Alberta Recreation, Parks and Wildlife Foundation, Alberta Fish and Wildlife Division, and the Camrose Veterinary Clinic.

The primary objective of this project is to diversify summering and breeding range of Trumpeter Swans in Alberta. A secondary objective is to diversify migration and wintering traditions.

Project goals are:

1. To transplant 12 family groups of Trumpeter Swans over the next 3 years from the Grande Prairie, Alberta, flock, to suitable wetlands within EINP.
2. To refine capture and transplant techniques, and to determine which are the most efficient to meet the above goal.
3. To determine if cygnets released on marshes at EINP will home to these areas and to assess the impact that the relocation will have on both cygnets and guide birds.
4. To reintroduce a base population of Trumpeter Swans which will result in the establishment of 10 breeding pairs in EINP.
5. To evaluate the impact that swans will have on the existing biotic resources should swans become seasonal residents.

This progress report outlines the methods utilized and results obtained during year 1, (1987) of this reintroduction project. Suggested modification in techniques for year 2 will also be discussed.

METHODOLOGY

Project approval and funding

Based on preliminary efforts to reintroduce Trumpeter Swans into EINP in 1983 and 1984 (Shandruk 1988) and the evaluation of favorable habitat carried out by Burgess and Burgess (1986), CWS and Parks Canada staff were encouraged to develop a Wildlife '87 project proposal. This Trumpeter Swan reintroduction proposal was submitted to WWF-Wild West, Alberta Recreation, Parks, and Wildlife Foundation, CWS, and Parks Canada for funding. During the fall of 1986, favorable funding responses were received from these agencies and a total of $27,000 was committed for year 1 of the project. The Camrose Veterinary Clinic agreed to provide veterinary support up to $500. The transplant project proposal was also submitted to the Pacific Flyway Council Trumpeter Swan Technical Subcommittee and Alberta Fish and Wildlife Division for review and approval. Capture, transport, and transplant permits were obtained from CWS and Alberta Fish and Wildlife Division. The detailed basis for this 3-year cooperative project is outlined in a letter of understanding between CWS and Parks Canada.

Project guidelines

Implementation and management of this project follows the guidelines and recommendations for Trumpeter Swan transplants outlined by the Pacific Flyway Council (1985) and Turner and McKelvey (1983). No transplant will occur if the number of Trumpeter Swan nests in the Grande Prairie flock falls below 25. The proponant of the project is responsible for evaluation of the breeding population and the effects of the removals. The project proponant is also required to produce a report on the fate of the swans or eggs removed.

This project also conforms to management guidelines for cooperative activities set out by Parks Canada, June 1980 and February 1981. It has been undertaken in the spirit of the EINP Management Plan and Park Conservation Plan. It also complies with the Federal regulations in the Migratory Birds Convention Act and the Alberta Wildlife Act.

Project administration

The overall administration of the project is the responsibility of the CWS. Parks Canada will provide support and assistance to all phases of the project. Parks Canada will provide the lead role in the management and monitoring of Trumpeter Swans at EINP. It has also assumed the lead in the development of the public relations activities associated with the project. More detailed responsibilities of specific agencies are outlined in the CWS, Parks Canada letter of agreement, April 1986. Assistance in administration and management of funds has been provided through the Friends of Elk Island Society and the University of Alberta - Forestry Department.

Public relations

Parks Canada and the CWS held meetings in June 1987 to formalize a public relations plan for the project. It was intended to generate support and understanding of the project and to ensure that public information releases were accurate. Parks Canada interpretation personnel provided media contact for the project. A public relations plan was developed to target the general media, local naturalists, hunters, landowners in the area of the Park, all interested observers along the suspected migration route, and U. S. state and Federal biologists within the suspected and adjacent wintering areas. Media news releases were concentrated on three major periods during the year:

1. Pre-capture: to explain the project.

2. Capture/transplant: to explain the project and increase awareness of Albertans to the project.

3. Pre- and post-migration: to solicit assistance in observation of swan movements during migration and use of wintering habitat.

Local newspapers and radio stations were very supportive and ran articles and interviews which increased local awareness of the project and Trumpeter Swans. A media package, information poster, and a swan identification brochure were developed and distributed as key components to the public relations effort.

Field methods

Aerial surveys

In order to comply with transplant guidelines it was necessary to assess the spring breeding status of Trumpeter Swans in the Grande Prairie flock. This survey also provided assistance in the selection of candidate pairs for the transplant. A fall production survey was also flown to aid in assessing the impact of the transplant on the Grande Prairie Trumpeter Swan flock and to determine flock status. The aerial surveys were conducted using fixed-wing aircraft (Cessna 182) by flying along designated routes 100-150 m agl at 150 - 200 kph. An observer-navigator and an observer plus the pilot participated in each survey. Repeated passes were made over groups of swans or families until all observers agreed upon the number of swans observed. Swans were recorded as paired birds with or without broods, cygnets, single swans, or flocks. Single swans accompanied by cygnets were recorded on data sheets, but were considered as breeding pairs in the results.

Capture and transplant

Prior to the capture of family groups, a short reconnaissance flight using a Bell 206 helicopter was undertaken on 16 July 1987. This determined the status of moult of the candidate family groups and the accessibility of the specific wetlands for helicopter capture.

Capture of swans was conducted during the morning of 17 July. A central staging area in the Saddle Hills was chosen where vehicles and the capture helicopter rendezvoused. An A-Star helicopter was used for the capture and a Parks Canada truck and horse trailer were used to transport birds to Elk Island. In order to facilitate capture, the rear door on the pilot's side and both rear seats were removed. A safety harness was affixed to the interior of the helicopter, allowing a person holding a salmon landing net enough mobility to step out onto the helicopter skid and net the swans. Once the helicopter was modified and required equipment stowed away, the pilot, netman, and assistant proceeded from the staging area to the potential capture site. The helicopter approached the family group of swans from the shore side of the wetland and usually downwind. An initial pass was used to assess whether both adults were unable to fly. If one of the adult pair was able to fly, or there were less than three cygnets in the brood, or the family group was in an area where they could not be safely approached or captured, the helicopter proceeded to an alternate capture lake. Actual capture of swans was accomplished by hovering the helicopter over the swans at about 1.5 m and netting a swan with the salmon net from the skid of the helicopter. The netted swan was then brought into the helicopter and restrained by the assistant. This procedure was repeated until the whole family group was captured. The helicopter then returned to the staging area where the swan families were processed by the ground crew. Swans were sexed, weighed, measured, banded, and placed in plastic kennels for transport to Elk Island. It was originally planned to band and mark cygnets, however all cygnets captured were too small for any form of marking.

After capture of the four family groups was completed, they were transported to EINP. A press conference was held at the Park prior to release of the swans. The late arrival of the swan radio collars resulted in delay of the releases until after dark. It was decided to release two family groups during the night and hold the other two for release during the early morning of 18 July. To facilitate the release, adult swans were removed from the transport kennels and radio collars were installed. Collar codes and radio frequencies are listed in Table 1. Once the epoxy used to fasten the collars was set, the adults and cygnets were placed into release pens situated on the shore of the wetland. The family groups were held in the release pens for about 15 to 20 minutes prior to their release onto the wetlands. This was done to calm the adults, reestablish the family group bond and orient the swans to the wetland. Similiar procedures were used to release the remaining two family groups the following morning. During the morning release,the cygnets were not placed with the adults until the adults were ready to be released from the holding pen.

The cygnets were recaptured via helicopter in early September to mark them. The capture technique used was the same as used for the family group capture except that an A-Star helicopter was used. Cygnets were banded, weighed, and measured at this time. One female cygnet was equipped with a radio collar (Table 1).

Summer and migration monitoring

At EINP, monitoring of transplanted family groups was conducted weekly by the Park Warden Service using a Telonics Tr-2 receiver and a hand-held yagi antenna. Access to transplant lakes was accomplished by canoe, horseback, or foot, and observations were made from a distance to keep disturbance to the swans at a minimum. Locations of swans and their movements were recorded on a data form and plotted on a 1:15,000 scale map. With the onset of freeze-up and possible migration of swans, monitoring frequency was increased to every 2 to 3 days.

When it was observed that the cygnets were flying and family groups became much more mobile, aerial monitoring was initiated. Aerial monitoring was conducted using a Cessna 182 equipped with two, four-element yagi antennae and a Telonics scanner receiver. Swan family locations were also monitored on the ground by project personnel and input from local observers until larger staging wetlands were frozen. Immediately after total freeze-up, a final aerial survey was conducted over all major staging lakes in the vicinity of the Park to ensure that swans had migrated.

Winter and spring habitat monitoring

Through the public information component and personal contacts, a network of observers in western Canada and northwestern United States is being developed. It is anticipated that this network of observers will provide one method of tracking and determining habitat use by migrating and wintering swans. All Trumpeter Swan collar numbers and radio frequencies were forwarded to U. S. observers. Sightings of collared swans were requested from state and Federal personnel conducting swan and/or waterfowl surveys throughout the Tristate and adjoining areas. The project supplemented some of these surveys with partial funding. All reports of collared swans, their location, status, and other pertinent information were tabulated and stored on an electronic database using an IBM micro-computer. One or more aerial surveys of EINP and the surrounding wetland habitats is planned for the spring to assess whether any Trumpeter Swans have returned to the area. The breeding pair survey during June will determine whether collared transplant swans have returned to the Saddle Hills.

RESULTS AND DISCUSSION

Aerial surveys

A total of 209 Trumpeter Swans was observed in the Grande Prairie area during the 4 June 1987 survey. Forty-two pairs (84 swans) were observed nesting in the Alberta portion of the survey. The stipulation set by the Pacific Flyway Council for a minimum of 25 nesting pairs in the Grande Prairie area was met, and the transplant project was able to proceed. Forty-

Table 1. Status of Trumpeter Swans transplanted to Elk Island National Park, September 1987.

Swan	Sex	Collar no.	Leg band no.	Radio freq (MHz.)	Lake
Adult	M	01AC*	193900008	151.032	Walter
Adult	F	07AC	61905016	151.174	Walter
Cygnet	M	20AC	193900019		Walter
Cygnet	M	25AC	193900024		Walter
Adult	M	03AC	193900009	151.108	Bailey
Adult	F	11AC	193900010	151.520	Bailey
Cygnet	F	04AC	193900020	151.154	Bailey
Cygnet	M	18AC	193900015		Bailey
Cygnet	M	13AC	193900016		Bailey
Adult	M	10AC	193900011	151.500	Flyingshot
Adult	F	02AC	193900012	151.081	Flyingshot
Adult	M	09AC	193900014	151.194	South Bailey
Adult	F	05AC	193900013	151.163	South Bailey

*Collars were yellow with black alphanumeric codes.

eight swans were observed as pairs without nests and 77 swans were observed as singles or in flocks. These observations are above the 5-year mean for breeding pairs, but are below the high total numbers observed in 1984.

During the 17-18 September survey, a total of 357 Trumpeter Swans was observed (Table 2). This total was slightly greater than the previous record number of swans (n = 347) observed in 1986. The number of lakes and the survey route were similiar during these 2 years. Although the 1987 total flock size was greater than in previous years, the number of pairs with cygnets (n = 25), the number of cygnets (n = 83), and the average brood size (n = 3.32) was lower than observed in 1986 and the 5-year averages. A Student-t test indicated that the 1987 observations were not significantly different from the 5-year means at the .05 level. The observed increase in the total flock size in 1987 was probably due to the high cygnet production and survival in 1986 which is reflected in the high numbers observed in the "other adult" (n = 178) category. The removal of eight adults and 18 cygnets from the flock for the transplant and lower numbers of breeding pairs than in 1986 could partially account for the lower number of cygnets observed in the 1987 fall survey.

Table 2. Fall status of Trumpeter Swans in the Grande Prairie region.

Year	Paired	Cygnets	Other	Total
1983	46	68(23)*	108	222
1984	74	118(37)	149	341
1985	50	93(25)	141	284
1986	66	124(33)	157	347
1987**	50	83(25)	224	357
5-year mean	57	97(29)	156	310

* ( ) Number of broods

** Not included -- 8 adults and 18 cygnets removed for EINP transplant.

Capture and transplant

On the morning of 17 July, over a period of approximately 5 hours, four family groups of swans were captured from lakes in the Saddle Hills, northwest of Grande Prairie (Table 3). Capture time varied from 13 to 47 minutes per family. The time required was mainly dependent upon ferrying time to capture lakes, location of swans on the wetlands, condition of the moult of the adult pairs, size of the family, and the time required for the actual capture. One pair with five cygnets each, was taken from Boone, E. Boone, and Albright Lakes. A fourth pair with three cygnets was taken from a small lake near the British Columbia border we called "Lost Cygnet Lake." Weights and measurements of swans can be found in a report by Winkler (1987).

Transport of family groups by horse trailer to Elk Island required about 8 hours. Because of technical difficulties, it was decided to split the release of swans into two separate times. Prior to the releases, adults were collared with radio transmitters. Two family groups were released during the night of 17 July onto Flyingshot and Walter Lakes. The other two families were released on Bailey and South Bailey Lakes during the early morning of 18 July. Problems with adults trampling cygnets were encountered during the night release. This was probably the major reason for the early mortality of the three cygnets at Flyingshot Lake. To remedy this problem, cygnets were not placed in the release pens until the adults were about to be released at the Bailey Lakes sites. During the morning releases, cygnets oriented to and followed the adults out onto the wetlands without difficulty. Observations of the morning releases indicated that they worked well.

Summer and migration monitoring

After family groups were released, they were allowed 1 day to adjust to their respective transplant sites without disturbance. Initial monitoring commenced on the second day after the release and revealed high cygnet mortality. By the third day after the release, 11 of the 18 cygnets released were missing from the family groups. Potential causes of mortality could include transport stress, poor release methods, predation, and/or lack of parental care. Two additional cygnets were missing by mid-August. The remaining cygnets grew rapidly and were in good condition when recaptured in mid-September. Mean weight of the male cygnets was 9.5 kg while the one female weighed 7.5 kg.

All transported swans preferred small ponds over the larger release lakes. Within several weeks of their release, they moved to small beaver ponds and channels. The Walter Lake group was the widest ranging, moving approximately 3.5 km from their release site.

The two pairs which lost all their cygnets remained in the Park until the onset of migration. They were the first to move to the surrounding lakes out of the Park but returned to the release lakes occasionally. Due to warm weather throughout the fall, swans remained in the Park until the period 6 to 10 October. On 20 October, an observer reported the collar numbers of the two adults and three cygnets from Bailey Lake, on Beaverhill Lake about 20 km southeast of the Park.

On 23 October, a monitoring survey was flown over Elk Island and the surrounding area. Three of the four family groups were located on Beaverhill Lake. The South Bailey pair was not located. Mild weather conditions continued until early November. Freeze-up finally occurred on most lakes between 10 and 15 November. No Trumpeter Swans were observed nor were any of the radio frequencies encountered during the 18 November aerial survey of major staging lakes in the area.

Winter habitat monitoring

On 15 November, an Idaho State biologist observed the Bailey Lake family, yellow collars 03AC (adult), 11AC (adult), 04AC (cygnet), and 13AC (cygnet) on Hebgen Lake in southeastern Montana. The cygnet 18AC was not observed. An 18 November aerial survey of the major Trumpeter Swan wintering areas, conducted by U. S. biologists in the Tristate, yielded no observations of the Elk Island transplants. The same Bailey Lake family was again observed at Red Rock Lakes National Wildlife Refuge (RRLNWR) on McDonald Pond on 20 November. Another yellow-collared adult, 05AC, was observed by a U. S.

Table 3. 1987 Elk Island National Park transplant summary.

Source lake	Family group* Adults + cygnets	Release lake	Status 18 July 87 Adults + cygnets	Status 15 Sept. 87 Adults + cygnets
Boone	2 + 5	Walter	2 + 5	2 + 2
E. Boone	2 + 5	Flyingshot	2 + 2	2 + 0
Albright	2 + 5	S. Bailey	2 + 5	2 + 0
Lost Cygnet	2 + 3	Bailey	2 + 3	2 + 3
Totals	8 + 18		8 + 15	8 + 5

* Captured on 17 July 87.

Forest Service biologist on the Teton River near Driggs, Idaho, on 27 November. In early January, Wyoming biologists reported a family group of four collared swans wintering on the Snake River in Grand Teton National Park. No collar numbers were obtained.

To date, only five of a potential collared 13 Elk Island transplants that were still alive in the fall in Alberta, have been accounted for. But we now know that transplanted swans are able to migrate from transplant areas to wintering habitat. Should the four swans in Grand Teton National Park be the Walter Lake group, then nine of the 13 would be accounted for. (Icing of collars has been a major problem in the Tristate and this may be one of the problems which has resulted in the low numbers of collars reported.) Another extensive Tristate aerial survey with the capacity to monitor radio frequencies of the transplants is planned for mid-February.

Transplant impact

To date, it has not been possible to determine the impact of the transplant on the eight adult Trumpeter Swans that were moved to Elk Island. It is anticipated that the adult transplants will return to their original breeding lakes in the Saddle Hills. It is possible that they may choose to return to EINP, although this is highly unlikely.

The transplant has had an impact on the 18 cygnets removed from the Grande Prairie flock. If we assume a 40-percent mortality factor (Turner 1981) on cygnets up to fledging, then the Elk Island transplants should have fledged about 11 cygnets. (Some undetermined quantity of mortality occurred prior to the transplant and may or may not have changed the preceding estimate.) The 1987 transplant theoretically reduced the fledging population by six individuals or 6.4 percent of the Grande Prairie, Alberta, flock. We feel confident that with a modification of techniques we can fledge at least 60 percent of the cygnets we transplant in 1988.

CONCLUSIONS AND RECOMMENDATIONS

The major components and methods of this project have operated well and we are satisfied with the results attained to date. One area which we hope to improve upon during year 2 of the project is the number of cygnets fledged from the Park. By delaying our capture of family groups to as late as possible in the moulting sequence of the adult female, we hope to obtain larger cygnets. We will attempt to capture the same adults in year 2 as in 1987. These swans will have been exposed to the Park environs and should be better able to rear cygnets than inexperienced transplants. Funding permitting, we would like to transport transplants by aircraft from the Saddle Hills to EINP. This will reduce the travel and holding time, and consequently will reduce the stress on the cygnets. In addition to providing cygnets water during transport, fresh aquatic vegetation will be collected and made available. Release of family groups will follow the procedures used in the morning release in 1987. This will reduce the chances of adults trampling and stressing cygnets. Family groups will only be released during daylight hours. This will allow for better observation of released birds, and immediate recovery of the cygnets should problems arise.

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SPRING STAGING AREAS FOR TRUMPETER SWANS IN THE SOUTHERN LAKES REGION OF YUKON

James S. Hawkings

ABSTRACT

Ground and aerial surveys during the past 15 years indicate that at least four wetlands in the Southern Lakes region of southwest Yukon are important spring migration areas for Trumpeter Swans. These areas, located on Tagish, Marsh, Teslin, and Kluane Lakes, provide open water and food several weeks in advance of that availability at other wetlands. Peak use of these areas is during 15-20 April, but a few Trumpeters are often present in late March and some linger into early May. At McClintock Bay on Marsh Lake, for which the most complete data are available, the peak spring population is presently approximately 500 Trumpeters, roughly double the largest counts available from 1976-78. Data from the other areas are scanty, but the peak population of all four areas combined could be as high as 1,600 birds.

The common hydrologic feature of these areas is that they are located at the outlets of large lakes where the relatively warm flow from the middle or bottom layers reaches the surface and eliminates ice very early in the spring. The Trumpeters staging in the Southern Lakes region appear to winter on the Pacific Coast and breed in interior Alaska. The only immediate threat appears to be mild disturbance of birds by human activities at two of the sites; none of the sites have any protected status.

RESULTS OF THE COOPERATIVE ROCKY MOUNTAIN POPULATION TRUMPETER SWAN STUDY

Ruth Gale

I want to give you an overview today of our recently-completed study of the Rocky Mountain Trumpeter Swan Population (RMP). This effort, which lasted from August 1984 to August 1987, was made in response to growing concerns over the continuing decline of the Tristate Subpopulation, particularly at Red Rock Lakes National Wildlife Refuge (RRLNWR).

Although the successful restoration of the Trumpeter Swan was officially declared by the U. S. Fish and Wildlife Service (USFWS) in 1968, it was immediately obvious that the recovery of the Tristate Subpopulation was not proceeding smoothly. High cygnet mortality and widely fluctuating annual cygnet production were concerns throughout the 1960's. Even as managers declared success, the number of adults in the Subpopulation dropped from 519 in 1967 to 431 in 1968. Throughout the 1970's, high cygnet mortality continued to occur, while adult numbers remained relatively stable. Projections, however, indicated that the nesting adults were not fledging enough cygnets to replace themselves, and that a population decline was inevitable when the long-lived adults eventually died.

By the early 1980's, it was obvious that the Tristate Subpopulation was in serious trouble. Cygnet production continued to decline. This decline was particularly evident at RRLNWR, where only 13 cygnets fledged from 96 nesting attempts in 1980, 1982, and 1984 combined. In addition, the predicted results of poor cygnet production were finally observed. Both total adult numbers and the number of nesting pairs declined. The September 1983 Tristate count of 398 adults was the lowest count in 20 years. At RRLNWR, the number of nesting pairs dropped from 44 in 1981 to 24 in 1982. In nearby Yellowstone National Park, the number of adults dropped to a 50-year low by 1986. Clearly, if this downward spiral of declining nesting effort and poor productivity continued, the future of the Tristate Trumpeters was in jeopardy.

Despite some 50+ years of intensive management and a variety of research efforts, managers in the early 1980's realized that their efforts lacked a cohesive strategy or direction. It was not at all clear what additional management efforts or research were needed. It was clear, however, that management was extremely fragmented, and that this fragmentation hindered understanding. For example, the Tristate Trumpeters are managed in varying degrees by two national wildlife refuges, two national parks, seven national forests, and three states, while the Bureau of Reclamation controls critical water flows. The Interior Canada Subpopulation, which winters in the Tristate Region, is managed by all the entities mentioned above, as well as by the Canadian Wildlife Service, several provinces and territories, and, I suspect, an equal myriad of local and private jurisdictions.

Although survey efforts had been relatively well coordinated for over 40 years, jurisdictional boundaries placed strong constraints on the management, data gathering, and the understanding of the RMP as a whole. In short, although each agency managed its individual piece, it was no one's job to understand the Population as a whole and attempt to understand the requirements of the swans on a year-round basis as they traveled across man-made political boundaries.

With the active support of the RMP Trumpeter Swan Subcommittee, my supervisor, Dr. Joe Ball (Montana Cooperative Wildlife Research Unit), and I began this study in August 1984. Our goal was to take all of the available information previously gathered on the Rocky Mountain Trumpeter and to weave it together; to summarize our current knowledge of the Population as a whole and identify the most glaring gaps. Before the many managers set off in a new direction, or continued along the old, they needed to understand what answers had already been found, but lay unused in scattered filing cabinets. While our primary goal was to understand the acute problems facing RRLNWR and provide management recommendations, we felt that this could only be done in the context of understanding the problems facing the entire Tristate Subpopulation, and, indeed, the RMP as a whole.

Funding was provided primarily by the USFWS with additional contributions by The Trumpeter Swan Society and the states of Idaho, Montana, and Wyoming. This effort would never have been completed without the help of many people, including most of the swan researchers and managers who are in this room today. Everyone was extremely helpful and generous in sharing their data and their insights. It was a rare privilege to work with so many of those whose lives have been touched by the Trumpeter, and whose commitment to restoring the species has spanned several decades.

I don't believe that anyone really understood how much information had been gathered on the RMP Trumpeters. Certainly, I didn't. From the United States and Canada, we brought together numerous graduate theses, 40 years of banding data, 20 years of sightings of color-marked swans, 50 years of census data, necropsy reports, and cygnet mortality studies, miscellaneous observations from state files, the conclusions of Dave Lockman's Wyoming research, data and insights from Winston Banko's 1960 monograph, 50 years of water-flow records from Island Park Dam, and a variety of raw data and published reports on the Canadian flocks.

However, by far, the bulk of the data came from the RRLNWR files which contained the details on 50 years of management. It took almost 1-1/2 years to assemble and organize all of the Refuge data. The result was a unique documentation of the Centennial Valley swans and their habitat. We were able to construct data sets that varied from 30 to 50 years in length for variables such as clutch size, number of nests, location of nests, date of peak hatch, cygnet survival, duck and goose production, snowpack, minimum and maximum temperatures, precipitation, aquatic vegetation measurements, water levels, amounts of grain fed, and timing and methods of feeding. In addition, Refuge Annual Narrative Reports and other unpublished in-house reports provided information on movements of marked birds and a wealth of miscellaneous observations dating back to the early 1930's.

While much of the work consisted of organizing and consolidating existing information, we also contracted with Dr. Oz Garton, University of Idaho, to analyze relationships between population and habitat variables at RRLNWR. We were very fortunate because the Refuge had quite complete population data and weather data for the nesting area. Dr. Garton calculated annual birth rates and mortality rates from the available census data, and then calculated correlations between these rates and some 20 environmental variables. We were pleasantly surprised to find that many of the correlations were highly significant and consistent with biologically meaningful relationships.

In the time available today, I cannot cover our findings in much detail. I have chosen, rather, to explain the overall conclusions that we reached and the management actions that we recommended. I'd be happy to talk with any of you in more detail during the week if you have questions about some of our specific findings.

First, we concluded that the RMP faces two immediate problems that threaten its continued recovery. These are 1) the vulnerability of increasing numbers of wintering swans that depend upon extremely harsh and insecure winter habitat in the Tristate Region, and 2) the poor productivity and occasionally high overwinter mortality of swans in the Tristate Subpopulation.

We concluded, however, that these two problems are only the symptoms of an underlying disorder that had its origins in events which occurred decades ago. In essence, the chronic, long-term disorder is the Population's loss of migratory traditions. These traditions took Trumpeters to more productive winter and spring habitats than are available today at RRLNWR. Although managers have been partially successful in restoring the numbers of swans in the RMP, they have not yet been successful in restoring the Population's traditional patterns of habitat use.

How did this destruction of migratory traditions come about? By the beginning of the 20th century, Trumpeter Swans had been nearly eliminated outside of Alaska and the Pacific Coast. Of the thousands that once inhabited most of Canada and the lower 48 states, migrating across much of the continent, the last known survivors were a few families that wintered in the Tristate Region, within and surrounding Yellowstone National Park. We found no evidence that the Tristate Region was historically a preferred wintering habitat. Due to its high elevation and extremely harsh climate, it appears to be quite inferior to the coastal estuaries or more southerly marshes where Trumpeters were known to have wintered. We do know, however, that it possessed two qualities that made it rather unique in North America. It provided extreme winter isolation from human contact until the end of the 19th century, and it possessed many geothermal areas. These warm springs maintained small areas of dependable, ice-free habitat through even the most brutal winters. It did not provide the best food sources, but it provided virtually complete isolation and absolutely dependable small areas of ice-free habitat. Only a few families, perhaps totaling 100-200 swans, managed to find winter food near the warm springs, but these were the apparent last survivors, who became the ancestors of the present Rocky Mountain Population.

This surviving remnant apparently retained only two basic patterns of movement, some swans remained year-round in the Tristate Region, and others migrated north to nest in Canada. Marking studies of wild Trumpeters in Wyoming and Grande Prairie, Alberta, have shown that adult pairs are very traditional in their annual movements and areas of seasonal use. These long-lived swans maintain strong parent/cygnet and sibling bonds, sometimes lasting even 3 or 4 years. Cygnets and subadults appear to be highly dependent upon these movement patterns and other knowledge that they acquire from their parents. When families of Trumpeters are destroyed, their particular unique migration routes and key habitats are lost to the remaining Population.

Whatever other migratory traditions had been followed by the Rocky Mountain Trumpeters, whether to lower elevations along the Snake River in Idaho, or south to the Gulf of Mexico, or southwesterly to the California coast, those traditions were broken as the more southerly migrants were destroyed.

Working intensively with those few Tristate survivors, managers were successful in their efforts to increase the number of swans in the 1930's and 1940's. While the swans reproduced and increased in number, however, cygnets most often followed the movement patterns of their parents, particularly to wintering sites. As a result, although the swans have now expanded their summer distribution, some 1,600 Trumpeters, representing all the known breeding flocks of Canada and the Tristate Region, still return to winter where their parents wintered.

We concluded that the availability of winter habitat in the Tristate area has limited the growth of both the Tristate and the Interior Canada Subpopulations and will continue to limit them until the swans venture southward and gain access to additional wintering areas. Over the past 50 years, managers were able to successfully increase the number of swans in the RMP by artificially increasing the winter carrying capacity of the Tristate Region. This occurred both deliberately and inadvertently through two major events.

First, although virtually no natural winter habitat existed in the Centennial Valley, grain feeding at RRLNWR has provided a crucial energy subsidy for the swans since 1935. Currently, this program makes it possible for some 500 swans to winter there. Second, dams that were built in the 1930's and 1940's created extensive downstream areas of ice-free riverine habitat as water was continually released from the warmer bottom layers of reservoirs. The prime example of this situation is Island Park Dam on the Henry's Fork of the Snake River. In most year's, flows from the Dam maintain ice-free water for some 20 miles downstream, including about 8 miles of prime habitat in the vicinity of Harriman State Park. Although warm springs in this vicinity historically kept small portions of this area ice-free, the number of Trumpeters that depend upon this habitat today is far larger than what the warm spring habitat is capable of supporting. As we speak, some 500-600 Trumpeters are utilizing the aquatic vegetation available in this area below the Dam, and food availability this winter is jeopardized by extremely low water releases.

Throughout the period of recovery of the RMP, two winter food sources, the grain available at RRLNWR and the ice-free habitat available below Island Park Dam have comprised a major portion of the winter resources available to swans in the Tristate Region. Our analysis showed that over the decades both of these key components have fluctuated widely and erratically, in effect resulting in gross annual variations in the winter carrying capacity of the Tristate Region.

We traced the history of grain feeding at RRLNWR and found wide fluctuations in both the amounts fed and the timing and methods used to distribute the grain since 1935. We concluded that the very low amounts of grain fed in the early 1980's, combined with feeding methods that reduced the distribution of the feed, strongly contributed to the decline of the Centennial Valley flock, and, in turn, the Tristate Subpopulation. The amount of grain fed per swan in the early 1980's was the lowest in the 50-year history of the Refuge. Our analysis found that the rate of overwinter swan losses from the Centennial flock was higher in years when the amount of grain fed per swan was low.

We also reconstructed the pattern of winter water releases at Island Park Dam and found that the water had been virtually shut off for several months in most winters prior to 1986. During years with curtailed flows for 3 or 4 months, overwinter losses from the Centennial flock also increased. We found that most of the seemingly erratic fluctuations of the Tristate Subpopulation after the mid-1950's were closely related to winter losses of swans. These losses resulted in large part from the severe and unpredictable variations in winter carrying capacity due to the interactions of changes in the feeding program and/or the flow regime of the water at Island Park Dam.

The winter availability of aquatic vegetation in the Tristate area is influenced to a large extent by fluctuations in ice cover. This, in turn, is strongly influenced by water flows and winter air temperatures. Drought conditions, such as the Region is currently experiencing, can lead to extensive ice formation when coupled with normal winter temperatures. Increasing numbers of wintering swans may soon be competing for limited supplies of available vegetation at some sites, if they are not already doing so. We concluded that swans which winter in the Tristate area and depend primarily upon aquatic vegetation are often in poor condition by late winter and their mortality increases with increasing winter severity.

We also concluded that a Trumpeter's clutch size, egg hatchability, and cygnet viability are strongly influenced by the breeding adults' opportunity to find adequate food and rebuild their depleted energy reserves during the prenesting period. Trumpeters must obtain and store sufficient food during the prenesting period to adequately provision a viable clutch of eggs and maintain an adequate incubation constancy. We found that factors that reduce water temperatures and delay the growth of spring foods (e.g., heavy April precipitation, cold May temperatures, high spring water levels) were associated with reduced cygnet production. Grain-fed swans come through the winter in better condition than those that do not utilize the grain when adequate grain was supplied and well distributed. However, grain-fed birds must also have access to a prenesting diet of green vegetation to reproduce successfully.

Canadian Trumpeters, which surpass the performance of Tristate swans in virtually every productive parameter, depart the Tristate Region by early March. These birds have access to more varied, lower elevation spring habitats as they slowly migrate northward than do the resident Tristate birds. The Tristate swans, in contrast, often remain locked in winter for 4 to 6 weeks after the Canadian Trumpeters depart, and spring feeding sites may remain ice-bound until early May. When spring conditions are unusually mild, as in 1987, however, increased numbers of Tristate Trumpeters lay larger clutches and are able to reproduce successfully. Mild spring conditions also increase the amount of food available in June for newly-hatched cygnets.

We concluded that the decline of the Tristate Subpopulation mirrors the decline of the swans of the Centennial Valley and that a "quick fix" is needed to reverse the trend. The key to preventing a further decline in the Tristate Subpopulation is to restore the productivity of RRLNWR. In addition to the problems with the grain feeding program, we concluded that production at RRLNWR has declined due to flooding, the random increase in the frequency of cold, wet springs, increased human disturbance, and the decrease in spring food resources due to the maintenance of high water levels. Most of these problems had been previously identified.

Red Rock Lakes NWR managers should be able to greatly increase the number of cygnets raised on the Refuge in all but the harshest of years if they reduce the flooding potential through changes in the water control structure, reduce human disturbance, and substantially increase the amount and availability of grain in the winter. Higher overwinter survival and productivity will result if the wintering swans are adequately fed. I am optimistic that the needed changes are already well underway and that both the Refuge flock size and its productivity will increase. As the Refuge flock increases, it will once again provide swans that will disperse to other Tristate areas, such as Yellowstone National Park, where both available prenesting habitat and cygnet production are the poorest in the Tristate Region.

We also stressed that steps be taken to reduce mortality of resident birds in all seasons. Again, we emphasized that increased winter feeding is the key, coupled with elimination of lead from swan habitat, and the provision of adequate winter water flows below Island Park Dam. We concluded that bringing the swans through the winter in good condition will greatly reduce winter losses and improve the condition of breeding birds in the prenesting season.

We stressed, however, that the "quick fix" if it works, only buys managers some time and provides more birds to work with. It is only the first step in the job that lies ahead. It really amounts to improving a semi-farm situation, raising grain-fed Trumpeters efficiently and allowing some to disperse to off-

Refuge nesting habitats. We should never mistake that for our true goal -- the recovery of a once-endangered Subpopulation. As we make the Tristate Subpopulation numerically more secure, we will also be increasing the numbers of wintering swans either congregating to feed on grain or dependent on harsh Tristate habitats. To achieve true Population recovery, we recommended a management approach that would protect the existing subpopulations and prevent further losses and rebuild the habitat use patterns that will allow the RMP to survive without intensive Trumpeter management, difficult water management problems to solve, and continued supplemental feeding.

A real solution to the problems facing the RMP requires that managers actively work to rebuild or replace broken migratory traditions and expand the swans' knowledge of alternate wintering and prenesting habitats. Alternate wintering sites must be identified and site-specific strategies for restoring wintering use must be developed. When the swans have developed wintering traditions, managers must gradually terminate the winter feeding program at RRLNWR. Although the winter feeding program is currently essential to the existence of the Tristate Subpopulation, we also realize that its elimination is necessary in order to motivate the swans to use alternate wintering sites. The gradual phase-out of feeding must go hand-in-hand with the restoration of migration to more suitable habitats.

The restoration of migration will not be easy. Despite the recent increases in numbers and summer distribution of the RMP, almost two-thirds of the Population are currently wintering either on grain at RRLNWR or below Island Park Dam. It is only a matter of time before disaster strikes.

In many ways, the Tristate Trumpeters are like a critically-ill patient. Wildlife managers should be rightfully proud that their management efforts rescued their patient from the brink of death. But, the job is not over. For over 60 years the patient has lingered in intensive care. It is our job now, not merely to keep the Trumpeter alive, but to restore it to health once again. We must move beyond the treatment of symptoms and cure the underlying disorder. We must recognize that a healthy Population is much more than numbers alone and that the Rocky Mountain Trumpeters will not recover until a healthy distribution is restored and they, once again, have access to adequate winter and spring habitats.

ROCKY MOUNTAIN TRUMPETER SWAN POPULATION SUBCOMMITTEE REPORT -- PACIFIC FLYWAY

Dave C. Lockman, James Bartonek, Leonard Shandruk, Harold Weaver, Barry Reiswig, Jeff Herbert, Don Childress, Justin Naderman, Ruth Gale, and Mary Maj

ABSTRACT

Following the evolvement of the North American Management Plan for Trumpeter Swans, the Pacific Flyway's Rocky Mountain and Pacific Coast Population Trumpeter Swan Subcommittees have assumed an aggressive proactive role in continental Trumpeter Swan management. Past and current activities of the Rocky Mountain Population (RMP) Subcommittee include:

1. Coordinating Population monitoring.
2. Directing research efforts.
3. Promoting and participating in the evolvement of The History, Ecology, and Management of the Rocky Mountain Population of Trumpeter Swans by Gale et al.
4. Evaluating the influence of lead poisoning on the Tristate Subpopulation.
5. Developing an educational program.
6. Identifying Trumpeter Swan-use areas and winter range in Wyoming and Idaho.
7. Developing a contingency plan to prevent abnormally high swan mortality in the event of winter freeze-up on the Henry's Fork of the Snake River.
8. Developing strategies to expand winter range of the Tristate Subpopulation (1988-93).
9. Evaluating potential wintering areas in Idaho and Wyoming (1988) and southwestern U. S.
10. Revising the RMP plan.

PANEL DISCUSSION - RESTORING MIGRATION TRADITION AND CREATING NEW WINTERING TRADITIONS IN THE ROCKY MOUNTAIN POPULATION OF TRUMPETER SWANS

Moderator - Dave Paullin
Panel - Ruth Shea Gale, Dave C. Lockman, Jim King, David K. Weaver

Author Dave Lockman's note:

At the conference, the panel discussion was supposed to encourage input from the audience on a proposed Rocky Mountain Population swan range expansion project prepared by the Rocky Mountain Population Subcommittee. Panel participants included Dave Lockman, Ruth Shea Gale, Jim King, and Dave Weaver. Although the panel discussion did not generate much audience participation, it did introduce the proposal to the membership. Copies of the first draft proposal were reviewed by several of the members, after the panel discussion. As a result of input from flyway study committee and Society members, a final draft of the range expansion project was prepared. The project was approved unanimously for implementation by the Pacific Flyway Technical Study Committee on 10 March 1988. The approved project document is presented for inclusion in the Proceedings and Papers of the 11th Trumpeter Swan Sociey Conference, and, for the Trumpeter Swan of the intermountain west, represents an initial step toward range expansion. The Rocky Mountain Population Trumpeter Swan Subcommittee appreciates the assistance of many Society members in the preparation of this document.

A Contingency Plan for Management of Wintering Trumpeter Swans in the Vicinity of Harriman State Park follows, as the two are related.

ROCKY MOUNTAIN TRUMPETER SWAN POPULATION RANGE EXPANSION PROJECT, 1988-1993

Dave C. Lockman, principle author[1]

BACKGROUND

The objectives for the Rocky Mountain Population (RMP) of Trumpeter Swans and the procedures to achieve those objectives were identified in the North American Management Plan for Trumpeter Swans (U. S. Fish and Wildlife Service 1984). This range expansion project will specifically address the following objectives from the North American Plan:

1. To maintain a wintering population of at least 1,100 wintering swans within the Tristate Region.

2. To expand the distribution of swans wintering and nesting in the Tristate Region by establishing a tradition for use of at least four new wintering sites within Montana, Wyoming, and eastern Idaho. Each site should be able to support 50-150 wintering swans. By 1990, we should have evaluated and attempted to establish at least two new sites, and by the year 2000, another two sites should be ready for use or in use.

In July 1984, the RMP Subcommitte approved a project for cooperative funding from the U. S. Fish and Wildlife Service (USFWS), the states of Wyoming, Idaho, and Montana, and The Trumpeter Swan Society to compile, analyze, and report all historical and current knowledge on the ecology and management of this Population. This project was completed through a contract with the Montana Cooperative Wildlife Research Unit (MCWRU). Project leaders were Dr. Joe Ball and Ruth Shea Gale. The Subcommittee also decided that range expansion projects and the use of Tristate swans for restoration projects would not be initiated until the MCWRU analysis was completed.

"The history, ecology, and management of the Rocky Mountain Population of Trumpeter Swans" by R. S. Gale, E. O. Garton, and I. J. Ball was completed in August 1987. Equipped with a more thorough understanding of the RMP problems, the Subcommittee began, in 1987, to act on the expansion project authorized by the North American Management Plan.

Although efforts to restore the RMP from near extinction are in their sixth decade, managers have not yet dealt with the chronic problems that have plagued this Population. During the species decline in the 18th and 19th centuries, virtually all of the breeding Trumpeters of Canada and the lower 48 states were destroyed. Only the birds of the extremely remote sites in the Tristate avoided the slaughter. In this extremely harsh wintering habitat, a few families found geothermal features which created small ice-free areas in even the most severe winters.

Some of these last families apparently remained year-round in the Tristate while others migrated north to nesting sites in Canada. The remnant that survived by wintering in the Tristate were the ancestors of the current Tristate and Interior Canada Subpopulations, which together are the RMP. All Trumpeters that migrated to milder and more productive habitats were eliminated by commercial, subsistence, and sport hunting. As these migratory groups were destroyed, their knowledge of traditional migration routes and habitat use patterns died with them.

Grain feeding at Red Rock Lakes National Wildlife Refuge (RRLNWR) since 1935 and the creation of additional ice-free habitats downstream from dams has allowed managers to increase the number of swans wintering in the Tristate Region. Although swan numbers have increased, broken migratory traditions have not yet been restored. As a result, increasing numbers of swans are attempting to winter under very marginal conditions, and the survival of the majority of the Tristate Subpopulation is dependent upon winter grain feeding and/or limited food resources below Island Park Dam on the Henry's Fork of the Snake River in Idaho. In addition, the productivity of resident Tristate swans is strongly linked to the availability of adequate spring prenesting food resources. In many years, these resources are marginally available or virtually nonexistent due to snow and ice cover at these high elevation nesting areas.

The migratory Canadian flocks have access to more varied, lower elevation spring habitats once they depart the wintering grounds in March. These birds are more productive than the Tristate year-round residents. Despite their high productivity and increasing numbers, all of the Interior Canadian birds return to the Tristate for the winter. With record numbers of Trumpeters wintering on marginal habitat in the Tristate, the Population is increasingly vulnerable. A significant reduction in open water habitat due to drought or extreme cold weather, or an outbreak of disease at the feeding sites or on the Henry's

[1] Prepared by the Rocky Mountain Population Trumpeter Swan Subcommittee of the Pacific Flyway Study Committee, February 1988. Approved by the Pacific Flyway Study Committee, March 1988. Approved by the Pacific Flyway Council, March 1988.

Fork, could cause a large die-off of swans and quickly undo decades of efforts to restore the Population. The region currently faces drought conditions which will likely cause a significant reduction of available winter habitat during the coming winter.

Active management will be required to recreate habitat-use patterns that will give Trumpeters access to more productive, lower elevation wintering sites and nesting areas. Access to a variety of milder winter and prenesting habitats will allow Tristate Trumpeters to return to their nesting territories with the energy reserves essential for successful reproduction, and will greatly reduce the vulnerability of the RMP to winter mortality.

This document describes those management strategies and tasks which will be employed in the RMP range expansion project during 1988-93.

RANGE EXPANSION STRATEGIES

1. Identify potential winter habitats peripheral to (less than 150 km) current Tristate winter range.
2. Conduct field evaluations of physical, social, and biological factors relevant to establishment of use of new habitat by swans, and identify four new, high quality wintering areas.
3. Develop site specific strategies using propagation, transplant, and translocation techniques to achieve a tradition for swan-use at each selected wintering site and associated summering area.
4. Concurrent with translocation efforts, implement techniques to reduce the numbers of swans that currently are short-stopping and/or wintering at RRLNWR and Harriman State Park on the Henry's Fork of the Snake River.
5. Develop Memoranda of Understanding between state and Federal agencies in Idaho, Wyoming, and Montana that would be affected by the range expansion project.
6. Develop marking protocol and identify monitoring needs in order to evaluate the success of range expansion efforts.
7. Test methods employed in 1988-93. Modify throughout the test period as needed. Redesign methods to achieve optimal results in winter and breeding range expansion in the most expedient and cost-effective manner. Evaluate feasibility, and the need for increasing range expansion efforts to suitable wintering areas in other states.

TASKS, ASSIGNMENTS, AND SCHEDULE

Habitat identification and evaluation

1. Identify all currently-used (1978-87) winter areas in the Tristate range.

   This task has been completed. Information is available from the Midwinter Tristate Trumpeter Swan Survey.

2. Identify and evaluate potential swan winter habitats within 150 km of the current Tristate use areas.

   This task is underway and will be completed based upon the following timetable:

   Salt River, Wyoming. Evaluation completed by Wyoming Game and Fish Department (WGFD); currently could support up to 133 wintering swans. With habitat improvements, carrying capacity could be increased.

   Snake River, Idaho. The southeastern area will be evaluated in 1987-88 by the Idaho Fish and Game Department (IFGD) and USFWS.

   Southcentral Idaho. Identify and evaluate potential wintering areas and companion nesting habitats by October 1989 (IFGD and USFWS).

   Bighorn River, Wyoming (Thermopolis to Kirby). An evaluation was initiated by WGFD in 1986 and potential power line and hunting conflicts were indentified. WGFD will complete the evaluation by 1990, if adequate solutions to these problems can be found.

   Other areas, Wyoming. WGFD and USFWS will identify and evaluate other potential areas by 1992 (e. g., the lower Green River and the Wind River).

   Montana. Identify and evaluate potential areas by 1992, particularly in the Livingston area (Montana Department of Fish and Wildlife (MDFW) and USFWS).

3. Identify and evaluate other potentially suitable winter habitats located greater than 150 km from current range in Idaho, Wyoming, Colorado, Utah, Nevada, Arizona, New Mexico, and California. Subcommittee responsibility evaluations will be conducted each year through 1993 or as determined necessary by the Subcommittee.

   North Platte River, Wyoming. Evaluation to be completed by WGFD by January 1989.

   Solicit information from others. Present the winter habitat slide program to wildlife professionals and laymen to gain their suggestions for potential wintering areas and to identify areas where pioneering Trumpeters are currently wintering.

   Utilize available information. Burgess (pers. comm.) and Gale et al. have compiled information on identification of adequate wintering sites.

   Evaluation. Annually review information on sightings of wintering Trumpeters outside the Tristate Region, review the list of potential wintering areas, select areas for field evaluation, and make arrangements for the evaluations to be conducted. Factors to be considered in the evaluations will include: (1) available forage resources, (2) size of the area, (3) land ownership, (4) local interest in the project, (5) potential mortality factors, (6) probable migration routes and exposure to hazards, and (7) methods to minimize hunting losses in states with white goose or swan seasons.

Strategies. Finally, incorporate all of the above information to develop specific strategies to create new traditions of swan-use at each chosen site, where evaluation determines that use by wintering Trumpeters is feasible. Strategies will be developed in conjunction with the respective state involved.

Range expansion and restoration of migratory traditions

In November 1987, the Subcommittee made the decision to prioritize efforts for 1988-93. Initial top priority efforts, beginning in 1988, would be to establish winter use by at least 75 swans in the Salt River drainage, Wyoming. During 1988, IFGD will proceed to identify and evaluate potential wintering sites in the Snake River drainage, Idaho. After at least 75 swans occupy the Salt River wintering area, or after a decision is made to drop this site due to currently unforeseen circumstances, efforts will be expanded to relocate swans to the potential Idaho wintering sites.

The Subcommittee will implement and monitor the effectiveness of the following techniques:

1. Reduce the number of swans that shortstop and winter at RRLNWR and Harriman State Park. Make these wintering sites less attractive to swans in late fall and early winter. This will be attempted through a combination of reducing water flows and creating early ice formation, delaying the start of feeding at RRLNWR, and increasing the level of human presence at Harriman (primarily cross country skiiers and fishermen). These techniques will be implemented in autumn 1988.

2. Increase public information in eastern Idaho, western Wyoming, and states further south. Inform bird watchers and waterfowl hunters to be on the lookout for migrating Trumpeters, and caution hunters against accidental shooting of Trumpeters.

3. Release salvaged cygnets (prefledging). Birds at least 80 days-of-age would be released onto target winter range areas (Salt River, Wyoming, and Snake River, Idaho), and onto nearby summer range sites (Mud Lake Wildlife Management Area (WMA), Grays Lake NWR, and Camas NWR). Prefledged cygnets will also be translocated to summer habitat in the Upper Green River near Pinedale, to supplement existing swan numbers in low elevation breeding range.

   These cygnets will establish use of the targeted lower elevation habitats, and also function as decoys to attract swans that disperse from RRLNWR and Harriman State Park. Cygnets would come from annual collection of salvage eggs at Tristate nest sites. Eggs would be hatched and reared at a facility located at RRLNWR or another suitable site. Cygnets raised from salvage eggs would not result in a loss to the population, as salvage eggs would be removed from sites where cygnet survival is generally poor or chances of survival in a given year are determined to be poor. The rearing facility should be ready for operation by 15 May 1989. Idaho, Wyoming, Montana, and RRLNWR will deliver salvage eggs to the facility. Cygnets at the facility should have access to an enclosed area of natural open water foraging habitat and be accompanied by a wing-clipped or pinioned female. Propagation techniques should be designed to facilitate imprinting to adult Trumpeters, foraging after 4 weeks in native habitat, and normal escape behavior. Cooperators will be responsible for transporting and releasing prefledged cygnets.

4. Relocate yearling swans during their first adult molt. Move swans in July from flocks at RRLNWR and Lima Reservoir to targeted wintering sites and nearby summer habitats at the southern fringe of currently-occupied Tristate range. Grays Lake NWR and the Salt River are first priority summer/winter release sites. Wintering areas on the Snake River, southeastern Idaho, and summering areas at Camas NWR and Mud Lake WMA are second priority release sites. These subadult birds are likely to establish movement patterns that include increased use of the targeted lower elevation winter/summer habitats, while allowing these young birds to continue to interact with the Subpopulation. Some of these birds will also function as decoys to attract swans that are dispersed from RRLNWR and Harriman State Park.

   The number of yearling swans moved from RRLNWR and/or Lima Reservoir in 1988-90 will be limited to those excess swans not required for recruitment as replacement breeders. Based on stochastic modeling and survival rates reported by Gale et al. (1987) and discriminate modeling by Lockman and Wollrab (pers. comm.), an estimated 50 fledged cygnets or 34 yearlings would be required annually in the RRLNWR vicinity (Centennial Valley) to sustain a Tristate subadult and adult population of 400 swans ($\pm$ 20 swans). This assumes that other Tristate production areas fledge about 30 cygnets annually. Translocated yearling groups should contain a minimum of four birds, if other Trumpeters are not already present.

5. Use available salvaged cygnets, yearlings, or adults as opportunities arise. This includes injured birds that can be rehabilitated and released into the wild. These birds should be released at the targeted winter/summer habitats to supplement numbers and act as decoys. Cooperating states will develop Memoranda of Understanding to permit the transport of these swans across state lines, as opportunities develop.

6. Closely monitor wintering swan distribution. USFWS and states involved in swan relocation will closely monitor swan distribution during the winter. Methods for trapping and translocating wintering swans will be developed, and managers will be prepared to move swans from RRLNWR by 1989-90. If the methods employed in 1988-89 result in the movement of Trumpeters to lower elevation wintering sites in the Salt and Snake River drainages, trapping could be used to translocate those swans that fail to disperse from RRLNWR. Trapped birds would be translocated to the target sites in the Salt and Snake River drainages, and held during the first winter with grain, if needed. All translocated birds will be marked.

7. Monitor marked birds. The Subcommittee has developed a marking protocol for this project, and is currently awaiting authorization from the Bird Banding Laboratory. Each state will monitor winter range distribution and marked birds on a monthly basis, from December through April. The semi-annual cooperative Tristate Aerial Survey (USFWS) will monitor the Tristate Subpopulation in September, and the Rocky Mountain Population in February. In addition, each state and the USFWS at RRLNWR will conduct an aerial survey between 5-10 July. This survey will locate marked swans, identify summer molt locations, and document hatching success.

   At the annual July meeting, the Subcommittee will review results, modify techniques, and prescribe additional monitoring, as required.

The following tentative release schedule will be employed, with annual modifications, provided that initial results prove successful (Table 1).

Releases will be made in order of priority, depending upon the number of birds available in a given year, the results of prior releases, movements of other Trumpeters due to decoy efforts, and dispersal of swans from RRLNWR and Harriman State Park.

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Table 1. Tentative Trumpeter Swan releases into new summer and winter ranges.

Year	Release area	Time of release and number and type of swans
1988[1]	**Priority 1:** Salt River/ Grays Lake NWR	Summer. Five cygnets and five yearlings onto the Salt River winter area as decoy birds. In addition, 30 yearlings and five to 15 cygnets onto Grays Lake summer habitat.
	Priority 2: Camas NWR/ Mud Lake WMA	Summer. Ten to 20 yearlings onto summer habitat.
	Priority 3: Upper Green River	Summer. Five to 20 yearlings onto summer habitat.
1989	**Priority 1:** Salt River/ Grays Lake NWR	Summer. Ten to 25 cygnets and five to 20 yearlings to Grays Lake NWR.
	Priority 2: Camas NWR/ Mud Lake WMA	Summer. Five to 20 cygnets and five to 20 yearlings onto summer habitat.
	Priority 3: Snake River, ID	Summer. Five to 20 cygnets and five to 20 yearlings onto winter areas identified in 1988.
	Priority 4: Upper Green River	Summer. Five to 20 cygnets and five to 10 yearlings onto summer areas.
1989-90	Salt River/ Grays Lake NWR	Winter. Possible translocation of up to 75 swans (mixed ages) from RRLNWR or Harriman State Park, pending results of previous efforts.
	Snake River, ID	Winter. Possible translocation of up to 150 swans (mixed ages) from RRLNWR or Harriman State Park, pending results of previous efforts.

[1] In 1988, an estimated 50 yearlings (in excess of 34 yearlings) will be available from RRLNWR/Lima Reservoir. It is estimated that three cygnets released on the Salt River in 1987 will survive to yearling age class.

CONTINGENCY PLAN FOR MANAGEMENT OF WINTERING TRUMPETER SWANS IN THE VICINITY OF HARRIMAN STATE PARK, IDAHO[1]

BACKGROUND

Over the past 15 years, the Rocky Mountain Population (RMP) of Trumpeter Swans has rapidly increased, both in total numbers and in distribution of swans summering in Canada. The recovery of the Population is precarious, however, because all of the known breeding flocks of Canada join with the Tristate Subpopulation to winter in the extremely harsh, high elevation wintering sites of the Tristate Region. The traditional migrations of RMP Trumpeters to more southerly wintering sites were eliminated during the near-total destruction of the species in the 1800's. Although managers have successfully increased swan numbers, they have not yet attempted to restore the Population's migratory traditions. As a result, the birds remain totally dependent upon supplemental feeding at Red Rock Lakes National Wildlife Refuge (RRLNWR), and the very limited ice-free river habitats of the Tristate Region.

Increasing numbers of wintering swans now depend on the limited ice-free waters of the Henry's Fork of the Snake River, in and near Harriman State Park. Approximately one-third of the entire RMP was counted at this site in January 1988. In recent years, increasing numbers of ducks and geese have also wintered at Harriman State Park and have increased competition with the swans for the limited aquatic plant food resource. Although this area is the most heavily utilized winter swan habitat in the Tristate Area, food availability is determined by the extent of ice cover, which in turn is determined in large part by water releases from Island Park Dam. The North American Management Plan for Trumpeter Swans (NAMPTS) described the increasing vulnerability of these swans to starvation during periods of severe ice formation, or to a disease outbreak among the winter-stressed birds.

The NAMPTS states that, "The State of Idaho and participating Subcommittee members will develop a contingency [plan] for wintering Trumpeter Swans should an emergency arise and sufficient winter habitat become unavailable to swans at Harriman State Park. This should be accomplished by 1 November 1984 and led by Idaho Fish and Game Department (IFGD)."

During the autumn of 1987, it became apparent to the Subcommittee that drought conditions would likely result in low winter water releases from Island Park Dam, and would lead to extensive ice formation in key downstream feeding sites if normal or below normal winter temperatures occurred. The Subcommittee also anticipated that alternate Tristate wintering sites would be less available due to low water flows throughout the Region, and particularly at the Teton River wintering sites. In order to reduce the potential for high mortality at Harriman State Park during the winter of 1987-88, the Subcommittee prepared this contingency plan at its November 1987 meeting in Jackson Hole, Wyoming.

CONTINGENCY ACTIONS

1. Work with the Bureau of Reclamation (BOR) to maintain a release of at least 100 cfs from Island Park Dam at all times. This is the minimum flow needed to maintain the fishery.

2. As described in the Memorandum of Understanding between BOR and USFWS, water will be adversely stored in Island Park Reservoir prior to 15 November. This water will be released during the winter months to reduce ice formation and will be available for downstream power generation.

3. From November through mid December, swans will be discouraged from settling in at Harriman State Park. The goal in this period is to motivate swans to move through the area and continue southward while they are in relatively good condition, and while the Tundra Swan migration is still in progress. Water flows should be kept in the 150-250 cfs range in order to increase surface ice formation. Low flows during this period will also result in the increased availability of stored water during later critical periods.

4. If swan use continues to increase and the birds show no tendency to disperse by late December, flows will be increased if water is available from BOR. If adequate water is available, releases should be maintained at least at 400 cfs. If water is in short supply, the flows should be pulsed to break out sheet ice as needed. Any pulsing of flows should be ramped back down in close cooperation

[1] Prepared by the Rocky Mountain Population Trumpeter Swan Subcommittee of the Pacific Flyway Study Committee, February 1988. Approved by the Pacific Flyway Study Committee, March 1988. Approved by the Pacific Flyway Council, 1988.

with IFGD fisheries biologists so that fish are not left stranded as flows decline. Pulses should be timed to occur as the weather begins to moderate after cold snaps. If water availability is very low, it is important to use the water as efficiently as possible by not running it down the river during the coldest periods when ice formation is inevitable.

5. If severe ice formation continues after the supply of adversely stored water is exhausted, the following steps will be taken:

   a. IFGD will work with BOR to obtain any possible increase in water releases, particularly during the period prior to 20 February. By late February, water flows are less critical because swans are beginning to disperse and migrate north, and the afternoon sun can usually maintain ice-free areas. If weather is unusually harsh however, the remaining birds may be in extremely poor condition and ice formation can be a problem well into March.

   b. If swans appear to be in good physical condition, attempt to haze birds out of the area. This effort should start in December to aid in moving migrants through the area. Hazing can be indirectly accomplished through location of cross country ski trails near the river at Harriman State Park.

   In the event the above steps fail to disperse the swans and severe ice conditions continue, more drastic measures will be necessary.

6. If more than 50 swans remain in the Harriman vicinity (Last Chance to Pinehaven, Idaho), and it is apparent that aquatic food sources are inadequate for survival, supplemental feeding will be initiated by IFGD. Feeding will be used only as a last resort and begun only when the situation is deemed critical to the swans' survival.

7. If feeding becomes necessary and weather conditions and alternate lower elevation wintering sites are available, efforts will be made to trap and translocate swans from Harriman to these sites. This effort coincides with the Subcommittee's strategy for creating new wintering sites and migratory traditions. Up to 133 swans could be moved to the Salt River in Wyoming and up to 100 swans could be moved to the lower Snake River in Idaho.

   If an emergency is averted in 1987-88 through water management and/or above normal air temperatures, efforts should none-the-less continue to test trapping methods, as follows:

   a. Investigate potential trapping techniques in addition to rocket netting.

   b. Develop reliable methods.

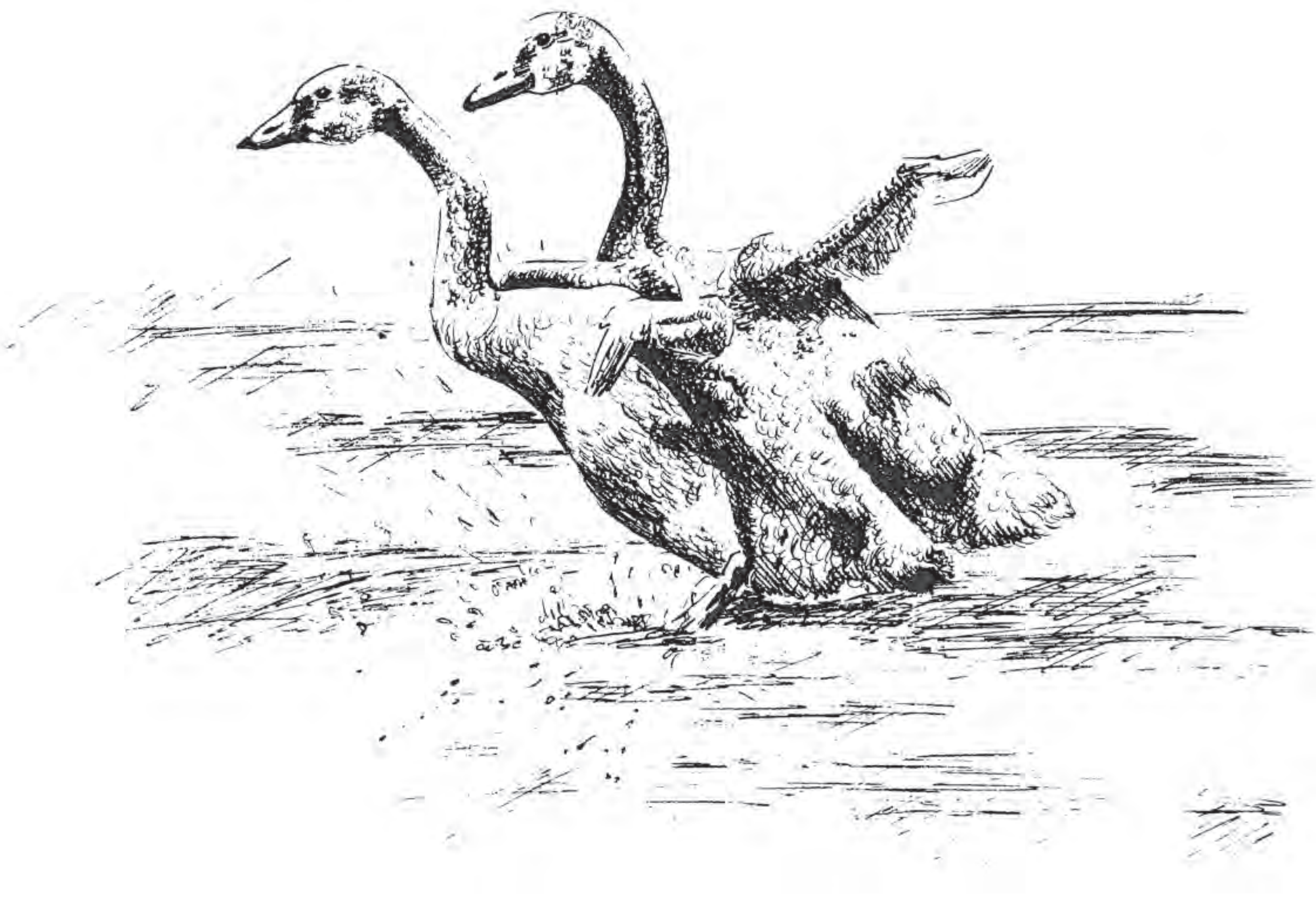
   c. Obtain necessary permits and cooperative agreements.

   d. Identify source of funding for emergency feeding and trapping.

   e. Identify manpower, equipment, and financial help available from states, federal, and private sources.

   f. Identify biological and political/social suitability of Idaho release sites.

RESTORATION PROJECTS



THE TRUMPETER SWAN RESTORATION PROGRAM IN ONTARIO - 1987 PROGRESS REPORT

Harry G. Lumsden

In 1986, five Trumpeter Swan cygnets reached flight stage in Cranberry Marsh. One of these birds disappeared in October, but the rest survived. Two were seen regularly in the Port Credit, Ontario, area all winter. The second brood of two cygnets left the area and may have been seen in January on Saratoga Lake in eastern New York. They returned by 20 February, and their tag numbers were read at the Windermere Basin at Hamilton. By late March, they were back at Whitby Harbour. All four spent the summer close to Cranberry Marsh and were seen most often on Lynde Creek. All were recorded in mid-October 1987 at Leslie Street Spit, and the Humber Bay west of the landfill site. They have therefore survived their first perilous year of life during which losses of yearling Trumpeters are often heavy.

One objective of the restoration program has been to replace the Mute Swan population in Ontario with Trumpeters. As a first step toward this goal, we have been preventing the Mute Swans from increasing by removing their eggs. We have not always been successful in finding all the Mute Swan nests, and each year one or two pairs have succeeded in hatching cygnets. Each year, however, there have been some losses among the breeders so that the population has remained fairly stable.

Restoration of Trumpeters through fostering with Mute Swan adults has gone very slowly primarily due to shortage of eggs. It has become apparent that the fostering technique for restoration must now rely on eggs laid by captive pairs.

In 1987, we tried experimentally to increase the number of eggs laid by two pairs of captive Trumpeters. When they started to lay, the first egg was replaced with a dummy, and as each subsequent egg was laid it was removed. Under this regime, one pair, 5-years-old and nesting for the first time, laid a single clutch of 16 eggs. A second pair, which had nested in 3 previous years, laid 12 eggs in a first clutch and after a 12-day interval, laid seven eggs in a second clutch. It appears that removing eggs as they are laid may be a satisfactory means of increasing egg production.

An aviculturist, who wishes to remain anonymous, successfully exchanged nine eggs from his breeding pair of Trumpeters for four eggs from a pair belonging to the program. Thus he obtained new blood for his flock and the restoration program benefitted with extra eggs. Also, in 1987, seven eggs were retained for hatching under captive pairs and 31 were used in the fostering program. Of the fostered eggs, 16 did not hatch due to infertility, early embryonic death, or death at the time of pipping; four were stolen by persons unknown from a Mute Swan nest at Cranberry Marsh and 11 hatched. Table 1 summarizes the project results since 1982.

Table 1. Summary of eggs used in Ontario Trumpeter Swan restoration project and their fates, 1982-87.

	1982	1983	1984	1985	1986	1987	Total
Eggs used	2	6	12	7	17	31	75
Failed to hatch	0	0	2	1	5	16	24
Stolen from nest	0	0	0	0	0	4	4
Eggs preyed on	0	0	0	3	0	0	3
Hatched	2	6	10	3	12	11	44
Died on nest	0	0	2	0	5	0	7
Disappeared	0	4	6	3	2	8	23
Accidental death	0	0	0	0	0	1	1
Retrapped	0	0	0	0	0	1	1
Fledged	2	2	2	0	5	1	12

Of the 11 cygnets which hatched in 1987, only two survived. One, with its foster parents, moved from Cranberry Marsh to Lynde Creek in August. It was caught, marked with wing tags, and banded on 6 October, just before it reached flight stage. One was picked up sick and treated by Dr. Holmes at the Anderson Veterinary Clinic. It survived in captivity (see below). One was found dead with the hooks of a fish line stuck in its beak and wrapped around its body. Four cygnets disappeared at 1-7 days-of-age, and four at 5 to 8 weeks.

Cranberry Marsh seems to have been declining in productivity since 1982. We have noticed progressively fewer duck broods, nesting Black Terns, and less thrifty growth of pondweeds. All of the Trumpeter cygnets fostered by Mute pairs in Cranberry Marsh in 1987 left the marsh in August, and all swans were gone by mid-September. We have never seen Cranberry Marsh deserted by swans at any time during the open water period.

More serious, one of the fostered cygnets which was picked up sick, was found to have developed paddle wing, a condition known to occur as a result of an imbalance in nutrition. This bird is being held in captivity, its wings have been taped in the correct position, and it may recover enough for eventual release.

ACKNOWLEDGEMENTS

We are grateful to many who helped the program in 1987. Mr. Tom Young of Stouffville, Ontario, joined the program as a cooperator and cared for a pair of Trumpeters on his pond. He donated the eggs they laid to the program. Unfortunately, the male of this pair died during the summer. A spare male is available at Kortright Waterfowl Park, Guelph, Ontario, and we expect that Mr. Young will have a producing pair again in 1988.

No Trumpeter Swan eggs were received from Grande Prairie, Alberta, in 1987, but Mr. Robert Andrews, Director, Alberta Fish and Game Division, generously donated an adult pair of Trumpeters for the Ontario Program. This pair arrived in August, has been placed with Mr. Gill Henderson at St. George, and will be available for egg production in 1988.

The World Wildlife Fund (Canada) set aside $10,000 for the restoration program in 1987, $5,000 of which was donated by Canada Life Assurance Company.

David McLachlin and Sylvie Plourde carried out the field work. They searched for Mute Swan nests, placed Trumpeter Swan eggs, and caught and marked swans. Sylvie Plourde did most of the snapping turtle trapping using traps loaned by Professor Ron Brooks of the University of Guelph. She caught and relocated 31 turtles.

Dr. A. Binnington of the Veterinary College, University of Guelph, pinioned adult Trumpeters for placement with cooperators and Mr. R. Ortleib of Kortright Waterfowl Park cared for some of these birds.

Dr. J. A. Holmes of the Anderson Veterinary Clinic in Whitby cared for a sick Trumpeter cygnet.

Mr. Campbell of the Central Lake Ontario Conservation Authority and his staff helped with accommodations and the necessary permits for the program on Cranberry Marsh.

AN UPDATE OF THE MINNESOTA DEPARTMENT OF NATURAL RESOURCES TRUMPETER SWAN RESTORATION PROJECT

Steven M. Kittelson

ABSTRACT

This paper is an update of the Minnesota Department of Natural Resources Trumpeter Swan restoration efforts. Forty-four subadults are being managed for release in 1988. Fifty eggs were collected in Alaska and artificially incubated, and, in addition, cygnets were obtained from several sources in 1987. The 1987 birds are being reared for release in 1989. Artificial incubation and captive-rearing techniques are continually being refined. New research is being conducted on aspergillosis testing, lead levels, and genetic variation within the flock. Birds released in 1987 are being monitored regularly. Publicity is an important component of the project because of increasing numbers of free-flying swans. Public awareness is heightened by the use of newspapers, radio, television, billboards, and newsletters.

The Nongame Program of the Minnesota Department of Natural Resources (MN DNR), Section of Wildlife, continued its efforts to restore Trumpeter Swans (Cygnus buccinator) to Minnesota in 1987. As in 1986, eggs were collected from Alaska, and, for the first time, subadults were released in the Detroit Lakes, Minnesota, area.

The second of three planned egg collections in Alaska took place on 9 June 1987 at Minto Flats, west of Fairbanks. Carrol Henderson, Nongame Wildlife Supervisor, Dave Ahlgren, DNR volunteer and Northwest Airlines employee, and Rod King, U. S. Fish and Wildlife Service pilot/biologist, made the collection. The eggs were taken to the Carlos Avery Wildlife Office at Forest Lake, Minnesota, and placed in incubators.

The eggs hatched from 16-27 June 1987. A hatch success of 43 of the 50 eggs (86 percent) was achieved. This rate was identical to the hatch success of 1986. The hatch period in 1986 was 18-28 June.

The unhatched eggs from 1986's collection were examined at the U. S. Fish and Wildlife Service Lab in Patuxent, Maryland. Of the seven eggs which did not hatch, one was infertile, and the remaining six were examined for pesticide contamination, deformities, and other problems. The primary concern was that the wintering area used by the Minto Flats, Alaska, birds may have high enough pesticide levels to cause pesticide contamination in the adults. Elevated pesticide levels would then be likely in the eggs and embryos. No pesticide problems were confirmed. Problems encountered included: 1) two embryos with bill and skull deformities, 2) two embryos in reversed position in the eggs, 3) one embryo that died fairly early in development, and 4) one that died very near the time of hatching. The causes of the above problems could not be determined.

The seven eggs that failed to hatch in 1987 will not be examined at the Patuxent Lab. No deformities or reversed positions were observed. One embryo died very early in development, several embryos died within the final days of incubation, and two or three embryos vocalized but were already dead or near death when intervention in the hatching process occurred.

Data will continue to be collected on the incubation process in 1988. Very little intervention in 1986 and slightly more in 1987 resulted in identical hatching rates. The timetable for intervention during the hatching process will be reexamined prior to the 1988 incubation period. Based on discussions with swan propagators familiar with hatching eggs in incubators, more assistance will likely be given to slow-hatching embryos in 1988. It may be possible to save some of the embryos that vocalize and then fail to hatch, without disrupting any embryos that would hatch on their own.

The program suffered a setback in June 1987, when a mink entered the duck house and killed 31 of the 43 Alaskan cygnets. The duck house was determined unsuitable for the program, and a new facility will be ready for the 1988 season. The impact to the overall program was minimized with the acquisition of cygnets from other sources. The 1987 hatched birds currently number 35 cygnets. The goal is to have 40 swans in each age class at the time of release.

A cooperative effort with the University of Minnesota Raptor Research and Rehabilitation Program (RRRP) and Hennepin Parks, to study and improve swan, health was intensified in 1987. Captive swans were examined and bled periodically to determine normal blood parameters, and to monitor blood lead levels, aspergillosis exposure, and parasite loads (Degernes 1987). If an opportunity arose, free-flyers were bled as well. Hopefully, the testing will lead to early detection of problems and methods of treatment that will increase survival. Opportunities for prevention may also be discovered. The Minnesota Zoo flock will be included in the testing in 1988. All carcasses collected were channeled through Dr. Laurie Degernes, Staff Veterinarian at RRRP, to maximize data collection on causes of death as well.

The Minnesota DNR Chemistry Lab is in the preliminary stages of genetic testing on the flock. The objective is to determine genetic lines and the amount of genetic variation among the birds, where possible. It may be particularly helpful when obtaining swans from Red Rock Lakes National Wildlife Refuge (RRLNWR) stock and in artificially pairing stock prior to release.

The highlight of 1987 was the first release of swans in northwestern Minnesota. On 21 April, 10 pairs of swans were released in and around Tamarac National Wildlife Refuge in Becker County, Minnesota. The release sites were selected after a review of data gathered in a 1986 survey (Hines 1986). The evaluation criteria included food and cover availability, lead shot deposition, physical hazards, human activity, and potential nesting sites. One pair of swans was released at each site, except for one very large lake where two pairs were released. Orange patagial wing tags with black numerals were used to mark the birds.

The Minnesota Air National Guard provided air transport on a C-130 to move the swans from holding sites near Minneapolis to Fargo, North Dakota. The swans were then transferred to several vehicles and driven to their specific release sites. The birds were captured in the morning (except at the Minnesota Zoo) and released by approximately 7:00 pm on the same day. (The swans being held at the Minnesota Zoo had been captured the day before and placed in holding facilities. The rest of the birds were captured at Hennepin Parks and Carlos Avery on the morning of 21 April.)

Over 200 people gathered to witness the release of a pair on Jim's Marsh, adjacent to Tamarac NWR headquarters. Public interest has remained high. Tamarac staff reported that visitor center use was up by 30 percent. They attributed the rise to the presence of the released swans.

The birds were released with clipped wings, giving them over 3 months to settle in and become acquainted with each other and the release site before regaining flight.

A cooperative effort with Hennepin Parks, Minnesota Zoological Garden, and RRRP to educate the public about swans continued in 1987. News releases to the media generated stories on television, radio, and in the newspapers. A public service announcement showing the difference between swans and Snow Geese was filmed at the Minnesota Zoo. Signs at public lake access points informed recreational visitors of the possible presence of swans. Posters showing swans and Snow Geese were placed in retail establishments where hunting licenses were sold. Billboards asking the hunting public not to shoot Trumpeters were distributed in and between the Twin Cities and the Detroit Lakes release area. The 1987 Nongame Program poster which is distributed widely throughout the State displayed a pen on the nest with her cygnets. And, finally, an effort was made to enlist the help of science teachers to reach younger outdoor users via the classroom.

The united publicity efforts seem to have made a difference. The number of human-caused swan injuries and mortalities was reduced from 1986. Continued public education will be necessary to ensure that the trend continues.

As of 27 January 1988, the known mortalities were: 1) a female hit by a car while walking across a road, 2) a female found dead, cause undetermined, and 3) a third female missing, presumed dead by vandalism. This female was replaced with another female. The replacement female and the original male were then clipped and forced to remain at their release site over winter. (This particular release site was one of two

Table 1. Trumpeter Swans being held for release in 1988 and 1989 for Minnesota DNR restoration program.

Year of hatch	Source	Number	
Unknown	Hennepin Parks, MN	2	
1983	Brookfield Zoo, IL	1	
1984	Minnesota Zoo	2	
1985	Minnesota Zoo	2	
1985	George Knapp (private propagator, IL)	1	1988 release
1986	Minnesota Zoo	5	
1986	Brookfield Zoo, IL	4	
1986	Minto Flats, AK	34	
1987	Minnesota Zoo	12	
1987	Brookfield Zoo, IL	5	
1987	George Knapp, IL	6	1989 release
1987	Minto Flats, AK	7	
1987	Delta Waterfowl Research Station, Manitoba	5	
Total captive swans		86	

emergency aeration and feeding sites established for birds reluctant to migrate.) As of 27 January 1988, there were 13 swans from the state program free-flying in Minnesota and areas to the south.

A pair of swans was injured by gunshot in late October. They were captured and treated at RRRP, where each required the amputation of one wing. This pair was placed at the Minnesota Zoo, where it is hoped they will produce offspring for the program. A male was captured 23 January in western Iowa and was found to have lead poisoning, as well as injuries from being shot. It was in treatment at the time of this paper.

As of 27 January, sightings of swans down the Flyway indicate that a migration did occur. A pair was confirmed in mid-December on the Mississippi River at Monticello, Minnesota. This location is approximately 150 miles southeast of the release area. Three swans from the Hennepin Parks flock were confirmed at that location on the same day. This pair was still in Monticello on 20 January 1988. Other sightings to the south included a group of five swans in Lyon County, in northwest Iowa, unconfirmed sightings in east-central Missouri, and three swans on 10 January 1988 unconfirmed in Mills County, in southwest Iowa.

The efforts of the program in 1988 will begin with the release of two pairs of swans in April at Swan Lake in south-central Minnesota. A release of 15 to 20 pairs is scheduled for mid-April in the northwestern Minnesota release area (Table 1).

The collection of eggs at Minto Flats will take place in June 1988. The program is looking forward to another good hatch and better survival with each year's added experience. These birds will be held for release in 1990. Released birds will be monitored to determine movements, survival, and reproductive efforts. Turtle trapping will be used to reduce predation on selected breeding locations. Data will be collected to continue the study of flock health and swan biology. Genetic testing will be refined for use in monitoring the gene pool of captive and released swans.

Trumpeter Swan restoration in Minnesota is making progress. At times, it seems slow and uncertain, but, through cooperative efforts, we are moving the restoration ahead and gathering considerable knowledge in the process. It is hoped that this information can be used to benefit Trumpeter Swan programs in other areas.

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TRUMPETER SWAN STATUS REPORT FOR WISCONSIN

Michael J. Mossman and Sumner W. Matteson

INTRODUCTION

In 1987, the Wisconsin Department of Natural Resources (WDNR) initiated a program to restore the Trumpeter Swan (Cygnus buccinator) as a breeding species in the State. This paper summarizes the results from the first year's work, and describes plans for future reintroduction and research efforts.

STATEWIDE STATUS OF TRUMPETER AND MUTE SWANS

Trumpeter Swans apparently nested in Wisconsin until the late 1800's, although no unequivocal nest records have been found (Coale 1915, Kumlien and Hollister 1903, Schorger 1964, 1968). Except for a record from the Green Bay area in October 1937 (Richter 1937), the species was not recorded subsequently in Wisconsin until 1981, when birds propagated in Minnesota first began to appear (Matteson et al. 1986).

At two sites in northwestern Wisconsin, Minnesota Trumpeter Swans have recently given some indication of establishing breeding territories. In spring 1985, a male and a 2-year-old female from the Hennepin Parks (Minnesota) restoration flock displaced a Mute Swan (Cygnus olor) pair at Gordon Flowage (Douglas County). Both birds returned to the Minneapolis area that fall and subsequently migrated. The male died before the following March, and the female returned alone to spend the summer at the Gordon Flowage. The female died of lead poisoning in Iowa the following February. An unmated male, hatched at Hennepin Parks in 1983, spent the summers of 1986 and 1987 at Oakridge Lake (St. Croix County), returning both winters to Hennepin Parks.

In Wisconsin, the exotic Mute Swan is a potential competitor of Trumpeter Swans, but also a potential foster parent for Trumpeter cygnets. It may also serve as an indicator of environmental conditions that are important to Trumpeters. Feral Mute Swans have been present in the State since at least 1958 (Wisconsin Society of Ornithologists (WSO) records), and a 1986 WDNR survey estimated a minimum of 200 free-flying individuals Statewide. The WSO checklist (Temple and Cary 1987 and in litt.) recorded Mute Swans in 28 of 72 Wisconsin counties during the period 1983-86. The largest breeding concentration is in the Waukesha County area of southeastern Wisconsin.

THE WISCONSIN RECOVERY PROGRAM

The Wisconsin Trumpeter Swan Recovery Plan (Matteson et al. 1986) was approved by the Mississippi Flyway Council in 1987. It established a recovery goal of at least 20 breeding pairs of self-sustaining, migrating Trumpeter Swans by the year 2000 through a program involving cross-fostering with Mute Swans and the release of captive-reared subadults.

For these purposes, the WDNR was to secure a total of at least 50 Trumpeter Swan eggs from both wild (Alaskan) and captive pairs, annually from 1987 through 1996. The plan also outlined the added options of placing adult Trumpeter Swans of the appropriate sex on Wisconsin marshes used by lone Trumpeters of known sex that had dispersed from the Hennepin Parks flock.

In 1987, our allotment of 10 Alaskan eggs was incubated, hatched, and cared for at Minnesota DNR's Carlos Avery facility. Due to heavy predation of cygnets at that site by mink (Mustela vison), we received only two cygnets, which are being maintained as future captive breeders at Monastery Lake near Milwaukee.

In 1987, WDNR also obtained 20 eggs for cross-fostering with Mute Swans in southeastern Wisconsin. These eggs came from Trumpeters owned by George Knapp at the Timberedge Wildlife Foundation in Elgin, Illinois. On 14 May, WDNR personnel placed five eggs into each of two active Mute Swan nests. On 3 June, they did the same with each of two additional Mute Swan nests, where pairs had renested after their first clutches were removed. Eleven (55 percent) of the 20 eggs hatched, but no young survived beyond the age of 4 weeks. Eight were apparently taken by snapping turtles (Chelydra serpentina) and/or mink, despite WDNR's trapping and removal of snappers from the nesting areas during the breeding season. One cygnet was trampled by an adult. The remaining two may have been victims of vandalism.

In autumn 1987, Ray Whitney of Dellwood, Minnesota, donated five cygnets that had been hatched at George Knapp's facility. Along with a sixth cygnet from the Lincoln Park Zoo (Illinois), these wing-clipped birds are being overwintered on an aerated pond in St. Croix County, Wisconsin, for eventual pairing and release into potential breeding marshes during spring of 1989 or 1990.

WISCONSIN RESEARCH

In November 1987, WDNR initiated a research program to evaluate and help guide the Trumpeter Swan recovery project. One research objective is to determine the nature, extent, and distribution of suitable breeding habitat in the State, so that appropriate sites can be selected for the release of adult and subadult swans. A broader objective is to evaluate the relative effectiveness of various reintroduction strategies (Table 1) in producing a self-sustaining, breeding population. The measure of effectiveness is the number of wild cygnets fledged by each released bird and the subsequent productivity of the offspring.

Table 1. Current reintroduction options in Wisconsin's Trumpeter Swan recovery program.

Option	Egg Source	Hatch/brooded by*	Release
1	Captive	Natural captive TS parents**	At 23 months
2	Captive or wild (Alaskan)	Captive MS**	At 23 months
3	Captive or wild (Alaskan)	Incubator, no brooder parents**	At 23 months
4	Captive	Wild feral MS	Fledge naturally
5	Captive or wild (Alaskan)	Captured feral MS**	As family at 5 weeks
6	Wisconsin semi-wild (pinioned or wing-clipped)	Natural semi-wild parents	Fledge naturally

* TS = Trumpeter Swan MS = Mute Swan

** Has additional option of being brooded with or without human contact.

In Options 1-3 (Table 1), young birds are raised in captivity until 23 months-of-age, then released as wing-clipped, male-female "pairs" into suitable breeding sites, with the hope that they will return to breed at the same or other sites in subsequent years. Because captive-reared Trumpeter Swans may become hyperaggressive toward humans (H. G. Lumsden pers. comm., D. Compton pers. comm.), we will test the efficacy of rearing birds in isolation from human contact. We also hope to learn something about the effect of brood-parent type (Trumpeter, Mute, none) on the survival and productivity of offspring released to the wild.

Simple cross-fostering (Option 4) has been hampered in Wisconsin, Michigan, and Ontario by predation of young cygnets. Option 5 is an attempt to minimize this problem by capturing breeding pairs of feral Mute Swans, allowing them to nest and foster Trumpeter Swans in captivity, and then releasing these foster families back into the wild when the cygnets have passed their most vulnerable stage of development.

In Option 6, captive-raised or wild-caught adult pairs are pinioned or wing-clipped, then released onto a large tract of potential breeding habitat and allowed to nest without human interference. Successful wing-clipped parents will be allowed to molt and fly free with their fledged offspring. Arrangements must be made to overwinter pinioned and unsuccessful wing-clipped birds. A modification of this option is to place a wing-clipped adult of appropriate sex into a marsh in which a free-flying Trumpeter of known sex has established itself, in hopes that they will eventually mate.

One major aspect of the research program focuses on Mute Swans, largely because of their role as potential foster parents. Statewide surveys are needed to better determine breeding and wintering distributions. We will gather information on reproductive success of natural families for comparison with foster families and use that information to determine the best parents for cross-fostering attempts. In addition, WDNR will continue its program of winter and summer health monitoring of feral Mute Swans, to determine geographic areas from which Trumpeters should be discouraged because of contagious disease and/or high lead concentrations.

To facilitate keeping track of released birds, they will be marked with green patagial tags bearing white numerals, and several will also be monitored by radio telemetry. We are marking feral Mute Swans with numbered yellow collars. We will observe Trumpeter individuals and, especially, broods to determine habitat use, feeding behavior, and interactions, in a manner consistent with that of Lumsden (1986 and in litt.) Health status of captive and wild birds will be monitored during the summer molt and at wintering sites.

CONCLUSIONS

The Wisconsin Trumpeter Swan Recovery Program produced no young through cross-fostering in 1987, but important information was gained, and a captive flock was initiated. The initiation of a comprehensive research program will help develop productive restoration techniques. To maximize its effectiveness, this research should be coordinated with other Trumpeter Swan recovery programs. In 1988, WDNR will experiment with several restoration strategies.

ACKNOWLEDGMENTS

This program was initiated with the help and guidance of many individuals and agencies. We, especially, thank the following: Tom and Carol Bintz, Donna Compton, Ed Diebold, Larry Gillette, Carrol Henderson, Dick Hunt, Joe Johnson, Steve Kittelson, George Knapp, Ray Whitney, and those WDNR wildlife managers involved in the project.

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TRUMPETER SWAN STATUS REPORT FOR MISSOURI

John W. Smith

ABSTRACT

Missouri's experimental Trumpeter Swan restoration effort continued in 1987 with the transfer of 10 subadult swans from Lacreek National Wildlife Refuge (NWR) in July 1987. Three of the birds died prior to release. The remaining seven were released on 17 July (five at Mingo NWR and two at a wetland in central Missouri). Nine swans are known to remain at Mingo NWR, including several from previous releases.

The Missouri Department of Conservation, in cooperation with the U. S. Fish and Wildlife Service, initiated an experimental Trumpeter Swan restoration program in 1982. During the 10th Trumpeter Swan Society Conference held a year or so ago in Grande Prairie, Alberta, I reported in detail regarding our restoration activities conducted under that program between 1982-86 (Smith 1988). My purpose here is to report on the 1987 swan transfer/release and bring you up-to-date on the overall status of the Missouri restoration effort, including a look at where we hope to go from here.

As of the last conference, we knew of four Trumpeter Swans remaining on the Mingo National Wildlife Refuge (NWR) from previous releases, and six others were listed in the "status undetermined" category (Smith 1988). I'm happy to report that the component of birds released prior to 1987 whose status is unknown was reduced from six to five during the past year (Table 1). One of those birds is now known to have returned to Lacreek NWR (the source of our restoration birds). That bird, one of six released at Mingo in 1985, was observed at Lacreek NWR during a waterfowl survey in December 1986.

In 1987, the Department acquired 10 subadult Trumpeter Swans from Lacreek NWR, South Dakota, and transferred them to Missouri on 9-10 July. The birds were held in aquatic holding pens for 1 week prior to their release on 17 July. The holding period provided an acclimation and orientation period that helped to minimize the effects of stress related to capture and handling. As I discussed in detail at the last conference (Smith 1988), I believe that stress-related mortality was a significant factor in losses of translocated swans during 1983-86. The period of pre-release captivity in 1987 was very successful in increasing post-release survival. Three birds died in the pen during the holding period. This was not unexpected because four birds had exhibited signs of severe stress when we processed them at Lacreek NWR. A fourth bird, another of the high-stress birds that had been identified during the transfer process, was found dead in October 1987.

Table 1. Status of Trumpeter Swans transplanted to Missouri (1982-87).

Year	No. released	No. mortalities	No. surviving 1 year (%)[a]	No. remaining on refuge[a]	Status undetermined
1982	5	2	3 (60)	2	1
1983	7	5	1 (14)	0	2
1985	6	5	1 (17)[b]	0	0
1986	7	3	3 (43)	2	2
1987	7[d]	1	N/A[c]	4	2
Totals	32	16 (50%)	8 (32%)[e]	8 (25%)	7 (22%)

[a] Minimum figures.
[b] Had returned to Lacreek NWR by December 1986.
[c] Released 17 July 1987.
[d] Two birds were released at Grand Pass Wildlife Area in central Missouri, the remainder were released at Mingo NWR.
[e] Includes only those 25 birds released prior to 1987.

Of the seven swans released in 1987, five were released at Mingo NWR (one died) and two were released at Grand Pass Wildlife Management Area, a wetland area on the Missouri River in central Missouri. Eight swans are known to remain at Mingo NWR, including several from previous releases (Table 1). The two birds released in central Missouri have left that area, and their location is presently unknown. There were no known nesting attempts in 1987.

In the future, we hope to continue the cooperative effort with Lacreek NWR. In addition, our concept proposal for acquisition of Trumpeter Swans from Alaska was approved by the Mississippi Flyway Council in 1987, and, in 1988, a formal implementation plan will be prepared for submission to the Missouri Conservation Commission for funding. If our proposal receives the necessary final approval, we hope to acquire swans from Alaska, beginning in 1989.

ACKNOWLEDGMENTS

I'd like to express the sincere appreciation of the Missouri Department of Conservation to Rolf Kraft and the staff at Lacreek NWR, and to Gerald Clawson and the staff at Mingo NWR, for their continued interest and support in what has truly been a cooperative restoration effort.

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STATUS REPORT OF THE LACREEK NATIONAL WILDLIFE REFUGE, SOUTH DAKOTA, TRUMPETER SWAN FLOCK MANAGEMENT PLAN

Rolf H. Kraft

ABSTRACT

A total of 268 Trumpeter Swans returned to Lacreek National Wildlife Refuge in South Dakota, following the 1987 breeding season, including 86 cygnets. This compares favorably to 229 Trumpeters, including 63 cygnets, in 1986; 187 Trumpeters, including 43 cygnets, in 1985; and 237 Trumpeters, including 47 cygnets, in 1984. Ten Trumpeter Swans were captured on Clubhouse Lake, Cherry County, Nebraska, on 8 and 9 July 1987 for transfer to Missouri. Sixteen additional swans were also captured and collared on Clubhouse Lake, to increase the number of marked birds in the wild for future identification. The annual aerial production survey this summer was conducted 29 and 30 July and 8 and 12 August 1987. A total of 191 Trumpeter Swans was observed including 34 nesting pairs, 23 broods with 81 cygnets, and 32 nonbreeders in four flocks. This is a 9-percent increase in production over last year and an 8-percent increase in total swans. Following the midwinter peak of 268 on 4 January 1988, the Lacreek population dropped sharply to 192 on 20 January 1988, indicating a migration of about 76 Trumpeters, including four with collars (15FA, 25FA, 26FA, 27FA).

POPULATION REPORT - JANUARY 1988

A total of 268 Trumpeter Swans returned to Lacreek National Wildlife Refuge (NWR) following the 1987 breeding season, including 86 cygnets. This compares favorably to 229 Trumpeters, including 63 cygnets, in 1986; 187 Trumpeters, including 43 cygnets, in 1985; and 237 Trumpeters, including 47 cygnets, in 1984 (Table 1). In the 1986 Status Report, it was speculated that the reduced 1985 winter population peak of 187 may have been the beginning of a small southern migration tradition that began in 1983 when severe cold forced some birds south. The 1986 winter peak of 229 brought the Lacreek winter population back to normal, and the minor migration may indeed be continuing. Following the midwinter peak of 268 on 4 January 1988 (called the winter of 1987), the Lacreek population declined sharply to 192 on 20 January 1988. This rapid disappearance of an estimated 76 birds indicates that some migration must be occurring. Seventy-six birds could not have died without some evidence. An aerial survey of the surrounding swan wintering habitat failed to reveal any of the missing birds. Four collared swans are among the missing (15FA, 25FA, 26FA, 27FA). The collared birds were observed 18 December 1987 and have not been seen since. The missing collared birds all have exhibited independence from the flock; three have histories of escape. 15FA is an old pen originally collared as 53TY in 1973 and paired with an unmarked cob. They nested on North Cody Lake, southeastern Bennett County, South Dakota, for many years. This pair chose an isolated site and usually stayed there year-round. They were not there this year. 25FA is a pen that was captured for the Missouri transplant program in 1985, but escaped the Refuge holding pen. As noted in the August 1986 Status Report, when capturing birds for the Missouri project, 26FA and 27FA, plus 19FA, were captured on Scotchman Lake and marked, but other birds on the lake had not yet molted and could not be caught. It was decided to release these birds back onto Scotchman Lake to reduce stress and to recapture them in a few days when the other birds could also be caught. The three collared birds were observed crossing the sandhills on foot during an aerial survey a few days later and were not seen again that summer. 26FA and 27FA were observed during the fall of 1986 and, again, in December 1987 as reported above. (19FA was never seen again.) From the data available now, it appears that the apparent population declines of 1985 and 1987-88 were the result of a winter migration. Hopefully, the missing collared birds will be seen and reported.

Table 1. Breeding season peak population and production data for Trumpeter Swans wintering on Lacreek NWR.

Breeding season	Adults	Cygnets	Total
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
1980	140	56	196
1979	119	65	184
1978	138	36	174
1977	126	65	191
1976	146	41	187
Averages	158	55.4	213.4

It has been recognized for some time that the key to finding out more about the migration habits of this population is to mark more birds so that the Lacreek birds can be identified whenever and wherever they are observed. Last year, we attempted to band and collar some adult Trumpeters in the southern part of the local breeding range in the Nebraska Sandhills. The attempt was fraught with frustrations due to the logistical problems of getting people and equipment over many miles of dirt roads and rough trails just to get to the remote lakes. The dense vegetation surrounding the breeding lakes made access with our airboat impossible on all but two lakes, and an early molt put most of the birds in the air at the time of the attempt. As a result, only one Trumpeter Swan was collared. The marking attempt was so costly in time and expense, when compared to any possible benefits, it was postponed until a more efficient method can be found.

During the June 1987 aerial surveys to locate subadult Trumpeters for the transplant project with the State of Missouri, a flock of 28 Trumpeter Swans was found on Clubhouse Lake, Cherry County, Nebraska (approximately 15 miles south southeast of the Refuge). Ten Trumpeter Swans were captured on Clubhouse Lake on 8 and 9 July 1987 for transfer to Missouri. The birds were collared 25RA - 32RA, 37RA, and 38RA. Sixteen additional swans were captured and collared on Clubhouse Lake to increase the number of marked birds in the wild for identification later. The collars affixed were 33RA, 34RA (dead 2 July 1987), 35RA, 36RA, and 39RA - 50RA. The other two birds on the Lake were already collared 21RA and 22RA. Hopefully, some of the marked birds will fall in with the birds we suspect are migrating, and we will be able to get some positive identification.

AREA PRODUCTION REPORT

The aerial survey this past summer was conducted 29 and 30 July and 8 and 12 August. The survey included Bennett, Todd, Jackson, Mellette, Shannon, and Pennington Counties in South Dakota, and Cherry, Sheridan, Garden, and Arthur Counties in Nebraska. A total of 191 Trumpeter Swans was observed including 34 nesting pairs, 23 broods with 81 cygnets, and 32 nonbreeders in four flocks. This was a 9-percent increase over last year in the number of adults, and an 8-percent increase in total swans (Table 2). The only major differences this year over 1986 was a 45-percent decrease in the number of pairs without broods (20 down to 11, an 18-bird difference), coupled with a 355-percent increase in the number of flocked birds (nine up to 32, a 23-bird difference). Apparently, the unsuccessful pairs flocked together early this year. The unsuccessful pairs also raised havoc in the nesting territories of two pairs with young this year, a phenomenon never previously observed. In one instance on Clubhouse Lake, 21RA and 22RA, the resident pair of first-time breeders, had two cygnets when 18 nonbreeding birds began using the Lake. The two cygnets died, but it is unknown whether the loss was due to the disturbance from the flock or the inexperience of the breeding pair. A flock of 14 nonbreeders invaded the nesting territory of an old experienced pair with seven cygnets on their traditional nesting marsh 1 mile north of Goose Lake, Cherry County, Nebraska, in late August. The flock was tolerated, and the pair and the cygnets remained together, isolated from the rest of the birds. No losses from this brood were observed.

No swan production report cards were received this year from Ottumwa, Fairpoint, or Mud Butte, in northwestern South Dakota, but it was assumed that normal production occurred. A new report was received from Dave Lockman, Wyoming Game and Fish Department, concerning a pair with a brood of three in Crook County, just north of the town of Colony, in northeastern Wyoming. We had had reports of nesting Trumpeters in northeastern Wyoming for several years, but this was the first confirmed report with a definite location.

Table 2. Breeding performance of Nebraska and South Dakota Trumpeter Swans.

Year	No. adults	No. pairs	No. broods	No. cygnets	Total
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	---------------No Data---------------				
1982	---------------No Data---------------				
1981	104	30	16	54	158
1980	120	28	18	44	164

REFUGE PRODUCTION - 1987

Nesting swans on Lacreek NWR in 1987 produced 11 cygnets to flight stage, compared to 19 in 1986 (Table 3). Six nesting pairs were observed during the nesting period, but only five hatched cygnets. There were no obvious reasons for the reduced production on the Refuge.

The pair on Pool 9 has had considerable nesting experience, but failed to hatch eggs this year. It is possible that the present pair was not the same pair as in previous years. Last year's birds raised four cygnets to flight.

The pair on Pool 11 hatched three, but brought only one cygnet to flight stage. The pair on Pool 8 was an old experienced pair that hatched five and brought all of them to flight. The two pairs on the north and south ends of Pool 6 hatched and brought to flight only one cygnet each this year, compared to two, and three, respectively, last year. However, last year was the first year either pair successfully raised cygnets to flight stage. The pair on the south end of Pool 6 had a leucistic (white) cygnet this year, and one of the three cygnets they raised last year was also leucistic. The two pairs on Pool 6 have been nesting there since 1985 when the old traditional pair (82TY and 98TY) was transferred to Missouri.

The pair in Pool 2 are gaining experience. They hatched and brought three cygnets to flight this year. They hatched their first two eggs in 1985 but lost them, and raised two cygnets to flight in 1986. Overall survival in 1987 was quite good, probably the result of experienced breeders.

Table 3. Production data for Trumpeter Swans on Lacreek NWR.

Year	Nesting pairs	Broods	Hatched	Fledged
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
1982*	7	3	9	4
1981	5	3	12	6
1980	6	4	11	6
1979	5	5	14	5
1978	6	5	17	12
1977	5	4	15	14
1976	5	5	11	6

* Includes one pair with three fledged cygnets transferred to Missouri and the removal of eight eggs for Minnesota.

First flights occurred during the last week in September. With hatching occurring between 1-15 June, the hatch/fledge time was estimated at 100 days. A review of our past records produced only one instance where a recorded hatch date and a first flight date were available for a specific brood. That brood hatched 2 June and fledged 9 September -- 99 days.

MISSOURI TRANSPLANT REPORT

Ten Trumpeter Swans were captured and transferred to the State of Missouri in 1987. The capture was considerably easier this year than last year. The birds last year were in more widely-scattered, small groups, and the capture date (30 June) was at the very beginning of the molt -- too early. This year, the birds settled into one large flock on Clubhouse Lake. The flock was observed on 11 June during the first pre-capture aerial survey conducted for the Missouri transplant. On 22 June, the flock was still there and had grown to 25 Trumpeters. Since Trumpeters have a history of moving around between several lakes prior to actual molt, aerial surveys were conducted again on 27 June and 5 July to continue surveillance and look for molted feathers. The first signs of molting were seen on 5 July and considerable molting was observed on 7 July. Plans were made to capture the next day. Thirty Trumpeters were on Clubhouse Lake during the first capture run on 8 July. Eight Trumpeter Swans were captured, marked, and transported to the Refuge holding pen for the transfer. The next morning (9 July),two additional swans were captured, marked, and held for the Missouri restoration project, and 16 others were captured, collared, and released. The nesting pair on Clubhouse Lake (21RA and 22RA), banded and collared last year and their cygnets were not disturbed. Two additional swans were still flighted and were not captured.

A number of the captured birds had large cysts on the webbing between their toes. The cysts on three swans (41RA, 44RA, and 48RA) were palpated and then lanced. The lanced cysts were probed and appeared to be caused by small thorns that were removed. It was assumed that the thorns were cactus spines from the surrounding grasslands. Another affected bird (27RA) was transferred to Missouri and John Smith (Missouri Department of Conservation) had the cyst removed by the College of Veterinary Medicine, University of Missouri, Columbia, for diagnosis. This cyst was diagnosed as either a chondrosarcoma, or a myxosarcoma. Swan 27RA was showing signs of stress during the transfer and died prior to release. Whether the malignancy of the sarcoma was a factor in the death is not known. If any of the other affected birds are captured in the future, the feet will be examined for healing or further lesions.

The transferred birds were collared 25RA-32RA, 37RA, and 38RA. During the banding process, some of the swans began to show signs of stress. Their condition and collar numbers were noted. The 10 birds were transferred via aircraft to Missouri on the evening of 9 July, arriving early on 10 July 1987. They were held in a holding pen at Mingo National Wildlife Refuge for 7 days in an effort to reduce post-release mortality. Three swans (27RA, 31RA, and 38RA) died in the holding pen, apparently from stress-induced problems prior to the release. Two of the three birds that died were ones noted as being in poor condition prior to their transfer to Missouri. It may be necessary to simply release birds back into the capture lake when they are in poor condition due to the stress of capture. This would hopefully avoid some of the transfer mortality, but it would also reduce the number of birds that could be transferred. Another swan (28RA) was found dead on 12 October 1987.

From past experience, we were not surprised during a post-capture aerial survey on 12 July to find that 14 of the swans marked on Clubhouse Lake on 9 July had walked over a mile north to an unnamed lake. This susceptibility to disturbance, and the drastic measures Trumpeter Swans take to avoid further disturbance, continues to be a major contributor to mortality, and a matter of considerable concern while planning Trumpeter Swan projects.

One Trumpeter (23FA) from the 1985 transfer migrated back to Lacreek in 1986. The bird was missing from Mingo in October 1986 and was observed at Lacreek on 5 December 1986. Three swans (19RA, 20RA, and 28RA) from the 1986 transfer and four swans from the 1987 transfer were still alive at Mingo NWR in January 1988. Two swans (26RA and 37RA) from the 1987 transfer were released on the Grand Pass Wildlife Management Area near Marshall in northern Missouri and were still in good condition (Table 4).

The first pair of Trumpeters transferred to Missouri in 1982 (82TY and 98TY) were not observed during the nesting period in 1987. It is not known if they nested or hatched any cygnets. They were observed in August without cygnets.

SUMMARY

The High Plains flock of Nebraska and South Dakota seems to be in good condition. Although the number of adults on the breeding grounds has stabilized, the breeding performance of the nesting pairs, the number of cygnets brought to flight, and the breeding season peak population returning to Lacreek each winter, continues to increase. These statistics indicate that either winter mortality has increased, or some birds are migrating somewhere. Increased numbers of marked birds will hopefully confirm the migration theory. As we proceed with the transplants to Missouri, increased experience and awareness of stress factors will likely result in more effective methods of transfer. The Trumpeter Swan project at Lacreek NWR is definitely making progress.

Table 4. Status of Trumpeter Swans transferred to Missouri as of August 1987.

Transfer year	Collar no. *	Age/Sex**	Transmitter	Fate
1982	82TY	Ad/F	No	Alive
1982	98TY	Ad/M	No	Alive
1982	7FA	Cy/M	No	Found dead 12/82
1982	8FA	Cy/M	Yes	Found dead 8/84
1982	9FA	Cy/F	Yes	Missing 1/83
1983	10FA	Ad/F	No	Alive-moved out of area
1983	11FA	Ad/M	Yes	Killed by predator 10/83
1983	17FA	Cy/M	Yes	Killed by predator 11/83
1983	18FA	Cy/M	Yes	Killed by predator 10/83
1983	12FA	Ad/M	Yes	Killed by predator 9/83
1983	13FA	Ad/F	No	Killed by predator 10/83
1983	16FA	Cy/F	No	Missing as of 10/83
1984	No transfer -------------------------			
1985	16RA	SA/F	Yes	Found dead 10/85
1985	20FA	SA/F	Yes	Found bird/weak-died 11/85
1985	21FA	SA/F	Yes	Killed by bobcat 9/85
1985	22FA	SA/M	Yes	Found dead 1/86
1985	23FA	SA/M	Yes	Returned to Lacreek 12/5/86
1985	24FA	SA/F	Yes	Found dead 1/86
1986	17RA	SA/F	No	Died-stress 7/86
1986	18RA	SA/M	No	Died-stress 7/86
1986	19RA	SA/M	No	Alive
1986	19RA	SA/M	No	Alive
1986	20RA	SA/F	No	Alive
1986	23RA	SA/M	No	Died-flying accident 8/86
1986	28RA	SA/F	No	Alive
1986	29RA	SA/F	No	Died-stress 7/86
1987	25RA	SA/F	No	?
1987	26RA	SA/F	No	Grand Pass WMA
1987	27RA	SA/F	No	Cyst, died prior to release
1987	28RA	SA/F	No	Found dead 10/12/87
1987	29RA	SA/M	No	?
1987	30RA	SA/M	No	?
1987	31RA	SA/F	No	Died prior to release
1987	32RA	SA/F	No	?
1987	37RA	SA/M	No	Grand Pass WMA
1987	38RA	SA/M	No	Died prior to release

* FA & TY suffix = South Dakota capture.
RA suffix = Nebraska capture.
** Ad = adult, Cy = cygnet, and SA = subadult when transferred.

POTENTIAL TRUMPETER SWAN RESTORATION AND EXPANSION

Harold H. Burgess, Ruth L. Burgess, and David K. Weaver

Historical severances of traditional Trumpeter Swan (Cygnus buccinator) migrations to adequate wintering areas limit the expansion and restoration of Trumpeters to their original ranges. Man eliminated the Trumpeters in the temperate lowlands, isolating remnants in the less accessible and less productive high mountains and far north until they became a threatened species (Johnsgard 1978). Today's generation has an opportunity and responsibility to reestablish Trumpeter migrations and to bring the Trumpeter back.

The Pacific Coast Population of Trumpeter Swans numbers about 10,000. It nests primarily in Alaska's lower elevations and continues to migrate along coastal Alaska, British Columbia, Washington, and Oregon (Fig. 1). Some managers believe that this Population is large enough, yet many potential nesting sites remain unoccupied, and few Trumpeters have returned to their historical wintering grounds in the Sacramento Valley and farther south.

The Rocky Mountain Population of Trumpeters, comprised of the Interior Canada and Tristate Subpopulations, numbers about 1600. The Interior Canada Trumpeters nest in Alberta, Saskatchewan, eastern British Columbia, Yukon Territory, and Northwest Territories. The Tristate Trumpeters nest in southeastern Idaho, western Montana, and western Wyoming.

In addition, there are restored Trumpeter Swan flocks throughout the continent. Breeding birds at Malheur, Ruby Lake, and Turnbull National Wildlife Refuges (NWR) in Oregon, Nevada, and Washington are administratively managed as Pacific Coast Trumpeters. A Trumpeter flock of about 200 has been reestablished on Lacreek NWR and nesting now occurs within a 100-mile radius of the Refuge in South Dakota and Nebraska. A similar flock of about 100 Trumpeters has been reestablished at Hennepin Parks, in Minnesota's Twin Cities Metropolitan Area. Experimental releases have also been made at Delta Waterfowl and Wetlands Research Station in Manitoba, Lake Ontario's waterfront in Ontario, Mingo NWR in Missouri, Tamarac NWR in Minnesota, and Alleghan Wildlife Management Area in Michigan.

The Interior Canada Subpopulation of about 600 swans is mobile, with marked wintering Trumpeters appearing in eastern Montana, Wyoming, Colorado, Nebraska, and Missouri in one corridor, in Yellowstone National Park and the Snake River in Wyoming, in Ninepipe, Lee Metcalf, and Red Rock Lakes NWRs in Montana, on the Henry's Fork and Teton River in Idaho, in Bear River NWR in Utah, and in southern Nevada in other corridors. This Population is expanding, supplemented by imaginative experimental releases by the Canadian Wildlife Service, Parks Canada, and Alberta Fish and Wildlife Division.

The Tristate Subpopulation is considered nonmigratory. It is sedentary due to the year-round availability of open water due to warm springs and fast-moving streams, supplementary winter feeding at Red Rock Lakes NWR, and the selective mortality experienced by those Trumpeters that do attempt to migrate. Yet, Trumpeters translocated from Red Rock Lakes' "nonmigratory flock" do show some migratory tendencies as indicated by unaccountable and accountable winter disappearances of Trumpeters from Malheur and Lacreek NWRs and Hennepin Parks' flocks.

Marked Lacreek Trumpeters have migrated and wintered in Nebraska and Missouri. Lacreek is also a likely source of some of the unmarked Trumpeters observed in Arkansas, Kansas, Oklahoma, and Texas. Marked and unmarked Hennepin Parks Trumpeters have wintered in Nebraska, Iowa, Oklahoma, Kansas, Missouri, and as far east as New Jersey.

Trumpeters that winter on the Henry's Fork and Teton River in Idaho, on Red Rock Lakes NWR and Hebgen Lakes in Montana, and on the Snake and Salt Rivers in Wyoming are of primary concern at this time. They represent the majority of the Rocky Mountain Population and are currently wintering in very limited, marginal, and vulnerable areas. These birds are subject to frigid weather, freeze-out, lead poisoning, disease, human development, and human disturbances. This pressure could be reduced by restoring this Population's southward migration tradition.

There still exists a trickle of birds migrating south along the "Eastern Front" from the Tristate area into southern Colorado, New Mexico, west Texas, Utah, and Nevada. We propose encouraging these migrations by development of safe, decoy/staging refuges, resting stops, and adequate southern wintering areas. The decoy Trumpeters could consist of a small restored flock, a family, a breeding pair, or a single adult. Free-flying Trumpeters would be preferable, but, in some cases, clipped or permanently captive Trumpeters may be needed.

A "migratory enhancement program" could be started with bonded pairs or families as decoys on the proposed staging and wintering areas and additional decoy birds enroute. (Other swans and white domestic geese might be used temporarily at proposed rest stops and wintering areas, until Trumpeter decoys could be established at those critical areas.)

The restoration sites should be chosen carefully. They would serve our purpose best if they were also suitable breeding areas. In the midcontinent mountain areas, sites must be found that have at least 60 frost-free days and sufficient aquatic foods to feed a swan family from nest building to

Figure 1. Current nesting, wintering, and restoration areas for Trumpeter Swans, as well as widely-dispersed occurences of Trumpeters in North America, 1988.

fledging, or a minimum of 142 days. It is important, also, that the site chosen not be subject to chilling spring winds (as on a north-facing slope) and rains falling off snow-covered peaks and slopes.

We are nominating Grays Lake NWR, in southern Idaho, as our first choice for establishing a new Trumpeter migration-staging area. Its marshes lie in a wide basin at about 6,000 feet above mean sea level -- 100 miles south and slightly lower in elevation than Red Rock Lakes NWR at 6,600 feet. Grays Lake NWR has an average of 81 frost-free days and good aquatic habitat for Trumpeters. Migrant Trumpeters, even today, move through this Refuge seasonally and, from time to time, attempt to nest there. The Refuge could be managed for Trumpeters without compromising its Whooping Crane (Grus americana) fostering program and other Refuge objectives. The current small number of Trumpeters using the Refuge should be supplemented with several bonded pairs translocated from Lima Reservoir, Montana, or other sources.

The second-best option for a new staging area is Ouray NWR in northeastern Utah. It is about 300 miles southeast of Red Rock Lakes NWR and is at a much lower elevation. Ouray is on the Green River and could serve as a staging-rest area for Trumpeters migrating down the Green, as well as for those moving south from Grays Lake or from the Salt River in Wyoming. At least one bonded pair or a family of Trumpeters should be established at Ouray to serve as decoys.

Seeskadee NWR, Wyoming, up the Green River 100 miles north of Ouray, could serve as the initial "jump off" for Green River Trumpeters. At 6,100 feet in elevation, it should be a better Trumpeter nesting area than Pinedale, Wyoming, at 7,100-foot elevation and 34 frost-free days. But, Seeskadee's main service would be to fuel migrant Trumpeters that would then be required to fly nonstop over massive soda ash pits to reach Flaming Gorge Reservoir in Utah or Browns Park NWR in Colorado.

Fish Springs NWR, Utah, at 4,300 feet above sea level, about 300 miles south of Red Rock Lakes NWR, is another area that could be developed as a Trumpeter Swan decoy/staging/breeding area. Migrant Trumpeters have been reported in Fish Springs, along with several hundred Tundra Swans (C. columbianus), almost every year. One or more pairs of Trumpeters established at Fish Springs could decoy those Trumpeters that escaped the Bear River NWR and Salt Lake swan hunts and refuel them for further migrations to southern Nevada and central California.

C. A. Hughlett (pers. comm.) has searched the region south of Utah and Nevada for potential Trumpeter wintering areas. His choice is Topock Marsh in Arizona, a part of Havasu NWR. This extensive marsh would serve Trumpeters coming down the Green and Colorado Rivers, as well as those coming overland from Utah and Nevada. One or two bonded Trumpeter pairs should be established on this marsh to decoy migrant Trumpeters.

A few Trumpeters have persisted in migrating down the Rio Grande, probably into central Mexico. Trumpeters have periodically been observed at Bosque del Apache NWR, Elephant Butte Reservoir, and elsewhere in New Mexico. Perhaps, they are Interior Canada Trumpeters migrating down the eastern side of the Rocky Mountains. This Subpopulation is expanding and needs additional wintering space. One or more bonded Trumpeter pairs should be established at Bosque del Apache NWR to decoy these wanderers to a safe wintering area. (New Mexico Waterfowl Biologist, Greg Smith, suggests that we also investigate Morgan Lake, a cooling pond near Farmington, New Mexico. Tundra Swans have reportedly wintered on that area.)

Two decoy Trumpeter Swan rest stops have been nominated. Others probably will be nominated as the Trumpeter migration restoration progresses. The most needed is Alamosa NWR, in Colorado, to safeguard Trumpeter migrating down the Rio Grande. The other is Browns Park NWR, also in Colorado, to protect the few Trumpeters now migrating down the Green River.

In summary, the recommendations for establishment of a safe migration tradition for Trumpeters currently wintering in the Tristate includes establishment of four decoy/staging/breeding areas, two wintering areas, and two decoy rest stops. This proposal would require a minimum of 8-10 bonded pairs and/or family groups to be translocated from an, as yet, undetermined site or sites to the best wetlands within each of the above areas, as well as site enhancement for Trumpeter Swans.

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PANEL DISCUSSION - TRUMPETER SWAN RESTORATION PROJECTS

Moderator - Dave Paullin

Panel - Tom Rothe, Leonard J. Shandruk, Rolf H. Kraft, Ken Kalenak, Joe Johnson, John W. Smith, James A. Cooper

RECIPIENT STATE'S PERSPECTIVE[1]

John W. Smith

I appreciate the opportunity to share with you some viewpoints regarding Trumpeter Swan restoration from the perspective of a "recipient state."

For me, the terms "donor" and "recipient" bring to mind a hospital patient in need of a transfusion. The analogy is not totally appropripate in all cases, but, it fits fairly well for states such as Michigan that have a severe infection of "white starling" disease. The long-range objective of treatment is, of course, to replace bad blood with good -- in this case, to replace feral Mute Swans with the ultimate leucocytes, native Trumpeter Swans.

When it comes to states such as Missouri and others that have no Mute Swan problem, the situation is somewhat different. Indeed, Dr. Degernes might be tempted to declare us clinically dead, but, this may be the only situation in history where it is easier to treat a patient with no white cell count rather than with an elevated one.

Although local objectives and strategies for restoration have tended to vary widely from state to state, it has been my observation that states involved in or contemplating Trumpeter restoration share the common goal of enhancing the numbers and status of the Trumpeter Swan throughout North America. As a group, we are driven by a sincere desire to restore a magnificent species to its rightful place in the wildlife faunas of our respective states. But, the bottom line is, and must continue to be, to provide for the long-term welfare of the species. Outside of Alaska, this can only be accomplished by expanding the Trumpeter's breeding range into historic-but-unoccupied nesting habitat and, perhaps more importantly, by establishing new traditions for use of historic wintering areas. While the specific needs and capabilities of various states and provinces may differ, it is the common thread of providing for the greater good of the Trumpeter Swan that binds us together in the restoration arena, as well as in The Trumpeter Swan Society itself.

Just as physicians have a responsibility to both the donor and recipient in a blood-transfusion situation, agencies involved in Trumpeter Swan restoration efforts have responsibilities at each end of the donor-recipient pipeline. As Dr. Jim Cooper has pointed out extremely well during this conference, recipient states must plan to acquire a large enough transfusion to allow this patient to not only survive, but, to grow and expand. To do anything less is planning for failure.

At the other end of the pipeline, however, is the donor population, the continued health of which must be the first priority of agencies responsible for their management. That applies not only to smaller populations such as that at Lacreek National Wildlife Refuge, where Rolf Kraft keeps his finger on the pulse of the flock, but also to the relative bounty of states such as Alaska. Recipient states should do or advocate nothing that would be detrimental to the health and productivity of donor populations. We have heard from Alaska's Tom Rothe in this regard already this morning. I have heard it suggested by some during the past few years that Alaska and the Pacific

[1]Editor's note:
Each panel member presented his view on restoration efforts as they are proceeding and what future efforts should include. Most participants did not submit their comments for publication. The following, John Smith's (Missouri Department of Conservation) panel presentation, represents a good overview of current restoration issues and his opinion on where to focus attention to insure success.

Flyway have taken somewhat of an "obstructionist" view toward providing Trumpeter Swans for restoration purposes. I take extreme exception to that viewpoint. We in Missouri applaud the careful approach that is being taken in Alaska to safeguard a priceless resource. To carefully monitor removal programs and establish guidelines is not obstructionist -- it is wise management. If, after a careful review of the experimental egg removal program, Tom Rothe and the Pacific Flyway deem that a large enough number of Trumpeter Swans can realistically be provided from Alaska to meet the demands of existing restoration proposals, that will be great. But if, on the other hand, the availability still does not meet the demand, then it is up to other Flyways to prioritize the proposals from their respective states to maximize the benefits that can be realized from the available restoration stock.

Missouri is pleased to be involved in Trumpeter Swan restoration, and as I said yesterday, we have some unique opportunities to provide for the long-term enhancement of Trumpeter Swan populations in the Mississippi Flyway. But, as more and more states become involved in restoration efforts, the warning bells that have been sounded by Jim Cooper should be clearly heard. We cannot afford to divide the limited resources available for restoration so finely that none of the patients survive. Decisions must be made, and I believe must be made at the Flyway level, to balance the conflicting demands for limited Trumpeter Swan resources within the constraints of swan availability.

PACIFIC COAST POPULATION

A SUMMARY OF THE 1987 ALASKA TRUMPETER SWAN SURVEYS

John I. Hodges, Jr., Bruce Conant and Steven L. Cain

ABSTRACT

This year, there was mixed success by Trumpeter Swans (Cygnus buccinator) nesting in Alaska. The Gulf Coast unit, specifically the Copper River Delta, was inundated by rain for 58 consecutive days during May and June 1987 which apparently caused widespread nest failure. Of the remaining three geographical units with large populations of Trumpeters, only the Lower Tanana unit had a sufficient number of surveys to make an inference about production. Half of the Trumpeters summering in Alaska occurred in the Gulkana or Cook Inlet units, yet only two sample maps were surveyed in these areas. The 80-map random sample completed in 1986 was not done in 1987.

INTRODUCTION

This report summarizes all 1987 Trumpeter Swan (Cygnus buccinator) data gathered with standard methods in Alaska and sent to Migratory Bird Management offices (MBM) in Juneau, Alaska, for digitizing and computer tabulation.

The data are summarized by area and by individial map. The objective was to include all Trumpeter Swan nesting data collected by standard methods in map form (USFWS 1987). Trumpeter Swan Alaskan nesting areas are organized into 11 geographically-separated units (Fig. 1). Each unit is comprised of varying numbers of U. S. Geological Survey (USGS) maps.

In 1986 (Hodges et al. 1986), a random sampling technique was devised to allow annual sampling of these 11 units and thus adequately sample the nesting population.

ACKNOWLEDGEMENTS

We thank the dedicated biologists, pilots, and other personnel from the following projects for contributing their data to this summary:

- U. S. Fish and Wildlife Service: Migratory Bird Management in Juneau, Nowitna National Wildlife Refuge, Tetlin National Wildlife Refuge, Migratory Bird Management in Fairbanks and Kenai National Wildlife Refuge.
- Bureau of Land Management: Fairbanks and Glenallen Districts.
- Department of the Army: Natural Resources in Fort Wainwright.

SURVEY AREAS

The distribution of Trumpeter Swans in Alaska as plotted during the 1985 census (Conant et al. 1988) is displayed in Figure 1. The areas surveyed in 1987 were localized in portions of Trumpeter habitat occurring in 6 of the 10 units. The eighth unit, Koyokuk, was dropped from the Trumpeter Swan analysis in 1987, because of recent findings which indicate that the majority of swans in this unit are Tundra Swans (C. columbianus) (Loranger and Lons 1990).

METHODS

In 1987, 70 sample maps, 1:63,360-scale USGS topographic maps, were surveyed by various organizations. The sample maps were not randomly selected, and two major production areas were poorly represented. No sample maps were surveyed in the Cook Inlet area, and two maps were surveyed in the Gulkana area. The 80-map random sample survey completed in 1986 (Hodges et al. 1986) was not repeated in 1987.

All surveys were conducted using the standard survey method described by King (1973). Generally, a system of parallel tracks was flown over all known and suspected swan habitat within each map at an altitude of 500 to 600 feet above ground level. The pilot/biologists flying the surveys were responsible for navigation, making swan observations, and ensuring that all swan habitat was adequately surveyed. The front seat observer was responsible for recording the flight path and swan observations on the USGS topographic maps. Factors such as visibility and the observer's level of training were taken into consideration. When non-biologist pilots did the flying, all of the survey duties were performed by the primary observer. For some surveys, backseat observers were used to assist in making swan observations.

Data from the field maps were entered into portable Epson HX-20 computers, either in the field or at the MBM office. These data were then merged with exact latitude and longitude coordinates for each observation, using a Tektronix digitizing system. The final data files formed the framework from which statistical summaries and transparent map overlays of swan observations can be produced.

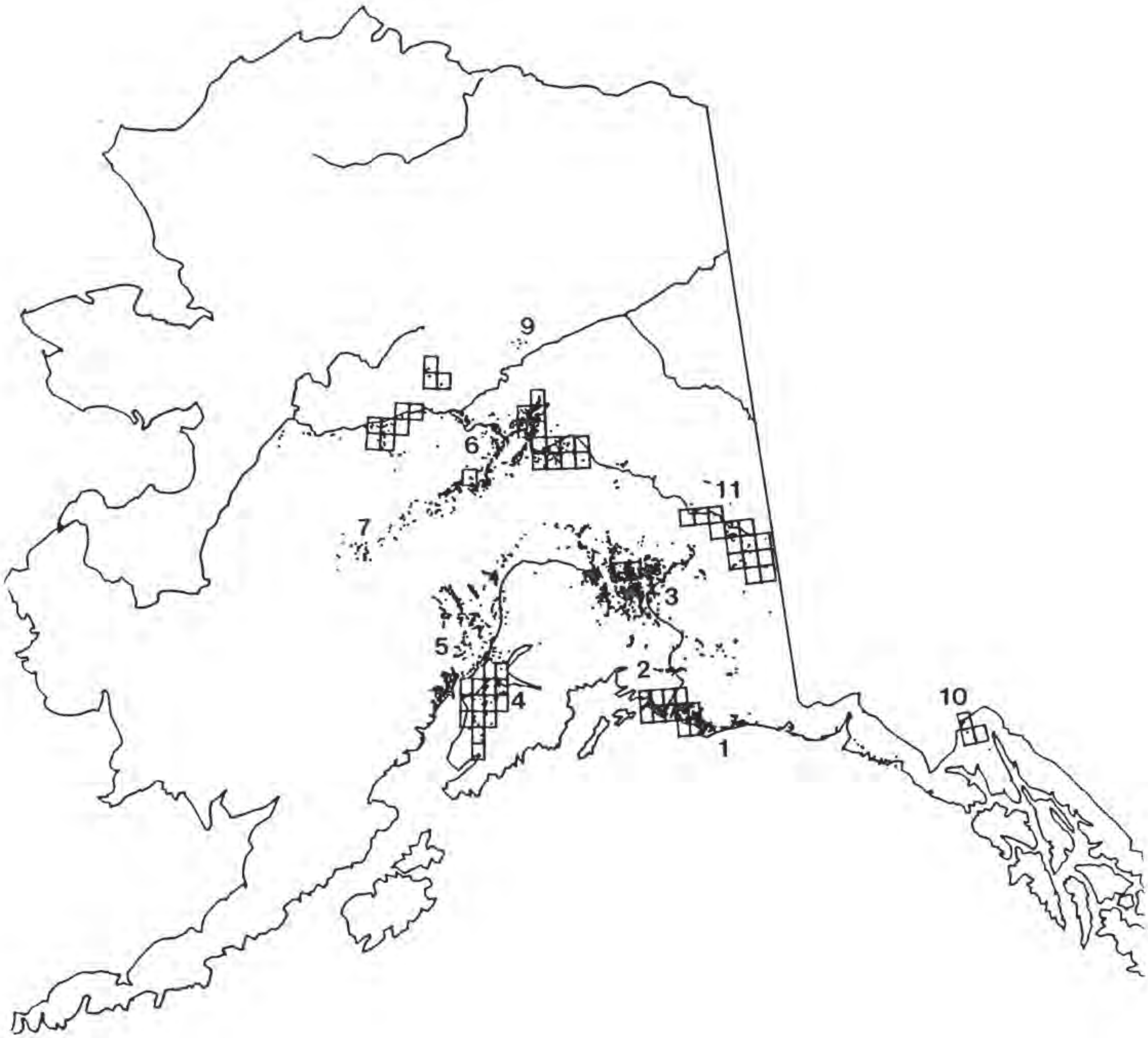

Figure 1. Alaska Trumpeter Swan observation points plotted during the 1985 census. Maps surveyed in 1987 are outlined. Units include: 1) Gulf Coast, 2) Cooper River, 3) Gulkana, 4) Kenai, 5) Cook Inlet, 6) Lower Tanana, 7) Kuskokwim, 9) Yukon Flats, 10) Chilkat River, 11) Upper Tanana.

Table 1. Comparative results of non-random sample maps surveyed by area in 1987. Values are not actual totals, but are computed using proportional changes in the maps surveyed applied to the 1985 totals.

			Adults and subadults									
Unit	Year	Maps surveyed	in pairs	as singles	in flocks	subtotal	Cygnets	Total swans	Number of broods	Average brood size	Percent juvenile	Broods per pair
1. Gulf Coast	1985	39	778	76	440	1294	164	1458	57	2.9	11	.15
	1986	16	722	45	263	1030	303	1333	100	3.0	23	.28
	1987	11	700	76	241	1017	92	1109	37	2.5	8	.11
2. Copper River	1985	6	74	8	108	190	11	201	3	3.7	5	.08
	1986	0										
	1987	0										
3. Gulkana	1985	77	1736	143	595	2474	533	3007	191	2.8	18	.22
	1986	27	1724	115	486	2325	1179	3504	378	3.1	34	.44
	1987	2	1682	158	868	2708	1106	3814	371	3.0	29	.44
4. Kenai	1985	23	92	5	40	137	51	188	16	3.2	27	.35
	1986	4	100	10	36	146	51	197	22	2.3	35	.44
	1987	15	94	5	15	114	130	244	29	4.5	53	.62
5. Cook Inlet	1985	68	800	66	454	1320	241	1561	85	2.8	15	.21
	1986	9	718	91	81	890	216	1106	85	2.5	20	.24
	1987	0										
6. Lower Tanana	1985	76	1202	113	426	1741	503	2244	179	2.8	22	.30
	1986	29	1422	86	247	1755	717	2472	244	2.9	29	.34
	1987	26	1530	50	755	2335	1249	3584	358	3.5	35	.47
7. Kuskokwim	1985	24	122	0	62	184	55	239	18	3.1	23	.30
	1986	1	0	0	0	0	0	0	0	0	0	0
	1987	0										
9. Yukon Flats	1985	4	10	0	0	10	3	13	1	3.0	23	.20
	1986	0										
	1987	0										
10. Chilkat Valley	1985	4	16	1	17	24	16	40	3	5.3	40	.37
	1986	4	20	0	12	32	23	55	5	4.6	42	.50
	1987	4	26	0	20	46	31	77	8	3.9	40	.62
11. Upper Tanana	1985	58	84	14	43	141	64	205	19	3.4	31	.45
	1986	16	96	11	34	141	61	202	16	3.8	30	.33
	1987	14	144	9	48	201	61	262	21	2.9	23	.29
Total*	1985	379	4914	426	2185	7515	1641	9156	572	2.9	18	.23
	1986	106	5008	366	1329	6703	2619	9322	872	3.0	28	.35
	1987	70	5100	397	2198	7695	2954	10694	931	3.2	28	.37

* Missing values for units in 1986 and 1987 have been filled with previous year's data.

RESULTS AND DISCUSSION

Spring surveys in 1986 (Cain and Conant 1986) and 1987 were conducted only in the Gulf Coast and Lower Tanana units. These two areas contained 51 percent of the Trumpeter Swans censused in Alaska in 1985 (Conant et al. 1988). Comparing only the maps flown in both years, nests found in the Gulf Coast unit declined 18 percent from 1986 to 1987, while in the Lower Tanana unit nests increased 18 percent. Data are summarized by geographical unit in Table 1.

Fall production surveys indicated that 1987 was a year of mixed success (Table 1). Proportional changes from the 1985 surveys were computed for each unit, using only maps surveyed both years. The proportional changes were applied to the 1985 unit totals to produce subsequent estimated unit totals.

Production was poor on the Copper River Delta (Gulf Coast unit) apparently due to excessive rainfall during incubation. Cordova recorded 58 consecutive days of rain during May and June. The effect was widespread nest failure, probably due to saturation and cooling of the nest bowl. Only 11 percent of the pairs produced young with 8 percent young in the population. This was the lowest production ever recorded on the Delta.

In contrast, the Tanana Valley production was extremely high. Cygnets comprised 35 percent of the population, 47 percent of the pairs had broods, and average brood size was 3.5. With this type of production, the Tanana Valley could soon overtake the Gulkana unit as the geographical area supporting the most Trumpeter Swans in Alaska.

The Chilkat Valley, about 100 miles north of Juneau, was a success story for swan expansion. The number of swans increased from two in 1975 to 46 white swans and 31 cygnets in 1987. Forty percent of the population in the Valley has been young from 1985 to 1987. At this rate, the Valley's swan habitats may soon become saturated. When this occurs, we will obtain information about maximum density for breeding swans, the population dynamics that occur at saturation, and the pressures that may lead to pioneering of new habitat. These birds may spread out into other areas of southeast Alaska.

CONCLUSION

Trumpeter Swan production varied markedly between geographical areas. However, our ability to extrapolate or make conjectures about the overall population was inhibited in 1987 by a lack of data for half of the swans and the non-random method of data collection.

Anyone wishing to contribute to this effort in the future should request a copy of the Alaska Swan Survey Protocol (USFWS 1987) prior to commencing surveys. Completed, original survey maps should be forwarded to the Migratory Bird Management office in Juneau prior to October of each year for inclusion in the data base.

Requests for computer-generated summaries and map overlays from the swan survey data bank should be made through Migratory Bird Management, Regional Office, U. S. Fish and Wildlife Service, 1011 E. Tudor Road, Anchorage, Alaska 99503, telephone 907/786-3450.

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SUMMER AND MIGRATORY MOVEMENTS OF TRUMPETER SWANS USING THE KENAI NATIONAL WILDLIFE REFUGE, ALASKA

Theodore N. Bailey, Mary F. Portner, Edward E. Bangs, William W. Larned, Robert A. Richey, and Robert L. Delaney

INTRODUCTION

The Pacific Coast Population of Trumpeter Swans (Cygnus buccinator) is the largest Trumpeter Swan population in North America. It comprises about 80 percent of the continent's approximately 12,000 Trumpeters. The breeding and nesting habitat of the Population is primarily in coastal and interior southcentral Alaska. Although the majority of this habitat occurs on lands not specifically dedicated to the conservation of wildlife, one area within south central Alaska established to conserve wildlife, including Trumpeter Swans, is the Kenai National Wildlife Refuge (NWR). In this report, information is provided on the movements of Trumpeter Swans on the Kenai NWR and their migratory route to wintering areas. Management implications, actions taken, and potential problems are discussed.

ACKNOWLEDGEMENTS

We are indebted to Bruce Conant, Rod King, Jack Hodges, and Jim King, U. S. Fish and Wildlife Service (USFWS) pilot-biologists for locating Kenai NWR Trumpeter Swans. We also thank Walt Galetti and Russ Canniff for reporting collared Trumpeter Swans.

STUDY AREA

The 7,972 km^2 Kenai NWR is situated in southcentral Alaska on the Kenai Peninsula. Initially designated the Kenai National Moose Range in 1941 and redesignated the Kenai NWR in 1980, this Refuge includes a vast lowland area of Trumpeter Swan nesting habitat. This lowland area contains over 4,000 lakes, ponds, and bogs, plus streams, all of which provide nesting habitat for 20 to 50 pairs of Trumpeter Swans. Typical vegetation surrounding these bodies of water is boreal forest dominated by white spruce (Picea glauca), black spruce (P. mariana), birch (Betula papyrifera), aspen (Populus tremuloides), alders (Alnus spp.), and willows (Salix spp.).

METHODS

Trumpeter Swans on the Refuge have been censused annually since 1957 (Bailey et al. 1986). Swans were captured from 1982 through 1985 during their flightless periods when they were either too young to fly (cygnets) or molting (adults). Cygnets were captured in August and September and adults in July. Most swans were captured in the water using a long-handled (1.5 to 2.5 m) fish dipnet from the floats of a Piper PA-18 Supercub or Cessna 206 aircraft. Others were captured by hand along shorelines as they attempted to hide in dense vegetation.

Captured swans were weighed, sexed, and fitted with aluminum and plastic tarsus bands and a plastic collar. The plastic bands and collars were matched for color and code for each bird.

Some captured swans were also fitted with a small radio transmitter attached with a backpack harness. Swans fitted with radio transmitters were located by aircraft at 1-day to 4-week intervals before the birds left the Kenai Peninsula. One to four monitoring flights were made throughout the fall, winter, and spring of each year along the north Pacific Coast. Most of these flights were confined to Alaska between the Kenai Peninsula and Yakutat, but other flights occurred between Anchorage and Juneau, Alaska, and Seattle, Washington.

RESULTS

Numbers of Trumpeter Swans and locations

Forty-five Trumpeter Swans (20 cygnets, 25 adults) were captured and fitted with radio transmitters between 1982 and 1985 (Table 1). The known sex ratio of captured cygnets was 1 to 1, but captured adult females outnumbered adult males 5 to 1 (Table 2). This high proportion of adult females probably reflected the period of capture. Males molt before females (Hansen et al. 1971) and 22 of 24 captures of adults of identified sex occurred between 6 and 20 July after most males molted. [Editor's Note: Gillette (1982) reports that breeding males molt after the breeding female has regained flight (late July to mid-August). This schedule would also account for the greater proportion of adult females captured in this study.]

Twenty-nine of the captured swans were associated with families. Our study objective was to attach radio transmitters to only one cygnet per family in 1982, two cygnets per family in 1983, and one or more of the adults per family in 1984. One adult captured in 1984 and all 12 adults captured in 1985 were not associated with young or nesting territories and were assumed to be nonbreeders. Some members of a particular family group in a teritory were captured each of the 3 years,

Table 1. Numbers and ages of Trumpeter Swans fitted with radio transmitters and the number of times they were relocated on the Kenai NWR, Alaska, 1982 to 1986.

Year	Trumpeter Swans radio-monitored		Number of
	Cygnets	Adults	relocations
1982	5	--	34
1983	15	--	133
1984	--	13	137
1985	--	12	77
1986	--	--	5
Total	20	25	386

Table 2. Sexes of Trumpeter Swans fitted with radio transmitters on the Kenai NWR, Alaska, 1982 to 1985.

Age	Sex			Total
	Male	Female	Uncertain	
Cygnets	8	8	4	20
Adults	4	20	1	25
Total	12	28	5	45

while those in other family groups were captured only 1 year (Table 3). We were able to mark swans at 70 percent of the planned capture locations in 1983 and 1984 (Table 1). Of this 70 percent, 94 percent of the marking was accomplished from July through October.

SUMMER-FALL MOVEMENTS

Trumpeter Swan families

Movements of Trumpeter Swans between nest lakes and other bodies of water (lakes, ponds, bogs, or streams) was typical for 88 percent of the 24 Trumpeter Swan families monitored from July through October (Tables 4 and 5). Only swans on Windy, Fox, and Moose Lakes were observed only on their nest lakes during the entire monitoring period. Windy Lake is quite isolated with no other waterbodies within 2.7 km. Fox Lake had only one small pond 0.3 km away, and the 30,000 ha glacial-fed Tustumena Lake was only 0.4 km away, which the swans avoided. The swan on Moose Lake was monitored 66 days before she shed her transmitter harness; she was never located off her nest lake.

Trumpeter Swan families usually moved as cohesive units between bodies of water, and family members were seldom located alone. Monitored cygnets were with other family members during 85 percent of all cygnet sightings. Eighty-eight percent of the observations of adults were with the brood or the other parent. Among cygnets, there was no significant difference between the number of times male or female cygnets were observed alone. Capture bias favoring adult females prevented a similar comparison between the movements of adult males and females of swan families.

Most swan families used one to seven other bodies of water in addition to their nest lake during July to October. This use of other bodies of water resulted in movements of swan families up to 44.5 km with an average of 3.4 km (Table 5). Some of these movements were apparently overland before cygnets were able to fly. Assuming some cygnets required only 90 days of development before being able to fly, and cygnets hatched as early as 4 June (Hansen et al. 1971), the earliest-hatched cygnets on the Kenai NWR would have been capable of flying in early September. Flightless cygnets in nine of 24 families (38 percent) exhibited movements between lakes: one of five families in 1982 (20 percent), two of eight families in 1983 (25 percent), and six of 11 families in 1987 (55 percent). Seven of these nine incidents (78 percent) were believed to be related to capture disturbance, because the movement of the flightless cygnets occurred 1 to 6 days following capture. During these periods, flightless cygnets moved 0.1 to 2.4 km overland; one family could have moved either 0.8 km overland or 1.4 km via a creek to reach a small pond near their nest lake.

The number and age of swans captured in family groups appeared to influence subsequent movements of flightless cygnets. When one cygnet from a brood was captured, 20 percent of the families moved flightless young overland to another lake. Even if two cygnets per brood were captured, a procedure which took more time and created a greater disturbance, only 25 percent of the families moved flightless young overland. However, if one of the adults was captured (almost always the female during our study), then 55 percent of the families immediately moved flightless young overland.

Three of seven pairs of monitored siblings from broods became temporarily or permanently separated from their families in 1983 before their families migrated from the Refuge. The family group on Phalarope Lake was last seen together (five cygnets, two with radio equipment) on 26 September. One of the monitored cygnets remained with the family until it migrated from the Refuge on 12 October. The other monitored bird was alone on 30 September, and remained alone until 19 October, the last date it was seen on the Refuge. This cygnet was 1.8 to 4.0 km away from the family group as it moved between three separate lakes during the 22-day period.

One of two monitored cygnets from the Hook Lake brood of five was alone the day after its capture on 18 August, rejoined the family by 24 August, was again alone on 26 September, rejoined the family by 30 September, and then remained with the family until they migrated from the Refuge sometime after 21 October. While separated, this lone cygnet used lakes 1.6 and 4.6 km from the lakes being used by the other family members.

One of two monitored cygnets from the Beaver Lake brood of five was alone the day after its capture on 16 August, remained separated until at least 2 October, rejoined the family by 12 October, and remained with the family until it migrated from the Refuge after 25 October. The other monitored cygnet stayed with the family until at least 16 September, was alone on 22 September, and remained alone until last seen on the Refuge on 19 October. The maximum distance of separation of this lone cygnet from his family was 30 km on 12 October (Figure 1).

Table 3. Trumpeter Swan nesting territories and sexes of cygnets and adults captured and fitted with radio transmitters on the Kenai NWR, Alaska, 1982 to 1984.

Nesting territory lake name	Cygnets 1982 Radio-monitored swans M	F	U*	Cygnets in brood	Cygnets 1983 Radio-monitored swans M	F	U	Cygnets in brood	Adults 1984 Radio-monitored swans M	F	U	Cygnets in brood
Beaver					1	1		4		1		4
Campfire			1	5								
Camp Island	1			4								
Curlew										1		4
Donkey					1	1		5		1		2
Doroshin										1		1
Fox			1	5	1	1		6		1		5
Grebe					1	1		2				
Grey Cliff										1		1
Hook			1	4		2		5				
Moose					1			4		1		5
Nest										1		3
N. Pepper									1	1		4
Phalarope			1	3	2			5		1		4
Quill										1		1
Windy						2		4				
Total birds being monitored	5			21	15			35	12			34

* M = male, F = female, U = unknown

Table 4. Monthly distribution of radio relocations of Trumpeter Swans on Kenai NWR, Alaska.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0	5	4	2	1	56	93	108	105	5	6	386

Although the initial separation of a cygnet from the Hook Lake and Beaver Creek families was probably related to capture disturbance, both cygnets eventually rejoined their families 6 and 57 days, respectively, after separation. However, these Trumpeter Swan families, as well as the one from Grebe Lake, did leave cygnets behind that were capable of flying when they migrated.

Twelve captured adults from 11 family groups were monitored from July 1984 until they migrated from the Refuge in October. Of these, three (27 percent) from Donkey, Doroshin, and Moose Lakes were never separated from their families until monitoring contact was lost or they migrated. Adults from five other families (46 percent) were located alone or apart from their families on only one occasion, for maximums of 10 to 28 days, before they rejoined and migrated with their respective families. These included the Fox Lake female who remained with her family until at least 21 September, was separated from the brood but with six other adult swans 10 km from the nest lake on 5 October, rejoined the family and other families of swans at Watson Lake 35 km away by 18 October, and migrated soon after 23 October. Another female from Quill Lake stayed with her family until at least 6 August, was 0.4 km from the family on an adjacent lake (Decoy Lake) on 10 August, rejoined the family by 15 August, and remained with them until they migrated. A female from Curlew Lake was alone 1.6 km away from the family on 27 July, but had rejoined the family by 6 August and remained with the family until migrating. Similarly, a female from Nest Lake stayed with her family until 27 July, was alone on 10 August, and rejoined and stayed with the family after 7 September. Both monitored parents from the Pepper Lake family were 1.6 km away from their cygnets on 27 July, but rejoined by 6 August, and were always located together thereafter.

Adults from two (18 percent) of the 11 families that were monitored became permanently separated while on the Refuge. A female from Grey Cliff Lake stayed with her family through 8 August, was alone by 15 August, and was 30 km away and still alone when last located on 19 October. The male, who stayed with the brood, paired with another swan, presumably a female, during this period. The female from the Phalarope Lake family stayed with the family until 7 September, was alone on 17 September, and was never located again on the Refuge. However, in contrast to the Grey Cliff female, the Phalarope Lake female apparently rejoined her family before or during migration because she was observed near Burlington, Washington, on 2 December, with another adult and four cygnets, presumably her own.

A more complex association of an adult female and her family was exhibited by the female captured on Beaver Lake. She remained separated from her family for 12 days following capture on a very small pond 1 km from the nest lake. She was joined on the small pond by another adult, possibly her mate, from 25 to 27 July, was alone from 6 to 15 August, and returned to her brood on Beaver Lake by 7 September. However, on 12 September she was alone on the nest lake, but rejoined the family 10.9 km away by 13 October. By 17 October, the family had moved 8 km to a staging area, and migrated with other swans sometime after 23 October.

Before departing the Kenai Peninsula, eight of 24 (33 percent) monitored swan families joined other swans including other families at staging areas before migrating. Staging areas were ice-free when most of the other lakes and ponds were frozen. The most-used staging area was a wide and shallow stretch of the lower Moose River, at the confluence of the Kenai River. Four of 11 families (36 percent) joined other swans at this location in mid-October prior to migration. This group included swan families from the Pepper Lake area, 40 km, Beaver Lake, 17.6 km, Donkey Lake, 11.2 km, and Doroshin Lake, 10.7 km away from the lower Moose River stretch. A minimum of 23 adults and 20 young-of-the-year were observed together with the radio-monitored swans on this stretch of the lower Moose River during October 1984.

Watson Lake was another staging area used by the Fox Lake family (38 km away) and other unmarked adults and cygnets. Small ponds within the eastern Chickaloon River Flats also served as staging areas for swans including the Campfire Lake family, 38 km away. Swans of the Hook Lake family joined another adult on King Lake, 17.6 km away, before migrating. Swans from the Quill Lake area joined others only 2 km away on the nearby Swanson River before departing from the Refuge.

Nonbreeding Trumpeter Swans

Thirteen nonbreeding adults captured in 1984 (1 swan) and 185 (12 swans) were monitored through 1986. In contrast to members of swan families, nonbreeders moved greater average distances (8.5 km vs. 3.4 km) and maximum distances (9.6 to 52.8 km) between lakes than members of swan families (0 to 44.5 km) during the July-through-October period (Table 6). Although eight of the captured nonbreeders were captured in pairs including two male-female pairs, one female-female pair, and one female-unknown pair, only the female-unknown pair remained together from mid-July to mid-October 1985. None of the three monitored pairs which became separated, rejoined during the monitoring period. Nonbreeders avoided territories used by families of swans, but were with other presumably nonbreeding swans during 67 percent of the 78 summer-fall observations. The only times monitored nonbreeders were located with cygnets were in the late fall at staging areas. An adult female from the Curlew Lake area was with a group of five adults and three cygnets at the outlet of the lower Russian River on 10 October 1985. Another adult female was located with a group of 36 adults and three cygnets on the lower Moose River on 9 October 1985.

Certain lakes on and adjacent to the Refuge attracted aggregations of nonbreeding swans. These included the lower

Table 5. Movements of Trumpeter Swan families on the Kenai NWR, Alaska.

Numbers of separate water bodies in addition to nesting lake used by radio-monitored Trumpeter Swans and distances (km) swans moved between these locations on the Kenai Peninsula, Alaska.

	Cygnets						Adults		
	1982			1983			1984		
Nest lake name	# of water bodies used	Maximum distance (km)	Average distance[1] (km)	# of water bodies used	Maximum distance (km)	Average distance (km)	# of water bodies used	Maximum distance (km)	Average distance (km)
Beaver				7	24.5	5.3	2	10.9	4.2
Campfire	4	44.5[2]	1.9						
Camp Island	4	15.2	5.3						
Curlew							2	8.3	4.1
Donkey				2	1.8	1.6	2	11.5[2]	1.3
Doroshin							2	11.2[2]	0.3
Fox	0	0	0	1	1.8	1.6	3	35.2[2]	5.8
Grebe				2	11.0	7.6			
Grey Cliff							5	20.0	6.7
Hook	4	20.2[2]	3.7	5	30.1	8.4			
Moose				5	20.0	5.4	0	0	0
Nest							5	8.2	3.4
N. Pepper							5[2]	34.4[2]	3.4
Phalarope	3	7.8	4.9	6	8.0	2.9	2	1.9	1.5
Quill							4	3.0	1.7
Windy				0	0	0			

[1] Excludes movements to staging area.
[2] Movement to a staging area.

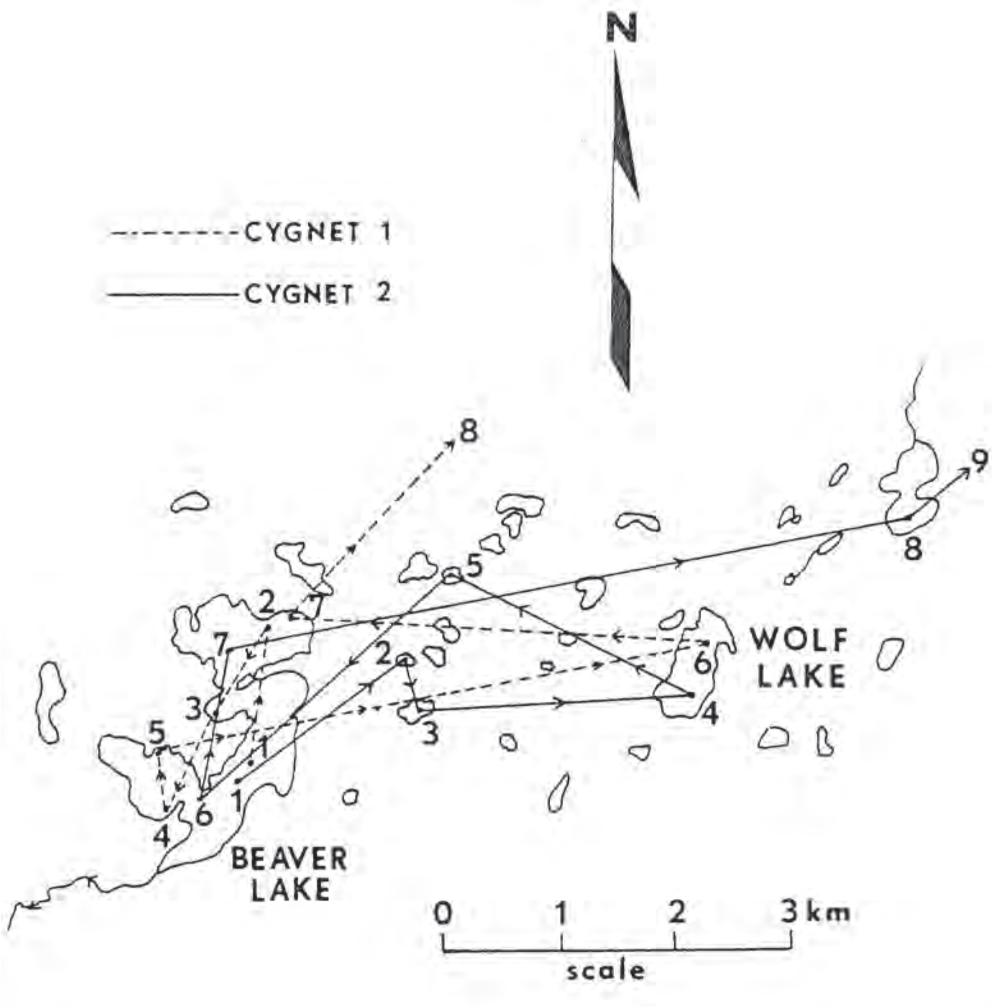

Figure 1. Sequential locations indicated by numbers showing lakes used by and movement patterns of Trumpeter Swan cygnets from the same brood on the Kenai National Wildlife Refuge, Alaska, August-October 1983. Location 1 is a brood capture site. Cygnet 1 was alone at locations 2-8 but joined adults 15.3 km away. Cygnet 2 was with adults at locations 1-4 but alone on subsequent locations.

Moose River (45 swans), Meadow Lake (14 swans), and a small unnamed lake northwest of Moose Lake (11 swans). These lakes were usually shallow, had abundant aquatic vegetation, were ice-free, and generally were not used by families of swans except in the fall. Flock size of nonbreeders appeared to increase throughout the summer. Aggregations of at least four swans were observed as early as 9 July, 11 swans by 9 August, 14 swans by 6 September, and 36 swans by 9 October.

Table 6. Movements of nonbreeding adult Trumpeter Swans on the Kenai NWR, Alaska, July-October, 1984-85.

Capture location	Number of lakes used in addition to capture lake	Distance moved Maximum (km)	Distance moved Average (km)
Hook	6	21.0	8.2
N. Curlew	4	18.2	7.6
NW Curlew	5	51.5	22.4
W. Tundra	5	52.8	19.1
Rabbit Foot #1	4	3.7	2.5
Rabbit Foot #2	3	10.7	4.0
Meadow #1	2	17.4	5.5
Meadow #2	4	12.6	6.8
Gooseneck	3	9.6	4.3
Flat #1	5	10.8	6.4
Flat #2	3	24.3	11.3
Grouse #1	3	11.5	4.5
Grouse #2	3	11.5	4.5

FALL MIGRATION MOVEMENTS

Twenty-five sightings of 19 migrating swans between 1982 and 1986 indicated a Pacific Coast Population coastal migratory route at least as far south as northwestern Washington (Table 7). Movement of swans from the Kenai Peninsula was in a northeastly direction west of the Kenai Mountains to a pivotal point at the Chickaloon River Flats where swans abruptly turned east up the Turnagain Arm of Cook Inlet. They then crossed the Kenai Mountains in the vicinity of Portage Pass, to Prince William Sound. Once over Prince William Sound, some swans apparently flew directly across, stopping on Hinchinbrook Island to reach Cordova and the Copper River Delta. Swans from the Cordova-Copper River Delta area flew south along the coast stopping at Cape Suckling, Icy Bay, Malaspina Glacier, Yakutat, and Dangerous River. Once in southeastern Alaska, swans apparently took a route between the many islands with stops at least on Prince of Wales Island and in the Ketchikan area. From there, the next location of an observation was near Burlington and perhaps another (unconfirmed) from the Olympic Peninsula, Washington. Places of particularly high or extended use by swans along this migratory route, as identified in this study, were Eyak Lake at Cordova as well as the Copper River Delta and the Yakutat area including the Dangerous River Delta. Because of our infrequent and sporadic monitoring flights during the swan migration, it is likely that migrating Trumpeter Swans from the Kenai Peninsula also used many additional locations yet to be documented.

Although about 5,000 Trumpeter Swans from the Pacific Coast Population are believed to overwinter in British Columbia (McKelvey 1986), we did not detect a signal from any of the radio-collared Kenai NWR swans. However, because of the rugged terrain and flight path, such signals could have been missed. Most Trumpeter Swans previously banded on the Kenai NWR have been observed in the northwestern Washington area (Canniff 1986), but this may merely be a result of increased search effort and visibility in that locality.

Most migrating swans left the Kenai Peninsula by the second or third week in October (Table 8). Only a few swans remained the last week of October when most lakes were frozen. Swans observed during this late period were using small open water portions of ice-covered lakes (two swans), a large ice-free glacial lake (one swan), and the open outlet of a frozen lake (one swan). A swan still on the Refuge 17 October was at Cape Suckling, 350 km away, by 29 October. However, others were still further north in the Cordova area on 29 October. By 30 November, one swan was observed at Icy Bay having moved only 128 km from Cape Suckling in 30 days or less. Another swan had moved only as far southeast as the Malaspina Glacier by 23 December. Another swan, captured on Fox Lake and last seen on the Refuge on 23 October 1984, was at Prince of Wales Island at least 1,177 km away by 29 November. An adult female, captured on Kenaitze Lake and last observed on the Refuge on 17 September, 1984, was observed near Burlington, Washington on 2 December. She had made the entire trip of at least 2,257 km in no more than 76 days.

Only three of a total of 45 swans fitted with radio transmitters were located on the Kenai NWR the year after they were marked. A nonbreeding female captured near Hook Lake on 18 July 1984 was observed 10 July 1985 with three other adults near her previous year's capture site. Another nonbreeding female captured on Meadow Lake on 8 July 1985 was observed with another adult on 29 April 1986 near her capture site and was last seen, still nearby but alone, on 27 August 1986. An adult female from the Quill Lake family captured on 12 July 1984 shed her transmitter harness on the bank of the nearby Swanson River by 5 May 1986. She had been near Yakutat, Alaska, about 610 km away, on 27 March.

DISCUSSION AND MANAGEMENT IMPLICATIONS

An overview of the problems, procedures, and recommendations for managing the Pacific Coast Population of Trumpeter Swans (McKelvey 1986) indicated the two major management problems were loss or alteration of breeding, migration, and wintering habitat, and the need for more detailed life history information. We have attempted to address both of these problems on the Kenai NWR. However, as pointed out by Bangs et al. (1982), protecting wildlife and its habitat is a difficult task even on lands dedicated to wildlife conservation. Primarily because of our historical data and Trumpeter Swan studies, the Kenai NWR was successful in protecting nesting Trumpeter Swans and their habitat by instituting access regulations for aircraft use between 1 May and 30 September on all lakes used by nesting Trumpeter Swans and their broods. These regulations became effective in September 1986 despite opposition from the user group. The Refuge has also removed several aircraft taxi-operator and boat-equipped tent camps from Refuge lakes used by nesting Trumpeter Swans. Despite these measures at least two instances were documented where nesting Trumpeter Swans abandoned Refuge lakes

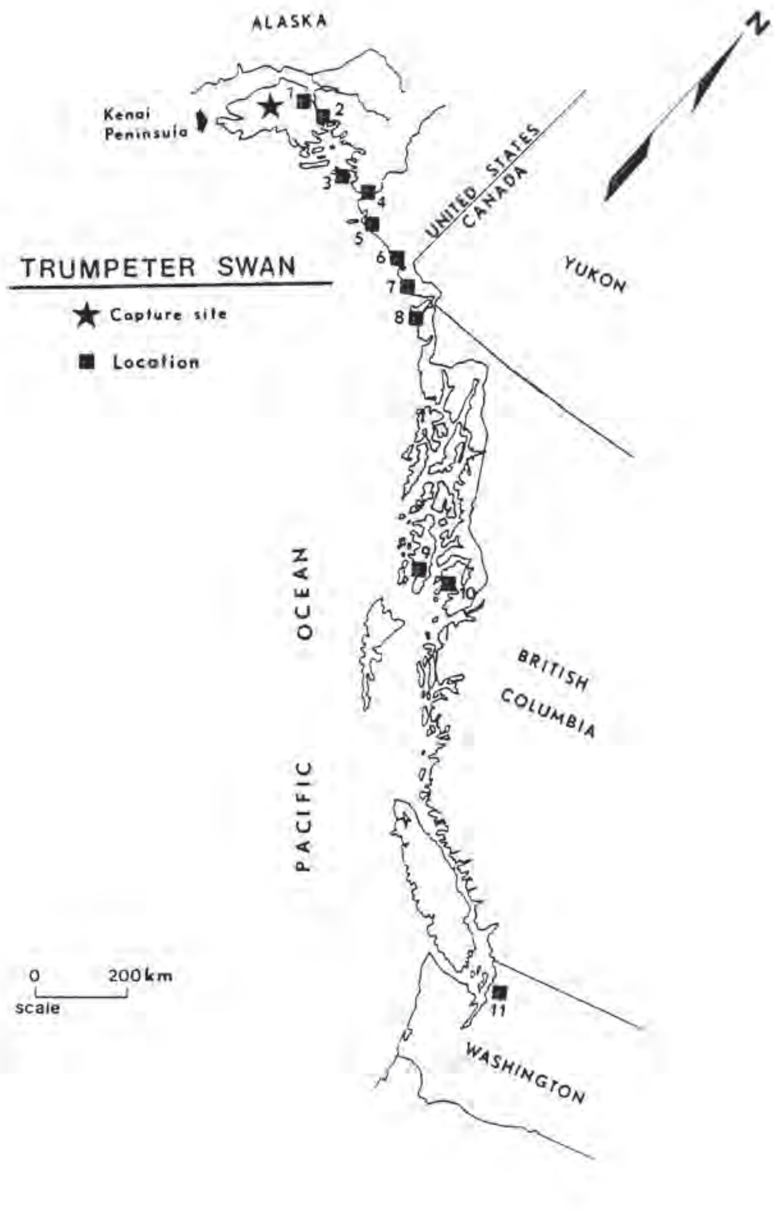

Figure 2. Relocations of migratory Trumpeter Swans fitted with radio transmitters on the Kenai NWR, Alaska, 1982-85. See Table 7 for description of numbered locations.

Table 7. Locations, straight line distances (km), observation dates, and numbers of Trumpeter Swans observed along migration routes from Kenai NWR to Washington State.

No.*	Area	Distance to next location (km)	Observation (month/day)	Number of individuals seen: Cygnets	Adults	Total
1	Chickaloon R.	56	10/9, 15	2	0	2
2	Portage Glacier	155	10/29; 11/4	1	1	2
3	Hinchinbrook Is.	32	10/29	0	1	1
4	Cordova/Copper River Delta	107	10/23,29; 12/1; 5/19;	3	3	6
5	Cape Suckling	128	10/29	0	1	1
6	Icy Bay	67	11/30	0	1	1
7	Malaspina Glacier	64	12/23; 3/27	2	1	3
8	Yakutat/Dangerous R.	568	12/1; 3/27; 4/19; 5/16	3	3	6
9	Prince of Wales Is.	95	11/29	0	1	1
10	Ketchikan	985	1/8	0	1	1
11	Burlington, WA	0	12/2	0	1	1
	Total	2257		11	14	25

*See Figure 2.

Table 8. Fall migration periods of Trumpeter Swans on the Kenai National Wildlife Refuge, 1982-85.

Date	Numbers of monitored swans remaining on the Refuge*: 1982 Cygnets	1983 Cygnets	1984 Breeders	1984 Nonbreeders	1985 Nonbreeders
October 1- 7	5	9	11	1	12
October 8-15	5	8	10	1	12
October 16-23	1	8	9	1	3
October 24-31	1	1	0	0	1
November 1- 7	0	0	0	0	0

*Excludes mortalities occurring on the Refuge.

boat occurred.

Our movement data on Trumpeter Swans suggests that water bodies adjacent to nest lakes may be just as important to successful reproduction for some families of swans as are their nest lakes. These bodies of water are serving as additional feeding areas and places to seek refuge from disturbance on the nest lake. We suspect that swans rearing cygnets on isolated nest lakes could experience lower productivity if food was limited and the family group was frequently disturbed.

Data also suggest that mortality rates may increase among cygnets if they are disturbed and are moved overland to an adjacent lake or if they spend considerable time along the shore of the nest lake attempting to hide in dense vegetation. Such behavior apparently exposes cygnets to increased predation.

Protection of staging and migratory stop-over areas located on lands not dedicated to wildlife conservation is one of the great difficulties in habitat protection for Trumpeter Swans. For example, an important fall staging area for Trumpeter Swans nesting on the Kenai NWR is the lower Moose River adjacent to, but outside the Refuge. Increasing residential development and recreational use of the area makes the future use of this area by Trumpeter Swans unlikely. The long-term security of habitat used by Trumpeter Swans migrating from the Kenai Peninsula is unknown. Until now, many of these areas have retained their value for swans and other wildlife because of their remoteness and minimal disturbance. With increasing use by humans such values are likely to decline. Perhaps it is fortunate that some wintering Trumpeter Swans appear capable of adapting to new sources of food incidentally provided by man and to man-caused disturbance (Canniff 1986, Jordan 1986, McKelvey 1986). This characteristic may be a key to the survival of the Pacific Coast Population of Trumpeter Swans.

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MIGRATION OF TRUMPETER AND TUNDRA SWANS IN EAST-CENTRAL ALASKA DURING SPRING AND FALL, 1987.

Brian A. Cooper and Robert J. Ritchie

ABSTRACT

Migratory movements of Trumpeter (Cygnus buccinator) and Tundra Swans (C. columbianus) were monitored in east-central Alaska during spring and fall, 1987. During April and May, we observed a total of 3,997 swans in 835 hours (h) (4.8/h). Of those sightings, 73 and 1,189 birds were identified as Trumpeter and Tundra Swans, respectively. Peak spring migration of both species occurred from 24 April to 8 May. During fall migration we observed 7,878 swans in 967 h (8.1/h). Of those sightings, 403 and 3,845 birds were identified as Trumpeter and Tundra Swans, respectively. Peak fall migration occurred during the first 2 weeks of October. During both spring and fall, the majority of Trumpeter Swans flew between 15 and 152 m above ground level (agl), while the majority of Tundra Swans flew between 30 to 305 m agl. Mean flock size was highly variable. Mean flock size for Trumpeter Swans was 6.6 during spring and 10.6 during fall. The mean for Tundra Swans was 30.5 during spring and 66.3 during fall. Several mixed flocks containing both swan species were observed during spring (3 of 50 known species flocks) and fall (12 of 96 known species flocks). Flight direction for both swan species was predominantly west or northwest during spring migration and east or southeast during fall migration.

INTRODUCTION

The Tanana River Valley is heavily used by bird populations from the Central Flyway and is one of Alaska's most important migration corridors (King and Lensink 1971). Most waterbirds approach the Tanana River corridor in fall from the north and west, then follow the eastern flank of the Rocky Mountains south through Canada. Spring migration is generally a reversal of the fall situation.

Some information exists on numbers and origin of swans using this migration corridor. The Tetlin National Wildlife Refuge (NWR) in the Tanana River Valley is an important staging area on the primary migration route for Tundra Swans entering Alaska (USFWS 1985). Some of these Tundra Swans breed in northwestern Alaska. Trumpeter Swans are represented by increasing local populations of breeders and important subpopulations near Fairbanks, Alaska (King 1985). These swans migrate in fall in mixed species flocks as far south as northwestern British Columbia.

The U. S. Air Force has proposed an Over-The-Horizon Backscatter (OTH-B) Radar site in the upper Tanana River Valley near Tok. Information gathered for the Environmental Impact Statement for this site suggested potential collision hazards for migrating birds including large-bodied birds such as swans. The goal of our monitoring program was to provide baseline information on avian use in the vicinity of the proposed radar site. Specifically, we sought to determine migratory flight patterns, flight altitude, areas of use, and species composition during spring and fall migration. Tundra and Trumpeter Swans were two of the species we recorded during our studies.

STUDY AREA

Ground observations were conducted in the study area which was approximately 180 km^2 of land between Tok and Tetlin Junction. This area, known as the upper Tanana Valley, is situated around the confluence of the Tanana and Tok Rivers in east-central Alaska (Figure 1). Elevation within the study area ranged from a low of 530 m above sea level (asl) in the northwest corner to 560 m asl in the center. Northeast of the Tanana River are several broad hills that crest at approximately 750 m asl. Southwest of the study area, the Alaska Range and foothills rise abruptly. Portions of the area are swampy with large tracts of black spruce (Picea mariana) muskeg and occasional ponds. Other areas are well drained and support forests of white spruce (P. glauca) and aspen (Populus tremuloides).

The area over which aerial surveys were conducted included wetlands between Cathedral Bluffs and the western boundary of the Tetlin National Wildlife Refuge (Figure 1). This area encompassed approximately 378 km^2 of wetland habitat including the Tanana River, its adjacent floodplain, and four large lakes on the north side of the valley: Mansfield, Glammon, Wolf, and Fish Lakes.

METHODS

One primary and two to four secondary observation stations were established in the study area to monitor migratory bird movements through the study area. The primary station and one of the secondary stations consisted of wood platforms on towers constructed from portable steel scaffolding. The remaining stations in the study area were located at natural or man-made vantage points.

The primary station tower was located in a quarry on a large observer at approximately 10 m above ground level (agl). This station was manned daily from 10 April to 24 May and 16 August to 14 October 1987. In spring, 24-hour watches were conducted 25 percent of the time with at least 12 hours per day

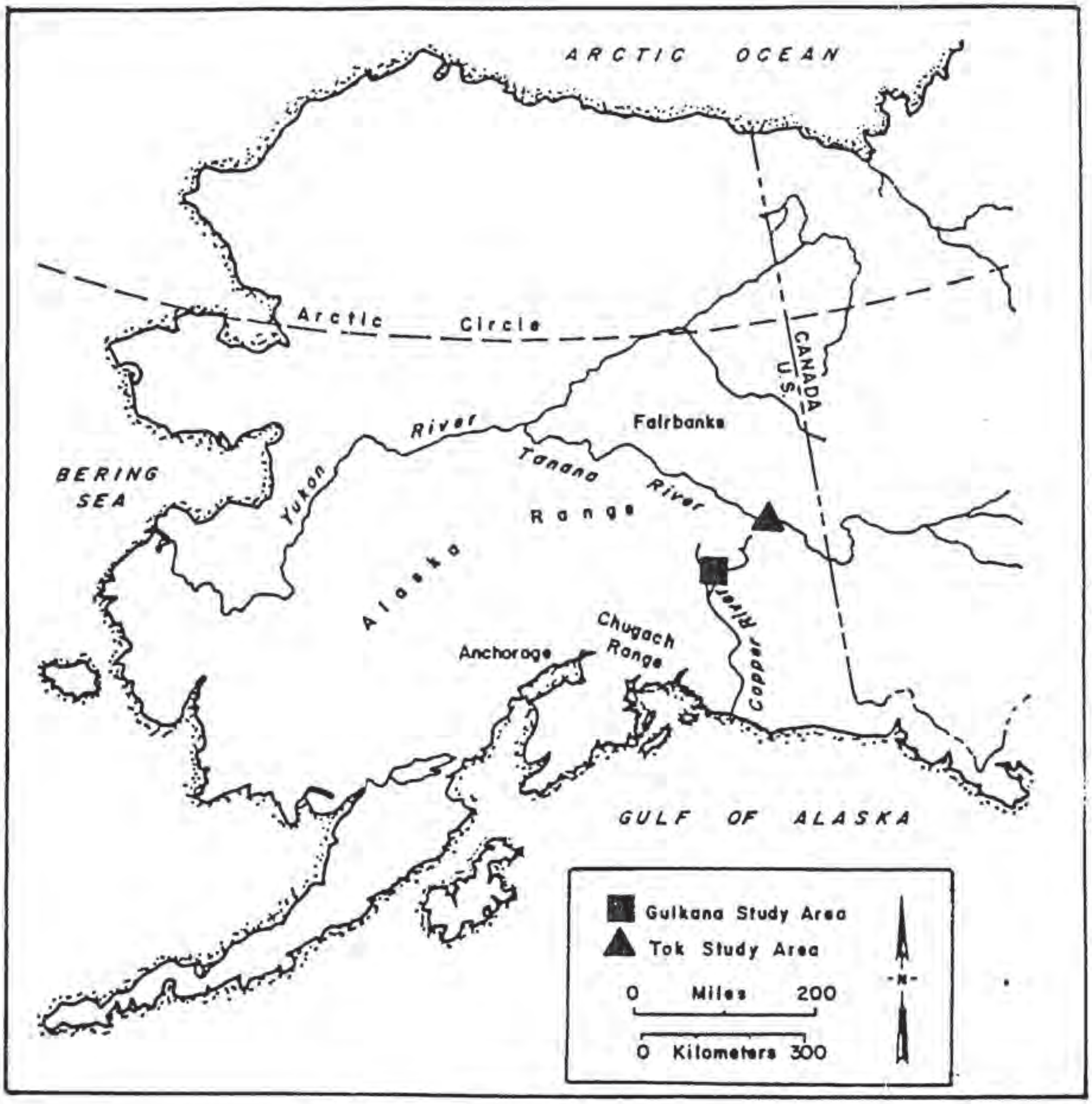


Figure 1. Map of Alaska showing location of the Tok Study Area and major physiographic features.

(h/d) for the remainder of the time (with the time of observation varied to sample the entire 24-hour period). In fall, we attempted 24-hour coverage through September, which included radar coverage at night. Secondary stations were manned 4 to 8 h/d during periods of peak migration in the spring or fall.

We collected the following data as birds crossed transect lines radiating from the stations:

- time - Alaska Daylight Time (ADT)
- species
- number
- distance to bird (seven categories)
- flight altitude (six categories)
- flight direction (eight categories)
- wind speed (six categories)
- wind direction (eight categories)
- cloud cover (percent)
- ceiling height (seven categories)
- visibility (seven categories)
- precipitation (11 categories)
- air temperature (°C)
- barometric pressure
- barometric trend

Weather information was collected every hour during spring observations unless conditions changed; in which case we collected information as the changes occurred. In the fall, weather information was collected every 20 minutes.

We estimated flight altitude and distance to birds from the observation stations with the aid of trees marked with colored flagging at various heights and distances, man-made structures of known height and distance (such as telephone poles and LORAN towers), and numerous geological features of known height and distance (such as mountains and hills). The LORAN towers were especially helpful because of their great height (213 m) and because they were marked at regular intervals by guy-wire attachments and strobe lights. As part of their orientation, observers were taken to the base of the LORAN towers to obtain better estimates of bird flight altitudes at close distances.

In addition to diurnal observations, we attempted to monitor nocturnal movements of birds in the study area. During spring, we used auditory cues and a prototype of a Litton (2x) light intensifier. The night-vision device was not the appropriate tool for this objective. In the fall, we used a mobile radar lab comprised of two marine radars. The surveillance or horizontal beam radar (Furuno Model FCR-1411) was used to obtain information on migration intensity, direction of flight, and location of flight corridors. Field tests indicated that a 3-nautical-mile range setting was the best to identify large-bodied birds on the horizontal beam radar. A fixed-beam radar (Furuno Model FR-1900) was oriented vertically and used to collect information on flight altitudes. Since the vertical radar could not detect targets below 30 m agl, we used a Noctron V night-vision device equipped with a 5x telescopic lens and binocular viewing attachment to search for birds flying below 30 m.

Finally, we used aerial surveys flown approximately one to three times per week to determine the locations and patterns of waterfowl use in the upper Tanana River Valley. A Piper PA-18 ("Super Cub") aircraft was flown at 50 to 150 m agl and at 145 km/h on each survey. A single observer made complete counts of all waterfowl in wetland survey units. In addition, aerial surveys were undertaken specifically to enumerate and locate swans during peak swan migration in the fall.

RESULTS

Spring

A few Tundra Swans began to appear in the study area during the first 2 weeks of April. U. S. Fish and Wildlife Service (USFWS) personnel observed approximately 100 swans southeast of our study area on 9 April. Swans were first observed on aerial surveys on 15 April (Figure 2). Swans are early waterfowl migrants into interior Alaska (Bellrose 1978, Gabrielson and Lincoln 1959).

The first major pulse of swan migration was observed on 24 and 25 April (Figure 3). Swan migration continued through the first week of May. A total of 3,997 swans was observed during 835 hours of tower observations (4.8 birds/h). Peak migration of both swan species occurred from 24 April to 8 May. In spring, roughly 30 percent of the total swans observed from towers was identified to species. Of the sightings, 73 were Trumpeter Swans and 1,189 were Tundra Swans.

Swans flew most frequently in two height categories, 30 to 152 m, and 152 to 305 m (Figure 4). Only a few (9 percent) Tundra Swans were observed flying below 30 m. Trumpeter Swans were more often recorded flying beneath 30 m (31 percent).

Mean flock size was 30.5 Tundra Swans/flock (39 flocks) and 6.6 Trumpeter Swans/flock (11 flocks). Some mixed swan flocks (3 of 50 known-species flocks) were observed in spring. Predominant flight directions for both species were west and northwest following the primary orientation of the valley (100 percent of Tundra Swans, 95 percent of Trumpeter Swans).

Fall

Trumpeter Swans nested in the study area and were in all aerial surveys from August into October (Figure 5). The first recorded pulses of swan migration were noted on 30 September (Figure 6). Swan migration comprised a prominent portion of bird migration until mid-October.

A total of 7,878 swans was observed from the tower in 967 hours (8.1/h) of diurnal observations. In fall, roughly 54 percent of swans recorded could be identified to species. Of the sightings, 403 were identified as Trumpeter Swans and 3,845 were identified as Tundra Swans.

As in the spring, swans flew most frequently above 30 m (Figure 7). Most Tundra Swans (97 percent) flew above 49 m; 45 percent of Trumpeter Swans were observed flying between 16 m and 49 m agl. Records in the northeastern U.S. include observations of most Tundra Swans flying between 914 and 1,524 m asl (Bellrose 1978).

Mean flock size was highly variable with 10.6 birds/flock for Trumpeter Swans, and 66.3 birds/flock for Tundra Swans. Several mixed swan flocks (12 of 96 known-species flocks) were observed in fall. King also described this phenomenon (1985). Predominant flight direction for both species was east and southeast along the Tanana Valley (100 percent of Tundra

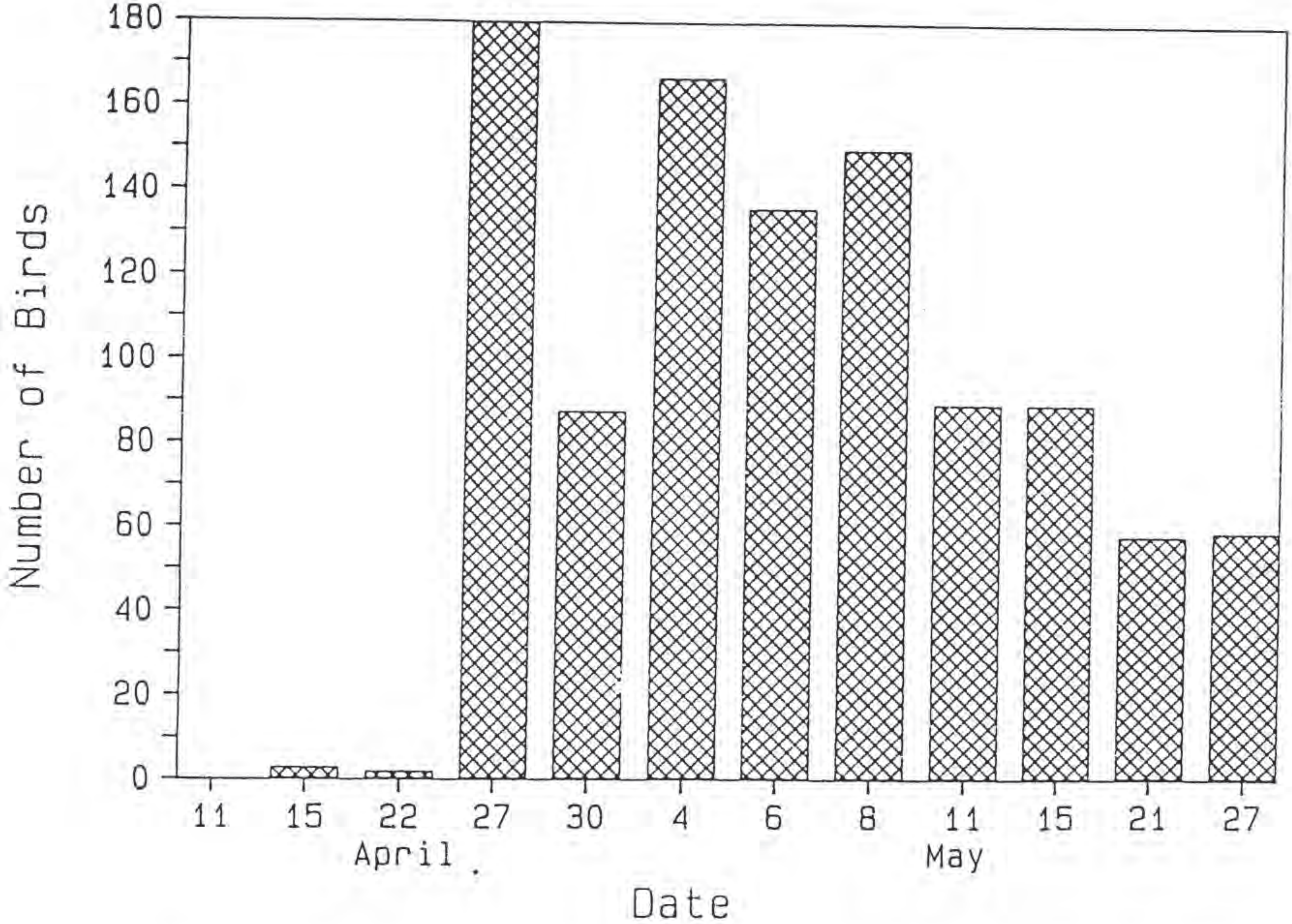


Figure 2. Total numbers of swans observed on aerial surveys in the Tok Study Area, Alaska, during spring migration 1987.

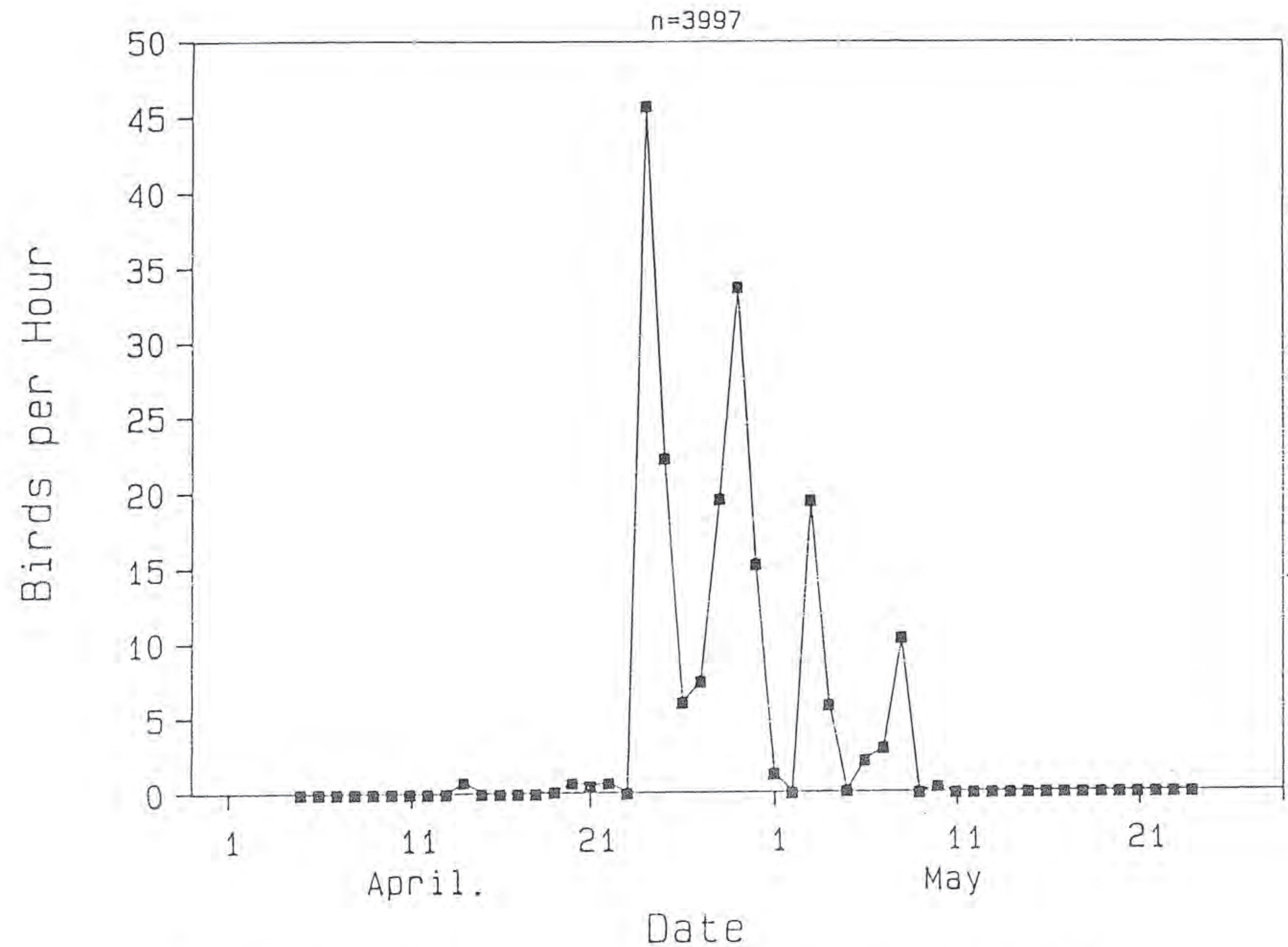


Figure 3. Daily migration rates (birds/h) for swans in the Tok Study Area, Alaska, during spring migration 1987.

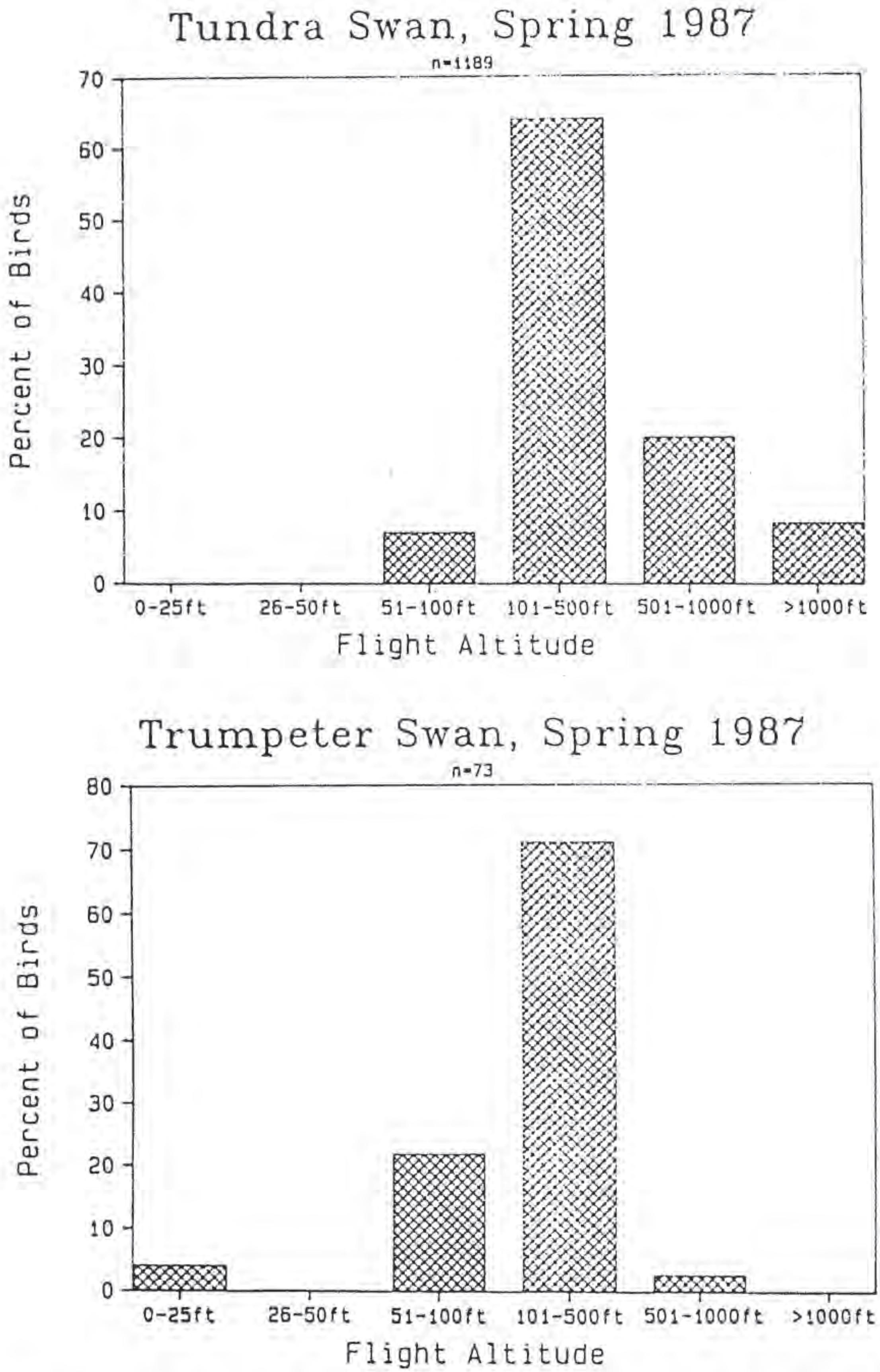


Figure 4. Percent of Tundra and Trumpeter Swans in flight altitude categories (agl) in the Tok Study Area, Alaska, during spring migration 1987.

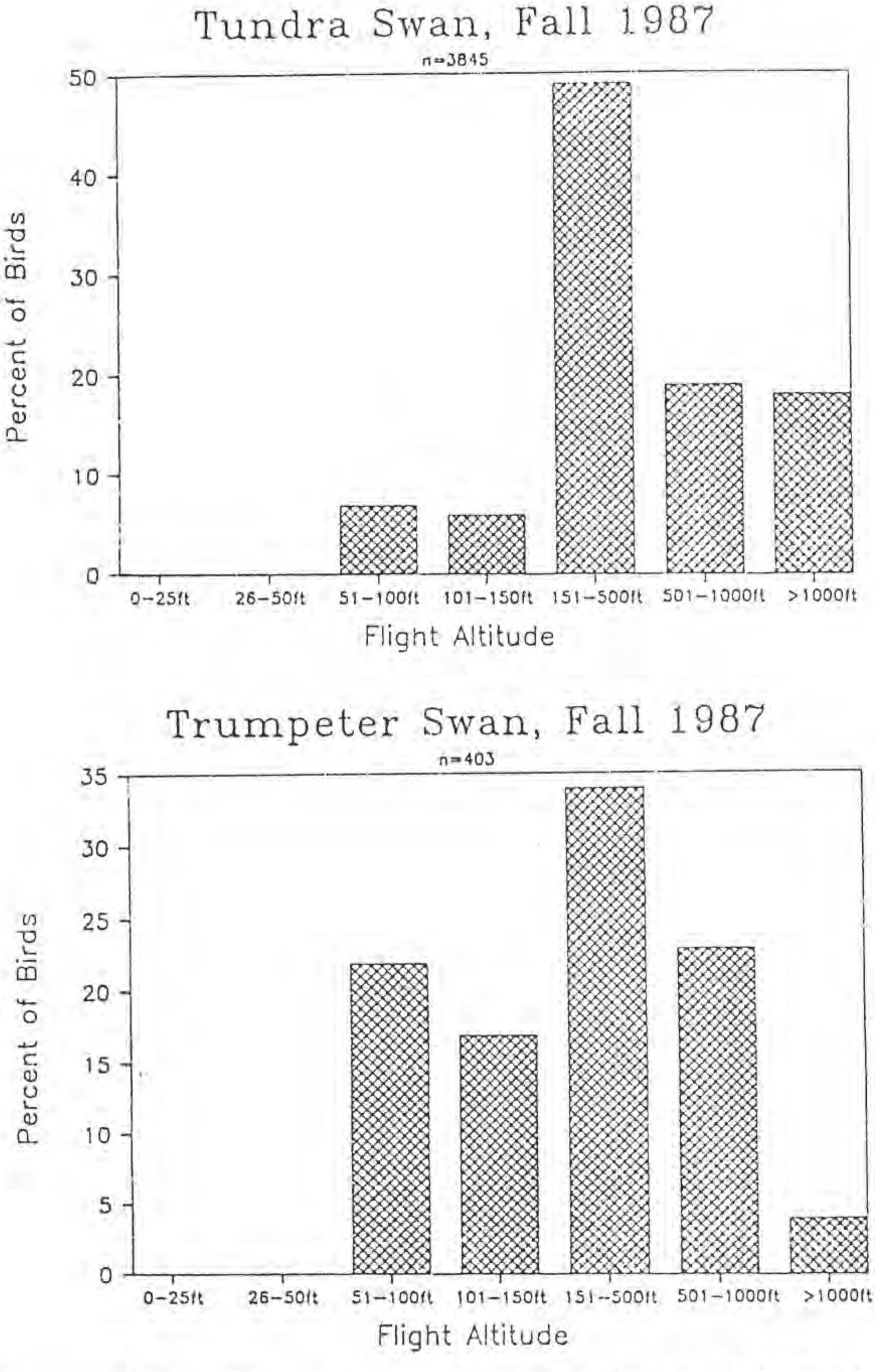


Figure 5. Percent of Tundra and Trumpeter Swans in flight altitude categories (agl) in the Tok Study Area, Alaska, during fall migration 1987.

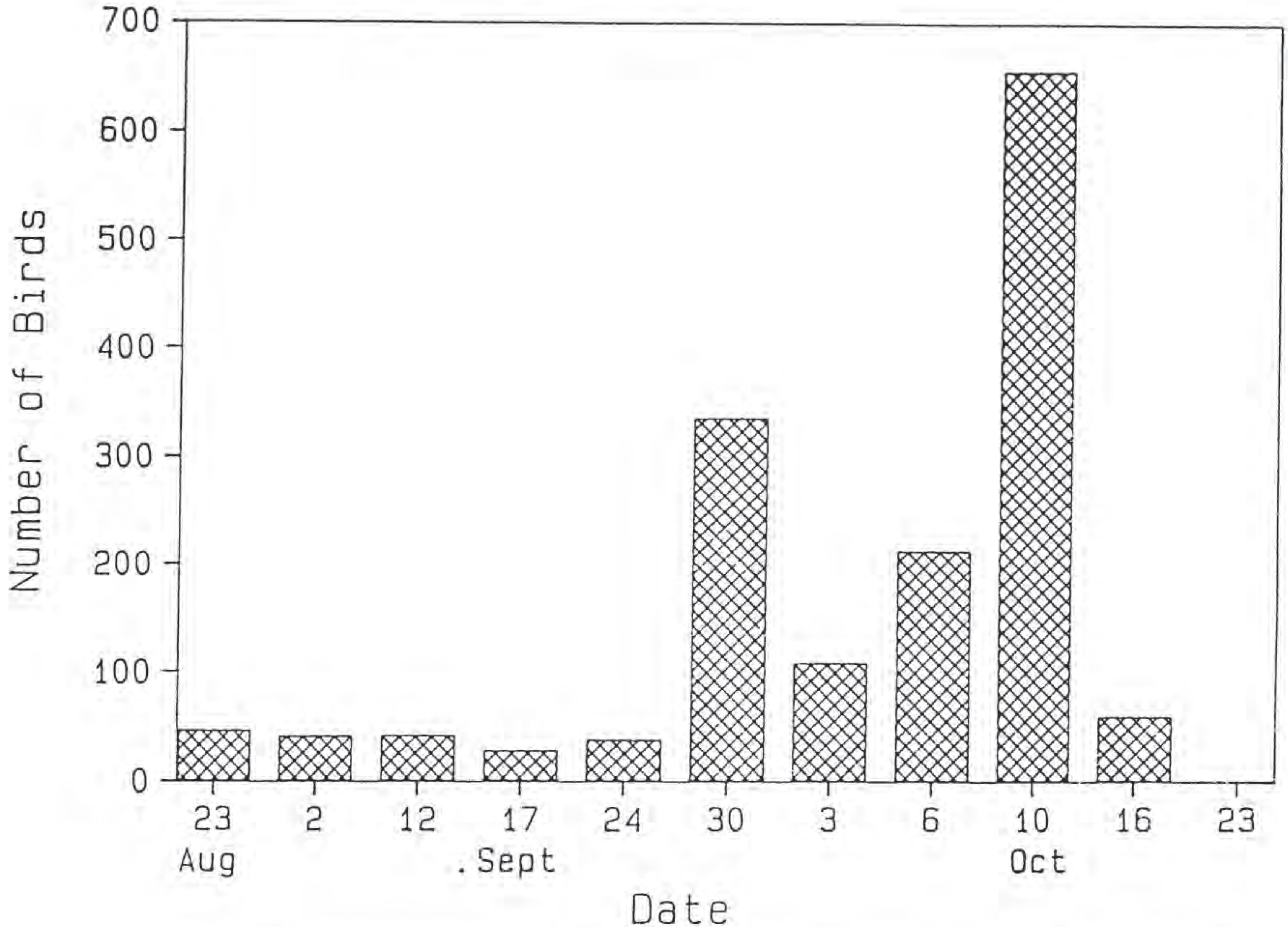
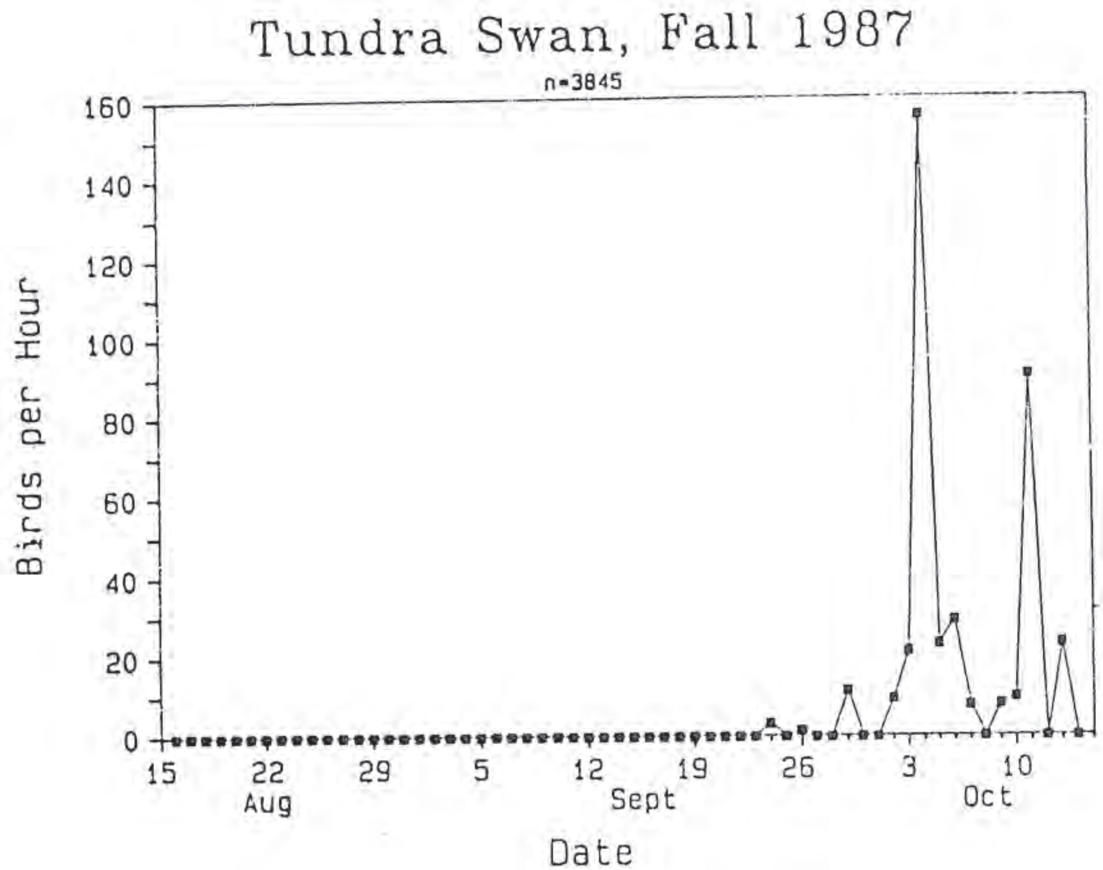


Figure 6. Total numbers of swans observed on all aerial surveys in the Tok Study Area, Alaska, during fall migration 1987.



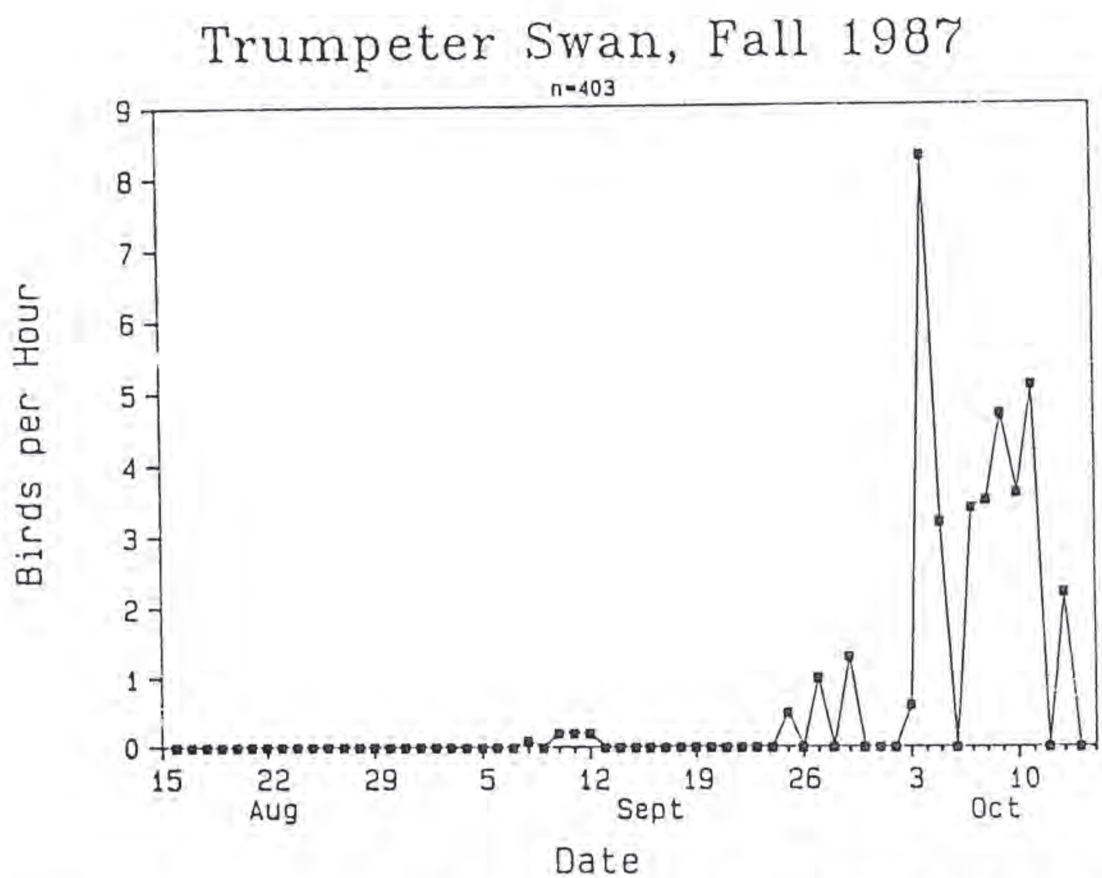


Figure 7. Daily migration rates (birds/h) for Tundra and Trumpeter Swans in the Tok Study Area, Alaska, during fall migration 1987.

Swans, 94 percent of Trumpeter Swans). Similar flight patterns were observed for unidentified swans. Results of our radar surveillance also provided informatin for some nocturnal movements of swans. Nocturnal migration pulses during October were associated with the period of peak daylight swan migration. We identified some of the targets by their calls. Tundra Swans were heard on the nights of 4, 9, and 13 October. Bellrose (1978) stated that Tundra Swans often fly at night during fall migration.

SUMMARY

Spring and fall swan migration in the upper Tanana River Valley is a spectacular component of a rich migration. Its duration, chronology, and geographic limits have been described by a number of studies using aerial surveys and collar and radio telemetry transmission relocations. Less data were available regarding flock composition and flight behavior such as altitude of flight and nocturnal movements. We hope to further refine the picture of swan migration in the upper Tanana River Valley through continued direct observation and radar techniques. The result of these studies will improve our understanding of swan migration, the effects of weather on flight behaviors, and complement other studies of swan biology undertaken in the upper Tanana River Valley.

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RELATIVE ABUNDANCE OF SYMPATRIC TRUMPETER AND TUNDRA SWAN POPULATIONS IN WEST-CENTRAL INTERIOR ALASKA

Andy Loranger and Daryle Lons

ABSTRACT

Nesting swan pairs were identified to species on the Nowitna and Koyukuk National Wildlife Refuges (NWR) in west-central interior Alaska from 1985 through 1987 to determine the relative abundance of Trumpeter and Tundra Swans and extent of breeding range overlap in this region. Of 28 pairs identified on the Koyukuk NWR, 27 were Tundra Swans. Forty-four of 49 nesting pairs identified on the Nowitna NWR were Trumpeter Swans. Five of 25 nesting pairs identified on the Nowitna NWR in 1986 were Tundra Swans; all nesting pairs identified on the Nowitna NWR in 1987 were Trumpeter Swans. More detailed study in the Koyukuk unit of the U. S. Fish and Wildlife survey area is needed to determine if revision of the study area is warranted.

In 1986, the area of breeding range overlap included the Nowitna geographic area in the Lower Tanana unit of the Trumpeter Swan survey area. Continued monitoring of the relative abundance of nesting Trumpeter and Tundra Swans on the refuges is recommended to increase the precision of population estimates obtained from annual surveys and to document shifts in relative abundance and nesting distributions which may occur concurrent with changes in their population status.

INTRODUCTION

The breeding range of the Trumpeter Swan (Cygnus buccinator) in Alaska extends from the central interior to the south-central coast (Bellrose 1976). Tundra Swan (C. columbianus) breeding range in Alaska is thought to be confined mainly to the subarctic and arctic tundra along the western and northern coasts (Bellrose 1976).

The Alaska Statewide Trumpeter Swan Survey is conducted at 5-year intervals over all potential Trumpeter Swan breeding habitat by U. S. Fish and Wildlife Service (USFWS) personnel (Conant et al. 1985). Surveys of randomly selected units within this area are conducted in interim years (Hodges et al. 1986).

Limited information from early field work on the Nowitna and Koyukuk National Wildlife Refuges (NWR) indicated that both Trumpeter and Tundra Swans were nesting in the region. Both refuges fall within the USFWS Alaska Trumpeter Swan survey area and all swans observed during annual aerial surveys have heretofore been considered Trumpeter Swans. Expanded ground studies to determine the relative abundance and nesting distributions of the two species in this area of range overlap were conducted on the Koyukuk NWR from 1985 to 1987 and on the Nowitna NWR in 1986 and 1987.

STUDY AREA

The Nowitna and Koyukuk NWRs are located in west-central interior Alaska (Figure 1). The Nowitna NWR is comprised of 2.0 million acres in the middle Yukon River Valley approximately 175 km west of Fairbanks. The Yukon River forms its northern boundary, and it is bisected by the Nowitna River. The Koyukuk NWR includes 4.5 million acres in the Koyukuk Basin, an extensive lowland area surrounded by high hills. It is bisected by the Koyukuk River, a major tributary of the Yukon and one of 13 rivers on the Refuge. The Northern Unit of the Innoko NWR is administered by the Koyukuk NWR staff.

Both refuges fall within the northern boreal zone of central Alaska. Major vegetation types include open and closed spruce forest, closed spruce-hardwood forest, and dwarf scrub-graminoid tussock peatland. Important species in the forest vegetation classes include black and white spruce (Picea mariana and P. glauca), balsam poplar (Populus balsamifera), paper birch (Betula papyrifera), and aspen (P. tremuloides). Labrador tea (Ledum decumbens), crowberry (Empetrum nigrum), blueberry (Vaccinium spp.), dwarf birch (B. glandulosa), and sphagnum moss (Sphagnum spp.) are the predominate species in the dwarf scrub peatland type. Thousands of lakes, ponds, and marshes characterize low-lying areas on the refuges, largely due to poor drainage caused by extensive areas underlain by permafrost. Wetlands associated with major drainages constitute the refuges' primary waterfowl habitat.

METHODS

Locations of nesting swan pairs were determined during annual aerial swan surveys on the refuges. The aerial survey techniques were described by King (1973). All accessible nesting swan pairs on the two refuges were identified to species subsequent to these surveys. Survey units consisted of entire or quarter-sections of U. S. Geological Survey 1:63,360 topographic quadrangles. The 1986 and 1987 surveys on the Koyukuk NWR included four and two survey units, respectively. In 1985, nesting swan pairs were located during random flights over the Koyukuk Refuge. All potential swan

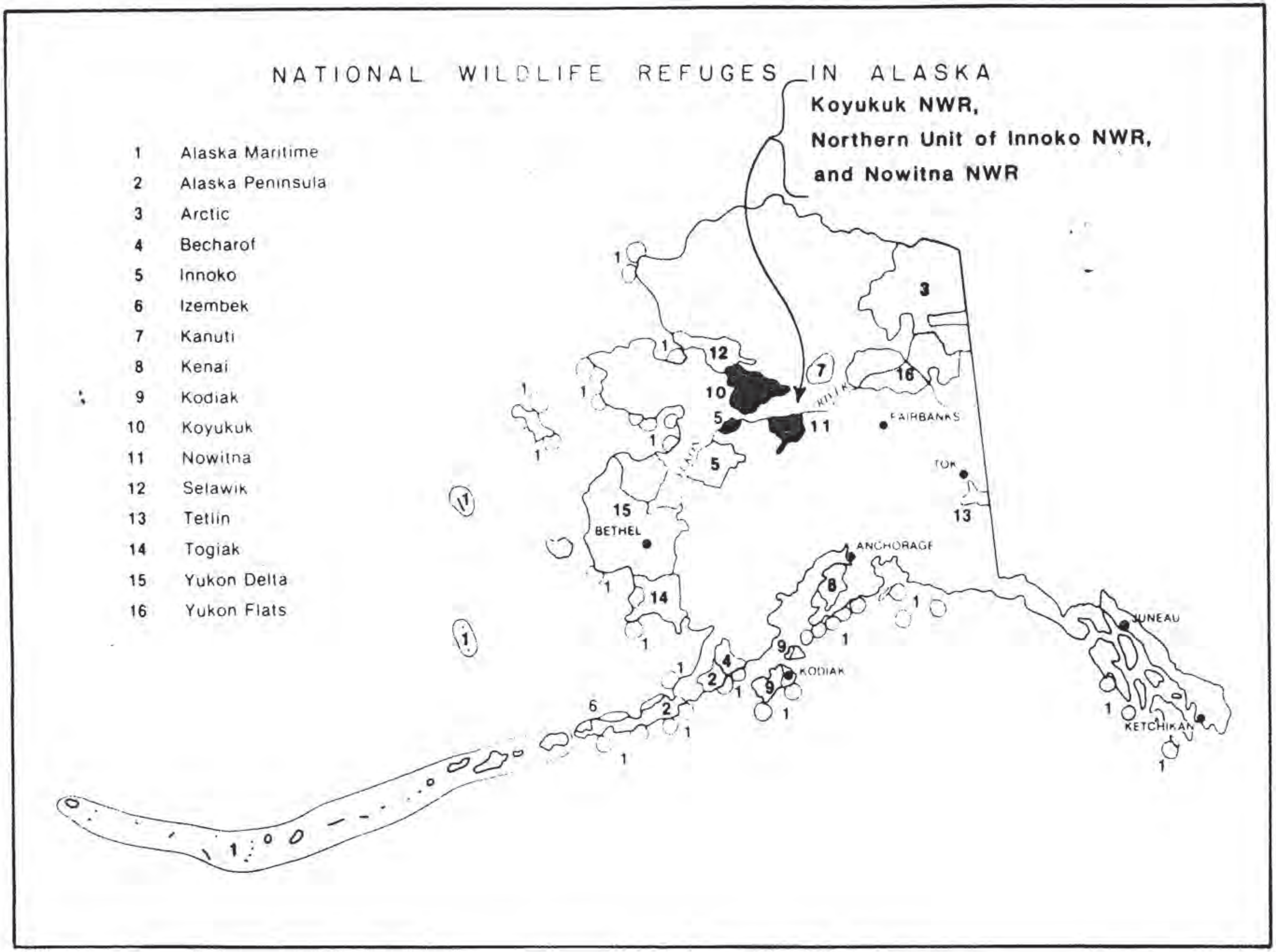

Figure 1. Location of Nowitna and Koyukuk NWRs, Alaska.

habitat on the Nowitna NWR (18 entire quadrangles and two quarter sections) was surveyed in 1986 and 1987.

Accessibility was restricted to those pairs on or adjacent to (within 1/2 mile) open water which could be landed on with small fixed-wing aircraft. Access to these areas was by a float-equipped Cessna 185 or Piper Super Cub (PA-18) aircraft. Whenever possible, adjacent open water areas were used for landing to minimize disturbance. Several swan pairs and nonbreeding swans were identified coincidental to other field work on the refuges during the study period and are included in the data summaries.

Observations were made using a 30x spotting scope. Criteria for species identification included the presence of yellow lores or red-bordered lower mandible, head and bill shape, and neck configuration. Whenever possible or necessary, the distinct calls of the two species were used in combination with morphological characteristics. Most identifications involved both physical and auditory criteria.

RESULTS AND DISCUSSION

Twenty-eight nesting pairs were identified to species during ground surveys on the Koyukuk NWR (Table 1). Of this total, 27 were Tundra Swan pairs and one was a Trumpeter Swan pair. Results have been consistent throughout the 3-year study period; all nesting swan pairs identified in 1985 and 1987 (nine and 10, respectively), were Tundra Swans, as were eight of nine pairs identified in 1986. Seven additional nesting swan pairs have been identified to species on the Refuge coincidental to other field work over the same time period (Table 1). These observations included three Trumpeter Swan pairs and four Tundra Swan pairs. Most swan identifications were made in the northern and east-central portions of the Refuge (Figure 2).

Forty-nine nesting swan pairs were identified to species on the Nowitna NWR in 1986 and 1987 (Table 2). Of this total, 44 were Trumpeter Swan pairs and five were Tundra Swan pairs. Five of 25 nesting pairs identified in 1986 were Tundra Swan pairs, and all 24 pairs identified in 1987 were Trumpeter Swans. Swan observations coincidental to other fieldwork on the Refuge since 1985 have included three Trumpeter Swan pairs, 12 nonbreeding Trumpeter Swans, and three nonbreeding Tundra Swans. Both species are distributed throughout potential swan habitat on the Refuge (Figure 3).

The Koyukuk NWR lies within the USFWS Alaska Trumpeter Swan survey area's Koyukuk unit. Totals of 303 and 87 swans were observed in this unit during Statewide surveys in 1985 (Conant et al. 1985) and 1986 (Hodges et al. 1986), respectively. Our results indicate that the majority of these swans were Tundra Swans. However, ground surveys were conducted primarily in the northern half of the Refuge and sample size is presently not adequate to conclusively determine relative abundance.

The Nowitna NWR is part of the Lower Tanana unit of the survey area. In 1986, the breeding range of Tundra Swans in Alaska included the Nowitna geographic area in the western portion of this unit. Nesting Tundra Swans have been reported as far east as the Minto Flats outside of Fairbanks (Rod King, pers. comm.). A systematic ground survey in the Koyukuk and Lower Tanana units is recommended to determine if revision of the Trumpeter Swan survey area is warranted and to increase the precision of swan population estimates obtained from annual Statewide and refuge surveys.

Table 1. Locations by survey unit of swan species identifications on the Koyukuk NWR, Alaska, 1985-87.

	Trumpeter Swan pairs			Tundra Swan pairs		
Survey unit	1985	1986	1987	1985	1986	1987
1. Kateel River A-2	0	0	0	1	0	0
2. Kateel River C-1	0	0	0(1)*	2(1)	0(1)	7
3. Kateel River C-3	0	0	0	0	2	0
4. Kateel River D-1	0	0	0	3	4	0
5. Kateel River D-3	0	1	0	1	2	0(1)
6. Kateel River D-4	0	0	0	1	0	0
7. Melozitna C-4	0	0	0(1)	0	0	0
8. Melozitna C-5	0	0	0	0	0	3
9. Melozitna D-6	0	0	0	1	0	0
10. Nulato B-5	0	0	0(1)	0	0	0(1)
Totals	0	1	0(3)	9(1)	8(1)	10(2)

* ( ) Observations incidental to other field work.

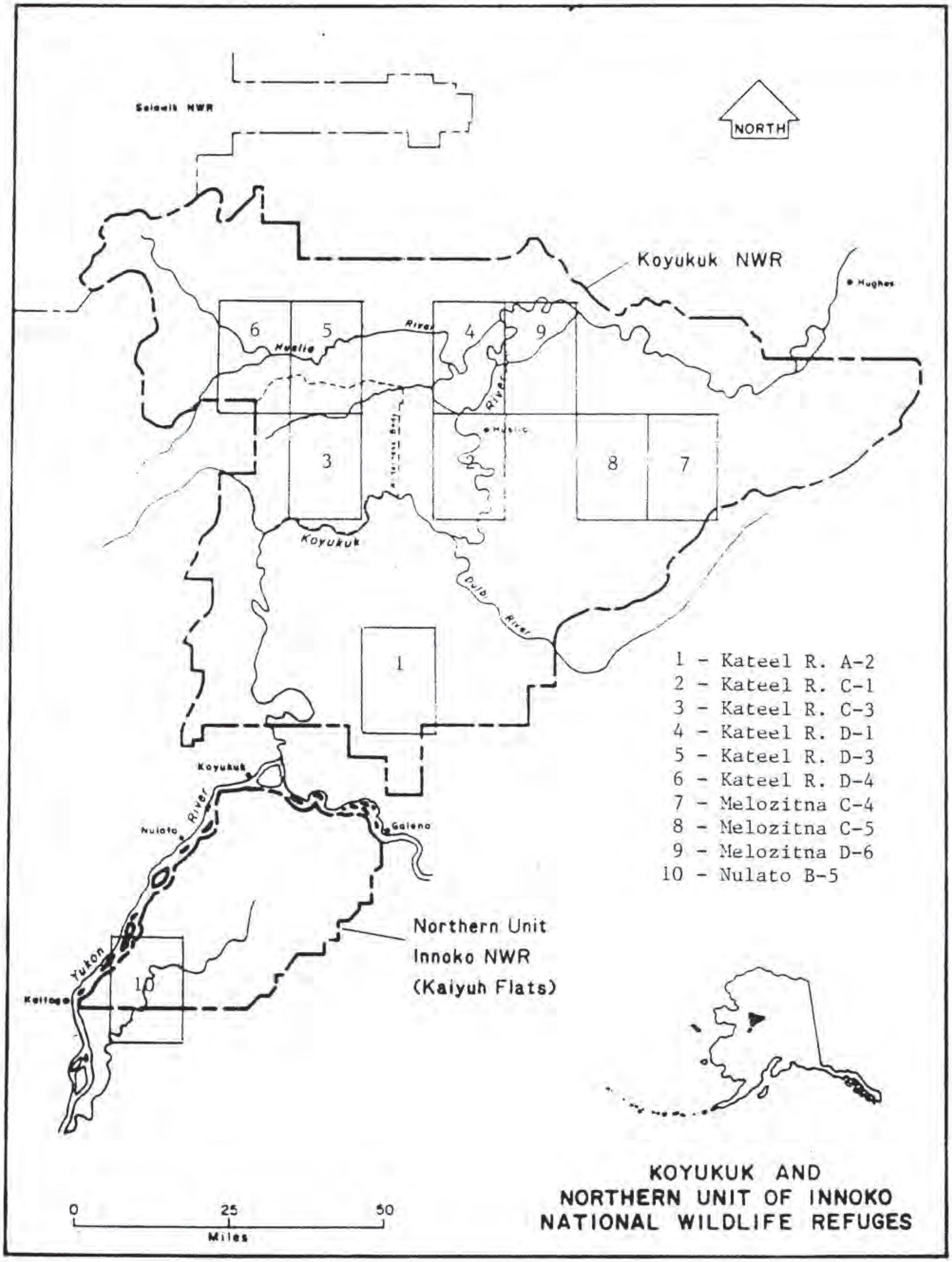

Figure 2. Survey units used in swan species identification ground surveys, Koyukuk NWR, Alaska, 1985-87.

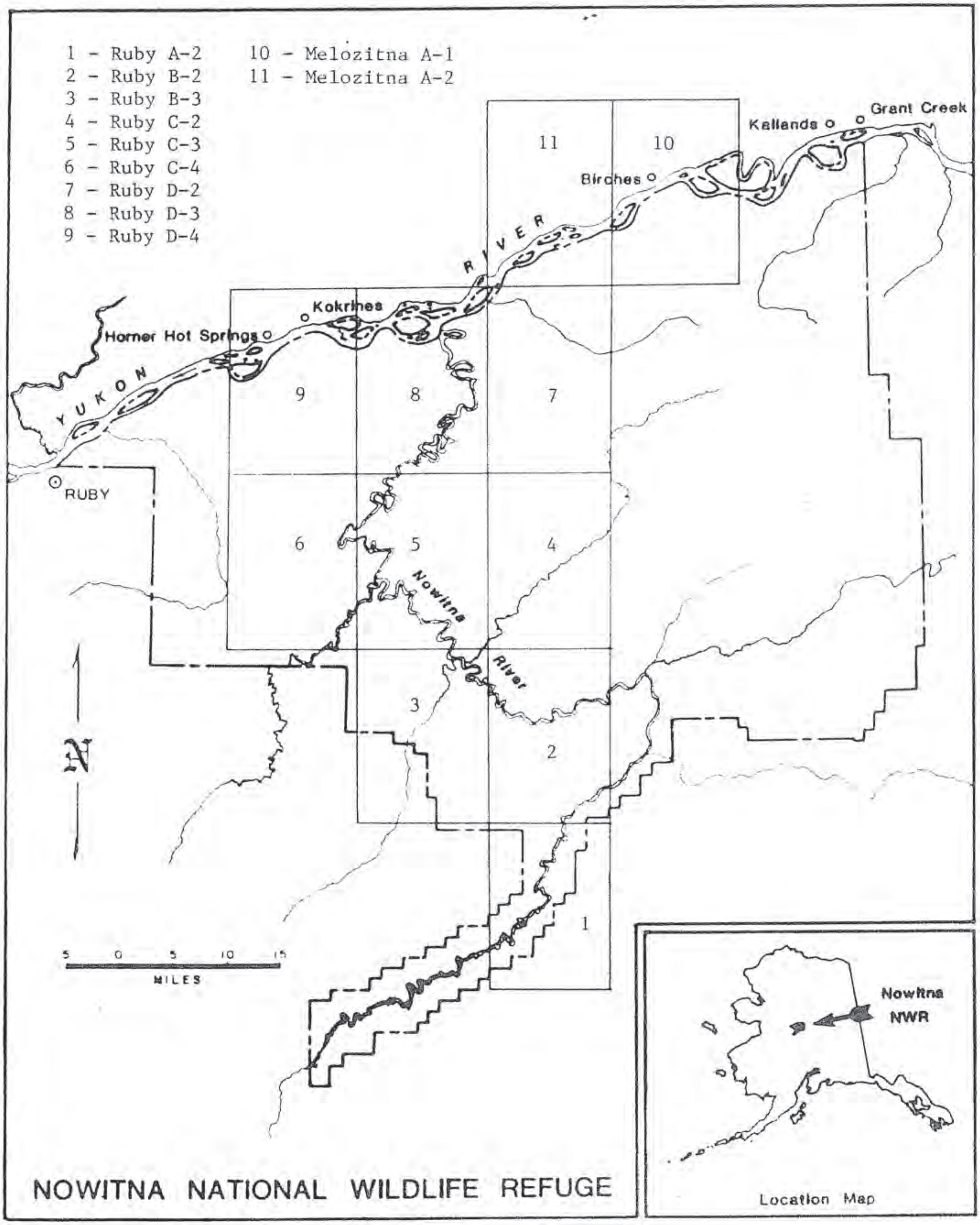

Figure 3. Survey units in swan species identification ground surveys, Nowitna NWR, Alaska, 1986-87.

Table 2. Locations by survey unit of swan species identifications on the Nowitna NWR, Alaska, 1985-87.

Survey unit	Trumpeter Swan pairs 1985	Trumpeter Swan pairs 1986	Trumpeter Swan pairs 1987	Tundra Swan pairs 1985	Tundra Swan pairs 1986	Tundra Swan pairs 1987
1. Ruby A-2	0	1	0	0	0	0
2. Ruby B-2	(1)*	2	2	0	0	0
3. Ruby B-3	0	1	1	0	0	0
4. Ruby C-2	0	1	1	0	0	0
5. Ruby C-3	0	7	3	0	2	6
6. Ruby C-4	0	3	6	0	1	0
7. Ruby D-2	0	0	1	0	0	0
8. Ruby D-3	(1)	4	5	0	1	0
9. Ruby D-4	(1)	1	3	0	1	0
10. Melozitna (A-1)	0	0	1	0	0	0
11. Melozitna (A-2)	0	0	1	0	0	0
Totals	(3)	20	24	0	5	6

* ( ) Observations incidental to other field work.

Alaska populations of both Trumpeter and Tundra Swans have increased in recent years, and the amount of range overlap between the two species is also probably increasing. These population increases have manifested themselves by increases in densities in high quality habitats and range expansion into peripheral habitats (Conant et al. 1985). It is probable that the presence of Tundra Swans on the Koyukuk and Nowitna NWRs is the result of range expansion since predominant habitat types on the two refuges are considered peripheral for this species. Although historical information is limited, it is possible that Tundra Swan breeding range in Alaska has historically included portions of interior habitats.

The sympatric relationship between Trumpeter and Tundra Swan populations in interior Alaska may be a dynamic one. All observations of nesting and nonbreeding Tundra Swans on the Nowitna NWR were made prior to 1987. Of the five lakes that had nesting Tundra Swan pairs in 1986, two had nesting Trumpeter Swans in 1987, two had no nesting swans, and one had a nesting swan pair that could not be conclusively identified. Definitive conclusions regarding changes in the relative abundance of the two species on the Nowitna NWR from 1986 to 1987 are not possible since limited accessibility precludes identification of all nesting swans on the Refuge. However, it is noteworthy that no Tundra Swans were observed during the course of expanded fieldwork in 1987. Concurrently, spring and fall aerial swan surveys on the Refuge in 1987 documented a marked increase in swan density over 1985 and 1986 (Table 3). If it is assumed that the observed increase corresponded with an increase of the Trumpeter Swan population summering on the Refuge, the absence of Tundra Swans may be due to displacement as preferred Trumpeter Swan habitat becomes saturated.

Table 3. Comparative results of 1986 and 1987 spring swan surveys and 1985 and 1987 fall surveys on the Nowitna NWR, Alaska.

Survey	1985 Pairs	1985 Total swans	1986 Pairs	1986 Total swans	1987 Pairs	1987 Total swans
Spring survey	-	-	48	121	57	146
Fall survey	20	54	-	-	34	139

CONCLUSIONS

Revision of the Alaska Trumpeter Swan survey area, specifically in the Koyukuk geographic area is likely warranted since Tundra Swans appear to predominate in this region. Tundra Swan breeding range has in recent years also included the western portion of the survey area's Lower Tanana unit. Systematically determining the relative abundance of the two species in the region is necessary to increase the precision of swan population estimates obtained from annual surveys. This information would also provide an historical benchmark for documenting and comparing long-term shifts in nesting distributions and relative abundance which may occur concurrent with changes in the two species population status.

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POPULATION EXPANSION OF TRUMPETER SWANS IN THE UPPER TANANA VALLEY, ALASKA, 1982 TO 1987.

F. David Stearns, Steven Breeser, and David Sowards

ABSTRACT

Population inventories of Trumpeter Swans (Cygnus buccinator) were conducted in the Upper Tanana Valley of eastern Alaska from 1982 through 1987. Standard aerial survey methods developed by the U. S. Fish and Wildlife Service in Alaska were used to enumerate breeding pairs, flocks, single birds, and determine production. Observations of migration, nesting, departure, and wintering birds were included. Large increases in the number of swans were recorded and related to weather and habitat. It was determined that weather patterns, ice-free days, and impoundment configuration were factors which had unquantified effects upon the population increase.

INTRODUCTION

On 2 December 1980, Tetlin National Wildlife Refuge (NWR) was created by the Alaska National Interest Lands Conservation Act. With this designation came increased interest in the waterfowl populations in the Upper Tanana Valley. The legislation-mandated Refuge Master Plan prompted data gathering that included Trumpeter Swan information.

In addition to direct observations of Trumpeter Swans, we recorded freeze-up and ice-free dates, pond vegetation, and other phenological events. Collectively, these data document the population expansion that we observed from 1982 through 1987.

STUDY AREA

Tetlin NWR lies in an upland basin at the head of the Tanana Valley and includes about 924,000 acres in the Chisana and Nabesna River drainages (Figure 1). Its boundaries form a rough triangle, bounded by Canada on the east, the Wrangell-St. Elias National Park on the south, the Tetlin Indian Reserve on the west, and the Alaska Highway on the northeast. The study area extended beyond the Refuge from the junction of the Robertson River with the Tanana River, east to the Canadian boundary, and north from the foothills of the Alaska Range to the Alaska Highway.

This basin is located on the north flank of the Alaska Range and is on a major migration route serving as a principal stopping point for swans from western, northern, and central Alaska. Frequently, from 200 to 1,000 swans are seen in this area during a single day of the spring or fall migration.

HABITAT CHARACTERISTICS

The area has a continental climate with recorded extremes of 91°F and -72°F. Spring, summer, and fall are often cool and punctuated by rain, hail, sleet, or snow. Average annual precipitation is 10.6 inches.

According to Hansen et al. (1971), the most important climatological data in relation to Alaska Trumpeter Swan ecology are not annual monthly medians, but fall and spring temperatures which cause ice formation and destruction. To aid in determining the nesting season, we recorded break-up and freeze-up dates between 1982 and 1987 (Table 1).

Table 1. Ice formation observed on Tetlin NWR, Alaska, 1982-87.

Year	Ice cover	Break-up	Ice-free days
1982	10 Oct.	4 May	159
1983	9 Sept.	5 May	175
1984	20 Oct.	8 May	165
1985	23 Oct.	17 May	159
1986	21 Oct.	15 May	159
1987	26 Oct.	7 May	172

WATER RESOURCES

Wildlife production, especially waterfowl, is greatest in the wetland complexes on the north end of Tetlin NWR (Figure 2). River and stream overflows influence water and nutrient levels in these wetlands. The area's two major rivers, the Nabesna and Chisana, rise from glaciers in the Wrangell Mountains south of the Refuge and contribute large amounts of sediment to the basin.

Most standing water in the basin is contained in thousands of closely spaced ponds and small lakes separated by strips of wet meadow, willow (Salix spp.), or spruce (Picea spp.) forest. Pond sizes vary from less than an acre to nearly 3,000 acres. The northern portion of the Refuge is almost 100 percent wetlands (Figure 2). The Refuge's southern plateau has concentrations of small ponds that are generally thaw lakes,

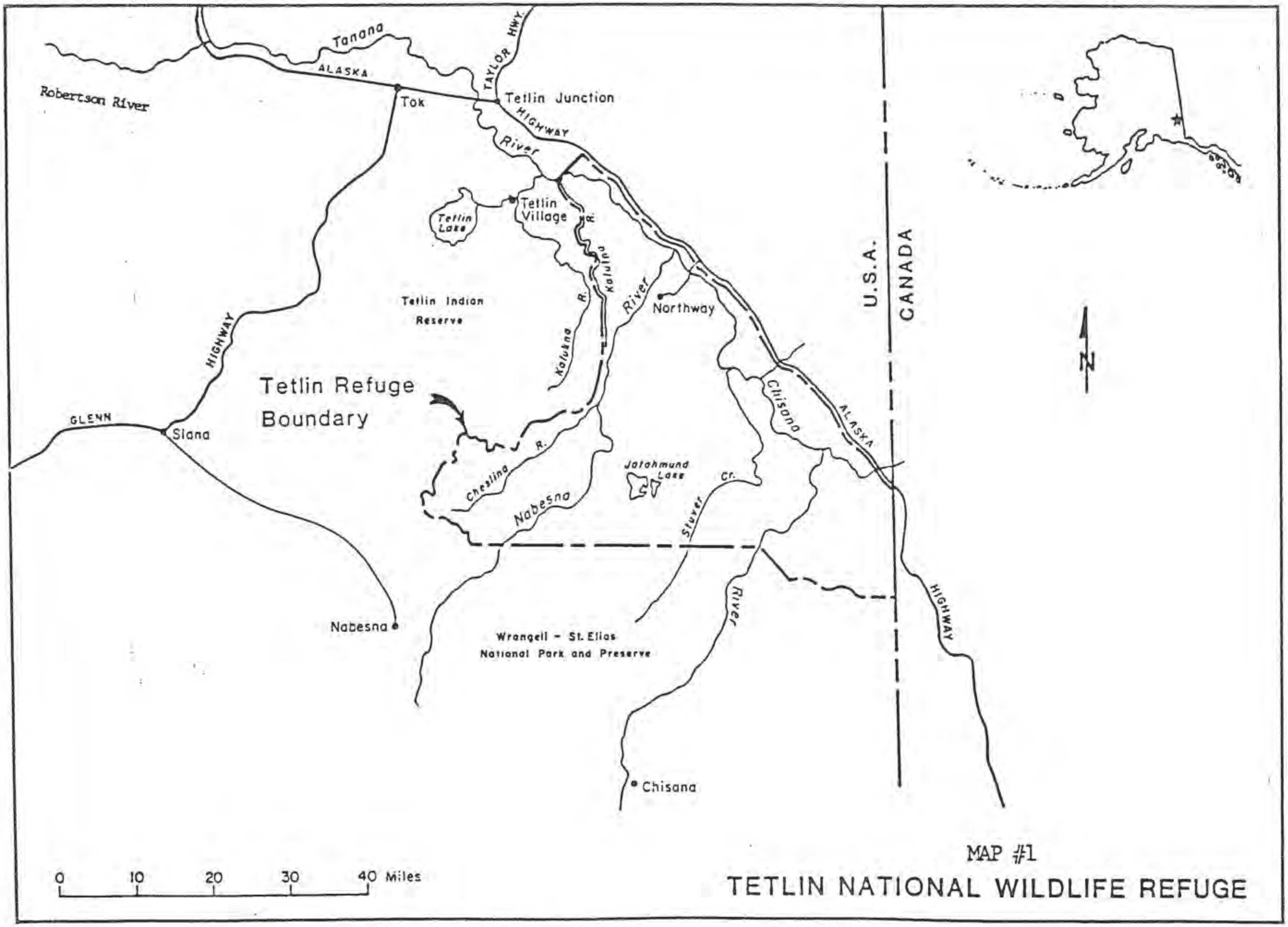

Figure 1. Tetlin National Wildlife Refuge, Alaska.

low in waterfowl use, and flanked by spruce stands. Conversely, most lowland ponds and lakes throughout the Refuge are connected to rivers and streams. The connected lakes support many invertebrates, fish, and waterfowl. With color infrared photography it has been estimated that 50 percent of the ponds are stream-connected with wide, shallow perimeters. Islands are present in 5 to 10 percent of the ponds. There are over 8,000 impoundments in the basin (Kerr 1987).

VEGETATION

The area's vegetation is part of the circumpolar northern coniferous forest, which extends south from the Brooks Range and east into Canada. Forest dominates the uplands at elevations below treeline (975 m). Open stands of black spruce (P. mariana) are common in low-relief, wet terrain. White spruce (P. glauca), occasionally growing with white birch (Betula papyrifera) and aspen (Populus tremuloides), is found in better-drained, warmer sites. Birch, willow, and aspen may dominate following fires. Poorly-drained, wet meadows influenced by permafrost are dominated by tussocks of cottongrass (Eriophorum spp.).

Pond margins vary considerably. Most shallow ponds have emergent vegetation consisting of sedge (Carex spp.) and horsetail (Equisetum spp.). Small amounts of cattail (Typhus spp.) and willow are also present. Floating aquatics such as pondweed (Potamogeton spp.), yellow water lily (Nuphar spp.), and duckweed (Lemna spp.) are also common in the basin. Some impoundments are surrounded by black or white spruce while others are ringed by aspen, willow, or birch. Often, as eutrophication progresses, the margin of some ponds becomes shallow, supporting dense stands of horsetail and sedge.

HISTORICAL TRUMPETER SWAN DISTRIBUTION IN ALASKA

Trumpeter Swan observations in Alaska are numerous. Several early observations are given by Hansen et al. (1971) in Table 2. It is noteworthy that none of these observations were in the Upper Tanana River Valley in spite of the considerable work conducted there since 1950 (Hansen et al. 1971, King 1985). Bellrose (1976) makes no mention of nesting swans in this area, nor does Banko (1960), who does mention nesting in several other Alaskan locations (i.e., Norton Sound, Nome, Copper River Delta). Interviews with elderly native people in the villages of Tetlin, Northway, and Tanacross generally confirmed Hansen et al.'s (1971) findings. Titus David (pers. comm.), age 81, Tetlin Village Council President, recalls that as a child in Tetlin, swans (probably both Tundra and Trumpeters) arrived in the village in the spring and fall, but did not nest in the basin. The above evidence leads us to believe that little or no swan nesting occurred in the Upper Tanana Valley from 1965 to 1980.

Table 2. Interior Alaska Trumpeter Swan sightings, 1952-65.

Observer	Location (Alaska)	Air miles from Tetlin NWR	Date
Frank Glaser	Gulkana River	120 south	1952
Robert Burkholder	Glenallen	150 south	1957
Jim King	Minto Flats	200 west	1959
Jim King	Sand Lake	50 west	1965

Source: Hansen et al. 1971.

PRESENT STATUS

Hodges et al.'s (1986) data indicate that the Trumpeter Swan population is increasing dramatically in eastern interior Alaska (Table 3). Beginning in 1981, the Refuge staff conducted several swan censuses to enumerate breeding pairs, cygnets, and nonbreeding birds. Partial censuses were obtained in 1981 and 1984, and complete surveys for the area were done in the remaining years. Our information is incorporated with that of Hodges et al. (1986) in Table 4. Both sets of data indicate that the Upper Tanana Valley has a rapidly expanding swan flock.

To further define the movements and populations of Trumpeters in the Upper Tanana Valley, 13 cygnets were collared in 1983, and seven in 1984. A radio transmitter-equipped collar was put on one swan in 1984. This portion of the project was a cooperative effort with Rod King, USFWS Pilot/Biologist.

RESULTS AND DISCUSSION

Inventory and census

While we were unable to do a complete swan census in 1984, the partial survey provided some information on the valley's Trumpeter Swan population increase. The information has been included in our analysis of population trends.

As Table 4 illustrates, there was a very rapid increase in swan numbers near Tetlin NWR. In 1981, there were probably no swans using the area. The number of successful nests also rose from six in 1982 to 12 in 1987. At the same time, total swan numbers increased from 56 in 1982 to 176 in 1987, with 44 or more fledged young in 1985, 1986, and 1987.

Nest sites

Physical data from 12 successful nest sites were recorded in 1987 (Table 5). We found that occupied ponds varied in size from 11 to 806 acres, with an average size of 152 acres. Ten of the 12 sites were on shallow, interconnected lakes with margins over 50 feet wide, vegetated with sedges and/or horsetail. Vegetation at 11 of the lakes had a margin water depth of 1 to 2 feet, with abundant emergent vegetation. None of the sites had close shoreline encroachment by trees. Nests, when not built on an island, were under construction for at least a 2-year period, presumably by the same birds that eventually nested there.

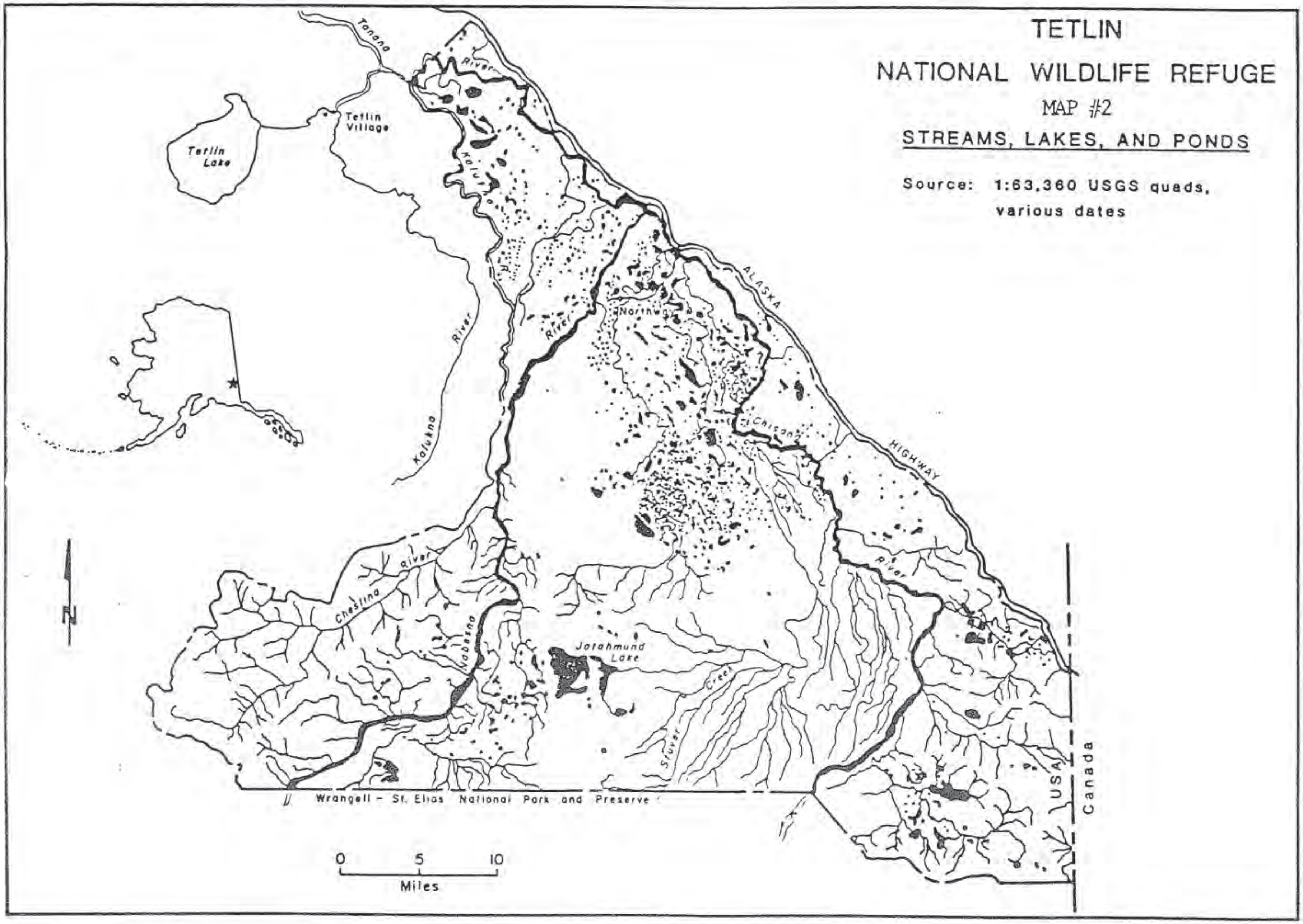

Figure 2. Tetlin NWR, streams, lakes, and ponds.

Table 3. Trumpeter Swan surveys in eastern interior of Alaska, 1968-85.

Location	Year	Total birds	Broods	Average brood size	Percentage of pairs with broods
Gulkana	1968	590	52	3.7	36
	1975	1,038	93	3.1	33
	1980	2,360	194	3.4	36
	1985	3,007	191	2.8	22
Lower Tanana	1968	476	42	3.3	33
	1975	1,112	112	3.5	42
	1980	2,120	202	3.8	54
	1985	2,244	179	2.8	29
Upper Tanana	1968	--	---	---	--
	1975	--	---	---	--
	1980	15	1	4.0	33
	1985	205	19	3.4	45

Data from Conant et al. (1985) and Tetlin NWR files.

Table 4. Trumpeter Swan numbers near Tetlin Refuge 1981-87.*

Year	Total birds	Number of broods	Average brood size	Number of cygnets	Percentage of pairs with broods
1981**	0	0	0	0	0
1982	56	3	4.0	12	20
1983	27	6	4.5	27	--
1984**	36	9	4.0	34	--
1985	146	13	3.8	49	50
1986	140	11	4.0	44	38
1987	176	12	3.7	44	28

* From Hodges et al. (1985) and Tetlin NWR files.
** Incomplete surveys.

Weather observations

From 1982 until 1987, we observed a wide variety of climatic conditions in the Tanana Valley. In 1985 and 1986, cold spring conditions delayed waterfowl arrival and break-up conditions by about 2 weeks, while, in 1982, 1983, 1984, and 1987, near normal break-up dates (Table 1) occurred.

Fall cold weather conditions in 1982 arrived near the expected date. From 1984 through 1987, ice-free conditions were extended into the fall by 10 to 20 days. This could have been a short-term warming trend. However, by examining National Weather Service (1986) records, we were unable to detect that a warming trend had taken place over the past 40 years.

During years of early freeze-up or late thaw, mild temperatures at the opposite end of that season extended the number of ice-free days to near normal. There was only a 15-day maximum variation during 6 years of observations.

Movements

Reports of marked swans from the collaring program in the valley were received in 1984 and 1986. All sightings were from the wintering areas. Canadian observers reported a collared family with five cygnets in the central part of Vancouver Island, near Klaklakama Lake, on 10 January 1984. A single cygnet collared north of Tok was seen at the mouth of the Qualicum River in southeastern Vancouver Island 17 January 1984.

The radio-equipped collared bird was found dead on Vancouver Island in February 1984. In 1986, a single collared swan was observed in July near its natal site on the Tetlin NWR. No other observations of the marked birds have been reported. From these sightings and other USFWS records, we believe that the swans hatched in the Upper Tanana Valley winter in the inland lakes of Vancouver Island.

Table 5. Nest sites used by Trumpeter Swans in the Upper Tanana Valley, Alaska, 1987.

Nest pond size (acres)	Estimated percentage of basin vegetated	Cygnets	Lake margin description	Nest site location
550	5	3	Shallow (0-1.8') w/grass and Equisetum emergents common. Nuphar common.	1/4 acre island
50	50	3	Shallow (0-1.5') Carex and Equisetum throughout.	Existing platform
37	90	4	Very shallow (0-1') Extensive beds of Equisetum and Carex.	Existing platform
11	60	6	Same as above.	New platform
22	60	6	Same as above.	Existing platform
56	40	6	Same as above.	Existing platform
145	20	5	Same as above.	Island w/o platform
72	50	4	Same as above.	Existing platform
28	20	1	Same as above.	Existing platform
117	70	5	Same as above.	Existing platform
806	5	4	Deep (6'+) w/3 islands: Some emergents.	Existing platform
78	60	2	Shallow (1-2') good emergents. Not connected.	Existing platform

CONCLUSIONS

Based on our 6 years of observations, it is evident that a significant breeding population of Trumpeter Swans has become established in the Upper Tanana Valley. It appears that prior to 1981. there were no nesting swans in the Upper Tanana Valley. The nesting population in 1987 was 176 and will likely increase.

From 1982 through 1987, the late thaw delayed initial swan nesting. However, the total ice-free period period was extended in the fall by warm weather. Thus, the late spring probably did not have a major effect on production. Historically, the number of ice-free days each year is unknown for this area. Further investigation is needed to determine if this factor could have had a limiting effect on nesting swans prior to the 1980's.

Potential swan nesting sites appear to be in good supply and able to accommodate considerably more swans than now use the valley. Breeding age swans continue to be attracted to this area.

Human impacts on nesting swans in the Upper Tanana Valley are undocumented. Because of the increasing number of nesting swans, this issue needs to be investigated and the effects of potential human activity on swans determined.

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IMPACTS ON TRUMPETER SWANS (Cygnus buccinator) FROM EGG COLLECTION ACTIVITIES IN MINTO FLATS, ALASKA, 1987.

Rodney J. King

ABSTRACT

The U. S. Fish and Wildlife Service (USFWS) is analyzing the effects of egg collection on resident Trumpeter Swans in Minto Flats, Alaska. The collection is being done to supply Trumpeters to Midwest restoration efforts. Collection activities include landing a float-equipped, single-engine aircraft on the nesting lake and removal of all but two fertile eggs from the nest. Immediate (nest desertion) and long-term (cygnet survival) impacts are monitored. This is the second year of a 3-year study, and comparisons between 1986 and 1987 show some similar results.

Sixteen nests were needed each year to collect the authorized 50 eggs. During 1987, 81 percent or 13 nests hatched at least one cygnet. In the control area where no collection was made, 89 percent or 55 nests hatched. By mid-September, 72 percent of the cygnets in the control area had survived compared to only 33 percent survival in the collection nests. Of the 16 sites collected from in 1986, 13 (81 percent) were occupied in 1987, compared with 78 percent occupancy at other nest sites in the study area. It appears that hatching success may not be affected by collection disturbance. However, cygnet survival may significantly decrease. Nest site faithfulness does not appear to be altered by egg collection activities.

NUMBER AND AGE COMPOSITION OF TRUMPETER SWANS WINTERING ON THE EAST COAST OF VANCOUVER ISLAND, BRITISH COLUMBIA, 1983-1988

Karen F. Morrison

ABSTRACT

Trumpeter Swans wintering on the east coast of Vancouver Island from Courtenay-Comox to the Cowichan Estuary have been routinely censused using ground counts throughout the fall and winter months since 1983. These surveys provided information on total number of swans, proportion of cygnets to adults, and habitat selection. The total number of Trumpeter Swans increased from 646 to 1,415 birds, with the largest concentrations occurring in the Courtenay-Comox area. The proportion of cygnets varied from 7 to 24 percent. Habitat types used by swans in the study area were primarily winter pasture or potato field stubble.

INTRODUCTION

Annual aerial counts of wintering concentrations of Trumpeter Swans were conducted over all of Vancouver Island from 1969 to 1981 by the British Columbia Fish and Wildlife Branch (Figure 1). During this period, large increases were noted in the wintering swan population with apparent shifts in distribution, particularly toward the east coast (Blood and Smith 1971, Davies 1978, Davies 1981). The counts of Trumpeter Swans were curtailed in 1981. Ground counts were initiated in 1983 in an area located on the east coast of Vancouver Island between Courtenay-Comox and Cowichan Bay-Duncan (Figure 2).

The purpose of this paper is to present information on Trumpeter Swans collected through ground counts conducted from 1983 to 1988, with a discussion of abundance, distribution, proportion of cygnets, and habitat use.

METHODS

Selection of the ground count area was based on the following criteria: known areas with large concentrations of swans, agricultural fields in the Comox area with concentrations of swans where conflicts with farmers resulted in a need for monitoring swan use, and a count area that could be surveyed in 2 days and was large enough to include a significant portion of Vancouver Island's wintering swan population.

The count area was divided into two sections, the Courtenay-Comox section and from Nanaimo south to the Cowichan Estuary (Figure 3). Ground counts were conducted each winter from 1983 through 1988 from mid-November to mid-March. Each section was searched thoroughly for swans, including coastal shoreline, estuarine habitats, fresh water lakes and agricultural fields. The highest 1-day counts from each monitored section were combined to give an overall total of Trumpeter Swans for each year. Annual aerial counts from 1978-81 have been included in the analysis to provide a comparison of trends of growth in the east coast population. Because the 1983-84 survey was the first year of ground census, areas of concentrations of swans were still being determined. Thus, the data collected in 1983-84 was considered weak and has not been included in the analysis.

RESULTS AND DISCUSSION

Abundance

The Trumpeter Swan population on the east coast of Vancouver Island appears to have increased approximately 300 percent since 1979, and now totals about 1,500 swans (Table 1). This represents an annual increase of 14 percent.

It is not known if this observed increase is common throughout Vancouver Island. Swan numbers and distribution have changed greatly on Vancouver Island since counts were initiated in 1969. The population remained relatively constant at 800 to 1,000 birds from 1969 to 1976. However, during this period, the west coast populations increased (Blood and Smith 1971, Davies 1978).

From 1977 to 1981, west coast populations increased above previous levels and east coast populations continued to increase rapidly, resulting in a 60-percent increase in the total Island swan population (Davies 1981).

The 1984 to 1988 data presented here suggests a continuation of this trend until at least 1985 followed by a leveling off of the population in the last 2 years. The east coast population now almost equals swan numbers observed on all of Vancouver Island in 1981 (Table 1). This suggests a very large increase in swans wintering on Vancouver Island, possibly totaling as many as 3,000 birds. Aerial counts would be required to adequately assess increases in numbers noted in these ground counts.

Proportion of cygnets

The proportion of cygnets in the east coast census area

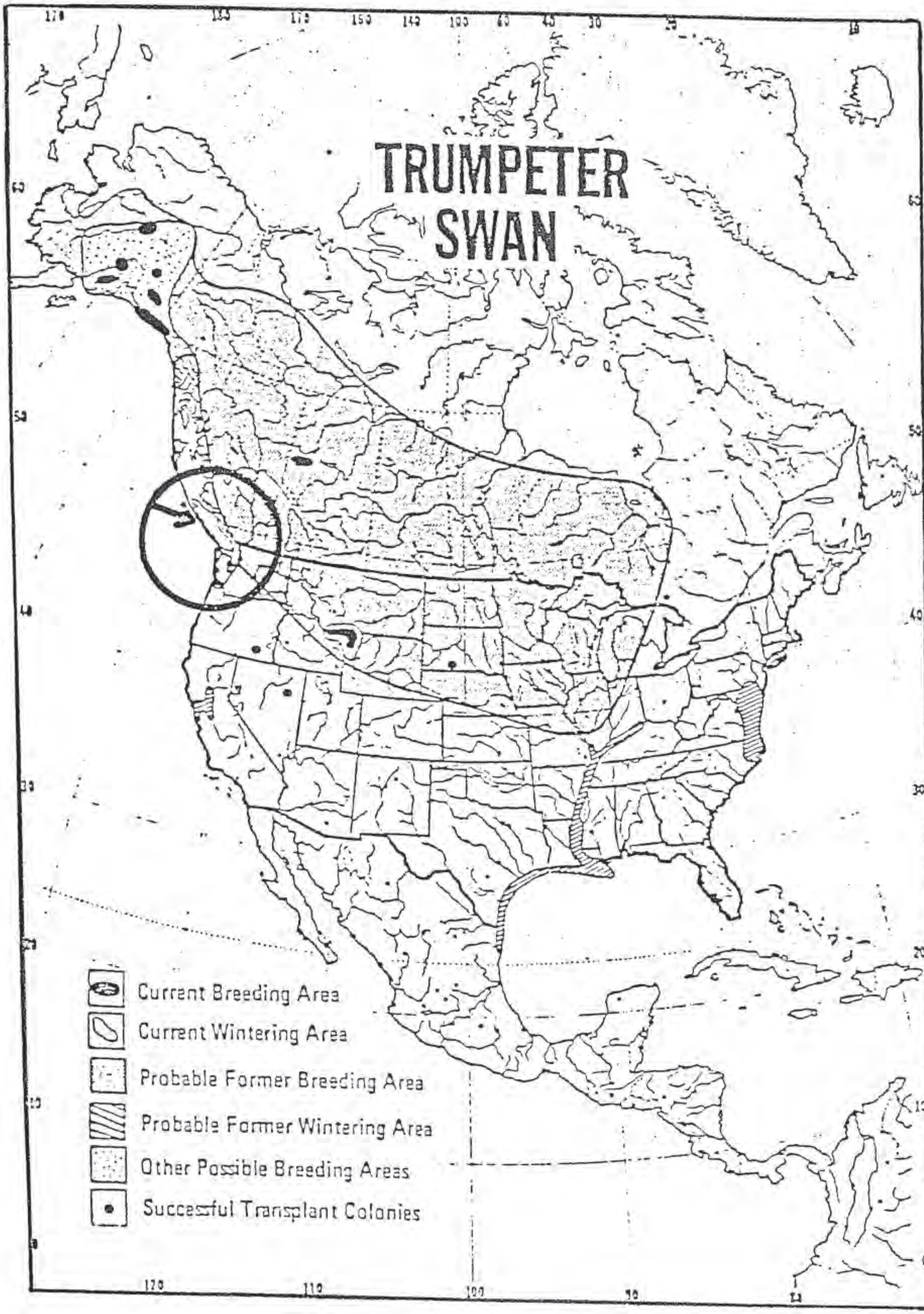

Figure 1. Location of Vancouver Island, British Columbia.

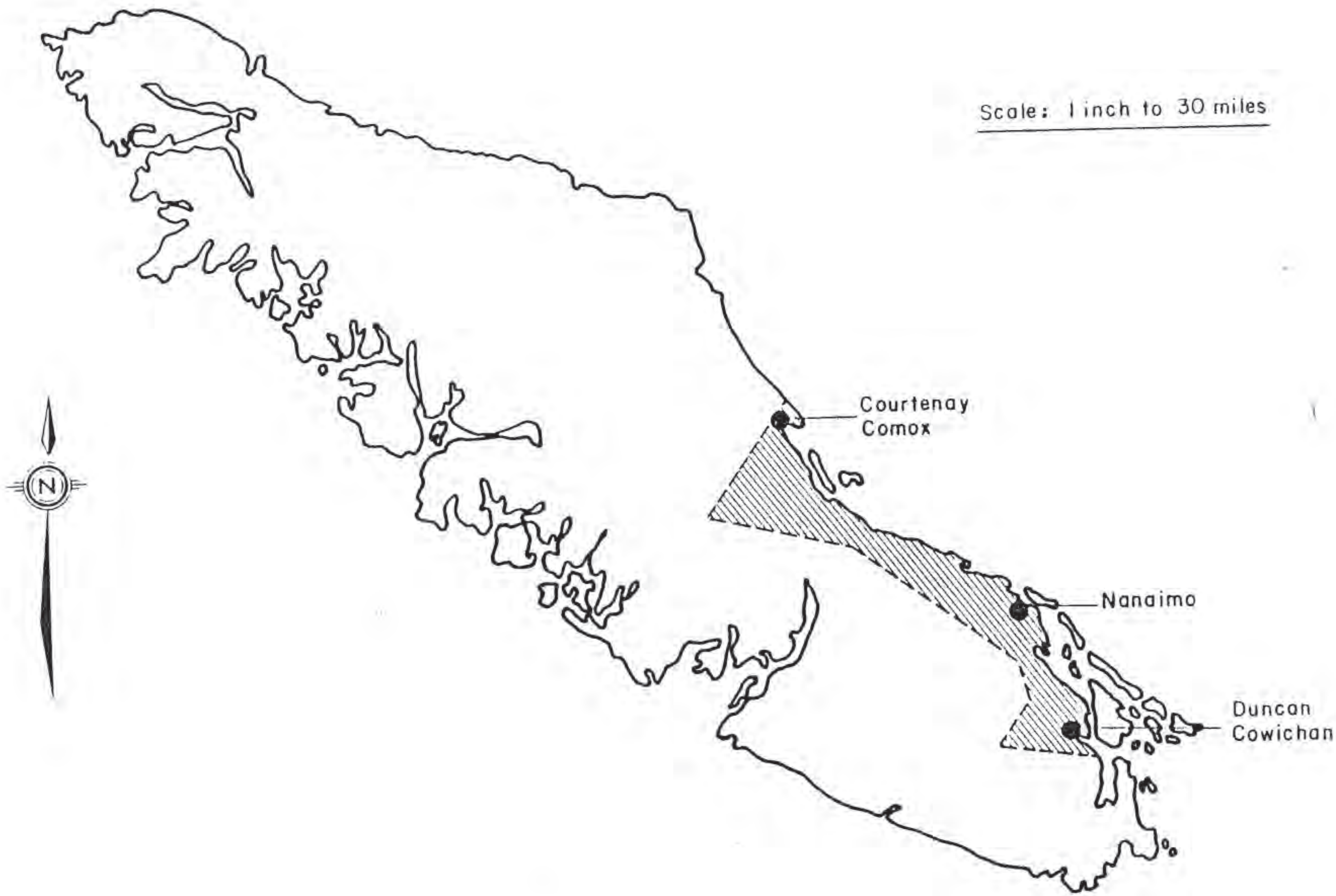

Figure 2. Area of winter census of Trumpeter Swans on Vancouver Island, British Columbia (crosshatched area).

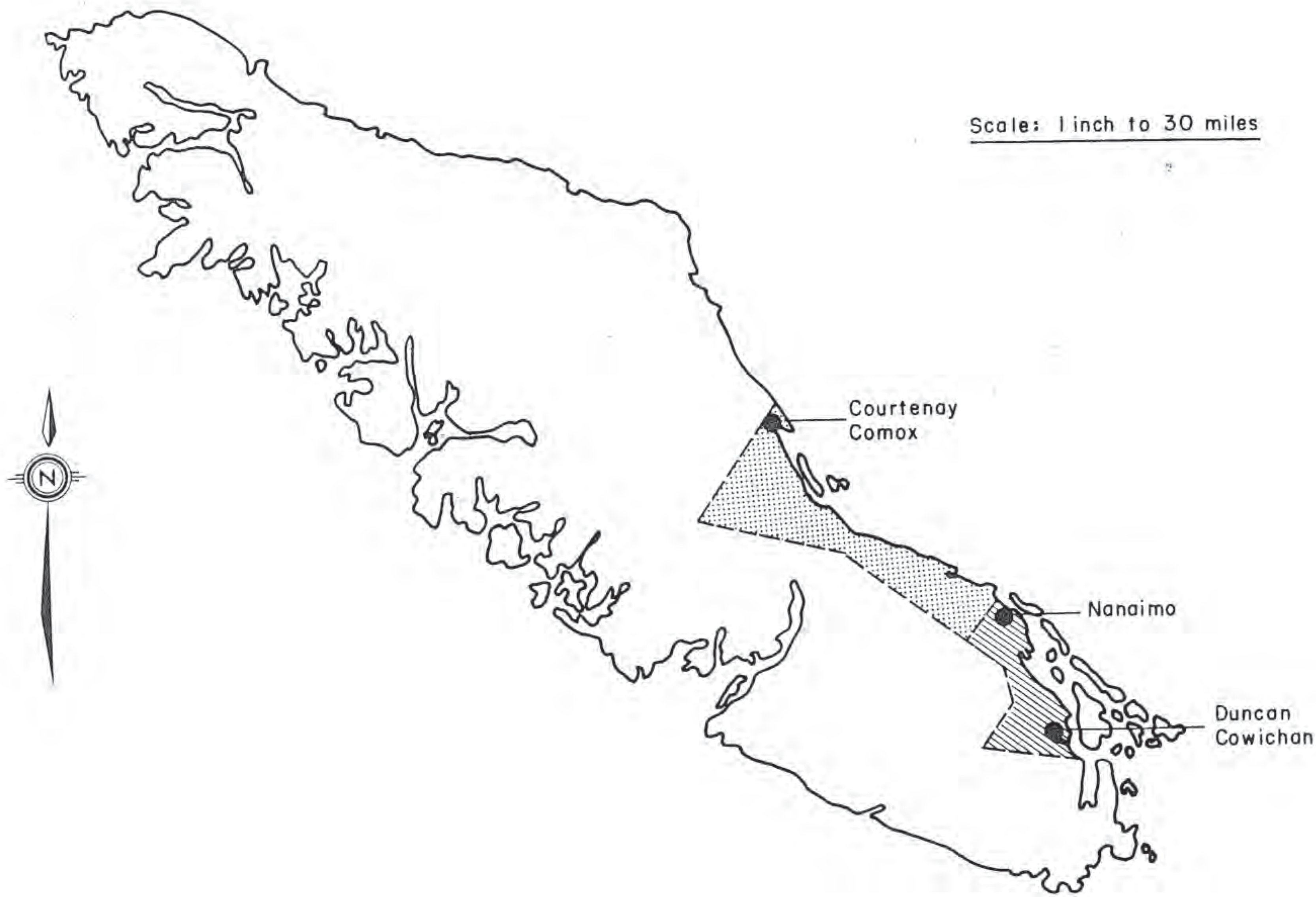

Figure 3. Division of census area, Vancouver Island, British Columbia.

Table 1. Number of Trumpeter Swans wintering on Vancouver Island, 1978-81, and on the east coast of Vancouver Island, 1978-88.

		Aerial counts			No census		Ground counts				
Area	Swans	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84*	1984-85	1985-86	1986-87	1987-88
East coast (Cowichan-Comox)	Total swans	518	617	710	--	--	646	1317	1434	1508	1415
	Total adults	384	459	499	--	--	533	1101	1336	1228	1081
	Total immatures	134	158	211	--	--	113	216	98	280	334
	Percent immatures	26	26	30	--	--	18	16	7	19	24
Vancouver Island annual aerial count	Total swans	958	1555	1685	--	--	--	--	--	--	--

* Considered weak data.

averaged 17 percent (range 7-24 percent) between 1984-1988. This percentage was similar to the 19-percent (range 13-24 percent) cygnets ratio for the same area between 1971-1977 (Davies 1978). The low proportion of cygnets (7 percent) in 1985-86 may reflect poor breeding success, low fledgling survival, and detrimental climatic conditions on the northern breeding grounds.

The high, 27-percent average (range 26-30 percent), of cygnets in the 1979-81 period may indicate high productivity. Increased total numbers of swans noted in the 1984 to 1988 census period may reflect the increased productivity that occurred in 1979 to 1981. The proportion of cygnets during the 1983-88 count period returned to the more typical average of 17 to 19 percent.

Habitat use

Wintering populations of swans in the east coast area utilize agricultural fields (pastures, potato stubble, market garden areas) more frequently than fresh or salt water environments during daylight hours. Moderate weather conditions during the census period (1983-1988) allowed swans to utilize these habitats throughout each winter. Intensive use of these fields has resulted in increased conflicts with farmers, primarily in the Courtenay-Comox area. This is of significant management concern, and requires continued monitoring.

RECOMMENDATIONS

Winter aerial surveys should be conducted every 5 years on Vancouver Island and the associated mainland. These need to be done in conjunction with continued local ground monitoring of the winter swan population.

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A SUMMARY OF THE STATUS OF TRUMPETER SWANS IN WASHINGTON STATE

Martha Jordan

INTRODUCTION

The purpose of this paper is to present a summary of Trumpeter Swans (Cygnus buccinator) occurring in Washington State from 1984 to 1988. Jordan (1986) and Canniff (1986) summarized the status of Trumpeter Swans in Washington prior to 1984. Information for this report has been gathered through the cooperation of private individuals, state, provincial, and Federal resource agencies. A network of local residents contributed their time and information to The Trumpeter Swan Society (TTSS). Without this assistance, the level of information on Trumpeter Swans in the Pacific Northwest would not be as complete. The Washington Department of Wildlife (WDW) and the U. S. Fish and Wildlife Service (USFWS) have also cooperated with TTSS through conducting limited aerial and ground surveys. In addition, several biologists from these agencies contributed sightings and habitat use information.

WINTERING AREAS

Eastern Washington

During the winter months, many water bodies and wetlands in eastern Washington freeze and food resources become unavailable to waterfowl. Prior to 1986, the only reported winter sighting of Trumpeter Swans was on or near Turnbull National Wildlife Refuge (NWR), and only in years when open water was available. Recently, reports of wintering Trumpeters have been increasing in numbers and in variety of locations. Trumpeters have been reported from the upper Columbia River above Chief Joseph Dam, Moses Lake vicinity south to Othello, near Walla Walla, and at the confluence of the Snake and Columbia Rivers (Figure 1).

However, the presence of large numbers of wintering Tundra Swans in the State of Washington and the lack of a large number of sightings carefully verified to species, as well as the lack of a comprehensive, statewide survey of swan winter-use, makes it impossible to draw any conclusions in eastern Washington.

Western Washington

Western Washington is one of the most important wintering areas for the Pacific Coast Population of Trumpeter Swans. Wintering habitats used by varying numbers of swans are scattered throughout the region (Figure 1). These habitats are of two types, agricultural fields adjacent to or near small lakes and wetlands, and ponds, lakes, and estuaries generally associated with forested areas. The principal difference between these types is where the swans obtain food. In the first type, feeding is primarily in the fields on grass, field corn, cruciferous vegetable crops, and potatoes. Where swans are associated mostly with ponds, lakes, and estuaries, their food is emergent vegetation.

The Skagit Valley is the most important wintering area in Washington. It is characterized by agricultural fields adjacent to or near small lakes and wetlands. Approximately 450 to 500 Trumpeter Swans winter in the Valley with an equal number of Tundra Swans.

Outside of the Skagit Valley, Trumpeter Swans are scattered in many areas as single individuals, family groups, or small flocks. The following are the principal wintering areas:

- Lower Nooksack River Valley
- San Juan Archipelago - principally San Juan Island
- The Olympic Peninsula
  - Mukkaw Bay: Waatch River
  - Lake Ozette and vicinity
  - Lake Quinalt
- Willapa Bay and the Long Beach Peninsula

The Lower Nooksack River Valley in northern Washington, near Bellingham, is similar in available habitats to the Skagit Valley. The swans using this area have steadily increased from 40 Trumpeters observed in 1983 to over 75 in 1987.

The San Juan Archipelago consists of over 50 large and small islands (Figure 1). It provides wintering habitat in the form of several marshes and small forested lakes on the larger islands. Since 1975, when Trumpeters were first observed at Three Meadows Marsh on San Juan Island, the population has grown to about 60 birds which use many of the small lakes and marshes scattered on the Island. Individual family groups have also been observed on Orcas and Lopez Islands.

Cape Flattery and the Northwest Coast provide forested wetland habitat for Trumpeters. Lake Ozette and several smaller lakes in the general vicinity are used each winter by pairs or family groups; as many as 30 have been sighted on Lake Ozette at the north end. This heavily forested wintering area is relatively large and is not well-defined. It extends from Lake Ozette at the northwest corner to Beaver Lake, near Sappho at the northeast corner, and south to the Hoh River. The swans that use this area move as family units between Lake Ozette and the numerous small lakes, wetlands, and rivers, including the Hoh and Bogachiel. An increasing number of Trumpeters are reported on the Hoh and Bogachiel Rivers by steelhead fisherman each year.

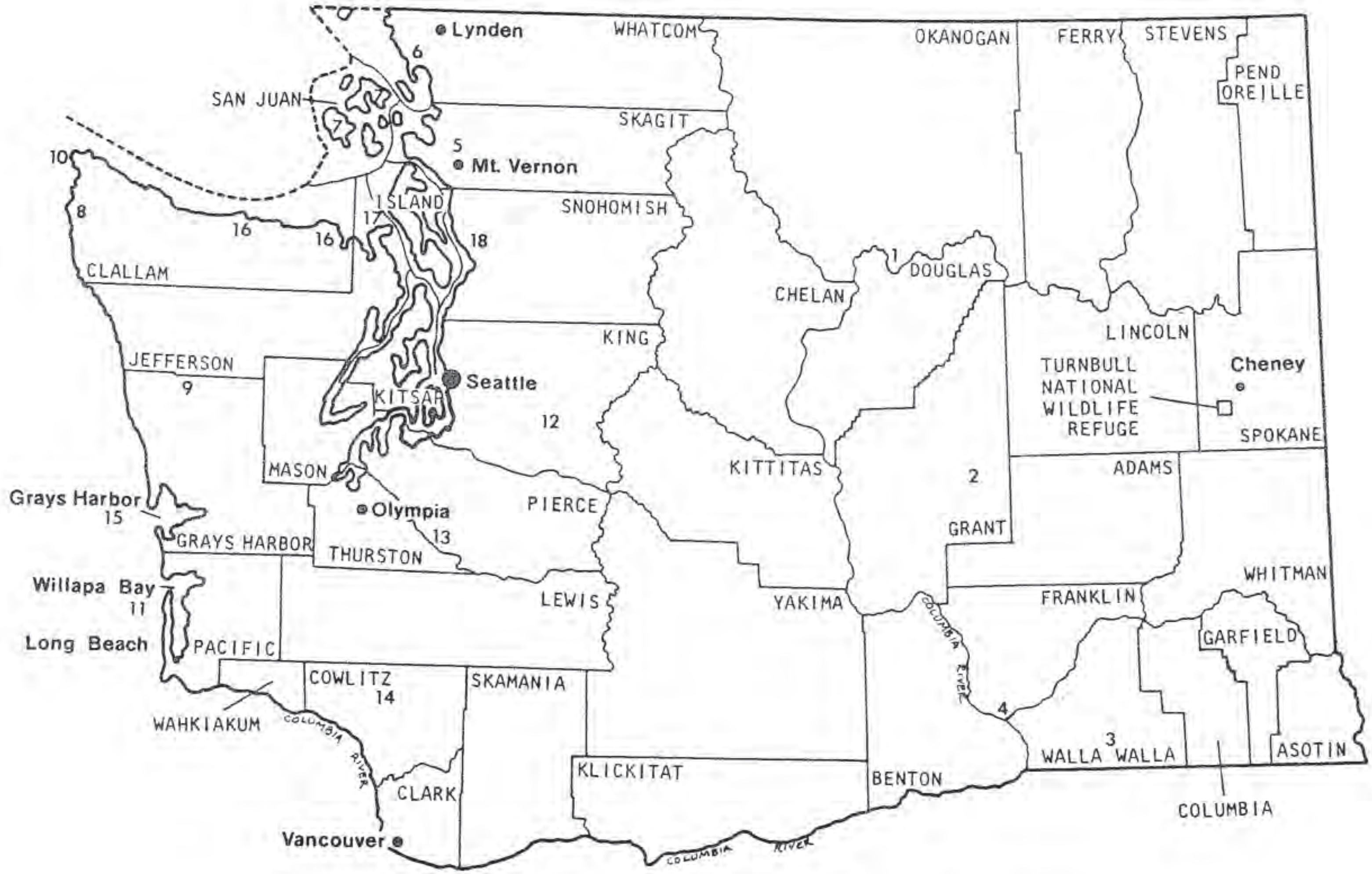

Figure 1. Key to Washington State Trumpeter Swan Locations

1. Chief Joseph Dam
2. Moses Lake area
3. Walla Walla
4. Snake & Columbia rivers confluence
5. Skagit Valley area
6. Lower Nooksack River Valley
7. San Juan Archipelago
8. Lake Ozette
9. Lake Quinalt
10. Cape Flattery area
11. Willapa Bay area
12. Cedar River area
13. Yelm-Deschutes River area
14. Silver Lake
15. Grays Harbor
16. Port Angeles-Sequim area
17. Port Townsend
18. Snohomish River Valley

Figure 1. Washington State Trumpeter Swan locations.

Lake Quinalt, in the central Olympic Peninsula, is used by a group of 15 to 30 Trumpeters. These birds primarily rest and feed at the eastern end of the Lake, near the mouth of Quinalt River. Family units and pairs probably belonging to this larger group have also been observed in the wetlands associated with the drainages west and south of the Lake.

Willapa Bay in the southwest corner of Washington has historically been an important wintering area for Trumpeter Swans. The small forested lakes and marshes on the Long Beach Peninsula and in the Lewis Unit of the Willapa NWR provide winter habitat for over 60 Trumpeters. Tundra Swans are also frequently found on the Refuge and to the south along the Columbia River.

In addition to these major wintering areas, family groups of Trumpeters have been observed in several other areas in western Washington. A pair, one with a blue collar, was observed in the Cedar River watershed southeast of Seattle. The area southeast of Olympia, from Yelm through the Deschutes River drainage, supports wintering Trumpeters, although observations have been sporadic over the years. Silver Lake, east of Castle Rock near Mt. St. Helens, supports five to 20 Trumpeters in the extensive marsh areas at the eastern end of the Lake. Grays Harbor, north of Willapa Bay, has family groups using the estuarine marshes of the Elk River and dune wetlands. Grays Marsh on Sequim Bay has supported 10 to 15 wintering Trumpeters for many years.

Trumpeter Swan pairs or single birds have also been observed at several other locations on the Olympic and Kitsap Peninsulas such as Lake Aldwell behind the Elwha River Dam near Port Angeles, a farm pond between Port Angeles and Sequim, and on Marrowstone Island, near Port Townsend. The Snohomish River Valley often hosts a pair or family late in the season, especially during years of heavy rainfall.

BREEDING AREAS

Turnbull NWR is currently the only place in Washington where Trumpeter Swans nest. The status of the swans in this area will be presented by June Bergquist later in the program.

CURRENT POPULATION STATUS

An estimate of 800 wintering Trumpeters in Washington appears to have increased since an aerial and ground census in 1982-83 and a limited survey in January 1984 (Jordan, pers. obs.). There has been a two-fold increase of Trumpeters at Willapa Bay, on San Juan Island, and in the Nooksack River Valley, with new sightings of wintering Trumpeters in eastern Washington along the upper Columbia River and near Moses Lake.

While a comprehensive Trumpeter Swan survey has not been done since 1982-83, there are records from midwinter waterfowl counts by WDW, the USFWS, and citizen observations. A comprehensive swan survey coordinated by TTSS is planned for the 1988-89 winter season.

MORTALITY

Disease, accidents, lead poisoning, and shootings are the primary sources of mortality for swans. At this time, comprehensive data are not available on mortalities in Washington from these sources outside the Skagit Valley.

Lead poisoning from ingestion of lead shot appears to be the principal cause of death for Trumpeters in Washington (Washington Department of Wildlife 1980-87). In the 1986-87 winter season, I treated six Trumpeters from the Skagit Valley with lead poisoning and another five swans were found dead in Barney Lake, near Mt. Vernon. I estimate that a minimum of 5 percent of the entire population of Trumpeters in the Skagit died of lead poisoning.

Aspergillosis is also a factor in swan mortality. This fungus is in the environment and may be present in healthy swans without causing illness. However, aspergillosis can contribute to death when swans are stressed from other causes such as lead poisoning, injury, or the lack of food in freezing weather.

A number of Trumpeters are killed each year by hunters and vandals. However, this appears to be a minor source of mortality in Trumpeters. Usually, one or two Trumpeters are shot in the Skagit Valley and one to four in the rest of western Washington. Statewide hunter and public education should improve this situation.

Striking power lines takes a toll each year on swans, especially in the Skagit Valley. While some measures have been taken at Barney Lake to mark power lines with red balls, it is usually the smaller roadside lines that are the biggest hazard. Statistics are not available on the number of swans killed each year from line strikes. However, I have personally observed three to four each year for the past 10 years.

It would be interesting to know if swans that collided with power lines have elevated lead levels. This factor may impair their flight ability or strength just enough so that they can not clear or avoid the obstacle in time to prevent impact. Tests for tissue lead levels should be done on all swan carcasses.

CURRENT PROBLEMS

Loss of habitat is the principal threat to wintering Trumpeter Swans in Washington. Wetland drainage and development adjacent to swan habitat are the primary causes of this loss. For instance, habitat is being lost to a single-family housing development and shopping malls in the Skagit Valley.

On the positive side, Hines Marsh, a 500-acre, 2-mile-long wetland, on the Long Beach Peninsula was historically a major wintering area for Trumpeters. It was illegally drained by developers in 1960 but has been restored as swan habitat. In 1984, TTSS participated in a mediated agreement with a developer and obtained two parcels of land for dike construction to correct water flow in the marsh. The dikes were installed, and water levels in the marsh have returned to predrainage levels. While it will take many years for the damage to the wetland to be corrected, Trumpeters have been observed on the marsh each winter following dike construction.

Lead poisoning continues to be a substantial source of mortality in Trumpeter Swans, as well as other waterbirds. Politically, it has been agreed that a gradual phase-in of nontoxic shot will occur until the entire State has a ban on lead shot in 1991. Even in areas where lead is prohibited, especially in Skagit County, Trumpeters are still dying and will continue to die from lead poisoning for years to come. It is estimated that it will take a minimum of 5 years following the ban on lead shot before lead poisoning in swans will no longer be a mortality factor.

A continuing effort is needed to institute a census of wintering Trumpeters and to inventory their habitat use in Washington and other areas of the Pacific Northwest. Only through cooperation of state and Federal agencies and private citizens can this effort continue to be as successful as it has been. A comprehensive swan survey for western Washington and Oregon is planned for January 1989 in cooperation with state and Federal agencies.

Another priority need is for a review of existing information on swans in the Pacific Northwest. This review is especially important for forested wetland habitats. Information on forested wetlands is woefully inadequate to address management issues in regard to swans.

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STATUS REPORT ON THE TURNBULL NATIONAL WILDLIFE REFUGE TRUMPETER SWAN POPULATION

June Bergquist

UPDATE INFORMATION

In 1963, Turnbull National Wildlife Refuge (NWR) in eastern Washington State began a Trumpeter Swan (Cygnus buccinator) reintroduction program. Results of this program were presented to The Trumpeter Swan Society in Victoria, British Columbia, Canada (1981). Updated information is provided in Table 1. Management activities for the swans at Turnbull NWR have been reduced to recording observations and minimizing disturbance. No new reintroduction efforts are anticipated.

ADDENDUM NOTE

The Canadian Wildlife Service reported a collared Trumpeter Swan in early April 1985 near Williams Lake and Risky Creek, located halfway up the province of British Columbia, Canada. The swan was banded and collared at Turnbull NWR as a juvenile female. Her collar was green with the number 16PA. She was seen traveling with a group of Tundra Swans. In February 1987, the same swan was sighted by Refuge personnel at the Lower Klamath NWR in southwest Oregon. The bird was with a flock of Tundra Swans and one other Trumpeter. It was not clear if the two Trumpeters were a mated pair.

Table 1. Trumpeter Swan population at Turnbull NWR from 1981 through 1987.

Year	On Refuge (spring)	Off Refuge	Production	Fledged
1981	10	-	5	3
1982	5	1	1	1
1983	3	-	1	1
1984	4	1	3	3
1985	5	-	-	-
1986	5	-	-	-
1987	3	1	3	3

POPULATION STATUS OF TRUMPETER SWANS IN SOUTHEAST OREGON

Gary L. Ivey

INTRODUCTION

The Malheur National Wildlife Refuge (NWR) Trumpeter Swan (Cygnus buccinator) population is the result of an introduction program which began in 1939. The history and status of this population through 1984 was summarized by Cornely et al. (1985). The program became a success when the first nesting was documented in 1958. Since 1958, the population has increased, but recently has experienced drastic fluctuations. This paper presents recent population trends, migrational movements, factors limiting the population, a population model, and management recommendations for enhancing the population.

POPULATION TRENDS

Trumpeter Swan population estimates for midwinter, spring, and fall counts in the Harney Basin of southeast Oregon from 1972-87 are listed in Table 1. (Malheur NWR lies within the Harney Basin.) Spring populations fluctuated between 22 and 53 birds during this period. Except for 2 years, spring numbers were lower than the previous fall populations by zero to 52 percent averaging 24 percent (Table 1). These rates of decline were highest during years of severe winters and locally low food supplies.

Increases in numbers from spring to fall fluctuated from 0 to 38 birds. Included in that fluctuation was recruitment from summer procuction, and possibly come mortality or migration out of the area. I suspect that nonbreeders dispersed in the spring to remote areas, and returned in the fall in time to be counted.

The midwinter data indicate that in most years the population is sedentary. However, in the dry years of 1975, 1977, 1978, and 1988, the majority of the population was absent from the local area in midwinter. Midwinter counts for the years 1979 through 1982, and for 1985 and 1987 reflected slight increases over the previous fall numbers, suggesting migrants were using the area. However, these extra birds may have been part of the local population which were missed during the fall censuses.

Production data since 1972 is summarized in Table 2. Production has fluctuated greatly, ranging from 0 to 34 cygnets fledged. The number of nesting pairs peaked in 1980, a year of abundant food resources, and has since shown a declining trend. Although the population has produced an average of 12 cygnets annually, the overall population has not significantly increased, and the number of nesting pairs has declined in recent years.

Table 1. Midwinter, spring, and fall population estimates for Trumpeter Swans in southeast Oregon, 1972 to 1987.

Year	Midwinter population	Spring population	Spring population decline from previous fall (%)	Fall population
1972	50	29	52	45
1973	32	28	38	40
1974	36	28	30	38
1975	15	32	16	40
1976	30	22	45	31
1977	17	32	0	33
1978	7	32	3	37
1979	41	26	30	64
1980	65	57	11	68
1981	77	53	22	62
1982	65	49	21	55
1983	52	43	22	72
1984	63	46	36	46
1985	51	36	22	40
1986	33	22	45	43
1987	49	44	0	52

Table 2. Production history of Trumpeter Swans in southeast Oregon, 1972-87.

Year	Nesting pairs	Cygnets hatched	Cygnets fledged
1972	7	16	13
1973	6	4	4
1974	5	12	9
1975	5	*	7
1976	*	12	8
1977	3	1	0
1978	11	16	13
1979	11	37	34
1980	19	28	19
1981	15	19	9
1982	13	19	19
1983	10	28	17
1984	10	14	6
1985	7	13	2
1986	9	23	22
1987	9	18	14

* No data.

POPULATION MOVEMENTS

In 1980, I initiated a Trumpeter Swan collaring study on Malheur NWR. The purpose of the study was to document the fate of swans after fledging and identify areas used by the local population throughout the year. A total of 65 cygnets and 10 adults have been collared. Until 1987, the data showed the population to be nonmigratory with only two reports from outside of Harney Basin. Both were within 50 km of the Refuge. However, in December 1987, I received a report that a collared bird was shot in Nevada. In January 1988, a live collared bird was reported at Lake Almanor, in northeast California. All Trumpeter Swan records that I am aware of outside the Harney Basin in eastern Oregon, northeastern California, and western Nevada are given in Figure 1.

FACTORS LIMITING THE POPULATION

Food resources

Local food resources appear to be the major factor limiting the population. Carp (Cyprinus carpio) have reduced aquatic habitat quality in many of the ponds and marshes of the Refuge by diminishing aquatic submergent plants. Malheur and Mud Lakes used to support three to five nesting pairs. Following a record wet cycle, these lakes (increased to record water levels) and carp populations expanded enormously, nearly eliminating swan feeding habitat in the lakes. No nesting has occurred there since 1984.

The availability of food resources in midwinter is perhaps the greatest limiting factor, as ice drastically limits access to already-reduced submergent plant resources.

Low recruitment

It appears that few young survive long enough to become breeders. The annual population estimates (Table 1) indicate that winter mortality has averaged 24 percent since 1982. The data from the collaring study showed a cygnet mortality rate of 31 percent during the first year. Winter mortality among subadults also appeared high (nine collared subadults were found dead). During severe winters, I have observed dominant adult pairs driving unpaired subadults away from feeding areas. I suspect that the subdominant birds may subsequently starve.

Mortality

Since 1958, 38 Trumpeter Swan mortalities have been documented. Thirteen swans were shot, nine died after power line collisions, one died from a fence entanglement, six were predated, and nine died from starvation, disease, and unknown causes. No evidence of lead poisoning has been found in this population.

Water management

Inadequate water control facilities have limited the potential for swan nesting in many areas of Malheur NWR. Forty-year-old facilities have deteriorated extensively, preventing proper management of marshes. Areas have suffered from uncontrolled water fluctuations, seasonal water shortages, and the inability to drain them to control carp and reinvigorate marsh soils. The inability to properly manage these areas has resulted in diminished food resources as well as nesting habitat for swans.

A POPULATION MODEL

A modified version of Pop-II, a computer program designed to simulate population dynamics (developed by J. Bartholow of Fossil Creek Software, Fort Collins, Colorado), was used to model population dynamics of the Malheur NWR Trumpeter Swan population. This version was developed for our use on Sandhill Cranes (Grus canadensis). It allows 25 age classes to be tracked with egg, chick, and adult mortality factors. Input for the model includes initial population sizes by age class, fall-winter mortality by age class, pre-fledge chick mortality by year, reproductive rates (eggs/100 breeding females) by year, age considered breeders, and the sex ratio at birth.

Refuge data from 1972 through 1987 were used to set up the model. The model was tested and factors adjusted to align the model to the existing data (1972-87). After achieving alignment of the model, two separate simulations through the year 1996 were run (Figures 2 and 3). In the first simulation, the input variables for the years 1972-80 (a drought cycle) were used to predict population changes for the years 1980-96, assuming that population dynamics in the future would mimic conditions in 1972-80. Input variables for the years 1979-87 (a flood cycle) were used for the second simulation to predict the swan population through 1996.

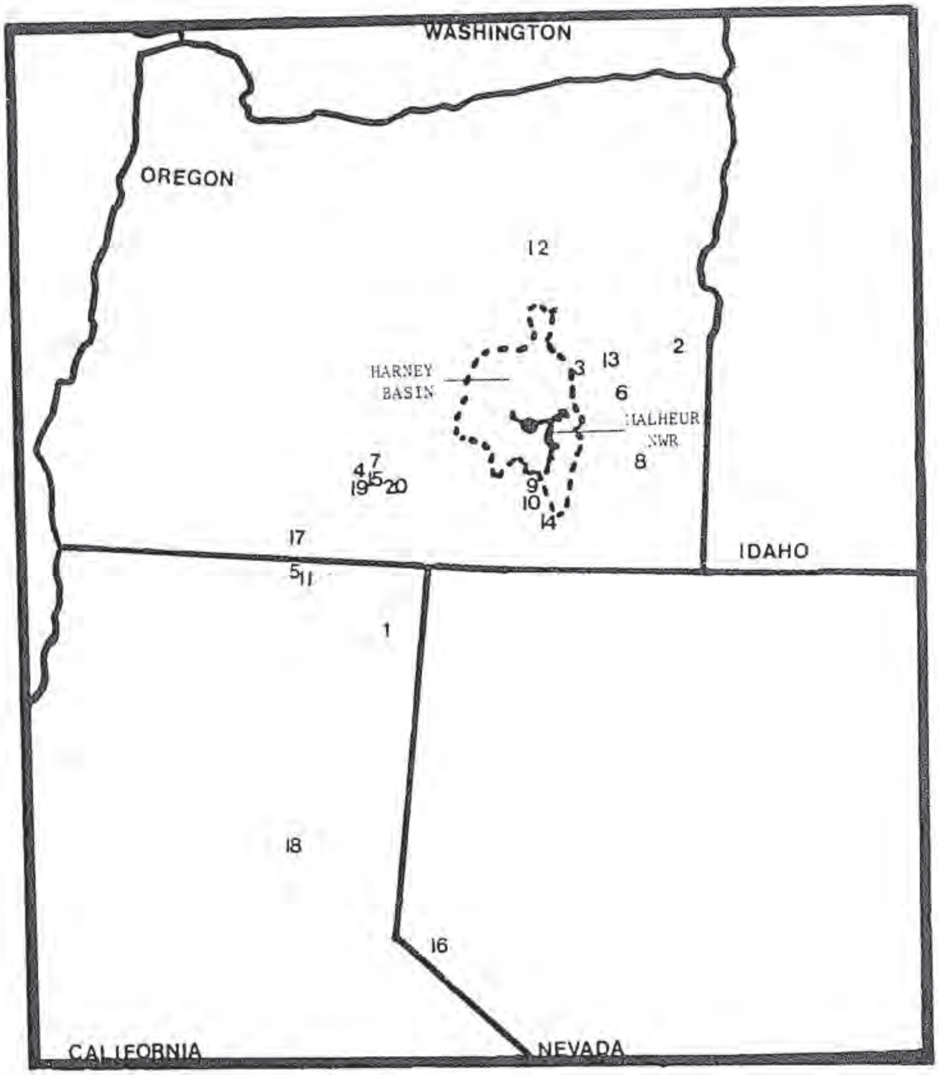
Comparing the two simulations, the population remained generally higher for the second simulation (the flood cycle). However, the 1996 population showed only three more birds than the drought cycle simulation. The most important conclusion from this modeling effort was that if environmental conditions do not drastically change from what they have been in the recent past, the population should remain relatively stable. However, if these drastic population crashes are allowed to continue the population could become too small to be viable.

MANAGEMENT RECOMMENDATIONS

Develop migrational traditions to better wintering areas

Because the local Trumpeter Swan population is generally sedentary, winter food availability limits the productivity and survival of individual swans and ultimately limits the population's potential for expansion. To overcome this factor, the swans need to develop migratory traditions to other wintering sites which have better winter food resources. A survey for potential wintering sites and an evaluation of their potential for swan use needs to be conducted. Potential wintering sites in Oregon which appear suitable for Trumpeter Swans include Summer Lake Wildlife Management Area (Lake County) and the Sprague and Williamson Rivers (Klamath County).

I recommend that molting, nonbreeding Trumpeters be captured and transported to potential winter sites to develop migratory traditions. They then can familiarize themselves with the area while finishing their molt. Hopefully, they will return to the Harney Basin and, in doing so, learn routes for migration to new wintering areas.



Record	Date	Number	Location	Source
1	March 1964	7	Modoc NWR, CA	C. Markley, USFWS
2	21 April 1971	1	Vale, OR	Malheur NWR files
3	21 March 1981	1	Beade Res., OR	A. Polenz, ODFW
4	25 June 1984	1	Summer Lake, OR	M. St. Louis, ODFW
5	Dec. 1984	1	Lower Kalmath NWR, CA	M. Robbins, Yreka, CA
6	Summer 1984, 1985	2 (a pair)	Crowley, OR	Rancher report
7	3 Oct. 1985	1	Summer Lake, OR	The Eagle Eye, Nov. 1985
8	3 Nov. 1985	1 (cygnet)	Rome, OR	R. Voss, USFWS
9	10 Jan. 1986	1	Catlow Valley, OR	G. Ivey, USFWS
10	July 1986	4 (2 ad, 2 cyg)	Catlow Valley, OR	G. Ivey, USFWS
11	4 Febr. 1987	2 (a pair)	Lower Klamath NWR, CA	M. Robbins, Yreka, CA
12	3 May 1987	1	Long Creek, OR	Duck Soup Newsl., 1987
13	15 Aug. 1987	1	Juntura, OR	K. Yates-Mills, Burns, OR
14	5 Oct. 1987	4 (2 ad, 2 cyg)	Skull Creek, OR	C. Carey, ODFW
15	29 Nov. 1987	1	Summer Lake, OR	M. St. Louis, ODFW
16	5 Dec. 1987	1	Mason Valley WMA, NV	T. Retterer, NDFW
17	6 Dec. 1987	2 (a pair)	Worden, OR	M. Robbins, Yreka, CA
18	12 Jan.-16 Feb. 1988	1	Lake Almanor, CA	T. Manolis, Scrmento, CA
19	10 Feb. 1988	1	Summer Lake, OR	R. Madigan, ODFW
20	27 Feb. 1988	3 (2 ad, 1 cyg)	Summer Lake, OR	M. St. Louis, ODFW

Figure 1. Records of Trumpeter Swans outside the Harney Basin, in eastern Oregon, northeastern California, and western Nevada.

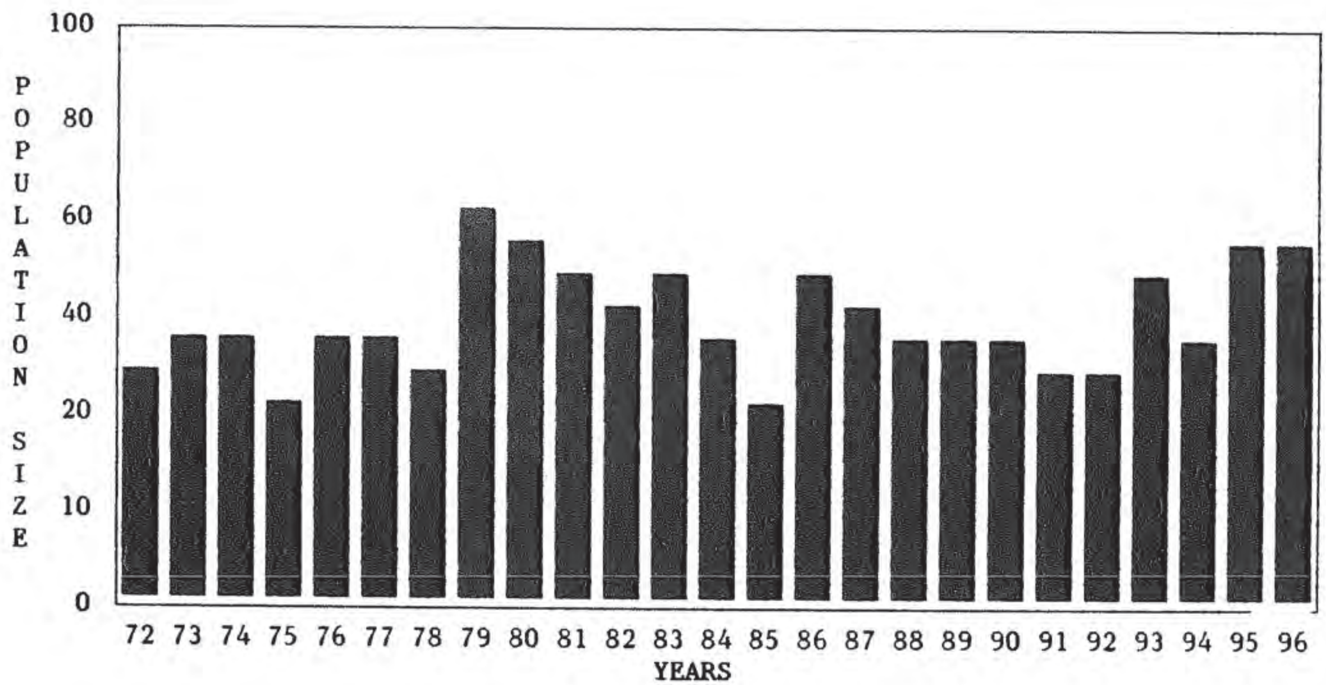


Figure 2. Pop-II Computer Model simulation of Malheur NWR Trumpeter Swan population dynamics using variables from 1972-80 (a drought cycle) to predict the spring swan population through 1996.

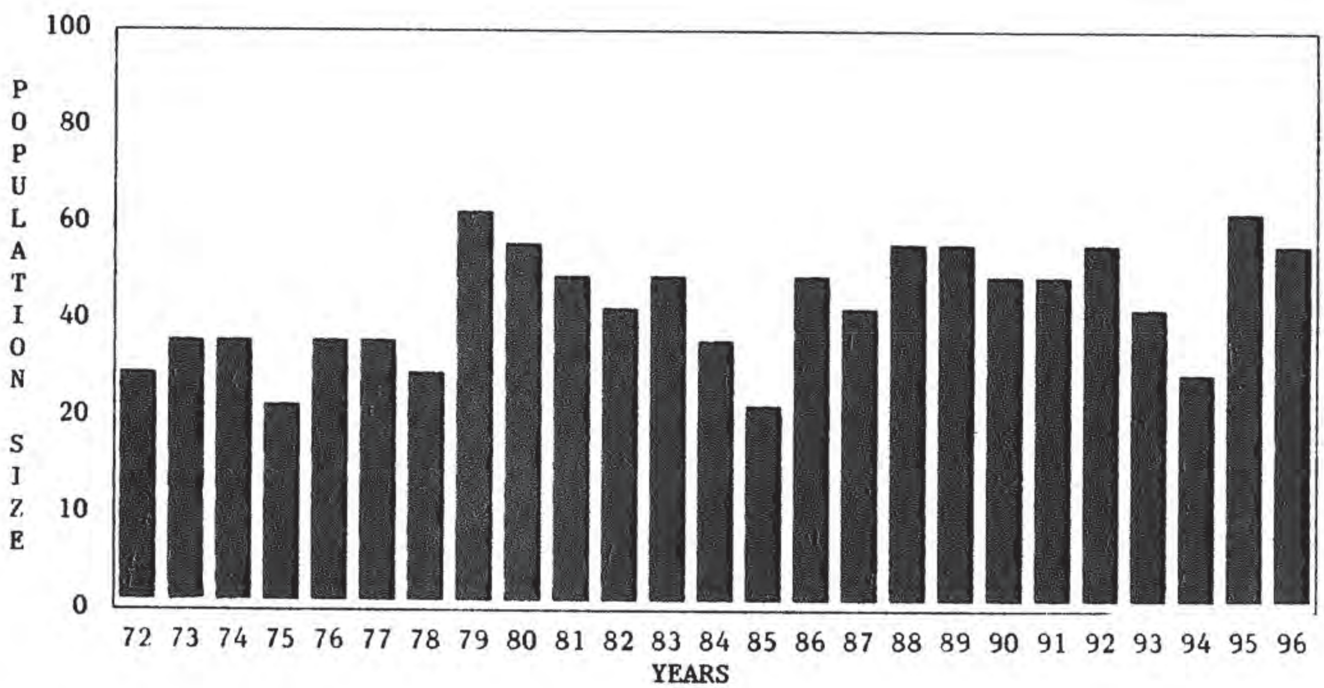


Figure 3. Pop-II Computer Model simulation of Malheur NWR Trumpeter Swan population dynamics using variables from 1979-86 (a flood cycle) to predict the spring swan population through 1996.

Establish a second nesting Trumpeter Swan population in Southeast Oregon
The Harney Basin has limited potential for supporting nesting Trumpeter Swans, because carp have drastically reduced submergent food resources. Development of a second population of Trumpeter Swans in an area of higher quality nesting habitat could lead to a larger and healthier Trumpeter Swan population in southeast Oregon. Evaluation of potential wetland areas in southeast Oregon is needed. Some potential areas which might support nesting Trumpeters include the Warner and Summer Lake Basins and Sycan Marsh in Lake County, and Klamath Forest National Wildlife Refuge in Klamath County.

I recommend that the most suitable area be selected in southeast Oregon and Trumpeters from some other population (possibly Red Rock Lakes NWR) be transplanted to establish a second population. Both nonbreeders and nearly fledged cygnets could be acquired (15 to 30 birds annually) and introduced for 3 to 5 years. Other options, such as transplanting family groups, should also be considered.

Improve habitat quality
Habitat management at Malheur NWR will require rehabilitation of the water management facilities. Federal funds have been limited, and progress has been slow. It is possible that private funds may be available (e.g., Ducks Unlimited) in the near future.

Carp populations have seriously reduced food supplies for Trumpeter Swans. Elimination or reduction of carp in Malheur NWR wetlands should be done at every opportunity. Drawdowns are an efficient and inexpensive method of carp control where possible. In areas where drawdowns were not possible, Rotenone has been used with some success. Carp barriers are being constructed to protect prime brood rearing marshes as money is available. However, these structures are expensive and progress will be slow. Refuge and State personnel are cooperating with commercial fishermen to determine a way to prevent carp from migrating out of Malheur Lake into Blitzen Valley and Double-O Units of the Refuge.

In addition to the carp infestation, many of Malheur's wetlands are choked with too much emergent vegetation and lack much open water for swan use. Techniques to convert these areas into better habitat are being explored. The goal is to provide more open water conditions (50:50 cover to open water) which should optimize feeding opportunities for waterfowl. Presently, a vegetation management plan is in progress to address techniques such as burning, grazing, mowing, and the use of herbicides to create more open water conditions in the wetlands.

Minimize mortality
Shooting was the most important mortality factor in documented swan deaths on Malheur NWR. Most of these were vandalism-type shootings, although a few were "accidentally" taken by hunters. A greater effort in public education regarding the status of Trumpeter Swans should reduce this type of mortality.

To prevent power line collision mortalities, orange aircraft markers have been placed on power lines where swan losses have been documented on Malheur NWR. Monitoring of power lines that cross wetlands for swan mortalities should continue as well as marking problem lines to prevent future losses.

Monitoring of predation rates on Trumpeter Swans (especially young birds) needs to be done. During some years, predators (particularly coyotes), appear to have significantly reduced numbers of pre-fledged swan cygnets on Malheur NWR. This problem was particularly serious when water levels in brooding areas were very low. If predation rates are high, predator control should be instituted.

Collect more population data
Collection of additional population data may be accomplished by the following:

- Continue to gather information on swan population dynamics.
- Continue the collaring study to get better data on population factors and migration/wintering area use.
- Radio a sample of swans and track their movements through the year to learn more about their migrational movements and identify important areas.
- Conduct a study on cygnet survival and mortality factors by radio tagging newly-hatched cygnets.

CONCLUSION

At Malheur NWR, work is being done to improve conditions and increase production of the Trumpeter Swan population. However, if these Trumpeters are not encouraged to find better winter habitat, the population will likely decline. Establishing a second nesting population of Trumpeters in southeast Oregon could enhance the Oregon Trumpeter Swan population and should lead to overall expansion of Trumpeter Swans in Oregon.

LITERATURE CITED

Cornely, J. E., E. L. McLaury, L. D. Napier, and S. P. Thompson. 1985. A summary of Trumpeter Swan production on Malheur National Wildlife Refuge, Oregon. Murrelet 66:50-55.

A STATUS REPORT OF THE INTRODUCED TRUMPETER SWAN POPULATION AT RUBY LAKE NATIONAL WILDLIFE REFUGE, NEVADA

Sara H. Brown

ABSTRACT

Ninety-six Trumpeter Swans (Cygnus buccinator) from Red Rock Lakes National Wildlife Refuge (NWR), Montana, were released at Ruby Lake NWR, Nevada, between 1947 and 1958. An average of 31 swans currently winter on the Refuge. Some swans disperse in April to areas within 100 miles of the Refuge. Numbers increase again in September and October. Trumpeter Swans generally use areas closed to or not easily accessible by the general public during the spring and summer. An increase in the number of nesting pairs from 3.3 to 6.6 pairs occurred after more restrictive boating regulations were put into effect in 1978. High water levels during 1983 to 1987 did not have an impact on the number of nesting pairs or the number of cygnets raised to fledging stage per pair. Stunted growth of cygnets continues to be observed without a cause determined to date.

INTRODUCTION

Ruby Lake National Wildlife Refuge (NWR), Nevada, is at an elevation of 6,000 feet and encompasses approximately 13,300 acres of wetlands. The area is a natural marsh within a closed basin. Runoff and springs feed the marsh. Annual precipitation averages 13 inches. The marsh is a mosaic of open water, channels, and islands. Hardstem bulrush (Scirpus acutus) borders the islands and channels. The aquatic bed is vegetated by sago pondweed (Potamogeton pectinatus), bladderwort (Utricularia sp.), northern water milfoil (Myriophyllum exalbescens), floating leaf pondweed (P. natans), and muskgrass (Chara spp.).

These 13,300 acres are divided by a dike system into eight units. Five units are 315 or less acres while the remaining three range from 1,755 to 7,320 acres. Water levels are manipulated, but at times this is difficult as there is no outflow. The Refuge staff periodically drains water off a unit for rejuvenation. The drawdown of the two largest units are planned as the opportunity arises with extreme drought conditions.

Trumpeter Swans (Cygnus buccinator) from Red Rock Lakes NWR were introduced to Ruby Lake NWR beginning in 1947. A total of seven releases involving 96 swans occurred over the following 12 years. Since then, Trumpeter Swans have become year-round residents of northeastern Nevada. Some are believed to leave the Refuge during April for surrounding areas up to 100 miles away. These areas may provide more isolation and less disturbance for nesting and rearing young. In September and October, Trumpeter Swan numbers begin to increase on the Refuge. An average of 31 swans used the Refuge during the last five winters. The marsh freezes from mid-November to mid-March with open water available at spring heads and along a portion of a collection ditch. It is during these winter months that the swans come close to human activity due to the location of open water.

Trumpeter Swans on the Refuge, for the remainder of the year,use areas closed or not easily accessible by the general public and at a distance from any traveled dike. Bouffard (1983) speculated that human disturbance is a factor limiting nesting at Ruby Lake NWR . Prior to 1978, there were few restrictions on boating at Ruby Lake NWR. To minimize disturbance to nesting birds on the marsh, restrictions on motor size and season-of-use were put into effect. Since 1978, numbers of nesting Trumpeter Swans have increased, averaging 6.6 pairs per year versus 3.3 pairs per year in the previous 10 years. The number of cygnets surviving to fledging per pair did not differ substantially between the two 10-year periods (0.97 cygnets/pair prior to 1978 versus 0.72 cygnets/pair since 1978). However, because of the small sample size, caution is needed in making conclusions.

The first known nesting in northeastern Nevada occurred in 1953 on Franklin Lake, a seasonal wetland just north of the Refuge. Since 1958, nesting and successful rearing of cygnets has been a regular occurrence. The only year that no nesting attempts were reported was 1964. In 1962 and 1974, there were no cygnets produced on the Refuge, but three individual and five pairs of swans were reported on nests located off the Refuge. Weather was unfavorable in 1962, 1964, and 1974. Snow and cool temperatures extended into May during 1962 and 1964 and precipitation was low during 1974, but runoff and spring flow was sufficient to maintain water levels in all units during the spring. Overall, a total of 130 cygnets are known to have been produced averaging 4.3 cygnets per year since 1958.

Similar to many areas in the west, Ruby Lake NWR has experienced high water levels the past 5 years. Levels were as much as 3 meters above objective levels in 1985. During late summer of 1987, objective levels were once again obtained. Despite the high water conditions, no significant change in production occurred. Each nesting pair produced 0.8 cygnets during the 5 years prior to 1983 compared to 0.6 cygnets produced per nesting pair the past 5 years (Table 1). Stunted growth continues to be noticed in cygnets, but, to date, it has only been speculated that food availability, disease, or parasites may contribute to this growth pattern (Bouffard 1983).

Table 1. Trumpeter Swan production, Ruby Lake NWR, 1978-87.

Year	Nesting pairs	Cygnets produced	
1978	4	2	
1979	6	9	
1980	9	11	0.8 cygnets
1981	8	5	per pair
1982	9	3	
1983	6	5	
1984	7	3	
1985	8	3	0.6 cygnets
1986	3	2	per pair
1987	6	5	

LITERATURE CITED

Bouffard, S. H. 1983. Trumpeter Swan information - Ruby Lake National Wildlife Refuge. Memo to J. Bartonek. U. S. Fish and Wildl., Ruby Valley, Nevada. 2 pp.

TRUMPETER AND TUNDRA SWAN COLLAR SIGHTINGS IN THE SKAGIT VALLEY, 1977-1978 to 1987-1988

Russell S. Canniff

INTRODUCTION

The Skagit Valley lies in northwest Washington State approximately 100 miles south of Vancouver, British Columbia, and 60 miles north of Seattle. At the heart of the Valley is the Skagit River flowing from the north Cascade Mountains west towards Puget Sound.

The Valley has a moderate maritime climate. The past two winters, 1986-87 and 1987-88, have been mild with short periods of freezing temperatures. However, the winter of 1985-86 was uncharacteristic for this region with cold and freezing conditions with ice and snow persisting through all of November and temperatures often in the teens and twenties. December and January were wet and windy with some flooding. The not-so-moderate conditions continued in February when cooler than usual temperatures included a period of snow mid-month.

The Skagit Valley is an area of great agricultural diversity located on the alluvial plain formed by the Skagit River. Dairy farming with its associated grasslands and field corn is a prominent agricultural industry. A variety of crops are grown including many cruciferous-type vegetables and peas, barley, strawberries, carrots, and potatoes. Also, the Skagit Valley is a world leader in production of several different seed crops.

The Valley, including the alluvial plain and extensive marshland estuaries, has historically been a wintering area for large numbers of waterfowl. The grasslands and corn fields associated with the dairy industry are especially important to Trumpeter and Tundra Swans (Cygnus buccinator and C. columbianus).

METHODS

The center of the study area is the cities of Mount Vernon and Burlington (Figure 1). The area encompasses approximately 200 km^2 from Edison to the north, Sedro-Woolley to the east, west of Interstate Route 5 by several miles, and Fir Island and Conway to the south. Information was gathered, in a very patient mode, by field observations from a vehicle using 7x35 binoculars and a 15-60x spotting scope. Field-time periods were from November through March every year, including Saturdays, Sundays, holidays, and random weekdays on a consistent basis for over 10 years.

RESULTS AND DISCUSSION

Tundra Swans have been wintering in the Skagit Valley since major settlement of the area began. The swans arrive in November and early December, with Tundra and Trumpeter swans in approximately equal numbers around the Mount Vernon-Burlington area fields and waterways. Tundras generally separate from the Trumpeters during the latter part of December moving west and south of Mount Vernon towards Fir Island. Tundra Swans use the tidal marsh at Jensen Access and winter grain fields in this area. Some day and nighttime intermixing of Trumpeter and Tundra Swans occurs here.

Trumpeter Swan use of the Skagit River floodplain (Barney Lake area) east of Mount Vernon, was first recorded in 1957, when six were observed (Washington Department of Wildlife 1979). In 1963, 20 Trumpeters were reported, and in 1971, I observed 50 Trumpeters on Barney Lake. Total population counts along with adult/juvenile ratios have been recorded since 1974 (Figure 2). The peak winter population usually occurs between 15 and 30 January each year. The 1987-88 winter peak population count for Trumpeter Swans was 480 with 133 juvenile birds and Tundra Swan totals were 675 birds with 164 juveniles.

A major change in habitat use began in 1980-81. Trumpeter Swans began moving from Barney Lake to the outlying dairy pastures and harvested field corn for feeding. Nighttime roosting also changed from Barney Lake to various surrounding water bodies.

The Trumpeter population appears to have stabilized from 1980 to 1984 at a winter average of 324 adults and 92 juveniles (Canniff 1986). Since 1984, the Valley wintering Trumpeter Swan population has increased to nearly 500 birds.

Trumpeter Swans begin arriving in the Valley during late October with 50 to 100 birds present by the first part of November. Population increases occur in three or four surges from late November to the first week in January. These surges may result from a combination of weather severity to the north and a search for additional food resources.

Major points of origin in Alaska for collared wintering Trumpeter Swans in the Skagit Valley have been identified as the Kenai National Wildlife Refuge (NWR) (Ted Bailey, banding from 1977 to 1985) and Fairbanks/Minto Flats (Rod King, banding 1982 to the present). Tundra Swans using the area have been banded on the Izembek National Wildlife Refuge, the Pavlof Unit (John Sarvis, banding from 1978 to present).

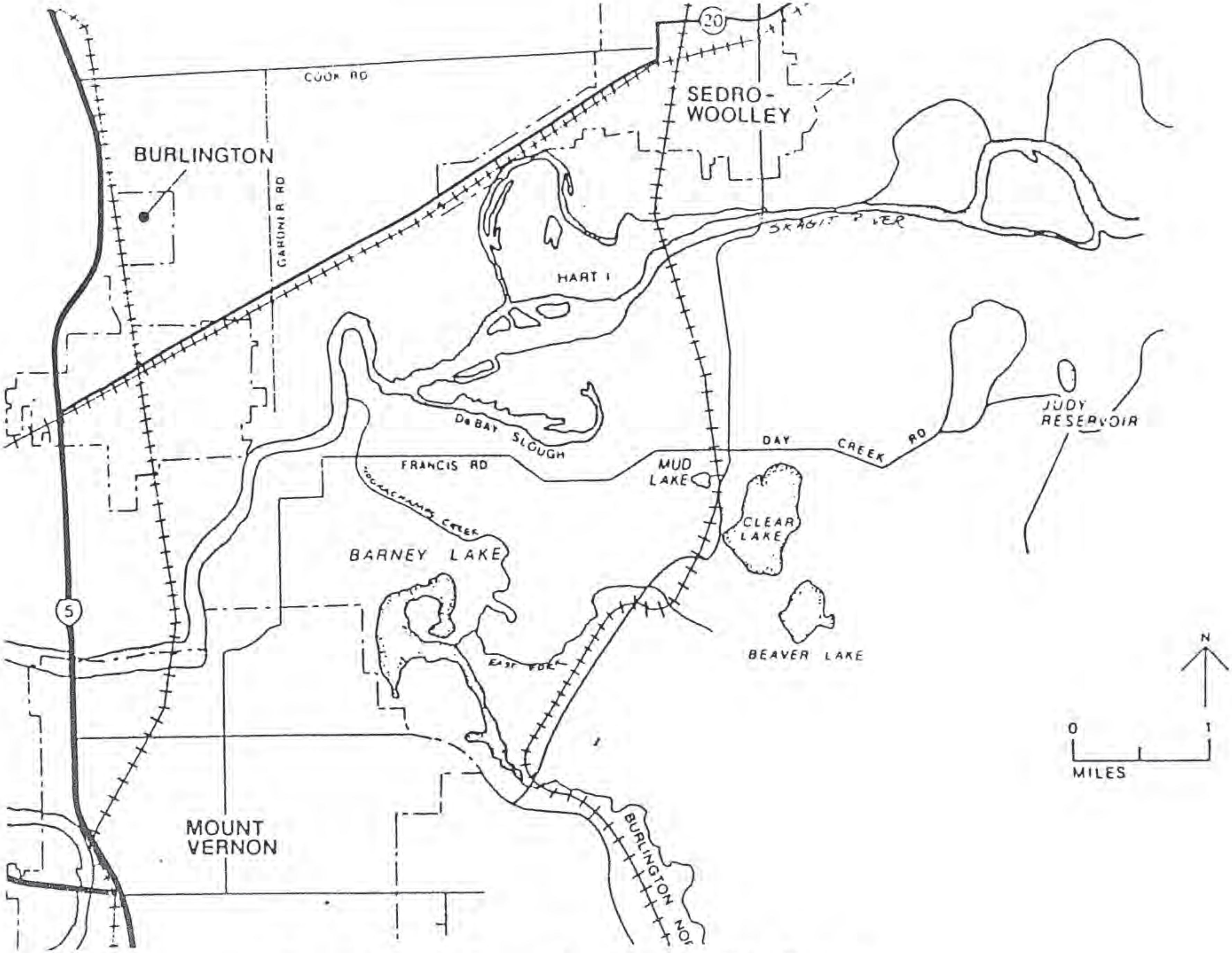


Figure 1. Area used by Trumpeter Swans in the Skagit Valley, Washington.

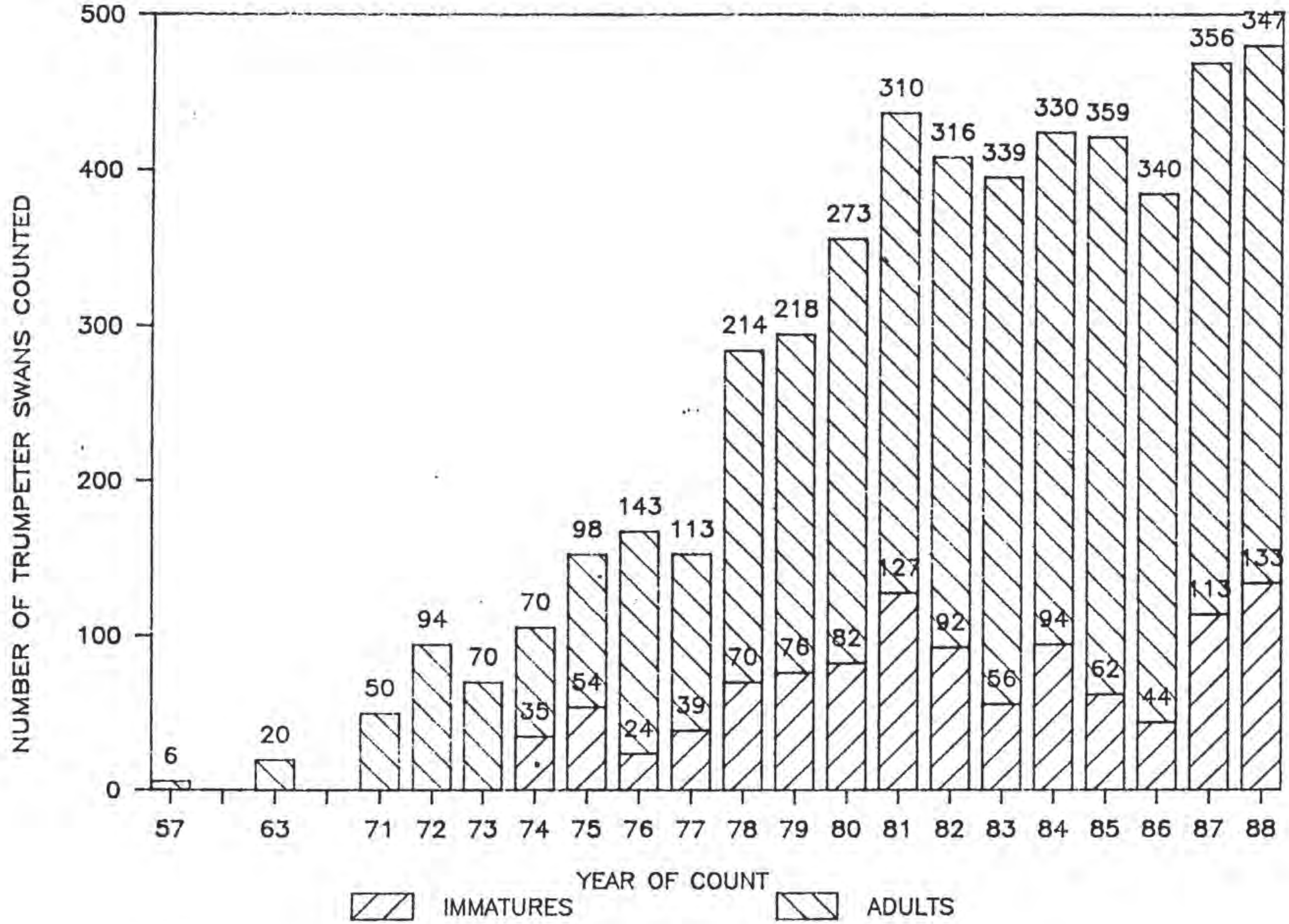


Figure 2. Maximum counts of adult and immature Trumpeter Swans in the Skagit Valley, Washington, 1957-88.

An alphanumeric code, consisting of two numbers and two letters, in white on a blue collar, was assigned for both the Kenai and Fairbanks areas. Each series included 100 collars, 00 - 99. Alpha codes used on the Kenai in sequence were VY, VT, and UR. For the Fairbanks area, collars included the alpha series EA and HC. Tundra Swan marking was done on blue collars with white alphanumeric combinations of one letter and one number or two letters.

Collar 09VY was placed on a subadult female Trumpeter Swan on the Kenai NWR in 1972. Swan 09VY was subsequently sighted occasionally in the Skagit Valley from 1972 to 1977. From 1977 to 1 March 1987, 09VY (recollared on 17 July 1979 as 00VT) was sighted consistently every year in the Skagit Valley (Table 1). Swan 00VT's collar was split and probably fell off in 1987 (a summer 1987 aerial survey of Trumpeters on the Kenai NWR suggests this as a possibility). In 00VT's traditional nesting site on Two Island Lake, an uncollared pair was noted nesting unsuccessfully (Ted Bailey, pers. comm.). In the winter season of 1987-88, collar 00VT was not seen in the Skagit Valley. Searches for an adult bird with a metal tarsus band were unsuccessful.

During 00VT visits from 1978-79 to 1986-87, she brought a total of 12 juvenile birds with her. Winter observations for 10 seasons indicate that she has not lost one first winter juvenile while in the Skagit Valley. The last winter appearance (1986-87) showed 00VT to be, for the first time, without a mate but having charge of one juvenile throughout the winter stay in Skagit Valley. Swan 00VT and mate appeared in the Valley without any juvenile birds in the winters of 1982-83, 1983-84, 1984-85, and 1985-86.

Trumpeter Swans 23HC and 24HC, are a pair collared on the Minto Flats west of Fairbanks on 16 July 1985 (Table 1). They made an initial appearance in the Skagit Valley in the winter of 1985-86 and subsequently in 1986-87 and 1987-88 seasons. The collared pair was closely associated throughout the first and second winters but did not appear with any young. In the 1987-88 winter season, 23HC and 24HC made their third consecutive appearance and, for the first time, were with one juvenile. Swan 24HC apparently lost his collar before arrival this 1987-88 winter season but was identified by his metal tarsus band. Swans 23HC and 24HC were sighted on two successive occasions at the end of January 1988, both times without a juvenile bird.

Behavioral observations in the past 10 years have shown close family bonds in Trumpeter Swan pairs with first year young. In large gatherings of at least 75 or more birds that include both families of the year and nonbreeding individuals, family units with three to six juveniles tend to group together. The smaller family units with only one or two young often associate with the nonbreeding groups.

During most observations of known pairs and family units (e.g., 00VT and 23HC and 24HC), I have observed a close relationship between the adults and their cygnets. At times when family units may be detached and scattered in the fields, especially while feeding on corn, I have determined the intent and direction of each individual member of a particular family unit. For the most part, I can say that family and pair-bond unity in a wild population of Trumpeter Swans in the winter is a priority. I have observed very little variance from this cohesive behavior.

Only two opportunities to observe pair-bonding behavior in known-age Trumpeters have occurred. Swan 11HC, collared on Minto Flats as a juvenile male on 20 September 1984, appeared in 2 consecutive years, the winters of 1985-86 (eight sightings) and 1986-87 (five sightings). Trumpeter 15EA, collared on Minto Flats 24 September 1982 as a juvenile male, made an appearance in the Skagit Valley for 2 consecutive years in the winters of 1984-85 (six sightings) and 1985-86 (10 sightings). Neither of these birds, while appearing in the nonbreeding social group, has been observed to pair or directly associate with another swan during the past two winter seasons. It is interesting to note that, although these birds were entering their third and fourth years, they still showed no inclination to pair with female birds.

In 1980-81, a family of Trumpeter Swans, two adults and three juveniles, appeared in the estuary of the Stillaguamish River. (The Stillaguamish River empties into Port Susan Bay just south of Stanwood and 15 km north of Everett.) This group has slowly grown in 8 years to now include 25 Trumpeter Swans. When these birds first arrived in 1980-81, they alternated use of dairy pasture land with the estuary tide flats. Since 1982-83, they have almost exclusively preferred tidal marshland habitat.

In the 1986-87 winter season, two collared juvenile birds, 46HC and 36HC, appeared in the estuary; both were collared on 18 September 1986 on the Minto Flats. Trumpeter 36HC had a transmitter attached to his collar and what appeared to be a badly damaged upper mandible. This bird made another winter appearance in January 1988 in the Stillaguamish estuary. The damaged beak did not appear to be a problem, and the bird appeared to be in good condition.

During the season of 1983-84, the first collared Tundras from Izembek NWR, located on the Alaskan Peninsula, made their winter appearance in the Skagit Valley. The pair 9U and 2F with six juveniles 0F, 1F, 4F, 6F, 8F, 2J remained inseparable on 15 winter sightings, the last sighting on 1 April 1984 (Table 2). Only one of these birds has been sighted in the Valley again. The following winter of 1984-85, 6F overwintered here. Since then, 1985-86 until 1987-88, collars CP, R5, R6, YP, and S2 and CF (paired) have made separate appearances; CP has returned twice. Swans CP, R5, R6, and YP were seen as single nonbreeding birds, S2 and CF as paired birds having no juveniles. All of these birds migrated from the Pavlof Unit of Izembek NWR located some 100 km northeast of Cold Bay. Most banding efforts prior to 1985 on Izembek NWR have been in the Izembek Unit. The majority of these collared birds have proven to be nonmigratory and spend their winters in the Cold Bay area on Unimak Island (John Sarvis, pers. comm.).

In the past 10 years, two other collars from areas other than Kenai, Fairbanks, or Izembek have appeared in the Skagit Valley. Trumpeter 34VT seen in 1979 to 1980 had been collared as an adult in July 1979 on the Copper River Delta at Bering Lake. It showed mixed social relations in its winter stay in the Skagit Valley (Table 1).

Tundra PO18 appeared in the Skagit Valley in the winter of 1986-87 with an unmarked mate and no juveniles. This bird was collared 17 July 1983 on the Alaska Peninsula NWR at the Dog Salmon River location southwest of Ugashik (Randy Wilk, pers. comm.). This bird did not appear during the 1987-88 winter season.

CONCLUSIONS AND RECOMMENDATIONS

Over 10 years of systematic observations of Trumpeter and Tundra Swans on wintering grounds in the Skagit Valley have resulted in the following conclusions and recommendations:

1. Collared Trumpeter Swans appearing in the Skagit Valley come from the Kenai NWR and Minto Flats west of Fairbanks; Tundra Swans come from the Izembek NWR, specifically the Pavlof Unit. There were two exceptions: a Trumpeter Swan from the Copper River Delta, and a Tundra Swan from the Alaska Peninsula NWR at Ugashik.

2. It is likely that 00VT was a consistent winter resident of the Skagit Valley from 1973 through 1987, although she was only sighted occasionally from 1973 through 1977. Since 1978, when a more systematic search was instituted, 00VT has been sighted every year.

3. Questions on pair bonding by known-age birds have remained unanswered. After two successive winter returns to the Skagit Valley, neither 15EA nor 11HC have been resighted here. Collaring programs should be focusing on known-age birds, watching for initiation of pair-bonding in wild populations.

4. Continued marking programs are needed on swans for further definition of family bonds and intraspecific behavior in the larger group.

5. A collaring program for a study of longevity and productivity in Trumpeter and Tundra Swans wintering in the Skagit Valley is appropriate.

6. Continued and expanded marking of Tundra and Trumpeter Swans should be encouraged to further define points of origin and avenues of migration.

7. Develop a program for collaring the first 50 or more Trumpeter Swans to appear in November in the Skagit Valley. This definitive group has never appeared marked in any way. It is possible that these birds are representative of the initial pioneering group of Trumpeter Swans in the Skagit Valley.

Table 1. Collared Trumpeter Swan Resightings
Skagit River Valley, Washington
Winter Seasons 1977-78 to 1987-88

Winter of	Collar Code	Tarsus	Sight Date	Area	Plumage-Sex	Status	Date Banded	Location
1977 to 1978	06VT		19 Feb 78	Mt. Vernon/Barney Lk/Water	J	w/07VT & 08VT	18 Aug 77	Kenai NWR, AK/Hook Lk Area
			26 Feb 78	Mt. Vernon/Thillberg Rd/pasture		w/07VT & 08VT		
	07VT		19 Feb 78	Mt. Vernon/Barney Lk/water	J	w/06VT & 08VT	18 Aug 77	Kenai NWR, AK/Hook Lk Area
			26 Feb 78	Mt. Vernon/Thillberg Rd/pasture		w/06VT & 08VT		
	08VT		19 Feb 78	Mt. Vernon/Barney Lk/water	J	w/06VT & 07VT	18 Aug 77	Kenai NWR, AK/Hook Lk Area
			26 Feb 78	Mt. Vernon/Thillberg Rd/pasture		w/06VT & 07VT		
	10VT		18 Feb 78	Mt. Vernon/Barney Lk/water	J - M	w/11VT	19 Aug 77	Kenai NWR/Warbler Lk Area
			25 Feb 78	Mt. Vernon/Barney Lk/water		w/11VT		
			26 Feb 78	Mt. Vernon/Thillberg Rd/pasture		w/11VT		
	11VT		18 Feb 78	Mt. Vernon/Barney Lk/water	J - F	w/10VT	19 Aug 77	Kenai NWR/Warbler Lk Area
			25 Feb 78	Mt. Vernon/Barney Lk/water		w/10VT		
			26 Feb 78	Mt. Vernon/Thillberg Rd/pasture		w/10VT		
	09VY		19 Feb 78	Mt. Vernon/Barney Lk/water	A - F		04 Aug 72	Kenai NWR/Two Island Lk
			26 Feb 78	Mt. Vernon/Barney Lk/water				
			04 Mar 78	Mt. Vernon/Barney Lk/water				
			11 Mar 78	Mt. Vernon/Barney Lk/water				
			12 Mar 78	Mt. Vernon/Barney Lk/water				
1978 to 1979	06VT	MLT PRT	18 Nov 78	Mt. Vernon/Thillberg Rd/pasture	A	w/07VT & Adult w/MLT	18 Aug 77	Kenai NWR/Hook Lk Area
			23 Nov 78	Mt. Vernon/Thillberg Rd/pasture		w/07VT & 11VT		
			02 Dec 78	Mt. Vernon/Judy Reservoir/water		w/07VT & Adult w/MLT		
			23 Dec 78	Mt. Vernon/McLaughlin Rd/pasture		w/07VT & Adult w/MLT		
			25 Dec 78	Mt. Vernon/Barney Lk/water		w/07VT		
			06 Jan 79	Mt. Vernon/Francis Rd E/pasture		w/07VT & Adult w/MLT		
			14 Jan 79	Mt. Vernon/Francis Rd E/pasture		w/07VT & Adult w/MLT		
			10 Feb 79	Clear Lk/water		w/07VT & Adult w/MLT		
			04 Mar 79	Mt. Vernon/Barney Lk/water		w/07VT & Adult w/MLT		
	07VT	NMT PRT	18 Nov 78	Mt. Vernon/Thillberg Rd/pasture	A	w/06VT & Adult w/MLT	18 Aug 77	Kenai NWR/Hook Lk Area
			23 Nov 78	Mt. Vernon/Thillberg Rd/pasture		w/06VT & 11VT		
			02 Dec 78	Mt. Vernon/Judy Reservoir/water		w/06VT & Adult w/MLT		
			23 Dec 78	Mt. Vernon/McLaughlin Rd/pasture		w/06VT & Adult w/MLT		
			25 Dec 78	Mt. Vernon/Barney Lk/water		w/06VT		
			06 Jan 79	Mt. Vernon/Francis Rd E/pasture		w/06VT & Adult w/MLT		
			14 Jan 79	Mt. Vernon/Francis Rd E/pasture		w/06VT & Adult w/MLT		
			10 Feb 79	Clear Lk/water		w/06VT & Adult w/MLT		
			04 Mar 79	Mt. Vernon/Barney Lk/water		w/06VT & Adult w/MLT		

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Winter of	Collar Code	Tarsus	Sight Date	Area	Plumage-Sex	Status	Date Banded	Location
1978 to 1979 (cont)	11VT		23 Nov 78	Mt. Vernon/Thillberg Rd/pasture	A	w/06VT & 07VT	19 Aug 77	Kenai NWR/Warbler Lk Area
			03 Dec 78	Clear Lake/water		w/6 unmarked adults		
			24 Dec 78	Mt. Vernon/Judy Reservoir/water		w/1 unmarked adult		
			14 Jan 79	Mt. Vernon/Francis Rd/pasture		Appears alone		
			10 Feb 79	Clear Lk/water		Appears alone		
			04 Mar 79	Mt. Vernon/Barney Lk/water		Appears alone		
	24VT	MLT	23 Dec 78	Mt. Vernon/MacLaughlin R/pasture	J	w/26VT w/2 A & 2 unmarked J	10 Aug 78	Kenai NWR/Warbler Lk Area
		PRT	06 Jan 79	Mt. Vernon/Francis Rd W/pasture		w/26VT w/2 A & 2 unmarked J		
			13 Jan 79	Mt. Vernon/Francis Rd W/pasture		w/26VT w/2 A & 2 unmarked J		
			14 Jan 79	Mt. Vernon/Francis Rd/pasture		w/26VT w/2 A & 2 unmarked J		
			03 Mar 79	Mt. Vernon/Barney Lk/water		w/26VT w/2 A & 1 unmarked J		
	26VT	MLT	23 Dec 78	Mt. Vernon/McLaughlin Rd/pasture	J	w/24VT w/2 A & 2 unmarked J	10 Aug 78	Kenai NWR/Warbler Lk Area
		PRT	06 Jan 79	Mt. Vernon/Francis Rd W/pasture		w/24VT w/2 A & 2 unmarked J		
			13 Jan 79	Mt. Vernon/Francis Rd W/pasture		w/24VT w/2 A & 2 unmarked J		
			14 Jan 79	Mt. Vernon/Francis Rd/pasture		w/24VT w/2 A & 2 unmarked J		
			03 Mar 79	Mt. Vernon/Barney Lk/water		w/24VT w/2 A & 1 unmarked J		
	25VT		24 Dec 78	Mt. Vernon/Barney Flats/pasture	J	w/27VT; no A associated	10 Aug 78	Kenai NWR/Warbler Lk Area
			06 Jan 79	Mt. Vernon/Francis Rd E/pasture		Appears alone; sick		
			14 Jan 79	Mt. Vernon/Francis Rd E/pasture		Appears alone; sick		
			20 Jan 79	Mt. Vernon/Barney Lk/shore		Found dead		
	27VT		24 Dec 78	Mt. Vernon/Barney Flats/pasture	J	w/25VT; no A associated	10 Aug 78	Kenai NWR/Warber Lk Area
			02 Jan 79	Clear Lk/ice		Appears alone		
			07 Jan 79	Mt. Vernon/Barney Lk/edge		Found dead; lead		
	86VT		23 Nov 78	Mt. Vernon/Thillberg Rd/pasture	J	w/87VT, 88VT, 1 un A, 2 un J	11 Aug 78	Kenai NWR/Nest Lake
			03 Dec 78	Clear Lk/water		w/87VT, 88VT, 1 un A, 2 un J		
			09 Dec 78	Clear Lk/water		w/87VT, 88VT, 1 un A, 2 un J		
			16 Dec 78	Mt. Vernon/McLaughlin Rd/pasture		w/87VT, 88VT, 1 un A, 2 un J		
			24 Dec 78	Mt. Vernon/Judy Reservoir/Shoreline		w/87VT, 88VT, 1 un A, 2 un J		
			06 Jan 79	Mt. Vernon/Francis Rd E/pasture		w/87VT, 88VT, 1 un A, 2 un J		
			14 Jan 79	Mt. Vernon/Francis Rd/pasture		w/87VT, 88VT, 1 un A, 2 un J		
			03 Mar 79	Mt. Vernon/Barney Lk/water		w/87VT, 88VT, 1 un A, 2 un J		
	87VT		23 Nov 78	Mt. Vernon/Thillberg Rd/pasture	J	w/86Vt, 88VT, 1 un A, 2 un J	11 Aug 78	Kenai NWR/Nest Lake
			03 Dec 78	Clear Lk/water		w/86VT, 88VT, 1 un A, 2 un J		
			09 Dec 78	Clear Lk/water		w/86VT, 88VT, 1 un A, 2 un J		
			16 Dec 78	Mt. Vernon/McLaughlin Rd/pasture		w/86VT, 88VT, 1 un A, 2 un J		
			24 Dec 78	Mt. Vernon/Judy Reservoir/Shoreline		w/86VT, 88VT, 1 un A, 2 un J		
			06 Jan 79	Mt. Vernon/Francis Rd E/pasture		w/86VT, 88VT, 1 un A, 2 un J		
			14 Jan 79	Mt. Vernon/Francis Rd/pasture		w/86VT, 88VT, 1 un A, 2 un J		
			03 Mar 79	Mt. Vernon/Barney Lk/water		w/86VT, 88VT, 1 un A, 2 un J		

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Winter of	Collar Code	Tarsus	Sight Date	Area	Plumage-Sex	Status	Date Banded	Location
1978	88VT		23 Nov 78	Mt. Vernon/Thillberg Rd/pasture	J	w/86VT, 87VT, 1 un A, 2 un J	11 Aug 78	Kenai NWR/Nest Lake
to			03 Dec 78	Clear Lk/water		w/86VT, 87VT, 1 un A, 2 un J		
1979			09 Dec 78	Clear Lk/water		w/86VT, 87VT, 1 un A, 2 un J		
(cont)			16 Dec 78	Mt. Vernon/McLaughlin Rd.pasture		w/86VT, 87VT, 1 un A, 2 un J		
			24 Dec 78	Mt. Vernon/Judy Reservoir/shoreline		w/86VT, 87VT, 1 un A, 2 un J		
			06 Jan 79	Mt. Vernon/Francis Rd E/pasture		w/86VT, 87VT, 1 un A, 2 un J		
			14 Jan 79	Mt. Vernon/Francis Rd/pasture		w/86VT, 87VT, 1 un A, 2 un J		
			03 Mar 79	Mt. Vernon/Barney Lk/water		w/86VT, 87VT, 1 un A, 2 un J		
	09VY	MLT	23 Nov 78	Mt. Vernon/Thillberg Rd/pasture	A - F	w/unmarked mate & 2 J	04 Aug 72	Kenai NWR/Two Island Lk
			24 Nov 78	Mt. Vernon/Thillberg Rd/pasture		w/unmarked mate & 3 J		
			09 Dec 78	Mt. Vernon/Francis Rd E/pasture		w/unmarked mate & 3 J		
			16 Dec 78	Mt. Vernon/McLaughlin Rd/pasture		w/unmarked mate & 3 J		
			23 Dec 78	Mt. Vernon/McLaughlin Rd/pasture		w/unmarked mate & 3 J		
			24 Dec 78	Mt. Vernon/Barney Flats/pasture		w/unmarked mate & 3 J		
			25 Dec 78	Mt. Vernon/Barney Lk/water		w/unmarked mate & 2 J		
			13 Jan 79	Mt. Vernon/Thillberg Rd/pasture		w/unmarked mate & 3 J		
			14 Jan 79	Mt. Vernon/Francis Rd E/pasture		w/unmarked mate & 3 J		
			03 Mar 79	Burlington/Gardner Rd/pasture		w/unmarked mate & 3 J		
1979	34VT	MLT	25 Dec 79	Burlington/LaFayette Rd/pasture	A	Appears alone	Jul 79	Copper River, AK/Bering Lk
to		PRT	29 Dec 79	Mt. Vernon/Judy Reservoir/shore		Appears alone		
1980			30 Dec 79	Mt. Vernon/Barney Lk/water		w/un partner; challenge 2 A		
			12 Jan 80	Mt. Vernon/Judy Reservoir/shore		w/un partner		
			19 Jan 80	Mt. Vernon/Francis Rd E/pasture		w/un partner		
			03 Feb 80	Mt. Vernon/Barney Flats/pasture		Appears alone; rest		
			15 Feb 80	Mt. Vernon/Barney Flats/pasture		Appears alone		
			23 Feb 80	Mt. Vernon/Barney Lk/water		Appears alone; poss. sick		
			02 Mar 80	Mt. Vernon/Barney Flats/pasture		Flew to Barney Lk w/partner		
			08 Mar 80	Mt. Vernon/Barney Lk/water		w/several A		
	00VT	MLT	12 Jan 80	Mt. Vernon/Judy Reservoir/water	A - F	w/un mate & 3 J	27 Jul 79	Kenai NWR/Two Island Lk
		PRT	19 Jan 80	Mt. Vernon/Barney Flats/pasture		w/un mate & 3 J	Rebanded	
			03 Feb 80	Mt. Vernon/Barney Lk/water		w/un mate & 3 J	from 09VY	
			15 Feb 80	Mt. Vernon/Barney Flats/pasture		w/un mate & 3 J	to 00VT	
			22 Feb 80	Mt. Vernon/Barney Lake/water		w/un mate & 3 J	MLT: 619.00900	
			02 Mar 80	Mt. Vernon/Barney Flats/pasture		w/un mate & 3 J		
			08 Mar 80	Mt. Vernon/Barney Lk/water		w/un mate & 3 J		
1980	20UR	MLT	05 Dec 80	Mt. Vernon/Barney Lk/water	J - M	w/2 un Adults as family	26 Aug 80	Kenai NWR/Phalarope Lk
to		PRT	06 Dec 80	Mt. Vernon/Barney Lk/water		w/2 un Adults as family		
1981			08 Dec 80	Mt. Vernon/Barney Lk/water		w/2 un Adults as family		
			12 Dec 80	Mt. Vernon/Barney Lk/water		w/2 un Adults as family		
			31 Dec 80	Mt. Vernon/Barney Lk/water		w/2 un Adults as family		
			12 Jan 81	Mt. Vernon/Barney Lk/water		w/2 un Adults as family		
			16 Jan 81	Mt. Vernon/Barney Lk/water		w/2 un Adults as family		

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1980	20UR	MLT	19 Jan 81	Mt. Vernon/Barney Lk/water	J - M	w/2 un Adults as family		
to	(cont)	PRT	25 Jan 81	Mt. Vernon/Barney Lk/water		w/2 un Adults as family		
1981			28 Jan 81	Mt. Vernon/Barney Lk/water		w/2 un Adults as family		
(cont)			07 Feb 81	Mt. Vernon/Barney Flats/pasture		w/2 un Adults as family; rest		
			12 Feb 81	Mt. Vernon/Barney Lk/water		Appears alone; sick		
			16 Feb 81	Mt. Vernon/Barney Lk/marsh		20UR dead		
	00VT	MLT	12 Jan 81	Mt. Vernon/Barney Lk/water	A - F	w/un mate & 3 J	04 Aug 72	Kenai NWR/Two Island Lk
		PRT	16 Jan 81	Mt. Vernon/Barney Lk/water		w/un mate & 3 J	as 09VY	
			19 Jan 81	Mt. Vernon/Barney Lk/water		w/un mate & 3 J		
			25 Jan 81	Mt. Vernon/Barney Lk/water		w/un mate & 3 J	27 Jul 79	Kenai NWR/Two Island Lk
			28 Jan 81	Mt. Vernon/Barney Lk/water		w/un mate & 3 J	as 00VT	
			02 Feb 81	Mt. Vernon/Barney Lk/water		w/un mate & 3 J		
			07 Feb 81	Mt. Vernon/Barney Flats/pasture		w/un mate & 3 J		
			15 Feb 81	Mt. Vernon/Barney Flats/pasture		w/un mate & 3 J		
			22 Feb 81	Burlington/Gardner Rd/pasture		w/un mate & 3 J		
1981	00VT	MLT	02 Jan 82	Mt. Vernon/Mud Lk Rd/pasture	A - F	w/un mate & 2 J	Same as above	
to		PRT	06 Jan 82	Clear Lake/water		w/un mate & 2 J & 1 other A		
1982			09 Jan 82	Burlington/Sterling Rd/fallow field		w/un mate & 2 J		
			17 Jan 82	Burlington/Gardner Rd/flooded pasture		w/un mate & 2 J		
			23 Jan 82	Burlington/Gardner Rd/flooded pasture		w/un mate & 2 J		
			06 Feb 82	Mt. Vernon/Francis Rd E/pasture		w/un mate & 2 J		
			14 Feb 82	Burlington/Peacock Ln/flooded pasture		w/un mate & 2 J		
			26 Feb 82	Mt. Vernon/Barney Flats/pasture		w/un mate & 2 J		
			13 Mar 82	Mt. Vernon/Barney Flats/pasture		w/un mate & 2 J		
1982	00VT	MLT	28 Nov 82	Mt. Vernon/Barney Flats/pasture	A - F	w/un mate & 1 un A; no J	Same as above	
to		PRT	11 Dec 82	Mt. Vernon/Francis Rd W/pasture		w/un mate & 1 un A; no J		
1983			01 Jan 83	Mt. Vernon/Mud Lk Rd/corn		w/un mate		
			08 Jan 83	Mt. Vernon/Francis Rd W/corn/flood		w/un mate		
			15 Jan 83	Mt. Vernon/Mud Lk Rd/corn/flood		w/un mate & 1 un A		
			16 Jan 83	Mt. Vernon/Mud Lk Rd/corn/flood		w/un mate & 1 un A		
			29 Jan 83	Mt. Vernon/Francis Rd W/corn		w/un mate & 1 un A		
			05 Feb 83	Mt. Vernon/Barney Flats/new pasture		w/un mate & 1 un A		
			12 Feb 83	Mt. Vernon/Francis Rd W/corn		w/un mate & 1 un A		
			19 Feb 83	Mt. Vernon/DeBay Slough/water		w/un mate & 1 un A		
			26 Feb 83	Mt. Vernon/Francis Rd E/corn		w/un mate & 1 un A		
1983	00VT	MLT	24 Nov 83	Mt. Vernon/Francis Rd w/corn	A - F	w/un mate & no J	Same as above	
to		PRT	25 Nov 83	Mt. Vernon/Francis Rd W/corn		w/un mate & no J		
1984			03 Dec 83	Mt. Vernon/Mud Lk Rd/corn		w/un mate & no J		
			24 Dec 83	Burlington/Gardner Rd/corn		w/un mate & no J		
			08 Jan 84	Mt. Vernon/Francis Rd W/flooded corn		w/un mate & no J		
			22 Jan 84	Burlington/Cook Rd/flooded corn		w/un mate & no J		
			04 Feb 84	Burlington/Gardner Rd/flooded corn		w/un mate & no J		

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1983 to 1984 (cont)	00VT (cont)	MLT PRT	11 Feb 84	Burlington/Gardner Rd/pasture	A - F	w/un mate & no J	Same as above	
	a22EA	MRT	24 Dec 83	Burlington/Cook & Collins Rd/corn	A - F	w un mate & 1 J 63EA	11 Aug 83	Minto Flats, AK/50 km West of Fairbanks
			31 Dec 83	Burlington/Gardner Rd/pasture		w/un mate & 1 J 63EA		
			02 Jan 84	Burlington/Collins Rd/corn		w/un mate & 1 J 63EA		
			07 Jan 84	Burlington/Gardner Rd/corn		w/un mate & 1 J 63EA		
			08 Jan 84	Mt. Vernon/Francis Rd W/corn		w/un mate & 1 J 63EA		
			21 Jan 84	Mt. Vernon/Bradshaw Rd/winter grain		w/un mate & 1 J 63EA		
			28 Jan 84	Burlington/Gardner Rd/corn		w/un mate & 1 J 63EA		
			11 Feb 84	Mt. Vernon/Barney Flats/pasture		w/un mate & 1 J 63EA		
			19 Feb 84	Mt. Vernon/Barney Lk/water		w/un mate & 1 J 63EA		
			03 Mar 84	Burlington/Gardner Rd/pasture		w/un mate & 1 J 63EA		
	63EA	MRT	24 Dec 83	Burlington/Cook & Collins Rd/corn	J - M	w/22EA & un A	20 Sep 83	Minto Flats, AK/50 km West of Fairbanks
			31 Dec 83	Burlington/Gardner Rd/pasture		w/22EA & un A		
			02 Jan 84	Burlington/Collins Rd/corn		w/22Ea & un A		
			07 Jan 84	Burlington/Gardner Rd/corn		w/22EA & un A		
			08 Jan 84	Mt. Vernon/Francis Rd W/corn		w/22EA & un A		
			21 Jan 84	Mt. Vernon/Bradshaw Rd/winter grain		w/22EA & un A		
			28 Jan 84	Burlington/Gardner Rd/corn		w/22EA & un A		
			11 Feb 84	Mt. Vernon/Barney Flats/pasture		w/22EA & un A		
			19 Feb 84	Mt. Vernon/Barney Lk/water		w/22EA & un A		
			03 Mar 84	Burlington/Gardner Rd/pasture		w/22Ea & un A		
1984 to 1985	00VT	MLT PRT	17 Nov 84	Burlington/Cook Rd/corn	A - F	w/un mate & no J	04 Aug 72 & 27 Jul 79	Kenai NWR/Two Island Lk
			22 Nov 84	Burlington/Cook Rd/corn		w/un mate & no J		
			24 Nov 84	Burlington/Kelleher Rd/corn		w/un mate & no J		
			02 Dec 84	Burlington/Gardner Rd/corn		w/un mate & no J		
			16 Dec 84	Burlington/Cook Rd/corn		w/un mate & no J		
			27 Dec 84	Burlington/Gardner Rd/corn		w/un mate & no J		
			12 Jan 85	Burlington/Gardner Rd/pasture		w/un mate & no J		
			19 Jan 85	Mt. Vernon/Francis Rd/corn		w/un mate & no J		
			20 Jan 85	Mt. Vernon/Francis Rd/corn		w/un mate & no J		
			27 Jan 85	Mt. Vernon/Francis Rd/pasture		w/un mate & no J		
			02 Feb 85	Burlington/Gardner Rd/pasture		w/un mate & no J		
			10 Feb 85	Mt. Vernon/Francis Rd/pasture		w/un mate & no J		
			17 Feb 85	Burlington/Gardner Rd/corn		w/un mate & no J		
			18 Feb 85	Burlington/Gardner Rd/corn		w/un mate & no J		
			23 Feb 85	Burlington/Gardner Rd/corn		w/un mate & no J		
			03 Mar 85	Mt. Vernon/Barney Flats/pasture		w/un mate & no J		

a) Transmitter attached; frequency 164.200; transmitter operable.

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Winter of	Collar Code	Tarsus	Sight Date	Area	Plumage-Sex	Status	Date Banded	Location
1984	15EA	MRT	17 Nov 84	Mt. Vernon/Kamb Rd/corn	A - M	Appears alone	24 Sep 82	Minto Flats, AK/50Km W of Fairbanks
to			02 Dec 84	Burlington/Gardner Rd/corn		Appears slone		
1985			27 Jan 85	Mt. Vernon/Kamb Rd/pasture		Appears alone		
(cont)			17 Feb 85	Mt. Vernon/Barney Flats/pasture		Appears alonee		
			18 Feb 85	Mt. Vernon/Younquist Rd/pasture		Appears alone		
			23 Feb 85	Mt. Vernon/Kamb Rd/pasture		Appears alone		
	b61UR	MRT	01 Dec 84	Burlington/Gardner Rd/corn	A - F	w/un mate & 4 J	20 Jul 84	Kenai NWR/Kenaitze Lk
			02 Dec 84	Burlington/Gardner Rd/corn		w/un mate & 4 J		
			15 Dec 84	Burlington/Cook Rd/corn		w/un mate & 4 J		
			16 Dec 84	Burlington/Cook Rd/corn		w/un mate & 4 J		
			20 Jan 85	Burlington/Cook Rd/corn		w/un mate & 4 J		
			27 Jan 85	Burlington/Gardner Rd/corn		w/un mate & 4 J		
			02 Feb 85	Mt. Vernon/Francis Rd/pasture		w/un mate & 4 J		
			10 Feb 85	Mt. Vernon/Francis Rd/pasture		w/un mate & 4 J		
			17 Feb 85	Mt. Vernon/Barney Flats/pasture		w/un mate & 3 J		
			23 Feb 85	Burlington/Gardner Rd/corn/feed barns		w/un mate & 3 J		
			02 Mar 85	Burlington/Gardner Rd/corn/feed barns		w/un mate & 3 J		
	98EA	MLT	05 Jan 85	Mt. Vernon/Francis Rd/pasture	J - M	w/99EA & 2 un A + 1 J w/MLT	18 Sep 84	Minto Flats, AK/50 km W of Fairbanks
			13 Jan 85	Mt. Vernon/Francis Rd/pasture		w/99Ea & 2 un A + 1 J w/MLT		
			20 Jan 85	Sedro-Woolley/Ratchford Rd/corn		w/99EA & 2 un A + 1 J w/MLT		
			27 Jan 85	Burlington/Kelleher Rd/corn		w/99EA & 2 un A + 1 J w/MLT		
			02 Feb 85	Mt. Vernon/Francis Rd/pasture		w/99EA & 2 un A + 1 J w/MLT		
			03 Feb 85	Mt. Vernon/Francis Rd/pasture		w/99EA & 2 un A + 1 J w/MLT		
			17 Feb 85	Mt. Vernon/Francis Rd/pasture		w/99EA & 2 un A + 1 J w/MLT		
			23 Feb 85	Burlington/Cook Rd/corn		w/99EA & 2 un A + 1 J w/MLT		
			02 Mar 85	Mt. Vernon/Mud Lk Rd/pasture		w/99EA & 2 un A + 1 J w/MLT		
			03 Mar 85	Mt. Vernon/Barney Flats/pasture		w/99EA & 2 un A + 1 J w/MLT		
	99EA	MLT	05 Jan 85	Mt. Vernon/Francis Rd/pasture	J - F	w/98EA & 2 un A + 1 J w/MLT	18 Sep 84	Minto Flats, AK/50 km W of Fairbanks
			13 Jan 85	Mt. Vernon/Francis Rd/pasture		w/98EA & 2 un A + 1 J w/MLT		
			20 Jan 85	Sedro-Woolley/Ratchford Rd/corn		w/98EA & 2 un A + 1 J w/MLT		
			27 Jan 85	Burlngton/Kelleher Rd/corn		w/98EA & 2 un A + 1 J w/MLT		
			02 Feb 85	Mt. Vernon/Francis Rd/pasture		w/98EA & 2 un A + 1 J w/MLT		
			03 Feb 85	Mt. Vernon/Francis Rd/pasture		w/98EA & 2 un A + 1 J w/MLT		
			17 Feb 85	Mt. Vernon/Francis Rd/pasture		w/98EA & 2 un A + 1 J w/MLT		
			23 Feb 85	Burlington/Cook Rd/corn		w/98EA & 2 un A + 1 J w/MLT		
			02 Mar 85	Mt. Vernon/Mud Lk Rd/pasture		w/98EA & 2 un A + 1 J w/MLT		
			03 Mar 85	Mt. Vernon/Barney Flats/pasture		w/98EA & 2 un A + 1 J w/MLT		

b) Transmitter attached; frequency 166.381

Table 1. Collared Trumpeter Swan Resightings
Skagit River Valley, Washington
Winter Seasons 1978-78 to 1987-88

Winter of	Collar Code	Tarsus	Sight Date	Area	Plumage-Sex	Status	Date Banded	Location
1985	00VT	MLT	09 Nov 85	Burlington/Cook Rd/corn stubble	A - F	w/un mate & no J	See page 4 of this table.	
to	(collar	PRT	16 Nov 85	Highway 9 & Skagit River/corn		w/un mate & no J		
1986	split)		23 Nov 85	Mt. Vernon/Beaver Marsh Rd/corn		w/un mate & no J		
			01 Dec 85	Clear Lk/ice/sleep		w/un mate & no J		
			07 Dec 85	Mt. Vernon/Beaver Marsh Rd/corn		w/un mate & no J		
			08 Dec 85	Burlington/Cook Rd/corn		w/un mate & no J		
			29 Dec 85	Burlington/Gardner Rd/corn		w/un mate & no J		
			05 Jan 86	Mt. Vernon/Kamb Rd/corn		w/un mate & no J		
			18 Jan 86	Mt. Vernon/Calhoun Rd/corn		w/un mate & no J		
			25 Jan 86	Mt. Vernon/Youngquist Rd/pasture		w/un mate & no J		
			02 Feb 86	Mt. Vernon/Mud Lake Rd/fallow field		w/un mate & no J		
	61UR	MRT	16 Nov 85	Highway 9 & Skagit River/corn	A - F	w/un mate & 1 J	20 Jul 84	Kenai NWR/Kenaitze Lk
		PLT	22 Nov 85	Highway 9 & Skagit River/corn		w/un mate & 1 J		
			01 Dec 85	Mt. Vernon/DeBay Slough/ice/sleep		w/un mate & 1 J		
			07 Dec 85	Burlington/Cook Rd/corn		w/un mate & 1 J		
			08 Dec 85	Burlington/Cook Rd/corn		w/un mate & 1 J		
			29 Dec 85	Burlington/Gardner Rd/corn		w/un mate & 1 J		
			18 Jan 86	Burlington/Green Rd/corn		w/un mate & 1 J		
			19 Jan 86	Burlington/Green Rd/corn		w/un mate & 1 J		
			23 Feb 86	Mt. Vernon/Mud Lk Rd/pasture		w/un mate & 1 J		
	11 HC	MLT	23 Nov 85	Mt. Vernon/Beaver Marsh Rd/corn	A - M	Appears alone	20 Sep 84	Minto Flats, AK/50 km W of Fairbanks
			07 Dec 85	Mt. Vernon/Beaver Marsh Rd/corn		Appears alone		
			29 Dec 85	Mt. Vernon/Calhoun Rd/corn		Appears alone		
			01 Jan 86	Mt. Vernon/Calhoun Rd/corn/barn eff.		Appears alone		
			05 Jan 86	Mt. Vernon/Calhoun Rd/potato field		Appears alone		
			18 Jan 86	Mt. Vernon/Calhoun Rd/corn/barn eff.		Appears alone		
			02 Feb 86	Mt. Vernon/Calhoun Rd/corn/barn eff.		Appears alone		
			19 Feb 86	Conway/Moberg/potato		Appears alone		
	23HC	MLT (sm)	23 Nov 85	Mt. Vernon/Francis Rd/corn stubble	A - F	w/24HC; pr; no J	16 Jul 85	Minto Flats, AK/ 50 km W of Fairbanks
	519-72830		07 Dec 85	Burlington/Cook/District Line Rds/corn		w/24HC; pr; no J		
			08 Dec 85	Burlington/Cook Rd/corn		w/24HC; pr; no J		
			29 Dec 85	Mt. Vernon/Francis Rd W/corn		w/24HC; pr; no J		
			01 Jan 86	Mt. Vernon/Beaver Marsh Rd/corn/barn eff.		w/24HC; pr; no J		
			05 Jan 86	Mt. Vernon/McLean Rd/pasture/sleep		w/24HC; pr; no J		
			12 Jan 86	Mt. Vernon/Beaver Marsh Rd/potato		w/24HC; pr; no J		
			18 Jan 86	Mt. Vernon/Calhoun Rd/corn		w/24HC; pr; no J		
			02 Feb 86	Mt. Vernon/Mud Lk Rd/fallow emerging		w/24HC; pr; no J		
			09 Feb 86	Mt. Vernon/Barney Flats/corn		w/24HC; pr; no J		
			23 Feb 86	Mt. Vernon/Mud Lk Rd/corn		w/24HC; pr; no J		
	24HC 619-15401	MLT (lg)	Information same as above for 23HC					

Table 1. Collared Trumpeter Swan Resightings
Skagit River Valley, Washington
Winter Seasons 1977-78 to 1987-88

Winter of	Collar Code	Tarsus	Sight Date	Area	Plumage-Sex	Status	Date Banded	Location
1985 to 1986 (cont)	15EA	MRT	07 Dec 85	Mt. Vernon/Beaver Marsh Rd/corn	A - M	Appears alone	24 Sep 82	Minto Flats, AK/50 km W of Fairbanks
			29 Dec 85	Mt. Vernon/Francis Rd W/corn		Appears alone		
			01 Jan 86	Mt. Vernon/Calhoun Rd/barn eff.		Appears alone		
			05 Jan 86	Mt. Vernon/Kamb Rd/corn/sleep		Appears alone		
			12 Jan 86	Clear Lk/Beaver Lk Rd/pasture		Appears alone		
			19 Jan 86	Mt. Vernon/Francis Rd/flood pasture		Appears alone		
			26 Jan 86	Mt. Vernon/Francis Rd/pasture		Appears alone		
			02 Feb 86	Mt. Vernon/Mud Lk Rd/fallow field		Appears alone		
			09 Feb 86	Mt. Vernon/Barney Flats/pasture		Appears alone		
			23 Feb 86	Mt. Vernon/Mud Lk Rd/corn/pasture		Appears alone		
1986 to 1987	00VT	MLT PRT	02 Dec 86	Highway 9 & Skagit Ri/corn	A - F	w/1 un J; no mate sighted	See page 4 of this table.	
			07 Dec 86	Mt. Vernon/Francis Rd E/corn		w/1 un J; no mate sighted		
			11 Jan 87	Burlington/Cook Rd/ corn		w/1 un J; no mate sighted		
			18 Jan 87	Mt. Vernon/Francis Rd W/corn		w/1 un J; no mate sighted		
			16 Feb 87	Mt. Vernon/Younquist Rd/corn		w/1 un J; no mate sighted		
			23 Feb 87	Mt. Vernon/Mud Lk Rd/corn		w/1 un J; no mate sighted		
			01 Mar 87	Burlington/Gardner Rd/corn		w/1 un J; no mate sighted		
	11HC	MLT	28 Dec 86	Mt. Vernon/Calhoun Rd/corn/barn eff.	A - M	Appears alone	20 Sep 84	Minto Flats, AK/50 km W of Fairbanks
			11 Jan 87	Mt. Vernon/Beaver Marsh Rd/corn		Appears alone		
			18 Jan 87	Mt. Vernon/Youngquist Rd/corn		Appears alone		
			01 Feb 87	Mt. Vernon/Calhoun Rd/corn/barn eff.		Appears alone		
			01 Mar 87	Mt. Vernon/Mud Lk Rd/pasture		Appears alone		
	23HC	MLT	30 Nov 86	Burlington/Cook Rd/corn	A - F	w/24HC; pr; no J	16 Jul 85	Minto Flats, AK/50 km W of Fairbanks
			01 Dec 86	Highway 9 & Skagit Ri/corn		w/24HC; pr; no J		
			14 Dec 86	Burlington/Cook Rd/corn/barn eff.		w/24HC; pr; no J		
			16 Dec 86	Mt. Vernon/Mud Lk Rd/corn		w/24HC; pr; no J		
			11 Jan 87	Mt. Vernon/Francis Rd/corn		w/24HC; pr; no J		
			18 Jan 87	Burlington/Green Rd/corn		w/24HC; pr; no J		
			16 Feb 87	Mt. Vernon/Barney Flats/pasture		w/24HC; pr; no J		
			22 Feb 87	Mt. Vernon/Mud Lk Rd/corn		w/24HC; pr; no J		
			01 Mar 87	Mt. Vernon/Mud Lk Rd/pasture		w/24JC; pr; no J		
	24HC	MLT	All information same as above for 23HC					
	c36HC		01 Jan 87	Port Susan/Stillaguamish Ri Estuary	J - M	w/46HC/upper mandible damage	18 Sep 86	Minto Flats, AK/ 50 km W of Fairbanks
			01 Feb 87	Port Susan/Stillaguamish Ri Estuary		w/46HC/upper mandible damage		
	46HC		Same dates and locations as above for 36HC		J - M	w/36HC	18 Sep 86	Minto Flats, Ak/50km W of Fairbanks

c) Transmitter attached to collar.

Table 1. Collared Trumpeter Swan Sightings
Skagit River Valley, Washington
Winter Seasons 1977-78 to 1987-88

Winter of	Collar Code	Tarsus	Sight Date	Area	Plumage-Sex	Status	Date Banded	Location
1986 to 1987 (cont)	54HC	MRT	22 Feb 87	Burlington/Gardner Rd/pasture	A - M	Appears alone; favors left wing	15 Feb 87	Mt. Vernon, WA
			23 Feb 87	Burlington/Gardner Rd/pasture		Appears alone		
			01 Mar 87	Mt. Vernon/Barney Flats/pasture		Appears alone; asleep		
1987 to 1988	23HC	MRT	20 Dec 87	Mt. Vernon/Beaver Marsh Rd/corn		w/uncollared mate/MLT & 1 J	16 Jul 85	Minto Flats, AK/50 km W
			22 Dec 87	Burlington/Cook Rd/corn		w/uncollared mate/MLT & 1 J		
	61UR		01 Jan 88	Burlington/Cook Rd/pasture	A - F	w/un mate & 4 J	20 Jul 84	Kenai NWR/Kenaitze Lk
			18 Jan 88	Burlington/Cook Rd/corn		w/un mate & 3 J		
	66HC	MLT	01 Jan 88	Burlington/Cook Rd/corn	J - M	w/68HC, 69HC & 92HC	28 Sep 87	Minto Flats, AK/50 km W of Fairbanks
	68HC	MLT	01 Jan 88	Burlington/Cook Rd/corn	J - M	w/66HC, 69HC & 92HC	28 Sep 87	Minto Flats/50km W of Fairbanks
	69HC	MLT	01 Jan 88	Burlington/Cook Rd/corn	J - M	w/66HC, 68HC & 92HC	28 Sep 87	Minto Flats/50km W of Fairbanks
	d92HC	MLT	01 Jan 88	Burlington/Cook Rd/corn	J - M	w/66HC, 68HC & 69HC	28 Sep 87	Minto Flats/50 km W of Fairbanks
	e36HC		18 Jan 88	Port Susan/Stillaguamish Ri Estuary	A - M	w/un Adult	18 Sep 86	Minto Flats/50 km W of Fairbanks

d) Transmitter attached to collar; frequency 164.3575
e) No transmitter observed on collar.

Legend: MLT = Metal Left Tarsus
MRT = Metal Right Tarsus
NMT = No Metal Tarsus
PLT = Plastic Left Tarsus
PRT = Plastic Right Tarsus
J = Juvenile
A = Adult
Corn= Corn Stubble
Fam = Family
un = Unmarked; no collar or tarsus band
eff = Effluent; liquid manure processed onto fields.

Table 2. Collared Tundra Swan Resightings
Skagit River Valley, Washington
Winter Seasons 1983-84 to 1987-88

Winter of	Collar Code	Tarsus	Sight Date	Area	Plumage-Sex	Status	Date Banded	Location
1983 to 1984	9U	MRT PLT	24 Nov 83	Mt. Vernon/Francis Rd W/corn	A - M	w/mate 2F & J's 0F, 1F, 4F, 6F, 8F, 2J; family intact all sightings	29 Jul 83	Izembek NWR, AK/Y Lakes
			05 Dec 83	Highway 9 & Skagit River/corn				
			24 Dec 83	Burlington/Gardner Rd/corn				
			31 Dec 83	Burlington/Gardner Rd/corn				
			02 Jan 84	Burlington/Collins Rd/corn				
			21 Jan 84	Mt. Vernon/Summers Rd/winter grain				
			22 Jan 84	Fir Is/Maupin Rd/winter grain/rest				
			04 Feb 84	Burlington/Gardner Rd/pasture				
			19 Feb 84	Sedro-Woolley/Burmaster Rd/pasture				
			17 Mar 84	Fir Is/Maupin Rd/winter grain/rest				
			18 Mar 84	Fir Is/Maupin Rd/winter grain				
			19 Mar 84	Fir Is/Maupin Rd/winter grain				
			25 Mar 84	Mt. Vernon/Bradshaw Rd/pasture				
			31 Mar 84	Mt. Vernon/Bradshaw Rd/pasture				
			01 Apr 84	Mt. Vernon/Bradshaw Rd/pasture				
	2F	MRT PLT	All sightings same as above for 9U; fam intact		A - F	w/mate 9U & J's 0F, 1F, 4F, 6F, 8F, 2J	29 Jul 83	Izembek NWR, AK/Y Lakes
	0F	MLT PRT	All sightings same as above for parents 9U & 2F		J	family intact	29 Jul 83	Izembek NWR, AK/Y Lakes
	1F	MLT PRT	All sightings same as above for parents 9U & 2F		J	family intact	29 Jul 83	Izembek NWR, AK/Y Lakes
	4F	MLT PRT	All sightings same as above for parents 9U & 2F		J	family intact	29 Jul 83	Izembek NWR, AK/Y Lakes
	6F	MLT PRT	All sightings same as above for parents 9U & 2F		J	family intact	29 Jul 83	Izembek NWR, AK/Y lakes
	8F	MLT PRT	All sightings same as above for parents 9U & 2F		J	family intact	29 Jul 83	Izembek NWR, AK/Y Lakes
	2J	MLT PRT	All sightings same as above for parents 9U & 2F		J	family intact	29 Jul 83	Izembek NWR, AK/Y Lakes
1984 to 1985	6F	MLT PRT	03 Nov 84	Mt. Vernon/Francis Rd/corn	A	appears alone	29 Jul 83	Izembek NWR, AK/Y Lakes
			17 Nov 84	Burlington/Cook Rd/corn		appears alone		
			15 Dec 84	Burlington/Cook Rd/corn		appears alone		
			16 Dec 84	Burlington/Cook Rd/corn		appears alone		
			22 Dec 84	Burlington/Gardner Rd/corn		appears alone		
			26 Jan 85	Ferndale/Church Rd/corn		appears alone		

Table 2. Collared Tundra Swan Resightings
Skagit River Valley, Washington
Winter Seasons 1983-84 to 1987-88

Winter of	Collar Code	Tarsus	Sight Date	Area	Plumage-Sex	Status	Date Banded	Location
1985 to 1986	CP	MRT	16 Nov 85	Highway 9 & Skagit River/corn	A - F	Appears alone	29 Jul 85	Izembek NWR, AK/Seal Lk/ Caribou Ri/100 Km NE Cold Bay/PAVLOF Unit
		PLT	07 Dec 85	Mt. Vernon/Beaver Marsh Rd/corn		Appears alone		
			01 Jan 86	Mt. Vernon/Calhoun Rd/corn/barn eff.		Appears alone		
			05 Jan 86	Mt. Vernon/Calhoun Rd/potato		Appears alone		
			18 Jan 86	Mt. Vernon/Calhoun Rd/pasture		Appears alone		
			02 Feb 86	Mt. Vernon/Calhoun Rd/potato		Appears alone		
			09 Feb 86	Mt. Vernon/Calhoun Rd/potato		Appears alone		
1986 to 1987	PO18	MLT	29 Nov 86	Conway/Fir Island/corn stubble	A - M	w/un mate & no J	17 Jul 83	Alaska Penisula NWR/ Dog Salmon Ri/SW of Ugashik, AK
		PRT	14 Dec 86	Burlington/Cook Rd/corn/barn eff.		w/un mate & no J		
			16 Dec 86	Burlington/Cook Rd/corn/barn eff.				
	R6		07 Dec 86	Burlington/Collins Rd/corn	A	Appears alone	31 Jul 86	Izembek NWR/Long Hike Lk/ Pavlof Unit
			14 Dec 86	Burlington/Cook Rd/corn		Appears alone		
			16 Dec 86	Burlington/Cook Rd/corn		Appears alone		
			03 Jan 87	Burlington/Cook Rd/Barn eff.		Appears alone		
	YP	MRT	07 Dec 86	Burlington/Collins Rd/corn	A	Appears alone	29 Jul 85	Izembek NWR/Seal Lk/ Caribou Ri/PAVLOF Unit, AK
		PLT	14 Dec 86	Burlington/Cook Rd/corn		Appears alone		
			16 Dec 86	Burlington/Cook Rd/corn		Appears alone		
			11 Jan 87	Mt. Vernon/Beaver Marsh Rd/corn		Appears alone		
			01 Feb 87	Mt. Vernon/Beaver Marsh Rd/winter grain		Appears alone		
1987 to 1988	S2	MRT	22 Nov 87	Burlington/Gardner Rd/corn stubble	A - M	w/CF & no J	31 Jul 86	Izembek NWR/Seal Lk/ PAVLOF Unit
		PLT	26 Nov 87	Mt. Vernon/Penn Rd/corn		w/CF & no J		
			06 Dec 87	Edison/Sunset Rd/corn		w/CF & no J		
			22 Dec 87	Edison/Sunset Rd/pasture		w/CF & no J		
			10 Jan 88	Port Susan/Stillaguamish Ri Estuary		w/CF & no J		
			18 Jan 88	Port Susan/Stillaguamish Ri Estuary		w/CF & no J		
	CF	MRT	Same as S2 above		A - F	w/S2 & No J	29 Jul 85	Izembek NWR/Seal Lk/ PALVOF Unit
		PLT						
	CP	MRT	26 Nov 87	Burlington/Kelleher Rd/corn/barn eff.	A - F	Appears alone	29 Jul 85	Izembek NWR/Seal Lk PAVLOF Unit
		PLT	05 Dec 87	Burlington/Green Rd/corn stubble		Appears alone		
			06 Dec 87	Burlington/Gardner Rd/corn		Appears alone		
			22 Dec 87	Edison/Thomas Rd/corn		Appears alone		
			10 Jan 88	Fir Island/Polson Rd/winter grain		Appears alone		
	R5	MRT	05 Dec 87	Fir Island/corn stubble	A	Appears alone	31 Jul 86	Izembek NWR/Long Hike Lk/ PAVLOF Unit
		PLT	06 Dec 87	Burlington/Gardner Rd/corn		Appears alone		
	YP	MRT	06 Dec 87	Edison/Sunset Rd/corn stubble	A	Appears alone	29 Jul 85	Izembek NWR/Seal Lk PAVLOF Unit
		PLT	27 Dec 87	Fir Island/winter grain		Appears alone		
	X6	MRT	19 Dec 87	Mt. Vernon/Beaver Marsh Rd/corn	A - F	Appears alone	25 Jul 87	Izembek NWR/PAVLOF Unit
		PLT	27 Dec 87	Fir Island/winter grain		Appears alone		
			10 Jan 88	Fir Island/winter grain		Appears alone		

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OTHER TOPICS OF INTEREST

HEMATOLOGICAL AND PARASITOLOGICAL SURVEY OF CAPTIVE MINNESOTA TRUMPETER SWANS

Laurel A. Degernes, D.V.M. and Patrick T. Redig, D.V.M.

ABSTRACT

Twenty-five Hennepin Parks Trumpeter Swans (Cygnus buccinator) and 41 Minnesota Department of Natural Resources (MN DNR) Trumpeter Swans were included in a survey between July and October 1987 to determine their health status (age range 3-1/2 months to 13 years). The parameters studied included complete blood counts (CBC's) blood lead analysis, aspergillosis ELISA's (Enzyme Linked Immunosorbent Assay), body weights, and random fecal samples for intestinal parasites.

The results are summarized as follows with all of the swans of different age, sex, and origins combined (mean + standard deviation): packed cell volume (PCV, expressed as a percent of red blood cells 42.98 + 4.2; total protein (TP, expressed as grams of plasma protein/100 mls.) 4.35 + 0.46; blood lead (ppm) 0.09 + 0.09; aspergillosis ELISA (optical density at 1:800 dilution) 0.117 + 0.09; and body weights (lbs) 19.73 + 3.1. The only intestinal parasite found was tapeworms.

In summary, the captive Hennepin Parks and MN DNR Trumpeter Swans were a healthy group of birds, showing very low lead, aspergillosis, and intestinal parasite exposure.

Very little information is available on Trumpeter Swan (Cygnus buccinator) hematological values or parasitic diseases (Cowan 1946, Lapage 1961, Bennett et al. 1981). A field survey of captive Minnesota Trumpeter Swans was conducted between July and October 1987, to begin developing a data base of hematological values and parasite incidence in this species. The data were also used to assess the health of this population as a whole and to screen for individuals with potential health problems.

The study involved 25 Hennepin Parks swans (eight cygnets, six subadult males, two adult females, seven adult males, two adult females) and 41 Minnesota Department of Natural Resources (MN DNR) swans (18 cygnets, 13 subadult males, nine subadult females). The Hennepin Parks swans were weighed and bled when they were captured for wing clipping (July-September). The MN DNR swans were housed at Carlos Avery Game Farm, which allowed us to capture and bleed the birds on two afternoons (subadult swans - August; cygnets - October). All cygnets sampled were > 3 months-of-age. The wing vein was used for collecting blood, and a digital platform scale or spring-scale was used for weighing the birds. The fecal samples were collected from random birds or from commonly-used loafing areas.

The hematological parameters studied included a complete blood count (CBC), blood lead analysis, and aspergillosis serology. A discussion of these tests is in order before presenting the results of the study.

A CBC can provide a variety of information from a very small sample of blood and includes the following components: 1) packed cell volume (PCV) or hematocrit - the percentage of a volume of blood comprised of red blood cells; 2) total plasma protein (TP) expressed as grams of plasma protein per deciliter of plasma (albumin, gamma globulins, and other proteins); 3) white blood count estimate (WBC est.) - expressed as an estimate of the number of white blood cells in a cubic ml of blood; 4) white blood cell differential - percentages of the different types of white blood cells (not included in this study); and 5) blood parasites - the number of Haemoproteus sp., Leucocytozoan sp., and Plasmodium sp. per 10,000 red blood cells.

Blood lead levels are used to determine the level of exposure to lead in the environment. The levels are expressed in parts per million (ppm) and were determined using an atomic absorption spectrophotometer. Based upon a classification scheme for lead exposure in Bald Eagles (Redig 1984), four categories have been described:

Category I (< 0.2 ppm) -	clinically normal birds, with little or no lead exposure.
Category II (0.2-0.6 ppm) -	usually clinically normal birds with mild exposure to lead.
Category III (0.6-1.0 ppm) -	mild to moderate clinical signs of lead poisoning, with moderate exposure to lead.
Category IV (> 1.0 ppm) -	moderate to severe clinical signs of lead poisoning, with significant exposure to lead.

For a more detailed discussion, please refer to the paper in these proceedings, entitled "The Diagnosis and treatment of lead poisoning in Trumpeter Swans" (Degernes and Redig 1990a).

Aspergillosis can be a serious and potentially fatal cause of respiratory illness in swans and is most commonly caused by the fungus Aspergillus fumigatus. Serologic testing for exposure to Aspergillus sp. was done using an enzyme-linked immunosorbent assay (ELISA). This assay was developed by Patrick Redig et al. (1986) for use in commercial turkeys and has since been applied to a variety of other avian species, including raptors, caged birds, and Trumpeter Swans. The purpose of the test is to measure the antibody production against Aspergillus sp. to determine the level of exposure or possible infection by these fungal organisms. The data presented are the optical density (O. D.) readings at 1:800 dilution (colorimetric method). Levels $\leq$ 0.2 O. D. are generally considered within the normal range and levels $\geq$ 0.2 O. D. are indicative of significant exposure to, and possible infection by, Aspergillus sp. Swans that died of aspergillosis usually had levels $\geq$ 0.3 O. D. For a more detailed discussion of aspergillosis, please refer to the paper in these proceedings, entitled "The Diagnosis and treatment of aspergillosis in Trumpeter Swans" (Degernes and Redig 1990b).

RESULTS AND DISCUSSION

Body weight

Body weights have been reported for Alaskan Trumpeter Swans (Hansen et al. 1971), but are not available for the Rocky Mountain or Interior Populations. The Alaskan swans averaged 26.4 lbs and 21.2 lbs for adult males and females, respectively, and 25.1 lbs and 21.5 lbs for subadult (yearling) males and females. The cygnets' ages and weights varied too dramatically to be used for comparison with the Minnesota cygnets (all $\geq$ 3 months-of-age). All of the Minnesota subadult birds had lower body weights than the weights reported by Hansen et al. for Alaskan birds (Table 1). The Hennepin Parks adult swans were comparable in weight to the Alaskan adults. The average weight of the Hennepin Parks cygnets and subadults was heavier than the MN DNR birds of the same age classes. One possibility for the low MN DNR weights recorded might be related to equipment problems with the digital platform scale.

Packed cell volume

Normal PCV data were not available for Trumpeter Swans. A normal summer value for Canada Geese (Branta canadensis) is 46% $\pm$ 3.5 (Shave and Howard 1976). For raptors at the Raptor Research and Rehabilitation Program (RRRP), PCV's between 40-50 percent are generally considered normal. Extrapolating from other avian species, the average PCV of the various groups fell within a normal range (Table 1). Factors which may alter these values include dehydration (increased PCV due to hemoconcentration of red blood cells) and anemia (decreased PCV, secondary to malnutrition, lead poisoning, infectious diseases, or estrogenic effect in reproductively active females).

Total protein

A study conducted by Mori and George (1978) showed spring and fall TP values of 5.36 $\pm$ 0.27 and 4.26 $\pm$ 0.13 g/dl, respectively, for migrating Canada Geese. A normal range for raptors at the RRRP is 3.2-4.5 g/dl. Extrapolating from these other avian species, the TP values found for the swans were considered normal among the different groups (Table 1). Infection or dehydration may result in elevated TP values, while malnutrition or liver disease may lower the TP level.

White blood count estimate

Currently, there are no techniques available to precisely count white blood cell numbers in avian samples. Consequently, these numbers are estimated, and the results may be altered by the quality of the blood smear, the counting technique used, and/or the experience of the technician (McEntee 1984).

Values of 18,800 to 21,800 white blood cells/cubic ml have been reported for Snow and Blue Geese (Chen caerulescens) and Canada Geese (Williams and Trainer 1971), which are significantly higher than the values reported for Trumpeter Swans in this study (Table 1). Differences in the technique employed or species variability may account for this discrepancy. In general, elevated WBC estimates are observed concurrently with some infectious diseases, while lower estimates may be seen with viral or other immunosuppressive diseases, or with starvation.

Blood parasites

Several blood parasites have been described in Trumpeter Swans: Haemoproteus sp., Leucocytozoan sp., and Plasmodium sp. (Bennett et al. 1981). None of these parasites were observed in any of the swans tested, regardless of habitat or location. The dry spring and summer in 1987 may have resulted in fewer insect vectors for these parasites, or perhaps these parasites are not present in the Minnesota flocks yet.

Blood lead

All of the swans tested for blood lead levels were either in Categories I (< 0.2 ppm) or II (0.2-0.6 ppm). Except for one MN DNR subadult with 0.45 ppm blood lead, all of the levels were consistent with "normal" background levels of lead in the environment, implying that these captive refuge and game farm birds were at very low risk for lead poisoning problems. Since these areas have not been used for waterfowl hunting for years, and lead shot is now banned for waterfowl hunting in Minnesota, it is unlikely that lead problems will be encountered in these birds in the future.

Aspergillosis ELISA

Aspergillosis ELISA's were run on all of the swans to start developing a data base to determine the level of exposure to Aspergillus spp. and the potential for developing the disease. It should be noted that a single sample may not be diagnostic since the antibody level may be influenced by the bird's immune system and the stage of the disease process.

Although the Hennepin Parks birds were clinically normal and showed no evidence of respiratory disease at the time of sampling, they had consistently higher aspergillosis ELISA's than the MN DNR birds. The Hennepin Parks subadult males had suspiciously elevated ELISA's in four out of six birds $\geq$ 0.2 O. D. None of these birds subsequently exhibited any respiratory disease problems in the next 5 months. However, one bird in the normal range died of tracheal occlusion and asphyxiation due to aspergillosis in December. It is possible that the Hennepin Parks birds have a higher exposure to Aspergillus spp. spores in the refuges where there is less control over weather or environmental conditions that favor mold growth, such as rain-soaked feed or feed spilled on the ground by raccoons. At the MN DNR facility at Carlos Avery Game

Table 1. Hematological data of Minnesota DNR and Hennepin Parks Trumpeter Swans.

Parameter	Overall[a] n = 65	MN DNR Cygnets[b] n = 18	MN DNR Subadult males n = 13	MN DNR Subadult females n = 9	Hennepin Parks Cygnets n = 8	Hennepin Parks Subadult males n = 6	Hennepin Parks Subadult females n = 2	Hennepin Parks Adult males[c] n = 7	Hennepin Parks Adult females n = 2
Body weight (lbs)	19.7 ± 3.1 n = 58	9.1 ± 2.2 n = 18	18.9 ± 2.5 n = 13	17.0 ± 2.4 n = 9	21.4 ± 1.7 n = 4	22.0 ± 2.3 n = 5	19.5 ± 0.7 n = 2	25.4 ± 2.6 n = 5	21.0 ± 1.4 n = 2
Packed cell volume %	42.9 ± 4.2 n = 56	42.9 ± 5.7 n = 18	42.5 ± 2.4 n = 13	42.2 ± 1.8 n = 9	43.6 ± 2.7 n = 8	49.5 ± 2.1 n = 2	--- -- --	42.7 ± 7.6 n = 4	41.0 ± 1.4 n = 2
Total protein (g/dl)	4.4 ± 0.4 n = 56	4.2 ± 0.4 n = 18	4.4 ± 0.4 n = 13	4.5 ± 0.5 n = 9	4.1 ± 0.4 n = 8	5.1 ± 0.8 n = 2	--- -- --	4.6 ± 0.2 n = 4	4.4 ± 0.1 n = 2
White blood cell est./ cu ml blood	11,180 ± 4,821 n = 56	9,885 ± 5,516 n = 18	12,330 ± 5,500 n = 13	9,899 ± 3,338 n = 9	13,810 ± 4,621 n = 8	9,000 ± 1,414 n = 2	-- -- --	11,750 ± 1,443 n = 4	13,625 ± 1,944 n = 2
Blood parasites/ 10,000 red blood cells	0 n = 56	0 n = 18	0 n = 13	0 n = 9	0 n = 8	0 n = 2	--- --	0 n = 4	0 n = 2
Blood lead (ppm)	0.09 ± 0.09 n = 56	0.03 ± 0.03 n = 15	0.12 ± 0.07 n = 13	0.10 ± 0.14 n = 9	0.15 ± 0.12 n = 4	0.09 ± 0.09 n = 5	0.04 ± 0.05 n = 2	0.10 ± 0.09 n = 6	0.16 ± 0.10 n = 2
Asper. ELISA O. D. at 1:800 dilution	0.12 ± 0.09 n = 65	0.06 ± 0.08 n = 18	0.08 ± 0.04 n = 13	0.11 ± 0.07 n = 9	0.15 ± 0.09 n = 8	0.25 ± 0.12 n = 6	0.15 ± 0.01 n = 2	0.15 ± 0.07 n = 7	0.15 ± 0.002 n = 2

[a] Overall group combines all swans regardless of age, sex, origin (MN DNR + Hennepin Parks).
[b] Cygnets - sex undetermined.
[c] Adults - ≥ 2 years old.

Farm, it is possible to change the feed troughs and discard damp or unused feed daily.

Intestinal parasites

Random fecal samples were collected and analyzed using direct smear and fecal flotation methods. The 13 fecal samples collected from Hennepin Parks swans included samples from wild, free-flying individuals, as well as captive birds; all were negative. The eight fecals run on the MN DNR swans were also negative for parasite ova. Although post-mortem results were not part of the study, it should be noted that four out of 27 swans autopsied had tapeworms (one Hennepin Parks and three MN DNR swans, species not identified). Since tapeworm ova are shed intermittently, multiple fecals might have to be collected to detect this parasite in the future.

CONCLUSIONS

Based upon 1 year's hematology data from 65 captive Minnesota Trumpeter Swans, and extrapolation from normal values reported for other avian species, this population has a normal hematology profile and shows very low exposure to environmental lead. The Hennepin Parks swans showed a higher level of exposure to Aspergillus spp. than the MN DNR swans which might reflect differences in management practices and environmental factors that allow mold growth. The absence of blood parasites and very low incidence of intestinal parasites are indicative of a healthy population.

The field study to collect hematology and parasitology data is an important first step in developing a data base of reference values for Trumpeter Swans. The information obtained is important, not only for assessing the overall health status of this population, but also for identifying individuals with potential health problems. Furthermore, in the areas of medical management of injured or diseased swans, one must have a set of reference values to use for comparison. In subsequent years, we plan to continue this project and hope to include data from some of the free-flying swans as well.

I gratefully acknowledge the assistance of Hennepin Parks personnel (Larry Gillette, Donna Compton, Judy Voigt Englund, Gary Stammer, and Mary Micelli) and MN DNR personnel (Steve Kittelson and Peggy Callahan) in collecting field samples, the technical staff at the RRRP for conducting hematology and parasitology exams (Diane Olson and Jean Dunnette), and the MN DNR toxicology lab for analyzing blood lead samples (Bob Glazer and Patricia Kirby).

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CAUSES OF MORTALITY FOR TRUMPETER SWANS IN CENTRAL MINNESOTA, 1980-1987

Laurence N. Gillette

ABSTRACT

Hennepin Parks has been releasing Trumpeter Swans each year from 1979 through 1987 to establish a free-flying population in central Minnesota. Although reproduction has been good for the released birds, mortality has been extremely high. Many of the carcasses have been retrieved and examined, especially during the last 3 years. Mortality factors are discussed, along with Hennepin Parks' efforts to reduce mortality. Although causes of death were numerous, shooting and lead poisoning were the two most common mortality factors for this population of Trumpeters.

Hennepin Parks operates a series of 1,000- to 5,000-acre park reserves in the western half of Hennepin County, Minnesota. The terrain is gently rolling with numerous wetlands. The Park District has undertaken a Trumpeter Swan restoration project which is intended to establish a flock of 100 free-flying, migratory Trumpeter Swans, with at least 15 nesting pairs, in south-central Minnesota. Releases of swans began in 1979 and have continued through 1987.

This report provides a brief update on Hennepin Parks' Trumpeter Swan flock during the past 8 years as an introduction to an examination of mortality factors for free-flying swans in Minnesota. A hypothetical mortality table was prepared to help assess the importance of the various factors. The impact that high mortality has on migration will also be discussed.

Table 1 shows the population changes that have occurred since 1980 for Hennepin Parks' total population and for that segment which is free-flying. It also shows the number of cygnets that fledged each fall. The overall population has not increased appreciably since 1983, despite consistently good production of young swans. The free-flying segment has increased more than the total flock because in addition to increases as a result of production, it has been augmented by releases of swans hatched in earlier years. More swans died in 1986 and 1987 than were produced.

Mortality of free-flying swans has increased faster than the rate of population growth during the last 5 years. In other words, the percentage of free-flyers that die each year has increased between 1983 and 1987, reaching a peak of 37 percent mortality in 1986, compared to the widely fluctuating (22-49 percent) annual production increases in the flock. This annual mortality rate is far too high to maintain a population for a species that requires 3 to 5 years to reach sexual maturity.

Table 1. Trumpeter Swan population 1980-87, Hennepin Parks, Minnesota.

Year	'80	'81	'82	'83	'84	'85	'86	'87
Total population*	31	37	55	72	84	81+	75+	75+
Cygnets to flight (but not necessarily released)	9	8	17	27	25	19	29	24
Free-flying swans (includes cygnets of the year)*	8	13	22	21	44	47+	49+	53+

* Numbers for the total population and free-flying swans are for 31 December of each year.

\+ Indicates that figures were minimum estimates.

Three factors appear to be responsible for the high mortality rate:

1. Newly-released swans disperse from the park reserves more rapidly when a larger percentage of the population is free-flying (since 1984). Dispersal increases the risk of shooting, lead poisoning, and collision with power lines.

2. A large segment of the population migrated for the first time in the winter of 1984-85. Those that failed to return were listed as dead in 1985. Smaller migrations have occurred each year since then. Swans that migrate have a higher mortality rate than those that stay in Minnesota.

3. The majority of the cygnets produced in recent years were produced by free-flying parents. These cygnets were allowed to fly free with their parents when they fledged. Cygnets raised by captive birds were kept clipped for 1 to 2 years prior to release. Mortality of free-flying cygnets and subadult birds was extremely

high, especially after they became separated from the adult swans. More swans died in the cygnet, 1- and 2-year-old-age classes than ever before due, in part, to the increased numbers of free-flying birds in those age classes and also to the vulnerability of birds in those age classes.

Dead swans were sent to the Raptor Research and Rehabilitation Program (RRRP) at the University of Minnesota for necropsy to determine the causes of death whenever possible. Table 2 shows the fates of released Trumpeters in Minnesota. All of the swans listed as disappeared are presumed to be dead. Shooting has remained the number one known mortality factor.

It is difficult to appreciate what is really going on in the population when the cause of death can not be determined for such a large percentage of the birds lost (either the swans disappear or the carcasses were too decomposed when retrieved to determine the cause of death). Therefore, a hypothetical mortality table was constructed. Development of the table was based upon three assumptions:

1. **Most carcasses of swans that hit power lines are retrieved.**

   In Minnesota, Trumpeter Swans fly primarily from mid-March until June and, again, from late September until early December. They are nesting or molting during the summer, and, at least in Minnesota where it is quite cold, they stay in refuges throughout most of the winter. Most power lines in Minnesota either parallel roads or cross agricultural fields. Road ditches and fields are sparsely vegetated during the majority of the time when swans are most likely to hit power lines. The large, white carcasses are easy to locate and retrieve.

2. **Many of the swans that are shot are also retrieved.**

   More people use wetlands during the hunting season than at any other time of the year. Many shootings are witnessed. Unless concealed, carcasses left in a marsh have a high probability of being located. Injured birds, if possible, will walk to water where they are usually spotted. In 1986 and 1987, only four of the 28 swans listed as missing or "too far gone" were likely shot. (Three carcasses were retrieved long after the birds disappeared, and the last swan which disappeared was reported injured on the same day one of its siblings was shot.) Most of the other swans that disappeared did so outside of the hunting season, or they frequented areas closed to hunting.

3. **Birds that die of lead poisoning or disease during spring or summer are difficult to locate.**

   Swans suffering from lead poisoning or disease die in secluded areas, often at a time when wetlands are not visited by people. The chances of recovery are slim. In Table 2, half of the retrieved swans for which a cause of death could be determined, other than shooting or collision with power lines, died of lead poisoning. Once corrections were made for shooting and collisions, it was assumed that 50 percent of the balance died of lead poisoning.

   This assumption is thought to be realistic, if not conservative, for two reasons. First, the Trumpeters' feeding behavior is such that the chances of picking up lead shot are good, especially in spring, even in areas where it may not be available to other water fowl. Second, the overall health of the Hennepin Parks' birds was determined to be excellent (Dr.

Table 2. Fates of Trumpeter Swans released by Hennepin Parks or raised in the wild by released swans 1980-87.

Causes of mortality for released or wild-reared Trumpeter Swans	1980-83	1984	1985	1986	1987	Total
Shot during hunting season	10	1	5	5	1	22
Hit power line	6	2	1	0	2	11
Lead poisoning	2	0	0	2	4	8
Aspergillus sp.	0	0	0	2	1	3
Leg infection	0	0	0	1	0	1
Severe trauma	0	0	0	1	0	1
Prolonged undetermined illness	0	0	0	1	1	2
Unknown (carcass recovered and examined)	0	0	0	0	1	1
Unknown (carcass recovered but too far gone to be examined)	2	3	1	2	6	14
Disappeared (spring-fall)	9	3	3	11	9	35
Disappeared during migration	0	1	8	4	0	13
Totals	29	10	18	29	25	111

Laurie Degernes, D.V.M., in this document). It is considered unlikely that a very large proportion of these healthy birds died of parasites or disease.

Based on the above assumptions, the mortality categories of "unknown" (carcass recovered but too far gone to be examined) and "disappeared" (spring-fall) were hypothetically divided up into four cause of death categories. Table 3 gives the suspected actual importance of each of the four primary causes of death for Trumpeters in south-central Minnesota. Shooting remained the number one cause of mortality, but lead poisoning became the second leading cause. Together, these two factors probably accounted for 55 percent of the mortality of Minnesota Trumpeter Swans. The importance of power line collisions was diminished.

Since lead poisoning is such a threat to Minnesota Trumpeters, Hennepin Parks, with the assistance of RRRP and the Nongame Program of the Minnesota Department of Natural Resources, took blood samples from wild and captive swans to test for lead. Gizzards of dead birds were examined for lead pellets, and liver tissue samples were tested for lead levels in all dead swans regardless of cause of mortality. A surprisingly low number of pellets was found in gizzards of swans that had died of lead poisoning, with one exception (Table 4). Only one gizzard from those taken from swans that died of other causes had any lead, and that was only one pellet.

Considering the apparent susceptibility of Trumpeter Swans to lead poisoning, it appears imperative that areas used by swans be closed immediately to the use of lead shot. Minnesota made a Statewide conversion to the use of nontoxic shot for over-water waterfowl hunting in 1987. It will be interesting to see if the rate of lead poisoning and the overall mortality rate declines in the future.

Mortality was too high to maintain a viable population. Hennepin Parks and the Minnesota Department of Natural Resources, Nongame Program, cooperated in a public information campaign to try to reduce shooting. Press releases, TV announcements, school programs, and billboards were all employed. How many past swan shootings were the result of not knowing versus not caring? Will anything help? Only time will tell. We hope that the switch to nontoxic shot and the increasing public awareness will reduce mortality sufficiently to allow the population to resume growth.

Swans listed in Table 2 that disappeared during migration were not included in the preceding discussion. Swans have migrated from Minnesota each year since 1984. A substantial percentage failed to return each spring. Only 18 of 29 returned in 1985, four of six in 1986, and one of two in 1987. Mortality was higher for swans that migrated than for those free-flyers that stayed in Minnesota for the winter.

Why do so many swans die during migration, and why has it been so difficult to establish and maintain a migratory tradition? The behavior and nature of the species contribute to the problem. Trumpeter Swans are much less gregarious than other waterfowl. Although they may concentrate on winter feeding grounds, they never form large flocks that stay together as Canada Geese or Tundra Swans do. Subadult Trumpeters may form loose associations, but the family unit, comprised of cygnets, parents, and, occasionally, yearlings, is the most common and important assemblage. Trumpeters migrate as families, not as large flocks. Cygnets must learn the migration route from their parents. Orphaned cygnets or released subadults will usually attempt a migration alone, rather than join up with more experienced swans. In so doing, they subject themselves to all the hazards which other birds may have learned to avoid.

Table 3. Hypothetical distribution of "cause of death unknown" Trumpeter Swan mortality in south-central Minnesota, 1980-87.

Cause of mortality	Actual loss of birds	Hypothetical distribution of "cause of death unknown" birds	Hypothetical distr. of total loss of birds
Shot	22	(7)	(29)
Lead poisoning	8	(19)	(27)
Power lines	11	(3)	(14)
Disease or other injury	8	(20)	(28)
Total	49	49	98

Assumptions for hypothetical distribution of "cause of death unknown" swans:

1. Three swans originally listed as disappeared probably hit power lines.
2. Seven swans originally listed as disappeared were shot.
3. If lead poisoning caused 50 percent of the known mortalities in the lead poisoning and disease categories, perhaps 50 percent of the remaining 39 unknown causes of death can also be attributed to lead poisoning.

Table 4. Results of gizzard examination and liver lead analysis for Trumpeter Swans that died in south-central Minnesota, 1980-87.

Swan	Origin	Cause of death	No. pellets found	Liver lead level (ppm)
33NA	Hennepin Parks	Lead poisoning	5	15.5
33NC	Hennepin Parks	Lead poisoning	1	10.9
62NA	Hennepin Parks	Lead poisoning	44	21.6
91NA	Hennepin Parks	Lead poisoning	0	17.8
Unmarked	Probably Ray Whitney	Lead poisoning	1	13.5
Unmarked	Probably Ray Whitney	Shot	1	9.2
58NA	Hennepin Parks	Power line collision	0	--
16NC	Hennepin Parks	Aspergillosis	0	--
04 (Red)	Hennepin Parks	Caught in fence -- severe hemorrhaging or suffocation	0	--
Unmarked	Ray Whitney	Shot	0	--
Whooper Swan*	Ray Whitney	Shot	0	4.6

* This was a captive bird.

To make matters worse, Trumpeters in Minnesota usually stay north until everything is frozen and they are forced to leave, at least when they are migrating for the first time. Swans departed from Minnesota on 12 and 28 December 1984 for their first migration. They left between 1 and 3 January 1988 for migration which occurred just prior to this Conference. Ponds, lakes, and rivers may be frozen from Minnesota to Missouri at this time of year. There is little room for error, and many of the migrators do not know where they are going. Lack of experience ensures high mortality during migration. High mortality in migration and throughout the rest of the year makes it extremely difficult to retain swans with migration experience.

Finally, swans may not migrate every year if they have the option to stay in the north. Two-thirds of the swans that survived the 1984-85 migration did not migrate the following year.

Since establishing a migratory pattern is so difficult, everything possible should be done to keep swans alive during migration and to make their migration destinations as attractive and safe as possible. The use of decoy swans and artificial feeding should be encouraged at carefully chosen southern locations to increase the migrators' chances of survival. When Minnesota's restoration goals are met and the swans are migrating on a regular basis, these efforts may be deemed unnecessary.

The Upper Midwest appears to be an ideal area for Trumpeter Swans in many ways. Clutches are large, cygnet survival is good, and the overall health of released birds has been excellent. The swans have virtually no parasites, and losses to diseases other than aspergillosis have been minimal. Finding a way to reduce man-induced mortality by shooting and lead poisoning is essential to restoring the Trumpeter to this part of its former range.

LEAD POISONING AND OTHER MORTALITY FACTORS OF TRUMPETER SWANS

Lawrence J. Blus, Richard Stroud, Barry Reiswig, and Terry McEneaney

ABSTRACT

Detailed necropsies or lead concentrations in livers were available for 72 Trumpeter Swans (Cygnus buccinator) found dead in seven western states from 1976 to 1987. Data from other published and unpublished sources (1925-87) are also summarized. Ingestion of lead artifacts (shot or fishing sinkers) accounted for about 20 percent of the known mortality of Trumpeter Swans in the Tristate area (Idaho, Montana, and Wyoming) where the population has been declining for several decades. In western Washington, incidence of lead-induced mortality was higher and accounted for nearly 50 percent of the known mortalities. Maximum lead concentration in livers of birds found dead and in whole blood from captured swans was 37 and 0.71 micrograms, respectively. A concentration of 2.95 micrograms selenium in blood was of concern; but, other elements, including cadmium, copper, and zinc, were generally not elevated in blood and tissue samples. It is uncertain that lead toxicosis induced by ingestion of artifacts is adversely affecting Trumpeter Swan populations. There were a number of other factors causing mortality of swans, including gunshot, disease, and human impacts.

See the following for complete article: Blus, L. J., R. K. Stroud, B. Reiswig, T. McEneaney. 1989.
Lead poisoning and other mortality factors in Trumpeter Swans.
Environmental Toxicology and Chemistry 8:263-71.

DIAGNOSIS AND TREATMENT OF LEAD POISONING IN TRUMPETER SWANS

Laurel A. Degernes, D.V.M. and Patrick T. Redig, D.V.M.

ABSTRACT

Between 1 January and 31 October 1987, five Trumpeter Swan were admitted to the Raptor Research and Rehabilitation Program (RRRP) with clinical signs of lead poisoning such as weight loss, weakness, depression, slight head tremors, wing droop, gastrointestinal problems, and/or bright green feces. All cases had blood lead levels ≥ 0.59 parts per million (range 0.59-3.3 ppm) and were treated with Ca EDTA, supportive fluids, B vitamins, and iron injections. Parameters monitored upon admission and throughout the course of therapy included complete blood counts (CBC), serum chemistries, blood lead analysis, and weight gains. Therapy can take as long as 3 weeks in debilitated birds.

One swan with 3.3 ppm blood lead died shortly after admission, two swans with blood lead levels of 1.4 and 1.6 ppm were successfully treated and are currently doing well in refuges, and two swans with blood lead levels of 0.59 and 0.6 ppm died or were euthanized for other reasons. Lead poisoning treatment can be considered successful when blood lead levels have been reduced to ≤ 0.5 ppm, blood tests yield normal CBC's and serum chemistry parameters, and body weight and behavior have returned to normal.

INTRODUCTION

Lead poisoning has been well documented as a significant cause of mortality among waterfowl populations (Bellrose 1959). However, reports of lead poisoning in Trumpeter Swans (Cygnus buccinator) have been limited (Munro 1925, Kendall and Driver 1982).

One of the leading causes of morbidity (illness) and mortality among Minnesota Trumpeter Swans in 1987 was lead poisoning. Nine swans were presented to the University of Minnesota Raptor Research and Rehabilitation Program (RRRP) for treatment of lead poisoning or post-mortem examination in 1987. Ingestion of lead shotgun pellets while feeding is the most likely source of the problem. (A common misconception is that lead poisoning may develop from absorption of lead from muscle or subcutaneous tissue as a result of being shot. In reality, very little lead is absorbed because of the body's reaction of walling off such insults.)

The purposes of this paper are to discuss the diagnosis and treatment of lead poisoning, review the clinical cases treated, and summarize the post-mortem results.

DIAGNOSIS

A systematic approach to the diagnosis of lead poisoning in Trumpeter Swans should include a physical examination, blood work, and radiographs. A thorough physical examination is important at the time of admission to help rule out other diseases or traumatic injuries. Clinical signs of lead poisoning may vary with the duration and severity of the disease. Characteristic signs include neurological abnormalities or behavioral changes, ataxia, weakness, lethargy, inappetence, emaciation, partial or complete paralysis of the legs or wings, and bright green diarrhea (Lumeij 1985). If paralysis of the proventriculus or gizzard has occurred, a food impaction of the esophagus and proventriculus may be palpable along the lower neck or visualized on a radiograph (Rosen and Bankowski 1960, Cook and Trainer 1966).

The extent of blood work done may vary with the availability of laboratory facilities and with monetary restrictions, but, at a minimum, should include a complete blood count (CBC) and blood lead analysis. Most veterinary clinics will be able to run CBC samples for the following information: hematocrit or packed cell volume (PCV), total plasma protein, white blood count estimate, plus an indication of the percentages of the different white blood cell types. The packed cell volume is a useful parameter in lead poisoned swans and is expressed as the percentage of blood occupied by the red blood cell portion. A normal hematocrit range for a Trumpeter Swan is 40-45 percent, but, in a lead-poisoned swan, there may be a 25 to 50 percent decrease, depending upon the duration and severity of the disease. This anemia is caused by the interference by lead upon delta-aminolevulinic acid dehydratase (ALAD) and heme-synthetase, two enzymes involved in hemoglobin synthesis.

The information derived from blood lead analysis is needed for the diagnosis, treatment protocol, and prognosis in lead-poisoned birds. Toxicology labs vary in their requirements, but most require approximately 3 cc of heparinized whole blood. It is recommended that a pretreatment sample be collected, as well as one 2 to 3 weeks after treatment was begun (wait at least 3 days after the last chelation treatment).

Four categories of lead exposure in Bald Eagles have been described (Redig 1984). When this system is applied to Trumpeter Swans, it is useful in determining treatment options and prognosis (Table 1). Usually birds in Categories I and II (< 0.6 ppm lead) are not clinically affected and do not require treatment. However, all birds showing clinical symptoms and blood lead levels ≥ 0.6 ppm (Categories III and IV)

Table 1. Categories of lead exposure.

Category	Blood lead level (ppm)	Clinical signs	Treatment	Prognosis
I	< 0.2	Clinically normal.	None.	Excellent
II	0.2-0.6	Usually clinically normal.	Usually none.	Excellent
III	0.6-1.0	Mild to moderate clinical signs, including weight loss, anemia, weakness, depression, neurological abnormalities, and diarrhea.	One to two courses of chelation therapy plus supportive treatment.	Good
IV	> 1.0	Moderate to severe clinical signs as listed above. May also have profound weakness or leg or wing paralysis.	Two or more courses of chelation therapy, plus supportive treatments.	1-2 ppm- fair to good 2-3 ppm- poor to fair > 3 ppm- poor

should be treated using the protocol discussed in the next section.

Other blood tests which may be conducted include serum chemistries and delta-aminolevulinic acid dehydratase (ALAD) enzyme activity (Hoffman et al. 1981). A serum chemistry panel may be helpful in evaluating electrolyte disturbances and liver or kidney dysfunction. ALAD activity reduction may be a highly sensitive and early indicator of the degree and duration of lead exposure. Lead-induced changes may be apparent before anemia is observed (Finley et al. 1976).

Radiographs (x-rays) may be helpful in diagnosing lead poisoning if radio-dense, metallic particles are visible in the gizzard or proventriculus. The absence of such particles, however, does not rule out lead poisoning. There have been cases where the lead has already been absorbed or eliminated. Likewise, with the requirements for use of steel shot in waterfowl hunting in many areas, not all metallic shot pellets observed on a radiograph will be lead. The presence of clinical signs, significantly elevated lead levels in the blood, and radiographic evidence of shot in the gastrointestinal system are all important factors in diagnosing lead poisoning.

TREATMENT

Treatment of swans in Category III and IV involves the following components (Redig 1984): 1) chelation therapy to remove solubilized lead from the blood, bones, and soft tissues; 2) removal of lead from the gastrointestinal tract; 3) restoration of a normal hematological profile; and, 4) return to normal body weight and physical condition prior to release. The treatment protocol used is summarized in Table 2.

Chelation therapy

The most common chelating agent used is Ca EDTA (calcium disodium ethaminediamine tetracetic acid; Havidote: Haver-Lockhart). However, Havidote is unavailable from the manufacturer as of December 1986. An equivalent human product (Versonate: Riker Laboratories) may be used. This drug acts by binding with lead ions in the blood and bone, followed by renal excretion of these complexes.

At a dose of 40 mg/kg body weight, Ca EDTA may be administered intravenously, intramuscularly, or subcutaneously two to three times daily (McDonald 1984). At the RRRP, the intravenous route is commonly used with a supplemental electrolyte solution (i.e., diluted in 50 ml lactated ringers solution). Clinical improvement may be evident after 24 to 48 hours of treatment. Chelation therapy should be limited to a regimen of 3 to 5 days on and 3 to 5 days off to prevent kidney damage, and should be continued until clinical signs have been resolved. With blood lead levels ≥ 1.0 ppm, usually three or more treatment cycles will be required. A second blood lead test should be conducted 2 to 3 weeks after treatment initiation (wait at least 3 days after last Ca EDTA treatment). Levels below 0.5 ppm are considered acceptable. Because of housing limitations at the RRRP, once chelation therapy was completed, the birds were wing-clipped and placed in a fenced refuge for an additional 1 to 2 months of convalescence.

Supportive treatment

Other areas of consideration during treatment for lead poisoning include the restoration of a normal hematological profile, normal hydration status, and normal body weight. Injectable iron dextran (5 mg) may be given intramuscularly for treatment of anemia upon diagnosis, followed by a second dose in 10 days. Another useful adjunct to therapy is daily thiamine (5 mg) or multiple B vitamin injections during chelation therapy. Thiamine injections have been shown to alleviate some of the

Table 2. Treatment protocol summary for lead poisoning.

Generic name	(Trade name: source company)	Treatment protocol
Ca EDTA	(Havidote: Haver Lockhart or Versonate: Riker Labs)	40 mg/kg IV, IM or SubQ twice daily for 3 to 5 days, followed by a 3- to 5-day rest (repeat as needed), for chelation of lead.
Iron dextran		5 mg IM, followed by a second dose in 10 days, if needed for anemia.
Thiamine or Multicomplex B vitamin		5 mg thiamine IM once daily throughout chelation therapy.
Dexamethasone		1 mg/kg IM for neurological abnormalities (repeat in 3 to 4 days if necessary).
5-fluorocytosine	(Ancobon: Roche Laboratories)	50 mg/kg orally twice daily for the first 10 days of treatment for aspergillosis prevention.
Fluid therapy		50-60 ml sterile lactated ringers solution IV or SubQ two to three times daily for the first 3 to 5 days for rehydration and maintenance. (Ca EDTA may be mixed in with fluids and administered together, IV). Oral electrolytes fortified with nutritional supplement (Nutrical: Vesco Laboratories) may be given two to three times daily, if swan is not eating or drinking (100-125 ml).
Diet		High quality, readily digestible waterfowl ration plus cracked corn and fresh pondweeds, if available.

symptoms of lead poisoning in domestic animals (Bratton et al. 1981). Dexamethasone may be used for treatment of neurological symptoms of lead poisoning (1 mg/kg intramuscularly--one or two injections at 3-day intervals).

Severely-affected birds are usually emaciated and dehydrated. Initial treatment should include intravenous or subcutaneous replacement fluids (50-60 cc lactated ringers solution twice daily). A well-balanced commercial waterfowl ration should be made available, but force-feeding a slurry mixture of this diet may be necessary in some instances.

Since Trumpeter Swans are highly susceptible to the fungal, respiratory infection aspergillosis, especially when they are stressed or immunosuppressed, a prophylactic, 10-day course of therapy with 5-fluorocytosine (Ancobon: Roche Laboratories) should be administered orally at a dose of 50 mg/kg, twice daily (Redig 1986).

Lead removal

If lead shot in the gizzard is observed radiographically, various products may be used to help coat the shot or cause them to be passed. A 2:1 ratio of warmed peanut butter and mineral oil (30-50 ml) and/or magnesium sulfate (milk of magnesia, 1 g/kg orally, once daily) have been reported to be effective in other avian species (McDonald 1985).

As a last resort, surgical removal of lead particles may be necessary when other conservation methods have failed (Poole 1986). However, the risk is great, and prior stabilization of the patient with chelation therapy and rehydration is critical to the success of the surgery.

CLINICAL CASE REVIEW

During 1987, five Trumpeter Swans were presented to the RRRP with clinical indications of lead poisoning (Table 3). All had blood lead levels ≥ 0.59 ppm upon admission and showed some or all of the classic signs of lead poisoning. The first bird was critically ill, had a blood lead level of 3.3 ppm, and died shortly after admission. The next two birds were both emaciated and anemic upon admission, with blood lead levels of 1.6 and 1.4 ppm, respectively. They responded well to chelation therapy and supportive treatment and were placed in a fenced refuge for observation for at least 3 months following treatment. Blood tests 2 months after treatment revealed a normal hematological profile and blood lead levels under 0.5 ppm in both birds.

The next swan, a 3-month-old cygnet, was presented after being diagnosed with a severe sand impaction of the proventriculus. The cygnet was weak, emaciated, dehydrated, anorexic, slightly anemic, and had a blood lead level of 0.6 ppm. After 24 hours of stabilization with Ca EDTA and supportive treatments, approximately 1 kg of sand was surgically removed from the distended proventriculus. Unfortunately, normal gastrointestinal motility did not return, and the cyg-

Table 3. Clinical case summary of lead poisoned Trumpeter Swans treated at Raptor Research and Rehabilitation Program, 1987.

Case no.	NS-2	NS-3	NS-17	NS-33	NS-19
Age	7 yr.	2 yr.	4 yr.	3-1/2 mos.	13 yr.
Sex	M	F	M	F	M
Admission weight	--	17 lbs.	--	14.3 lbs.	28 lbs.
Admission data					
Blood lead	3.3 ppm	1.6 ppm	1.4 ppm	0.60 ppm	0.59 ppm
PCV	51 %	33 %	19 %	37 %	--
Total protein	4.4 g/dl	3.6 g/dl	2.6 g/dl	3.2 g/dl	--
Post treatment data					
Blood lead	--	0.5 ppm	0.23 ppm	--	0.14 ppm
PCV	--	45 %	40 %	--	40 %
Total protein	--	5.0 g/dl	4.8 g/dl	--	5.2 g/dl
Clinical signs	Depression, weakness, head & neck tremors, mouth gaping, dehydration.	Depression, weakness, head shaking, weak vocalizations, green diarrhea, moderate weight loss, anemia.	Depression, weakness, ataxia, moderate weight loss, anemia.	Depression, weakness, impacted proventriculus (sand), dehydration, weak vocalizations, emaciation, slight anemia.	Bilateral wing weakness, reluctance to lay down, head and body tremors, diarrhea, bumblefoot problems developing.
Treatment	Started chelation & supportive treatment.	Three series of 3-day chelation treatments plus supportive treatments.	Three series of 3-day chelation treatments, plus supportive treatments.	Two series of 3-day chelation treatment, surgery and supportive treatments.	One 3-day chelation treatment plus supportive treatments.
Duration of treatment	< 1 day	3 weeks	3 weeks	1-1/2 weeks	2 weeks
Resolution	Died	Released to refuge (wing-clipped).	Released to refuge (wing-clipped).	Died--gastrointestinal motility never returned.	Euthanized 3 months later for non-lead poisoning problems.

net died a week after surgery. It was hypothesized that lead poisoning caused the depraved appetite and subsequent impaction (Cory-Slechta et al. 1980).

The final swan treated was a 13-year-old male presented with a 1-month history of progressive bilateral wing weakness, manifested by severely drooping wings and inability to fly. Initial blood lead levels of 0.549 ppm combined with other unusual neurological signs prompted chelation and supportive therapy for 2 weeks. Blood lead levels were reduced to a 0.23 ppm; however, the bird failed to improve after being returned to a refuge for 3 months. Exhaustive diagnostic tests, including serum chemistries, CBC's, thyroid function tests, radiographs, and nerve conduction tests in the wings failed to establish the cause of the clinical symptoms. In the end, the bird was euthanized. A thorough post-mortem examination failed to reveal the underlying problem, nor was there any indication of lead poisoning histologically.

POST-MORTEM SUMMARY

Twenty-six Trumpeter Swans were presented for post-mortem examination in 1987. Lead poisoning was established as the primary cause of death in six of these swans. Table 4 outlines the gross pathology observed in these birds. The presence of some or all of the observations combined with a liver lead level ≥ 6 ppm was considered diagnostic of lead poisoning (Kendall and Driver 1982, Windingstad and Hinds 1987).

Table 4. Gross observations of lead poisoned Trumpeter Swan carcasses in Raptor Reseach and Rehabilitation Program, 1987.

Observation	No. cases exhibiting	No. birds examined
Emaciation/lack of body fat	4	6
Pectoral muscle atrophy	4	6
Impacted proventriculus and/or esophagus	3	6
Green, bile-stained gizzard contents and lining	5	6
Enlarged gall bladder	5	6
Green-stained vent or diarrhea	5	6
Presence of lead shot in the gizzard	4	6

Liver lead analysis was conducted on nearly every swan necropsied, regardless of the cause of death (atomic absorption spectrophotometric or colorimetric bench methods). The average liver lead level in swans dying of causes other than lead poisoning was 1.22 ± 1.77 ppm (n = 11; range 0.01-5.8 ppm). Average liver lead levels in lead poisoned birds were significantly higher, at 15.86 ± 4.09 ppm (n = 6; range 13.5-21.6 ppm).

The number of lead shot recovered from the gizzards of the lead poisoned swans ranged from zero to 44, with no apparent correlation between the quantity of shot and liver lead levels. Similar observations have been made in Tundra Swans (Trainer et al. 1965).

SUMMARY

A diagnosis of lead poisoning in Trumpeter Swans may be based upon clinical signs, blood tests (blood lead analysis and hematocrit), and abdominal radiographs. Chelation therapy and supportive treatment should involve Ca EDTA, iron dextran, thiamine or Vitamin B injections, intravenous or subcutaneous replacement fluids, dexamethasone, 5-fluorocytosine, and a readily-digestible, palatable diet. Surgical removal of lead shot may be necessary in certain cases. The prognosis for recovery is good if treatment is initiated before the patient is in the terminal stages of the disease. Generally, birds with blood lead levels < 2 ppm have a fair-to-good prognosis with prompt treatment.

Lead poisoning as a cause of mortality among waterfowl has been recognized for over a century, and the battle to ban the use of lead shot for waterfowl hunting has been a long uphill struggle. Fortunately, the State of Minnesota banned the use of lead shot over water beginning in 1987. Over the next few years, we hope to see a substantial decline in the morbidity and mortality of Minnesota Trumpeter Swans due to lead poisoning.

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DIAGNOSIS AND TREATMENT OF ASPERGILLOSIS IN TRUMPETER SWANS

Laurel A. Degernes, D.V.M. and Patrick T. Redig, D.V.M.

ABSTRACT

Aspergillosis may play a significant role in the mortality of captive-raised and wild Trumpeter Swans. The most common etiologic agent is the spores of Aspergillus fumigatus which develop on damp corn or other food substances, or on damp bedding materials. Plaque-like lesions develop in any part of the respiratory system, with resulting clinical signs including weight loss or poor weight gains, dyspnea, wheezing, exercise intolerance, and/or changes in vocalizations. Ante-mortem diagnosis may be difficult and may include complete blood counts, aspergillosis ELISA's (Enzyme Linked Immunosorbent Assay - for serologic testing of exposure to aspergillosis spores), tracheal cultures, endoscopy, and radiology. Treatment is difficult and expensive using intravenous and intratracheal Amphotericin B, oral Ancoban (5-fluorocytosine), supportive fluids, and vitamins over a 2- to 4-week period. Prevention includes avoiding moldy or damp feed or bedding, and minimizing stressful situations. Oral Ancoban may be administered prophylactically at a rate of 50-75 mg/kg twice daily for 10 to 14 days, to birds that are subjected to stressful situations.

Aspergillosis is a complex fungal respiratory disease that has caused mortality in many avian species including waterfowl (O'Meara and Witter 1971, Wobeser 1981). Aspergillus fumigatus, the most common pathogen implicated, is found nearly worldwide and thrives on decomposing organic matter, especially under warm conditions. Typically, the respiratory disease develops after inhalation of spores from moldy feed, bedding, or nesting materials (Wobeser 1981). Infection from other contaminated individuals is not believed to occur.

Aspergillosis was one of the leading causes of known mortality in Minnesota Trumpeter Swans in 1987. In most cases, the diagnosis was made after the bird was found dead. The diagnosis and successful treatment of this disease remains a difficult and challenging problem for veterinarians and other individuals involved in the care of these valuable birds. The purpose of this paper is to discuss the diagnosis, treatment, and prevention of aspergillosis, and to summarize the typical post-mortem observations.

DIAGNOSIS

Three major forms of aspergillosis have been described: acute infection, chronic disseminated infection, and chronic localized infection (Redig 1986). The acute form may develop in young, immune-suppressed birds or in individuals that inhale an overwhelming number of spores. The respiratory disease develops rapidly, and death usually occurs in less than a week. The most common form of aspergillosis is the chronic disseminated form in which the lungs, trachea, and/or air sacs are extensively infiltrated by fungal organisms, eventually leading to airway obstruction and death. The number of spores inhaled and the immune status of the bird, combined with other stresses (such as traumatic injuries or other diseases) all affect the expression of this form of aspergillosis. The third form involves a chronic, but localized, infection occurring in the trachea, syrinx, or air sacs. Hemotogenous spread of the organism from sites in the respiratory system to the eye or brain have been reported (Wobeser 1981). Clinical signs vary with the location of the lesion or may be absent if the lesion has been encapsulated in a non-critical location.

Characteristic clinical signs of aspergillosis include weight loss, inappetence, dyspnea, wheezing, exercise intolerance, changes in vocalization, and diarrhea. In most cases, the onset of disease may be insidious, with early symptoms being easily overlooked, even in captive management situations (Wobeser 1981).

Various clinical tests and procedures which may be useful in differentiating aspergillosis from other respiratory diseases include (Redig 1986):

1. Physical exam: this should include auscultation of the lungs, trachea, and air sacs, in addition to a thorough external examination of the bird;

2. Complete blood count (CBC): the white blood cell estimate is usually significantly elevated with a pronounced heterophilia and monocytosis;

3. Deep tracheal culture: fungal growth may be evident in 48 to 72 hours after incubation on Sabaurod's Dextrose agar at 37°C;

4. Radiographs: in advanced stages, changes in the lungs and air sacs may be evident radiographically;

5. Serology: (discussed in more detail below);

6. Endoscopy: the use of this equipment permits visual examination of the air sacs, surface of the lungs, or anterior portion of the trachea to determine the presence and severity of fungal lesions; and

7. Exploratory surgery: this should remain a last resort option to determine the diagnosis and/or prognosis.

A new serologic test to aid in the diagnosis and prognosis of aspergillosis infection has been developed at the University of Minnesota (Redig et al. 1986). This ELISA or enzyme-linked immunosorbent assay was originally developed for commercial turkeys, but has been successfully applied to a wide variety of raptors, caged birds, and Trumpeter Swans. The assay appears to show a strong correlation between the level of exposure or disease potential, and the optical density (O. D.). The optical density is determined spectrophotometrically at a 1:800 dilution, and is a measure of the antibody response to Aspergillus sp. spores. In general, levels < 0.2 O. D. fall within the normal range, with minimal exposure to Aspergillus sp. However, levels ≥ 0.2 O. D. are regarded as indicative of significant exposure with a corresponding increased potential for developing infection. Birds in this category should be retested and cultured immediately, with no delay in initiating treatment if there is a strong suspicion of developing aspergillosis.

It is important to note that a single sample may not necessarily be diagnostic since the antibody level may rise or fall depending upon the host's immune response and the stage of the disease process. For example, one cygnet that died of aspergillosis had a steady rise in the ELISA levels from 0.16 O. D. upon admission, to 0.47 O. D. 1 week later, shortly before death.

TREATMENT

Once a diagnosis of aspergillosis has been made, treatment should be started immediately since the disease may progress rapidly in a susceptible host. The following protocol is used at the Raptor Research and Rehabilitation Program (RRRP) (Redig and Duke 1985, Redig 1986):

1. Amphotericin B. (Fungizone: Squibb) [generic name (trade name: company)] intravenously at 1.5 mg/kg three times daily, for up to 1 week (diluted in 3 to 5 ml sterile water).

2. Amphotericin B intratracheally at 1.0 mg/kg twice daily, for up to 1 week.

3. 5-fluorocytosine (Ancobon: Roche) orally 50 mg/kg two to three times daily, for up to 3 to 4 weeks.

4. Supportive treatment-fluid therapy and vitamins, as needed, and a high-quality diet.

Since Amphotericin B is extremely irritating outside the vein, intravenous treatment should be discontinued if hematomas develop along the veins. Intratracheal treatment should be discontinued if the fluid is poorly absorbed and "gurgly" sounds are audible. Ancobon may be safely administered without side effects for this period of time.

The prognosis for a successful outcome is good if the disease is caught in the early stages, but the prognosis is fair to poor if the bird is already exhibiting advanced signs of respiratory disease. In every case, extreme care should be made to minimize the stresses involved in handling and treating these birds in captivity.

PREVENTION

While it is impossible to eliminate all sources of this fungus due to its widespread nature, every effort should be made to minimize exposure in captive management situations such as game farms, zoos, or refuges. Strict attention should be paid to proper storage of the feed and avoidance of moldy or damp feed and bedding (O'Meara and Witter 1971). Conditions which promote mold formation should be eliminated or corrected, such as poorly-drained feeding areas or damp feed troughs. Regular, daily cleaning of feed and water troughs is also recommended.

The use of 5-fluorocytosine has been shown to be an effective prophylactic drug against aspergillosis for wild raptors undergoing treatment for injuries (Redig 1986) and has been used successfully in treating Trumpeter Swans at the RRRP, as well. It is recommended that all newly-admitted swan patients be placed on a 10-day course of 5-fluorcytosine at the onset of treatment (50 mg/kg orally twice daily).

CLINICAL CASE REVIEW

Two birds were treated for aspergillosis in 1987. The first bird, a 1-year-old cygnet from one of the Hennepin Parks refuges, was presented after respiratory signs were noticed. Aspergillosis was diagnosed based upon clinical signs, a positive tracheal culture, and a high aspergillosis ELISA of 0.66 O. D. (1:800). Treatment consisted of intravenous and intratracheal Amphotericin B for 1 week, plus 3 weeks on 500 mg 5-fluorocytosine twice daily. The ELISA levels decreased steadily to 0.22 O. D. during this period. Respiratory symptoms resolved after 2 weeks of treatment, and the bird was placed in another refuge where he apparently did well for the next 7 months. An aspergillosis ELISA run in July showed a very low level (0.14 O. D.). Unfortunately, the swan was found dead in mid-December, and a post-mortem examination revealed a localized aspergillosis lesion in the trachea which caused an airway obstruction. Otherwise, the bird was in good flesh and had only one other very small fungal lesion in one of the air sacs.

The second bird, a 2-month-old cygnet from Carlos Avery Game Farm (Minnesota DNR), was presented for weight loss, diarrhea, and weakness. Although the cygnet did not exhibit respiratory signs, the positive tracheal culture plus other clinical signs convinced us to treat for aspergillosis. The bird was treated for 4 days with Amphotericin B and for 8 days on Ancobon. However, he failed to improve and died 8 days after admission. The ELISA levels increased from 0.16 O. D. upon admission to 0.47 O. D. shortly before death. Post-mortem examination revealed a very extensive aspergillosis infection involving both lungs and most of the air sacs.

POST-MORTEM OBSERVATIONS

Five Trumpeter Swans that died of aspergillosis were necropsied (autopsied) in 1987: two were patients, as discussed earlier, and three were dead upon admission. Table 1 summarizes the post-mortem observations and includes data on age, sex, and origin of the birds.

Table 1. Aspergillosis post-mortem summary, Trumpeter Swans, Raptor Research and Rehabilitation Program, 1987.

Case #	Date of death	Age	Sex	Origin	Emaciation	Necropsy lesions	Comments
None	6/16/87	1 yr.	M	Free-flying Koochiching Co., MN	Yes	Extensive infiltration of Aspergillosis fumigatus throughout air sacs.	Found dead.
NS-37	7/10/87	1 yr.	M	Free-flying Sunny Lake Refuge Hennepin Co., MN	No	Extensive infiltration of A. fumigatus in anterior thoracic air sacs.	Found dead.
NS-23	8/29/87	2 mos.	M	Captive Carlos Avery Anoka Co., MN	Yes	Extensive infiltration of A. fumigatus throughout both lungs and air sacs.	Found dead.
NS-25	9/23/87	2 mos.	F	Captive Carlos Avery Anoka Co., MN	Yes	Extensive infiltration of left lung and abdominal air sacs by A. fumigatus.	Died during treatment.
NS-12	12/15/87	1-1/2 yrs.	M	Captive Baker Park Refuge Hennepin Co., MN	No	Localized A. fumigatus lesion in trachea and one small lesion in air sac.	Found dead 7 months after treatment.

All of the birds were either subadults or cygnets, and four out of five swans were male. Four swans died of the classic form of aspergillosis with extensive infiltration of the lungs and air sacs. Lesions in the air sacs typically appear as large tan or green plaques that resemble bread mold. These plaques may range in size from a pinpoint to a large, coalescing mat, lining the affected air sac. Lung lesions may vary from a few small, scattered white or tan nodular masses to extensively infiltrated lung parenchyma.

The last swan (NS-12) died acutely of asphyxiation due to an occlusion of the trachea caused by a localized Aspergillus sp. infection.

SUMMARY

Aspergillosis is a very complex and challenging disease to treat. A number of factors are interrelated which influence the disease process, including the age of the bird, the number of spores inhaled, the immune status of the bird, and the presence of other stressful conditions such as traumatic injuries or other diseases. Treatment may be successful if initiated during the early stages of the disease, but does not impart protection from repeat exposure after treatment. As with most diseases, the most effective treatment is prevention of the conditions which increase exposure potential in captively-managed swans. However, the post-mortem diagnosis of aspergillosis in two free-flying swans indicates that this problem is not restricted to captively-managed populations.

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THE IMPACT OF NESTING TRUMPETER SWANS ON OTHER SPECIES OF WATERFOWL

Laurence N. Gillette

ABSTRACT

Two pairs of Trumpeter Swans were observed at irregular intervals for several weeks after the hatch of their cygnets. Interactions with other waterfowl were recorded. While adult ducks were usually ignored, broods of ducklings were attacked by the swans, and ducklings were killed on several occasions. Although duck broods were attacked, most ducklings fledged successfully. Canada Geese, which had been chased from the nesting marshes prior to the hatch of the cygnets, were not allowed to return during the observation period.

This was a preliminary study intended to determine which parameters were important in assessing the impact of nesting swans on other waterfowl. These parameters are listed. A more detailed study is planned for 1988.

Trumpeter Swans aggressively defend nesting territories up to 100 acres in size against other swans. They have been known to attack and chase other species of waterfowl within their territories, especially Canada Geese. Numerous accounts of captive Trumpeters attacking and killing other swans, geese, and ducks in confined areas have been reported.

Because of their aggressive nature and the large size of the territory they defend, waterfowl biologists need to know what impact Trumpeter Swans will have on other species of waterfowl before they proceed with reintroductions. Will waterfowl production decrease on a wetland where swans take up residence? Will swans preclude use by other species of waterfowl on their nesting marshes, and, if so, which ones?

To try to assess the impact of Trumpeters on other species of waterfowl, waterfowl nesting records for two wetlands in Hennepin Parks, Minnesota, were reviewed to try to determine the changes that have occurred since Trumpeters began to nest on them. In addition, Mary Miceli, a summer intern, monitored these two wetlands during June 1987 to see what the swans did.

The wetlands studied were Kasma Marsh in Lake Rebecca Park Reserve, 30 miles west of Minneapolis, and the Beaver Pond in Baker Park Reserve, 20 miles west of Minneapolis, Minnesota.

Kasma Marsh is an 18-acre restored wetland. Maximum water depth is 4 feet. Submergent vegetation grows to the surface across the entire marsh, and duckweed and filamentous algae are abundant. Emergent vegetation is confined to 4 acres in the southeast corner of the marsh. Swans have an unobstructed view over most of the area. Three artificial nesting islands were constructed prior to flooding in the late 1970's.

Beaver created the Beaver Pond in 1979 when they plugged a farm ditch. The pond flooded 15 acres consisting of a combination of aspen, scrub willow, and reed canary grass. Maximum depth is only about 2.5 feet outside the ditch. Submergent vegetation is sparse, but duckweed is abundant. Woody stems and annual weeds obstructed visibility in many parts of the marsh through 1987.

Kasma Marsh has been an excellent brood production area ever since it was flooded. It rapidly became the primary goose brood-rearing area in the 2500-acre park, producing seven to eight broods per year. Geese nested on all three islands. Swans started nesting on Kasma Marsh in 1982. Between 1982 and 1984, geese continued to nest on the islands, but broods left for a nearby marsh immediately after hatching. Ganders were attacked by the cob whenever they were on the water, but could usually avoid attack by staying on land. Nesting geese were generally ignored while on the nest. The original cob disappeared during migration in the winter of 1984-85. He was replaced immediately by another male. It is unknown if any geese nested successfully on Kasma in 1985, but geese were not able to even initiate nesting in 1986 or 1987. Miceli observed only one pair of geese landing on Kasma Marsh during 67 hours of observation in 1987. They were chased off immediately.

The Beaver Pond was also used by geese, but use was sporatic. In 1984, there were seven broods with a total of 53 goslings. Swans began nesting on this marsh in 1986. All use by goose broods had ceased by 1987. Miceli observed only one pair of geese landing on the Beaver Pond during 10 hours of watching in June of 1987. They landed about 200 yards from a pair of swans and their 4-day-old cygnets. They were ignored for about an hour. Then the cob swam slowly over to within a few yards of the geese. He charged and killed one of the geese within seconds. The other goose escaped.

This behavior appears to be typical. Both pairs of swans displayed whenever geese flew over, and that display was usually adequate to prevent them from landing. Geese simply were not tolerated in either swan's nesting territory. How much of an area was defended could not be determined, but it was at least 15 acres in each of these situations.

Ducks appeared to fare much better than geese on the swan marshes, but they were not immune from attack. Kasma Marsh has been an excellent loafing and brooding-rearing marsh since it was flooded in the late 1970's. Broods of Blue-winged Teal, Mallards, and Wood Ducks were present each summer, and loafing adult ducks usually numbered between 20 and 75. This pattern did not change with the arrival of the swans in 1982. In 1987, three Mallard, three Wood Duck, and three Blue-winged Teal broods and 40 to 70 adult ducks of all three species were seen regularly on Kasma Marsh.

All was not peaceful, however. Miceli spent 67 hours monitoring the swans from the time the cygnets hatched on 21 May until the end of June. The Kasma male was observed attacking the duck broods three times (two Wood Duck and one Mallard brood) during the first 9 days after the hatch of his cygnets. In each case, the ducklings were less than 10 days old. The cob would fly into the center of the brood from as far away as 200 yards and begin attacking the ducklings as they dove underwater or scurried for cover. The hens were ignored, despite dramatic decoy defenses. In each attack, the cob killed one duckling by striking it with its bill.

The Kasma cob was observed chasing adult ducks only once during the first 9 days, despite their continued presence. He made short chases at several individuals for a few minutes, without catching or chasing any of them from the marsh.

Three other attacks on duck broods were observed when the cygnets were between 19 and 34 days old. In each case, the attacks appeared to be directed as much toward the hen as she went through her broken-wing imitation as they were toward the broods. All ducklings were able to escape. The swans occasionally lunged at other ducks that swam within a few feet of them, but no other major attacks against adult ducks were observed.

Only one brood of Wood Ducks was seen on the Beaver Pond, and no attacks were observed. However, no broods were reported from the Beaver Pond in the 2 years prior to the arrival of the swans. The extensive dead shrubs and emergents would have made attacks difficult for the swans. The openness of Kasma Marsh probably increased the likelihood of attacks over what would be expected on other swan marshes.

Observations at Kasma Marsh were conducted primarily in early morning and late afternoon. If attacks continued with the frequency observed, as many as 18 ducklings could have been killed during the first 2 weeks. However, this seems unlikely, because duck broods are less active and less visible during the middle of the day. Brood counts were not made at the beginning of the observation period, so duckling survival rates could not be determined. Although swans killed ducklings, broods of ducks were allowed to remain on the Marsh, unlike broods of Canada Geese.

These observations raise more questions than they answer. For example, what stimulates the attacks on the ducklings? Is it an increase in the aggressive nature of the cob following the hatch of the cygnets, the age of ducklings, their appearance, or their behavior? A duckling feeding on the surface may resemble the head of a swimming muskrat or mink. Does this resemblance stimulate an attack? There will be a more intensive study in 1988 at Hennepin Parks in an attempt to determine more precisely the conditions under which the attacks occur.

The temperament of individual swans, the size and shape of the wetland, the pattern and distribution of the emergent vegetation, and the species and age of the other waterfowl probably all interact to determine how Trumpeter Swans will react. Precluding Canada Geese from nesting territories appears to be typical. Aggression toward other waterfowl species does occur, but the impact of these interactions remains to be determined.

GROWTH CHARACTERISTICS OF TRUMPETER SWAN CYGNETS FROM DIFFERENT POPULATIONS

Clay Jobes

ABSTRACT

Growth parameters were compared among cygnets originating from Red Rock Lakes (MT), Hennepin Parks (MN), zoos (IL and MN), and Alaska. The parameters estimated included: 1) the linear growth rate (g/day) for days 11 through 42 and 2) the overall growth rate, k, taken from the Gompertz growth equation.

There were no significant differences due to sex or origin of the cygnets in either measure of growth rate. There was no correlation between hatching mass, and either asymptotic mass or overall growth rate.

These results suggest that there is very little variation in the overall growth pattern of Trumpeter Swan cygnets and implies that environmental factors (e.g., parental effects, food resources) are important variables determining cygnet growth performance.

A conceptual model was presented that suggested that cygnets go through an energy crunch immediately after hatch. Energy and protein requirements relative to body size are highest at this time. Selection experiments with other avian species have demonstrated that an increase in absolute growth rate is achieved primarily through increasing relative growth rate early in development. Cygnets are able to extract nutrients from the environment at a greater rate later in development. This implies that at the proximate level, internal constraints, i.e., food processing capacity, and not abundance of food resources, limit early growth rate.

EXPERIMENTAL RADIO TRANSMITTER IMPLANTS IN MUTE SWANS

Leonard J. Shandruk and Bruce Grahn, D.V.M.

INTRODUCTION

Neck bands have been used extensively to identify and study swan movements for the past 20 years. Canadian Wildlife Service initiated a Grande Prairie neck-banding program in 1973 (Turner 1988). Sladen (1973) proposed a protocol for the neck banding of North American swans which has been more or less adhered to by most researchers. Neck bands allow for recognition of individual swans in the field and permit more rapid accumulation of data related to habitat use, migration, and life history of swans as compared to the traditional leg bands. However, neck bands do have their limitations. Icing problems with collars and objections from the public to neck bands convinced Lumsden et al. (1988) to begin marking Trumpeter Swans (Cygnus buccinator) and Mute Swans (C. olor) with patagial tags. Other observers (McEneaney, Lockman, and Gale, pers. comm.) have reported icing problems on Trumpeter Swan collars during the winter months in the Tristate Region.

Biologists in Alaska, Alberta, and Montana have recently conducted studies on Trumpeter Swans using neck bands to which radio transmitters were attached. The combination of a radio transmitter package and antenna, undoubtedly, makes these collars more prone to icing problems. In addition, the added weight of the radio transmitter on the collar could have significant impacts on the physiology and behavior of collared swans, especially cygnets. To my knowledge, no direct mortality of swans has been attributed to the icing of radio collars or neck bands. In Canada, it was documented recently that icing of the neck bands caused the deaths of 12 Canada Geese. With an increase in swan neck banding, it is inevitable that some mortality will eventually occur. Public reaction to that mortality may eventually result in the banning of the use of neck bands for field study of swans.

Radio implants have been used successfully in several species of waterfowl (Korschgen et al. 1984) and may provide a viable alternative to radio collars. Implants may eliminate the majority of problems associated with neck bands and radio collars. The purpose of this paper is to describe preliminary investigations of a subcutaneous radio transmitter implant in Mute Swans.

REQUIREMENTS AND OBJECTIVES

The basis for this project was to investigate the feasibility of developing a system which would ultimately be used to mark and identify free-flying swans. Such a system would not be burdened with the major limitations and problems resulting from the use of radio collars or externally-attached transmitters. It would have to be lightweight and compact (less than 1 percent of the body weight of the bird) to minimize any stress from its attachment and/or transport. It would have to be possible to implant the transmitter package subcutaneously in a swan under field conditions. Ideally, the transmitter would in no way impede or alter the behavior of the bird. The radio signal must be transmitted to acceptable distances to facilitate location and monitoring from both aerial and ground-based receivers. For the system to be of practical value, it must continue to transmit a signal for at least 4 years. The objectives of this pilot study were to evaluate and develop surgical procedures that could be used under field conditions to subcutaneously implant radio transmitters in swans, and to evaluate the function and longevity of currently available, commercial radio implants.

METHODS

Transmitter

The transmitter chosen for this experimental implant was the RI-21 implantable transmitter with a frequency of 151 MHz made by Holohil Systems of Woodlawn, Ontario. A similar system was designed and tested with success in the black rat snake (Elaphe obsoleta) (Anderka and Weatherhead 1983). The major reason for selecting this transmitter was that it was readily available and inexpensive. It also satisfied at least some of the desired system requirements discussed previously.

Specifically, the transmitter design was a two-stage, crystal-controlled system described by Anderka (1980). Details of components and construction of the transmitter are described in Lotimer and Anderka (1982) and Anderka and Weatherhead (1983). In order for the transmitter to function for extended periods of time subcutaneously while exposed to ionic body fluids, it was housed in a hard brass cylinder (Figure 1). The bottom and top of the cylinder were attached using silver and soft solders certified for food handling equipment. The antenna and battery were also connected using silver and soft solders. The antenna end of the transmitter housing was sealed with a brass cone soldered into place after installation of the teflon sleeve and transmitter. Once the antenna was silver-soldered into place, a clear epoxy was poured over the cap and the antenna end of the transmitter housing was sealed with a brass cone soldered into place after installation of the teflon sleeve and transmitter. Once the antenna was silver-soldered into place, a clear epoxy was poured over the cap and antenna attachment. The sealed units were then cleaned, polished, and tested for leakage in a

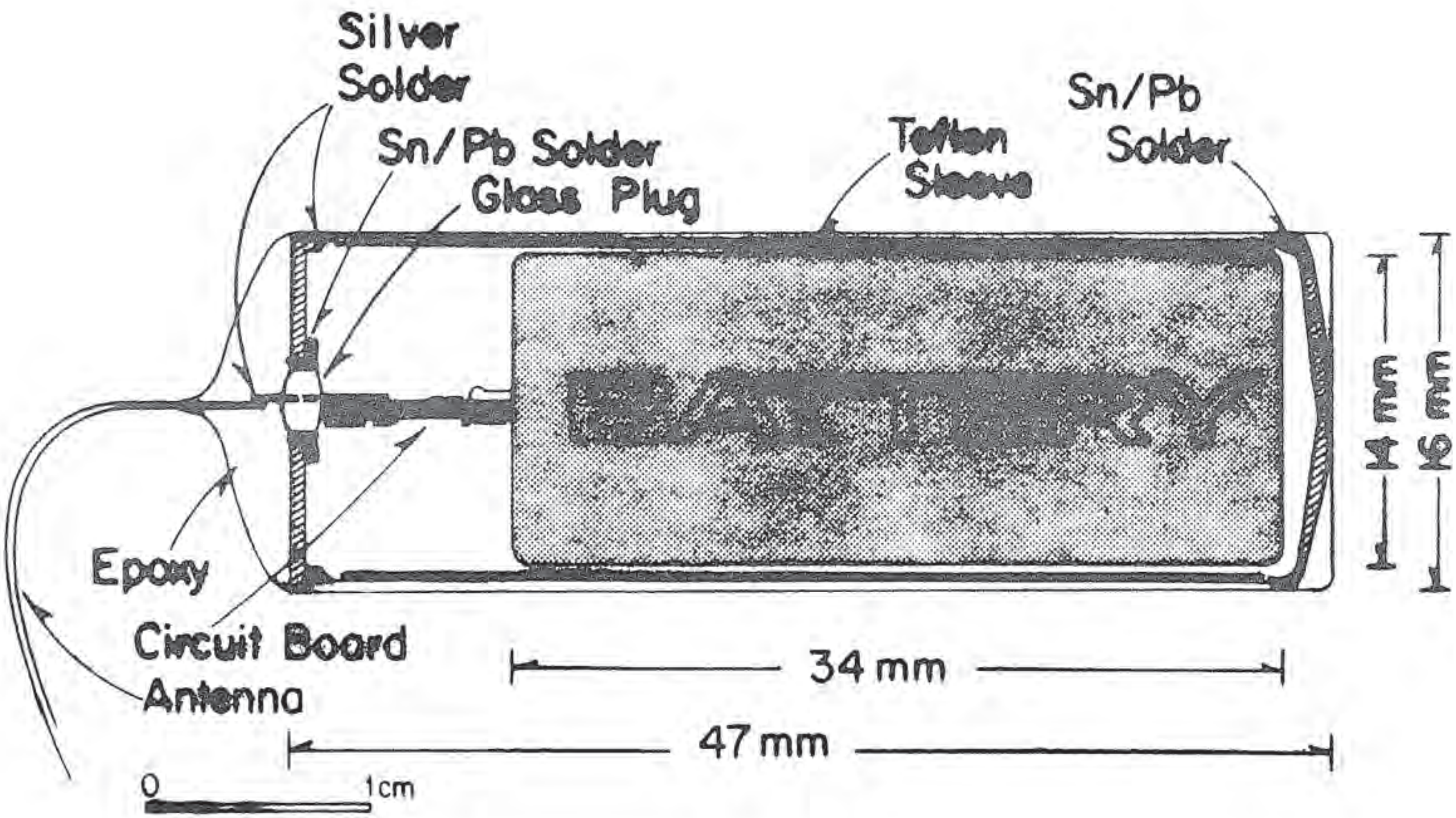

Figure 1. Cross-section of transmitter housing for implanting in Mute Swans.

vacuum container filled with acetone (Anderka, pers. comm.). Tested units were then plated with 1 micron of gold plate. Final dimensions of the cylinder were 47 mm long x 16 mm wide with a weight of 21.7 g. The 29 cm antenna was constructed of nylon-coated, braided, stainless steel wire (7 kg fishing leader). The power pack for the transmitter was a cylindrical 1.5 Ah (ampere-hour) lithium, thionyl-chloride battery. In order to conserve battery life and maximize transmitter longevity, the transmitter was also equipped with a magnetically deactivated reed switch. The pulse rate was reduced to about 40 to 50 pulses per minute and transmitter output was lowered slightly. With these modifications, it was anticipated that the transmitter would operate for a minimum of 18 months.

Implantation of transmitter

Two adult Mute Swans were selected for implantation, manually restrained, weighed, and sexed (Table 1). The skin in the right dorsal, cervical, thoracic, vertebral junction was plucked for a 7-cm oval, topically painted with isopropyl alcohol (99 percent PVU Victoriaville, Quebec, Canada), and subcutaneously infiltrated with 2-percent lidocaine (Neat Armitage Carroll, Guelph, Ontario, Canada) (Figure 2). The skin dorsal to cervical vertebrae numbers 10 and 14 was topically painted and infiltrated in a similar fashion. A 6-cm skin incision was made in the right thoracic area and subcutaneous tissues were teased open to form a pouch with a pair of straight kelly hemostats. The radio transmitters which had previously been sterilized with ethylene oxides (Anproline Sterilizer, H. W. Anderson Products, New York, USA) were laid aseptically in each pouch. A 5-mm incision was made over cervical vertebra number 14, and an alligator nasal forcep was introduced via the incision and advanced subcutaneously to the transmitter in the pouch. The antenna was grasped and pulled cranially in a folded fashion to the 10th cervical vertebra. On the cob, the incision was closed and the antenna was left folded over between cervical vertebrae 14 and 16. On the pen, the rest of the antenna was advanced cranially in a similar fashion to cervical vertebra number 10. All skin incisions were closed aseptically with 2-0 surgilene (Davis and Geck, Montreal, Quebec, Canada) in a simple interrupted suture pattern. After surgery, the birds' only noticeable clinical abnormality was a mild transient nasal and ocular irritation secondary to the isopropyl alcohol. The birds were reexamined and weighed in approximately 6 months. During the 9-month examination, radiographs were taken of the transplant sites.

Table 1. Weights and status of adult Mute Swans, 1987.

Sex	Band no.	April	November	Frequency (MHz)
Female	001	11 kg	12 kg	151.152
Male	5315	12 kg	12 kg	151.172

RESULTS AND DISCUSSION

After a rapid recovery with no complications, the two radio-implanted Mute Swans spent the summer on a pond in the City of Camrose in central Alberta. These swans were pinioned display birds and, therefore, not capable of flight. The activities of these subadult birds were equally divided between feeding and loafing. During late November (just before freeze-up), the swans were captured and placed in winter housing facilities. Visual inspection of the implant sites showed no physical problems related to the surgery or the implant. The incisions healed very well. Palpation of the site where the transmitter was located indicated that the transmitter was sitting in a right abaxial position at the base of the cervical vertebra. The antenna could be felt lying under the skin along the dorsal edge of the neck. Neither swan displayed any systemic abnormalities and fall weights were within yearly averages (Table 1).

During our fall inspection, only one minor problem was discovered. The male Mute Swan whose antenna was looped instead of running up the full length of the neck was found to have approximately 1 mm of the loop of the antenna on the surface of the skin. The skin around the entry and exit of the antenna was totally healed and in good condition. The protruding portion of the loop was covered by the neck feathers and did not seem to cause the swan any difficulties.

In January, our inspection of the birds, again, noted no systemic complications. However, the female swan had a broken antenna at the proximal end of the transmitter, visible via radiographic examination. Examination of the male swan revealed that the proximal portion of the folded antenna was extracted and hanging free. The exposed part of the antenna was removed at this time.

In general, we felt the implant technique worked well and could be used in a remote field application. A topical iodine solution would be preferable to isopropyl alcohol for topical skin preparation in the field application. Iodine was not used in this case because of the resulting feather staining which would have caused public concern for these display birds. The use of iodine would have eliminated the post-operative ocular and nasal discharge we observed. Future trials will utilize a trocar instead of the forceps to advance the antenna subcutaneously. This would eliminate the middle incision, and reduce the size of the incision required to implant the antenna. The authors speculate that continuous neck motion caused the antenna to break and exit the skin. These complications would be disastrous in field trials on wild swans. In an attempt to eliminate this problem, either the antenna could be reinforced where it enters the transmitter or the location of the antenna could be changed to circumvent the extreme flexing of the antenna in the neck region.

Ground-to-ground testing using an AVM receiver and a loop, hand-held antenna resulted in a range of about 2 km or just over 1 mile. This range is about normal for similar radio transmitters mounted on neck bands used on Trumpeters transplanted to Elk Island National Park (Shandruk 1988). We were unable to detect any signal strength difference between the transmitter which had the looped versus the full-length antenna. In January, both transmitters continued to operate, but the range of the transmitter with the broken antenna was reduced to about 0.3 km. A significant change in the range of the other transmitter was not observed. Although the implanted Mute Swans were not intensively observed, our observations indicated that the implants did not cause any physiological or behavioral changes in the birds.

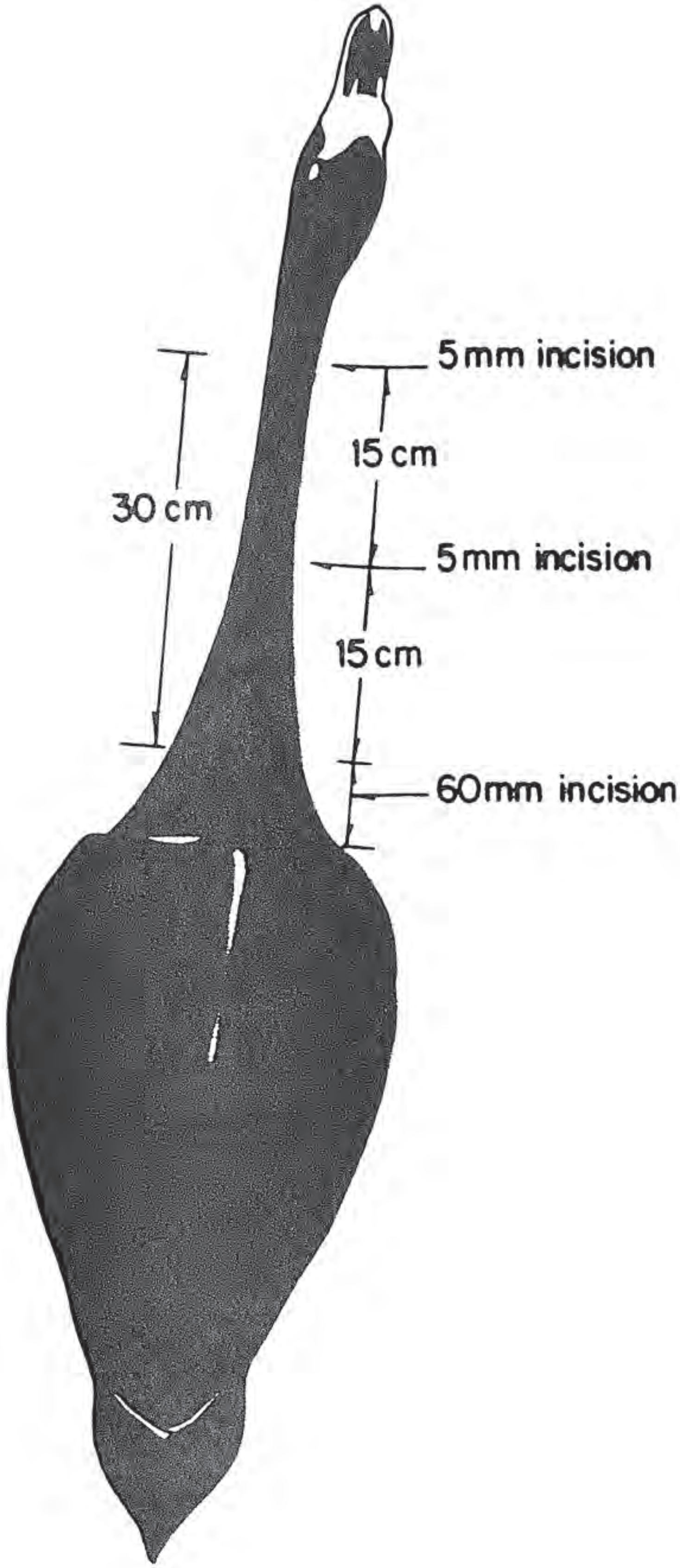

Figure 2. Location of incisions for implant of radio transmitter in Mute Swans.

The implants were operating for only 9 months at the time of this paper. Therefore, we were not able to evaluate the longevity of the transmitters. We do feel that longevity of the transmitter was the major limitation to this technique. Minimal longevity of 4 years is required for the practical marking of long-lived birds such as swans. Anderka and Weatherhead (1983) stated that an increase in the life of the transmitter could be achieved by reducing the pulse rate, pulse width, and/or signal strength. The transmitters we used for these implants had both the pulse rate and signal output reduced. It was impractical to reduce the pulse width. Another means of increasing the transmitter longevity would be to periodically shut the system off using a timer switch. A transmitter could be manufactured to transmit 8 hours a day. This should theoretically increase the life of the transmitter threefold or, possibly, up to 54 months. If it were possible to attain at least 4 years of signal transmission from such an implant, we feel that more field-oriented experimental implants should be conducted.

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EFFICIENCY OF TECHNIQUES FOR FEEDING WINTERING TRUMPETER SWANS

Carl D. Mitchell

ABSTRACT

Three methods of providing supplemental food to wintering Trumpeter Swans were compared from December 1986 through March 1987 at Red Rock Lakes National Wildlife Refuge (RRLNWR), Montana. Data were collected by visual observation and recorded on standardized field forms for 378 hours over 41 calendar days. The techniques evaluated were dry land feeders, wheat placed in the water in one large pile, and wheat broadcast in the water in numerous small piles. Broadcasting wheat was the most efficient technique when measured in terms of swan numbers observed eating and the percentage of time swans used wheat provided by each technique. Broadcasting wheat resulted in a mean of 7.8 swans eating/observation, and swan use on 90 percent of the days when wheat was provided in this manner. Use of dry land feeders and piled wheat was 0.43 swans/observation and 30 percent, and 3.3 swans and 87.5 percent, respectively. Data for swans observed tipping up on natural foods was 6.5 swans observed/observation. No measures were made on how long natural foods were available. Broadcast feeding was the most difficult and time-consuming method tested.

INTRODUCTION

Red Rock Lakes National Wildlife Refuge (RRLNWR) was established in 1935 expressly for the protection and management of Trumpeter Swans (Hull 1939). A winter feeding program was begun in 1936-37 (Banko 1980). The purpose of the winter feeding program was twofold. The first was to provide a supplement to the natural foods occurring on the one small wintering pond then available. The second was to try to hold the swans in protected areas, as illegal shooting elsewhere in the Tristate area of southwestern Montana, northwestern Wyoming, and adjacent Idaho was considered to be a significant source of mortality for Trumpeter Swans. Only 68 Trumpeters were known to inhabit this area at that time.

Informal studies (McEneaney 1986) on a variety of supplemental food types (e.g., wheat, barley, pelleted commercial game bird diets) and feeding techniques (e.g., broadcasting foods from a boat, scattering feed on the shore, placing feeds in dry land feeders, piling food in shallow shoreline waters) have been conducted since the feeding program was established (Hull 1939, Gale et al. 1987). Much of this information was recorded informally and remained "buried" in the Refuge files. This resulted in some duplication of research efforts in later years, as Refuge personnel changed. These data have recently been consolidated by Gale et al. (1987).

This study was initiated to further our knowledge of three specific feeding techniques and to provide some guidelines for future managers via a model. The three methods tested were: 1) dry land feeders, 2) piling wheat in shallow shoreline waters, and 3) broadcasting wheat in numerous scattered smaller piles.

The current staff of RRLNWR was instrumental in the planning and completion of this project. B. Reiswig, W. J. Kurtenbach, and C. E. Young were involved in all phases of the study, from its initial planning and fieldwork, through reviews of the draft report. J. R. Balcomb also assisted with the data collection, provided advice on appropriate statistical procedures, completed most of the statistical analysis contained in this report, and critiqued the draft. T. Kurtenbach also critiqued the draft manuscript, and typed the final report. This study would not have been completed without all of their very significant contributions.

METHODS

Feeding techniques were evaluated on the basis of total swan use, measured by the number of swans feeding on a given mode of food distribution per observation, and the percentage of time (in days) swans used wheat provided in any given manner.

All observations were made from blinds placed at feeding ponds prior to winter feeding. All observations were recorded on a standard field form. These data included site, date, temperature, percent cloud cover to the nearest 10 percent, estimated wind velocity, type of supplemental feed available, type of placement, total number of Trumpeters visible on the pond, the number of Trumpeters feeding, where they were feeding and on what, markings on any collared swans present, activity patterns of the flock (e.g., sleeping, preening), and the number of other waterfowl and their species composition on the pond. Activity patterns and total swan numbers were recorded at 1-hour intervals during observation periods.

Observations were made using unaided vision, a 10 x 50 binocular, and a Bushnell Spacemaster II 15-45X spotting scope.

Numerical analyses of data were made using appropriate statistical tests on a Casio fx-115M calculator.

RESULTS AND DISCUSSION

Dry land feeders

The primary purpose of the dry land feeder was to provide the swans with commercial game bird diets that contained high levels of nutrition. The commercial preparations tended to dissolve in water, and, if spread on the ground, would be rapidly consumed by other waterfowl. The feeder trough was high enough off the ground to eliminate access by other waterfowl.

Trumpeter Swans were observed at the MacDonald Pond feeder on 10 of 33 days. No swans utilized the feeder at Culver Pond during 8 days of observations. On 6 days, fewer than three Trumpeters used the feeder at MacDonald Pond. On 2 days, use of the dry land feeder stopped after wheat was placed in the water. All observations combined yielded a mean of 0.43 swans using the feeder per observation (N = 536, range = 0-3).

Trumpeter Swans used the feeders for relatively short feeding bouts. Of 27 timed bouts, Trumpeters fed for an average of 6.7 minutes (range = < 1-26, mode = 2). Trumpeters may be able to sate their appetite in this time period at a feeder. When not crowded, Trumpeter Swans often sat while eating out of the feeder. No more than three swans were ever observed eating at one time from the feeder. More often, only one or two swans fed simultaneously. On several occasions, swans at the feeder were displaced by other Trumpeters (including cygnets displacing adults).

Swan use of the feeder was intermittent. Swans used the feeder when no food was available in the water, either when it had been consumed, or when access to it was limited, as when feed was poured from the spout. It is possible that some individual Trumpeters used the feeder regularly, or that family or sibling groups fed together amiably, while unrelated Trumpeter Swans were more prone to aggression. These relationships could only be quantified with marked Trumpeters.

Occasionally, Trumpeters had difficulty swallowing feed they had picked up from the trough. Probably the feed was lumpy due to moisture in the trough or hopper. Difficult feeding would likely contribute to a lack of use by Trumpeter Swans. Part of the swans' reluctance to use the feeder could also stem from access problems. The shoreline at the feeder was fairly steep and difficult for swans to climb, especially when icy.

In addition, the feeder was situated next to the base of the grain storage bin at MacDonald Pond, and the view was blocked. It could be that the Trumpeters perceived this as potential predator cover. W. J. Kurtenbach (pers. comm.) once flushed a bobcat from under the grain spout, and also found evidence of mink predation on waterfowl at the feeder site. Although it could not be quantified, it appeared that if a lone swan approached the feeder, it was often very cautious about climbing up on the bank. Swans were less hesitant to approach when Mallards or Canada Geese were present, and showed no hesitation to approach when other Trumpeters were already there. However, the presence of magpies or other birds at the feeder did not seem to reassure the swans at all.

Magpies often used the feeder in great numbers. About 10 magpies were usually in evidence at the MacDonald Pond feeder, but counts of 20 or more were not uncommon. On one occasion, there were over 30 magpies at the Culver Pond feeder. (Since magpies were often continuously flying to and from the feeders, little effort was made to obtain exact counts.) Although it was not possible to quantify the amount of wheat and commercial feed consumed by magpies, it was the author's opinion that they ate the majority of the feed placed in the feeders. On numerous occasions, deer tracks were observed at the feeder, and three times a white-tailed doe and two fawns were seen eating out of the feeder trough. This, undoubtedly, results in substantial loss of feed as well.

In summary, while the dry land feeders provided the sole facility for distributing commercial feed preparations to the swans, this technique had several negative aspects. This method poses the greatest risk of transmitting disease. Trumpeter Swan use was limited, both numerically and temporally. Food consumption by other species (magpies, white-tailed deer, and a variety of passerine species in the spring) was considerable, and probably exceeded that by swans. Although the nutrition contained in the commerical preparations would have been beneficial to the swans, it appeared that most of it was wasted.

Feeding via grain bin spout

The technique of feeding via a grain bin spout entailed pouring wheat directly from the grain storage bin into adjacent shallow pond waters via a 20-foot-long spout. On days when this technique was utilized (N = 16), an average of 3.3 Trumpeters was recorded feeding per observation (N = 325, range = 0-26). Trumpeter Swans were observed using the wheat under the spout on 14 of the 16 days (87.5 percent) it was provided in this manner. Swans were also seen looking for wheat under the spout on 6 different days when wheat was not present. Trumpeters fed more heavily on wheat provided in this manner in early winter (26 Nov. - 6 Feb., $\overline{x}$ = 6.23 feeding/observation, N = 139, range = 0-26) than in late winter (17 Feb. - 6 March, $\overline{x}$ = 1.23 feeding/observation, N = 108, range = 0-5).

High numbers of Trumpeters normally only occurred for a short time after the wheat was distributed, and then only on days when no other wheat was available. On several occasions, no Trumpeters utilized the wheat on the day it was provided. This behavior was more common in late February and March.

Timed feeding bouts under the spout averaged 62.8 minutes (N = 5, range = 29-150), and involved two to seven swans. There was no correlation between the number of Trumpeters feeding under the spout and the length of time spent eating. On most occasions, it was not possible to determine which individuals remained under the spout for a given period, hence the low number of timed bouts.

Presumably, wheat provided via the spout was more accessible to the swans than the feed at the feeders. Although it was possible to have up to 26 swans at the poured wheat at one time, the average number observed (3.3) indicated that this technique was only slightly better than the dry land feeders in terms of making wheat available to large numbers of Trumpeters. When large numbers (more than seven) of swans were at or near the poured wheat, aggressive encounters were more common. It was not possible to determine exactly how many birds were feeding at one time, but it appeared that no more than 10 Trumpeters could reach the wheat at any given time. Access was limited by the ability of the equipment to distribute the wheat. The feed could only be placed in an area of 30 to 40 square feet. Groups of up to seven swans can feed in that size area without excessive altercations. It may be that family groups can forage in smaller areas than can two or more unrelated pairs. It should be noted that the wheat provided in this manner was accessible to and used by other waterfowl species as well and often in large numbers.

This method does have the advantage of being a rapid and safe method for Refuge personnel to use, and there was some potential for improving the area of spread. Possibilities include placing a mechanical spreader of some sort on the end of the spout, moving the dry land feeder and enlarging the area of water to include where the feeder now stands, and increasing the arc of the movable spout.

Broadcasting wheat from a boat

Broadcasting wheat from a boat involved putting a jon boat in the water and filling it with wheat directly from the spout. While one person rowed the boat, another shoveled the wheat into the water, making numerous small piles or rows over a large area of the pond (several hundred square feet).

This technique seemed to be the most efficient for feeding Trumpeters at RRLNWR, as measured by the number of swans observed feeding. Overall, a mean of 7.8 swans per recorded observation ($N = 232$, range = 0-107) used the broadcast wheat on days it was provided. Trumpeters ate broadcast wheat on 9 of the 10 days it was provided (90 percent). The swans used the broadcast wheat more heavily during December, January, and early February than in late February and March (early observations, $N = 138$, $\overline{x} = 12.5$, range = 0-107; later observations, $N = 94$, $\overline{x} = 1.8$, range = 0-11).

The mean number of Trumpeters observed on broadcast wheat was over twice that of the mean number observed when wheat was provided via the spout, and 18 times the mean number observed using the dry land feeder. Interestingly, the mean number of swans observed "tipping up" on natural foods (presumably aquatic macrophytes, tubers, and invertebrates) was 6.5 ($N = 407$, range 0-71). This closely approaches the mean number observed tipping up on broadcast wheat. This seems reasonable, as broadcasting wheat most closely approximates what might be termed the normal food distribution and feeding method used by Trumpeters in a wild situation. The larger mean number observed on broadcast wheat as opposed to the other wheat distribution techniques was likely a function, at least in part, of the emulation of natural feeding conditions, as well as of the lack of crowding at the food source. Little aggression was recorded when swans were feeding on broadcast wheat, and what aggression was seen was short-lived. When swans were displaced by others, they simply moved to another pile of wheat and resumed feeding.

Other waterfowl, primarily Common Goldeneyes, used the wheat provided by broadcasting as well, often in numbers exceeding 50 to 75 birds.

From the standpoint of feeding large numbers of Trumpeter Swans, broadcasting wheat proved to be the preferred alternative. This technique enabled Refuge personnel to feed up to 100 at one time, depending upon how large an area the wheat was spread over. Normally, there were less than 100 swans simultaneously, but counts of 20 to 50 swans at any one time were common. Interestingly, this technique was first used in 1937-38 at the Refuge (Hull 1939).

This procedure was potentially dangerous for Refuge personnel because of the unstable platform afforded when standing and shoveling wheat out of a heavily-laden boat with little freeboard. The hazard could be reduced by not loading the boat to maximum capacity and by placing a warming shed near the ponds. It is important to note that no accidents have been reported to date, due, in part, to the extreme caution exhibited by Refuge personnel when engaged in this activity.

Conclusions regarding supplemental feeding techniques

The data presented above indicate that the dry land feeders are not an efficient means of providing feed for Trumpeter Swans. It remains, however, the only technique we have at present to offer commercially prepared diets to the swans. Perhaps a reevaluation of the need to provide these feeds is in order. It appears that if sufficient high-quality, high-protein wheat is provided to the swans, overwinter survival and physical condition in the spring are good. Thus, the necessity of providing additional nutrition is suspect. If the game feed mix is to be offered in the future, the following modifications should be made: the dry land feeders should be moved away from the grain bin; a gently sloping access ramp should be provided near the feeder site; a dead magpie wired to the top of the feeder (out of view of Trumpeters) might be an effective scarecrow for magpies, blackbirds, and starlings attempting to use the feeders; cougar or coyote urine sprayed around the feeder could be used to discourage deer.

Pouring wheat from the grain bin spout was a safe, rapid, and effective technique for providing wheat to the swans. Its primary drawback was that the number of swans that had access to the feed at any one time was limited. If sufficient wheat were put out to last a large number of swans for 3 or 4 days, this may not pose a problem.

Attempts were made to develop a "spreader" by attaching revolving paddles to the end of the spout and hooking this up to an electric motor. As wheat poured out of the spout, it hit the rapidly-turning paddles and was thrown 40 feet out into the pond. Attempts, to date, have not resulted in a distribution pattern that is thick enough for the swans to use effectively. If this technique can be improved upon, so that Refuge personnel can place a layer of wheat over a large, fan-shaped area, then perhaps it will prove to be an acceptable method of supplemental food distribution. Continued experimentation with the method is recommended.

Broadcasting wheat from a boat into a number of small piles spread out over a relatively large area appears to be the best technique currently available to Refuge personnel for feeding large numbers of Trumpeter Swans. A large amount of food can be provided at once; there is sufficient space for large numbers of Trumpeters to eat simultaneously without much aggression; and the loss of wheat to other species is probably less (but currently unmeasured) using this technique. It is slow, but does not appear to adversely impact the swans to any measurable extent. Until other methods can be perfected, this method is the best wheat distribution method known and should be the primary method used at RRLNWR.

Modeling the amounts of wheat provided on wintering ponds

Because the past method of deciding how much wheat to provide to Trumpeters on any given day was based on the opinions of Refuge personnel as to the number of swans likely to be using the ponds over a 3- to 4-day period, the effects of wheat consumed by other waterfowl species, and other factors, there was considerable guesswork involved. This could have resulted in malnutrition, or even death if the errors were chronic. It is important to note that these subjective evaluations worked reasonably well when coupled with the idea that a lot of wheat must be available for the swans to eat. No recent deaths have been traced to inadequate winter food supplies. However, some swan mortality did occur in the past when the amount of wheat provided was reduced (see Gale et al. 1987, p. 173). If a model for providing wheat, accompanied by a rational for the model was available, there would then be a smaller chance of changing personnel at RRLNWR, resulting in widely fluctuating winter feeding regimes for Trumpeters. Indeed, as stated earlier, one of the purposes of this report is to provide information to managers not yet arrived including a summary of our observations so that they do not have to go through yet another round of experiments to determine what works best.

For example, although we do not know what a Trumpeter Swan's daily nutritional needs are, we can calculate approximately how much a swan can consume per day. We know that Trumpeters feed heavily on days prior to approaching storms, possibly in response to lowering atmospheric pressures (C. Mitchell, unpublished data). However, on very cold days, Trumpeter Swans spend most of their time sitting in heat- and energy-conserving postures, and feed very little, if at all (C. Mitchell, unpublished data, Bortner and Gale 1987). Thus, we can use long-range weather forecasts to tailor our food distribution to expected swan needs.

Until more data is available, the following model can be used to estimate the amount of food that should be provided on our wintering ponds.

$$A = 100\% \; (T \times I \times 1.25^{L} \times .75^{H}/20$$

where A = amount of wheat to be provided (in bushels),
T = the number of Trumpeter Swans present,
I = the interval between feedings (in days)
L = the number of days of low pressure expected between feedings,
and, H= the number of days expected between feedings, with winds exceeding 20 mph.

The number 20 used as a denominator comes from calculations that indicate that 20 Trumpeter Swans will consume one bushel of wheat per day under normal winter conditions. The addition of 10 percent comes from calculations that suggest that 10 percent of the feed provided will be consumed by other species.

Therefore, if counts indicate that an average of 200 swans will be present, the interval between feeding is 4 days, and the long-term weather forecast calls for a front moving through, followed by 2 days of strong winds, the equation is solved as follows:

$$A = 110\%(200 \times 4 \times 1.25^{1} \times .75^{2}/20)$$
$$= 110\%(800 \times 1.25 \times 0.5625/20)$$
$$= 28.125 \times 110\%$$
$$= 30.9.$$

Thus, 30.9 or 31 bushels of wheat should be provided. How this total should be divided between ponds is a matter that needs more data to resolve. It is likely that the swans will freely travel from one pond to another to eat, if food at the pond they prefer is absent.

This model is exceptionally crude. It will benefit from more precise data on all of the variables, but it provides a logical place to begin, especially for individuals without any "feel" for what amount of food should be provided. Preliminary information on feeding and behavioral patterns from the 1987-88 observations indicate that the model works.

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AVICULTURE TECHNIQUES USED IN MINNESOTA TRUMPETER SWAN RESTORATION

Steven M. Kittelson

ABSTRACT

The methodology used in the Minnesota Department of Natural Resources Trumpeter Swan Restoration Program includes collecting eggs and rearing cygnets until they are 2 years old. Methods of egg collection, transportation, and artificial incubation have been monitored and refined to obtain an 86-percent hatch rate in 1986 and 1987. Brooding and rearing methods and facilities have been altered as problems confronted the program. Research and methods of treatment and control on aspergillosis, lead poisoning, and genetic variation have been applied to enhance swan survival rates. Methods of transporting swans have been improved, and stress and injury rates have been significantly reduced.

The techniques used in the Minnesota Department of Natural Resources (MN DNR) Trumpeter Swan Restoration Program can be divided into four areas: incubation, brooding, holding subadults, and release.

INCUBATION

Eggs were obtained from several sources and transported to incubation facilities at the Carlos Avery Wildlife Office at Forest Lake, Minnesota. Special insulated cases were used to transport the eggs from the collection point to the incubation facility (Erickson 1981). They were equipped with hot water bottles to provide heat and a battery-operated fan for ventilation. These cases were used to safely transport Trumpeter Swan eggs over great distances for extended periods of time. Some eggs spent more than 30 hours in the cases. Eighty-six percent of the eggs collected in Alaska and transported to Minnesota in 1986 and 1987 hatched successfully.

Large commercial-sized incubator units were used to incubate eggs. They were maintained at 99.5° F dry bulb and 85.0 - 86.0°F wet bulb. The incubators rotated the egg trays through a full 90-degree tilt every 60 minutes. The eggs were turned top to bottom by hand and misted with water twice daily to supplement the moisture and movement provided by the incubator. The eggs were candled periodically to monitor development and movement of the embryo. Entire clutches were transferred to the hatcher unit when one or more embryos from a nest began to vocalize. The hatcher unit was maintained at 99.5°F dry bulb and 87.0 - 88.0°F wet bulb.

In 1987, the eggs were weighed daily to obtain data on weight loss during incubation. This data will be examined prior to the 1988 incubation season. However, it is not likely that any major changes in incubation settings will be made.

Eggs that were slow to hatch were given assistance in hatching as a last resort. However, some eggs were pipped by hand when the circumstances warranted. Of the 85 eggs successfully hatched in 1986 and 1987, 13 received some form of assistance. Thirteen additional embryos were assisted but failed to survive or were dead before assistance was given. It is possible that three or four of these embryos may have survived if intervention had occurred earlier and to a greater degree. The remaining nine or 10 embryos were deformed or had died at least several days prior to the clutch hatch date. Cygnets were placed with unhatched eggs in the hatcher to provide stimulus to the vocalizing embryo in the egg.

The yolk sack area was treated with tincture of iodine, and a leg band was placed on the cygnets soon after hatch. With this marker, a cygnet could be traced from the nest to the adult stage.

BROODING

The cygnets were transferred to brooding facilities after approximately 24 hours in the hatcher unit. The brooders were indoor boxes with heat lamps. This system allowed close monitoring of each individual bird. A commercial, 18-percent protein, duck-starter diet was sprinkled on paper on the floor of the brooder box to encourage feeding behavior. Cygnets were observed pecking at, and consuming food particles within 5 minutes of being placed in the brooder box. Several trays of food and water were also distributed on the floor of the brooder box to assure that a cygnet was always near food or water.

A daily record of the weight of each cygnet was kept. Incidents of weight loss or stability were suspect, and the affected cygnet was given special attention. The collection of weight data was continued on a daily basis until the cygnets were moved to the less accessible outdoor pens. In the outdoor pens, a daily weigh-in would have caused an intolerable amount of disturbance and stress on the cygnets. The procedure will be examined prior to the 1988 hatch, and the daily weight data may not be collected at all.

Clutches of cygnets were artificially created by grouping birds from nests in close proximity to one another or by other criteria, and each group was kept visually separated from the others until approximately 12 weeks-of-age. Each group consisted of six to eight cygnets from two or more clutches. This was a precaution to promote sibling imprinting among grouped birds and to prevent sibling imprinting between the remaining birds on the chance that such imprinting could hinder pair bonding outside of sibling groups at the time of release.

Through 1987, the cygnets were kept in the brooder boxes for about a week and then transferred to another building with a swimming area for each of the groups. This building was abandoned in mid-1987 after a mink entered the facility and killed the 31 cygnets within. A temporary facility was set up in the brooder building to provide swimming areas for the remaining cygnets. In 1988, new brooder boxes were designed to replace the temporary ones. These boxes will house the birds from the time of hatch until they are moved outside.

The cygnets were moved to outside brooder pens at approximately 6 weeks-of-age. They were kept in their artificial sibling groups. The pens were 16 ft. x 16 ft. x 8 ft. tall, roofed, wood framed, and covered with welded wire with 1- x 2-in. mesh. Brooder pens were placed entirely in the water in an area with a fairly level bottom and a water depth of 3-4 feet. Each pen had a resting platform large enough to accommodate all of the birds in the pen, plus a feeder. The pens were designed for approximately six cygnets. However, they have been used occasionally to hold as many as 11 cygnets in early stages of growth for short periods of time.

The overwater pens required the use of waders to check and feed the birds each day. This was somewhat cumbersome, but the pen design did offer good security.

Both static and free-floating resting platforms were used, and each had some advantages and disadvantages. The static platforms required support wires, posts, or braces which were potentially hazardous to the swans. They also were more difficult to maintain with fluctuating water levels. The floating platforms were free of obstructions and required no maintenance as water levels changed. They did require buoyancy adjustments periodically if they were made of a material that could become waterlogged. Logs were used as floats under the platforms and did need replacement. One cygnet died in 1987 when it dove underneath the free-floating platform and could not get out.

The diet of pure duck starter was slowly changed at 2 to 3 weeks-of-age by mixing increasing amounts of lower-protein duck grower (16 percent) with the duck starter. Aquatic vegetation was added to the diet beginning at 2 weeks-of-age in varying amounts, depending upon availability. Elodea sp. gathered from adjacent ponds was most commonly used. Reduced quantity and quality of vegetation caused by very low water levels altered the vegetation feeding schedule in 1987. It is not known what effect, if any, this had on overall flock health.

Beginning at 6 to 7 weeks-of-age, shelled corn was slowly introduced into the diet. The amount was steadily increased until the feed mixture was 50 percent duck grower and 50 percent shelled corn. This was the maintenance diet the birds received until they were released. The only time this diet was changed was during periods of severe cold weather or just prior to release, and then the proportion of duck grower was only slightly increased. Aquatic vegetation was supplied in large quantities when available.
Calcium grit was provided as an option in close proximity to the food during all stages beyond 1 to 2 weeks-of-age. Very little grit was consumed from this source.

HOLDING SUBADULTS

The cygnets were captured, wing-clipped, and moved to the holding pens by 12 weeks-of-age. Groups were combined at this time into two nearly equal "halves." Future pairings will be made with a bird from each group. Several on-site and off-site holding pens were used to hold the four groups (two groups from the current year's hatch) until release at 22 months-of-age.

The two on-site pens were about 1 acre in size, surrounded by a 5- to 6-foot woven wire fence. Each pen had a pond 8 to 10 feet deep, with an aeration system to provide open water in the winter. Feeders constructed from 20- and 30-gallon trash containers were placed on shore. Each of these pens could hold 20-25 swans.

In addition to the on-site pens, groups of swans were held in off-site pens at Hennepin Parks, the Minnesota Zoo, and private residences. These were usually larger, natural ponds or small lakes.

Once the swans were placed into the holding pens, they required less intensive care on a day-to-day basis. Daily observations for pen integrity and swan health were standard procedure. Early detection and treatment of injured or diseased birds are essential for effective treatment.

Blood samples for research on aspergillosis, blood lead levels, and genetics testing were collected when the swans were being handled for another purpose. Weight data was also collected at those times.

Some cases of flip wing were encountered. This condition was treated by wrapping the wing with an elastic bandage on a cycle of 2 days on and 2 days off until the problem was no longer observed.

It was necessary to have isolation facilities available at all times. They were needed to prevent healthy swans from attacking injured birds and to isolate diseased birds. These facilities may also be needed to house birds that begin to form pair bonds in the larger holding pens.

RELEASE

Moving swans to release sites or to holding pens can be extremely stressful for the birds. Wooden crates suitable for Canada Geese were not adequate for swans. One transfer of 22 swans to a distant holding pen resulted in several minor injuries and, several days later, one mortality occurred, possibly attributable to the crates. The injuries included scraped bills and raw wing joints from rubbing on the sides of the crate. Some lameness was observed for several days after the swans arrived at their destination, most likely a result of the rough ride caused by the stiff suspension system on the truck.

Vari-kennel dog crates (molded plastic, lightweight, and available in a variety of sizes) have proven to be the best for transporting swans. They have a smooth interior and wire ventilation windows and door that nearly eliminate the possibility of injury during transport. They are easy to clean and disassemble for transport and storage. Aircraft have been used to transfer birds over long distances, whenever possible. Air-conditioned vehicles were used during hot weather, or transport was delayed until the weather improved.

Transport of 24 swans from Minneapolis to the Detroit Lakes release sites (250 miles) involved two short truck rides and a flight of 55 minutes in a smooth, air-conditioned C-130 air transport. None of the transported birds showed any signs of injury or lameness when released. The alternative was a minimum of 6 hours in a rough-riding truck. This extended trip certainly would have resulted in some leg soreness at the very least. It also would have delayed the release of at least some of the swans until the following day, causing additional stress on the birds.

Release site selection included a survey of the quality of the vegetation for food, cover, and nesting, bottom sampling for the presence of lead shot, evaluation of human disturbance potential, and other criteria (Hines 1986). Sites were selected during the summer prior to the release.

These methods are continually being refined as problems confront the program. The MN DNR Nongame Program has confidence in the basic design and believes it is a suitable method to restore Trumpeter Swans.

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DOUBLE CLUTCHING OF TRUMPETER SWANS (Cygnus cygnus buccinator) AT THE MINNESOTA ZOOLOGICAL GARDEN

Jimmy Pichner, Nick Reindl, and Brad Geiszler

ABSTRACT

Double clutching of Trumpeter Swans, Cygnus cygnus buccinator, was attempted by the Minnesota Zoological Garden (MZG) to increase reproduction of the species. First clutches of eggs were removed from breeding pairs over a 3-year period for artificial incubation. The pairs renested successfully in each case. These findings indicate that reproduction of selected pairs of swans could be increased by the removal and artificial incubation of the first clutch of eggs.

The Minnesota Zoological Garden (MZG) is participating in the Minnesota Trumpeter Swan Restoration Project, along with the Minnesota Department of Natural Resources, Nongame Program, Hennepin Parks, Chicago Zoological Garden, and several private aviculturists. The Zoo's 485 acres of rolling, wooded hills and 14 ponds and marshes provide the natural resources needed to manage several pairs of Trumpeter Swans under semi-natural conditions. Since acquiring its first pair of Trumpeter Swans (Cygnus cygnus buccinator) from Hennepin Parks (then called Hennepin County Park Reserve District) in 1978, the Zoo has hatched 55 cygnets and presently has four breeding pairs of swans. Cygnets and juveniles are staged on the Zoo's main lake until they are 2 years-of-age. At that time, they are old enough to release into the wild.

Double clutching is widely known as a technique for increasing the production of rare and endangered avian species (Conway 1983, Snyder and Hamber 1985). However, until recently, it was believed that due to both ecological (e.g., effect of season, food availability) and physiological constraints, this technique could not be applied successfully to Trumpeter Swans (Banko 1960). Delacour (1954) (also noted by Banko 1960) reports on one unsuccessful attempt conducted at Red Rock Lakes National Wildlife Refuge (NWR), Montana, and concludes, "We had hopes that the robbed pair of swans would nest again, but they refused to do so, and the only supposed advantage of taking eggs rather than catching cygnets was thus disproved."

Nonetheless, earlier successes in double clutching and artificially incubating a variety of "difficult" waterfowl, including Barrow's Goldeneye (Bucephala islandica), Wandering Whistling Ducks (Dendrocygna arcuata), and Hooded Mergansers (Lophodytes cucullatus), encouraged us to try this method with Trumpeter Swans. Two factors, in particular, were in our favor:

1. First, the swans were provided with a high quality diet throughout the year, thereby enabling them to enter the breeding season in prime reproductive condition and to remain in this condition for an extended period of time. Unlike the situation in the wild (Krapu 1979, Murton and Westwood 1977), a second clutch was not precluded by depleted body reserves.
2. Second, by using aerators to keep the ponds open, the swans could be wintered in the same area where they were to nest. This allowed the birds to begin nesting in the spring as soon as weather permitted. In general, for most species, the earlier the first nest was initiated, the greater the chances of successful double clutching.

Renesting occurred (i.e., eggs were laid) in four of our six attempts to double clutch Trumpeter Swans. Second clutches averaged 4.25 ± 1.09 eggs per nest (ranging from three to six), as compared to 6.17 ± 2.17 eggs per nest (ranging three to 13) in 17 first clutches.

Second clutches were laid after first clutches were removed at 0, 4, 9, and 22 days into incubation, but not when first clutches were removed at 21 and 39 days into incubation. Also, in the two cases where second clutches were not laid, first clutch incubation was not initiated until 8 May. In the four cases in which second clutches were laid, incubation was initiated between 12 April and 6 May. The amount of time between removal of the first clutch and initiation of incubation of the second clutch varied from 22 to 27 days (average 24.25 days).

Although only two of the four, second clutches produced cygnets as compared to 12 of 17 first clutches, a slightly greater percentage of eggs hatched from second clutches (47 percent, N = 17) than from first (45 percent, N = 105). Of the nine second-clutch eggs which did not hatch, all were subsequently determined to be infertile. No assessment was made of fertility of the 58 first-clutch eggs that did not hatch.

Successful renesting (hatching of cygnets) occurred only when eggs were removed within 9 days of initiation of incubation. Similar behavior has been reported by Cooper (1978) and Balham (1954) in Canada Geese. The one renest of the four that occurred when eggs were removed after day 9 produced three infertile eggs. No renesting occurred if eggs were removed after 6 May.

Although our data is limited, it demonstrates that Trumpeter Swans can be successfully double clutched. The successful production of cygnets from a second clutch appears to depend on one or both of the following:

1. The date when the first clutch is laid (the earlier in cubation of the first clutch is initiated, the better the chances a second clutch will be laid), and/or

2. The days into incubation at which the first clutch of eggs is removed (the eggs should be removed as soon as possible after incubation has been initiated to maximize the chances of double clutching).

It is also important to give consideration to the nutritional value of the winter food as the physical condition of the swans entering the breeding season directly affects the birds' reproductive ability.

Double clutching can be used to increase the productivity of Trumpeter Swans in captivity and, possibly, in the wild. In areas where environmental factors are responsible for poor reproduction, removal of the first clutch of eggs and hand rearing of the cygnets may allow the pairs to renest after the environmental dangers have decreased. A management strategy of this type may be useful at a location such as Red Rock Lakes NWR where cygnet production may be depressed by drastic water fluctuations (Mitchell 1987). Cygnets produced from hand rearing could be used in restoration programs, and cygnet hatchability and survivability of second clutches may increase if environmental conditions responsible for earlier losses have mediated.

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