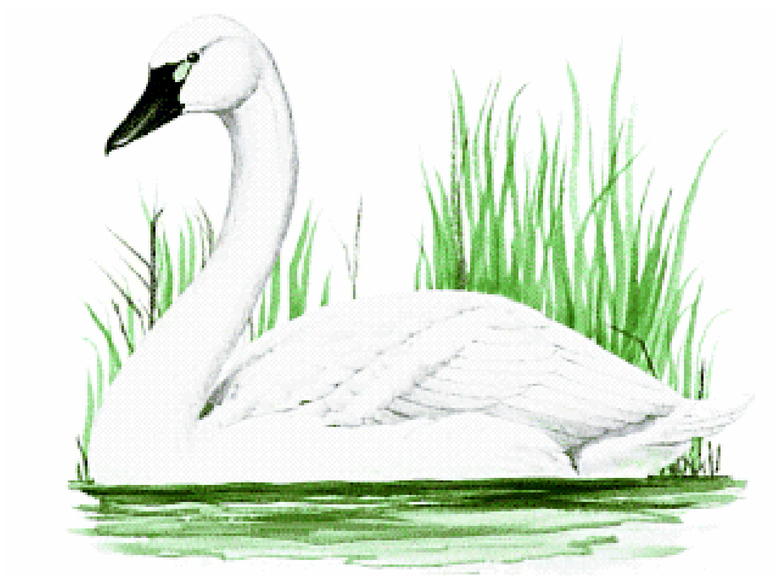
MANAGEMENT PLAN

FOR THE

EASTERN POPULATION OF TUNDRA SWANS



Flyway Council Review
Version 4 – Feb 12, 2007

Ad Hoc Eastern Population Tundra Swan Committee

A MANAGEMENT PLAN FOR THE EASTERN POPULATION OF TUNDRA SWANS

Prepared by the Ad Hoc Eastern Population
Tundra Swan Committee

February/2007

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EASTERN POPULATION OF TUNDRA SWANS

Prepared for

The Atlantic, Mississippi, Central and Pacific Flyway Councils

Prepared by

The Ad Hoc Eastern Population Tundra Swan Committee

Revision Draft 4, February 2007

Approved by: ______________________________ __________

Chair, Atlantic Flyway Council Date

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EXECUTIVE SUMMARY

The Eastern Population of tundra swans (EP) has been managed under a joint 4 Flyway management plan first developed and implemented in 1982. A harvest strategy for the EP was subsequently adopted in 1988. The last revision and incorporation of these documents occurred in 1998. The 1998 plan established population objectives based upon the Atlantic Flyway Mid-Winter Survey and identified a number of key research and data gaps needed for the continued management of this population.

Since 1998, a number of research projects have cast light upon some of the uncertainties identified in the 1998 plan. However, a number of new questions, particularly surrounding the use and accuracy of mid-winter counts as a population metric have also arisen. This updated plan incorporates this new information and sets a path forward for continued accumulation of knowledge for the Continental management of EP tundra swans.

The overall management goal is to maintain EP tundra swans at a population level that will provide optimum resource benefits for society consistent with the habitat availability and International treaties. The specific population objective is to maintain at least 80,000 EP tundra swans based on a 3-year average population index from the Midwinter Waterfowl Survey (MWS) in the Atlantic and Mississippi Flyways. This population objective will provide the level to satisfy public demand for enjoyment and appreciation of this resource and the desire to maintain distributions of EP swans throughout their range as well as continue to support both subsistence and sport harvest.

Inclusion of Mississippi Flyway MWS data is a change from the previous plan where only Atlantic Flyway data were considered. The addition of Mississippi Flyway MWS data is thought to provide a more complete dataset on which to monitor population trends. Despite the addition of Mississippi Flyway wintering numbers, no change to the population objective is deemed necessary at this time.

Protection of breeding, staging, and wintering habitat is critical to the long-term maintenance of EP tundra swans. Recent research projects have identified key staging locations whose protection is vital towards continued EP tundra swan population stability. Threats to both breeding and wintering grounds continue to increase. Several strategies and tasks have been identified to address these needs. Similarly, development of a breeding population index, or better enumeration of wintering numbers is an important need. Further refinement of a population model that will better inform management is another identified need.

The harvest strategy contained herein has been modified from previous harvest strategies. Clear, unambiguous population thresholds have been developed for the allocation of permits, and a revised system for permit transfers within and among hunt zones and Flyways has been incorporated. The targeted harvest rate for EP tundra swans is at or below 5%.

This plan and the harvest strategy should be reviewed and revised as needed at no longer than 5-year intervals.

PREFACE

The four Flyway Councils are administrative bodies established in 1952 to represent the state/provincial wildlife agencies and work cooperatively with the U.S. Fish and Wildlife Service, Canadian Wildlife Service, and Mexico for the purpose of protecting and conserving migratory game birds in North America. The Councils have prepared numerous management plans to date for most populations of swans, geese, doves, pigeons, and sandhill cranes in North America. These plans typically focus on populations, which are the primary unit of management, but may be specific to a species or subspecies. Management plans serve to:

- Identify common goals.
- Establish priority of management actions and responsibility for them.
- Coordinate collection and analysis of biological data.
- Emphasize research needed to improve management.

Flyway management plans are products of the Councils, developed and adopted to help state and federal agencies cooperatively manage migratory game birds under common goals. Management strategies are recommendations and do not commit agencies to specific actions or schedules. Fiscal, legislative, and priority constraints influence the level and timing of implementation. The first management plan for the Eastern Population (EP) of tundra swans (*Cygnus columbianus*) was prepared by an Ad Hoc Committee composed of the four Flyway Councils, the Canadian Wildlife Service (CWS), and the U.S. Fish and Wildlife Service (USFWS), and implemented in 1982. This plan provided guidelines for the cooperative management of EP tundra swans, including objectives for population levels, distribution, recreational use, depredation effects, survey and research needs, and contained guidelines for considering a hunting program. The USFWS first approved a hunting season on EP tundra swans with a limited number of permits in the Central Flyway portion of MT, ND, and SD in 1983 (only MT selected a season). In 1984, the USFWS authorized NC to initiate an experimental season in the Atlantic Flyway and finalized an Environment Assessment: Proposed Hunting Regulations on Whistling (Tundra) Swans to give detailed consideration to the action of harvesting EP tundra swans.

Although a harvest strategy was initially developed to be appended as a supplement to the 1982 management plan, this harvest strategy did not receive formal endorsement by the Flyway Councils. Therefore, an international sport-hunting plan was developed in 1988 to regulate harvest and permit allocations among the Flyways, including Canada, and was formally agreed upon. Subsequently, the EP tundra swan management plan, including the appended harvest strategy, was reviewed and revised in 1998 and was endorsed by the four Flyway Councils. Presently, the need exists to review and update the population objective and management guidelines of the 1998 Plan, and to evaluate the current harvest strategy. To accomplish this review, an Ad Hoc EP tundra swan committee was appointed and a meeting was held in Minneapolis, MN, October 11 and 12, 2006, to begin drafting a revised plan.

Membership of the Ad Hoc Eastern Population Tundra Swan Committee, October 2006	
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INTRODUCTION

Tundra swans (*Cygnus columbianus*) are divided into 2 populations for management purposes, the Eastern Population (EP) and the Western Population (WP) (Figure 1). These population management units are based on substantially segregated breeding, migration, and wintering distributions determined from banding data and not genetic differences. Because the EP spans all four flyways, this document is a joint product of the Atlantic, Mississippi, Central, and Pacific Flyway Councils. The first management plan for this population was implemented in 1982, and a harvest strategy was adopted in 1988. These plans were combined and updated in 1998. The purposes of this Flyway management plan are to identify population goals, establish guidelines and priorities for management actions, identify strategies and assign responsibilities, specify levels of public use, and emphasize research needs to improve the management of EP swans. This plan is scheduled for review and revision at no longer than 5-year intervals.

GOALS AND OBJECTIVES

THE MANAGEMENT GOAL IS:

TO MAINTAIN EP TUNDRA SWANS AT A POPULATION LEVEL THAT WILL PROVIDE OPTIMUM RESOURCE BENEFITS FOR SOCIETY CONSISTENT WITH HABITAT AVAILABILITY AND INTERNATIONAL TREATIES.

Opportunities for this resource to provide benefits to the general public are determined by the population size, its geographic and temporal distribution, and by interaction between consumptive and non-consumptive uses. Information obtained through research and monitoring provides data on which management decisions are based. Accordingly, objectives and strategies are presented for each of the following guidelines.

POPULATION GUIDELINES

OBJECTIVE A: The population objective is 80,000 EP tundra swans based on a 3-year average population index from the Midwinter Waterfowl Survey (MWS) in the Atlantic and Mississippi Flyways.

The population objective is set at a level that provides a sustainable population and reasonable benefits to society for both viewing and harvest opportunities. The objective in this revised Plan is unchanged from the previous (1998) plan. Based on experience with this objective, we believe 80,000 birds will satisfy public demand for enjoyment and appreciation of this resource and that this level maintains current distributions of EP swans throughout their range. Also, this population level has been sufficient to support both subsistence and sport harvest. Being a long-lived species with delayed sexual maturity and relatively low recruitment rates, absent extraordinary events, large changes in abundance from one year to the next are biologically unlikely. However, swan distributions on winter areas can vary annually, and counts of birds during surveys are not adjusted for birds present but not seen by aerial crews. Both factors influence the variability associated with these annual counts. Therefore, a 3-year average of the MWS for the Atlantic and Mississippi Flyway, rather than the annual index, will be used to reduce the effects of this variability in annual counts when making management recommendations. If the survey is incomplete for any reason, the average of the most recent complete surveys will be used as an index to the population.

Inclusion of Mississippi Flyway MWS data is a change from the previous plan where only Atlantic Flyway data were considered. Tundra swans first were enumerated in the Mississippi Flyway MWS in 1982 (Figure 2) and since that time have increased ($r^2 = 0.782$, $P < 0.001$), largely as a result of more swans wintering on the Great Lakes. This trend has continued since the 1998 EP Tundra Swan Plan was approved ($r^2 = 0.693$, $P = 0.005$). The addition of Mississippi Flyway MWS data will better reflect the status of the entire EP relative to only the Atlantic Flyway counts. Although the inclusion of the Mississippi Flyway MWS data is a departure from the previous plan and some number of tundra swans has always wintered in the Mississippi Flyway, no change to the population objective is deemed necessary at this time.

When considering the MWS from both the Atlantic and Mississippi Flyways, the number of EP tundra swans has increased significantly ($r^2 = 0.884$, $P < 0.001$) since the inception of mid-winter surveys in the mid 1950's (Figure 3). In 1983, the 3-year average population index first exceeded 80,000, which was the upper population objective established in the 1982 EP Tundra Swan Management Plan as well as the population goal set in the 1998 EP Tundra Swan Management Plan. The 3-year average has remained above the 80,000 level through 2006. A significant increasing trend is also evident during the last 20 years ($r^2 = 0.262$, $P = 0.021$), but considerable variation exists in the 3-year averages. Over the last 10 years, no statistically significant trend is evident from the combined Atlantic and Mississippi Flyway MWS ($r^2 = 0.058$, $P = 0.503$).

STRATEGY A-1: Maintain and improve population surveys.

Rationale: Numbers of EP tundra swans are estimated annually during the MWS conducted in early January. These data provide an index to population trends but have low precision and unknown bias due to a lack of a survey design that would allow for the estimation of these parameters. However, because swans are very visible on the wintering grounds, except when snow cover exists, the 3-year average winter indices may serve as an adequate index.

Although numbers of swans observed in the Mississippi Flyway have increased over time, the wintering range is still relatively limited to specific concentration areas in the mid-Atlantic and Great Lakes states and southern Ontario (Figure 4). The MWS remains a practical means of monitoring the abundance of EP swans, as well as monitoring changes in winter distribution. In order to maintain its comparability among years, Standard Operating Procedures (SOP's) must be explicit and maintained. Extreme year-to-year variation in the MWS counts is likely related to several factors including swans wintering in areas outside of the survey area, double counting, and inaccurate counting.

The likelihood of biased counts increases in years with a prolonged mid-winter survey in swan areas. In some years, the mid-winter survey may range over a 3-week period in swan areas. Significant redistribution during this time period may occur. Inaccurate counting can be a factor in areas of high swan concentrations especially where they co-occur with large numbers of other waterfowl. This may occur in several units in North Carolina where large concentrations (10,000 – 25,000 swans) occur. There is also a need to reduce variability and measure the precision of these midwinter estimates using new analytical methods. This improved capability will help to better monitor the population status and determine when management actions are needed to achieve management objectives. Another way to reduce the annual bias in the MWS swan counts would be to devise a swan-specific survey within the core of the AF wintering range.

Breeding surveys of EP swans have been conducted since 1986 on Alaska's Arctic Coastal Plain (ACP) and in certain areas of the Northwest Territories (NWT), Canada. These surveys provide useful population information for specific regions and for individual study purposes, but have limited application towards monitoring continental population trends. Because of the vast distribution of tundra swans throughout the arctic, a comprehensive, range-wide breeding ground survey is not practical at this time. However, since 2002, breeding surveys for other waterfowl species have been conducted across large expanses of the western and central Canadian Arctic, including many important tundra swan breeding areas. Ancillary to their primary objective, these surveys also have enumerated breeding EP tundra swans. Should these surveys for other breeding waterfowl become operational, they may provide secondary or perhaps a primary population index for future management. However, the lack of a standardized and agreed-upon breeding ground survey underscores the importance of improving MWS estimates.

Recommendation 1: Reduce variability of MWS estimates using SOP's for the MWS. To reduce the potential of inaccurate counts, survey units containing appreciable numbers of swans should be surveyed as soon as possible after initiation of the MWS in early January. Separate swan surveys concurrent with the MWS should be considered for high concentration survey units, especially in North Carolina.

Responsibilities: Atlantic & Mississippi Flyway MWS participating States and Provinces, US Fish and Wildlife Service (USFWS).

Recommendation 2: Improve precision and reduce variability of MWS estimates using new survey techniques and/or analytical methods, e.g., aerial photographic inventories.

Responsibilities: Atlantic & Mississippi Flyway MWS participating States and Provinces, US Fish and Wildlife Service (USFWS).

Recommendation 3: Support the maintenance and development of operational migratory bird surveys across the Alaskan and Canadian Arctic.

Responsibilities: US Fish and Wildlife Service (USFWS), Canadian Wildlife Service, and the Atlantic, Mississippi, and Central Flyways.

STRATEGY A-2: Monitor non-hunting mortality and address and mitigate when feasible.

Rationale: Swans are prone to ingestion of spent lead shot, and even lead fishing sinkers, which may cause lead poisoning mortality. These losses can be substantial when swans are concentrated in areas known to have large deposits of lead from decades of shooting. The most notable example of this occurred at Mattamuskeet National Wildlife Refuge between 1972 and 1976 where an estimated 7,200 swans died from lead poisoning (Blus, 1994). It is important to continue to enforce non-toxic shot requirements for hunting waterfowl and educate waterfowl hunters regarding the need for and use of non-toxic shot.

Total mortality attributed to diseases in EP tundra swans is unknown. Avian cholera, (*Pasteurella multocida*) has been responsible for losses of wintering WP swans, and avian cholera is known to occur in other waterfowl throughout their range. Losses of swans due to visceral gout are reportedly more common in Maryland than those caused by either lead poisoning or avian cholera (L. Hindman, MD Wildlife Division, personal communication). It is important to continue to monitor concentrations of EP Tundra swans for signs of disease and minimize situations that favor disease transmission wherever practical.

Other documented causes of non-hunting losses include collisions (usually with electric transmission lines), illegal or malicious shooting, and predation of eggs and cygnets on the breeding grounds. The relative importance of these losses remains unknown. Success of efforts to reduce mortality from disease and human-caused non-hunting factors may have an influence on our ability to maintain population goals and maximize resource benefits.

Recommendation 1: Continue to monitor the incidence of non-hunting mortality, including lead poisoning, illegal shooting, and disease. Continue non-toxic shot education effort.

Responsibilities: All cooperating agencies.

DISTRIBUTION AND HABITAT MANAGEMENT GUIDELINES

OBJECTIVE B: Monitor and maintain geographic and temporal distributions of EP swans, to the extent possible, consistent with the welfare of EP Tundra swans, in support of population objectives, and sustaining public values.

Active management programs can influence EP swan distribution, largely through management of habitats and human interactions at regional and local levels. Tundra swans are valued by people living throughout the range for subsistence and recreational harvests, viewing and aesthetic values. Management actions that could redistribute tundra swans would likely impact those public values. Thus, monitoring changes in swan distribution is important.

The most important strategy affecting distribution is to maintain traditional habitats used by EP swans in sufficient quantity and quality to support the population. This entails protection of important natural habitats, affecting the distribution of favorable cultivated habitats, and avoiding habitat loss and degradation from deleterious land uses. At local and regional levels, influencing the distribution of swans may be necessary to address concerns about crop depredation, nuisance impacts, or to avoid impacts from human developments. Should numbers of EP swans increase, management actions that encourage a wider distribution may become appropriate.

STRATEGY B-1: Monitor the distribution of EP swans through a variety of surveys and evaluate how swan distribution is influenced by existing management programs and practices.

Rationale: Tundra swans exhibit strong attachment to traditional breeding, migrating, and wintering habitats. Changes in seasonal swan distributions may be caused by natural changes in habitats, changes in weather and climate, and anthropomorphic impacts from habitat alteration and disturbance. An example of change in tundra swan distribution due to weather and climatic factors occurs in migration areas of North Dakota and South Dakota. Here the distribution and abundance of swans is influenced by the distribution and abundance of sago pondweed (*Potamogeton pectinatus),* a preferred food. During a series of high water years, the abundance of sago pondweed declines markedly on some wetlands, and so does the presence of swans on those wetlands. A series of drought years can also impact tundra swan distribution and abundance on migration areas, since dry wetlands obviously will have no swan food and no swans.

Periodic assessments of swan distribution should be done in conjunction with population surveys or special efforts to detect significant changes in habitat use, swan densities and productivity. Impacts of management actions including habitat programs, environmental reviews of development projects, and land use planning should be identified and efforts should be made by all cooperating agencies to maintain historic use patterns and seasonal abundance of EP swans. Existing habitat management practices on public and private lands should be evaluated with respect to impacts on historic and present EP swan distributions.

Recommendation 1: Closely monitor EP swan distribution and changes in use of habitat indicated by results of breeding population surveys, the MWS, and other periodic aerial surveys (i.e., molt and staging surveys, habitat assessments, research projects). Investigate any significant changes and, if practicable, implement corrective management measures.

Responsibilities: All cooperating agencies in the EP tundra swan range.

STRATEGY B-2: Protect breeding and northern staging areas from loss or degradation.

Rationale: Industrial and commercial development is increasing in some EP swan breeding areas in the tundra regions of Alaska and northern Canada. Oil and gas exploration and production has increased substantially on Alaska's Arctic Coastal Plain and in northwest Canada over the past 30 years, and energy demand is fueling further expansions of oilfields, processing facilities, and pipelines. In addition, mining and other extractive industries are also increasing their activities in the far north. Although loss and degradation of swan habitats have occurred locally around developments, expansive facilities and increased levels of ground and aircraft activity could displace tundra swans during nesting, brood-rearing, and pre-migration staging periods. In the boreal forest zone where tundra swans stopover during migration, timber harvesting, mining, and other developments are altering landscapes and disturbing swans on staging areas. Recent climatic warming trends and changes in wetland habitats in arctic and boreal areas warrant monitoring to detect impacts to tundra swans, amongst other affected species.

Recommendation 1: In conjunction with monitoring programs on EP tundra swan breeding areas (B-1 above), evaluate changes in densities and distribution in relation to northern development sites. Engage with development interests and regulatory agencies to conduct land use planning and establish regulatory measures to protect tundra swans and avoid or minimize impacts on their habitats.

Responsibilities: USFWS, CWS, Alaska, NWT, Nunavut

STRATEGY B-3: Protect EP tundra swan wintering and migration areas from habitat loss or degradation and support efforts to restore traditional habitats that have been degraded.

Rationale: Habitat integrity is essential to the health of EP swans and is necessary to prevent shifts from traditional areas. This effort requires continued support for wetland protection, water quality improvements, and input into government and private actions that may affect policy over agriculture, industry, urban expansion, water allocation, and other land uses. As noted in Strategy B-2 for breeding locales, increasing commercial and industrial development along with urbanization has occurred in key wintering locations and has the potential to degrade available habitats and may alter swan distribution. In North Carolina, recent development "threats" have included the possible construction of a Navy practice landing field and the development of a large poultry egg laying facility. Both of these examples occur in the core wintering range in the Atlantic Flyway. The conversion of preferred agricultural habitats to residential development is also occurring at many locations in North Carolina.

Historically, tundra swans fed almost exclusively on SAV. Changes in agricultural practices migration and wintering areas have resulted in a shift in feeding behavior of tundra swans. Agricultural field feeding of tundra swans was first noted in the late 1960s (Munro 1981). Field feeding by tundra swans is now quite common and may be related to growth of the EP swan population over the last 30 years. To minimize conflicts with farming interests, management efforts should promote the protection of key natural wetlands and emphasize the creation and effective management of man-made wetland habitats thus encouraging the use of these resources rather than continued dependence on agricultural crops. However, recent changes in crop production in key wintering areas of North Carolina, including long-term increases in acres of cotton coupled with a recent decline in acres of winter wheat, highlight a reduction in major forage crops that currently are important to swans (Figure 5). Also important to continued maintenance of EP swan numbers are the agricultural policies in the US and Canadian prairies and wetland restoration and enhancement projects. EP tundra swans rely heavily upon some of these resources during both the spring and fall migrations.

Recommendation 1: Identify and manage critical wetland habitats to provide an abundance of natural aquatic foods, avoidance of excessive disturbance, and areas of sanctuary. Engage with development interests and regulatory agencies to conduct land use planning and establish regulatory measures to protect tundra swans and avoid or minimize impacts on their habitats. Monitor trends in agricultural crop production in staging and wintering areas.

Responsibilities: All cooperating agencies

STRATEGY B-4: Identify and manage invasive species.

Rationale: Non-native, invasive plant and animal species have the potential to affect distributions of waterfowl including tundra swans. Invasive plant species including, but not limited to: common reed (*Phragmites australis*), alligator weed (*Alternanthera philoxeroides)* and purple loosestrife (*Lythrum salicaria*) have the ability to out-compete and dominate native food resources found in both natural and managed habitats and have been identified as posing a serious risk to waterfowl in the Atlantic Flyway (Atlantic Coast Joint Venture 2005). Mute swans (*Cygnus olor*), in particular, have the potential to affect distribution of tundra swans. This may occur through the degradation of aquatic habitats from overgrazing by mute swans, direct inter-specific competition for food resources, and exclusion of tundra swans from preferred habitats by aggressive mute swan behaviors (Atlantic Flyway Council 2003).

Recommendation 1: Promote and implement invasive species control programs to prevent exotic plant introductions, control the spread of exotics, and restore native vegetation for tundra swans.

Responsibilities: USFWS National Wildlife Refuges, state wildlife agencies, and other cooperating federal, state, and local organizations.

Recommendation 2: Prevent establishment of mute swan populations where they do not exist and pursue reduction of mute swan populations where they currently occur.

Responsibilities: USFWS, state wildlife agencies.

PUBLIC USE GUIDELINES

OBJECTIVE C: Provide opportunities for recreational and subsistence use of EP tundra swans consistent with population and distribution objectives.

EP tundra swans are valued for viewing, photography, and hunting during migration and on breeding and wintering areas. The continuation of these use opportunities is in the public interest and contingent upon ensuring that population and distribution guidelines are achieved and maintained into the future.

STRATEGY C-1: Provide for viewing, photography, and aesthetic uses while minimizing unnecessary disturbances during breeding and at staging and winter concentration sites used by EP tundra swans.

Rationale: EP tundra swans are conspicuous birds that attract considerable public attention, especially when found in concentrations near urban centers, highways, and other areas where they are accessible for viewing. For example, at remotely located Pocosin Lakes NWR in North Carolina, 8,000-10,000 people are estimated to visit the refuge for waterfowl viewing with tundra swans and snow geese being the primary species of interest (W. Stanton, Pocosin Lakes NWR, personal communication). However, concentration sites are limited, often in remote areas, and few opportunities exist to develop others. Therefore, new developments should maintain and enhance existing public use opportunities without creating hazards to aircraft, highway traffic, agriculture, or increasing risks to swans themselves.

Recommendation 1: Develop appropriately designed viewing areas for the public to observe and photograph EP swans.

Responsibilities: All cooperating agencies.

STRATEGY C-2: Provide for recreational hunting opportunities by maintaining and initiating programs consistent with population and distribution objectives.

Rationale: The tundra swan is a game species, as are all members of the family Anatidae, and hunting of the species is provided for by the Migratory Bird Treaty Act of 1918 (Serie and Bartonek, 1991b). Hunting is an important public use of EP tundra swans, and hunting opportunities are eagerly sought by waterfowlers throughout the range of EP swans in the United States. An environmental assessment entitled "Proposed Hunting Regulations on Eastern Population Whistling (Tundra) Swans, 1984" (USDI, unpublished report Washington, D. C., 1984) was prepared by the USFWS to evaluate the potential impact of hunting in the U.S. on EP swans. The first EP Hunt Plan was appended to the EP Management Plan in 1988 (Serie and Bartonek, 1991b), and an updated version subsequently was incorporated into the 1998 EP swan plan. The current harvest strategy, adopted as part of this revised plan, is found in Appendix C. EP swans have been hunted in the United States since 1983 (beginning in Montana) and are currently hunted by permit in 5 states. Since 1990 when all of these states participated in hunting, annual EP swan harvest (retrieved and unretrieved) has ranged from less than 3,100 birds to nearly 5,600 and averaged 3,313 (Tables 1 and 2). Since 1990, mean harvest rates for EP swans were 4.29% ± 0.27 and have ranged from 3.09% to 6.50%.

Recommendation 1: Manage hunting programs and harvest of EP tundra swans through implementation of the current harvest strategy (Appendix C).

Responsibilities: All cooperating agencies where hunting is permitted.

Recommendation 2: Continue to monitor the harvest of EP tundra swans under guidelines of the approved harvest strategy.

Responsibilities: All cooperating agencies where hunting is permitted.

Recommendation 3: Promote efforts, through enhanced education on suitable ranges and loads for taking swans, to reduce un-retrieved losses and improve hunter performance and responsibility when hunting tundra swans.

Responsibilities: All cooperating agencies where hunting is permitted.

STRATEGY C-3: Provide for subsistence use of EP tundra swans by promoting a cooperatively managed harvest consistent with conservation of the resource.

Rationale: EP tundra swans have been harvested for subsistence since humans first inhabited North America. This traditional harvest is nutritionally and culturally important to indigenous inhabitants of the northern range of EP tundra swans. Traditional spring and summer hunting was prohibited by international treaties until the United States and Canada amended the 1916 Convention for the Protection of Migratory Birds in 1995 (ratified by the U.S. Senate in 1997). The amended treaty acknowledged aboriginal hunting rights in Canada, and in Alaska it established a co-management system to involve subsistence hunters in migratory bird management and develop regulations for hunting. Formed in 2000, and consisting of representatives from the USFWS, Alaska Department of Fish and Game, and Alaska's Native peoples, the Alaska Migratory Bird Co-management Council (AMBCC) has engaged subsistence communities in all regions to monitor bird populations, develop annual spring and summer hunting regulations (since 2003), implement a statewide harvest survey program, and conduct extensive outreach efforts on conservation issues. Similarly, in Yukon, NWT and Nunavut, wildlife co-management boards have also been established.

Recommendation 1: Encourage active and full participation of northern subsistence hunters in cooperative management programs to support mutual conservation goals and objectives for EP swans, share population monitoring information, and manage harvest among all jurisdictions.

Responsibilities: CWS, USFWS, Flyway Councils, AMBCC, Native governments in both the US and Canada.

STRATEGY C-4: Expand and develop subsistence harvest survey programs within the EP range.

Rationale: Management of EP tundra swans can be improved with better data on the size of the subsistence harvest. Total subsistence harvest of EP tundra swans across their extensive and remote breeding range is unknown, but is believed to be less than 5,000 birds annually. Within the summer range of EP swans, there are an estimated 8,000 subsistence hunters in the NWT and 5,000 subsistence hunters in the other Canadian provinces and Alaska (R. Bromley, NWT Dept of Renewable Resources, and T. Rothe, AK Dept. of Fish and Game, personal communication). The magnitude of spring and summer harvest, however, is relatively low because swans are dispersed and hunting is locally opportunistic among widely scattered communities. During migration, swans from both the EP and WP appear to be available to subsistence hunters in the Mackenzie Valle, NWT, Yukon and Alaska (Figure 1).

Because spring hunting of waterfowl was illegal from 1916 to 1995, subsistence hunters in Alaska and other areas have been reluctant to report their harvests, particularly for swans. Limited harvest data have been gleaned mostly from short-term regional harvest surveys or socioeconomic community studies. The lack of regular comprehensive harvest surveys across the EP swan summer range precludes reliable estimation of harvest. Studies of the subsistence harvest in the Inuvik region of the NWT (Inuvialuit Settlement Area) have been done regularly since 19__, a five-year study of wildlife harvests throughout Nunavut concluded in 2001, and some recent harvest surveys have been initiated in other parts of northern Canada. With the amended U.S.-Canada migratory bird treaty, additional emphasis has been placed on fulfilling obligations to improve estimates of subsistence harvest. A statewide subsistence harvest survey has been conducted in Alaska since 2003, but it lacks funding and resources to annually reach full performance level.

Recommendation 1: Design and implement consistent and reliable subsistence harvest surveys in all key areas of EP swan harvest in Canada

Responsibilities: CWS, NWT, Nunavut

Recommendation 2: Continue subsistence harvest surveys in the northern Alaska part of the EP swan range and improve the level of support to sustain annual surveys.

Responsibilities: USFWS, AMBCC, Alaska

RESEARCH AND SURVEY GUIDELINES

OBJECTIVE D: Develop new and improved databases needed for management of the EP.

To reduce current uncertainty of select aspects of EP management, this plan requires improved information on the population status, breeding, migration, and wintering distribution, and other biological factors of EP swans. A coordinated research program is essential if resources are to be properly focused for the accumulation of needed data. Acquiring this information is dependent upon close cooperation among wildlife agencies and native peoples in breeding, migration, and wintering areas because funding sources are limited.

STRATEGY D-1: Continue development of a population model of the EP to be used as a tool for developing management strategies.

Rationale: A good population model can be a useful tool in decision-making for wildlife managers; however, any simulation model is only as good as the data upon which it is based. A basic population model (EPSWAN) was initially prepared for the EP. That initial model was driven by parameters, such as immature and adult survival and recovery rates and annual productivity. Parameterization of this initial model required reasonably precise and accurate estimates of survival and recovery rates. Tundra swans are longer lived and have lower reproductive rates than geese and other waterfowl. Survival and recovery rate estimates would be helpful in better understanding the effects of harvest regulations. A post-season (winter) leg-banding study would provide an estimate of average annual survival rates of after-hatching-year swans, but it requires capture of a large number of swans (>2,000/year) and does not provide information on first-year mortality. A pilot banding effort conducted in 2001-2003 indicated that this is likely not feasible. The difficulties in capturing an adequate sample in a discrete period of time proved immense and due to the long period of time required to band an adequate sample, numerous model assumptions were violated (Wilkins 2006). These violations of model assumptions resulted in very imprecise survival estimates.

Another potential method for acquiring estimates of survival and recovery rates is the resighting of neck collars in migration and wintering areas in conjunction with a core of trained observers. Theoretically, this technique would also provide good information on movements and affiliations of birds with migration and wintering areas. Pre-season banding or neck collaring, either in breeding areas or Canadian staging areas, would be required to obtain survival and recovery rates for immature birds. The work conducted in the Atlantic Flyway wintering grounds in 2001-2003 indicated that sample sizes required for precise and accurate survival and recovery rate estimates using neck collared birds and/or radio-marked birds cannot be reasonably obtained.

Conversely, developing a model whose parameterization did not rely upon extensive banding and marking efforts would be the most cost effective method. A model that used data from current operational surveys (MWS, hunting permits, production survey) has been developed (Wilkins 2006). Currently, however, this model is extremely insensitive to any of the parameter inputs, and more work needs to be done with regards to dataset weighting and model selection (best fit).

Recommendation 1: Continue development of a population model that can be used as a tool for determining optimum harvest levels of EP tundra swans.

Responsibilities: Lead responsibility USFWS, All cooperating agencies.

STRATEGY D-2: Assess fall productivity survey index

Rationale: Productivity surveys are necessary for continued development of population models and as an indicator of relative annual reproductive performance of the EP. Indices to productivity are derived from counts of gray-plumaged young and white-plumaged adults and sub-adults observed in flocks and from the number of young observed in family groups during fall and early winter. These productivity estimates are obtained from ground observations in New Jersey, Maryland, Virginia, and North Carolina. Production estimates are based on counts taken at the same locations each year, but the sampling effort has not been comparable among years. Since the counts are made during November and December after most swan hunting is over in the Central Flyway, they provide a minimal estimate of young produced. Also, observations have not been allocated properly among wetland and upland habitats based on the composition of age classes present at these sites. Thus, Standard Operating Procedures (SOP) for this survey need to be reviewed and changed to improve the accuracy and precision of these productivity data.

Age-ratios can be obtained through state harvest surveys, but these are not adjusted for age-related vulnerability to hunting, and are representative only of birds using the hunted areas. Productivity surveys will also be useful in continued development of population models and as an indicator of relative annual reproductive performance of the EP.

Recommendation 1: Assess the relationship between harvest age ratios and the fall productivity surveys.

Responsibilities: All harvest states, USFWS

Recommendation 2: Revise the Productivity SOP to improve the accuracy and precision of parameter estimates. This revision should include an examination of the allocation of observer effort across habitats.

Responsibilities: Atlantic Flyway Council (AFC), USFWS

Recommendation 3: Continue the productivity surveys to provide an index to annual recruitment.

Responsibilities: Atlantic Flyway Council (AFC), USFWS.

STRATEGY D-3: Assess current wintering distribution of eastern tundra swans.

Rationale: Recent MWS trends indicate an increasing wintering population of EP tundra swans in the lower Great Lakes and other areas outside of the AF. In addition, some movement of swans (>1,000) outside of the MWS survey units has been noted in recent years in North

Carolina. This possible re-distribution of swans poses a challenge to the current understanding of the wintering ecology of this species and presents a potential problem for accurately assessing annual abundance in relation to the current population objective as set forth in this plan.

Recommendation 1: Assess the extent of redistribution of wintering swans into the Great Lakes and in areas outside of the current MWS survey units in the Atlantic Flyway. Describe potential causes of redistribution and evaluate ecological and social implications. Consider modifications to MWS survey coverage and implementation of supplemental surveys.

Responsibilities: All cooperating agencies.

STRATEGY D-4: Develop feasibility study of conducting breeding ground survey.

Rationale: Due to the inherent problems associated with mid-winter counts, most hunted migratory waterfowl species are indexed through operational breeding population surveys. The current questions regarding wintering distribution and the accuracy of the current MWS for EP tundra swans exemplify the difficulties in using a winter count as a metric for population goals and harvest strategies. Establishment of population surveys across the EP swan breeding range could provide status and trend information to evaluate or eventually replace midwinter indices that are used to manage the population. In addition, breeding densities and productivity differ substantially among primary nesting areas because of demographic, ecological, and phenological factors. Knowledge of regional productivity would be very informative in understanding changes in abundance and productivity of the entire population.

Recommendation 1: Evaluate the feasibility of a breeding ground survey that would provide a management index for the primary range in Canada.

Responsibilities: USFWS (Tim Moser), CWS (Dale Caswell).

Recommendation 2: Continue and improve the Arctic Coastal Plain survey in Alaska as a measure of abundance and trends in the Alaska portion of the EP swan breeding range.

Responsibilities: USFWS

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APPENDIX A

DISTRIBUTION AND POPULATION DELINEATION

Neck-collar marking studies by W.J.L. Sladen in the early 1970's (Limpert et al. 1991) first suggested that the westernmost extent of the EP and an interface with the WP occurred in the Kotzebue Sound region of Alaska. However, collar marker and radio telemetry work by Spindler and Hall (1991) substantiated that most swans from Kotzebue Sound migrate through interior Alaska and winter in California. Although there are a few records of range overlap by marked EP and WP swans, and even swans that changed flyways, Point Hope is a practical demarcation line between the populations (Limpert et al. 1991).

The delineation of the EP and WP tundra swans (Figure 1) is based upon over 5,000 band recoveries from over 11,000 swans that were banded at breeding, migration, and wintering areas during 1924-92. While the range-wide bandings are not representative, band recoveries were sufficient to show differences between birds breeding on the North Slope and eastwards throughout Canada (EP oriented) from those breeding in the Kotzebue Sound area and southwards through western Alaska (WP oriented). Observations of breeding ground neck-banded and tarsus-banded tundra swans by Limpert et al. (1991) show similar delineation of WP and EP on their wintering areas. Recent satellite telemetry of wintering EP tundra swans and recoveries of Atlantic Flyway winter-banded swans reinforces the delineation of the 2 populations in Alaska.

There appears to be no identifiable sub-populations of EP tundra swans based on either exclusive use of migratory pathways, wintering grounds, or breeding grounds (K. Wilkins, U.S. Fish & Wildlife Service, unpublished data). Although wintering grounds movements suggest that swans were more likely to stay in the same region than to move, movement rates between regions were still large enough to cause significant mixing of the population within and between years (K. Wilkins, U.S. Fish & Wildlife Service, unpublished data).

Breeding

EP tundra swans nest largely in the Northwest Territories (NWT), with smaller numbers breeding in Alaska, Manitoba, Ontario, Nunavut, and northern Quebec. In the NWT and Nunavut, concentrations totaling 11,000 to 15,000 swans are known to occur in several areas of the western arctic, from the Mackenzie Delta east to the Parry Peninsula and peaking on the Tuktoyaktuk Peninsula at between 5,500 and 12,000 birds (Hines and Westover 1991, Hines et al. 2006), in the Rasmussen Lowlands (about 6,000 in the mid-1970s, McLaren and McLaren, 1984), and on the Kent Peninsula (>1,800, Bromley and Stenhouse 1993). Extensive areas of moderate density occur north of Coppermine, on southern Victoria and King William Islands and at the mouth of the Tingmeak River in Queen Maud Migratory Bird Sanctuary (Bromley and Stenhouse 1993), and low densities occur west of Hudson Bay (Allen and Hogg 1978). Small numbers occur throughout most of the tundra areas above the tree line and along the southern parts of islands in the Arctic Archipelago (e.g. Banks, Royal Geographic Society, and Baffin islands) in the NWT, in northern Yukon (Hines and Westover 1991), along west Hudson Bay in Manitoba and Ontario (Godfrey 1986) and in northern Quebec (Heyland et al. 1970).

In Alaska, EP tundra swans breed primarily in the Arctic Coastal Plain north of the Brooks Range (North Slope). This region is characterized by wet tundra overlying well-developed permafrost features in fine marine sediments. The central and western parts of the region have numerous basin complexes of thermokarst ponds and lakes with emergent beds. Areas with a combination of large shallow lakes and halophytic ponds with Pendant Grass (*Arctophila fulva*) are preferred for nesting and feeding (Derksen et al. 1981 Stickney et al. 2002, Earnst and Rothe 2003). Shallow channels in coastal river deltas contain beds of pondweed (*Potamogeton sp.*) that provide important food resources during late summer and just prior to fall migration when lakes freeze.

Highest swan densities are found near the central Beaufort Sea coast, in the Teshekpuk Lake area, and Colville River Delta (Derksen et al. 1981; USFWS unpubl. data; Figure A-1), as well as parts of the Arctic National Wildlife Refuge (Platte and Brackney 1987). Systematic aerial surveys of the Arctic Coastal Plain in Alaska conducted since 1986 indicated an average of nearly 10,000 swans (range 6,200-17,200). This constitutes approximately 8-10% of the Eastern Population (Mallek et al. 2006).

Migration

Migration for EP tundra swans is an important facet of the life cycle. Recent satellite telemetry projects (Petrie and Wilcox 2003, Wilkins 2006) indicate that EP tundra swans spend between 79-106 days on the spring migration and 73-84 days completing the fall migration. This migration between the breeding grounds and the wintering grounds composes over half of the life cycle of EP tundra swans. Spring migration is the most important migratory period for EP tundra swans. The breeding physiology of EP tundra swans necessitates that they acquire and carry the endogenous resources needed for egg production with them to the breeding grounds. The extended length of the spring migration relative to the time span of the fall migration may illustrate this need to acquire resources prior to nest initiation.

Timing of spring migration varies (Petrie and Wilcox 2003, Wilkins 2006). The earliest spring migrant (n = 67) was 1 February, and the latest was 28 March. Most birds, however, had left Atlantic coast wintering areas by the second week of March (Wilkins 2006). Bellrose (1976) previously identified the west end of Lake Erie, Saginaw Bay, and lakes in portions of west-central Michigan, Wisconsin, and North Dakota as intermediate resting areas for breeding ground bound EP tundra swans. The Lake Athabasca delta was also identified as one of the major western concentration area for EP swans prior to their final move to the Mackenzie and Anderson River deltas and other specific breeding areas. Contemporary satellite telemetry has re-confirmed these areas as integral to migrating EP tundra swans and identified several other key spring staging areas (Figure A-2). The use of satellite telemetry has also enabled the identification of several important migration corridors for EP tundra swans.

Spring staging areas used by EP tundra swans can be broken down into 4 regions; Atlantic coast, Great Lakes, northern prairies, and boreal forest. Birds wintering in North Carolina, Maryland, and Virginia tended to move into the upper Atlantic coast states prior to moving into the lower Great Lakes. Birds made 1-3 stops, using Chesapeake and Delaware Bays and the lower Susquehanna River (Petrie and Wilcox 2003) on their way to the lower Great Lakes. Important areas (Wilkins 2006) used by swans included the Ontario Peninsula (Long Point, Lake St Clair, Aylmer WMA). Saginaw Bay and marshes on the eastern shores of Lake Michigan and Green Bay Wisconsin were also important staging areas for swans in the lower Great Lakes. Horicon Marsh was also an important area for swans on their initial migration leg. The upper pools (4-8) of the Mississippi River also receive significant use by spring migrating EP tundra swans. While in the lower Great Lakes, birds used 3-6 different sites (Petrie and Wilcox 2003). Swans spent between 15-30 days staging in the lower Great Lakes before heading in late March and April into the northern prairies of western Minnesota, North Dakota, Manitoba, and Saskatchewan.

Important staging areas in the northern prairies identified through satellite telemetry were the Souris River, Cedar Lake in Manitoba, the Red River Valley, and the North and South Saskatchewan Rivers. While in the northern prairies, swans used 2-6 different sites and spent between 25-45 days in the northern prairies before moving north into the boreal forest. Birds leave the prairies mid April, with all moving into the boreal forest by mid May (Wilkins 2006). From the prairies, the final movements of birds to respective breeding areas varied, but generally followed 3 distinct paths, all through the northern boreal forests of Manitoba, Saskatchewan, Northwest Territories, Nunavut, and Alberta. Swans heading for the North Slope of Alaska or the Mackenzie/Anderson River Delta, tended to stage in the Peace-Athabasca Delta prior to moving to breeding areas. Birds heading into the central Canadian arctic also used the Peace-Athabasca Delta as a final stop before moving to the breeding grounds. Swans nesting on the western side of Hudson Bay and eastern Nunavut used the Churchill and Hayes Rivers extensively. Birds spent relatively less time in the northern boreal forest than in any other region during spring migration (~14 days).

Satellite telemetry also confirmed previous information on the fall migration of EP tundra swans (Figure A-3). The inner delta of the Mackenzie River is the staging area for Alaskan and western Canadian EP tundra swans during the fall migrations. From this point, the birds move to the Athabasca Lake delta in northern Saskatchewan and Alberta where they may associate with perhaps half of all WP tundra swans CITE. There is limited interchange of WP tundra swans from all breeding areas to Atlantic Coast wintering areas. Jensen (1971) reported swans switching wintering areas, e.g., 3 of 14 swans banded in Utah were subsequently recovered in the Atlantic Flyway. Limpert et al. (1991) reported that only 11 individuals (<1%) of 4,194 EP swans marked on the wintering grounds were later recovered in the WP. Another important area in the boreal forest for swans leaving the breeding grounds is Great Slave Lake. Birds spent between 32-49 days in the northern boreal forest on the return to wintering areas. Spring migration stopover areas were similar to those utilized in the fall. The duration of EP tundra swans residency in the prairies during the fall, however, was less than in the spring. Swans spent 2-3 weeks at most in the northern prairies before heading to the lower Great Lakes and upper Mississippi River. Sago pondweed (Earnst, 1994) and wild celery (*Vallisneria americana*) have been identified as important food plants at most of the major migration stops. Waste grains on the prairies are also extremely important to migrating EP tundra swans.

It seems that EP tundra swans spent more time using southerly staging areas in the spring than in the fall. Conversely, northerly staging areas in the boreal forest were utilized more heavily on the fall migration than in the spring. This pattern coincides with the physiological needs of the birds at each time in the annual cycle, and is important for conservation of these habitats. In the spring, swans need to acquire and store the necessary reserves for breeding. Northern habitats are either frozen or have few available resources in the late winter, early spring. Swan use of waste grain in the northern prairies is essential for weight gain, and thus, birds tend to spend more time using these resources in the spring than in the fall. Fall migration occurs at a time when northern wetlands in the boreal forest have abundant forage, and fall migration also occurs at the time when juvenile birds likely do not have the ability for long, sustained migration flights (Petrie and Wilcox 2003).

Wintering

Tundra swans winter in each of the 3 eastern flyways. However, the Atlantic Flyway is the primary wintering area for this population. The distribution of EP swans wintering in the Atlantic Flyway has changed (Figure A-4) since 1970. The number of swans wintering in the vicinity of Chesapeake Bay, Maryland has declined while the number wintering further south along coastal North Carolina has increased steadily. During 2002-06, an average of 67% of EP swans wintered in North Carolina, while 15% wintered in Maryland, and 7% in Virginia (Figure A-4). An increasing trend in numbers of swans observed in the Mississippi Flyway mid-winter survey has been noted in recent years. During the latest 5-year period, an average of 9% of EP swans have been observed in this region during the early January time period.

Movements of satellite marked birds indicate that EP swans arrive on primary wintering grounds in the AF in a very staggered fashion (K. Wilkins, U.S. Fish & Wildlife Service, unpublished data). No swans arrived prior to mid-October and all swans that moved to the mid-Atlantic coast arrived by late January. Swan movement back north to the Great Lakes region occurred as early as the 1st 2 weeks of February; however, some swans remained on the mid-Atlantic coast into late March. The most important regions in the EP wintering range in the AF include: 1) the lower Susquehanna River in Pennsylvania, 2) Chesapeake and Delaware Bays and their tributaries in Delaware, Maryland, New Jersey, and Virginia, 3) Back Bay and Currituck Sound in Virginia and North Carolina, and 4) areas adjacent to Albemarle and Pamlico Sounds in northeastern North Carolina (Figure A-5). Over half of the EP winters in the latter area, which encompasses Pea Island National Wildlife Refuge, and Pungo, Phelps, and Mattamuskeet Lakes.

Wintering EP tundra swans traditionally depended on wetland habitats with abundant submerged aquatic vegetation (SAV). Due to degraded water quality, many of these areas no longer provide this food resource CITE. In some coastal areas, swans have broadened their diet to include more invertebrate foods such as clams, while in other areas man-made impoundments provide a diversity of food resources. During the winter of 1969-70, weather conditions prevented swan access to submerged foods (e.g., SAV and clams) in coastal areas and feeding in agricultural fields was first observed (Munro, 1981). Since that time, field feeding by swans has become commonplace, with winter wheat, barley, corn and soybean stubble most frequently used. This shift to agricultural foods has fostered an expansion of their wintering range, and has caused some conflicts with agricultural producers. Swan damage to small grain sprouts from both foraging and trampling occurs during prolonged wet weather periods. However, damage reports have diminished in areas that have been open to hunting.

APPENDIX B

CURRENT DATA BASES

Population Status

Currently, there are no range-wide breeding ground indices for EP swans, but aerial surveys of Alaska's Arctic Coastal Plain (Mallek et al. 2006) provide abundance and trend information for that portion of the population (Table B-1, Figure B-1). Figure B-2 indicates a modest increasing trend in total swans over the past 20 years. Surveys conducted near the Prudhoe Bay and Kuparuk Oilfields on the central coast indicate stable to increasing numbers of swans during 1989-2000 (Ritchie et al. 2002).

Presently, EP tundra swans comprise nearly 55% of the total estimated number of tundra swans in North America. Indices derived from the January MWS show that EP tundra swans have increased about 57% between periods 1955-57 and 2004-06, and currently, they are estimated to number about 90,000 birds (avg. pop. = 88,177 during 2004-06). Over the long-term, there has been a significant ($r^2 = 0.884$, $P < 0.001$) upward trend in winter counts (Figure 3). Since 1997 the population index has been stable, fluctuating between 88 and 112 thousand birds.

Production

Since 1961, productivity has been estimated by standardized surveys conducted each November and December, on wintering areas in Maryland, Virginia, North Carolina, and New Jersey (Serie and Bartonek, 1991a, Serie et al. 2002). Spring weather on the breeding grounds is the major factor affecting production, although predation of eggs and cygnets may be a factor in some local areas. Table B-2 shows percentages of cygnets and young/family in the wintering population. The percentage of immature swans observed in the surveys has remained relatively stable over time ($r^2 = 0.024$, $P = 0.306$; Figure B-3).

Mortality

Reported causes of mortality among EP tundra swans include hunting, disease (including lead poisoning), predation, collision, and drowning (Bartonek et al. 1991). Because all causes of mortality may not be reported and known causes likely are not reported at the same rate, assessment of their relative importance is difficult. Among all mortality factors, hunting is probably most significant. About 3,500 EP swans are killed annually during regulated fall and winter hunting seasons (Tables 1 and 2), and an unknown number of EP and WP swans (<5,000 combined total) are taken during regulated and unregulated subsistence hunting. Among non-hunting mortality factors, lead poisoning may be the most important. An estimated 7,200 swans died over 5 winters at Lake Mattamuskeet in North Carolina between 1972 and 1976 (Blus 1994).

Bart et al. (1991) estimated survivorship of hatching-year tundra swans using adult/immature counts of birds across the EP range. Survival during the first migration averaged 52% and over the first winter averaged 76%. Nichols et al. (1992) estimated survival of tundra swans in Maryland and North Carolina in the 1970's, using observations of neck-banded birds. They estimated survival rates of adult male and female swans to be high (0.92). Estimates of survival of immature males were lower (0.81) and immature females the lowest (0.52). Recently, Wilkins (2006) calculated survival estimates of adult and immature swans using several different marking and analytical methods. Survival rates for adult swans ranged from 0.66 – 0.84 but were generally lower than those estimated by Nichols et al. (1992); however, direct comparison is not possible due to differences in estimation techniques. Wilkins (2006) estimated juvenile survival rates of 0.84-0.88.

APPENDIX C

EP TUNDRA SWAN HARVEST STRATEGY

Introduction

The purpose of this strategy is to establish guidelines for the cooperative harvest management of EP tundra swans. Because breeding and wintering areas for this population transcend vast geographic regions of North America and migration corridors intersect all flyways, this plan serves to coordinate the harvest among flyways and by regions within the United States. Although Canada does not currently allow a recreational harvest, this plan makes provision for such a program should a harvest in Canada be considered. The process for administration and management of any such harvest in Canada has not been considered in this plan.

This harvest strategy is consistent with the public use objectives identified above and is designed to meet the population goal of 80,000 birds based on a 3-year average population index from the Midwinter Waterfowl Survey (MWS). This goal was set to maintain the population of tundra swans to provide sufficient numbers to fulfill the needs of all resource users, and to minimize conflict with other resource and economic values. In order to maintain population and distribution goals stated in this Management Plan, this Harvest Strategy is scheduled for review at least every 5 years.

Harvest Objective

The original Hunt Plan, approved July 1988, set a harvest rate objective of 10 percent based on the 3-year Atlantic Flyway MWS average for 1985-87 (93,200). This objective was believed to be reasonable based on rapid population growth that exceeded objectives, sustainable harvest rates in existing WP hunt programs, an assumed 20 percent wounding loss rate, and subsistence harvest less than 5 percent of the population estimate.

The achieved permit hunt harvest rate on EP swans has averaged 3.76% ± 0.31 of the mean AF-MF MWS index since the inception of regulated sport harvest in 1983, and for the last 3 seasons (2003-05) was estimated to be 3.74% of 99,635 swans (Table C-1). Recent modeling efforts incorporating existing, operational survey data (Wilkins unpubl. data) indicate that current harvest levels may result in a 3% annual decline in the population. These modeling efforts, however, are preliminary, and much uncertainty exists in the model.

Since 1986, there is no relationship between harvest rate and the change in MWS from the previous year ($r = 0.14$, $P = 0.51$). Only the harvest from the 5 hunt states is known. Subsistence harvest and other sources of mortality are not adequately estimated at this time. Currently recreational and Alaskan subsistence harvest is regulated. Since population and distribution guidelines are being met, this plan recommends that the level of recreational harvest remain at or below 5 percent during the next 5-year period.

States having EP swan seasons should avoid harvest of trumpeter swans (*Cygnus buccinator*) by temporal and/or spatial considerations wherever possible. However, EP tundra swan seasons should not be precluded by the possibility of an occasional trumpeter swan being shot. This policy is consistent with the Interior Population Trumpeter Swan Management Plan, Western Population Tundra Swan Plan, Rocky Mountain Trumpeter Swan Plan, and has been endorsed by the Trumpeter Swan Society, the Central Flyway Council, and the Pacific Flyway Council.

Permit System

A special permit system will continue to be used for the sport harvest of EP tundra swans in the United States. Each permit allows the taking of one swan. A 37% success rate was realized for permits issued for the last 3 seasons (2003-2005). For simplicity and in order to prevent a significant increase in harvest, this harvest strategy will continue to assume a harvest of one swan for every 2 permits issued (50% success rate). The system assumes that only one permit is issued per hunter per state per season. Should all permits for a given hunt year not be issued, states will be allowed to issue up to 2 permits per hunter. The USFWS has approved issuing more than one permit per hunter in recognition that harvest rates are controlled by the total number of permits, and South Dakota has done that in recent years. No significant increase in harvest or success rate would be expected due to the issuing of multiple permits (likely to successful hunters). Recently, only South Dakota and Montana have had left over permits and in both states success rates are well below 50%.

A permit with either an accompanying hunter-questionnaire response card and approved tag or some other method of validating the harvest, acceptable to the USFWS, must be used. The permittee must sign the permit to validate it and must have the permit in personal possession while swan hunting. Immediately upon harvesting a swan, the bird must be tagged and the date of harvest recorded.

Permit Distribution

In the 1988 Sport Hunting Plan, an effort was made to distribute hunting opportunities equitably, by regional zones, in both Canada and the United States. A formula for permit allocation was developed which gave equal consideration to all areas of North America frequented by EP swans.

The nominal harvest distribution for the entire population was as follows:

Production Zone **-** 33% (3% Alaska [Game Management Units 23 and 26], 2% Yukon, and 28% NWT)

Migration Zone **-** 33% (11% Saskatchewan, Manitoba, and Ontario, 11% Central Flyway states, and 11% Mississippi Flyway)

Wintering Zone **-** 34% (Atlantic Flyway)

Since the inception of recreational hunting seasons on EP tundra swans, the following adjustments in permit allocation have occurred (Table C-2). The present permit distribution among zones varies from the original permit allocation formula (33,33,34) because some jurisdictions have chosen not to allow a hunt. To date, state requests for permits have not exceeded the number available; thus, in the absence of conflicts, the current distribution will remain for the period of the plan. Distribution will be reconsidered if new season requests are approved by the Flyway Councils. Currently the following EP swan seasons have been authorized with assigned permit quotas:

Zone	*State*	*Permits Assigned*
Production	None	None
Migration	Montana*	500
	North Dakota**	2,000
	South Dakota**	1,500
	Subtotal	4,000
Wintering	North Carolina	5,000
	Virginia	600
	New Jersey	0
	Subtotal	5,000
Total		9,600

*Central Flyway portion

**South Dakota has loaned 200 permits to North Dakota

This permit allocation distribution is 42% Migration Zone and 58% Wintering Zone. No permits are currently allocated to the Production Zone.

<u>Redistribution of existing permits to existing hunt states:</u>

A state may routinely have insufficient applicants to issue all available permits. As outlined above, available permits could first be distributed within that state, up to a total of 2 permits per eligible hunter. Should permits still remain unused, any portion of these unused permits would be available for temporary redistribution to participating provinces, territories, and states requesting them. The first step in the re-allocation process should be within the respective flyway. If there are no unassigned permits available in the Flyway, the next step should be to request permits from within the zone. The final step should be to request permits from the other zones. Re-allocated permits would return to the area of origin if provinces or states within the area of origin authorize a new tundra swan season or if the state that loaned the permits requests them back.

Permit distribution (including redistribution) within a Flyway should first be approved by the respective Flyway Council. Distribution of permits within a zone, which includes more than one Flyway (production, migration), or between zones should be approved by the affected Flyway

Councils. The Ad Hoc EP Tundra Swan Committee (Committee), responsible for updating the management and hunt plans, would be a good forum for originating and reviewing such proposals. In the United States, recommendations on permit actions from the Flyway Councils must also be approved by the USFWS following normal regulatory procedure. Councils should make their recommendations to the USFWS following their March meeting but no later than June 1 in order for the USFWS to evaluate and propose permit allocation during the late-season regulation process.

New Hunt States:

A one-year lead time is required for new season requests. Criteria for allocation of new permit hunts will be that the permit request cannot exceed an estimated 5% harvest rate of the most recent 3-year average of peak seasonal numbers in the new hunt location. Unless thresholds (see section below) are exceeded prior to the next harvest strategy revision, it is agreed that the current permit quota (9,600) is the maximum number of permits to be issued. Agencies within a hunt zone should re-allocate existing permits to facilitate a new hunt within that respective zone. If that is not amenable, then permit allocation for new hunts will come from a pool of 'borrowed' permits taken from all hunt zones. Permit allocation to new hunts will then come from that pool of 'borrowed' permits commensurate with the existing allocation among hunt zones. For example, the migration zone currently holds 42% of the permits while 58% are held by the wintering zone. If a new hunt state requests 500 permits, 42% (~200 permits) will be reallocated from migration hunt states, while 58% (~300 permits) will be reallocated from wintering hunt states. Requests to Flyway Councils need to be made in July the year prior to initiation of a new season.

All new seasons will be considered experimental for a 3-year period following their initiation. The results of operational and experimental hunting seasons will be monitored annually by each state by means of a special swan harvest survey. Annual reports for experimental hunts should include a summary of how hunts were administered, number of applications and permits issued, hunter participation rate, reporting rate, retrieved and un-retrieved harvest, and age ratio in the harvest. Population status will be measured by the January MWS in both the AF and MF and the results compared to objectives in the EP Tundra Swan Management Plan. Adjustments in experimental seasons or closures will be considered annually during the process of establishing migratory bird hunting regulations. Evaluation procedures will be in accordance with a Memorandum of Agreement between each state and the USFWS.

Harvest Management Thresholds in Relation to Permit Numbers:

The following thresholds will be used for the issuance of EP tundra swan hunting permits:

- At a 3-year MWS average at or below 40k, the EP tundra swan season will be closed and remain closed until the 3-year MWS average reaches 70k.
- When the 3-year MWS average falls below 70k, there will be a permit reduction of 25%, to remain until the 3-year MWS average is at or above 80K.
- When the 3-year MWS average is at or above 80k, permit allocation will be 9,600.

- When the 3-year MWS average is above 100k, the number of permits issued will increase 25%.

Figure C-1 indicates what the total hunt permit allocations would have been under this system since the inception of EP tundra swan hunting in 1989.

In the event of a need for permit reduction, permit reduction should be commensurate with the current permit allocation by hunt zone. Similarly, if permit increases are called for, allocation will be commensurate with the current hunt zone allocations.

Permits may be used by youth hunters during specific youth waterfowl hunt days provided the individuals are in possession of a valid permit/tag. This will pertain to all youth waterfowl hunting days, inside or outside the current framework.

Evaluation Procedure For All New Swan Seasons:

1) States will develop, print, and distribute permits to hunters wishing to participate in the season. The State will serially number or otherwise identify the permits and develop a list of the names and addresses of the permittees.

2) The State will provide each permittee with a swan harvest questionnaire to assess: (a) number of days hunted for swans, (b) if a swan was harvested, (c) location of harvest, (d) whether the head and neck plumage was white or gray colored, and (e) how many swans were downed but not retrieved. The permit will also request leg-band numbers and recovery information of harvested swans.

A follow-up survey (mail questionnaire or telephone) will be conducted if the response rate to the initial survey is below 75%. The State will summarize these findings in an annual report to the USFWS by the following June 1.

APPENDIX D

FIGURES AND TABLES

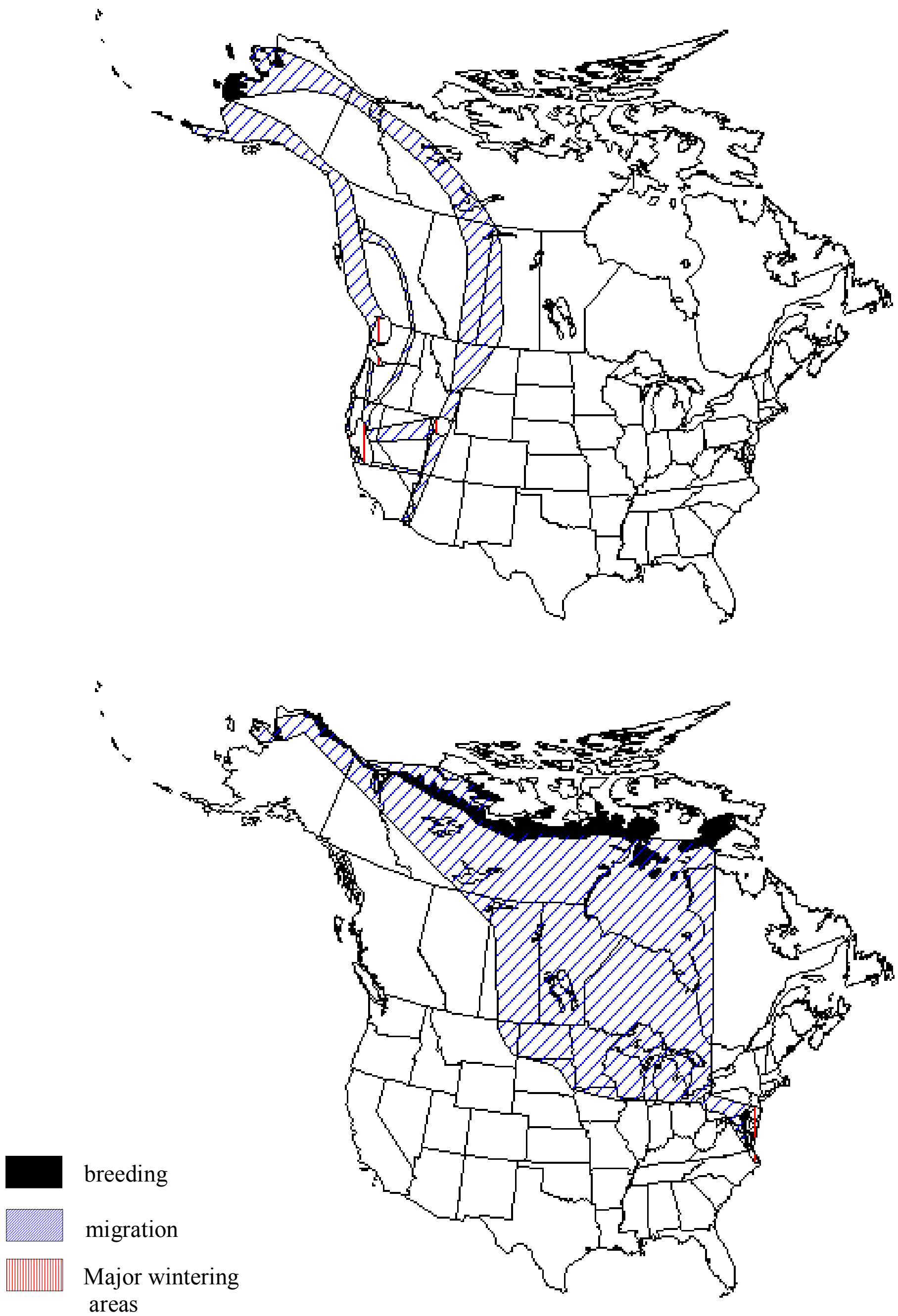
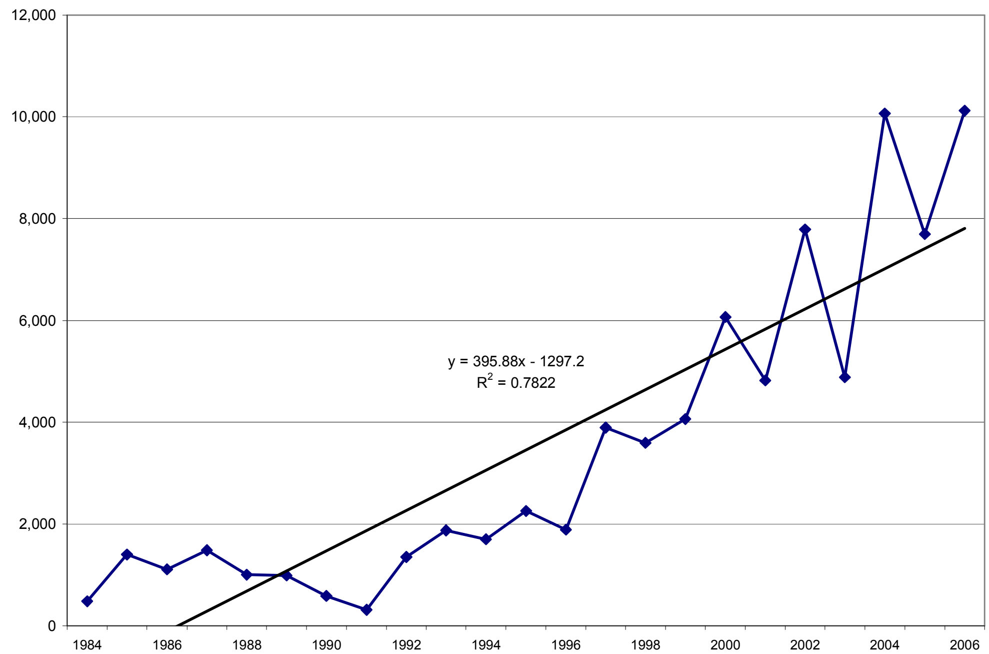


Figure 1. Range of Western (above) and Eastern Populations of Tundra Swans.



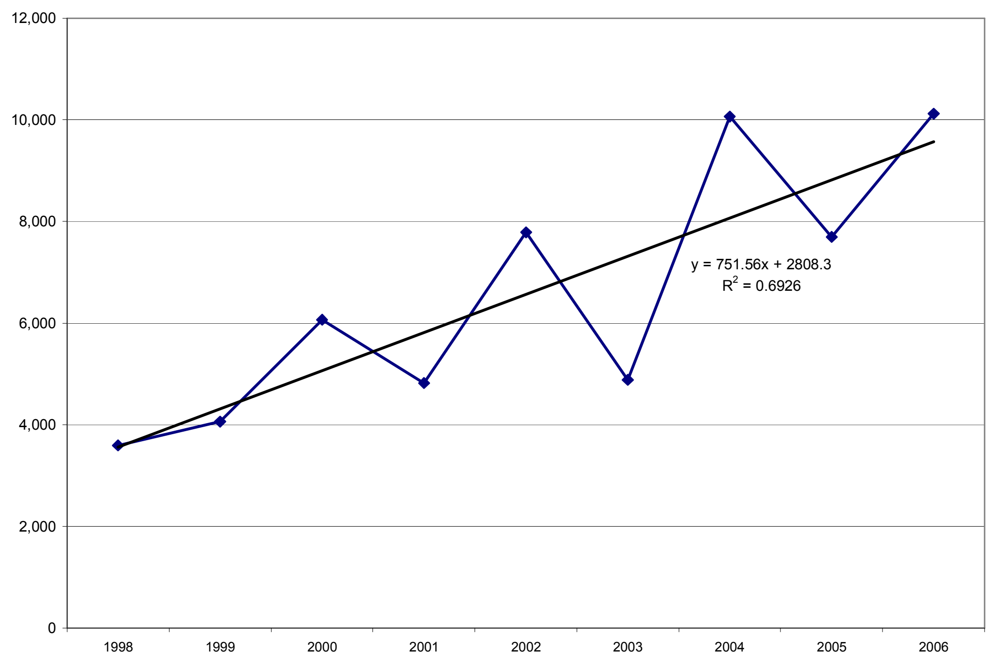


Figure 2. Trends in the 3-year average of tundra swans observed in the Mississippi Flyway (above) since 1982 and (below) since the approval of the 1998 EP Tundra Swan Management Plan.

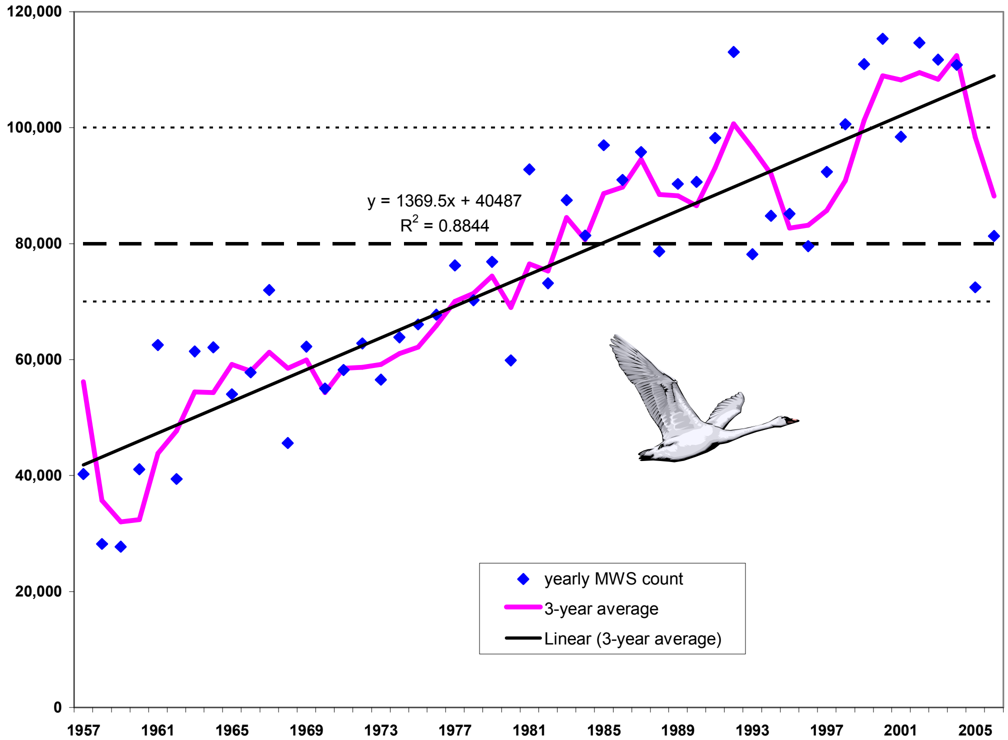


Figure 3. Eastern population tundra swan population trends as measured by the Atlantic and Mississippi flyway midwinter waterfowl survey, 1957-2006.

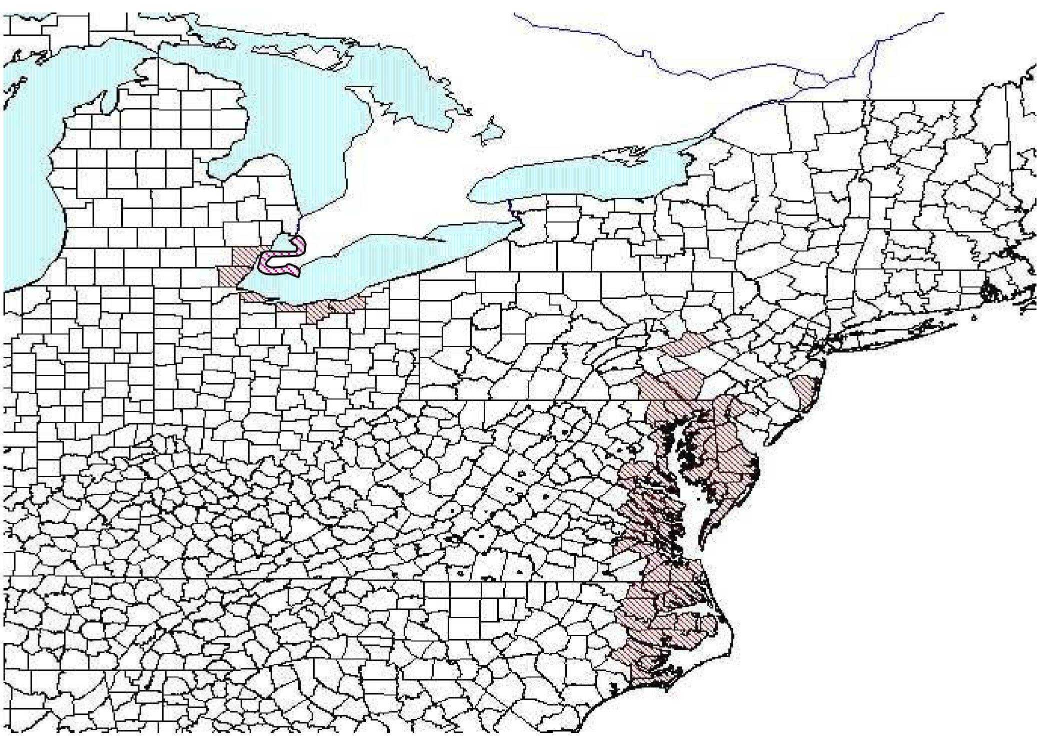


Figure 4. Wintering distribution of Eastern tundra swans.

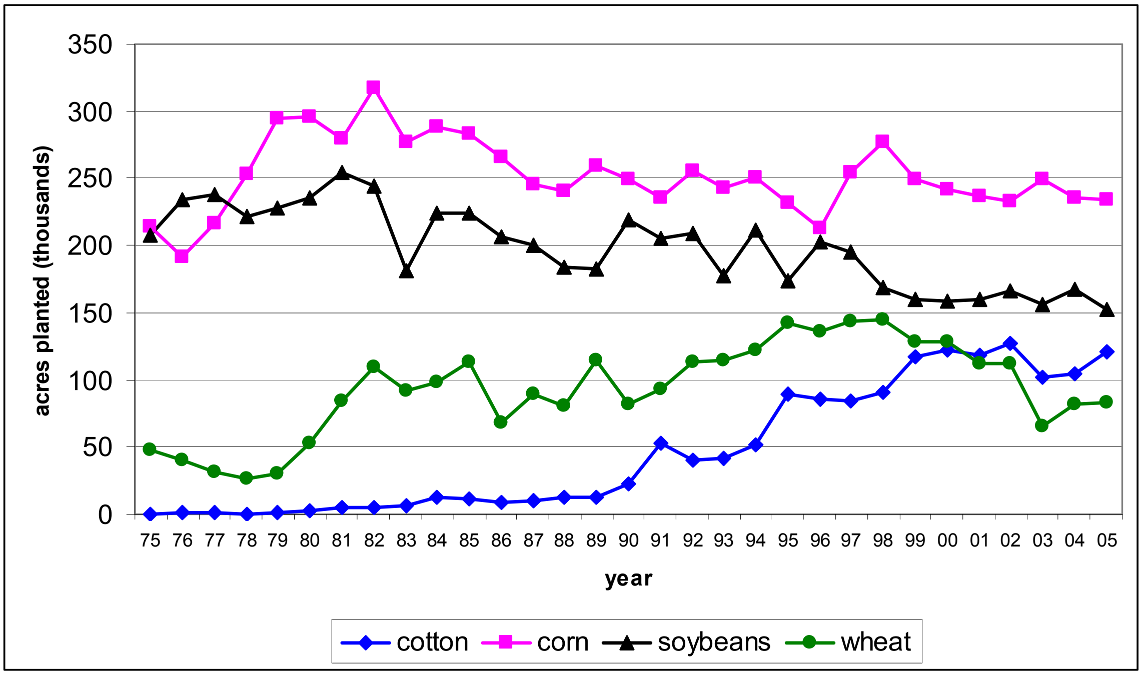


Figure 5. Trends of the four major planted crops within the primary wintering range in northeastern North Carolina (1975-2005).

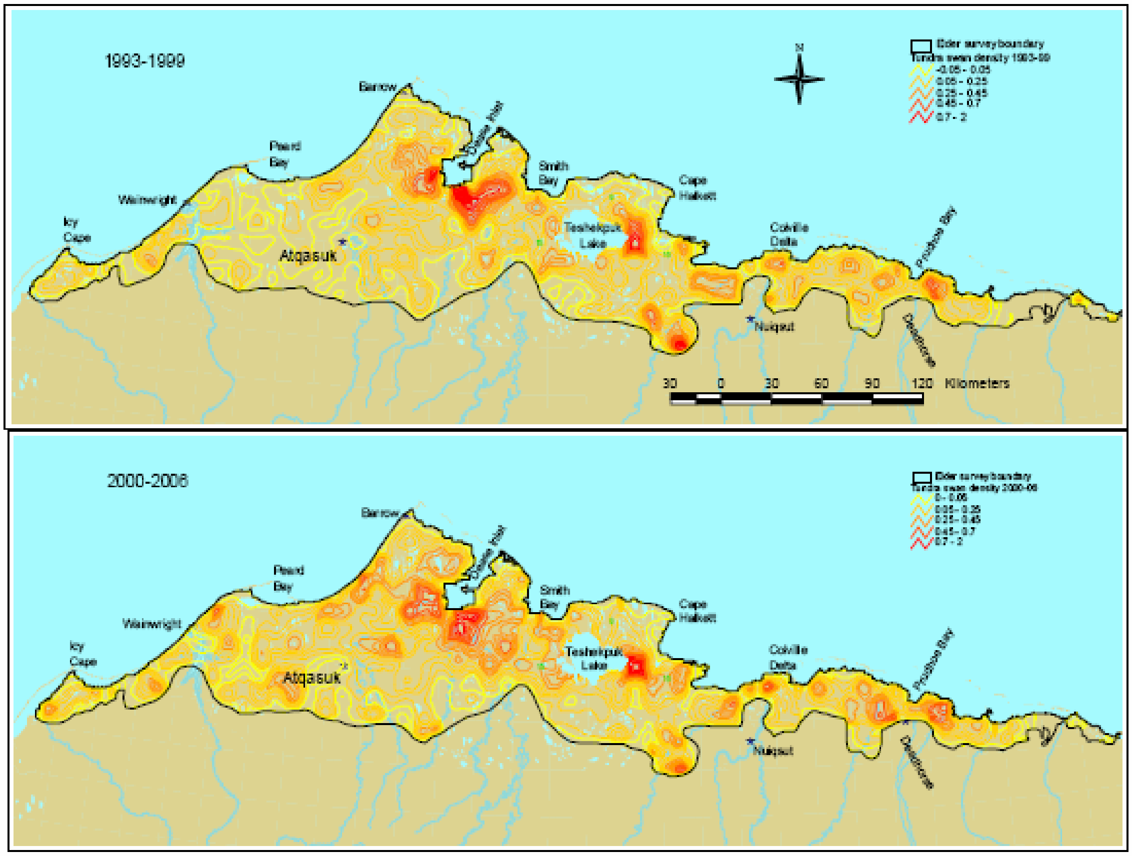


Figure A-1. Mean tundra swan breeding densities, Alaska Arctic Coastal Plain, 1993-99 (above) and 2000-06 (below).

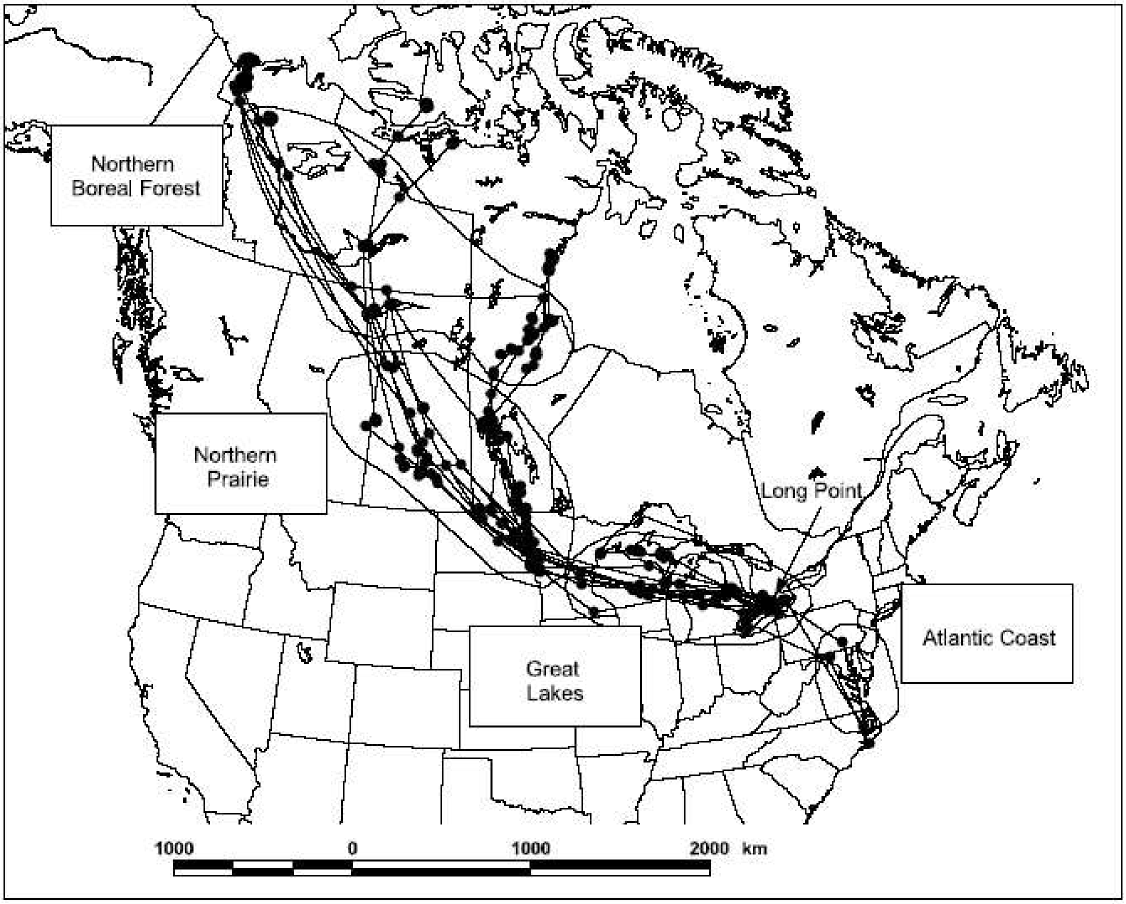


Figure A-2. Spring movement patterns and key migratory stopovers of satellite marked EP tundra swans (From Petrie and Wilcox 2003).

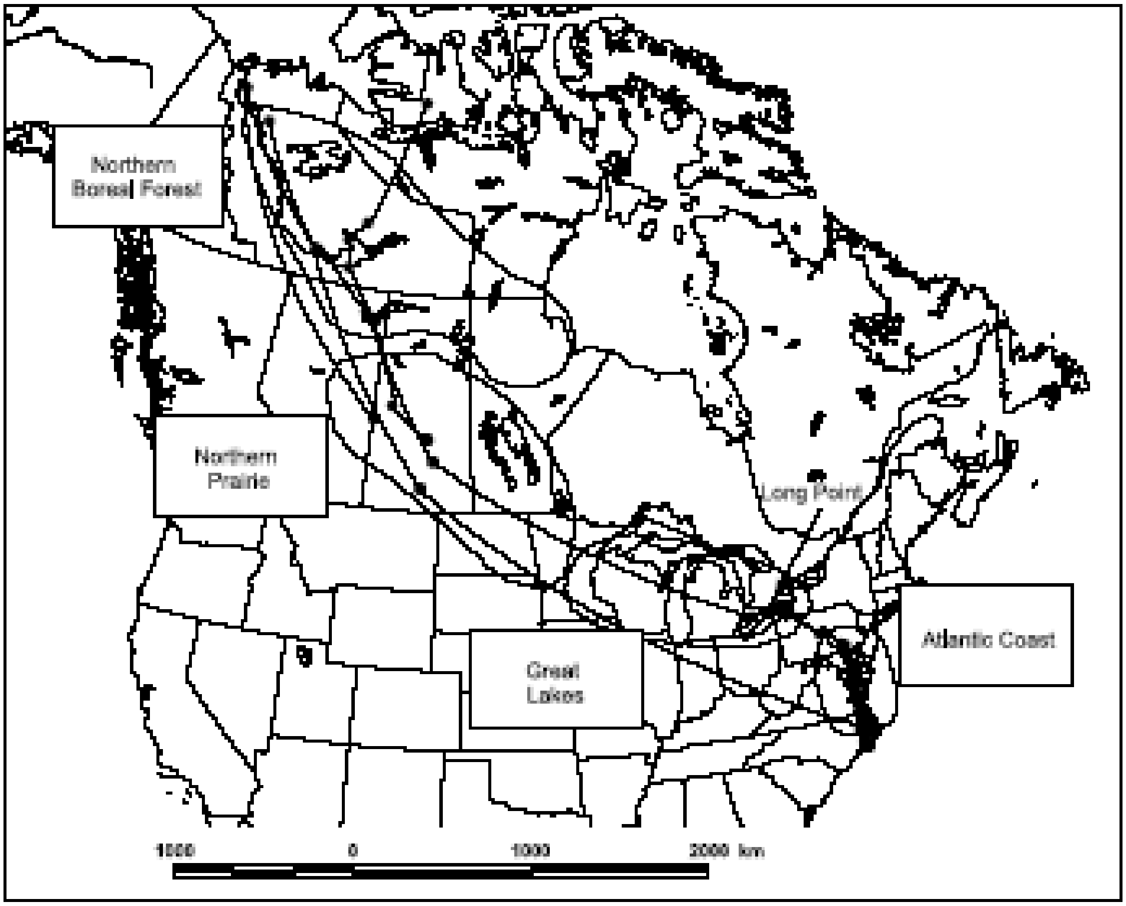


Figure A-3. Fall movement patterns and key migratory stopovers of satellite marked EP tundra swans (From Petrie and Wilcox 2003).

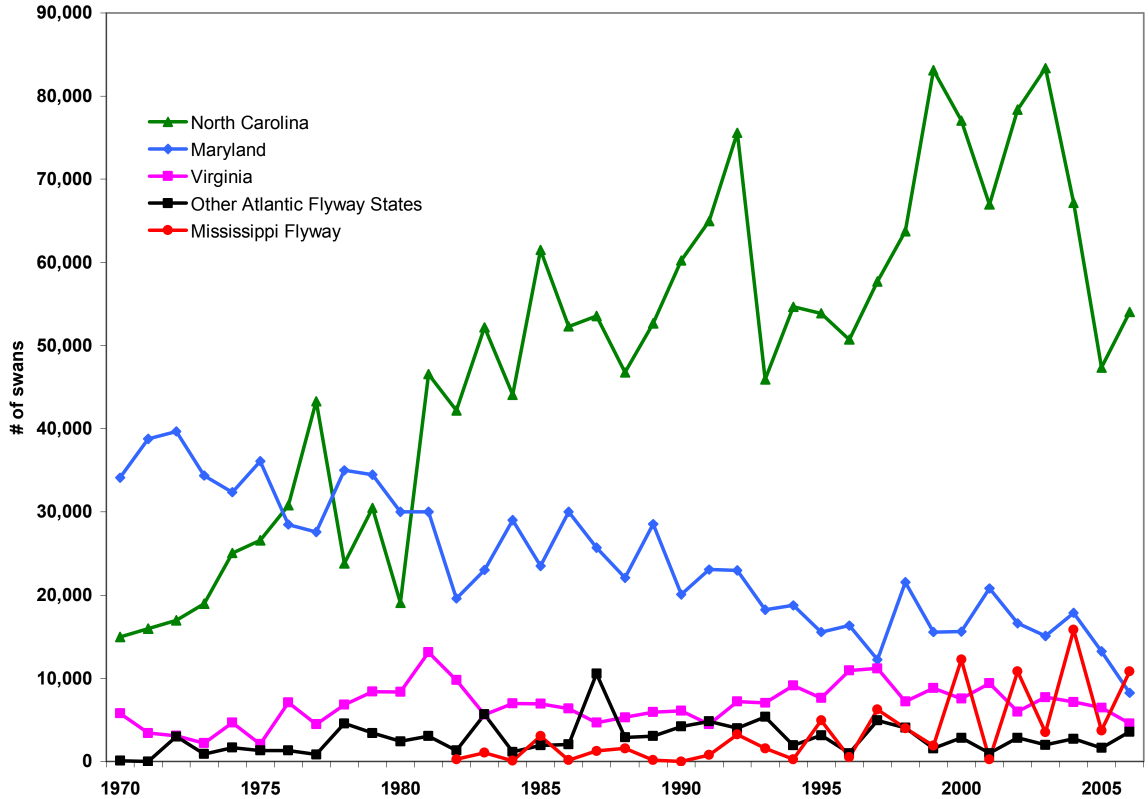


Figure A-4. Wintering distribution of EP tundra swans 1970-2006.

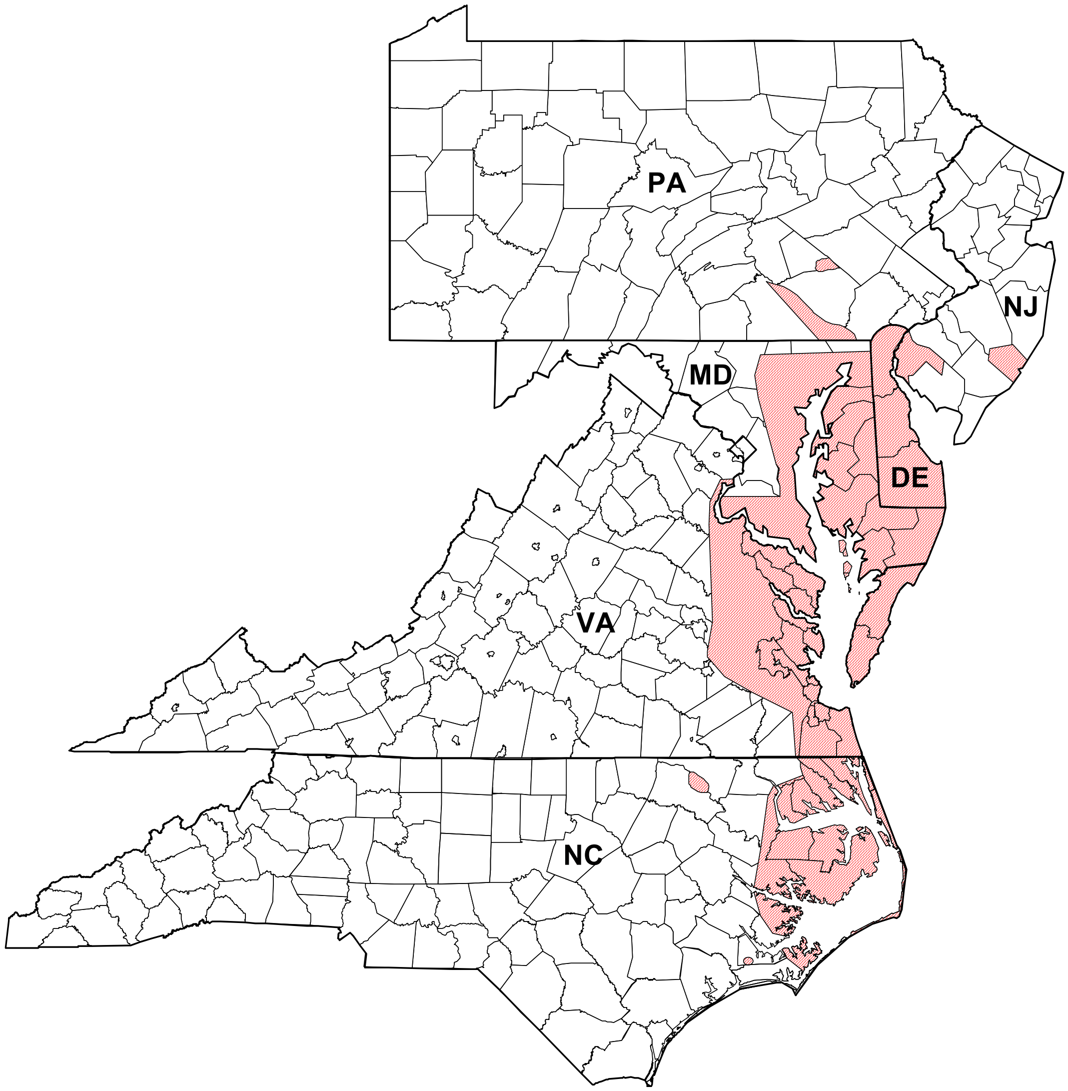


Figure A-5. Primary wintering range of EP tundra swans.

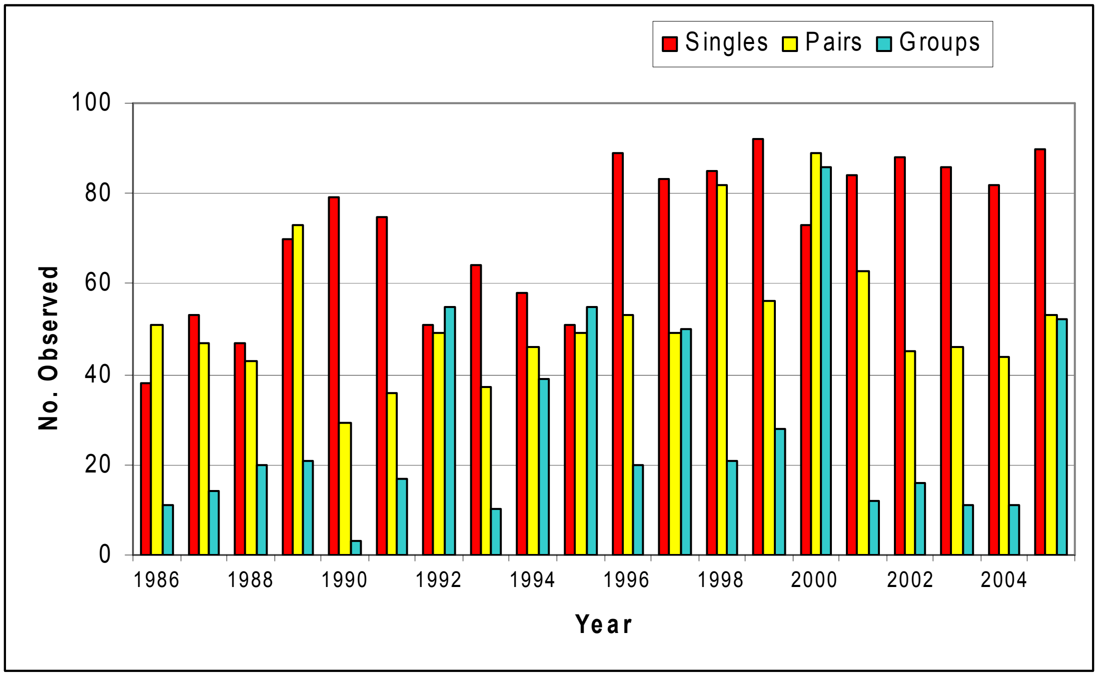


Figure B-1. Aerial breeding pair surveys of EP tundra swans on Alaska's North Slope, 1986-2005.

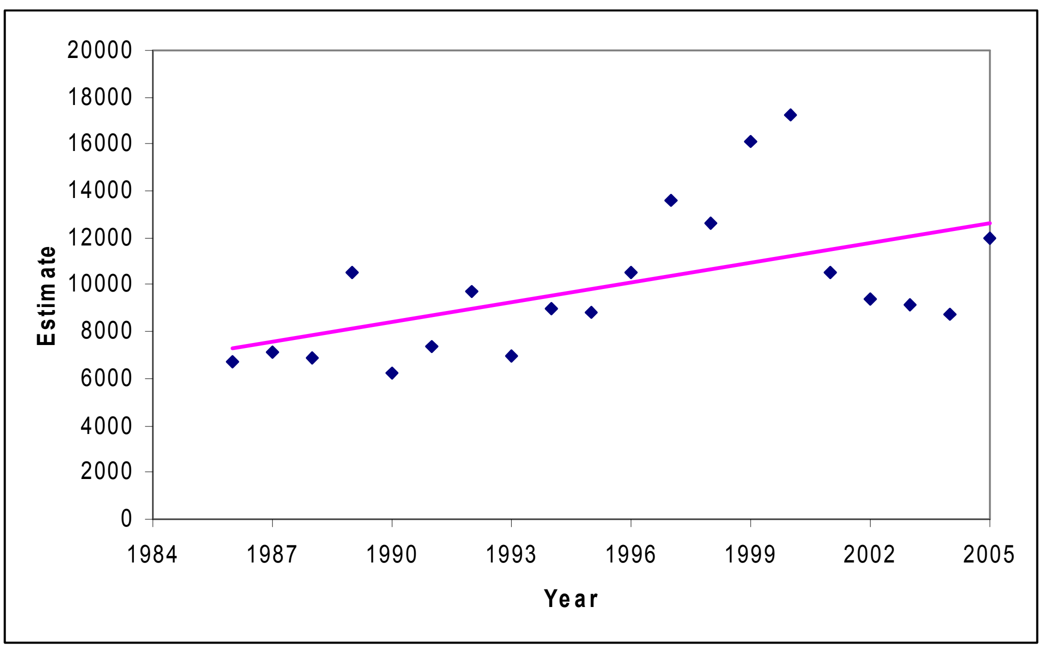


Figure B-2. Eastern tundra swan population index from aerial breeding surveys on Alaska's North Slope, 1986-2005. Mean annual growth rate from log-linear regression.

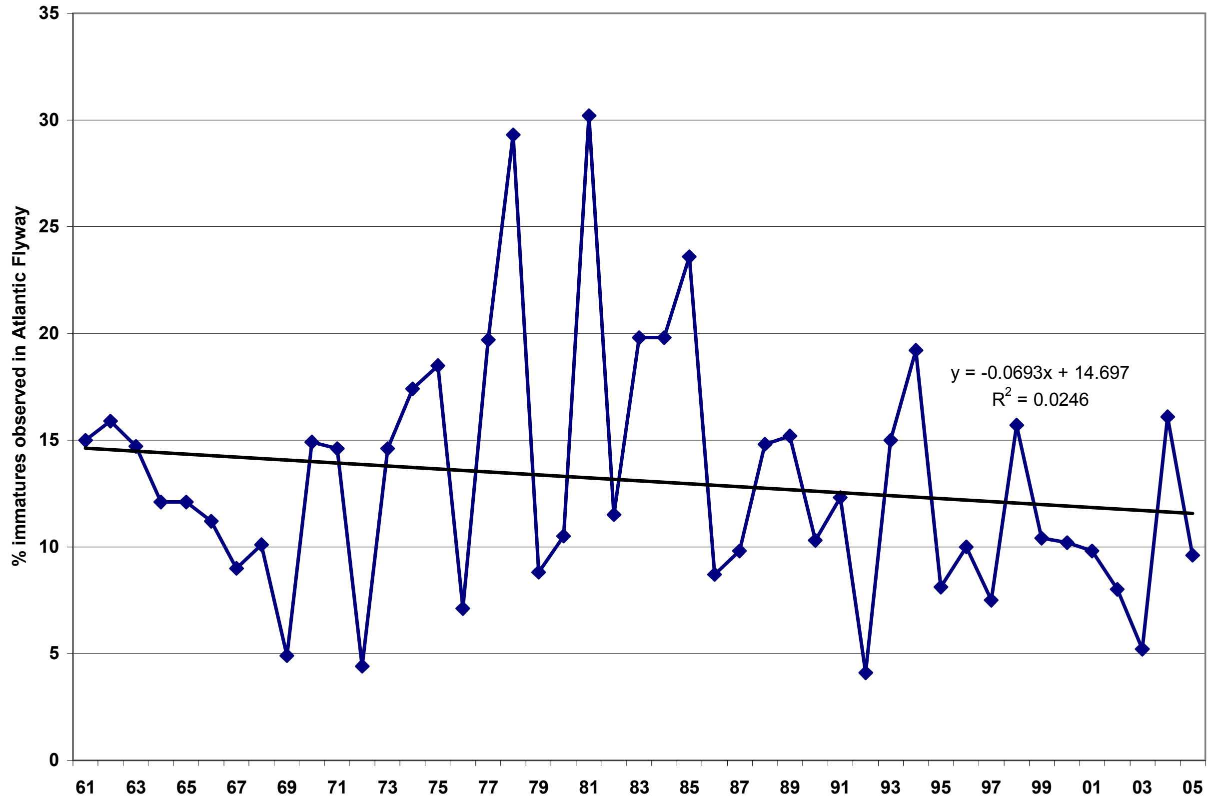


Figure B-3. Percent immature tundra swans observed in the Atlantic Flyway during annual productivity surveys, 1961-2005.

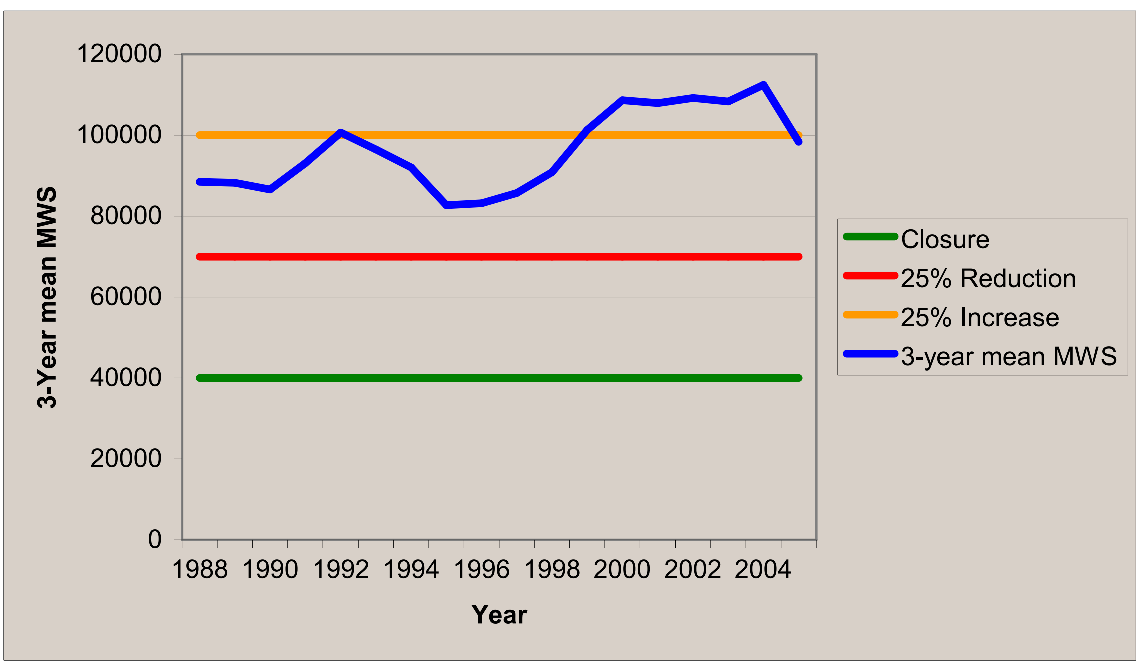


Figure C-1. Three-year mean population thresholds for allocation of EP tundra swan hunting permits. The 3-year mean MWS includes both the AF and MF surveys.

Table 1. Estimated retrieved harvest of Eastern Population tundra swans.

Year	Montana	North Dakota	South Dakota	North Carolina	Virginia	Total
1983	34					34
1984	22			313		335
1985	19			2,523		2,542
1986	41			2,302		2,343
1987	27			2,684	117	2,828
1988	25	191		2,488	117	2,821
1989	41	511		2,128	133	2,813
1990	59	474	339	2,855	128	3,855
1991	52	704	444	2,940	205	4,345
1992	37	833	814	2,609	187	4,480
1993	18	712	545	2,773	130	4,178
1994	62	690	483	3,750	194	5,179
1995	56	805	172	2,833	217	4,083
1996	61	663	233	2,177	195	3,329
1997	101	870	403	2,325	217	3,916
1998	81	618	233	2,363	248	3,543
1999	93	867	223	2,290	128	3,601
2000	115	751	151	2,515	179	3,711
2001	93	561	337	2,322	144	3,457
2002	51	688	193	2,363	177	3,472
2003	56	235	41	2,355	174	2,861
2004	105	719	134	1,745	159	2,862
2005	93	772	137	2,436	201	3,639
Average 2003-2005	85	575	104	2,179	178	3,121

Table 2. Estimated total harvest (retrieved and un-retrieved) of Eastern Population tundra swans.

Year	Montana	North Dakota	South Dakota	North Carolina	Virginia	Total
1983	34					34
1984	23			334		357
1985	19			2,783		2,802
1986	41			2,579		2,620
1987	28			3,007	117	3,152
1988	27	217		2,739	126	3,109
1989	46	592		2,364	151	3,153
1990	62	575	407	3,108	144	4,296
1991	53	813	515	3,169	219	4,769
1992	37	979	955	2,886	206	5,063
1993	22	787	689	2,994	137	4,629
1994	64	775	589	3,949	201	5,578
1995	59	900	198	3,193	224	4,574
1996	65	737	250	2,301	201	3,554
1997	114	937	448	2,505	226	4,230
1998	88	677	250	2,440	252	3,707
1999	96	956	248	2,352	134	3,786
2000	129	808	180	2,702	184	4,003
2001	93	561	337	2,501	152	3,457
2002	55	741	223	2,479	186	3,684
2003	57	260	44	2,479	184	3,024
2004	110	775	143	1,828	168	3,024
2005	100	845	156	2,575	216	3,892
Average 2003-2005	89	627	114	2,294	189	3,313

Table B-1. Breeding index of EP tundra swans on Alaska's North Slope, 1986-2005.

Year	Singles	Pairs	Groups	Index
1986	38	51	11	6718
1987	53	47	14	7136
1988	47	43	20	6895
1989	70	73	21	10544
1990	79	29	3	6229
1991	75	36	17	7334
1992	51	49	55	9726
1993	64	37	10	6937
1994	58	46	39	9000
1995	51	49	55	8843
1996	89	53	20	10514
1997	83	49	50	13601
1998	85	82	21	12632
1999	92	56	28	16105
2000	73	89	86	17227
2001	84	63	12	10504
2002	88	45	16	9389
2003	86	46	11	9118
2004	82	44	11	8745
2005	90	53	52	12002

Table B-2. Tundra swan productivity data for NJ, MD, VA, and NC, 1961-2005.

Year	Immatures (%)	Average	Immature/Family	Average	Sample Size
1961	15.0		-		2,282
1962	15.9		-		2,293
1963	14.7		-		2,092
1964	12.1		2.09		8,765
1965	12.1		2.10		15,286
1966	11.2		2.24		20,640
1967	9.0		1.80		9,307
1968	10.1		1.81		16945
1969	4.9	11.6 (n=9)	1.56	1.93 (n=6)	5461
1970	14.9		1.87		4603
1971	14.6		2.02		8604
1972	4.4		1.69		
1973	14.6		2.03		
1974	17.4		1.79		1954
1975	18.5		1.74		569
1976	9.0		1.16		7912
1977	19.7		2.19		3684
1978	7.7		1.33	VA only, n=337	2384
1979	8.7	13.0 (n=10)	1.60	1.74 (n=10)	1433
1980	10.5		1.80		2060
1981	30.5		2.30		1479
1982	11.4		1.90		5576
1983	19.8		2.00		7537
1984	10.8		2.20		8913
1985	23.6		2.00		11395
1986	9.2		1.70		11978
1987	10.0		1.60		8210
1988	14.3		1.90		10260
1989	15.2	16.5 (n=10)	1.70	1.91 (n=10)	13836
1990	10.3		1.90		11604
1991	12.3		1.60		3719
1992	4.1		1.60		11800
1993	15.0		1.00		13320
1994	19.2		1.30		5210
1995	8.3		1.20		6898
1996	10.0		1.20		15290
1997	7.5		0.84		11552
1998	15.7		1.20		13042
1999	10.4	11.3 (n=10)	1.57	1.33 (n=10)	13660
2000	10.2		0.85		7229
2001	9.8		1.21		13386
2002	8.0		0.90		25212
2003	5.2		1.34		35019
2004	16.1		2.43		12981
2005	9.6	9.8 (n=6)	1.13	1.31 (n=6)	6961

Table C-1. Estimated harvest of Eastern Population tundra swans in Montana, North Dakota, South Dakota, Virginia, and North Carolina as a percent of Midwinter Waterfowl Survey in AF and MF.

Year	Permits available	Permits issued	Total harvest	MWS	Success rate (%)	Harvest rate (%)
				87,514	31.2	0.04
				81,360	32.2	0.37
				96,934	45.8	2.99
				90,941	42.5	2.66
				95,754	51.3	3.85
				78,685	43.8	3.33
				90,300	43.7	3.36
				90,619	52.0	4.19
				98,198	48.6	4.05
				113,044	49.3	6.08
				78,190	45.8	5.18
				84,772	54.0	6.15
				85,142	44.0	5.44
				79,527	38.6	3.70
				92,380	46.8	4.04
				100,558	40.1	3.23
				110,955	42.6	3.21
				114,323	45.1	3.91
				98,444	38.5	2.93
				114,664	40.7	3.19
				111,726	32.8	2.66
				110,806	33.8	4.01
				72,457	43.4	4.57
1983-2005	8,526	7,981	3,500	91,679	42.8	3.61
2003-	9,600	9,041	3,313	99,635	36.7	3.74

[a] MWS for the January following the year indicated.

[b] (Total harvest/active hunters) x 100

[c] Total harvest/(MWS+Total Harvest) x 100

Table C-2. Historic allocation of EP tundra swan permits.

State	First Year Hunt	1989	1991	1996	1998	2003
New Jersey	n/a	0	0	0	0	0
North Carolina	1984	6000	6000	5000[b]	5000	5000
Virginia	1988	600	600	600	600	600
E. Montana	1983	500	500	500	500	500
S. Dakota	1990	500	1000	1000	1500	1500[c]
N. Dakota	1988	1000	2000	2000	2000	2000
Miss. Fly	n/a	1500	0[a]	0	0	0
Total Permits		10100	10100	4100	9600	9600

[a] *1500 permits to CF from MF*
[b] *NC reduced permits by 1000*
[c] *200 of ND permits on loan to SD*