

Pacific Flyway Management Plan for the

DUSKY CANADA GOOSE

Revised March 2008

This management plan is one of a series of cooperatively developed plans for managing migratory birds in the Pacific Flyway. Inquiries about this plan may be directed to the Pacific Flyway Representative, U.S. Fish and Wildlife Service, 911 N.E. 11th Avenue, Portland, OR.

Suggested Citation: Pacific Flyway Council. 2008. Pacific Flyway management plan for the dusky Canada goose. Dusky Canada Goose Subcomm., Pacific Flyway Study Comm. [c/o USFWS], Portland, OR. Unpubl. rept. 38 pp.+ appendices.

PACIFIC FLYWAY MANAGEMENT PLAN for the
DUSKY CANADA GOOSE

Prepared for the:

Pacific Flyway Council
U.S. Fish and Wildlife Service

by the

Dusky Canada Goose Subcommittee of the
Pacific Flyway Study Committee

October 1973
Revised July 1985
Revised July 1992
Revised July 1997
Revised March 2008

Approved by: /s/ Duane Shroufe 3/25/08
Chair, Pacific Flyway Council Date

ACKNOWLEDGEMENTS

This plan was prepared by the Pacific Flyway Study Committee, Subcommittee on Dusky Canada Geese. During the most recent review, those members of the Subcommittee and others who contributed significantly to this revised plan include:

Tom Rothe, Alaska Department of Fish and Game, Anchorage
Don Kraege, Washington Department of Fish and Wildlife, Olympia
Brad Bales, Oregon Department of Fish and Wildlife, Salem
Russ Oates, U.S. Fish and Wildlife Service, Region 7, Anchorage
Brad Bortner, U.S. Fish and Wildlife Service, Region 1, Portland
Bob Trost, U.S. Fish and Wildlife Service, DMBM, Portland
Dan Logan, U.S. Forest Service, Chugach NF, Cordova

The Pacific Flyway Council extends special thanks to USFWS Migratory Bird Management in Region 7 for improvements to population assessment methods: Bill Eldridge (Anchorage) who played a vital role in conducting spring aerial surveys for many years, and his work with Jack Hodges (Juneau) and others to bring the air:ground data analyses to fruition in the new breeding ground index. Julian Fischer (Anchorage) provided valuable insights on the factors involved in the new index and contributed a clear description of the survey protocol.

The Council is especially grateful to Barry Grand (Auburn University), Tom Fondell, Mike Anthony (USGS Alaska Science Center), and David Miller who mounted a research program over the past 10 years on some of the most pressing issues related to dusky goose breeding and production—the nature and importance of renesting, the changing dynamics of predators on the Copper River Delta, and fresh assessments of survival rates for population modeling. Bruce Dugger has contributed direction for new research on the wintering grounds; he and his students at Oregon State University are tackling critical questions about habitat capacity for geese, depredation, and management of public lands.

We also wish to recognize the important contributions made by many government and private individuals who have helped improve management of dusky geese, including Paul Meyers and the staff of the USFS Cordova Ranger District for their field work and interagency cooperation, Marty Drut who coordinated winter mark:resight surveys, all those involved in the collar-reading effort, and the dedicated personnel that gather data and maintain goose habitat on state and federal wildlife areas. The Council also wishes to thank the Farm Bureaus, agricultural producers, and hunters in Washington and Oregon for their cooperation and assistance with the complex management regimes on the wintering grounds.

TABLE OF CONTENTS

	Page
LIST OF FIGURES	iv
LIST OF APPENDICES.....	iv
INTRODUCTION	1
GOAL AND OBJECTIVES	5
STATUS	5
A. Taxonomy and Description.....	5
B. Distribution and Abundance	6
C. Nesting and Production.....	9
D. Migration	12
E. Wintering Grounds.....	12
F. Agricultural Depredation.....	12
G. Public Use.....	13
H. Scientific Use.....	13
I. Current Management.....	13
MANAGEMENT ISSUES	18
A. Breeding Grounds.....	18
B. Wintering Grounds.....	19
RECOMMENDED MANAGEMENT STRATEGIES	20
A. Habitat and Ecological Factors.....	21
B. Public Use	24
C. Crop Depredation Control.....	27
D. Inventories	27
E. Research.....	29
ANNUAL PLAN REVIEW.....	32
LITERATURE CITED	33
APPENDICES	1

LIST OF FIGURES

1. Primary ranges of the dusky Canada goose: (a) breeding; (b) wintering.
2. Winter population indices of dusky Canada geese from aerial surveys, photo-corrected aerial surveys, and indirect estimates from marked birds.
3. Estimates of total and paired dusky Canada geese from spring aerial surveys on the Copper River Delta, Alaska.
4. Primary management index for dusky Canada geese based on total indicated geese on Copper River Delta and adults on Middleton Island, Alaska.
5. Composition of nest predation on Copper River Delta (after Anthony et. al 2004).
6. Trends in 5-year average total Canada geese wintering in the Willamette Valley and Lower Columbia River regions of Washington and Oregon.

LIST OF APPENDICES

- A. Trends in numbers of Canada geese wintering in the Willamette Valley and Lower Columbia River regions of Washington and Oregon.
- B. Indirect population estimates of dusky Canada geese derived from observations of marked birds during winter.
- C. Estimates of dusky Canada geese from spring aerial surveys on the Copper River Delta, biennial counts of adults on Middleton Island, and management index of total dusky geese adopted in 2006.
- D. Estimates of percent young dusky Canada geese and sample sizes from July aerial surveys on the Copper River Delta.
- E. Numbers of dusky Canada geese observed and estimated production on Middleton Island, Alaska.
- F. Artificial nest islands on west Copper River Delta, occupancy by dusky Canada geese, and nest success.
- G. Subspecies composition and estimated harvest of Canada geese from check station data in southwest Washington and western Oregon.
- H. Geographic distribution (%) of band recoveries from dusky Canada geese.

PACIFIC FLYWAY MANAGEMENT PLAN FOR THE DUSKY CANADA GOOSE

INTRODUCTION

The Pacific Flyway Council is an administrative body that forges cooperation among public wildlife agencies for the purpose of protecting and conserving migratory game birds in western North America. The Council has prepared numerous management plans to date for most populations of swans, geese, and sandhill cranes in the Pacific Flyway (www.pacificflyway.gov). 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;
- Coordinate collection and analysis of biological data;
- Establish priority of management actions and responsibility for them; and
- Emphasize research needed to improve management.

Flyway management plans are products of the Council, developed and adopted to help state and federal agencies cooperatively manage migratory game birds under common goals. Management strategies are recommendations, but do not commit agencies to specific actions or schedules. Fiscal, legislative, and priority constraints influence the level and timing of implementation. Pacific Flyway plans generally guide management and research for a 5-year planning horizon.

This management plan for the dusky Canada goose (*Branta canadensis occidentalis*) is a revision of earlier plans adopted by the Pacific Flyway Council (1973, 1985, 1992, 1997). During the 1997 revision, Pacific Flyway agencies commissioned a conservation assessment to review biological knowledge of dusky geese and the history of management actions (Bromley and Rothe 2003); see this document for more extensive information and literature review.

Dusky Canada geese nest primarily on the Copper River Delta (CRD) of southcentral Alaska (Figure 1a). The primary wintering area is in the Willamette Valley of western Oregon and on the floodplain of the lower Columbia River in western Oregon and Washington (Figure 1b).

Historically, midwinter population indices for the dusky goose (Figure 2) increased from less than 10,000 in the early 1950's to over 26,000 in 1975, largely as a result of cooperative harvest management, expansion of winter foraging habitats, and creation of refuges in southwest Washington and western Oregon. The population declined steeply in the early 1980s, falling below 10,000 in 1984 and 1985, as effects of the 1964 Alaska earthquake accelerated changes to breeding ground habitats. Rapidly expanding shrubs and trees were favorable to brown bears and other mammalian predators that significantly increased predation on nests and adult geese. During the 1990s, low levels of production and a gradual decline in breeding birds resulted in a moderately stable population of about 15,000 dusky. Over the past five years, annual production has remained low, now primarily from nest predation by bald eagles, but the population has been maintained by a couple of productive years. With ongoing forest succession on the Copper River Delta and associated predation on geese, impaired production will likely limit the population of dusky geese for the long term.

In addition to concerns about the diminished population, management of dusky geese on their wintering grounds is complicated by the concurrent use by other goose subspecies, including lesser (*B. c. parvipes*), Vancouver (*B. c. fulva*), and western (*B. c. moffitti*) Canada geese; and Taverner's (*B. hutchinsii taverneri*), cackling (*B. h. minima*), and Aleutian (*B. h. leucopareia*) cackling geese (see Taxonomy below). Large numbers of mixed white-cheeked geese cause problems in conducting winter inventories, designing optimal harvest regulations, controlling crop depredation, and assessing carrying capacity of winter habitats for all geese (see Appendix A).

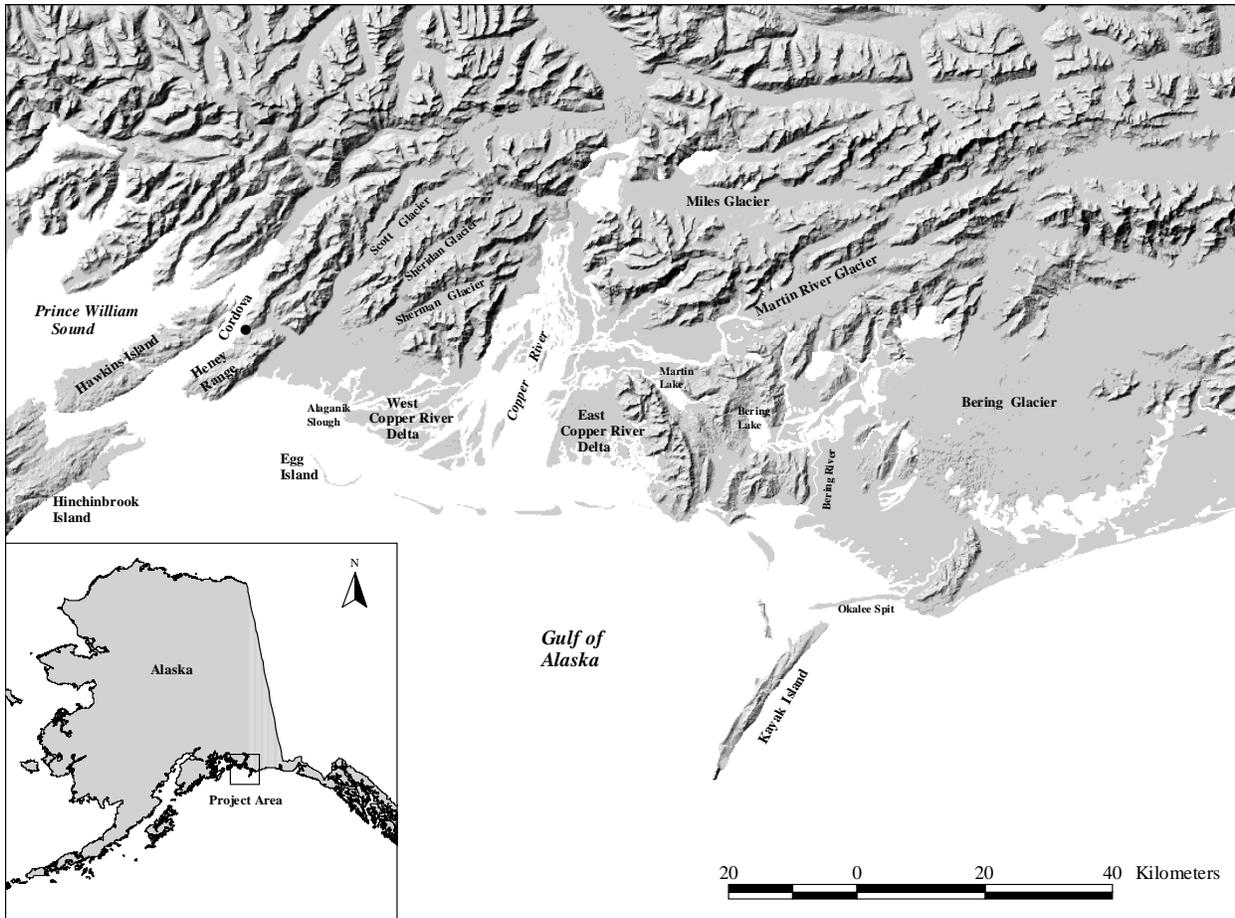


Figure 1a. Primary breeding range of the dusky Canada goose on the Copper River Delta.

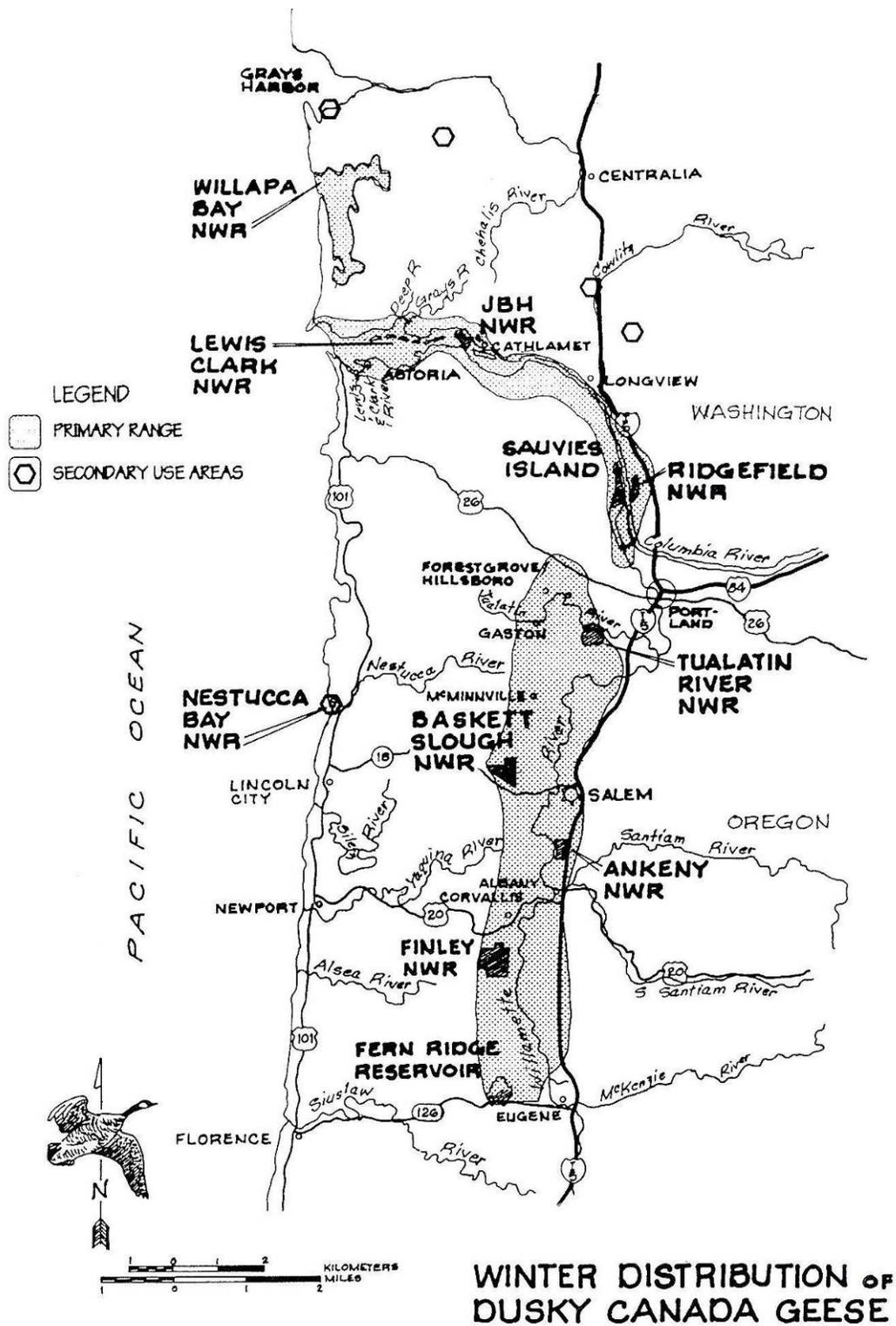


Figure 1b. Primary wintering range of the dusky Canada goose in Washington and Oregon.

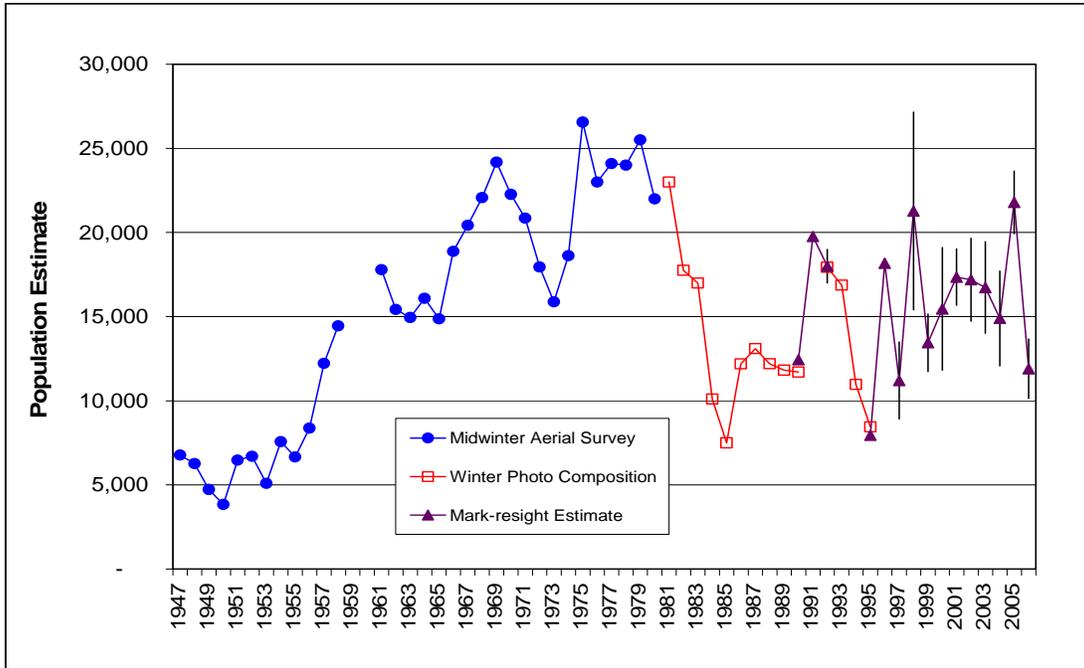


Figure 2. Winter population indices of dusky Canada geese from aerial surveys, photo-corrected aerial surveys, and indirect estimates from marked birds.

GOAL AND OBJECTIVES

The goal of this management plan is to maintain and enhance the dusky Canada goose population.

Objectives of this plan are to:

1. Manage the number of dusky geese to sustain the population within a range of 10,000 to 20,000 geese, as measured by indices of geese on Copper River Delta and Middleton Island, with primary consideration to:
 - a. Maintain the breeding population on Copper River Delta;
 - b. Maintain the dusky goose population to withstand an incidental harvest of duskys when harvests of abundant subspecies are desired to assist in depredation control.
2. Maintain and enhance breeding ground habitat conditions to achieve average annual production of 20% young, measured as the most recent 10-year average.
3. Manage and enhance wintering and migration habitat for dusky and other geese, with an emphasis on habitat objectives outlined in the NW Oregon/SW Washington Canada Goose Agricultural Depredation Control Plan (Pacific Flyway Council 1998).

STATUS

A. Taxonomy and Description

It is likely that the large, dark forms of Canada geese along the north Pacific coast, including Western, Vancouver, Dusky, and Lesser, became differentiated since the last glacial period. Most of the Alaska and British Columbia coasts were under glacial ice until about 10,000 years ago (Pewe 1975), and geese likely pioneered northward into emerging coastal habitats as the ice receded (see Ploeger 1968 for glacial history as a mechanism for subspeciation).

Taxonomy—The taxonomy of Canada geese along the north Pacific coast has been subject to debate for many years. Palmer (1976) combined Vancouver Canada geese with dusky Canada geese under the subspecies *B. c. occidentalis*. Sibley and Monroe (1990) did not recognize dusky geese as a subspecies in their review of world bird taxonomy. Historically, Pacific Flyway wildlife agencies have concurred with Delacour (1954) who identified 11 subspecies of Canada geese and found distinction between dusky Canada geese (*B. c. occidentalis*) and Vancouver Canada geese (*B. c. fulva*). Although dusky geese have been distinguished from other Canada geese for over 150 years (see Bromley and Rothe 2003), they have been classified largely through morphological analysis, most notably by Johnson et al. (1979). Pearce and Bollinger (2003) provide more detailed means of discrimination among dusky geese and other large, dark subspecies in the Pacific Flyway.

Recently, based on extensive genetic studies (see below), the American Ornithologists' Union (AOU) divided North American "Canada geese" into two species (Banks et al. 2004), with large bodied subspecies (including dusky geese) in the species *canadensis* (Canada goose) and small-

bodied forms in the species *hutchinsii* (Cackling goose). At lower levels, the AOU continues to reference Delacour (1954); thus, dusky geese remain *B. c. occidentalis*.

Genetic Studies—Specific questions about the uniqueness of dusky Canada geese, as well as broader taxonomic concerns stimulated genetics research on Canada goose subspecies in the Pacific Flyway. Shields and Wilson (1987) evaluated mitochondrial DNA (mtDNA) of eight Canada goose races and described distinct separation between a large-bodied group (Lesser, Dusky, Vancouver, Western) breeding along the north Pacific coast and small-bodied group (Taverner’s, Cackling, Aleutian) breeding in western and northern Alaska. This work was later expanded to describe subspecies phylogenies based on mtDNA (Shields and Cotter 1998). Additional analyses with mtDNA and nuclear DNA have solidified the current view of relatedness among Canada and cackling goose subspecies (Scribner et al. 2003).

A study of mtDNA from dusky-like geese on Middleton Island, compared to other geese from southcentral and Southeast Alaska, showed that Middleton Island geese share a unique haplotype with geese in Prince William Sound (Green Island), one not found in other breeding areas (Talbot et al. 2003). These results indicate that “island geese” are a slightly different but identifiable stock from other Canada geese. The study also confirmed that Middleton Island geese were not derived from a transplant of Copper River Delta duskys in the 1980s (see Campbell 1992).

Population Management—By definition, this plan addresses the Canada geese breeding on the Copper River Delta, Middleton Island, and Prince William Sound in Alaska. Banding data from over 50 years clearly demonstrates the cohesiveness of the core population of dusky geese that breed on the Copper River Delta and occupy a well-known traditional winter range. Recent studies of “island geese” indicate that, although they are genetically distinct and segregated from CRD birds during the summer, they are morphologically indistinguishable, differ genetically to a small degree, and they winter sympatrically with dusky geese. The geese breeding in the forested habitats of Prince William Sound, adjacent to Copper River Delta on the west, are widely dispersed and not numerous, but little is known about their numbers and annual range. Although a few of these were marked and located during winter in the Willamette Valley, from several hundred to 1,500 may winter in Prince William Sound (Hansen 1962; Isleib and Kessel 1973). The extent to which these geese migrate south and otherwise interact with components of the dusky goose population is unknown and warrants study.

Wildlife agencies subscribing to this plan are bound to maintain all populations of Canada geese. Future research on the adjacent groups of breeding geese, currently managed with Copper River Delta duskys, could change the terms of reference for management programs, but the Copper River Delta and Middleton Island birds will remain the primary focus of management efforts.

B. Distribution and Abundance

Dusky Canada geese were only known to breed on the Copper River Delta, prior to the late 1970s when a few duskys began nesting on Middleton Island in the Gulf of Alaska. The Willamette Valley in western Oregon and floodplain of the lower Columbia in western Oregon and Washington are the primary wintering areas for the dusky Canada goose. Historic records show occurrences of wintering duskys in southern British Columbia, coastal estuaries and

drainages of Washington and Oregon, and northern California. Wintering dusky geese are regularly observed on Vancouver Island, near Grays Harbor and Willapa Bay in Washington, and south to Nestucca Bay on the central Oregon Coast. Several hundred Canada geese wintering in Prince William Sound, Alaska are likely local breeders, but several geese collared on the Copper River Delta have been observed in these winter groups.

Historic population levels were measured by aerial surveys on the wintering grounds (Figure 2). From 1953 to 1974 the post-hunting season population of dusky geese averaged $16,200 \pm 4,680$, ranging from 8,000 to 28,000 (Hansen 1968, Cornely et al. 1985, Jarvis 1989 and 1990). Post-hunting season population indices were relatively high between 1975 and 1981, averaging $24,000 \pm 1,560$ and ranging from 23,000 to 26,500. However, from 1981 to 1990, the average declined to only $14,300 \pm 4,100$, and was $14,200 \pm 3,700$ during 1992-1995.

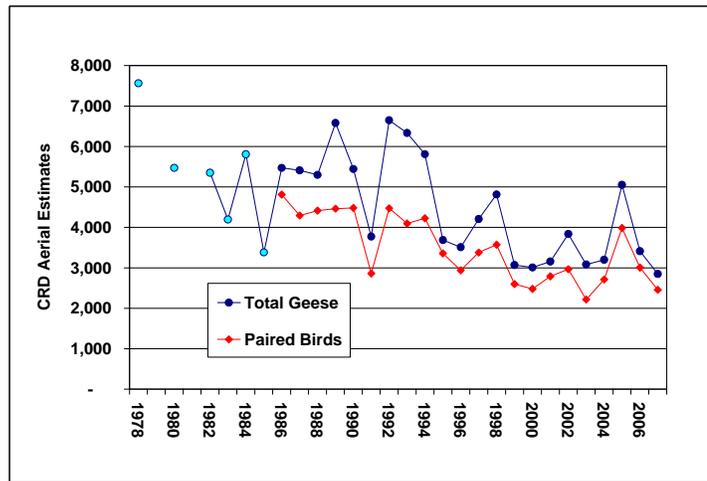
From the 1981 to 1997, post-hunting season population estimates were derived from photo composition counts, applied to wintering area visual counts of all Canada geese (Figure 2). Survey coverage expanded over time, and included counts from all known wintering areas of dusky Canada geese, including the Willamette Valley / Lower Columbia River, Columbia River estuary, Willapa Bay, Nestucca Bay, and minor outlying areas in southwest Washington and western Oregon. Results of the photo composition survey were increasingly difficult to interpret due to problems associated with growing numbers of other Canada geese in the survey area, particularly dense concentrations of cacklers. Survey results were of questionable value due to logistical problems with the survey related to weather delays, availability of experienced survey personnel, and coordination of total goose survey flights.

During 1990-1992, Sheaffer (1993) developed indirect population estimates using mark-recapture techniques during winter. The mark-recapture approach offered an estimate of statistical precision lacking in the photo composition survey, and was more defensible based on statistical design. With these advantages and confidence of the management agencies, the mark-recapture method was adopted in 1995 as the operational means of producing the annual management index; photo composition surveys were suspended in 1997. Mark-recapture data were collected with intensive collar monitoring during selected observation periods in December and January. The survey showed better correlation to breeding ground surveys and estimates derived from dusky population modeling (see Figure 2; Appendix B).

As a long-term strategy, management agencies agreed that dusky geese would be better managed based on a breeding ground population index, and that accuracy of the estimates should be improved. Since 1986, the USFWS has flown a May breeding ground survey on the Copper River Delta (see Butler and Eldridge 1991; Eldridge et al. 1998; Eldridge et al. 2005), providing estimates of breeding pairs and total geese (Figure 3; Appendix C). Development of a population index from the aerial survey, however, needed to address several issues, including: (1) a large majority of the population is not observed from the air; (2) reneesting by dusks confounded comparison of ground nest surveys to aerial breeding pair counts; and (3) breeding ground surveys for Copper River Delta and Middleton Island were not integrated. Research during recent years has provided a means to estimate reneesting rates and nest detection in relation to aerial breeding pair estimates (Fondell et al. 2006a). Additional analysis of all survey

data (Eldridge et al. 2005; Fischer 2006) now provides a means to incorporate factors for a breeding ground index that closely approximates results from winter indirect estimates.

Figure 3. Estimates of total and paired dusky Canada geese from spring aerial surveys on the Copper River Delta, Alaska.



Refinement of the aerial breeding ground index involves a correction factor for breeding birds that are missed by aerial crews. A ratio estimate is used to calculate the ratio of nest density measured by ground crews to breeding pair density measured from the air. Ground and air surveys from 1993-1995, 1998, 2004, and 2007 were

used to calculate the ratio of 3.39 (SE=0.17) nests/pair seen from the air (see Hodges and Eldridge 2007). This ratio is corrected for nest detection rate (0.832; Eldridge et al. 2005) and renesting (1.20 nests/female prior to May 15; Fondell et al. 2006). The corrected ground:air ratio is used to calculate an adjusted estimate of Indicated Paired Birds. Coordinated ground/air samples will be repeated every three years to update the ratio estimate. Addition of flocked birds to Indicated Paired Birds produces an estimate of Indicated Total Birds on the Copper River Delta. The final step involves adding an estimate of indicated adult birds from Middleton Island, using the most recent survey conducted by ADFG every two years (Petrula et al. 2006). Breeding ground survey data and basis of the new index is found in Appendix C. Figure 4 shows the new dusky goose population indices back to 1986.

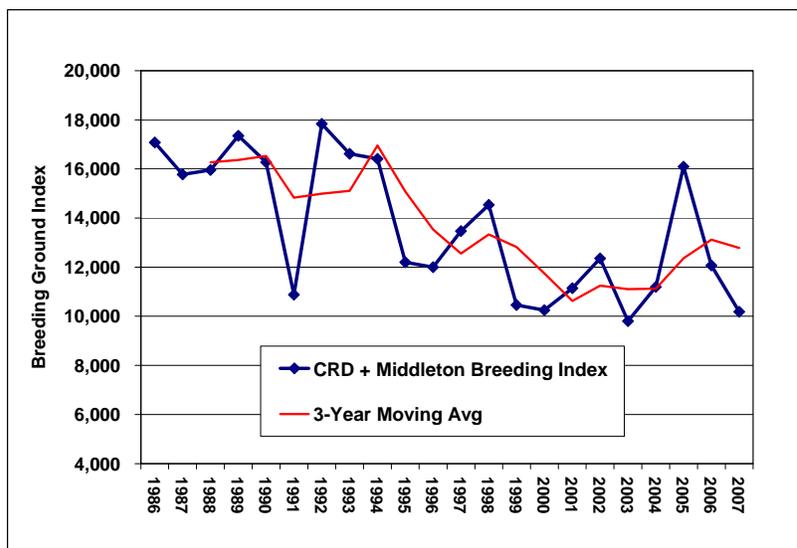


Figure 4. Primary management index for dusky Canada geese based on total indicated geese on Copper River Delta and adults on Middleton Island, Alaska.

C. Nesting and Production

The primary nesting area for dusky Canada geese is the Copper River Delta, near Cordova, Alaska (Figure 1a). Prior to 1964, the low elevation of the delta and periodic flooding during high tides maintained broad expanses of sedge meadow dissected by a reticulated pattern of drainage channels and sloughs. A mixed forb/low shrub community was found on slightly elevated slough banks (Trainer 1959). Brackish conditions significantly influenced productivity of waters and controlled the composition of plant communities. Early surveys (Trainer 1959) showed that dusky Canada geese selected mixed forb/low shrub nest sites, and that flooding was the major cause of nest losses. Nest predation by gulls was slight, and mammalian predators were considered rare on the outer delta. Overall, nest success was high.

The 1964 earthquake uplifted the Copper River Delta by 2 to 6 feet, drastically altering the frequency of tidal inundation and promoting drying of slough banks and meadows (Reimnitz 1972). The drier conditions and lack of suppression by saltwater have allowed the invasion and growth of shrubs such as alder and willow, and trees such as cottonwood and Sitka spruce. Between 1974 and 1984, shrub cover increased nine fold on the coastal delta (Campbell 1990a). The effects of habitat changes on dusky goose production are not fully known. Nesting geese have apparently adjusted to changes in vegetation physiognomy and composition, and are extensively using the drier, shrubby habitats (Bromley 1976, Campbell 1990a). Recent work by Miller et al. (2007) suggests that continued expansion and depth of shrub communities would have two offsetting effects on the dusky population. Increases in tall shrubs and trees (dense overhead canopy) could be beneficial, making nests less vulnerable to predation. But as areas of short high-density shrubs increase, females would become vulnerable.

The secondary effects of habitat change may be more significant. The number and species composition of predators on the delta have changed (Campbell and Griese 1987) and nest predation increased sharply during the 1980s. Predation by coyotes (*Canis latrans*), brown bears (*Ursus arctos*), and other mammals became prevalent (60-80% of losses in the early 1980s) when tall shrub habitats began to expand (see Bromley and Rothe 2003). With the change in predator species composition, nest predation increased from less than 6% in 1959 (Trainer 1959) to an average of over 55% during the 1980s and an average of over 60% from the 1990s to present (Campbell 1990b; Crouse et al. 1996; Grand et al. 2006). Consequently, dusky goose production has been significantly diminished for over two decades (Appendix D).

Over the long term, bald eagles have increased in the Prince William Sound region (Bowman et al. 1997) as a result of removal of a bounty in 1953, reduction in use of pesticides, more stringent legal protection, and possibly food subsidies from fish processing. Recent work by Anthony et al. (2004) suggested that bald eagles might account for as much as 80% of nest predation, with only 15% attributable to brown bears (Figure 5).

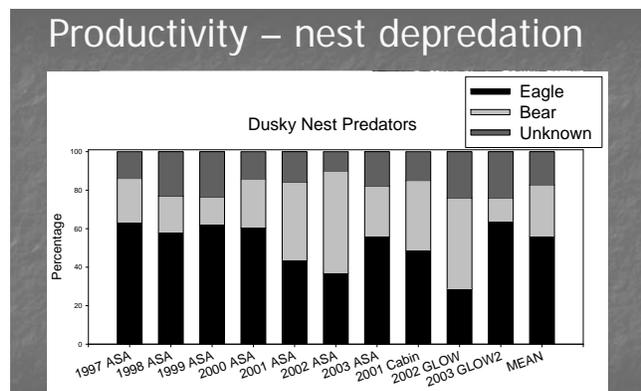


Figure 5. Composition of nest predation on Copper River Delta (after Anthony et. al 2004).

Nest success, while generally low (20-40 % in most years) shows a high degree of variation, reaching 50-80% in some years (Grand et al. 2006, Miller et al. 2006, Fondell et al. 2006b). This variation was related to the abundance of bald eagles and the timing of runs of eulachon (*Thaleichthys pacificus*), a small anadromous fish that acts as an alternate prey species for nest predators (Miller et al. 2006). Thus, when the eulachon run is strong and occurs early in the nesting period, eagles and possibly other nest predators switch from goose nests to eulachon as a food resource.

A further consideration is that after the destruction of a first nest, dusky geese lay continuation clutches and re-nest at relatively high rates (Fondell et al. 2006a). As a result of these replacement clutches and because late nests hatch at higher rates than early nests (Grand et al. 2006), estimates of female success (the percentage of females that successfully hatch a nest) were 32-100% greater than nest success (Fondell et al. 2006a) and a large proportion of the nests that hatch do so late in the nesting season. In recent years, clutch sizes have remained similar to historic averages (Bromley and Rothe 2003), and the seasonal decline in clutch size is not as steep as that for other geese nesting at northern latitudes (Fondell et al., submitted).

Direct effects of vegetation at and surrounding the nest on nest survival and female survival differed, and for nest survival changed within seasons (Miller et al. 2007). For nests, early in the season when bald eagle predation was high, survival was higher in tall shrubs and on islands than in short shrub and later in the season after eagles had switched to alternative prey there were no differences among the habitat types. For nesting females, the probability of mortality during a nesting attempt was 3-times greater for sites with high-density shrub than for sites with low-density shrub.

Gosling survival (to 50 days) was also low, ranging from 20 – 40% and decreased with hatch date (Fondell et al. accepted 2007). Gosling survival was positively correlated with nest success (Fondell et al. in prep. a), but predators of nests and goslings show a large degree of overlap (Bromley and Rothe 2003, Grand et al. 2003, Fondell et al. in prep.). The correlation between nest and gosling survival suggested that predation was an important cause of gosling mortality and that factors affecting nest predation had like effects on gosling survival. Nest survival also directly affected gosling survival because as nest survival decreased hatch dates increased and gosling survival declined with hatch date. Retrospectively, the correlation between gosling and nest survival, and the relatedness of predators affecting these reproductive parameters suggested that gosling survival declined concurrently with historic declines in nest success. Finally, the correlation between nest and gosling survival would have a multiplicative effect on productivity and increased annual variation in productivity would result. Further, both the long-term historic decline in these parameters and high variability in comparison to other demographic parameters (variation in adult survival is small; Sheaffer 1993, Fondell 2006b) suggested that productivity has had a large effect on both past and present population dynamics (Schmutz et al. 1997).

Aerial survey data suggested that dusky geese may be increasing on glacial outwash plain habitats, where they nest at low density, and decreasing in uplift marsh habitats where nest densities have been medium to high (W. Eldridge, U. S. Fish and Wildlife Service, unpubl. data). However, neither nest success (Fondell et al 2006b) nor gosling survival (Fondell et al. accepted 2007) differed between these habitat types.

Continuing poor production has not only resulted in a population decline, but has also led to an unfavorable age structure in the dusky goose population. A model of population age structure was developed from annual production estimates, survival rates from band returns prior to 1984, available age class survival estimates for non-hunted or minimally hunted Canada goose populations, and estimated productive life span of captive geese (ADFG unpubl.). The model suggested that nearly 60% of the population exceeded 7 years of age in 1990. Sheaffer (1993) also modeled population dynamics using estimates of survival from band recoveries and collar sightings, recruitment, and changes in harvest regulations. That model described an age structure in which 49% of birds were 3 years of age or older over the 1983-1990 period. Data gathered in recent research will provide a more complete basis for a new population model (Grand, pers. comm.).

In 1981, nesting by Canada geese was documented on Middleton Island, 80 miles south of the Copper River Delta in the Gulf of Alaska (Gould and Zablouil 1981). Based on an evaluation in June 1987, when 90 geese were observed and much of the island was deemed suitable for nesting, the decision was made to stock dusky geese from Copper River Delta on Middleton (see Campbell et al. 1989). The lack of mammalian predators and human activity were favorable. During 1987 and 1988, 179 goslings and 14 adult dusks were imported from Copper River Delta. After the translocation, the number of breeding geese increased to over 400 by 1992, but only six marked transplant birds were resighted on the island. During the same period, 43 marked transplant birds were observed back on CRD. An evaluation of the transplant by Campbell (1992) concluded that the project had not markedly enhanced the breeding population (see also Talbot et al. 2003, indicating that current Middleton birds are not derived from CRD).

During the 1990s, the number of geese on Middleton Island increased steadily to 1,987 birds and over 150 family groups in 1996 (Rosenberg et al. 1996). Since then, three biennial surveys indicate that the number of breeding geese (average = 1,456) and productivity (average = 860 young) have been stable (see Appendix E).

“Island geese” from Middleton Island (96 banded, 34 collars including 24 VHF radios) and Green Island in PWS (four banded and collared) were marked in 1998 to determine their affiliation with wintering areas (Crowley et al. 1998). Eighteen of the marked birds were detected during winter through March 1999—all in the Willamette Valley between Salem and Newberg, except one bird on Sauvie Island. This illustrates that 3 of 4 Green Island birds and 15 of 20 Middleton birds wintered in the core dusky goose winter range.

Middleton Island has been contributing a significant portion of production for the collective dusky goose population since the mid-1990s. The island is, however, only 2.5-3.0 mi. sq. and appears to have reached capacity for breeding pairs by 1996 (see Petrula et al. 2006). The importance of productivity on Middleton Island bears monitoring, but the fate of over 800 goslings produced each year that do not return to the island remains unknown and worthy of investigation.

D. Migration

Dusky Canada geese migrate along the Pacific coast of Alaska, British Columbia, and Washington. Based on collar observations, the islands in eastern Prince William Sound, Prince of Wales Island in southeast Alaska, and the Queen Charlotte Islands of British Columbia are important fall staging areas; although little is known about the habitats that dusky geese use in these areas or the length of time they use these areas in the fall or spring.

E. Wintering Grounds

The primary wintering range of the dusky Canada goose is the lower Columbia River floodplain and the Willamette Valley (Figure 1b). Dusky Canada geese most frequently congregate near state and federal management areas in northwest Oregon and southwest Washington. The subspecies composition of the wintering Canada goose aggregation in these areas has changed dramatically over the past 20 years. The dusky population has declined from historic levels while the total number of Canada geese (Figure 6; Appendix A) has reached record highs.

F. Agricultural Depredation

The dramatic increase of all Canada geese in the region has resulted in increasing complaints of crop depredation on private lands. Goals, objectives, and strategies for habitat management and public use have been identified in considerable detail in the NW Oregon/SW Washington Canada Goose Agricultural Depredation Control Plan (Pacific Flyway Council 1998). The goals of this plan, though focused on minimizing overall Canada goose depredation problems, also recognizes the need for balanced management for all goose subspecies.

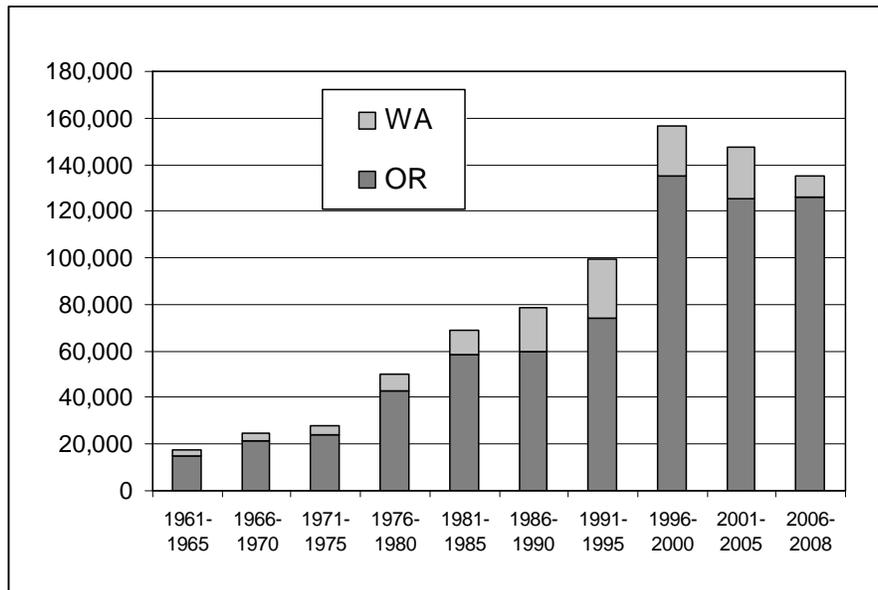


Figure 6. Trends in 5-year average total Canada geese wintering in the Willamette Valley and Lower Columbia River regions of Washington and Oregon (see also Appendix A).

G. Public Use

As the dusky population has declined, hunting seasons affecting dusky Canada geese have become more restrictive and complex. In addition to hunting, duskys and other Canada geese provide recreation opportunities to nonconsumptive users. Thousands of people visit state and federal areas along the Columbia River and in the Willamette Valley to view or photograph geese. Students and teachers from numerous universities, colleges, and public schools use the areas for environmental education.

H. Scientific Use

Dusky Canada geese have been the subject of a number of studies, both on nesting and wintering areas (see Chapman et al. 1969). Campbell and Cornely (1991) listed and annotate these studies, as well as agency surveys, inventories and federal aid reports dealing with the dusky Canada goose. Bromley and Rothe (2003) have summarized much of the historical and contemporary information, and suggested directions for future research. Since the last version of this plan, much effort has been focused on dusky goose breeding biology, nesting ecology in relation to changing habitats on the Copper River Delta, and the dynamics of nest and goose predators.

I. Current Management

Population Management.—Active management of dusky Canada geese began in the early 1950's. Production assessments and banding were conducted on the breeding grounds and midwinter inventories began on the wintering grounds. A Dusky Canada Goose Subcommittee of the Pacific Flyway Study Committee was formed by the Pacific Flyway Council in 1972. The Subcommittee developed guidelines for management of the population in the flyway's first goose management plan (Pacific Flyway Council 1973). The management plan and guidelines, with revisions, have been followed since 1973.

Nesting Area Ecological Management.—Management Authority—Nearly all of the nesting habitat of the dusky is under the management authority of the U.S. Forest Service (USFS) within the Chugach National Forest. In 1962, the USFS and ADF&G entered into the Copper River Delta Cooperative Management Agreement, recognizing wildlife and fisheries as the most important resources of the Delta, and clarifying agency roles in management. This agreement was revised in 1986 and expanded to include the Bureau of Land Management, U.S. Fish and Wildlife Service, and Alaska Department of Natural Resources. In 1978, the Alaska Legislature created the Copper River Delta Critical Habitat Area, encompassing federal, state, and private lands to facilitate management of biological resources and habitats.

The Alaska National Interest Lands Conservation Act of 1980 (ANILCA) provides that “*management of the Copper/Rude and Copper/Bering River Deltas will emphasize the conservation of fish and wildlife and their habitats.*” This legislative mandate and provisions of the recently updated Chugach National Forest Revised Land and Resource Management Plan (USDA Forest Service 2002) establish policy direction and frameworks for cooperative management of dusky Canada goose nesting habitat.

Habitat Manipulation—Since 1983, a total of 861 artificial nest islands of six different designs have been installed on the Copper River Delta to deter nest predation. This project was cooperatively planned and implemented by the U.S. Forest Service, with assistance from Alaska Department of Fish and Game and major funding contributions from Ducks Unlimited Inc. and Oregon Department of Fish and Wildlife. Over 300 islands have been available annually to nesting geese since 1996, averaging 329 islands in the past five years (Appendix F). Occupancy rates increased from about 10% initially to 25% by 1995. Use of islands has continued to increase and reached a high of 49% in 2006. Since 1984, 1,728 nests have been recorded on artificial islands, with average nest success of 60%, compared to an average of 26% success on natural nest sites (Fode et al. 2006). During recent studies, survival of nests was higher on artificial islands than in low-density shrubs early in the nesting season (prior to May 25th when predation by eagles was high), but was equal to nests in high-density shrubs. Nest survival did not differ between artificial islands and upland sites late in the season (Miller et al. 2007). The current objective of this project is to improve the characteristics of artificial island types to increase occupancy rates and nest success, while reducing maintenance costs.

Other habitat enhancement techniques, such as pond development, creation of large islands in ponds, and cutting off peninsulas have been tested. However, placement of small artificial nest islands is the only habitat enhancement option that has proven to be practical and effective in reducing nest predation.

Predator Management—Improved habitat suitability for a more diverse suite of avian and mammalian nest and goose predators has changed predator-prey dynamics on the Copper River Delta. Campbell and Griese (1987) examined a full range of management options for controlling the impacts of predators on geese. By necessity, management of predators has been evaluated carefully, to consider potential effects on both predator and prey populations and the diverse public interests in all wildlife species. Predator management on the Delta is greatly complicated by the wide variety and evolving composition of species preying on dusky Canada geese. In addition, it is difficult to estimate how management of particular predator species could affect interactions among all predators, and to predict net effects on dusky goose production (e.g., Do predator species operate independently or is predation compensatory among all predators?).

Campbell (1991) conducted a study of brown bear movements and predation on dusky goose nests on the delta, and reviewed brown bear population research. Goose nest plot studies during the 1980s indicated that sows with cubs often caused most of the nest losses in their spring use of coastal meadows. Brown bears caused substantial nest losses in some years, but they were not always the most important agents. An experimental translocation of 19 bears out of the primary dusky goose nesting area in 1987 produced only a small increase in nest success; other factors caused substantial losses (Campbell et al. 1988).

In addition to substantial doubt that brown bear reduction would significantly increase goose production, other aspects of bear population management must be considered. Low recruitment rates make brown bear populations particularly susceptible to long-term impacts from losses of females (Miller 1990, 1997). Campbell et al. (1988) indicated that sows with cubs were important nest predators. Hunting seasons on sows with cubs, however, are not generally desirable, because of potential overharvest and poor survival of orphaned cubs; thus, they are

protected from harvest by regulation. Beginning in 1997, the brown bear bag limit on the Copper River Delta was increased from one bear every five years to one bear/year in an attempt to reduce predation on moose calves. Average annual harvest increased by two bears on the east CRD where non-resident guiding occurs, but remained the same on the west CRD where guiding is prohibited. Further liberalization of brown bear season dates would have little effect on harvest.

Coyotes increased on the dusky goose nesting grounds from the 1950s through the 1980s, but their numbers have been stable in recent years. They are considered potentially more effective goose predators than bears, taking eggs, goslings, and adult birds. Alaska has very liberal hunting and trapping regulations for coyotes on the Copper River Delta, but public interest is minimal because fur prices are low and winter travel in the delta is very limited for trappers. Coyote control on the Copper River Delta may be very difficult because of the region's large size and extensive forest and shrub cover. It would entail intensive efforts, difficult logistics, and high costs. Given the currently small contribution by coyotes to nest predation and doubts that a sufficient proportion of the population could be removed, such intensive action would warrant a careful analysis of potential net benefits to nest success vs. costs and resources.

Wolves are known to prey on dusky Canada geese (Stephenson and Vanballenberghe 1995), but wolf density is low on the west CRD where most dusky geese breed and road-accessible trapping occurs. Wolves are more abundant on the East Delta (Carnes 2004) where trapping effort is minimal. Wolf predation on geese and nests has not been considered important enough to manage wolves for direct enhancement of dusky goose production. Wolves are known to suppress coyote populations in some situations (Mech 1970; Mech and Boitani 2003), but Carnes (2004) noted that coyotes benefited from scavenging on wolf kills. Manipulation of wolves on the CRD would require careful thought about interactions with other predators, and the welfare of the local moose population will be an important consideration.

There is a particularly diverse suite of birds that prey on and scavenge goose eggs, goslings, and adult birds. These include magpies, ravens, and crows; gulls and jaegers; owls, hawks, and bald eagles. Bald eagles are now responsible for up to 80% of dusky goose nest losses each year (Anthony et al. 2004) and also appear to be a major predator of goslings (Fondell in prep.). Annual rates of nest predation by eagles are influenced by the timing and abundance of eulachon as alternative prey (Miller et al. 2006). To date, no management actions have been taken to deter eagles from goose nests or reduce the presence of eagles on the CRD, nor is there a practical means of enhancing alternative food sources during goose nesting (although studies of eagle foraging and evaluation of supplemental feeding may be useful).

Wintering Area Habitat Management.—In the late 1950s it was recognized that mortality of dusky geese from hunting was very high and that a large percentage of the population was concentrated on a relatively small area of privately owned land in the Willamette Valley and lower Columbia River during the winter. As a result, the U.S. Fish and Wildlife Service purchased much of this land and established Ankeny, Finley, Baskett Slough, and Ridgefield National Wildlife Refuges during the mid-1960s. The primary purpose for establishment of these refuges was to provide protected and managed habitats for dusky Canada geese. Current management on these refuges emphasizes production of food resources for wintering Canada

geese and areas where geese can rest and feed undisturbed. The goose foraging areas are primarily managed to produce green forage, moist-soil vegetation, and row crops. ODFW and WDFW also own and provide goose forage on large blocks of land in the Sauvie Island, Fern Ridge, and Vancouver Lake/Shillapoo areas, which are used by wintering duskys. In addition, Willapa, Tualatin River, and Nestucca Bay NWRs provide additional winter habitat.

Harvest Management.—Hunting Season Structure. Seasons in Washington and Oregon between 1952 and 1983 provided from 7 to 11 weeks of hunting after most duskys had arrived on wintering areas, and harvest rates averaged over 25% of the population. In 1983 and 1984, Pacific Flyway agencies responded to the decline in dusky numbers by restricting harvest in primary dusky migration and wintering areas. In Alaska's Units 5 and 6, the opening of Canada goose season was delayed to allow time for duskys to migrate and to buffer harvest with other migrating Canada goose subspecies.

In 1985, the Northwest Special Permit Zone in Oregon and the Southwest Quota Zone in Washington were established with additional restrictions, including dusky goose quotas for emergency season closures (300 during 1985-95; 204 in 1996; 250 to present). Bag limits were reduced to one dusky per season in the permit zones, and successful hunters were required to report harvest to check stations. Hunters have had to complete goose identification training and, beginning in 1996, pass an identification test to receive a permit. Those who take a dusky or fail to report at check stations have been excluded from hunting in the special permit zones for the remainder of the season, and have had to pass another identification test prior to hunting the next season. Special late seasons extending as late as March 10 were enacted in 1996 and 1997 in both states to manage spring crop depredation.

Success of past regulatory regimes has varied. During the restrictive season structures in the mid-1980s and early 1990s the total annual harvest of dusky Canada geese did not exceed the quota limits (Appendix G), but it was common for some specific hunt areas to reach their annual unit quotas and close for the season. Sheaffer (1993) found that average annual survival rates for dusky geese were very high (76-85%) during this period, and that the population was not adversely affected by hunting regulations. However, that study also indicated that small changes in adult survival could lead to large changes in population levels, and that continued conservative regulations were necessary, given low recruitment rates.

Although permit hunt areas have been expanded in Oregon and Washington since the mid-1990s, the dusky goose harvest has declined and specific hunt units have seldom filled their quotas. Over the past ten years, an average annual harvest of approximately 100 dusky geese has been recorded at check stations, while the harvest of other Canada geese has been maintained at about 12,000 (Appendix G). Under recent harvest regulations during 1997-2004, estimates of dusky goose adult survival have remained stable (95% CI = 74-80%; Fondell et al. 2006b).

Harvest Distribution—During 1951-1984, prior to restrictive seasons, band recovery data indicated that about 70% of the harvest of dusky geese occurred in Oregon and the remaining 30% was distributed about equally between Washington, British Columbia, and Alaska (Appendix H). With increased hunting restrictions since 1985, band recoveries declined in all areas, especially in Oregon. The lower proportion of bands recovered in Oregon (average 48%)

caused proportional increases to 28% in Alaska and 15% in Washington (Appendix H). Band recovery distributions should be interpreted with caution because (1) band reporting rates likely vary across the range, and the effect of check stations on reporting rates is unknown, and (2) numbers of band recoveries have been low under restrictive seasons.

Historically, most band recoveries in Alaska are from the Cordova/Copper River Delta area and adjacent Gulf of Alaska coast, but not in southeast Alaska. A substantial portion of recoveries and collar sightings in British Columbia are from the Queen Charlotte Islands region, although recoveries from this region have declined recently. Less than 1% of band recoveries have been recorded from other areas of the Pacific Flyway.

Harvest Subspecies Composition—Through the mid-1960's, dusky Canada geese comprised 80% or more of western Oregon goose harvest (Chapman et al. 1969). As the population of Taverner's Canada geese increased in that area, the proportion of dusky Canada geese in the total goose harvest decreased. However, a combination of traditional hunting practices and behavioral differences between subspecies has resulted in a higher proportion of duskys in the harvest than expected from the subspecies composition (Simpson and Jarvis 1979). From 1982-85, duskys made up 48% of the Canada geese harvested at five state and federal management areas. During that same period, the proportion of duskys among all Canada geese wintering in the area averaged only 18% (see Figure 2; Appendix A). During 1976-83, before seasons were implemented to redirect harvest away from the subspecies, dusky geese were about 2.6 to 3.1 times more vulnerable to harvest than Taverner's geese (Simpson and Jarvis 1979, Jarvis and Cornely 1988).

Restrictive harvest regulations instituted in 1984 were designed to allow continuation of a Canada goose harvest on the wintering grounds by emphasizing harvest of other subspecies while protecting dusky and cackling Canada geese. Dusky geese made up only 4% of the Canada goose harvest in the Oregon - Washington wintering area during 1985-95, and have comprised about 1% of the harvest since 1996.

Recent genetic work done on 105 hunter-killed birds that were classified as dusky geese at check stations indicated that approximately 35 % of females and 50% of males probably originated from somewhere other than the Copper River Delta and Prince William Sound (Pearce et al. 2000). Analysis of 45 geese that were close in measurements but not classified as duskys found only about 2% duskys in that group. These results indicate that current classification criteria at check stations are accurate in detecting nearly all duskys, but that estimates of “dusky” harvest from check stations include other large, dark Canada geese.

One classification problem at check stations that could affect quota closures is the continued presence of a small group of dusky geese and presumed western-dusky hybrids that breed around Willapa Bay, Washington and on islands near the mouth of the Columbia River. These geese are not Alaska-breeding birds that are the object of the dusky harvest quota system. They are descendents of a captive breeding program initiated by Willapa NWR in 1958, when 40 dusky goslings were relocated from the Copper River Delta to a pen near the refuge headquarters (Welch, pers. comm.). This flock grew to about 400 by the mid-1970s, when the pen and nearby nest structures were dismantled. Although recent estimates of flock size are not available, each

year on Miller Sands Island in Oregon approximately 40 nests of dark Canadas are recorded. Since 1999, approximately 1,200 dark Canadas have been banded and collared on Miller Sands Island. In effect, harvest of unmarked “wuskys” are tallied as dusky geese at check stations and counted toward unit closure thresholds. Continued marking of this small population would reduce the unintended inclusion of these birds in permit zone harvest quotas for dusky geese.

MANAGEMENT ISSUES

Issues identified in this section are addressed in Recommended Management Procedures that follows this section.

A. Breeding Grounds

1. Changes on the Copper River Delta, resulting from uplift of the area during the 1964 earthquake, have affected goose production. Woody vegetation has increased greatly while aquatic and wetland habitats have declined. Trends in plant succession warrant continued monitoring, especially with regard to changes in habitat use by dusky goose and habitat characteristics that affect avian and mammalian predators.
2. There is considerable annual variation in the impacts of specific avian and mammalian predators on dusky geese. There is a continuing need to describe and monitor the changing predator-prey dynamics on the breeding grounds, particularly to measure predation on adult dusky geese and pre-fledging goslings (i.e., recruitment).
3. The results of recent research need to be fully analyzed to assess age-related productivity and population age structure, and be incorporated into a new population model. Such information is needed to determine the current reproductive potential of the population.
4. Because eagles appear to be the most important nest predator (Anthony et al. 2004), and an important predator of goslings (Grand et al. 2003, Fondell et al. in prep.), and eagle nesting habitat is increasing, there is a growing need to assess the trend in eagle numbers and distribution on the CRD and understand their foraging behavior in relation to nesting geese.
5. Eulachon are an alternative prey for eagles, and their abundance is strongly tied to rates of dusky goose nest success and probably also gosling survival. However, stocks of eulachon in the Pacific Northwest and California have shown precipitous declines (Moyle 1994, Hay et al. 1997), and this fish remains relatively unstudied in the Copper River region. Experimental commercial fisheries have been allowed on the lower Copper River since 1996, but harvests (dip net only) have been highly variable from small up to 78 metric tons because the timing and strength of runs is unpredictable.
6. Human disturbance on the Copper River Delta during the period of dusky goose use (mid-April to October) is low, but could increase. Increases in summer recreation, including commercial tourism, could have localized effects on dusky geese. Linkage of Cordova with the state highway system and/or any major economic development in the

region could substantially increase the number of residents and visitors using the Copper River Delta for recreation.

7. Potential road construction and resource extraction projects also could adversely impact goose habitat and the population. Oil spills may occur from the aging and corroding Trans Alaska Pipeline where it spans one of the Copper River tributaries, oil tanker traffic in the Gulf of Alaska, or future offshore drilling, resulting in direct mortality or chronic or catastrophic damage to dusky goose habitats.
8. There is dissatisfaction among hunters who forego opportunity to hunt migrant Canada geese in Unit 6 (CRD). Canada goose season is closed for the first month of the season, allowing dusky geese to depart, but also precluding harvest of cacklers, lessers, and Taverner's geese. If migrant Canada geese fail to stop on CRD after September 28, much of the annual goose hunting opportunity in this region is lost.

B. Wintering Grounds

1. The large wintering Canada goose aggregation in northwest Oregon and southwest Washington, of which the dusky Canada goose is a small portion, presents serious management problems. The increase of cackling geese (*B. h. minima*), which are recovering from historic population lows, has complicated management even further in the wintering area. Cacklers wintered mainly in California prior to the 1980's, but as the population recovered, its wintering range shifted northward to overlap the range of the dusky. With increasing goose numbers, complaints of crop depredation by all Canada geese have increased significantly
2. Implementing strategies to allow harvest of abundant subspecies of Canada geese while protecting the dusky goose is very time-consuming, controversial, and expensive. Dusky geese are more vulnerable to hunting, apparently due to their behavior and habitat use patterns, making control of their harvest difficult. Controlled goose hunts using specific open areas, check stations, stringent harvest permit requirements, hunter education, and law enforcement require substantial commitments of personnel, time, and money.
3. Conversion of bottomland pastures along the Columbia and Willamette Rivers to other uses, including commercial and residential development and crops that are not beneficial to wintering geese, reduces goose foraging habitat. Loss of wintering habitat concentrates geese on remaining lands, increasing depredation concerns. No objective methods have been developed to determine the amount of winter habitat needed to support the dusky population and the growing aggregation of other Canada geese. State and federal refuge areas are limited in maximizing habitat available for geese by economic and social factors.

RECOMMENDED MANAGEMENT STRATEGIES

The following management procedures are recommended even though the degree and timing of their implementation by the agencies involved may be influenced by human resource, fiscal and legislative constraints. Whenever possible, management procedures in this plan should be integrated with those in plans for other Pacific Flyway goose populations, local and regional land use plans, and habitat conservation programs. Management actions should be accompanied by monitoring efforts to examine their effectiveness in meeting population and habitat objectives in an adaptive management approach.

This plan identifies three action levels for increasingly intensive management efforts to benefit the population status of dusky Canada geese. These levels are designed to ensure adequate time for management actions to take effect, based on biological constraints and the expected response times of dusky Canada geese to the proposed management actions. Most of the more intensive actions have considerably higher monetary and socio-political costs to the participating agencies and thus are reserved for lower population levels. These actions are intended to provide reasonable opportunity for the dusky Canada goose population to recover from low levels. Significant improvements in the total population of dusky Canada geese will continue to be dependent on sustaining and enhancing that major portion of the population breeding on the Copper River Delta. Therefore, this plan identifies three increasingly intensive action levels primarily designed to maintain and enhance the number of dusky Canada geese on the Copper River Delta.

The choice of specific population levels that trigger certain management actions is based on the current best estimates of factors influencing the status of dusky Canada geese and the projected population responses to specific management actions. The population triggering levels are scaled to the first objective in the plan: Manage the number of dusky geese to sustain the population within a range of 10,000 to 20,000 geese.

Action levels are triggered by 3-year average indices, except that declines from level 2 to level 3 will be triggered by annual indices. If a reliable annual population index is unattainable in any given year, the last complete index survey and other relevant data on annual status will be used to determine the action level to be implemented. Determinations of whether annual surveys are reliable or not will be made by the surveys crew, and evaluation of apparent results in relation to previous survey data. A survey index that is more than 30% different from the previous index and deemed unreliable will not trigger a change in action level for the current year. If results of the subsequent survey support a change in action level, it will be implemented.

ACTION LEVEL 1:	20,000 – 10,000
ACTION LEVEL 2:	9,999 - 5,000
ACTION LEVEL 3:	below 5,000

Management procedures that relate to these levels are described in each section below. In the event that Action Level 3 is reached, the agencies will initiate a thorough population risk assessment, review the conservation status of dusky geese, and re-evaluate all feasible and practical intensive management options.

A. Habitat and Ecological Factors

Breeding Grounds - Action Level 1

- 1.1 Complete vegetation mapping at 10-year increments to quantify vegetation change over time and implications to dusky Canada geese.

Lead Agencies: USFS
Participating: ADFG, USFWS
Priority: 1
Schedule: Next in 2008

- 1.2 Continue a policy of stringent habitat protection through management of USFS lands for fish and wildlife, and management of the state Critical Habitat Area to prevent habitat degradation and enhance goose production.

Lead Agencies: USFS, ADFG
Priority: 1
Schedule: Ongoing

- 1.3 Continue to maintain and monitor dusky Canada goose artificial nest islands to increase occupancy and minimize costs. Evaluate additional sites suitable for nest islands.

Lead Agencies: USFS
Participating: ADFG, USFWS
Priority: 1
Schedule: Ongoing

- 1.4 Increase the number of artificial nest islands by 200 within ponds that meet island criteria.

Lead Agency: USFS
Participating: ADFG, ODFW
Priority: 1
Schedule: Ongoing

- 1.5 Evaluate concepts to enhance nesting habitat on barrier islands of Copper River Delta.

Lead Agencies: USFS, ADFG
Participating: USFWS
Priority: 2
Schedule: Ongoing

- 1.6 Monitor all habitat enhancement techniques to determine success and feasibility.

Lead Agency: USFS
Participating: ADFG, USGS-BRD
Priority: 1
Schedule: Ongoing

1.7 Manage mammalian predator populations through public hunting and trapping, and other feasible and practical means that are consistent with multi-species management goals and public policy.

Lead Agencies: ADFG, USFS
Participating: USFWS
Priority: 1
Schedule: Ongoing

1.8 Establish CRD as an eagle donor site for restoration programs; implement capture and relocation.

Lead Agency: USFWS
Participating: USFS, ADFG
Priority: 1

1.9 Develop an options paper for a comprehensive predator management program based on best available information, including a program of evaluation and testing of specific strategies.

Participating: ADFG, USFWS, USFS, USDA-WS
Priority: 1
Schedule: 2008

1.10 Test and evaluate deterrence and redistribution of coyotes and other mammalian predators on defendable areas to increase goose production, based on patterns of nest/gosling predation and area evaluations. Includes experimental feeding at lure sites.

Lead Agency: ADFG
Participating: USFWS, USFS, USDA-WS
Priority: 1
Schedule: 2008-2009

1.11 Test and evaluate the use of avian predator deterrence and redistribution, based on predation patterns and area evaluations. Includes experimental feeding at lure sites.

Lead Agencies: ADFG, USFWS
Participating: USFS, USDA-WS
Priority: 1
Schedule: 2008-2009

Breeding Grounds - Action Level 2

2.1 Install maximum number of artificial nest islands in suitable habitats on the Copper River Delta.

Lead Agency: USFS
Participating: ADFG, ODFW
Priority: 1

2.2 Implement habitat enhancement practices on the barrier islands, based on previous research.

Lead Agencies: USFS, ADFG

Participating: USFWS

Priority: 2

2.3 Develop brown bear guided hunt areas on the Copper River Delta to increase bear harvest. Most of the WCRD is closed to guides under “home rule” provisions of the Chugach NF plan, but some other areas can be opened without amending the plan

Lead Agencies: ADFG, USFS

Priority: 1

2.4 Implement deterrence, redistribution, and further liberalized hunting and trapping of coyotes and other mammalian predators on defendable areas to increase goose production. Requires action by the Alaska Board of Game.

Lead Agency: ADFG

Participating: USFWS, USFS, USDA-WS

Priority: 1

2.5 Implement avian predator deterrence and redistribution, based on previous research and experimental tests in Level 1.

Lead Agencies: USFWS, ADFG

Participating: USFS, USDA-WS

Priority: 1

2.6 Initiate an environmental analysis for NEPA compliance on directed predator control options. Prepare a draft NEPA document that could be implemented at Level 3.

Lead Agencies: USFS, USFWS, USDA-WS

Participating: ADFG

Priority: 1

2.7 Develop an assessment of the feasibility and costs of captive-rearing dusky geese on Copper River Delta.

Lead Agencies: ADFG, USFWS

Participating: USFS, ODFW, WDFW

Priority: 1

Breeding Grounds - Action Level 3

3.1 Implement directed predator control programs that have been deemed feasible and have undergone the public review process specified in item 3.2 above.

Participating: ADFG, USFS, USFWS, USDA-WS

Priority: 1

3.2 Implement a program of captive brood-rearing to enhance survival of goslings to fledging.

Lead Agencies: ADFG, USFS, USFWS
Participating: ODFW, WDFW
Priority: 1

Migration Areas - All Action Levels

1. Identify and protect habitat along migration routes through resolution from the Flyway Council and/or individual agencies and through cooperative agreements with other land management agencies.

Lead Agencies: USFWS, ADFG, WDFW, ODFW, PCJV
Participating: CWS, BCMOE
Priority: 2
Schedule: Ongoing

Wintering Grounds - All Action Levels

1. Maintain existing state and federal areas for goose resting, feeding, and sanctuary.

Lead Agencies: WDFW, ODFW, USFWS
Priority: 1
Schedule: Ongoing

2. Develop new cooperative management programs for public lands, other than national wildlife refuges and state management areas, that result in increased goose food production and reduced disturbance of geese during winter, especially for dusky geese.

Lead Agencies: ODFW, WDFW, USFWS
Participating: Other federal, state, and private organizations
Priority: 1
Schedule: Ongoing

3. Analyze survey and neck-collar information to identify high goose use areas, review management plans for these areas and develop cooperative land management agreements or other means to improve habitat management for dusky geese.

Lead Agencies: USFWS
Participating: ODFW, WDFW, other federal, state, and private organizations
Priority: 1
Schedule: Ongoing

B. Public Use

As stated in the objectives of this plan, agencies seek to minimize the incidental harvest of dusky geese, to be consistent with population maintenance and growth, while allowing management of abundant subspecies as necessary to assist in depredation control.

Public Use – **Action Level 1**

- 1.1 Maintain conservative hunting regulations for dusky Canada geese when the 3-year average population index is between 10,000 and 20,000. Maintain harvest quota of 250 for Oregon and Washington (allocating 165 to Oregon and 85 to Washington) and delayed Canada goose season in Alaska Game Management Units 5 and 6.

Lead Agencies: USFWS, ADFG, WDFW, ODFW
Priority: 1
Schedule: Ongoing

- 1.2 Relax hunting restrictions when the 3-year average population index exceeds 20,000 (e.g., modify or reduce the quota zones in Oregon and Washington; in Alaska, open Canada goose season earlier in affected units).

Lead Agencies: USFWS, ADFG, WDFW, ODFW
Priority: 1
Schedule: Ongoing

- 1.3 Maintain check stations at appropriate locations in southwest Washington and western Oregon to monitor harvest using standardized classification criteria, and continue additional field enforcement emphasis to monitor and encourage compliance with regulations.

Lead Agencies: WDFW, ODFW, USFWS
Priority: 1
Schedule: Ongoing

- 1.4 Encourage hunters in Alaska GMUs 5 and 6 to participate in a voluntary check of harvested Canada geese to more accurately determine harvest location and subspecies composition.

Lead Agencies: ADFG
Participating: USFWS, USFS
Priority: 1
Schedule: Ongoing

- 1.5 Evaluate harvest levels of birds wintering in British Columbia, and develop and implement complementary regulatory packages aimed at conservation of dusks in B.C.

Lead Agencies: CWS, BCMOE
Priority: 1
Schedule: 2008

- 1.6 Maintain efforts to educate hunters on goose identification and the rationale for current regulations in an effort to reduce the take of dusky Canada geese; avoidance of the dusky quota limits for season closures will maintain goose hunting through the full framework to mitigate crop depredation.

Lead Agencies: USFWS, ADFG, ODFW, WDFW
Priority: 1
Schedule: Ongoing

- 1.7 Maintain interpretive programs such as visitor centers and written and pictorial information on the life history and management of the dusky Canada goose.

Lead Agencies: ADFG, WDFW, ODFW, USFS, USFWS
Priority: 2
Schedule: Ongoing

Public Use – Action Level 2

- 2.1 Implement a combined dusky Canada goose harvest quota of 175 in primary dusky use areas of Washington, Oregon, and Alaska (OR – 90, WA – 45, AK – 40).

Lead Agencies: USFWS, WDFW, ODFW, ADFG
Participating: USFS
Priority: 1

- 2.2 In Washington and Oregon, all Canada goose hunting in the Northwest Oregon/Southwest Washington Quota Zones would be targeted to optimize depredation control.

Lead agencies: USFWS, WDFW, ODFW
Priority: 1

- 2.3 In Alaska, implement a permit-only Canada goose hunt in the core dusky goose area (Alaska GMU 6-C and parts of D), hunter education program, and mandatory check-in.

Lead Agencies: ADFG
Participating: USFWS, USFS
Priority: 1

- 2.4 After a period of very restrictive regulations, resumption of Action Level 1 hunting seasons will be considered when the 3-year average population index exceeds 12,500 dusks.

Lead Agencies: USFWS, ADFG, WDFW, ODFW
Participating: USFS
Priority: 1

Public Use - Action Level 3

- 3.1 Minimize the harvest of dusky Canada geese to the extent possible in the Northwest Oregon/Southwest Washington Quota Zones and British Columbia.

Lead Agencies: USFWS, WDFW, ODFW, CWS, BCMOE
Priority: 1

- 3.2 Minimize the harvest of dusky Canada geese to the extent possible in the Alaska dusky goose core area (GMU 6-C, parts of D) delineated with harvest data and fall goose surveys.

Lead Agency: USFWS, ADFG
Priority: 1

3.3 After a period of closure, resumption of Action Level 2 hunting seasons will be considered when the population index exceeds 7,500 duskys (3-year average).

Lead Agencies: USFWS, ADFG, WDFW, ODFW
Priority: 1

C. Crop Depredation Control

Increasing numbers of geese wintering in southwest Washington and northwest Oregon have made crop depredation control a major management concern. Strategies to address the collective effects of seven goose populations on agricultural lands have been developed in the NW Oregon/SW Washington Canada Goose Agricultural Depredation Control Plan (Pacific Flyway Council_1998). This plan provides guidance for management of goose habitats on private and public lands, as well as approaches to managing hunting programs to mitigate crop damage. The depredation control plan includes consideration for goals, objectives, and management procedures identified in Pacific Flyway management plans for each goose population, including this one for dusky geese.

1. Take advantage of opportunities to secure additional goose use areas for resting, feeding, and sanctuary through either fee acquisition or development of conservation/agricultural easement programs.

Lead Agencies: ODFW, WDFW, USFWS
Participating: Other federal, state, and private organizations
Priority: 1
Schedule: Ongoing

D. Inventories

Breeding Grounds

1. Conduct a spring aerial survey of birds on the nesting grounds along standard density-stratified transects. Conduct experimental surveys in additional areas where breeding dusky geese are detected.

Lead Agency: USFWS
Priority: 1
Schedule: Annually

2. Conduct a survey of dusky geese and productivity on Middleton Island as a component of a breeding ground population estimate.

Lead Agency: ADFG
Priority: 1
Schedule: Biennial (next 2008); may be done annually at Level 2

3. Monitor stratified random nest plots to determine correction factors for aerial surveys and trends in nest densities and nest success. Compare spring aerial survey and ground nest plot data to re-evaluate the air:ground ratio estimate used to adjust the spring index. Monitoring should include analysis of nest success in relation to habitat types and evident predator species.
 Lead Agency: USFS
 Participating: USFWS, ADFG, ODFW, WDFW
 Priority: 2
 Schedule: 3-year intervals, next in 2010

4. Conduct annual aerial production surveys on the Copper River Delta.
 Lead Agency: ADFG
 Priority: 1
 Schedule: Ongoing

5. Periodically band dusky geese on the Copper River Delta breeding grounds and peripheral areas to support analyses of harvest distribution and survival, and research objectives. Banding goals are 300 geese collared and banded; 300 leg-banded only every two years.
 Lead Agencies: ADFG
 Participating: USFWS, USFS
 Priority: 1
 Schedule: Ongoing, next in 2008

6. Conduct a winter survey of Canada geese in Prince William Sound.
 Lead Agency: ADFG
 Participating: USFWS, USFS
 Priority: 2
 Schedule: 2007-2008

7. Compile breeding season records of Canada geese in Prince William Sound, evaluate potential methods for an index survey, and explore options to mark a sample of geese.
 Lead Agency: ADFG, USFS
 Participating: USFWS, USGS-BRD
 Priority: 2
 Schedule: Ongoing

8. Conduct spring and fall distribution surveys of Canada geese on Copper River Delta to identify staging areas and assess harvest vulnerability of dark goose aggregations.
 Lead Agencies: USFS
 Priority: 2
 Schedule: 2009, biannually

Wintering Grounds

1. Conduct the annual midwinter waterfowl inventory.

Lead Agencies: USFWS
Participating: WDFW, ODFW
Priority: 1
Schedule: Ongoing

2. Conduct periodic Canada goose monitoring in the WV-LCR to acquire data on the total wintering goose population, distribution of dusky neck collars, subspecies composition, and use of habitats.

Lead Agencies: USFWS
Participating: WDFW, ODFW
Priority: 1
Schedule: Ongoing

3. Continue a banding and marking program on dusky and western-dusky hybrids that breed on the lower Columbia River to identify these birds and avoid counting them as dusky geese during surveys and at hunter check stations.

Lead Agencies: WDFW, ODFW
Priority: 1
Schedule: Ongoing

4. Evaluate existing information on dusky migration and wintering areas in B.C. to develop feasible monitoring programs within Canadian wildlife agency budgets.

Lead Agencies: CWS, BCMOE
Priority: 1
Schedule: 2009

E. Research

1. The Subcommittee will make recommendations for research and review research proposals. Priority will be given to proposals that address high priority management problems.

Priority: 1
Schedule: Ongoing

2. Develop a comprehensive population model, based on results of recent research, to integrate information on factors that affect recruitment and population size. These include breeding propensity and reneating, clutch size, nest success, age-related productivity, population age structure, and seasonal and annual survival of goslings and adults.

Priority: 1
Schedule: Ongoing

3. Determine timing and patterns of migration, and spring distribution of subadults and other nonbreeding birds.
Priority: 2
Schedule: To be determined
4. Examine survival rates and sources of mortality of adult dusky Canada geese during the nesting period.
Priority: 2
Schedule: To be determined
5. Examine methods of improving production surveys on Copper River Delta to better reflect observed annual variation in nest success and gosling survival (e.g., replicate surveys, detection of markers in relation to visibility in the range of habitat types).
Priority: 1
Schedule: Ongoing
6. Investigate the ecology and productivity of Canada geese breeding in Prince William Sound including Green, Hinchinbrook, and Montague Islands.
Priority: 2
Schedule: To be determined
7. As an alternative to other methods, estimate recruitment on the Copper River Delta and elsewhere using DNA isolated from eggshell membranes.
Priority: 2
Schedule: To be determined
8. Evaluate factors involved in the loss of goose nesting on Egg Island.
Priority: 1
Schedule: To be determined
9. Determine changes in aquatic habitat on the breeding grounds and the implications to brood-rearing.
Priority: 1
Schedule: To be determined
10. Investigate bald eagle movements and identify alternative prey resources during the dusky breeding season to examine the relation between eagle abundance, alternative prey sources, and goose predation. Predation by immature and non-breeding eagles seems inversely related to abundance of eulachon, but the role of nesting eagles (territorial birds) in predation on geese is unknown; studies of the feeding ecology of nesting pairs may be important.
Priority: 1
Schedule: To be determined

11. Initiate studies to better assess eulachon stocks on the Copper River Delta, including annual variation in strength and timing of runs, threat factors, and harvest potential.
Priority: 1
Schedule: To be determined
12. Re-evaluate dusky goose habitat use patterns during nesting and brood-rearing in relation to plant community succession.
Priority: 2
Schedule: Ongoing
13. Mark and track Middleton Island progeny to determine emigration pattern.
Priority: 1
Schedule: To be determined
14. Re-examine the genetic composition of hunter-killed Canada geese submitted at check stations and classified as dusky Canada geese (after Pearce et al. 2000) to identify source populations.
Priority: 1
Schedule: 2007-2008
15. Compare habitat requirements among subspecies of geese wintering in the Willamette Valley and Lower Columbia River region to evaluate how management options designed to reduce crop depredation will impact individual subspecies.
Priority: 1
Schedule: Ongoing
16. Develop methods to determine the amount and type of winter habitat needed to support the dusky population and the growing aggregation of other Canada geese.
Priority: 1
Schedule: Ongoing
17. Compare nutritional quality among major forage types used by geese in SW Washington and NW Oregon and assess energetic carrying capacity of public lands.
Priority: 1
Schedule: Ongoing

ANNUAL PLAN REVIEW

The Subcommittee shall meet twice annually, or as needed, to review progress towards achieving the goal and objectives of this plan, and to recommend actions and revisions. The Subcommittee shall report to the Pacific Flyway Council through its Study Committee on accomplishments and shortcomings of the cooperative management efforts. This Subcommittee shall coordinate management activities with those of the subcommittees on lesser/Taverner Canada geese, cackling Canada geese, and Pacific population of western Canada geese.

The Subcommittee shall be composed of a representative from the Canadian Wildlife Service, U.S. Fish and Wildlife Service, and state and provincial agencies responsible for management of the dusky goose population. It shall be the responsibility of those members to assure that the objectives and procedures of this plan are integrated and coordinated with those plans and activities of the various wildlife and land management agencies and local planning systems within their agency's venue. Chairmanship shall be appointed biennially and rotated among member agencies (except for Canadian agencies). The Subcommittee will exercise its prerogative to invite to attend and participate (ex officio) at meetings any individual, group, agency, or representative whose expertise, counsel, or managerial capacity is required for the coordination and implementation of management programs.

Agencies: Subcommittee
Priority: 1
Schedule: Twice annually--at the March and July meetings of the Pacific Flyway Study Committee. The schedule for rotation of the chair, beginning October 1, is:

2007 - FWS Region 1
2009 - Oregon
2011 - FWS Region 7
2013 - Washington
2015 - Alaska

LITERATURE CITED

- Anthony, R.M., J.B. Grand, T.F. Fondell, and B.F.J. Manly. 2004. A quantitative approach to identifying predators from nest remains. *J. Field Ornith.* 75:40-48.
- Banks, R.C., C. Cicero, J.L. Dunn, et al. 2004. Forty-fifth supplement to the American Ornithologists' Union checklist of North American birds. *Auk* 121(3): 985-995.
- Bowman, T. D., P. F. Schempf, J. I. Hodges. 1997. Bald eagle population in Prince William Sound after the Exxon Valdez oil spill. *J. Wildl. Manage.* 61:962-967.
- Bromley, R.G.H. 1976. Nesting and habitat studies of the dusky Canada goose (*Branta canadensis occidentalis*) on the Copper River Delta, Alaska. M.S. thesis. Univ. Alaska. Fairbanks. 81 pp.
- Bromley, R.G.H. and T.C. Rothe. 2003. Conservation assessment for the dusky Canada goose (*Branta canadensis occidentalis* Baird). Gen. Tech. Rep. PNW-GTR-591. U.S. Dept. of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. 79 pp.
- Butler, W.L., and W.D. Eldridge. 1991. Development of an aerial breeding pair survey for dusky Canada g (*Branta canadensis occidentalis*) on the Copper River Delta: final report. Unpubl. rept. U.S. Fish and Wildl. Serv., Anchorage. 30 pp.
- Campbell, B.H. 1990a. Annual waterfowl program progress report. Unpubl. rept., Alaska Dep. Fish and Game. Anchorage. 41 pp.
- Campbell, B.H. 1990b. Factors affecting the nesting success of dusky Canada geese, *Branta canadensis occidentalis*, on the Copper River Delta, Alaska. *Can. Field Nat.* 104:567-574.
- Campbell, B.H. 1991. Activities of brown bears on the Copper River Delta, Alaska and their impact on nesting dusky Canada geese. *Northwest Naturalist* 72:92-99.
- Campbell, B.H. 1992. Results of a Canada goose transplant in Southcentral Alaska. Unpubl. rept., Alaska Dept. Fish and Game. Anchorage. 8 pp.
- Campbell, B.H., and H.J. Griese. 1987. Management options for dusky Canada geese and their predators on the Copper River Delta, Alaska. Unpubl. rept., Alaska Dep. Fish and Game. Anchorage. 91 pp.
- Campbell, B.H., D.H. Rosenberg, and T.C. Rothe. 1988. Annual report of survey and inventory activities - waterfowl. Vol. XVIII, Part XIII. Fed. Aid Wildl. Rest. Proj. W-22-6. Alaska Dept. Fish and Game, Anchorage. 75 pp.

- Campbell, B.H., and T.C. Rothe. 1989. Annual report of survey and inventory activities - waterfowl. Vol. XIX, Part XIII. Fed. Aid Wildl. Rest. Proj. W-23-1. Alaska Dept. Fish and Game, Anchorage. 42 pp.
- Campbell, B.H., and J.E. Cornely. 1992. Dusky Canada goose: An annotated bibliography. U.S. Fish and Wildl. Serv. Resource Publ. No. 187. USDI, Washington, DC. 30 pp.
- Carnes, J.C. 2004. Wolf Ecology on the Copper and Bering River Deltas, Alaska. Ph.D. Dissertation. Univ. of Idaho, Moscow.
- Chapman, J.A., C.J. Henny, and H.M. Wight. 1969. The status, population dynamics, and harvest of the dusky Canada goose. *Wildl. Monogr.* 18:1-48.
- Cornely, J.E., B.H. Campbell, and R.L. Jarvis. 1985. Productivity, mortality, and status of dusky Canada geese. *Trans. N. Amer. Wildl. and Nat. Resour. Conf.* 50:540-548.
- Crowley, D., M.J. Petrula, T.C. Rothe, D.H. Rosenberg, and B. Scotton. 1998. Marking Canada geese on the North Gulf Coast of Alaska – 1998. Unpubl. rept. Alaska Dept. Fish and Game, Anchorage. 5 pp.
- Delacour, J. 1954. *The Waterfowl of the world.* Vol. 1. Country Life limited, London. 284 pp.
- Eldridge, W.D., and J. Hodges. 2007. Methods used to analyze aerial dusky Canada goose data in relation to the ground nest surveys on the Copper River Delta. Unpubl. Rept. U.S. Fish and Wildl. Serv., Anchorage. 8 pp. + appendices.
- Eldridge, W.D., R. Platte, C.P. Dau, and W. Larned. 1998. Report to the Pacific Flyway Study Committee on 1986-1998 breeding ground surveys of dusky Canada geese on the Copper River Delta. Unpubl. rept. U.S. Fish and Wildl. Serv., Anchorage. 6 pp.
- Eldridge, W., D. Logan, J. Hodges, J. Fode, D. Youkey, and J. Crouse. 2005. Preliminary analysis of nest numbers related to aerial observations of breeding pairs of dusky Canada geese on the Copper River Delta, Alaska. Unpubl. rept. U.S. Fish and Wildl. Serv., Anchorage.
- Fisher, J. 2006. Transition from indirect to direct estimates of dusky Canada. Unpubl. Rept. U.S. Fish and Wildl. Serv., Migr. Bird Manage., Anchorage. 2 pp.
- Fode, J., P. Meyers, and D. Logan. 2006. Artificial nest island program for dusky Canada geese on the Copper River Delta, Alaska. Unpubl. rept. U.S. Forest Service, Cordova Ranger District, Cordova, AK. 7 pp.
- Fondell, T.F., J.B. Grand, D.A. Miller, and R.M. Anthony. 2006a. Renesting by dusky Canada geese on the Copper River Delta, Alaska. *J. Wildl. Manage.* 70(4): 955-964.

- Fondell, T.F., J.B. Grand, and R.M. Anthony. 2006b. Productivity and survival of dusky Canada geese on the Copper River Delta, Alaska. Unpubl. progr. rept. U.S. Geological Survey.
- Fondell, T.F., J.B. Grand, D.A. Miller, and R.M. Anthony. Manuscript submitted. Seasonal clutch size decline in dusky Canada Geese: nest success and season length.
- Fondell, T.F., D.A. Miller, J.B. Grand, and R.M. Anthony. Accepted 2007. Survival of dusky Canada goose goslings in relation to weather and nest success. *J. Wildl. Manage.*
- Fondell, T.F., D.A. Miller, J.B. Grand, and R.M. Anthony. In prep. Predators of dusky Canada goose goslings based on transmitters.
- Gould, P.J., and A.E. Zabloudil. 1981. Reproductive ecology of seabirds at Middleton Island, Alaska, 14-26 June 1981. Unpubl. Rep., Marine Bird Section, U. S. Fish and Wildl. Serv., Anchorage. 15 pp.
- Grand, J.B., T.F. Fondell, and R.M. Anthony. 2003. Productivity and survival of dusky Canada geese on the Copper River Delta, Alaska. Unpubl. prog. rept. U.S. Geological Survey.
- Grand J.B., T.F. Fondell, D.A. Miller, and R.M. Anthony. 2006. Nest survival of dusky Canada geese: use of discrete time models. *Auk* 123:198-210.
- Hansen, H.A. 1962. Canada geese of coastal Alaska. *Trans. N. Amer. Wildl. Conf.* 27: 301-329.
- Hansen, H.A. 1968. Pacific Flyway Canada goose management -federal and state cooperation. Pages 47-49 in R. L. Hine and C. Schoenfeld, eds. *Canada goose management: current continental problems and programs.* Dembar Educ. Res. Serv., Madison, WI.
- Hay, D.E., J. Boutiller, M. Joyce, and G. Langford. 1997. The eulachon (*Thaleichthys pacificus*) as an indicator species in the North Pacific. Pages 509-530 in *Forage fishes in marine ecosystems.* Alaska Sea Grant College Program. No. 97-01. Univ. of Alaska, Fairbanks.
- Hills, M.R., B.H. Campbell, and M. Naughton. 1991. Status of the dusky Canada goose. Unpubl. report to Dusky Canada Goose Subcomm., Pacific Flyway Study Comm. U. S. Fish Wildl. Serv., Ridgefield, WA. 7 pp.
- Isleib, M.E.; and B. Kessel. 1973. Birds of the North Gulf Coast--Prince William Sound Region, Alaska. *Biological Papers* 14. Fairbanks, AK: University of Alaska. 149 pp.
- Jarvis, R.L. 1989. Estimated mid-winter population of dusky Canada geese, 1988-89. Unpubl. report to Dusky Canada Goose Subcomm. Pacific Flyway Study Comm. Oregon St. Univ., Corvallis. 4 pp.

- Jarvis, R.L. 1990. Estimated mid-winter population of dusky Canada geese, 1989-90. Unpubl. report to Dusky Canada Goose Subcomm. Pacific Flyway Study Comm. Oregon State Univ., Corvallis. 5 pp.
- Jarvis, R.L., and J.E. Cornely. 1988. Recent changes in wintering populations of Canada geese in western Oregon and southwestern Washington. Pages 517-528 in M. W. Weller, ed. Waterfowl in winter. University of Minn. Press, Minneapolis. 624 pp.
- Johnson, D.H., D.E. Timm and P.F. Springer. 1979. Morphological characteristics of Canada geese in the Pacific Flyway. Pages 56-80 *in* R.L. Jarvis and J.C. Bartonek, eds. Management and biology of Pacific Flyway geese. Oregon State Univ. Book Stores, Inc. Corvallis.
- Mech, L.D. 1970. The wolf: ecology and behavior of an endangered species. The Natural History Press, New York. 384 pp.
- Mech, L.D., and L. Boitani. 2003. Wolves: behavior, ecology, and conservation. University of Chicago Press, Chicago.
- Miller, D. A., J.B. Grand, T.F. Fondell, and R.M. Anthony. 2006. Predator functional response and prey survival: direct and indirect interactions affecting a marked prey population. *Journal of Animal Ecology* 75:101-110.
- Miller, D.A., J.B. Grand, T.F. Fondell, and R.M. Anthony. 2007. Optimizing nest survival and female survival: consequences of nest site selection for Canada geese. *Condor* 109: 769-780.
- Miller, S.D. 1990. Population management of bears in North America. *Int. Conf. Bear Res. and Manage.* 8:357-373
- Miller, S.D. 1997. Impacts of heavy hunting pressure on the density and demographics of brown bear populations in southcentral Alaska. Research Final Rep. Grants W-24-2, W-24-3, W-24-4. Fed. Aid Wildl. Rest. Study 4.26. Alaska Dept. Fish and Game, Anchorage. 97 pp.
- Moyle, P. 1994. The decline of anadromous fishes in California. *Conserv. Biol.* 8: 869-870.
- Pacific Flyway Council. 1973. Guidelines for management of the dusky Canada goose. Unpubl. rept. Pacific Flyway Study Comm. [c/o USFWS, MBMO] Portland, OR. 12 pp.
- Pacific Flyway Council. 1985. Pacific Flyway management plan for the dusky Canada goose. Unpubl. rept. Pacific Flyway Study Comm. [c/o USFWS, MBMO] Portland, OR. 23 pp.
- Pacific Flyway Council. 1992. Pacific Flyway management plan for the dusky Canada goose. Unpubl. rept. Pacific Flyway Study Comm. [c/o USFWS, MBMO] Portland, OR. 25 pp.

- Pacific Flyway Council. 1997. Pacific Flyway management plan for the dusky Canada goose. Unpubl. rept. Pacific Flyway Study Comm. [c/o USFWS, MBMO] Portland, OR. 46 pp. + appendices.
- Pacific Flyway Council. 1998. Pacific Flyway management plan for Northwest Oregon – Southwest Washington Canada goose agricultural depredation control. Unpubl. rept. Pacific Flyway Study Comm. and Canada Goose Agric. Depred. Working Group [c/o USFWS, MBMO] Portland, OR. 31 pp. + appendices.
- Palmer, R.S., Ed. 1976. Handbook of North American birds, Vol. 2. Waterfowl (Pt. 1). Yale Univ. Press, New Haven, CT. 520 pp.
- Pearce, J.B., and K.S. Bollinger. 2003. Morphological traits of Pacific Flyway Canada geese as an aid to subspecies identification and management. *J. Field Ornithol.* 74(4): 357-369.
- Pearce, J.B., B.J. Pierson, and S.L. Talbot, D.V. Derksen, D. Kraege, and K.T. Scribner. 2000. A genetic evaluation of morphology used to identify harvested Canada geese. *J. Wildl. Manage.* 64: 863-874.
- Petrula, M.J., T.C. Rothe, D.H. Rosenberg, D. Crowley, and D. Logan. 2006. Canada goose survey on Middleton Island – 2006. Unpubl. rept. Alaska Dept. Fish and Game, Anchorage. 4 pp.
- Pewe, T.L. 1975. Quaternary geology of Alaska. U.S. Geol. Surv. Prof Pap. 835. 145 pp.
- Ploeger, P.L. 1968. Geographical differentiation in arctic Anatidae as a result of isolation during the last glacial. *Ardea* (56):1-159.
- Reimnitz, E. 1972. Effects in the Copper River Delta. Pages 290-302 *in* The great Alaska earthquake of 1964: Oceanography and coastal engineering. Nation. Acad. Sci. Publ. 1605. Washington, D.C.
- Rosenberg, D.H., D. Crowley, M. Petrula, and T.C. Rothe. 1996. Middleton Island Canada geese: a status report. Unpubl. rept. Alaska Dept. Fish and Game, Div. Wildl. Conserv., Anchorage. 8 pp.
- Schmutz, J.A., R.F. Rockwell, and M.R. Petersen. 1997. Relative effects of survival and reproduction on the population dynamics of emperor geese. *J. Wildl. Manage.* 61: 191-201
- Scribner, K.T., S.L. Talbot, J.M. Pearce, B.J. Pierson, K.S. Bollinger, and D.V. Derksen. 2003. Phylogeography of Canada geese (*Branta canadensis*) in western North America. *Auk* 120: 889-907.
- Sheaffer, S.E. 1993. Population ecology of the Dusky Canada goose. Ph.D. Thesis. Oregon State University, Corvallis.

- Shields, G.F.; and J.P. Cotter. 1998. Phylogenies of North American geese: the mitochondrial DNA record. Pages 405-411 *in* Rusch, D.H.; Samuel, M.D.; Humburg, D.D.; Sullivan, B.D., eds. *Biology and management of Canada geese: Proceedings of the International Canada Goose Symposium*. Marler Graphics, Middleton, WI.
- Shields, G.F., and A.C. Wilson. 1987. Sub-species of the Canada goose (*Branta canadensis*) have distinct types of mitochondrial DNA. *Evolution* 41: 662-666.
- Sibley, C.G. and B.L. Monroe. 1990. *Distribution and taxonomy of birds of the world*. Yale Univ. Press.
- Simpson, S.G., and R.L. Jarvis. 1979. Comparative ecology of several subspecies of Canada geese during winter in western Oregon. Pages 223-241 *in* R. L. Jarvis and J. C. Bartonek, eds. *Management and biology of Pacific Flyway geese*. Oregon State Univ. Book Stores, Corvallis.
- Stephenson, T.R.; and V. Van Ballenberghe. 1995. Wolf, *Canis lupus*, predation on dusky Canada geese, *Branta canadensis occidentalis*. *Canadian Field-Naturalist* 109: 253-255.
- Talbot, S.L., J.M. Pearce, B.J. Pierson, D.V. Derksen, and K.T. Scribner. 2003. Molecular status of the dusky Canada goose (*Branta canadensis occidentalis*): A genetic assessment of a translocation effort. *Conservation Genetics* 4: 367-381.
- Trainer, C.E. 1959. The 1959 western Canada goose (*Branta canadensis occidentalis*) study on the Copper River Delta, Alaska. *In* *Annual Waterfowl Rept., Alaska*. U. S. Fish Wildl. Serv., Juneau. 9 pp.
- USDA Forest Service. 2002. Revised land and resource management plan: Chugach National Forest. U.S. Forest Serv., Chugach Natl. Forest, Anchorage, Alaska.

APPENDICES

APPENDIX A. Trends in numbers of Canada geese wintering in the Willamette Valley and Lower Columbia River regions of Washington and Oregon.

Year	Oregon	Washington	Total
1961	16,773	1,222	17,995
1962	15,302	2,175	17,477
1963	12,742	1,786	14,528
1964	16,494	2,649	19,143
1965	14,937	2,099	17,036
1966	19,909	905	20,814
1967	8,545	2,780	21,325
1968	23,962	4,461	28,423
1969	23,138	2,350	25,488
1970	22,834	5,200	28,034
1971	22,260	5,592	27,852
1972	17,877	5,297	23,174
1973	18,537	4,448	22,985
1974	33,240	1,449	34,689
1975	28,163	2,960	31,123
1976	35,033	5,783	40,816
1977	44,294	5,954	50,248
1978	27,013	4,576	31,589
1979	48,614	7,913	56,527
1980	59,453	10,900	70,353
1981	43,365	8,841	52,206
1982	65,943	12,380	78,323
1983	63,019	3,405	66,424
1984	65,446	12,847	78,293
1985	55,791	14,838	70,629
1986	63,239	20,479	83,718
1987	69,576	12,690	82,266
1988	55,654	20,928	76,582
1989	49,941	18,720	68,661
1990	58,992	22,816	81,808
1991	40,257	24,839	65,096
1992	65,372	24,287	89,659
1993	66,953	30,964	97,917
1994	86,196	15,985	102,181
1995	112,364	28,743	141,107
1996	109,480	30,075	139,555
1997	96,921	20,502	117,423
1998	145,935	22,638	168,573
1999	138,901	14,689	153,590
2000	183,247	21,493	204,740
2001	170,272	18,731	189,003
2002	122,432	14,578	137,010
2003	108,567	37,057	145,624
2004	No survey	No survey	No survey
2005	101,420	15,690	117,110
2006	131,862	6,753	138,615
2007	112,892	8,513	121,405
2008	133,660	10,891	144,551

APPENDIX B. Indirect population estimates of dusky Canada geese derived from observations of marked birds during winter.

Winter	Estimate	SE
1989-90	12,438	997
1990-91	19,768	2,001
1991-92	17,996	1,580
1992-93		
1993-94		
1994-95	7,948	2,292
1995-96	18,175	5,880
1996-97	11,198	1,711
1997-98	21,280	3,642
1998-99	13,447	1,679
1999-00	15,459	2,459
2000-01	17,346	2,719
2001-02	17,191	2,820
2002-03	16,724	1,856
2003-04	14,892	1,767
2004-05	21,788	2,367
2005-06	11,901	1,125
2006-07	14,112	2,802

APPENDIX C. Estimates of dusky Canada geese from spring aerial surveys on the Copper River Delta, biennial counts of adults on Middleton Island, and management index of total dusky geese adopted in 2006.

	Total Geese		Paired Geese		Flocked	Expanded Paired ¹	CRD Total w/Flocked	Middleton Adults ²	Indicated Total ³	3-Year Average
	Survey Total	95% CI	Survey Paired	95% CI						
1986	5,469	356	4,811	389	658	16,335	16,993	80	17,073	
1987	5,408	504	4,294	409	1,114	14,580	15,694	84	15,778	
1988	5,296	364	4,412	325	884	14,981	15,865	90	15,955	16,269
1989	6,582	565	4,463	369	2,119	15,154	17,273	75	17,348	16,360
1990	5,442	669	4,482	457	960	15,218	16,178	93	16,271	16,525
1991	3,773	437	2,861	356	912	9,714	10,626	249	10,875	14,831
1992	6,648	835	4,472	284	2,176	15,184	17,360	473	17,833	14,993
1993	6,334	495	4,096	265	2,238	13,908	16,146	473	16,619	15,109
1994	5,810	432	4,226	253	1,584	14,349	15,933	473	16,406	16,953
1995	3,685	323	3,357	250	328	11,398	11,726	473	12,199	15,075
1996	3,509	267	2,936	190	573	9,969	10,542	1,456	11,998	13,535
1997	4,208	271	3,379	176	829	11,473	12,302	1,168	13,470	12,556
1998	4,814	350	3,571	203	1,243	12,125	13,368	1,168	14,536	13,335
1999	3,068	224	2,599	174	469	8,825	9,294	1,168	10,462	12,823
2000	3,009	184	2,477	128	532	8,410	8,942	1,309	10,251	11,750
2001	3,157	202	2,788	181	369	9,466	9,835	1,309	11,144	10,619
2002	3,836	294	2,966	173	870	10,071	10,941	1,416	12,357	11,251
2003	3,083	222	2,215	129	868	7,521	8,389	1,416	9,805	11,102
2004	3,198	235	2,712	190	486	9,208	9,694	1,499	11,193	11,118
2005	5,050	614	3,986	418	1,064	13,534	14,598	1,499	16,097	12,365
2006	3,412	26	3,006	301	406	10,207	10,613	1,453	12,066	13,119
2007	2,848	188	2,456	157	392	8,339	8,731	1,453	10,184	12,782

¹ Expanded paired (Paired Geese x 3.39) is adjusted for nest detection and reneating rates, and air:ground detection rate.

² Most recent count of adults from surveys every other year.

³ Indicated total = Expanded Paired + Flocked + Middleton Adults

APPENDIX D. Estimates of percent young dusky Canada geese and sample sizes from July aerial surveys on the Copper River Delta.

Year	% Young	Geese sampled	Year	% Young	Geese sampled
1971	16.2	5,717	1990	23.5	5,530
1972	10.6	8,193	1991	23.5	5,530
1973	36.0	5,873	1992 ²	23.1	7,633
1974	51.4	8,199	1993	5.0	4,542
1975	17.9	8,990	1994	5.7	6,977
1976	24.2	7,092	1995	3.9	5,818
1977	44.3	--	1996	21.7	6,329
1978	24.8	--	1997	10.5	6,253
1979	16.0	12,700	1998	11.7	4,919
1980	23.7	7,500	1999	14.7	4,156
1981	17.9	8,740	2000	24.1	4,397
1982	23.7	8,473	2001	25.4	3,165
1983	15.0	7,740	2002	30.5	3,708
1984	18.3	11,913	2003	7.2	5,929
1985	3.7	13,780	2004	27.8	5,678
1986 ¹	10.7	13,309	2005	11.8	5,364
1987	9.8	12,448	2006	23.1	6,216
1988	22.5	6,917	2007	20.9	4,246
1989	8.6	6,114			
37-Year Avg.	19.2	7,234	10-Year Avg.	19.7	4,778

¹ Estimates made with regression of flock size error 1986-1988.

² Prior to 1992, surveys conducted by fixed-winged aircraft; since 1993 with Robinson R-22 or R44 helicopter.

APPENDIX E. Numbers of dusky Canada geese observed and estimated production on Middleton Island, Alaska.

Date	Number of Adults	Number of known-sized broods (#young)	Number of unknown-sized broods (#young)	Number of suspected broods ^a	Estimated number of young ^b	Estimated number of broods	Average brood size (SD)	Total geese observed ^c	Total geese estimated ^d
1996 Jun 20-22	1456	27 (111)	118 (420)	38	752±246	183	4.11 (1.58)	1987	2208±246
1997 Jun 23-25	1168	27 (106)	156 (490)	18	789±282	201	3.93 (1.62)	1764	1957±282
2000 Jun 19-21	1309	163 (638)	108 (284)	39	1227±284	310	4.01 (1.93)	2231	2536±284
2002 Jun 27-29	1416	107 (347)	136 (314)	17	843±226	260	3.24 (1.48)	2077	2259±226
2004 June 20-22	1499	105 (360)	110 (258)	39	871±219	254	3.43 (1.47)	2117	2370±219
2006 June 22-24	1453	167 (564)	54 (98)	31	864±160	252	3.53 (1.88)	2115	2317±160

^a Single or paired adult geese that flushed from thick vegetation close to the observer. Goslings were suspected of being present but were not observed.

^b Number of young in known-sized broods + [(number of unknown-sized broods + number of suspected broods) * average brood size ± standard deviation].

^c Adults + all observed young.

^d Adults + estimated young

APPENDIX F. Artificial nest islands on west Copper River Delta, occupancy by dusky Canada geese, and nest success.

Year	Islands in Program (No.)	Islands Monitored (No.) ^a	Islands Available (No.)	Nest Attempts (No./%)	Successful Nests (No./%)	Destroyed Nests (No./%)	Unknown Nests (No./%)
1984	39	39	39	5/13	5/100	0/0	0/0
1985	37	37	37	4/11	3/75	1/25	0/0
1986	132	121	116	10/9	4/40	4/40	2/20
1987	279	279	256	24/9	16/67	4/17	4/17
1988	534	520	480	55/11	40/73	9/16	6/11
1989	524	303	238	30/13	17/57	6/20	7/23
1990	546	327	288	39/14	28/72	8/21	3/8
1991	603	379	338	63/19	35/56	11/17	17/27
1992	582	331	254	43/17	34/79	7/16	2/5
1993	601	379	292	66/23	40/61	7/11	19/29
1994	548	302	258	58/22	12/21	35/60	11/19
1995	496	324	256	64/25	20/31	34/53	10/16
1996	409	395	337	93/28	56/60	26/28	11/12
1997	366	364	328	90/28	54/59	30/33	6/7
1998	367	366	345	104/30	42/40	44/42	18/17
1999	362	356	354	99/28	52/53	43/43	2/2
2000	359	354	346	110/32	83/75	25/23	0/0
2001	361	357	337	147/44	82/56	52/36	1/6
2002	360	349	344	105/31	79/83	7/7	0/0
2003	345	345	334	108/32	66/61	39/36	0/0
2004	336	336	331	137/41	99/72	30/22	8/6
2005	334	334	317	137/43	86/63	40/29	11/8
2006	328	328	320	156/48	53/40	63/47	18/13
2007	330	330	314	154/47	51/33	81/53	10/6

^a Approximately half the nest islands in the program were monitored 1989–1995. Summary data for those years only apply to the monitored islands.

APPENDIX G. Subspecies composition and estimated harvest of Canada geese from check station data in southwest Washington and western Oregon.

Northwest Oregon

Season	Cackler	Dusky	Lesser	Taverner	Vancouver	Western	Other ¹	Total	% Cackler	% Dusky
1984-85	0	603	0	641	0	0	21	1,265	0.0%	47.7%
1985-86	8	157	257	1,156	2	95	0	1,675	0.5%	9.4%
1986-87	19	134	103	1,157	0	0	127	1,540	1.2%	8.7%
1987-88	54	118	235	2,524	3	258	1	3,193	1.7%	3.7%
1988-89	26	142	273	3,067	3	415	0	3,926	0.7%	3.6%
1989-90	16	79	346	2,563	5	1,623	2	4,634	0.3%	1.7%
1990-91	18	177	572	2,684	6	1,846	0	5,303	0.3%	3.3%
1991-92	42	121	378	2,287	9	1,091	0	3,928	1.1%	3.1%
1992-93	36	147	422	2,294	8	1,333	1	4,241	0.8%	3.5%
1993-94	72	188	748	2,699	41	1,348	4	5,100	1.4%	3.7%
1994-95	1,220	142	447	2,669	9	1,415	9	5,911	20.6%	2.4%
1995-96	1,758	83	462	1,885	10	598	20	4,816	36.5%	1.7%
1996-97	2,503	87	809	1,773	9	1,110	1	6,292	39.8%	1.4%
1997-98	3,113	112	853	2,439	26	1,448	17	8,008	38.9%	1.4%
1998-99	5,641	127	751	3,266	40	1,513	6	11,344	49.7%	1.1%
1999-00	7,302	93	418	3,002	8	1,525	5	12,353	59.1%	0.8%
2000-01	4,972	70	385	3,259	28	1,319	7	10,040	49.5%	0.7%
2001-02	3,652	49	306	1,335	19	1,083	10	6,454	56.6%	0.8%
2002-03	4,911	42	225	1,732	18	1,293	15	8,236	59.6%	0.5%
2003-04	3,631	43	343	1,459	177	926	7	6,586	55.1%	0.7%
2004-05	6,824	34	552	2,018	26	1,250	18	10,722	63.6%	0.3%
2005-06	4,734	36	525	1,959	9	1,222	5	8,490	55.8%	0.4%
2006-07	5,503	26	347	1,907	24	1,247	2	9,056	60.8%	0.3%
5-Yr Avg	5,121	36	398	1,815	51	1,188	9	8,618	59.4%	0.4%

Southwest Washington

Season	Cackler	Dusky	Lesser	Taverner	Vancouver	Western	Other ¹	Total	% Cackler	% Dusky
1984-85	0	37	0	63	0	20	0	120	0.0%	30.8%
1985-86	11	66	116	113	0	67	25	398	2.8%	16.6%
1986-87	8	36	51	172	0	241	0	508	1.6%	7.1%
1987-88	7	45	225	478	4	224	35	1,018	0.7%	4.4%
1988-89	17	43	136	617	0	763	7	1,583	1.1%	2.7%
1989-90	37	52	92	455	9	391	0	1,036	3.6%	5.0%
1990-91	28	65	165	555	20	383	3	1,219	2.3%	5.3%
1991-92	39	88	295	675	14	483	15	1,609	2.4%	5.5%
1992-93	84	91	270	1,340	25	722	2	2,534	3.3%	3.6%
1993-94	93	90	299	944	8	697	4	2,135	4.4%	4.2%
1994-95	422	77	246	1,011	31	704	6	2,497	16.9%	3.1%
1995-96	334	59	144	862	12	536	1	1,948	17.1%	3.0%
1996-97	1,030	35	475	1,705	18	932	3	4,198	24.5%	0.8%
1997-98	1,311	58	392	2,197	33	742	5	4,738	27.7%	1.2%
1998-99	1,820	46	306	1,877	34	833	9	4,925	37.0%	0.9%
1999-00	1,455	27	209	1,265	155	623	33	3,767	38.6%	0.7%
2000-01	1,450	32	235	1,242	95	687	35	3,776	38.4%	0.8%
2001-02	758	23	130	644	112	496	11	2,174	34.9%	1.1%
2002-03	1,291	38	153	896	93	591	61	3,123	41.3%	1.2%
2003-04	674	28	104	483	78	413	19	1,799	37.5%	1.6%
2004-05	1,079	25	123	597	122	461	53	2,460	43.9%	1.0%
2005-06	1,037	31	157	863	108	584	30	2,810	36.9%	1.1%
2006-07	1,085	26	141	580	110	410	52	2,404	45.1%	1.1%
5-Yr Avg	1,033	30	136	684	102	492	43	2,519	41.0%	1.2%

¹ Other includes Aleutian Canadas, domestic x Canada hybrids, and unidentified geese

APPENDIX H. Geographic distribution (%) of band recoveries from dusky Canada geese.

Year	N ^a	Alaska	British Columbia	Washington	Oregon	Other ^b
1951	3	0.0	0.0	0.0	100.0	0.0
1952	35	17.1	2.9	5.7	74.3	0.0
1953	105	9.5	24.8	8.6	57.1	0.0
1954	198	10.1	7.1	18.7	63.6	0.5
1955	87	5.7	3.4	10.3	80.5	0.0
1956	93	4.3	23.7	8.6	63.4	0.0
1957	156	4.5	26.3	8.9	58.9	1.3
1958	130	5.4	14.6	11.5	68.5	0.0
1959	145	6.9	20.0	4.1	68.9	0.0
1960	165	4.8	19.4	17.6	58.2	0.0
1961	53	11.3	18.9	9.4	60.4	0.0
1962	107	14.0	11.2	13.1	61.7	0.0
1963	117	5.9	16.2	5.9	69.2	2.6
1964	70	5.7	7.1	15.7	71.4	0.0
1965	111	8.1	14.4	16.2	60.4	0.9
1966	92	7.6	8.7	3.2	80.4	0.0
1967	75	8.0	6.7	16.0	69.3	0.0
1968	96	9.4	18.8	9.4	62.5	0.0
1969	98	10.2	10.2	12.2	67.3	0.0
1970	153	11.1	8.5	8.5	71.9	0.0
1971	69	10.1	5.8	5.8	78.3	0.0
1972	112	8.0	0.0	8.9	83.0	0.0
1973	64	18.8	4.7	10.9	64.1	1.6
1974	176	13.6	5.1	15.3	65.9	0.0
1975	194	14.4	5.2	12.9	67.5	0.0
1976	233	10.3	11.6	13.3	64.3	0.4
1977	243	17.2	4.9	10.7	66.7	0.4
1978	230	26.5	3.5	11.7	56.1	2.2
1979	123	13.8	1.6	16.3	67.5	0.8
1980	101	3.9	2.9	9.9	82.2	0.9
1981	57	7.0	0.0	8.8	84.2	0.0
1982	64	12.5	0.0	9.4	76.6	1.6
1983	71	7.0	0.0	8.5	84.5	0.0
1984	63	20.6	7.9	7.9	63.5	0.0
Avg^c	114	10.0	9.3	10.4	69.8	0.4

APPENDIX H. (cont.)

Year	N ^a	Alaska	British Columbia	Washington	Oregon	Other ^b
1985	47	8.5	12.8	34.0	42.6	2.1
1986	26	26.9	15.4	11.5	46.2	0.0
1987	22	36.4	13.6	0.0	50.0	0.0
1988	43	32.6	11.6	25.6	30.2	0.0
1989	30	63.3	3.3	3.3	30.0	0.0
1990	35	48.6	5.7	8.6	37.1	0.0
1991	19	57.9	0.0	15.8	26.3	0.0
1992	27	33.3	3.7	18.5	40.7	3.7
1993	13	15.4	0.0	23.1	61.5	0.0
1994	12	41.7	0.0	16.7	41.7	0.0
1995	10	0.0	10.0	10.0	80.0	0.0
1996	12	16.7	8.3	8.3	66.7	0.0
1997	15	53.3	0.0	13.3	20.0	13.3
1998	26	19.2	7.7	34.6	38.5	0.0
1999	34	41.1	17.6	17.6	23.5	0.0
2000	32	18.8	0.0	18.8	62.5	0.0
2001	32	15.6	9.4	9.4	62.5	3.1
2002	29	27.6	14.0	14.0	44.8	0.0
2003	28	14.3	10.7	17.9	57.1	0.0
2004	29	24.1	3.4	10.3	62.1	0.0
2005	13	0.0	0.0	7.7	92.3	0.0
Avg^d	25	28.3	7.0	15.2	48.4	1.1

^a Shot = 4,184 geese; found dead = 164 geese; band found or reported = 46; other = 29.

^b California = 17 geese; N. Dakota = 2 geese; Utah, Idaho, Minnesota, and Alberta = 1 goose.

^c Average prior to significant restrictive harvest regulation (1951 – 1984).

^d Average after significant restrictive harvest regulations (1985 – 2005).