file

Alaska Department of Fish and Game
Division of Game
Federal Aid in Wildlife Restoration
Annual Report of Survey—Inventory Activities

WATERFOWL

by
Bruce H. Campbell
Daniel H. Rosenberg
Thomas C. Rothe

Vol. XVIII, Part XIII
Project W-22-6, Job 11.0
July 1988

STATE OF ALASKA
Steve Cowper, Governor

DEPARTMENT OF FISH AND GAME
Don W. Collinsworth, Commissioner

DIVISION OF GAME
W. Lewis Pamplin, Jr., Director
Steven R. Peterson, Research Chief

Additional copies of this report, or reports on other species covered in this series may be obtained from:

Publications Technician
ADF&G, Game Division
P.O. Box 3-2000
Juneau, AK 99802
(907) 465-4190

CONTENTS

1986-87

ALASKA WATERFOWL REGULATIONS SUMMARY - SEASONS AND LIMITS

Species and Units	Open Seasons	Bag Limits
DUCKS (Except sea ducks)		
Units 1-4	Sept. 1-Dec. 16	7 a day, 21 in possession*
Units 5-7, 9, 14-16 and 10 (Unimak Island only)	Sept. 1-Dec. 16	8 a day, 24 in possession*
Units 8 and 10 (except Unimak Island)	Oct. 8-Jan. 22	7 a day, 21 in possession*
Units 11-13 and 17-26	Sept. 1-Dec. 16	10 a day, 30 in possession*

*Except no more than 3 daily, 9 in possession may be pintails.

Species and Units	Open Seasons	Bag Limits
SEA DUCKS (Eiders, scoters, old squaw, harlequin) and mergansers		
Units 1-7, 9, 10 (Unimak Island only) and 11-26	Sept. 1-Dec. 16	15 a day, 30 in possession
Units 8 and 10 (except Unimak Island)	Oct. 8-Jan. 22	15 a day, 30 in possession
CANADA GEESE (Except Cackling Canada)		
Units 1-4, 7, 9 (except 9E), 10 (Unimak Island only), 11-17, and 19-26	Sept. 1-Dec. 16	4 a day*, 8* in possession
Units 5 and 6	Sept. 21-Dec. 16	4 a day*, 8* in possession
Units 8, 9E, 10 (except Unimak Island) and 18	No open season	

*No more than 4 a day or 8 in possession may be any combination of Canada or white-fronted geese. The combined bag limit of Canada, white-fronted and snow geese is 6 a day, 12 in possession.

Species and Units	Open Seasons	Bag Limits
WHITE-FRONTED GEESE		
Units 1-7, 9, 14-18	Sept. 1-Dec. 16	2 a day, 4 in possession
Unit 8	Oct. 8-Jan. 22	2 a day, 4 in possession
Unit 10 (except Unimak Island	Oct. 8-Jan. 22	4 a day*, 8* in possession
Unit 10 (Unimak Island only), 11-13, and 19-26	Sept. 1-Dec. 16	4 a day*, 8* in possession

*No more than 4 a day, 8 in possession may be any combination of Canada and white-fronted geese. The combined bag limit for Canada, white-fronted and snow geese is 6 a day, 12 in possession.

Species and Units	Open Seasons	Bag Limits
SNOW GEESE		
Units 1 (except 1C) 2-7, 9, 10 (Unimak Island only), and 11-26	Sept. 1-Dec. 16	6 a day*, 12* in possession*
Units 1C	No open season	
Units 8 and 10 (except Unimak Island)	Oct. 8-Jan. 22	6* a day, 12* in possession*

*The combined bag limit for snow, Canada, and white-fronted geese is 6 a day, 12 in possession

Species and Units	Open Seasons	Bag Limits
BRANT		
Units 1-7, 9, 10 (Unimak Island only) and 11-26	Sept. 1-Dec. 16	2 a day, 4 in possession
Units 8 and 10 (except Unimak Island)	Oct. 8-Jan. 22	2 a day, 4 in possession
EMPEROR GEESE	No open season	
SNIPE		
Units 1-7, 9, 19 (Unimak Island only), and 11-26	Sept. 1-Dec. 16	8 a day, 16 in possession
Units 8, and 10 (except Unimak Island)	Oct. 8-Jan. 22	8 a day, 16 in possession
CRANES		
Units 1-7, 9, 10 (Unimak Island only) and 14-17	Sept. 1-Dec. 16	2 a day, 4 in possession
Units 11, 12, 13 and 18-26	Sept. 1-Dec. 16	3 a day , 6 in possesion
Unit 8 and 10 (except Unimak Island)	Oct. 8-Jan. 22	2 a day, 4 in possession

WEAPONS: Waterfowl may be taken with a shotgun (not larger than 10 gauge) or bow and arrow, but not rifle or pistol.

PLUGS: Shotguns must be plugged to a 3-shell capacity or less for waterfowl hunting.

CONVEYANCES: Hunting is not permitted from an aircraft, motor-driven vehicle, airboat, jet boat, or propeller driven boat, which the motor of such has not been completely shut off and its progress therefrom has ceased.

POSSESSION: No state tagging requirements, see Federal Regulations.

TRANSPORTATION: Waterfowl may be plucked in the field, but one fully feathered wing or the head must remain attached while being transported.

SHOOTING HOURS: One half hour before sunrise to sunset.

STAMPS: No person 16 or more years of age may take waterfowl unless he carries a current validated Federal migratory bird hunting stamp (Duck Stamp) and Alaska Waterfowl Conservation tag (stamp) on his person.

SPECIAL RESTRICTIONS: In the Palmer Hay Flats State Game Refuge, no person may transport any waterfowl, snipe, crane, or a part of these, or any waterfowl hunter or waterfowl hunting gear, with the use of a mortorized vehicle except within the main channels of the Matanuska River, Rabbit Slough, Knik River, and adjacent tidal saltwaters.

WATERFOWL HARVEST AND HUNTER ACTIVITY

GAME MANAGEMENT UNITS: All

GEOGRAPHIC DESCRIPTION: Statewide

PERIOD COVERED: 1 July 1986-30 June 1987

Introduction

Because the state waterfowl-hunter survey was being redesigned, it was not used by the Alaska Department of Fish and Game (ADF&G) in 1986. In its absence, the U. S. Fish and Wildlife Service (FWS) mail questionnaire and parts collection surveys were used to estimate hunter activity and harvest during the 1986-87 season.

Methods

Survey methods used by the FWS are summarized in Voelzer et al. (1982). Briefly, the FWS categorizes data from their parts collection surveys according to codes listed in Table 1. Data are coded to either specific locations within 11 harvest areas (Fig. 1), or if birds were not taken at the specific locations listed in Table 1, then the general harvest area code is assigned; e.g., a duck harvested at Palmer Hay Flats would be coded to the specific harvest area code 1123, while a duck shot on the Kasilof Flats would be coded to the region code 1103 (Cook Inlet) because there is no code for that specific harvest location. Harvest and hunter activity data in this report are from Carney et al. (1987) and are based on Federal Duck Stamp sales for the 3rd quarter. For Alaska, these estimates typically do not vary significantly from final survey data and are considered adequate representation of harvest and hunter activities.

Results

Number of Hunters:

Based on the sale of 19,570 Federal Duck Stamps in Alaska, representing increases of 26% and 20% from the 1985 and 1967-85 averages, respectively (Fig. 2), approximately 12,830 people hunted waterfowl during the 1986-87 season (Table 2). This estimate, which was adjusted for stamp sales to collectors and inactive hunters, represented increases of 34% and 14% from the 1985 and 1967-85 FWS averages, respectively. An estimated 71.2% of the hunters were active in 1986, compared with estimates of 65.4% (FWS) and 66.1% (state) in 1985 (Fig. 2).

Table 1. Summary of FWS codes used to assign harvest locations in Alaska.

Old Code	New Code	ADF&G Region (R) and Place Names	Original FWS "County" Name	Harvest Zone
0001	0000	Unknown	Unknown	Unknown
0011	0101	North Slope (R)	Arctic Slope	NW
0031	0301	Seward Peninsula (R)	Seward Peninsula	NW
0051	0502	Yukon Valley (R)	Upper Yukon-Kuskokwim	Central
0051	0512	Yukon Flats	Upper Yukon-Kuskokwim	Central
0071	0702	Central (R)	Fairbanks-Minto	Central
0071	0712	Minto Flats	Fairbanks-Minto	Central
0071	0722	Eielson AFB	Fairbanks-Minto	Central
0071	0732	Salchaket Slough	Fairbanks-Minto	Central
0071	0742	Healy Lake	Fairbanks-Minto	Central
0071	0752	Delta Area	Fairbanks-Minto	Central
0071	0762	Tok-Northway	Fairbanks-Minto	Central
0091	0901	Yukon Delta (R)	Yukon-Kuskokwim Delta	NW
0111	1103	Cook Inlet (R)	Anchorage-Kenai	SE
0111	1113	Susitna Flats	Anchorage-Kenai	SE
0111	1123	Palmer-Hay Flats	Anchorage-Kenai	SE
0111	1133	Goose Bay	Anchorage-Kenai	SE
0111	1143	Potter Marsh	Anchorage-Kenai	SE
0111	1153	Chickaloon Flats	Anchorage-Kenai	SE
0111	1163	Portage	Anchorage-Kenai	SE
0111	1173	Trading Bay	Anchorage-Kenai	SE
0111	1183	Redoubt Bay	Anchorage-Kenai	SE
0111	1193	Kachemak Bay	Anchorage-Kenai	SE
0131	1303	Gulf Coast (R)	Cordova-Copper River	SE
0131	1313	Copper River Delta	Cordova-Copper River	SE
0131	1323	Yakutat Area	Cordova-Copper River	SE
0131	1333	Prince William Sound	Cordova-Copper River	SE
0151	1503	Southeast Coast (R)	Juneau-Sitka	SE
0151	1513	Chilkat River	Juneau-Sitka	SE
0151	1523	Blind Slough	Juneau-Sitka	SE
0151	1533	Rocky Pass	Juneau-Sitka	SE
0151	1543	Duncan Canal	Juneau-Sitka	SE
0151	1553	St. James Bay	Juneau-Sitka	SE
0151	1563	Mendenhall Wetlands	Juneau-Sitka	SE
0151	1573	Farragut Bay	Juneau-Sitka	SE
0151	1583	Stikine River Delta	Juneau-Sitka	SE
0171	1704	Kodiak (R)	Kodiak Island	SW
0171	1714	Kalsin Bay	Kodiak Island	SW
0191	1904	AK Peninsula (R)	Cold Bay-AK Peninsula	SW
0191	1914	Cold Bay	Cold Bay-AK Peninsula	SW
0191	1924	Pilot Point	Cold Bay-AK Peninsula	SW
0191	1934	Port Moller	Cold Bay-AK Peninsula	SW
0191	1944	Port Heiden	Cold Bay-AK Peninsula	SW
0211	2104	Aleutian Chain (R)	Aleutians-Pribilofs	SW

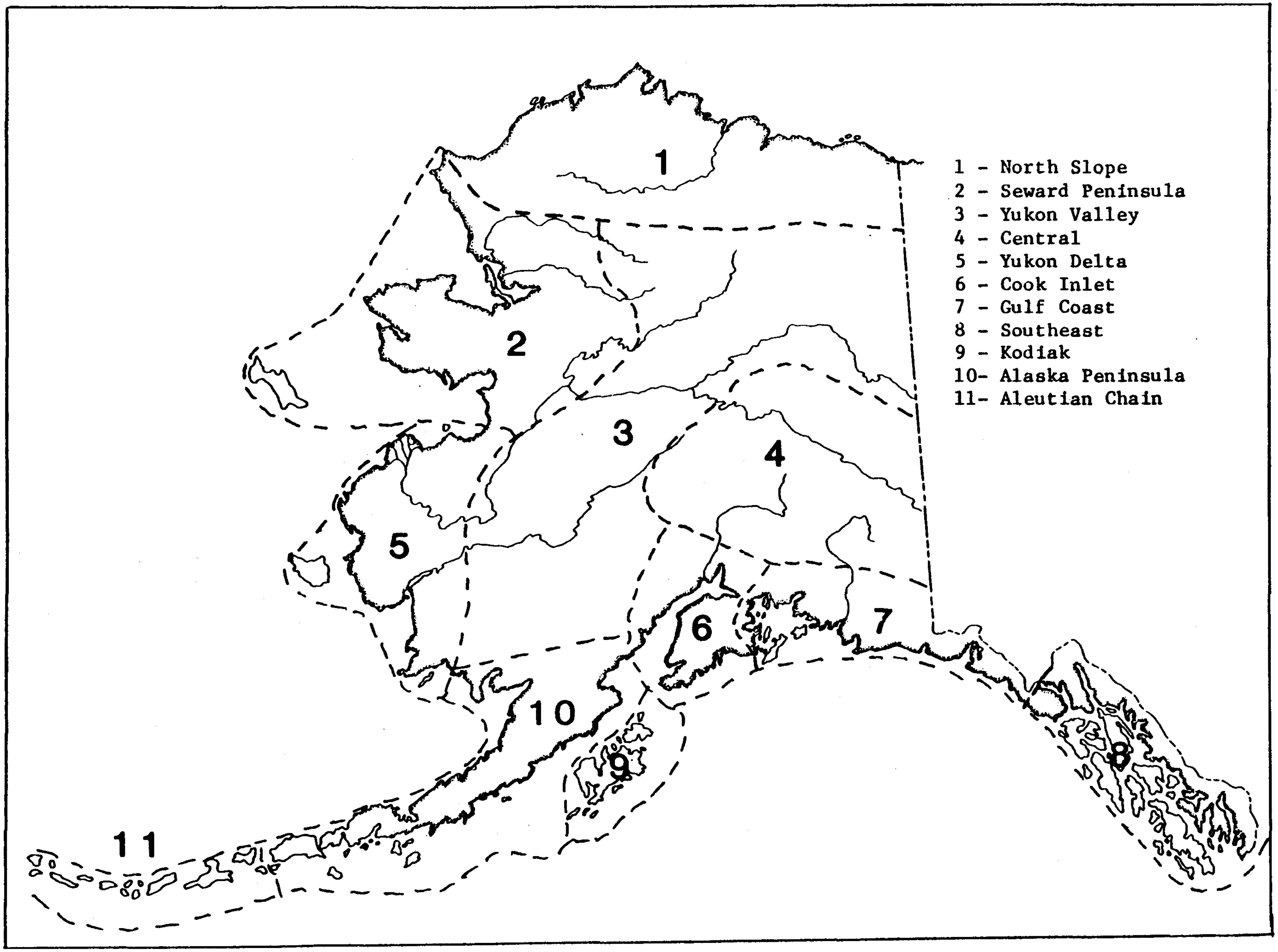
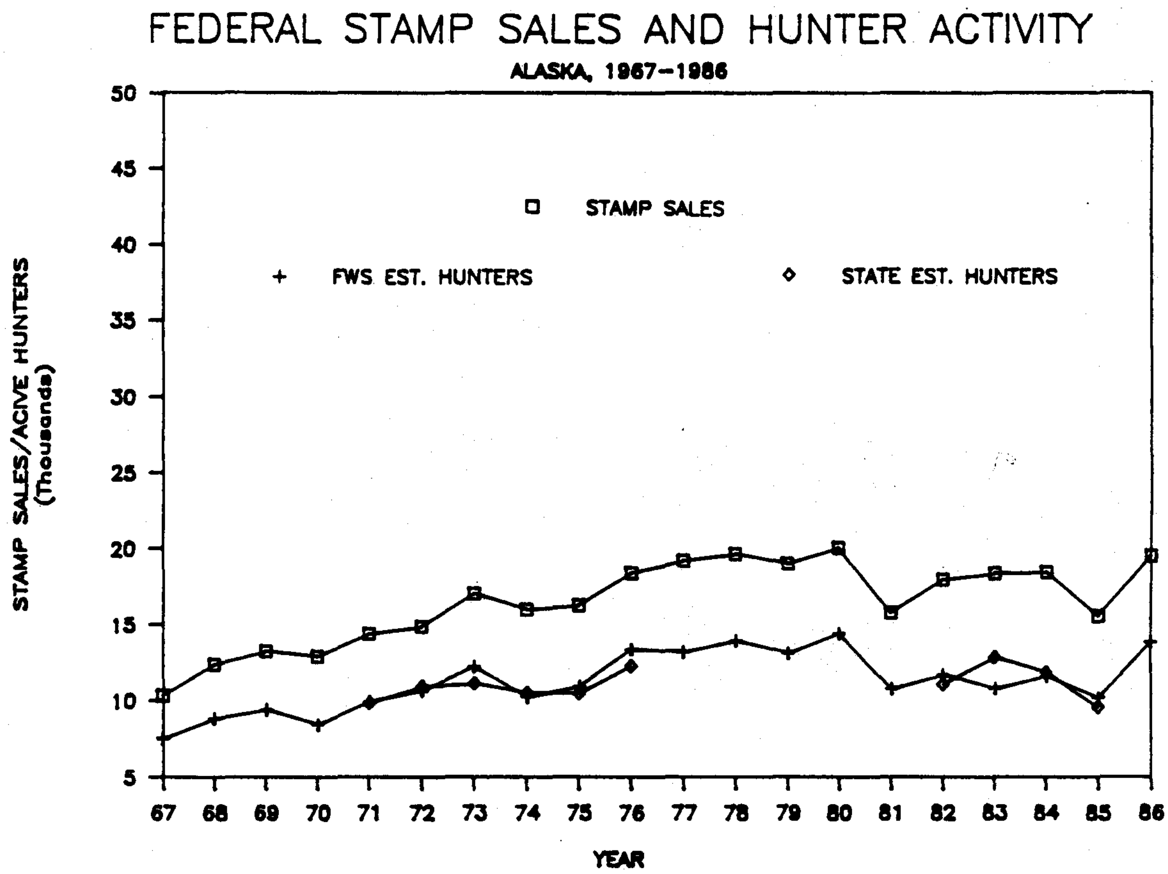


Fig. 1. Fish and Wildlife Service waterfowl harvest survey regions.



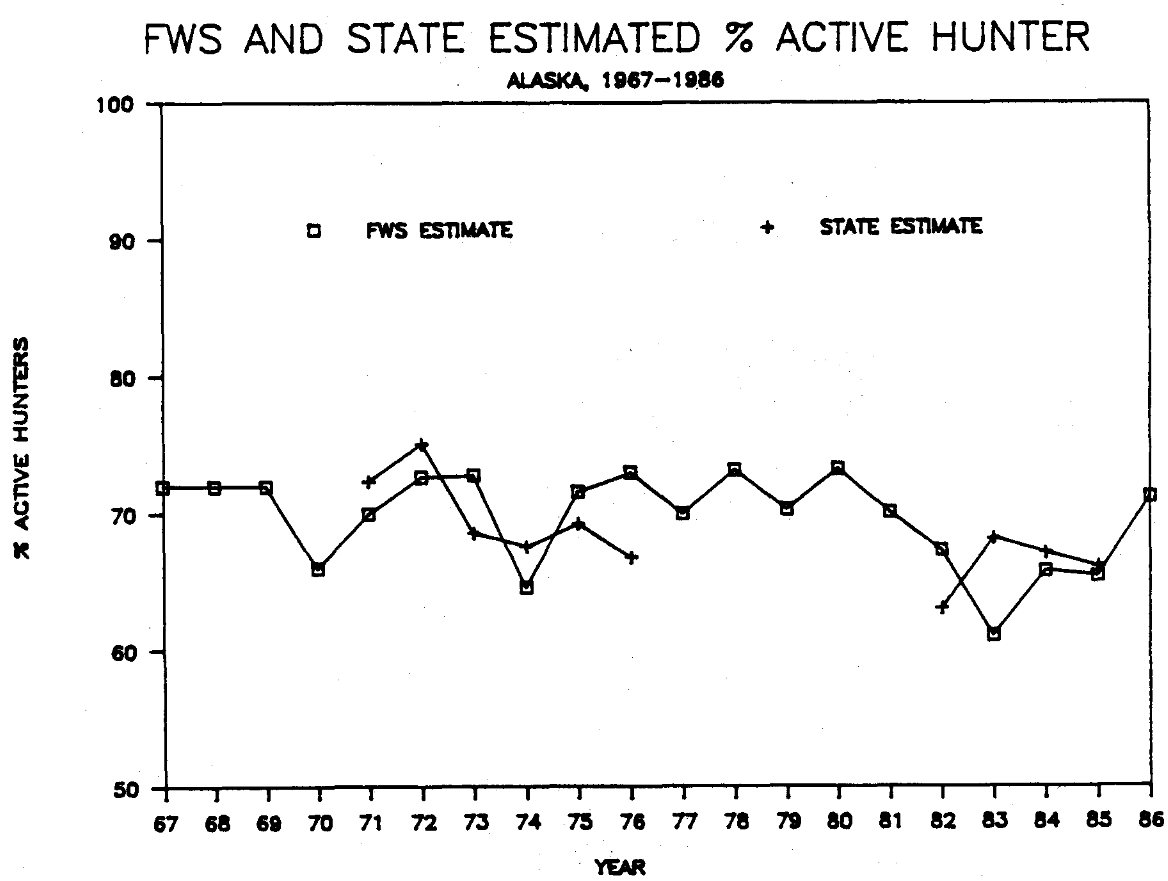


Fig. 2. Federal duck stamp sales and Fish and Wildlife Service and State estimated hunter activity in Alaska, 1967-86.

Table 2. Summary of Alaska waterfowl hunter activity and harvest from the FWS mail questionnaire survey, 1986-87 (Carney et al. 1987).

Total federal duck stamps sold: 19,570

Federal duck stamps sold to potential hunters in Alaska: 18,015

Number of active hunters: 12,830 (71.2%)

Calculated statewide fall sport harvests:

Ducks: Dabblers/divers: 95,050; sea ducks: 4,065; Total 99,215

Geese: Canada: 8,409; white-fronted: 935; brant: 208

snow: 104; Total: 9,656

Cranes: 731

Calculated Hunter Days: 78,531

Hunting Activity:

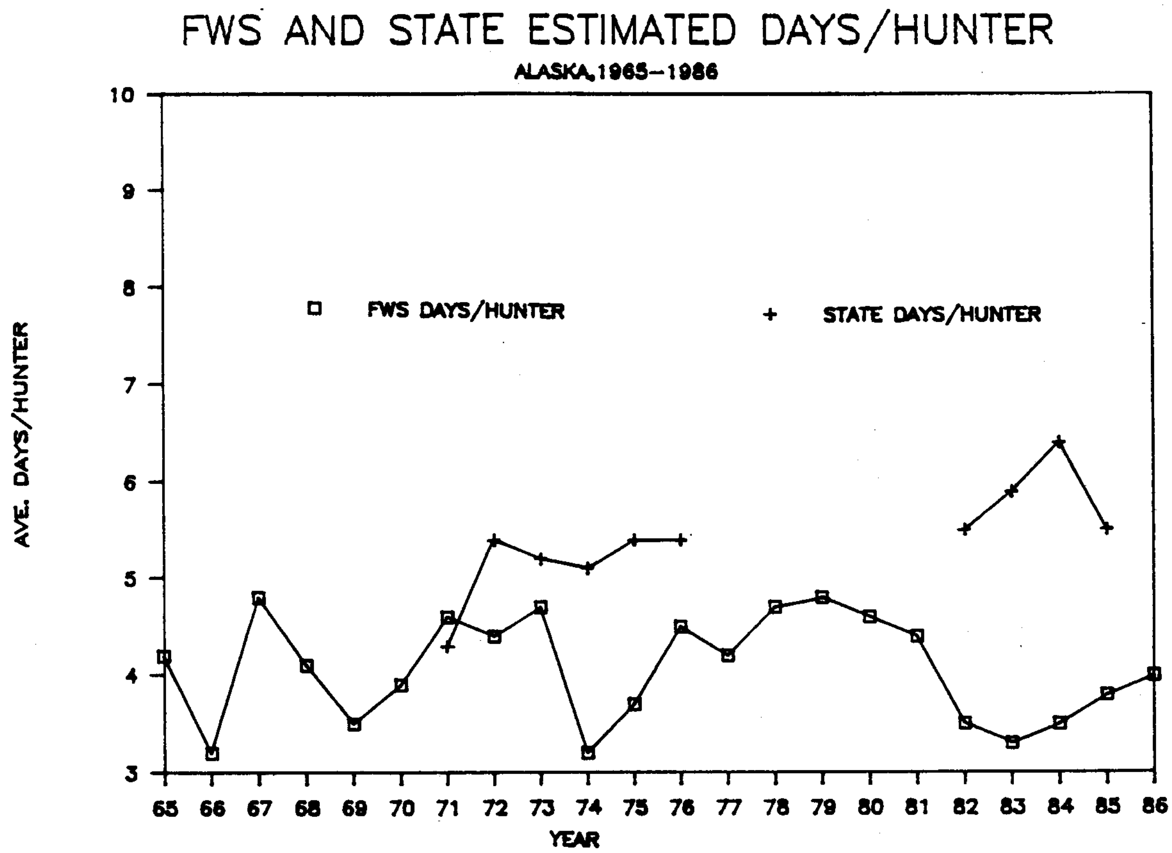
Hunters reported hunting an average 4.0 days during the 1986-87 season, compared with 5.5 days for the 1985-86 season. This projects to a total of 78,531 waterfowl hunter-days (Table 2), up 32% and 49% from the 1985 FWS and ADF&G estimates, respectively, and 15% and 30% above the 1965-85 FWS average and 1971-76 as well as 1982-84 ADF&G averages, respectively (Fig. 3). The FWS survey does not provide information for a breakdown of hunting activity by area.

Duck Harvest:

An average of 5.3 ducks/active hunter was taken in 1986. This compares with the 1985 state and federal averages of 9 ducks/active hunter and 5 ducks/active hunter, respectively, and the federal (1965-85) and state (1971-76, 1982-85) averages of 5.6 ducks/active hunter and 8.5 ducks/active hunter, respectively (Fig. 4). The FWS calculated average daily hunting success was 1.3 ducks/hunter in 1986, compared with the ADF&G average of 1.6 ducks/hunter in 1985.

The FWS projected statewide duck harvest was 99,215; of these, 95,050 (95.8%) were dabblers and divers and 4,065 (4.2%) were sea ducks and mergansers (Table 2). The 1985 FWS and ADF&G harvest projections were 74,133 and 86,790 ducks, respectively. In 1985 the FWS harvest was composed of 71,315 (96.2%) dabblers and divers and 2,820 (3.8%) sea ducks and mergansers, while the ADF&G harvest projection was composed of 79,605 (92%) dabblers and divers and 7,185 (8%) sea ducks. The 1986 harvest was up 34% and 14% from the 1985 FWS and ADF&G harvest estimates, respectively; it was also about 14% above the 1965-85 FWS harvest average and 4% above the 1971-76 and 1982-84 ADF&G harvest average (Fig. 4). Table 3 summarizes distribution of the 1986 duck harvest to the greatest level of detail allowed by the FWS parts survey.

Based on the FWS parts collection survey, the mallard (*Anas platyrhynchos*) was the most important game duck in 1986, composing about 30% of the harvest, followed by American wigeon (*Anas americana*) (18%), green-wing teal (*Anas crecca*) (14%), and pintail (*Anas acuta*) (12%) (Table 4). Species composition of the statewide duck harvest has remained relatively constant during the past 21 years, with 86% of the harvest composed of dabbling ducks, 10% diving ducks, and 4% sea ducks and mergansers (Table 5). As calculated from the FWS survey, over 34% of the duck harvest occurred in Cook Inlet; the central and Alaska Peninsula regions contributed an additional 22% and 15%, respectively (Table 3).



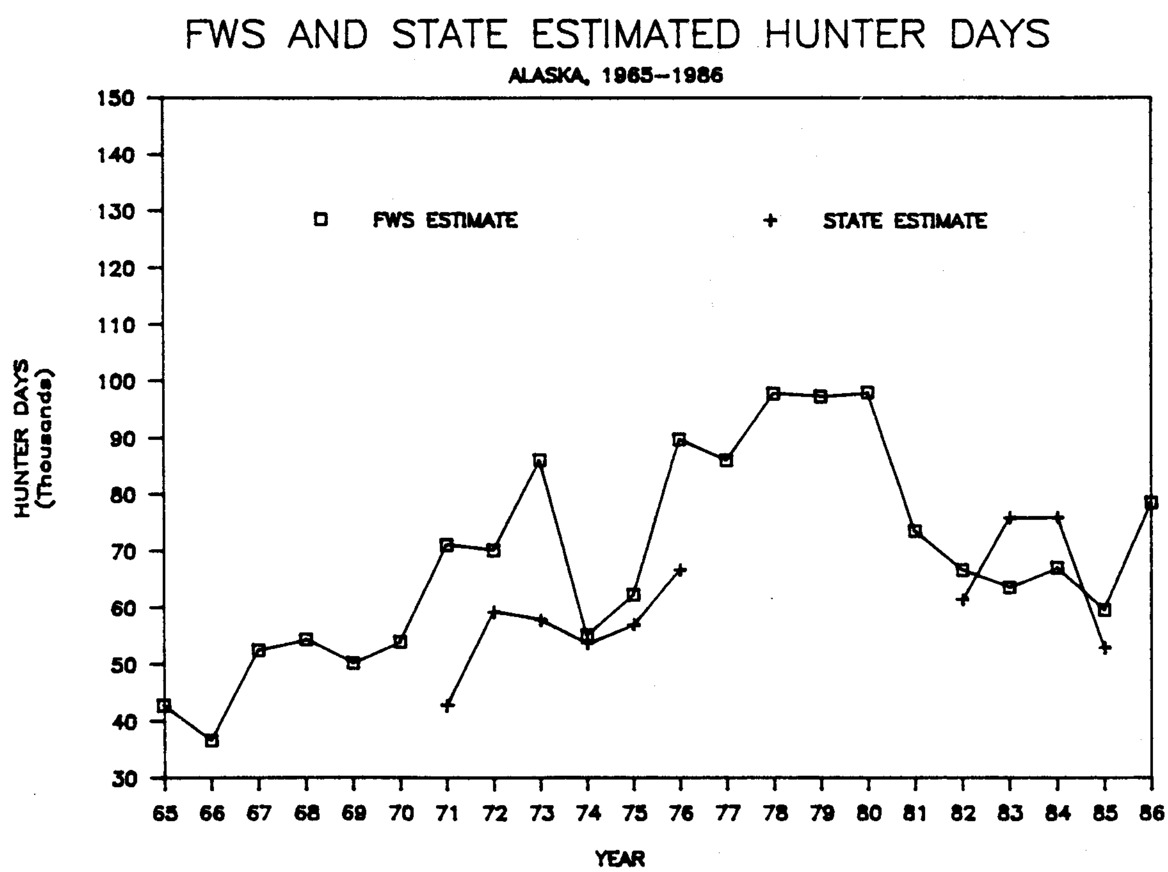
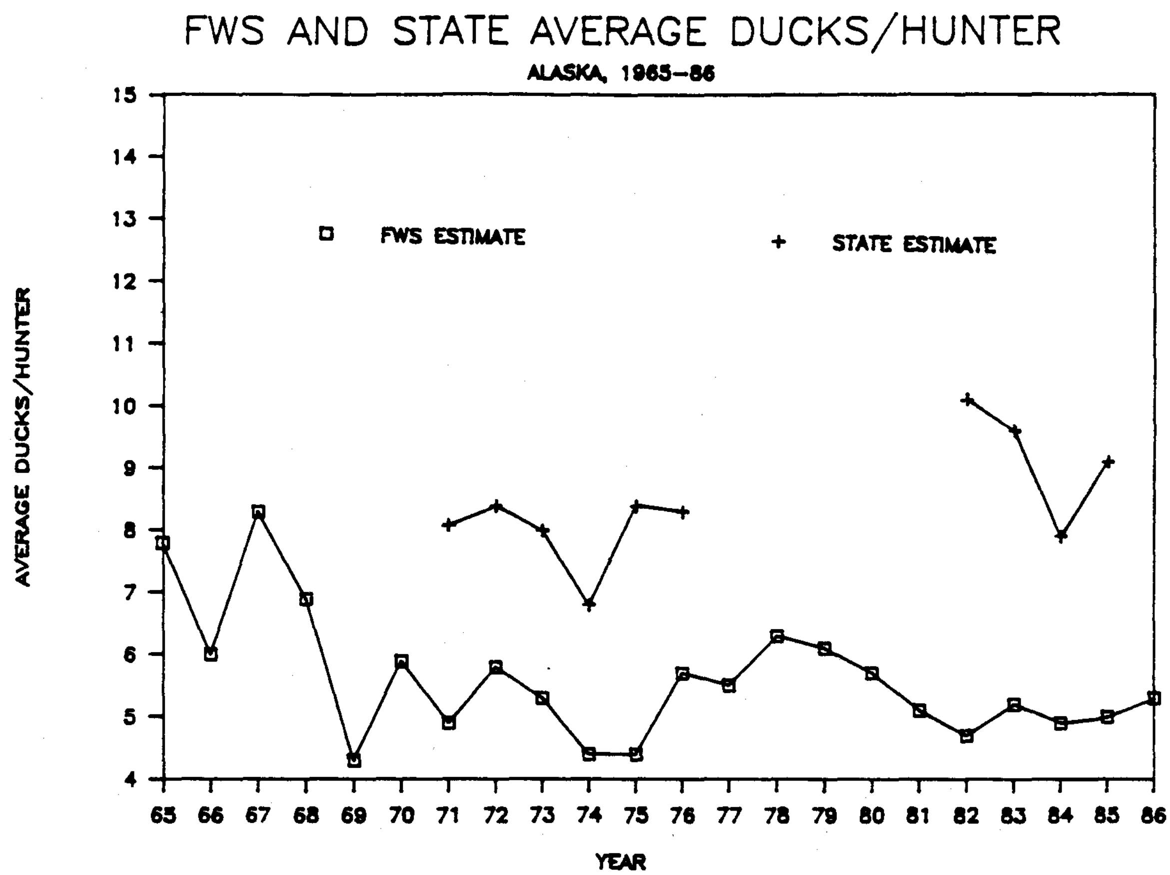


Fig. 3. Fish and Wildlife Service and State calculated waterfowl hunter days and average days per hunter in Alaska, 1965-86.



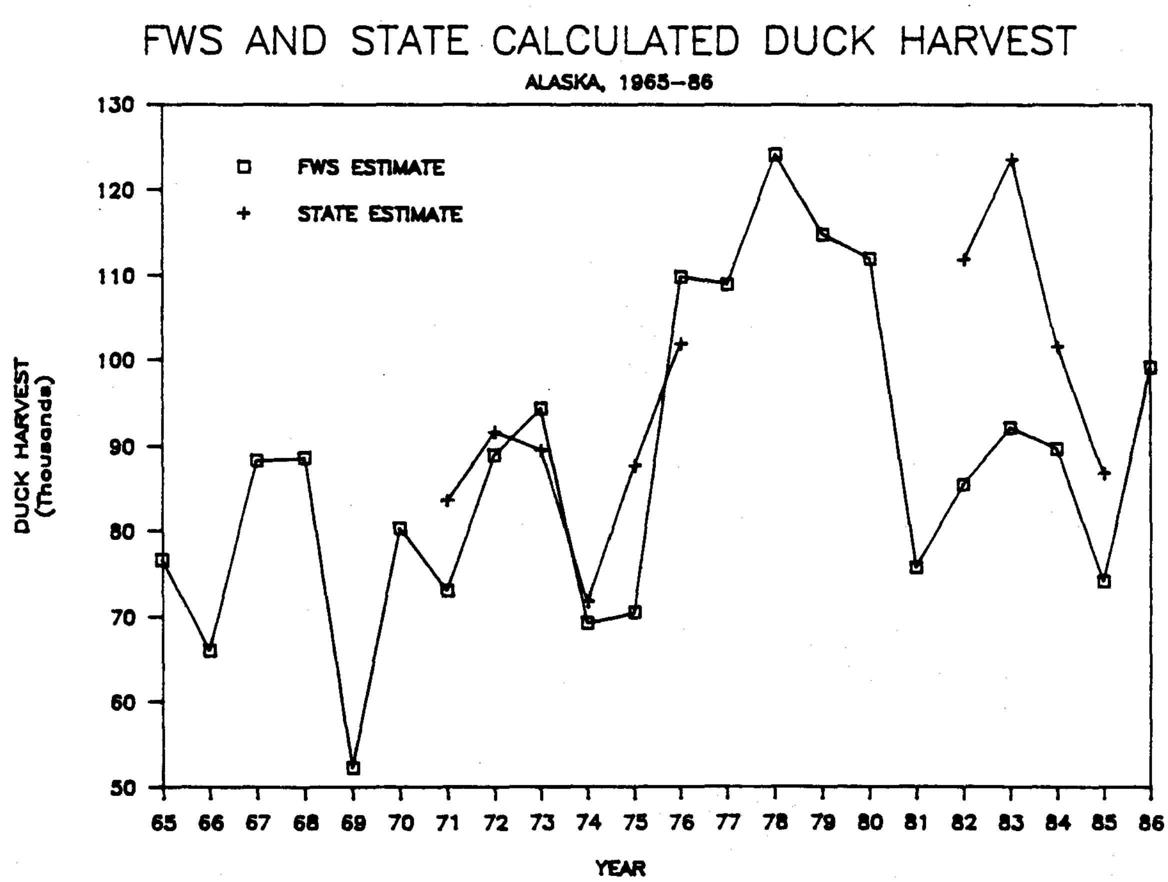


Fig. 4. Fish and Wildlife Service and State calculated ducks harvested per hunter and annual duck harvest in Alaska, 1965-86.

Table 3. Distribution of duck harvest in Alaska for the 1986-87 season as determined from the FWS parts collection survey.

Harvest region	Calculated duck harvest n	 % of state total
North Slope	0	0
Seward Peninsula	0	0
Yukon Valley	1,654	1.7
Central	22,206	22.4
Yukon Delta	0	0
Cook Inlet	33,830	34.1
Gulf Coast	7,953	8.0
Southeast	12,810	12.9
Kodiak	5,854	4.9
Alaska Peninsula	14,908	15.0
Aleutian Chain	0	0

Table 4. Species composition of the duck harvest, 1986-87 waterfowl season. [a]

Species	Yukon Valley	Central	Cook Inlet	Gulf Coast	Southeast	Kodiak	Alaska Peninsula	Percent of total statewide[b]
Mallard	11.3	24.5	31.1	33.3	47.3	40.6	16.5	30.0
Pintail	--	6.0	14.7	7.2	5.6	4.3	25.6	12.2
American Wigeon	60.9	23.9	12.0	38.2	10.7	5.7	18.9	18.1
Green-winged Teal	22.2	10.4	13.3	5.2	23.2	4.3	18.5	13.7
Shoveler	--	9.8	8.6	3.8	2.4	--	1.1	5.9
Blue-winged Teal	--	--	0.5	1.3	--	--	--	0.3
Gadwall	--	--	1.8	--	0.4	16.2	5.8	2.5
Total Dabblers	94.4	74.6	82.0	89.0	89.6	71.1	86.4	82.7
Lesser Scaup	--	10.7	0.3	--	0.4	--	0.6	2.6
Greater Scaup	--	--	2.0	--	--	--	3.7	1.2
Bufflehead	5.6	11.2	4.9	--	2.8	--	--	4.6
Common Goldeneye	--	0.8	0.1	1.9	--	2.8	4.4	1.5
Barrow's Goldeneye	--	--	4.2	1.4	0.4	13.8	--	2.2
Ringneck	--	--	1.7	--	--	--	--	0.6
Canvasback	--	0.2	0.4	--	--	--	--	0.3
Redhead	--	--	0.2	--	--	--	--	0.1
Total Divers	5.6	22.7	13.8	3.3	3.6	16.6	8.7	13.1
White-winged Scoter	--	--	0.7	--	--	--	--	0.3
Surf Scoter	--	--	0.7	2.6	1.2	--	--	0.6
Harlequin	--	--	0.7	1.3	4.8	4.3	2.2	1.6
Steller's Eider	--	--	--	--	--	--	2.2	0.3
Common Merganser	--	--	--	1.3	0.4	--	--	0.2
Oldsquaw	--	--	0.6	--	--	8.2	--	0.7
Hooded Merganser	--	--	--	0.6	0.4	--	--	0.1
Red-breasted merganser	--	--	0.2	1.9	--	--	0.6	0.3
Total Seaducks/ Mergansers	--	--	2.9	7.7	6.8	12.5	5.0	4.2
Total	100	97.3	89.7	100	100	100	100	99.9

[a] No harvest reported by FWS for the North Slope, Seward Peninsula, Yukon Delta, and Aleutians.
[b] Includes birds harvested in unknown locations.

Table 5. Composition (%) of the statewide duck harvest in Alaska, 1966-86.[a]

Year	Dabbling ducks	Diving ducks	Sea ducks/ mergansers
1966	86.5	10.3	3.0
1967	84.6	10.1	5.1
1968	89.6	8.9	1.8
1969	83.8	10.1	6.1
1970	86.0	9.0	5.0
1971	89.7	5.9	4.3
1972	90.0	7.6	2.3
1973	90.5	8.7	0.9
1974	82.3	16.4	1.4
1975	88.0	5.8	6.2
1976	82.6	9.5	7.9
1977	88.2	10.3	1.5
1978	82.5	11.1	6.5
1979	87.5	8.2	4.2
1980	85.0	12.5	2.5
1981	87.8	9.9	2.3
1982	85.4	11.0	3.6
1983	82.7	15.3	2.2
1984	88.3	9.6	1.8
1985	84.0	10.9	4.9
1986	82.7	13.1	4.2
$\bar{x}$	86.1	10.3	3.6

[a] Based on FWS parts collection surveys.

Goose Harvest:

Based on the FWS survey, an average of 0.6 geese were taken per active waterfowl hunter in 1986. This was down from the 0.9 geese/active hunter reported by the ADF&G for 1985 but up from the 0.4 geese/active hunter reported by the FWS for 1985. The average goose harvest per hunter in 1986 was below both the FWS 1965-85 average of 0.8 geese/hunter and the ADF&G 1971-76 and 1982-84 average of 1.3 geese/hunter (Fig. 5). The calculated 1986 statewide goose harvest was 9,656, up 62% and 10% from the 1985 FWS and ADF&G estimates, respectively. The 1986 harvest estimate was below both the 1965-85 FWS average annual harvest of 12,227 geese and 1971-76 and 1982-85 ADF&G average annual harvest of 13,875 (Fig. 5).

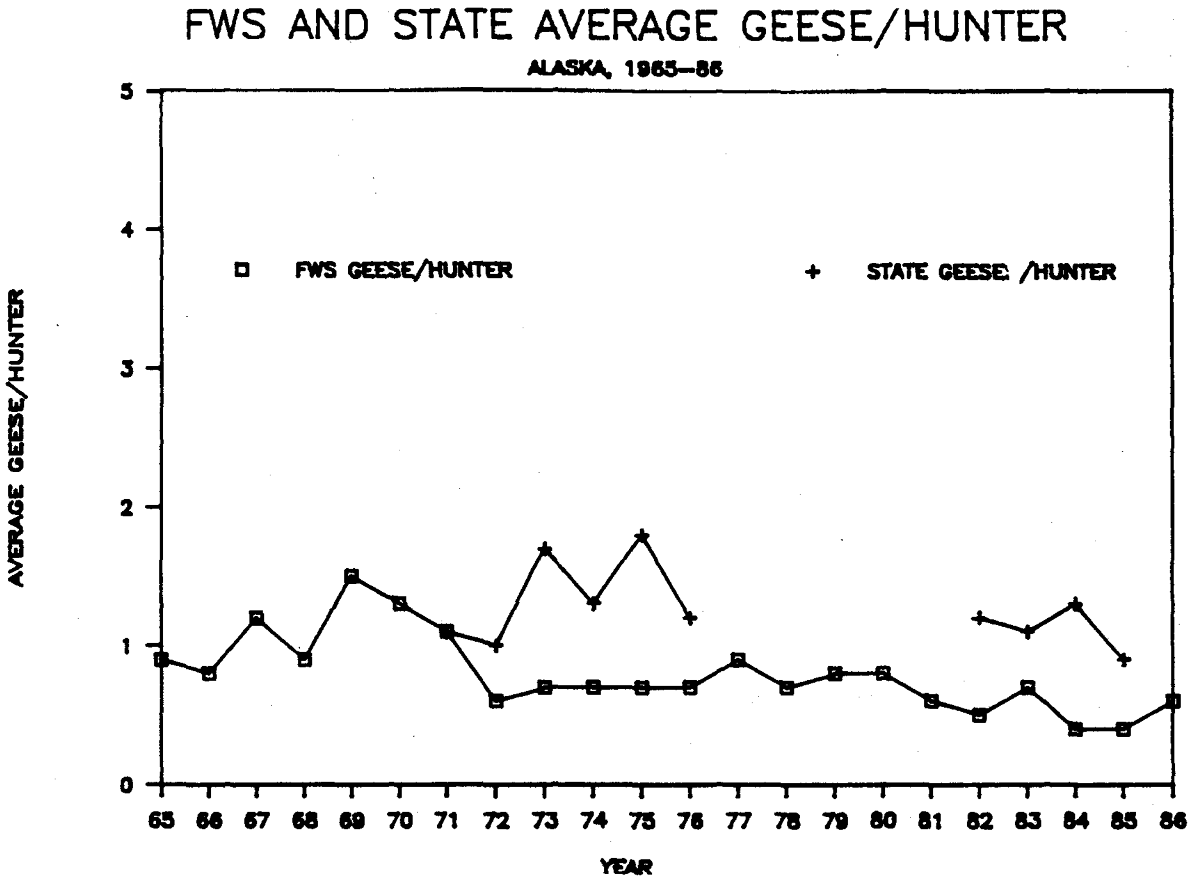
The Canada goose (*Branta canadensis*) was the most common goose harvested by hunters in 1986 (Table 2). According to the FWS harvest survey, this species made up over 85% of the harvest, followed by white-fronts (*Anser albifrons*) at 9.7%, Pacific brant (*Branta bernicla*) at 2.2%, and snow geese (*Chen caerulescens*) at 1.0% (Table 2). This compares with the ADF&G estimate of 63% Canadas, 10% emperors, 10% snow goose, 8% brant, and 6% white-fronts in 1985. The 1966-84 average species composition for the Alaska goose harvest is 72% Canadas, 12% emperor, 7% white-fronts, 7% brant, 4% snow, and 0.5% unknown. The FWS survey does not provide adequate information for a regional breakdown of the goose harvest by species.

Crane Harvest:

In 1986, 731 sandhill cranes (*Grus canadensis*) were harvested in Alaska (Sorensen 1987) (Table 2). In 1985 the federal and state harvest estimates were 642 and 1,270, respectively. The FWS average annual harvest for 1971-76 is 709 birds, compared with a 1971-76 and 1982-85 ADF&G average of 1,222 cranes. Distribution of the crane harvest is not provided by the FWS survey.

Discussion:

No state harvest survey was conducted for the 1986-87 season, precluding the usual comparison with federal survey data. Typically both surveys, with their different methods and strengths, collectively provide the most complete picture of harvest and harvest patterns. The lack of comparison is particularly unfortunate this year, given the unexpected, significant increase in estimated hunters and derived statistics on harvest indicated by the federal data. The 26% increase in Federal Duck Stamp sales is a critical factor that was used to calculate the indicated increases in active



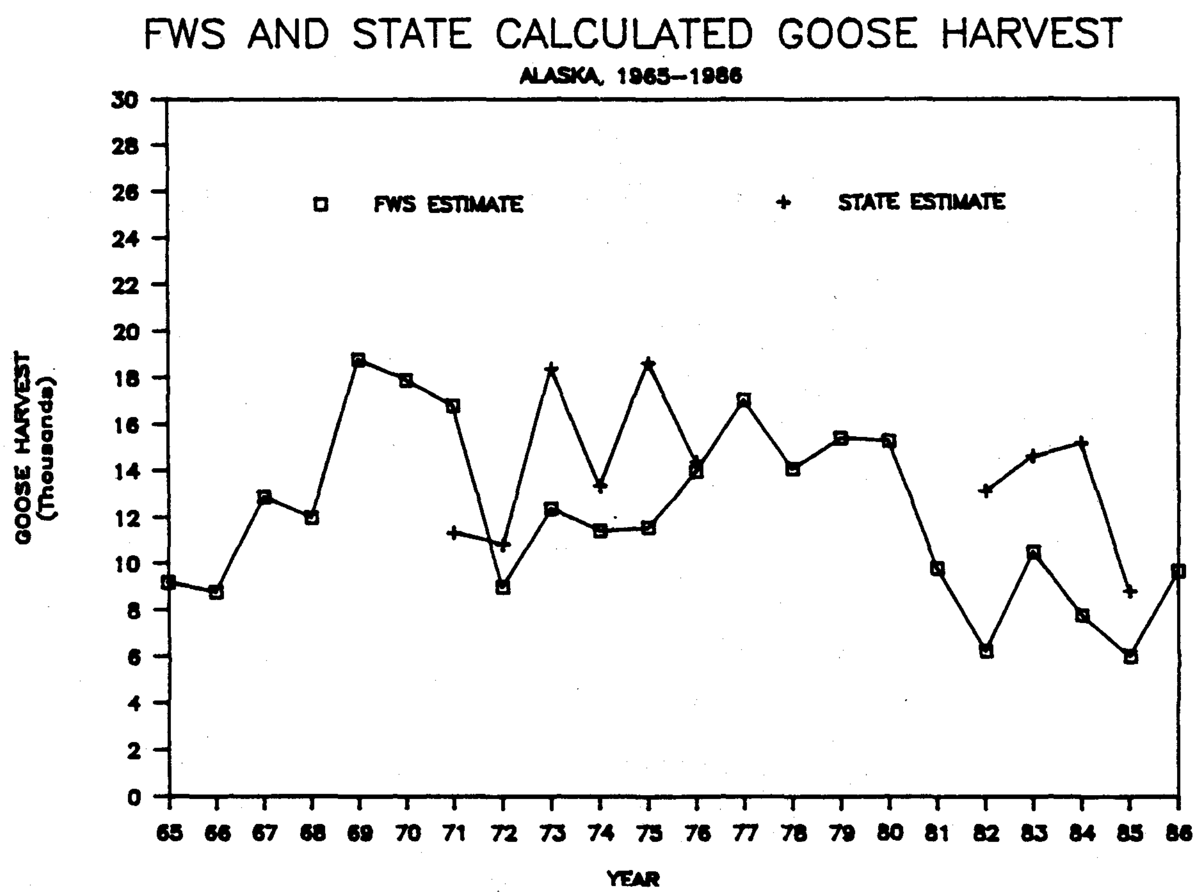


Fig. 5. Fish and Wildlife Service and State calculated geese harvested per hunter and annual goose harvest in Alaska, 1965-1986.

hunters (+34%), hunter days (+32%), total duck harvest (+35%), and total goose harvest (+62%).

It is difficult to reconcile these apparent increases in hunters and harvest with phenomena affecting hunters in Alaska, considering that stamp sales have been following a downward national trend since 1981, the state population base is decreasing, economic conditions are poor, fall flight forecasts have been discouraging, and broad restrictions on goose hunting have been put in place. Because there was relatively little change in average days afield per hunter and average harvests of ducks and geese per hunter, the indicated increases in harvest are nearly all attributable to a rise in the estimate of active hunters generated from stamp sales.

One plausible explanation for the large increase in stamp sales is philatelic interest. If stamp collectors purchased substantially more stamps in 1986 and a standard philatelic correction was applied to total stamp sales, the estimates of hunters and harvest would be inflated. In recent years, the Federal Duck Stamp anniversary (1984), the initiation of the Alaska and Canada Duck Stamps (1985), and the nationwide marketing of federal and state duck stamp prints have greatly increased public awareness of these programs as well as sales to stamp and print collectors. Also, the poor status of prairie habitats and duck populations has likely increased public contributions through the purchase of extra stamps. In effect, it seems likely that the proportion of philatelic sales of federal stamps has increased and adjustments for estimating the number of waterfowl hunters need to be reevaluated.

Because of questions about the estimated 1986 harvest, it is difficult to make comparisons with other years; however, the contribution of pintails to the bag was much lower than expected. Pintails ranked fourth, composing 12% of the bag; it is only the 2nd time they have ranked so low and only the 7th year they have ranked below number two in the last 20 years. The reasons for fewer pintails in the bag are not clear, given that the Alaska pintail breeding pair index was up 42% from 1985 and nesting conditions were good; to an unknown extent, the daily limit of 3 pintails imposed in 1985 may have been a contributing factor. If an inflated estimate of hunters in the federal survey occurred, as discussed above, the 1986 pintail harvest could have been substantially less.

Goose harvest data indicate a substantial (62%) increase in total goose harvests in 1986; nearly all were Canada geese. Lesser Canada geese taken at Cold Bay accounted for over 60% of the increase in Canadas; Cook Inlet and the Delta area of east central Alaska also showed increases. The number of goose tails from other species received in the federal parts collection survey was inadequate to provide a useable sample. A season closure was instituted on emperor geese in 1986, and there was no reported harvest.

The Department will resume the state waterfowl harvest survey in 1987, based on sampling of State Duck Stamp buyers. This should increase the number of useable responses, improve the accuracy of hunter participation and harvest estimates, and allow a better assessment of federal survey results.

LITERATURE CITED

Carney, S. M., M. F. Sorenson, and E. M. Martin. 1987. Waterfowl harvest and hunter activity in the United States during the 1986 hunting season. U. S. Fish and Wildl. Serv. Admin. Rep. 27pp.

Sorensen, M. F. 1987. Sandhill crane harvest and hunter activity in the Central Flyway during the 1985-86 hunting season. U.S. Fish and Wildl. Serv. Admin. Rep. 8pp.

Voelzer, J. F., E. Q. Lauxen, S. L. Rhoades, and K. D. Norman (eds.). 1982. Waterfowl Status Report. 1979. U.S. Fish and Wildl. Serv. Special Sci. Rep. Wildl. No. 246. Washington, D.C. 96pp.

DUSKY CANADA GOOSE STUDIES

GAME MANAGEMENT UNIT: 6

GEOGRAPHIC DESCRIPTION: Copper River Delta

PERIOD COVERED: 1 July 1986-30 June 1987

Introduction

Dusky Canada geese (Brant canadensis occidentalis) are known to nest only on the Copper River Delta of Alaska and to winter primarily in the Willamette Valley of Oregon and southwestern Washington. Until the late 1970's, population size, which has ranged from a midwinter index of 7,500-8,000 in 1953 to 28,000 in 1960, was limited by hunting on the wintering grounds. Hunting was responsible for nearly all (95%) of the 45% annual population mortality (Chapman et al. 1969). Band recoveries indicated that about 70% of this harvest occurred in Oregon; the remaining 30% was about equally split between Washington, British Columbia, and Alaska. Production was typically good, and during the mid-1970's the population increased, despite a heavy annual harvest. Around 1979 production dropped off considerably, and the population began to decline. Failure of the population to respond to harvest restrictions during 1983-86 indicates that conditions influencing production in Alaska are now limiting the population.

The Dusky Canada Goose Subcommittee of the Pacific Flyway Study Committee was formed to set objectives and coordinate management of the dusky goose. This subcommittee has developed a council-endorsed management plan for the dusky goose that establishes a population objective of 20,000, based on the midwinter population index, and recommends guidelines for achieving and maintaining that objective. Recommended management procedures in the plan that involve ADF&G are as follows:

1. Monitor and describe changes in nest site selection and nest success as related to changes in vegetation.

2. Monitor annual nest density and success.

3. Conduct annual production surveys and develop fall flight forecasts.

4. Mark and band geese annually to monitor population age structure, survival rates, harvest distribution, and support studies on the wintering grounds.

5. Describe and evaluate interactions between habitat change, predator ecology, and production.

In addition to these procedures, in 1986 the Pacific Flyway Council endorsed a subcommittee recommendation that ADF&G develop and implement appropriate, biologically sound strategies to reduce predation on dusky geese by brown bears and coyotes. The following is a summary of ADF&G projects or actions addressing the above recommendations.

Study Area

The Copper River Delta is an approximately 650-km^2 deltaic plain at the mouth of the Copper River on the Gulf of Alaska (Fig. 1). It is bounded on the west, north, and east by the Chugach Mountain Range and by the Gulf of Alaska on the south. The area has a typical maritime climate: cool summers, mild winters, and abundant precipitation. Annual precipitation averages 205 cm, including 318 cm of snowfall and annual temperatures averaging 3.4 C, ranging from averages of -5 C in January to 12 C in July.

The major dusky goose nesting area is the approximately 450-km^2 west Copper River Delta. This area is interlaced with tidal sloughs, glacial streams, and numerous small, shallow, freshwater ponds between drainages. Plant communities are evolving as a result of the uplifting of the area by as much as 2 m during the 1964 Good Friday earthquake (Potyondy et al. 1975). Currently, coastal communities are dominated by freshwater sedge meadows (*Carex* spp.) interspersed with dense, tall shrub (*Alnus crispa* and *Salix* spp.) stringers along drainages. Stands of tall shrub and shrub-bog (*Myrica gale*, *carex* spp. and *Menyanthes trifolicata*) increase in frequency inland from the coast; an alder (*Alnus crispa*), Sitka spruce (*Picea sitchensis*), and Western hemlock (*Tsuga heterophylla*) community becomes dominant 7-11 km from the coast.

Projects

Monitor Nest Densities and Fate:

Methods. Ten sample plots ranging from 0.23 to 0.88 km^2 have been established on the west Copper River Delta (Fig. 2). Eight of these plots were established in 1974 and, with the exception of 1980 and 1981, have been sampled annually since that time. Additional plots at the mouth of Eyak River and on Egg Island were established in 1982 in response to apparent increases in the density of nesting geese in the areas.

All plots are extensively sampled twice each nesting season: once immediately after the peak of incubation and again after

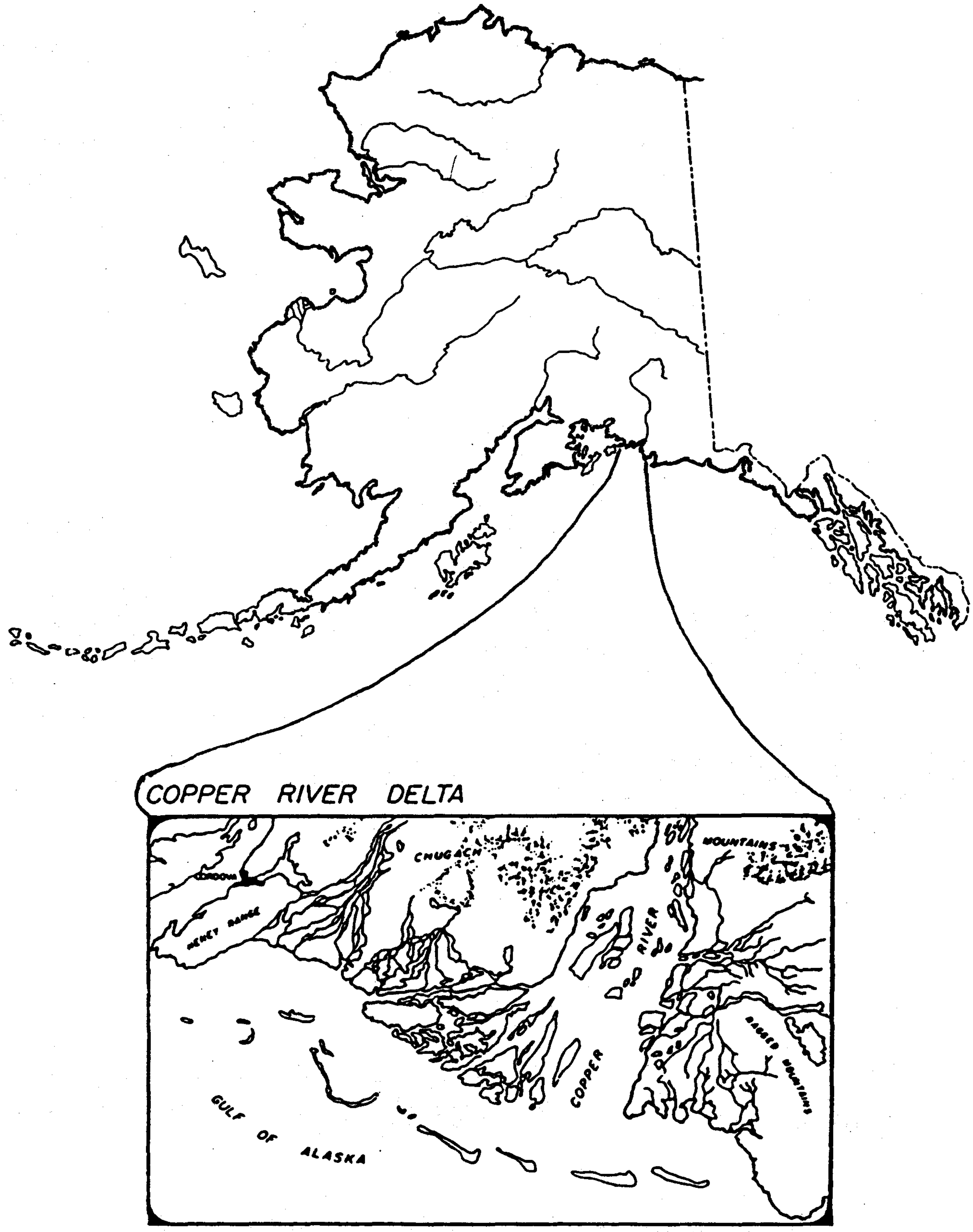


Fig. 1. Location of the Copper River Delta, Alaska.

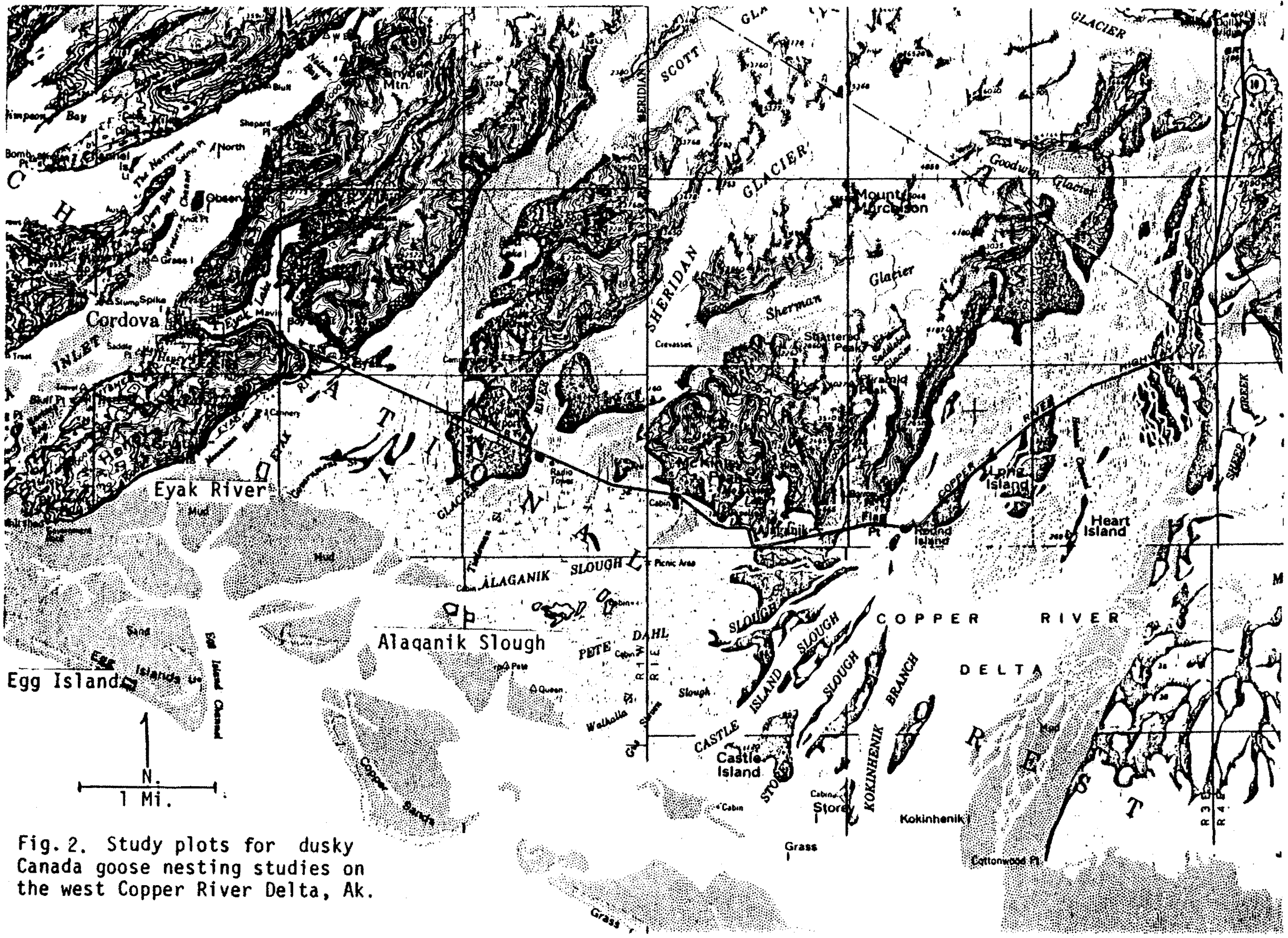


Fig. 2. Study plots for dusky Canada goose nesting studies on the west Copper River Delta, Ak.

the peak of hatch. Peak of incubation was determined by monitoring nests along the Copper River Highway; the peak of hatch was determined by adding the appropriate number of days (based on egg floatation data) to the mean age of clutches on the study plots to complete the average 28-day incubation period. During the first search, the number of eggs and stage of development for active nests were recorded. To facilitate relocation, all nests were also marked with wands and their locations were plotted on large-scale (1:330-1:700) maps. Wands were placed at least 50 feet from the nests to minimize the possibility of attracting predators.

During the second visit, the fate of both previously located nests and newly discovered nests was determined. Nests in which one or more eggs had hatched were considered successful. Attended nests were considered to be incubating, and nests that were unattended and the egg development had ceased were classified as abandoned. Nest destruction was classified as avian, unknown mammal, canid, or bear when sufficient evidence allowed, using published characteristics of predation (Darrow 1938, Sooter 1946, Rearden 1951) and techniques applicable to the local area that were developed during the study.

Areas adjacent to the study plots that had similar habitat types were searched after the peak of hatch. Nest fate information from these areas was used as a control to determine if the presence of field crews influenced nest success on the study plots.

This project was a cooperative venture; assistance was provided by the Oregon Department of Fish and Wildlife, Washington Department of Wildlife, Region I Fish and Wildlife Service, U. S. Forest Service, and nongovernmental groups from Oregon and Montana.

Results. Nesting conditions for the dusky goose, which arrived on the Delta during early April 1987 (Griese, pers. comm.) were mixed (i.e., good and poor). Favorable conditions through early nest initiation consisted of unseasonably warm and dry weather and average foliage phenology; however, the weather degenerated during the 2nd week of May, and unseasonably cool temperatures and record-setting precipitation persisted throughout the remainder of the nesting period. Overall, spring weather in 1987 was poorer than normal (Table 1). This undoubtedly placed nesting geese under additional energy stress and contributed to an abnormally high nest abandonment rate.

Peak nest initiation (N = 121 nests) was biomodal; a primary peak occurred during 5-12 May 1987, and a secondary peak occurred during 17-22 May 1987. The average clutch size

Table 1. Weather indices developed for the spring months of April, May, and June, according to Bromley (1976) for the Copper River Delta, 1971-87.

Year	Temperature deviation from normal (c°)	Snow depth on ground (cm)	Precipitation deviation from normal (cm)	Weather index
1971	+0.7	71.1	+51.9	-327.3
1972	-7.1	297.2	+2.1	-343.3
1973	-1.6	27.9	+16.6	-118.9
1974	+1.9	5.1	-8.8	+48.4
1975	-1.7	66.0	+7.3	-110.0
1976	-1.6	73.1	+9.2	-90.3
1977	+3.9	42.4	+3.2	-26.1
1978	+2.3	4.6	-0.4	+7.4
1979	+0.1	2.8	-10.1	+7.6
1980	+5.2	3.6	+11.6	+10.9
1981	+5.8	4.3	-3.3	+28.1
1982	-1.9	5.8	-3.5	+2.2
1983	+4.5	2.5	-6.2	+51.1
1984	+4.8	2.5	-17.7	+110.0
1985	-5.4	71.1	+7.1	-133.6
1986	-1.2	10.2	-16.6	+66.8
1987	+1.5	3.1	+22.5	-107.8
$\bar{x}$	+0.5	43.1	+2.7	-51.1

for nests initiated during the 2nd peak (5.6 ± 1.3, $\underline{N} = 35$) was larger than that for nests started during the 1st peak (5.4 ± 1.3, $\underline{N} = 64$); this suggests that the secondary peak in initiation represents something other than, or in addition to, renesting. Overall, the average clutch size was 5.5 ± 1.3 ($\underline{N} = 121$), which is considerably above the long-term average (Table 2). The calculated density of nests on the study areas was 116/mi^2, similar to that for 1986 but below the 1959-86 average of 126/mi^2 (Table 3).

While nest success was much better than the previous 2 years, it was still poor in 1987. Only 23.7% of the nests in the study area were successful (Table 3). Success of nests from a widely distributed sample (i.e., the study area, Castle Island, Walhalla Slough, and additional Eyak River and Egg Island areas [$\underline{N} = 213$ nests]) was similar at 23.9%. The presence of field crews on the study plots apparently had little effect on the fate of nests. There was no significant difference ($\underline{X}^2 = 0.68$, df = 3, $P > 0.99$) between the fate of nests on the study plots and the 68 control (previously unvisited) nests.

As has been the case in recent years, predation was the primary cause of nest failure in 1987. About 58% of the 196 nests on the study plots and 61% of the 213 total nests sampled were destroyed by predators. Unlike the previous 4 years (i.e., when brown bears [*Ursus arctos*] were the primary cause of nest destruction because of their experimental transplant to the study area), avian predators were the primary cause of nest destruction; nearly half (47%) of the nest destruction was by these predators, followed by brown bears (29%), canids (12%), and flooding (7%) (Table 2). Predation on nesting birds by coyotes was down considerably from 1986; only 15 goose carcasses or kill sites were located on the study plots. Compared with 34 in 1986, 17 in 1985, and four in 1984, this likely reflects an increase in availability of alternative prey species. A capture index (captures/hour) of 0.01604 from assessment traplines on the study plots in 1987 indicated a sharp increase in the abundance of microtines from 1985 (0.00064) and 1986 (.00133).

Flooding of nests was a significant cause of nest failure for the first time since before the 1964 earthquake. Heavy rains combined with high levels of beaver activity resulted in the flooding of over 7% of the nests. Beavers have dammed many of the drainages on the Delta, backing water into meadows and over low levees. Judging from nests that were viable in May but flooded in June, water levels had risen by up to 2 feet behind newly constructed dams in some areas. The long-term positive or negative benefits of beaver activity on nesting waterfowl are unknown. Wetter conditions may benefit nesting

Table 2. Fate of dusky Canada goose nests on the west Copper River Delta study area, 1959, 1974-75 and 1982-87.

Year	No. nests	% Successful	% Abandoned	% Fate unknown	% Destroyed	Type destruction: % Mammal	% Avian	% Flooded	% Unknown
1959[a]	1,162[b]	79.6	1.8	2.0	6.0	0	11.4	88.6	0
1974[c]	81	82.7	2.5	ND[d]	14.8	ND[d]	---[e]	0	ND[d]
1975[c]	215	31.6	3.7	ND[d]	64.6	ND[d]	---[e]	0	ND[d]
1982	158	49.2	1.8	ND[d]	49.0	45.0	33.8	0	21.8
1983	162	51.9	3.7	8.0	35.2	64.8	5.6	0	29.6
1984	161	75.8	3.1	6.2	14.9	62.4	37.6	0	4.0
1985	168(258)[f]	8.9(7.0)	3.6(1.9)	6.5(10.9)	78.6(81.0)	78.8	18.4	0	2.8
1986	201	11.4	9.0	12.5	67.2	83.7	5.2	0	11.1
1987[g]	196(213)[f]	23.7(23.9)	17.4(14.1)	0.6(1.0)	58.2(61.0)	45.6	47.3	7.0	0.2

[a] Trainer 1959
[b] Eggs rather than nests
[c] Bromley 1976
[d] Not reported.
[e] Percentages not given, but major losses attributed to avian predators.
[f] Numbers in parentheses are for the study area plus additional sample areas on the CRD.
[g] Preliminary, pending further data analysis.

Table 3. Dusky Canada goose nest densities, hatching success, and average clutch size on the west Copper River Delta study area, 1959-87.

Year	$nests/mi^2$	Nest success N	Nest success %	Clutch size N	Clutch size $\bar{x}$
1959	105	222	89.2	194	5.6
1964	-	102	82.4	114	4.3
1965	-	221	62.9	140	5.8
1966	-	100	97.0	100	4.8
1967	111	-	-	-	-
1968	-	38	86.8	75	5.1
1970	-	164	88.2	146	5.4
1971	-	100	76.0	113	3.6
1972	-	116	81.0	92	4.4
1973	-	-	-	48	4.9
1974	-	81	82.7	-	-
1975	179	215	31.6	215	4.8
1976	156	168	-	168	4.8
1977	175	229	79.0	181	5.4
1978	183	390	56.2	-	-
1979	133	409	18.8	338	5.7
1980	108	152	-	152	5.4
1981	-	-	-	28	4.9
1982	102	158	49.2	135	4.8
1983	91	162	51.9	87	5.5
1984	95	161	75.8	123	5.6
1985	97	168	8.9	64	4.4
1986	119	201	11.4	78	4.9
1959-86 $\bar{x}$	127		59.4		5.0
1987	116	196	23.7	121	5.2

geese by averting terrestrial mammalian predators to drier areas away from the nesting grounds. On the other hand, the increased availability of impoundments in conjunction with depressed fur prices and the inaccessibility of the Delta to trappers may stimulate growth of the river otter population. River otters are potential predators of goose nests. Impacts resulting from reduced availability of elevated, dry nesting sites and flooding of shrub habitats that are preferred for nesting are unknown.

Nest abandonment also contributed significantly to poor nest success in 1987. A record 17% of the nests on the study plots and 14% on all areas sampled were abandoned (Table 2). Extensive abandonment was likely the result of flooding as well as cold, wet weather during nesting. The rising water that flooded many nest bowls and the high energy demands associated with attending nests during the extended period of cold, wet, and stormy weather probably caused geese to abandon their nests.

Habitat Availability and Use Study:

A 5-year investigation of the availability and use of nesting habitat by dusky geese was completed in 1986. The objectives of this investigation were to determine how habitat availability and use on the west Copper River Delta have changed since the mid-1970's and how those changes, if any, have influenced dusky goose production.

Methods. In conjunction with the dusky goose nest fate and density project (1982-86), habitat types for all nests on the study plots were classified. Because the physical configuration of habitat apparently has a major influence on how geese select nest sites (Long 1976, Heagy and Cooke 1979, McCabe 1979), classification was based primarily on physical vegetation structure. Table 4 summarizes species composition and structural characteristics of the various habitat classes used.

Availability of habitat on the sample areas was ascertained by analyzing aerial photography taken in June 1986. A series of near-vertical 35-mm slides of each study plot was taken from an altitude of approximately 7,500 ft. Habitat maps were developed from these slides by transcribing major habitat types, sloughs, and ponds onto mylar. These maps were then digitized to determine the portion of the plots composed of each habitat type or physical feature.

Assistance for this project was provided by the Oregon Department of Fish and Wildlife, Washington Department of Wildlife, Region I of the Fish and Wildlife Service, Forest

Table 4. Characteristics of habitat types used by dusky Canada geese for nesting on the west Copper River Delta, 1982-86.

Habitat type	Species composition	Structural characteristics
Tall Shrub	Alder (Alnus) and willow (Salix).	Taller than 48".
Low Shrub	Alder and willow or sweetgale (Myrica).	Less than 48" tall.
Levee	Prostrate willow, forbs, wild iris (Iris), moss (Sphagnum), scattered low shrubs, and sedge (Carex).	Very open, typically vegetation less than 12" tall with little to no overhead cover.
Meadow	Monotypic sedge meadows possibly with scattered grass and low shrubs.	Open meadows, typically in pond basins between levees and ponds.
Grass/Forb Bench	Grasses, tall forbs such as Rumex, Cicuta, and Urtica with moss ground cover.	Only found on Egg Island. Structurally resembled low shrub.

Service, nongovernmental groups from Oregon, and a number of private individuals.

Results. A draft final report is currently under review and will be completed in spring of 1988. A brief summary of the results of the investigation are presented here.

Habitat structure and availability have changed dramatically on the west Copper River Delta since 1974. While the portion of the plots covered by ponds and meadows has remained relatively constant on the mainland, cover by shrub habitats has increased from 2.5% to 22.9%. This increase was at the expense of the levee habitat type, which has declined from 40% to 20%. On Egg Island, habitat diversity has increased; low shrubs and meadows have developed on what was bare ground and tide flats in 1974. A grass-forb-moss community has developed on the bench between the dune and tide flat habitats on the inland side of the island.

Comparison of habitat availability and utilization by a chi-square goodness-of-fit test indicates that on the mainland dusky geese prefer both low- and tall-shrub habitats for nesting. Levee habitat was selected against, and meadows were used in proportion to their availability. On Egg Island, geese preferred to nest in either low-shrub or grass-forb habitats.

Annual variations in habitat use on the mainland were associated with spring weather. During "late" (i.e., cool and wet) springs, relatively more nests were located in the open-levee habitat type; during "early" springs, nests were more common in shrub habitats. These relationships probably reflect the influence of snow and ice pack on habitat availability during nest site selection. There was no annual variation in nest distribution on Egg Island.

On the mainland, there was little variation in nest fates between habitat types during any year, but overall fates have varied considerably between years. This variation was most closely associated with spring weather; nest success was typically poorer during "late" springs. This does not mean that nest predation was unimportant; rather, it implies that, regardless of the level of nest destruction or success, predation was consistent in all habitat types during any year. In contrast to the mainland, nest fate on Egg Island varied between habitat types during any year.

The differences in the distribution of nest fates between habitat types and years on Egg Island and the mainland delta likely reflect habitat preference and foraging patterns of the various predators active on the nesting grounds. On Egg

Island, avian predators, primarily gulls, were the primary cause of nest failure; they consistently destroyed a disproportionately large number of nests in low-shrub habitat from year to year. This probably reflects the greater availability of goose nests in low-shrub habitat as well as the gulls preference for foraging in low-shrub habitats (Hanson and Browning 1959). On the mainland delta, brown bears were the primary cause of nest failure. These wide-ranging predators showed little preference for any habitat while foraging, taking nests in all habitat types at about the same rate. For unknown reasons, the magnitude of bear predation on nests varied from year to year; however, fewer nests were destroyed during "early" springs.

The level and distribution of nest predation by coyotes (Canis latrans), the 3rd major predator on the Delta, was independent of spring phenology and habitat types. A strong negative correlation (R=-0.98) between availability of small mammals, as determined from assessment traplines, and predation on nesting geese suggests that the abundance of buffer prey species determines the distribution and level of nest destruction by coyotes.

Production Survey and Midsummer Population Index:

Methods. A production-inventory survey was conducted on 19 July 1987. Parallel transects at 0.25- to 0.5-mile intervals were flown in a Cessna 185 between saltwater and shrub-bog habitat, including the barrier islands on the west Copper River Delta. Two observers, a recorder, and a pilot were used; the pilot and front-seat observer searched for flocks and navigated. The 2nd observer, seated behind the front passenger seat, assisted with the search until geese were spotted. At that time, passes or circles were flown so that the 2 observers on the right-hand side of the aircraft could have an unrestricted view of the geese. The front observer counted adults, while the rear observer counted young geese and periodically photographed flocks. The 4th individual recorded data and assisted with the photography. Elevation and speed of the aircraft varied according to conditions and group size. Searches were conducted at an altitude and speed of 500-800 feet and approximately 100 mph, respectively.

Once geese were spotted, airspeed and altitude were reduced to allow adequate counts and classification. Photographs of flocks were taken periodically to facilitate development of weighted regressions that would provide estimates of total geese and number of young in the population. Statistical support for this inventory was provided by Earl Becker (ADF&G staff Biometrician, Anchorage).

Results. Conditions were good for flying, with sunny skies and westerly winds to 15 mph; however, they were poor for surveying geese because of very bright light conditions and temperatures in excess of 75 F.

Approximately 9,771 (9,141 adults and 630 goslings) were counted (i.e., visually) during 4.5 hours of flying. Incorporation of visual counts and counts from photographs into weighted regressions resulted in an adjusted total count of 12,448 geese. This adjusted total was composed of 11,231 ± 105 adults and 1,217 ± 200 young, resulting in a production estimate of 9.5%.

The midsummer population index of 12,448 geese was down 6.5% from the 1986 index of 13,309 geese. This decline is identical to that reported by Conant (pers. comm.) for the spring survey and is within the 95% confidence limits of an alternate spring population index (Butler, pers. comm.) that indicated up to an 11% decline. The observed 6.5% decline also compares well with the 5% decline predicted by Campbell and Griese (1987).

Goose Banding and Collaring:

Methods. Flightless geese (i.e., molting and brooding flocks) were captured by driving them into portable drive nets with a Hughes 500 helicopter. All unmarked geese were banded with FWS leg bands; however, over 500 were collared with red plastic collars supporting white characters. Previously marked geese that were recaptured were released after their identity had been determined and recorded.

Assistance for this project was provided by the Washington Department of Wildlife, Region I of the Fish and Wildlife Service, Forest Service, nongovernmental groups, and private individuals.

Results. A total of 773 geese were captured at 6 locations on the delta between 23-26 July 1987 (Fig. 3). One hundred and thirty-six were marked and 637 were unmarked geese. Six hundred and thirty-six were banded; 544 of these were also collared. The number, age, sex, and banding status of the birds are summarized by capture location in Table 5.

Eighty-three geese collared between 1984-86 were recaptured in 1987, bringing the 3-year total for recaptures of previously collared birds to 253. The average annual collar retention rate for these birds was 0.889 ± 0.07, although there was considerable variation between the retention rate in 1984 and other years (Table 6). This rate for geese is well within the

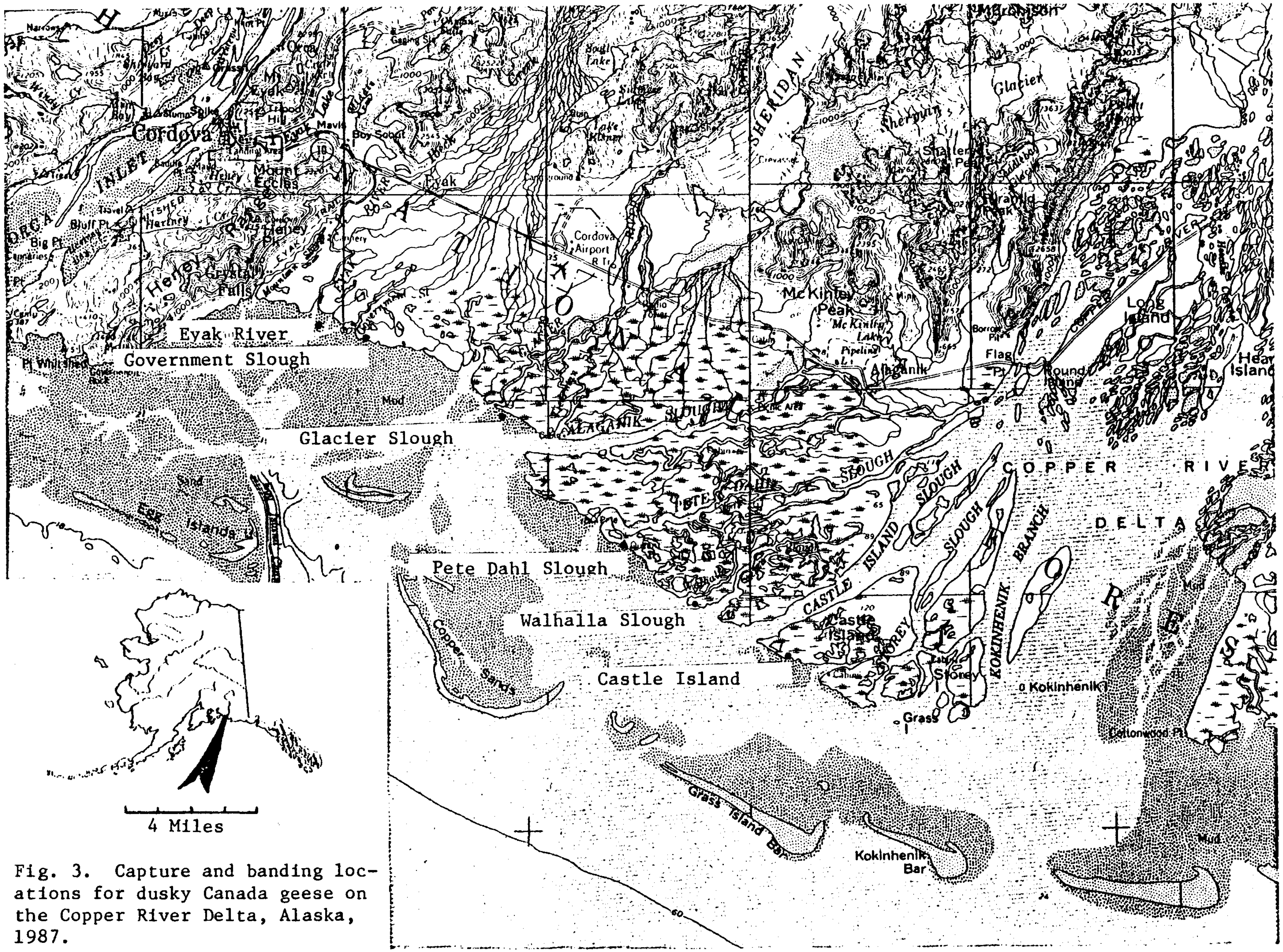


Fig. 3. Capture and banding locations for dusky Canada geese on the Copper River Delta, Alaska, 1987.

Table 5. Summary of dusky Canada geese captured and marked on the Copper River Delta, Alaska in 1987.

Capture location	Total geese captured	Number of recaptures	Number of geese banded[a]					Number of geese collared				
			AHYM	AHYF	AHYU	LM	LF	AHYM	AHYF	AHYU	LM	LF
Eyak River	76	17	17[b]	16[c]	0			17	16	0		
Government Slough	104	19	24	20[f]	1[d]	48[d]	48[e]	24	20	1	47[d]	41[d]
Glacier Slough	55	13	6	6	0			6	6	0		
Pete Dahl Slough	234	54	101	78	1			75	50	1	0	0
Walhalla Slough	135	25	65	45	0			62	39	0	0	0
Castle Island	168	8	87	73	0			77	62	0	0	0
Totals	773	136	300	238	2			261	193	2	47	41

[a] AHYM = Adult male, AHYF = Adult female, AHYU = Adult of unknown sex, LM - Local male or male gosling, LF = Local female or female gosling.
[b] One transplanted to Middleton Island.
[c] Six transplanted to Middleton Island.
[d] All transplanted to Middleton Island.
[e] Forty-seven transplanted to Middleton Island.
[f] Three transplanted to Middleton Island.

Table 6. Collar retention rates for dusky Canada geese collared on the Copper River Delta, Alaska, 1984-86.

Collaring year	Collar retention rates		
	Year 1	Year 2	Year 3
1984	0.772 (57)	0.895 (24)	1.000 (18)
1985	0.978 (89)	0.973 (41)	
1986	0.875 (24)		
$\bar{x}$	0.894	0.846	1.000

range of those reported by others (Zicus and Pace 1986, Raveling 1978, Fjetland 1973).

Except for recovery distribution, detailed band recovery analysis for the dusky geese was not completed in 1987. Erratic banding during the 1960's and 1970's preclude recovery analysis by BROWNIE (Brownie et al. 1985) as originally planned. No additional recovery analysis is anticipated until funding as well as a more sophisticated program for analysis can be obtained.

Evaluation of the Interactions Between Habitat Change, Predator Ecology, and Production:

A 3-year investigation of the activity of brown bears and their impact on nesting dusky Canada geese was completed in 1987. The primary objectives of this study were to document (1) the timing of brown bear movement onto the west Copper River Delta in the spring and their home ranges and (2) their use of habitat during the period when geese are nesting (May-June). A secondary objective was to collect information; i.e., annual home ranges, seasonal fidelity to the delta, denning locations, and denning dates. Progress reports for the first 2 years of the study have been written. The 3rd year of data collection and analysis has been completed, and a final report will be available in 1988.

This project was cooperatively funded by the Oregon Department of Fish and Wildlife, Forest Service, and ADF&G. Partial support and assistance were provided by the funding agencies, Region I of the Fish and Wildlife Service, and private individuals.

Strategies for Increasing The Dusky Goose Population:

As a result of the Pacific Flyway Council recommendation that ADF&G develop and implement strategies to reduce predation on dusky geese, a management options paper (Campbell and Griese 1987) was developed in late 1986 to identify and recommend the following management actions that would increase dusky goose numbers:

1. Transplant geese,
2. Enhance habitat on the nesting grounds,
3. Test nest avoidance techniques and effectiveness,
4. Liberalize hunting and trapping regulations for coyotes in GMU 6(C) and 6(B), and

5. Transplant brown bears from the Copper River Delta to test if reduced bear densities would increase goose production.

With the exception of recommendation No. 3, all of these actions have been initiated. Numbers 1 and 5 involved waterfowl program staff and funds during the 1986-87 and are summarized in this report.

Goose Transplant:

Methods. Goslings and adult guide birds were captured during the banding operation in July 1987. Birds were placed in cardboard cartons (2 adults or 4 young per box) and transported by a Hughes 500 helicopter to the U. S. Coast Guard facility at mile 13 of the Copper River Highway. Geese were held in a cool, shaded area for 4-6 hours before being placed on a Coast Guard H3 helicopter for transport to Middleton Island. Upon arrival at the release site, birds were placed in a holding pen constructed of portable drive nests. All birds were banded with FWS leg bands, and goslings large enough to carry a collar were marked with red ones engraved with white alpha-numeric codes starting with the letter "M." All geese were released as a flock.

This transplant was cooperatively funded by ADF&G, Oregon Department of Fish and Wildlife, Ducks Unlimited, and Washington Department of Wildlife. Support was provided by the U. S. Coast Guard, Region I of the Fish and Wildlife Service, and private individuals.

Results. A total of 106 geese (48 male goslings, 47 female goslings, 9 adults females, 1 adult male, and 1 adult of unknown sex) were moved to Middleton Island on 24 July 1987 (Table 5). In addition to leg bands, all 11 adults and 88 of the 95 goslings were marked with collars.

Pending adequate gosling production on the Copper River Delta, a second transplant to Middleton Island will take place in 1988. Middleton Island will also be visited in the spring of 1988 to assess return rates for birds moved in 1987.

Brown bear transplant:

Methods. Brown bears are a major predator of dusky goose nests. To test the hypothesis that dusky goose nest success and production would increase with reduced bear numbers, the bear population was reduced by 40-60% in 1987. Reduction was accomplished by transplanting animals a sufficient distance from the delta to minimize the likelihood of their return before goose nests hatched. Because transplanted brown bears are capable of returning from long distances (Miller and Ballard 1982), a majority of the bears were expected to return.

We tested the hypothesis that reduced bear numbers would increase goose nest success; the chi-square goodness-of-fit test was applied to the actual number of successful and destroyed nests in each habitat type after the bear transplant as well as to the expected number of successful and destroyed nests in each habitat type. Numbers were derived by multiplying the results of a computer model (log linear logit) that incorporated the influences of spring weather, habitat, and nest predation between 1982-86 (Campbell, unpubl. data) by the total number of nests in each habitat type.

Between 18 and 24 May 1987, brown bears were captured using procedures described by Miller and McAllister (1982) and Spraker et al. (1981). A fixed-wing aircraft was used to locate bears and direct their capture. Animals were immobilized from a Hughes 500 helicopter using Telazol R (tiletamine and zolazepam hydrochloride, A.H. Robins, Richmond, VA). Individuals radio-collared as part of the brown bear study were radio-tracked and captured, and the west delta was extensively searched for unmarked bears or bears with nonfunctioning radio-collars; these bears were also captured. Immobilized animals were transported by helicopter to Coast Guard facilities at Mile 13 of the Copper River Highway where they were processed and loaded onto a Coast Guard H3 helicopter for translocation. Standard morphological and physiological samples were taken from all bears, and newly captured animals were tattooed. All 2-year-old and older ones were temporarily radio-collared so that they could be relocated to confirm their absence from the delta during the study period. Radio-collar attachment was made temporary by replacing a 2- to 4-inch segment of the butyl collar material with a cotton strap that would decompose after a period of time and allow the collar to drop off. Bears were periodically radio-tracked after translocation to determine their location and movement.

Goose nest fate information was collected as part of the nest density and nest fate monitoring project. Nest fate information was collected from nesting study plots on the mainland delta at the mouth of Eyak River and lower Alaganik Slough. Additional areas on Castle Island, lower Walhalla Slough, Lower Alaganik Slough, and Eyak River were also sampled (Fig. 4). Only data from nests of known fate on the mainland Copper River Delta were used in this analysis. Information from the Barrier Islands study plot was not included because of the infrequent occurrence of bears on the island.

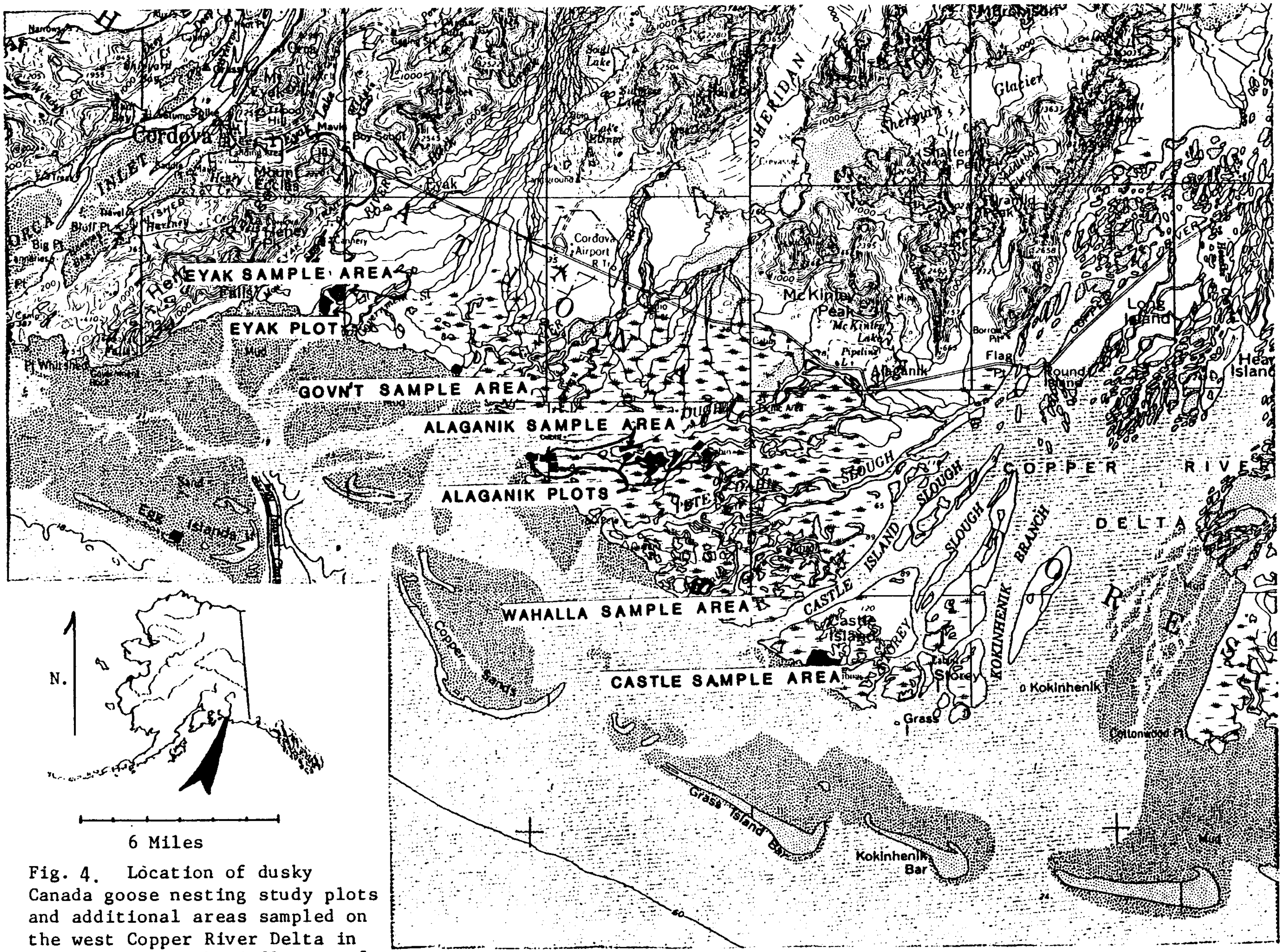


Fig. 4. Location of dusky Canada goose nesting study plots and additional areas sampled on the west Copper River Delta in 1987 to assess the influence of reduced bear density on goose nesting success.

Much appreciated and needed advice and assistance with statistical analysis of the data was provided by Earl Becker (ADF&G, Biometrician, Anchorage). Funding for this project was provided by ADF&G, Oregon Department of Fish and Wildlife, and Ducks Unlimited. Support was provided by the U. S. Coast Guard and Forest Service.

Results. The brown bear population on the West Copper River Delta and adjacent areas was reduced by 19 bears during the spring of 1987. Three animals (1 adult female and 2 immature bears) were removed by hunters and 16 bears (Table 7) were translocated to the Kaliakh-Buktoth River area, approximately 100 miles to the southeast of the Copper River Delta. Very poor weather limited radio-tracking of the translocated animals to only 4 times during May-June. Three to four of the bears had returned to the west Delta by peak of hatch during the 3rd week in June. With the return of these animals as well as the presence of at least 1 adult male and 1 adult female with 2 yearling cubs, a minimum of 7-8 bears were active on the delta during at least part of the nesting period.

A total of 238 goose nests was sampled: 173 on the study plots and 65 at other locations on the west Delta. The fate of 234 of these nests was ascertained: 170 from the study plots and 64 from additional locations (Table 8). Fate of nests on the plots and additional areas were very similar ($X^2 = 0.003$, df = 2, $P > 0.99$); about 22% of the nests were successful, 60% were destroyed, and 18% were abandoned.

The observed odds of a nest succeeding after bear numbers were reduced were 0.377:1.0 or failing 2.556:1.0. Predicted, unadjusted odds of nest success using the logit model based on 1982-86 data (Campbell, unpubl. data) were 0.0859:1.000. Because weather is a major influence on these odds (Campbell, unpubl. data), an adjustment to compensate for differences between the spring weather in 1987 and years between 1982-86 was necessary. Linear extrapolation of logit results for years with more favorable and less favorable spring weather (Fig. 5), as determined by the weather index, resulted in adjusted predicted odds of 0.286:1.000 and 3.492:1.00 for a nest succeeding and failing, respectively.

The lack of a significant difference ($X^2 = 0.623$, df = 7, $P > 0.95$) between actual and expected nest success and failure rates (Table 9) rejects the hypothesis that dusky goose nest success will improve significantly with a 40-60% reduction in brown bear density on the nesting grounds during May and June. This does not mean that their reduction in numbers did not reduce nest predation by bears (i.e., the portion of nest

Table 7. Age, sex, and status of bears captured on the west Copper River Delta and translocated to the Cape Yakataga area in May, 1987.

Animal No.	Sex	Age	Associates	Previously tagged	Date tagged	Radio-collared for translocation
013	F	13	2 2-yr-old cubs (027 and 028)	yes	5/84	yes
016	M	7	none	yes	5/85	yes
018	F	3	none	yes	5/86	yes
019	M	3	none	yes	5/86	yes
021	M	3	none	yes	5/86	yes
023	F	4	none	yes	5/86	yes
027	F	2	013 and 028	no	--	yes
028	M	2	013 and 027	no	--	yes
029	M	4	none	no	--	yes
031	F	7	2 yrlng cubs	no	--	yes
032	F	1	031 and 033	no	--	no
033	F	1	031 and 032	no	--	no
034	M	2	102	no	--	yes
102	F	15	034	yes	5/84	yes
108	F	6	none	yes	5/84	yes
609	M	16	none	yes	5/84	yes

Summary	
Adult males	2
Adult females	4
Immature males	5
Immature females	5

Table 8. Fate and types of nest destruction for dusky goose nests of known fate on the mainland west Copper River Delta, 1987.

Area	Total nests	Nests with known fate (N)	Successful nests (%)	Destroyed nests (%)	Abandoned nests (%)	Types and extent of nest destruction					
						N	Flooding (%)	Brown bear (%)	Canid (%)	Unidentified mammal (%)	Avian (%)
Mainland study plots	173	170	22.4	58.8	18.8	102	7.8	32.4	11.8	3.9	44.1
Additional areas	65	64	23.4	57.8	18.8	35	2.9	11.4	14.3	14.3	57.1
Total	238	234	22.6	58.5	18.8	137	6.6	27.0	12.4	6.6	47.4

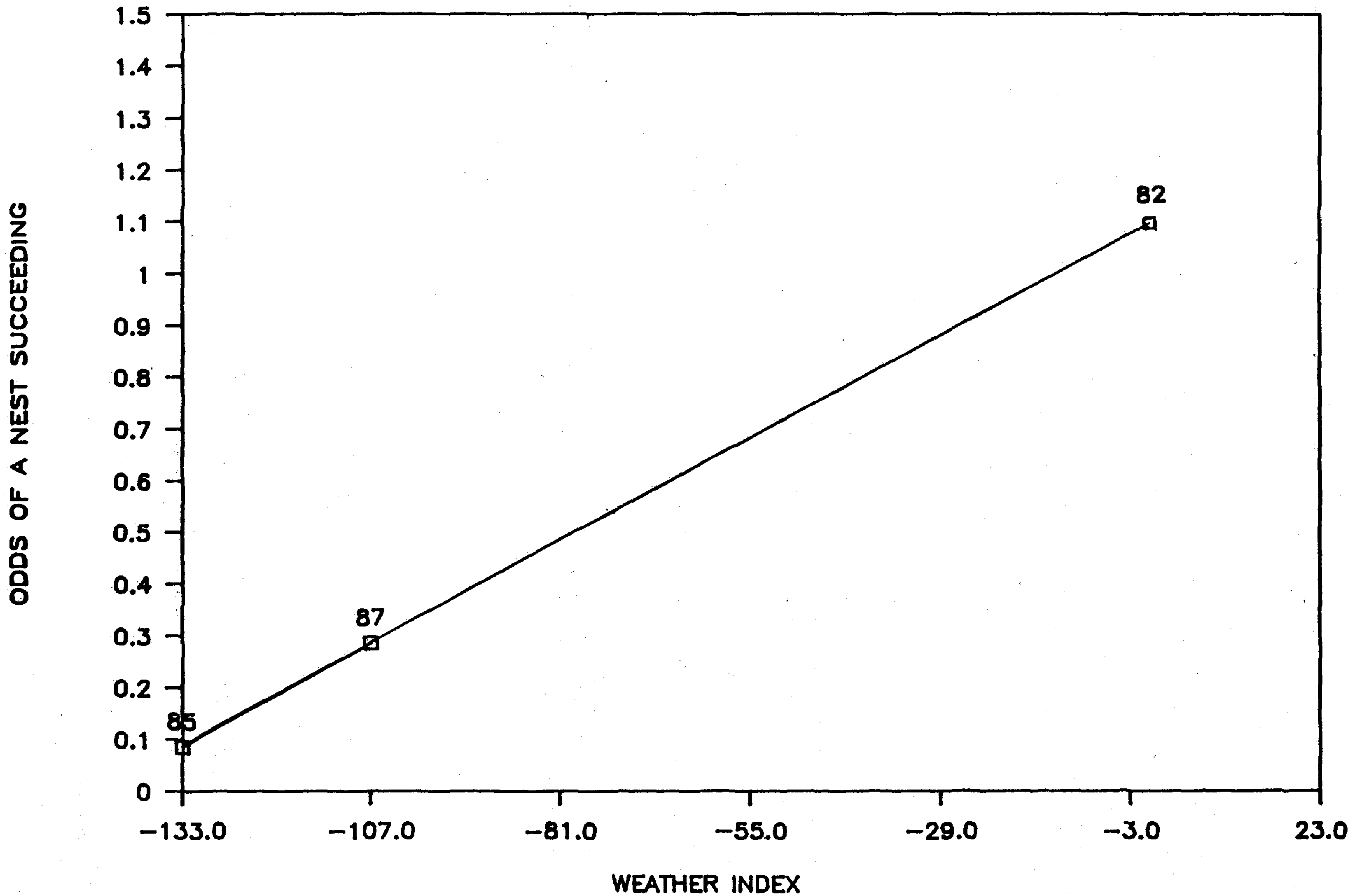


Fig. 5. Linear extrapolation of logit model results between a poor (-133) and average (+2.2) years between 1982-86 to obtain adjusted predicted odds of dusky goose nest success on the Copper River Delta, Alaska in 1987.

Table 9. Actual and expected dusky goose nest success and failure, and chi squares goodness-of-fit test by habitat, after reduction in brown bear numbers on the west Copper River Delta in 1987.

Habitat type	Total nests	Successful nests Actual N (o_i)	Successful nests Predicted N[a] (e_i)	X^2	Destroyed nests Actual N (o_i)	Destroyed nests Predicted N[b] (e_i)	X^2
Tall shrub	64	18	18.32	0.006	46	45.68	0.002
Low shrub	31	9	8.88	0.002	22	22.12	0.001
Levee	11	2	3.15	0.419	9	7.85	0.168
Meadow	40	11	11.45	0.018	29	28.55	0.007
Σx^2							0.623

[a] Total nests x adjusted predicted odds of succeeding.
[b] Total nests x adjusted predicted odds of failing.

predation by bears dropped from 50.4% to 27.0%); rather, it means that other forms of nest destruction were compensatory.

Most of the compensatory nest destruction was the result of 150% increase in avian predation over the 1982-86 average (Table 2). Most of that destruction was by glaucous-winged gull and parasitic jaeger, which probably reflects the inclement weather in 1987. Unseasonably cold, wet weather undoubtedly placed nesting geese under additional energy stress, causing birds to frequently leave nests for prolonged periods to feed and increasing the vulnerability of nests to avian predators. Nest losses to predatory birds may be less during average to "early" springs when the energy demands of nesting are lower. However, based on spring weather indices between 1950-87, any given spring has about 40% chance (or 1 out of every 2-3 springs) of being unfavorable for nesting geese (Fig. 6); so the potential for considerable nest destruction by avian predators is always high.

Nest predation by canids, primarily coyotes, can probably be additive or compensatory, depending on coyote numbers and prey availability. A strong inverse relationship exists between the rodent population and predation on nesting geese on the delta. During years when rodent numbers were low and canids had destroyed 27% of the nests (e.g., 1985), predation would probably have been compensatory and would have, at least, partially offset any gains in production achieved by reducing other predator numbers. On the other hand, during years when rodent populations were building from a low cycle and coyotes had been responsible for only 12.4% of the nest destruction (e.g., 1987), predation would have probably been additive.

Campbell and Griese (1987) estimated that with current nest densities at least 43% of the dusky goose nests must be successful to produce the 15% young necessary to maintain the population at its current level. Based on the results of the experimental brown bear transplant, it appears that nest predation by the major predators is or can be compensatory, depending on factors such as spring weather and availability of buffer prey. Because (1) 43% nest success apparently cannot be achieved and maintained for any length of time by reducing just the brown bear population, (2) poor spring weather, nest abandonment, and potentially high avian predation are likely to occur 1 out of every 2-3 years, and (3) rodent populations and potential canid predation are cyclic, manipulation of all three major predator types is probably necessary to consistently achieve a level of gosling production that will maintain or increase the dusky population.

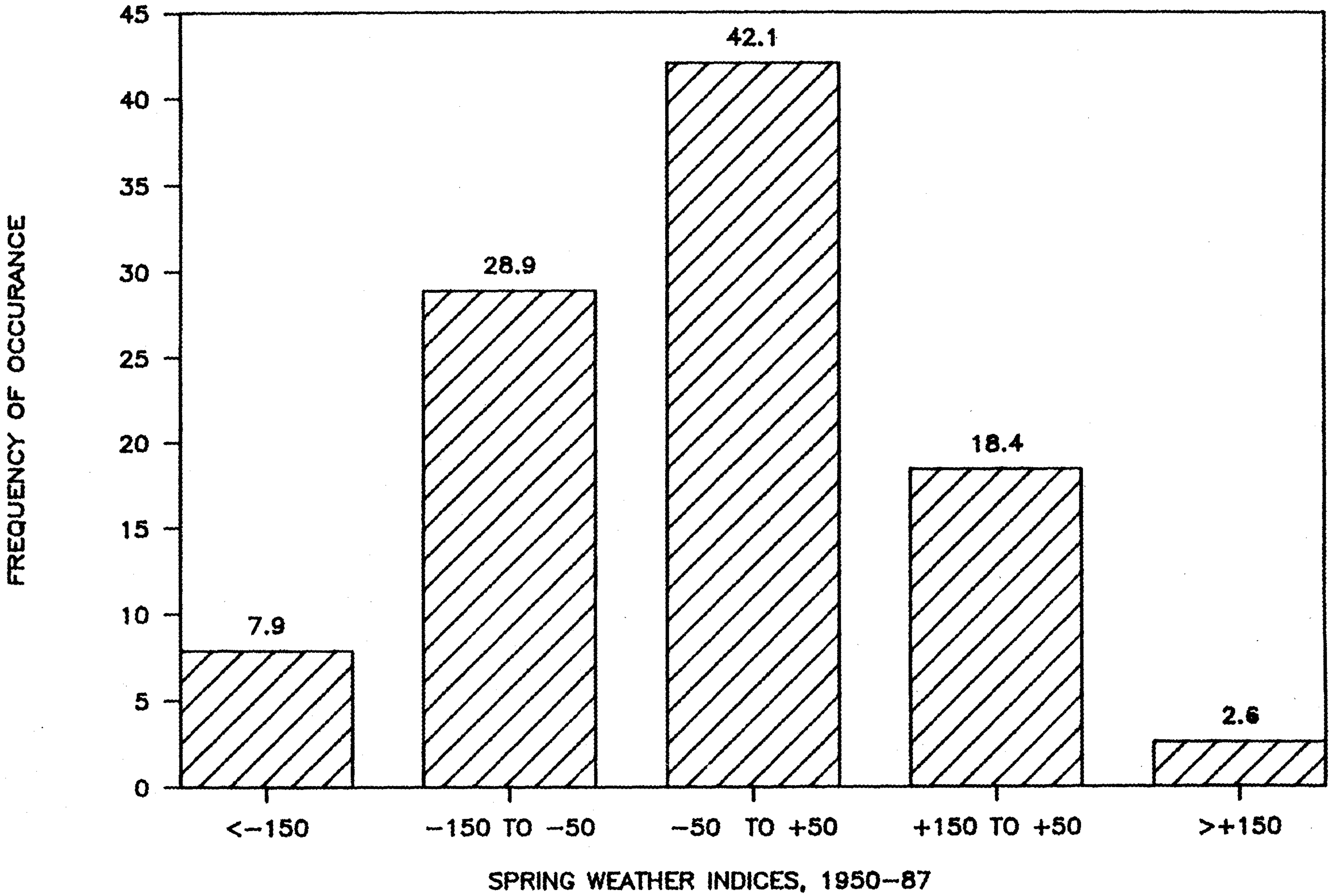


Fig. 6. Frequency of occurance of spring (April, May, and June) weather indices calculated according to Bromley (1976) for the Copper River Delta, Alaska from 1950-87. Negative indices are considered unfavorable for nesting geese.

LITERATURE CITED

Agresti, A. 1984. Analysis of ordinal categorical data. John Wiley and Sons, New Your. 287pp.

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. 81pp.

Brownie, C., D. R. Anderson, K. P. Burnham, and D. S. Robson. 1985. Statistical inference from band recovery data - A hand book. U. S. Fish and Wildl. Serv. Resource Pub. 156. Washington, D. C. 305pp.

Campbell, B. H., D. H. Rosenberg, and T. C. Rothe. 1987. Annual report of Survey-inventory activities, Part XIII. Waterfowl, Vol XVII. Alaska Dep. of Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-5, Job 11.0 Juneau. 55pp.

__________ and H. J. Griese. 1987. Management options for dusky Canada geese and their predators on the Copper River Delta, Alaska. Alaska Dep. Fish and Game. Anchorage. 91pp.

__________. In prep. Habitat availability, utilization, and nest success of dusky Canada geese on the Copper River Delta, Alaska. Alaska Dep. Fish and Game, Anchorage.

Chapman, J. A., C. J. Henney, and H. M. Wright. 1969. The status, population dynamics, and harvest of the dusky Canada goose. Wildl. Monogr. 18. 44pp.

Darrow, R. 1938. Possibilities of recognizing the evidence of predation and the species involved in the remains of grouse and grouse nests found destroyed. Trans. No. Amer. Wildl. Conf. 3:834-838.

Fjetland, C. A. 1973. Long-term retention of plastic collars on Canada geese. J. Wildl. Manage. 34:176-178.

Hanson, W. C. and R. L. Browning. 1959. Nesting studies of Canada geese on the Hanford Reservation, 1953-56. J. Wildl. Manage. 23:129-137.

Heagy, M. I. and F. Cooke. 1979. Vegetation characteristics of snow goose nest sites. Can. J. Bot. 57:1502-1504.

Long, R. J. 1976. A study of nest site selection by island nesting Anatids in central Alberta. MS Thesis. Univ. of Alberta, Edmonton. 123pp.

McCabe, T. R. 1979. Productivity and nesting habitat of great basin Canada geese, Umatilla, DR. In, Jarvis, R. L. and J. C. Bartonek (eds.). Management and biology of Pacific Flyway geese. OSU Book Stores, Inc., Corvallis, OR. 117-129pp.

Miller, S. D. and W. B. Ballard. 1982. Homing of transplanted Alaskan brown bears. J. Wildl. Manage. 46:869-876.

__________ and D. C. McAllister. 1982. Susitna hydroelectric project, Phase I final report. Big game studies. Vol. VI, Black and brown bear. Alaska Dep. Fish and Game. Juneau. 223pp.

Pacific Flyway Council. 1985. Dusky Canada goose management plan. 35pp.

Potyondy, J. P., M. P. Meyer, and A. C. Mace, Jr. 1975. An analysis of 1964 earthquake effects upon the vegetation and hydrology of the Copper River Delta, Alaska. Inst. Agric., Forest., Home Econ., Remote Sens. Lab. Rep. 75-6. 84pp.

Raveling, D. G. 1978. Dynamics of distribution of Canada geese in winter. Trans. No. Am. Wildl. and Nat. Resour. Conf. 43:206-225.

Rearden, J. D. 1951. Identification of waterfowl nest predators. J. Wildl. Manage. 15:386-395.

Sooter, C. A. 1946. Habits of coyotes in destroying nests and eggs of waterfowl. J. Wildl. Manage. 10:33-38.

Spraker, T. H., W. B. Ballard, and S. D. Miller. 1981. Brown bear studies, Game Management Unit 13. Alaska Dep. Fish and Game, Final Fed. Aid. Wildl. Rest. Prog. Rep. W-17-10 and 11, Job 4.13R. Juneau. 57pp.

Trainer, C. E. 1959. The 1959 western Canada goose (Branta canadensis occidentalis) study of the Copper River Delta, Alaska. In Annual waterfowl report, Alaska. U.S. Fish and Wildl. Serv. Juneau. 9pp.

Zicus, M. C. and R. M. Pace. 1986. Neck band retention in Canada geese. Wildl. Soc. Bull. 14:388-391.

INVESTIGATIONS OF LEAD SHOT INGESTION AND ABSORPTION BY WATERFOWL

GAME MANAGEMENT UNIT: 14 and 16

GEOGRAPHICAL DESCRIPTION: Cook Inlet

PERIOD COVERED: 1 July 1986-30 June 1987

Introduction

In 1985 the Alaska Department of Fish and Game initiated a study to assess lead ingestion and absorption rates in the gizzards and livers of mallards (*Anas platyrhynchos*) and northern pintails (*A. acuta*) in upper Cook Inlet (Campbell et al. 1987). This report presents the preliminary findings of those investigations. More detailed analyses will be conducted, and a final report will be prepared under separate cover. Timm (1980) presented findings from a similar study in Cook Inlet, but that study did not match corresponding livers and gizzards from the same birds (paired samples).

Methods

Paired samples of livers and gizzards were collected from mallards and northern pintails harvested by hunters in the Palmer Hay Flats and Susitna Flats State Game Refuges and Redoubt Bay in 1985 and 1986. Gizzards and livers were frozen until analysis.

Ingestion Rates:

Gizzard contents were inspected by X-ray radiography (Montalbano and Hines 1978). Gizzards were cut open, and the contents were washed under pressure into filter paper. Condition and color of gizzard linings were recorded, as were presence of entry or exit wounds. Excess water was removed from each sample using a Buchner funnel and vacuum pump; filters and contents were air dried, packaged in individual plastic zip-loc bags, labeled, and mounted on 36- x 43-cm cardboard sheets, 24 samples per sheet. Each sheet contained a lead shot control sample. Cardboard sheets were placed over standard 36- x 43-cm X-ray film (Kodak Diagnostic Film, General Purpose Ultra Blue) and X-rayed using a Universal Easymatic Super 325 X-ray machine set at an exposure of 60 Kv for 0.15 milliseconds at 200 milliamps.

Gizzards with ingested shot were paired with livers having lead levels below 2 ppm (wet weight basis) and inspected for shot-in lead pellets, as opposed to ingested pellets. Shot-in pellets were found in 19.2% of these gizzards. Whether pellets were shot-in or ingested was determined by physical appearance of the shot (Anderson and Havera 1985). Those gizzards with corresponding liver levels above 2 ppm have yet to be inspected for the presence of shot-in pellets.

Liver Lead Concentrations:

Lead concentrations in livers were measured using atomic absorption spectrophotometry with a Perkin-Elmer ICP-5500, following procedures of the U.S. Fish and Wildlife Service National Wildlife Health Lab (T. Bennett, unpubl. data). Chemical analysis of lead is presented on a wet-weight basis to facilitate comparisons with the FWS criteria. All livers with lead values greater than 99.00 ppm (wet weight) were eliminated from the analysis because of possible contamination.

Results

Ingestion Rates:

A total of 348 pintail and 226 mallard gizzards were examined for the presence of ingested lead shot pellets (Table 1). Ingested lead pellets were detected in the gizzards of 27% of mallards and 17% of northern pintails (Table 2). Highest incidence of ingestion occurred in samples from the Palmer Hay Flats, where 38% of mallard and 28% of pintail gizzards contained ingested shot. Lowest ingestion rates for mallards occurred on the Susitna Flats; 18.4% of birds contained 1 or more pieces of shot. Lowest ingestion rates for northern pintails occurred in Redoubt Bay, with 7.7% of the birds having ingested shot. Twenty-six percent of birds collected on 1 September(i.e., the opening day of waterfowl season) contained ingested shot.

Large numbers of ingested shot were found in individual gizzards; 1 northern pintail had ingested over 80 shot. Analysis of individual gizzards with greater then 10 pieces of shot is still in progress. A frequency distribution of the number of lead pellets found in the gizzards of mallards and pintails is presented in Table 3.

Liver Lead Concentrations:

Liver lead levels greater than or equal to 2 ppm occurred in 19.1% of all birds sampled (Table 4). Liver lead levels were greater than or equal to 2 ppm for 39.5% of mallards and 19.4% of northern pintails collected from the Palmer Hay Flats, 21.6% of mallards and 9.0% of pintails from the Susitna Flats,

Table 1. Summary of paired samples of livers and gizzards collected for mallards and pintails (by age and sex) in 1985 and 1986 for 3 locations in Upper Cook Inlet.

	Pintails						Mallards						
	Adults		Immature				Adults		Immature				Grand
Location	M	F	M	F	Unk	Total	M	F	M	F	Unk	Total	total
Palmer Hay Flats	7	7	48	44	0	106	4	6	47	34	0	91	197
Susitna Flats	17	19	74	76	4	190	13	16	36	36	2	103	293
Redoubt Bay	1	4	16	16	15	52	4	2	13	12	1	32	84
TOTALS	25	30	138	136	19	348	21	24	96	82	3	226	574

Table 2. Proportion of mallards and pintails with one or more lead shot in their gizzards (sample size in parentheses) collected on three areas in Cook Inlet, 1985-86.

Area	September 1 - 15		September 16 - 30		October		Totals		
	Mallards	Pintails	Mallards	Pintails	Mallards	Pintails	Mallards	Pintails	Both species
Palmer Hay Flats	39.5 (86)	29.3 (99)	0.0 (4)	0.0 (3)	100.0 (1)	25.0 (4)	38.4 (91)	28.3 (106)	33.0 (197)
Susitna Flats	14.0 (57)	14.1 (121)	5.6 (18)	13.2 (38)	35.7 (28)	9.7 (31)	18.4 (103)	13.2 (190)	15.0 (293)
Redoubt	16.7 (18)	6.8 (44)	0.0 (0)	0.0 (2)	28.6 (14)	16.7 (6)	21.9 (32)	7.7 (52)	13.1 (84)
TOTALS	28.0 (161)	18.6 (264)	4.5 (22)	11.6 (43)	34.9 (43)	12.2 (41)	27.0 (226)	17.0 (348)	20.9 (574)

Table 3. Frequency distribution of number of ingested lead shot pellets found in gizzards of mallards and pintails in Cook Inlet in 1985 and 1986.[a]

	Area					
	Palmer Hay Flats		Susitna Flats		Redoubt Bay	
Number of shot	No. of gizzards	% of total	No. of gizzards	% of total	No. of gizzards	% of total
0	132	67	249	85	73	87
1	20	10	28	10	9	11
2	6	3	4	1	0	0
3	7	4	3	1	1	1
4	1	0	0	0	0	0
5 - 10	13	7	5	2	1	1
>10	18	9	4	1	0	0
TOTALS	197	100	293	100	84	100

[a] Partially corrected for shot-in pellets.

Table 4. Proportion of mallards and pintails with lead concentrations greater than or equal to 2.00ppm, on a wet weight basis, in their livers (samples size in parentheses), collected from three areas in Cook Inlet, 1985-86.

	September 1 - 15		September 16 - 30		October		Totals		
Area	Mallards	Pintails	Mallards	Pintails	Mallards	Pintails	Mallards	Pintails	Both species
Palmer Hay Flats	40.7 (86)	19.8 (96)	0.0 (4)	33.3 (3)	100.0 (1)	0.0 (4)	39.5 (91)	19.4 (103)	28.9 (194)
Susitna Flats	19.6 (56)	11.6 (121)	0.0 (18)	5.3 (38)	39.3 (28)	3.2 (31)	21.6 (102)	8.9 (190)	13.4 (292)
Redoubt Bay	27.8 (18)	13.6 (44)	0.0 (0)	0.0 (2)	21.4 (14)	0.0 (6)	25.0 (32)	11.5 (52)	16.7 (84)
TOTALS	31.9 (160)	14.9 (261)	0.0 (22)	7.0 (43)	34.9 (43)	2.4 (41)	29.3 (225)	12.5 (345)	19.1 (570)

and 25% of mallards and 11.5% of northern pintails from Redoubt Bay. Lead levels in livers of northern pintails and mallards ranged from 0.16 to 56.01 ppm and 0.22 to 41.64 ppm, respectively (Table 5). Liver lead levels greater than or equal to 6 ppm occurred in 8.6% of all birds.

Mean liver lead levels for mallards were highest on the Palmer Hay Flats (i.e., 4.37 ppm + SD 7.09) and lowest for birds collected in Redoubt Bay (i.e., 2.19 ppm + SD 2.19) (Table 5). Mean liver lead levels for northern pintails were also highest on the Palmer Hay Flats (i.e., 2.53 ppm + SD 6.70) and lowest on the Susitna Flats (i.e., 1.62 ppm + SD 4.55). Mean levels of absorbed lead by time period and location for mallards and northern pintails are presented in Tables 6 and 7.

Liver lead levels consistently averaged higher for birds with ingested shot (i.e., 6.77 ppm + SD 9.45), compared with those with no shot in the gizzard (i.e., 1.03 ppm + SD 3.19) (Table 5). Of 67 birds with only 1 or 2 ingested pieces of shot, 55% had liver lead levels below 2 ppm and 45% had liver lead levels greater than or equal to 2 ppm. For those birds with 5 or more shot, 97% had liver lead levels greater than or equal to 2 ppm.

Discussion

Mallards and pintails using Cook Inlet marshes have high rates of ingestion of spent lead shot, relative to other areas in the United States. Sanderson and Bellrose (1986) report mean ingestion rates (i.e., percentage of gizzards with one or more shot) are 8.1% and 11.7% for mallards and pintails, respectively, from 25 studies conducted throughout the United States from 1973 to 1984.

Shot present in the gizzard reflects the degree of recent exposure to lead shot. Lead in the liver reveals the degree of assimilation of lead into the tissues and is indicative of potential health problems. A liver lead level of 2 ppm represents significantly higher than normal concentrations of lead accumulated in tissues (U.S. Fish and Wildlife Service 1986). These criteria have been commonly used to identify areas with lead-poisoning problems, which may exist in areas with one or more ingested shot in 5% or more of gizzards sampled and 2 ppm (wet weight basis) or higher lead levels in 5 % or more of livers sampled (U.S. Fish and Wildlife Service 1986). Ingestion rates for both mallards and pintails in Cook Inlet exceed the U.S. Fish and Wildlife Service criteria in all 3 areas sampled.

The incidence of absorbed lead in livers is also relatively high when compared with other parts of the nation. The FWS's

Table 5. Mean levels of absorbed lead (parts per million on a wet weight basis) in livers of mallards and pintails in Cook Inlet in 1985 and 1986.

Area	Totals mean ± standard deviation (range) Mallards	Pintails	Both species
Palmer Hay Flats			
All Birds[a]	4.37 ± 7.09 (0.22 - 36.40)	2.53 ± 6.70 (0.16 - 56.01)	3.48 ± 6.93 (0.16 - 56.01)
With Shot[b]	9.96 ± 8.61 (0.38 - 36.40)	5.87 ± 11.30 (0.42 - 56.01)	8.10 ± 10.04 (0.38 - 56.01)
Without Shot[c]	0.89 ± 2.06 (0.22 - 15.05)	1.20 ± 2.67 (0.16 - 17.26)	1.07 ± 2.42 (0.16 - 17.26)
Susitna Flats			
All Birds[a]	2.92 ± 7.22 (0.23 - 41.64)	0.92 ± 1.58 (0.18 - 12.93)	1.62 ± 4.55 (0.18 - 41.64)
With Shot[b]	8.28 ± 11.69 (0.35 - 41.64)	2.83 ± 3.00 (0.20 - 12.93)	5.18 ± 8.34 (0.20 - 41.64)
Without Shot[c]	1.69 ± 5.10 (0.23 - 39.77)	0.63 ± 0.95 (0.18 - 10.95)	0.99 ± 3.09 (0.18 - 39.77)
Redoubt Bay			
All Birds[a]	2.19 ± 6.06 (0.22 - 34.39)	1.36 ± 5.09 (0.21 - 37.00)	1.67 ± 5.46 (0.21 - 37.00)
With Shot[b]	7.19 ± 12.04 (1.52 - 34.39)	2.15 ± 1.13 (0.47 - 2.94)	5.36 ± 9.69 (0.47 - 34.39)
Without Shot[c]	0.79 ± 1.37 (0.22 - 6.41)	1.29 ± 5.29 (0.21 - 37.00)	1.12 ± 4.35 (0.21 - 37.00)
TOTALS			
All Birds[a]	3.40 ± 7.03 (0.22 - 41.64)	1.47 ± 4.36 0.16 - 56.01)	2.23 ± 5.65 (0.16 - 56.01)
With Shot[b]	9.12 ± 9.93 (0.35 - 41.64)	4.30 ± 0.31 (0.20 - 56.01)	6.77 ± 9.45 (0.20 - 56.01)
Without Shot[c]	1.28 ± 3.87 (0.22 - 39.77)	0.89 ± 2.65 (0.16 - 37.00)	1.03 ± 3.19 (0.16 - 39.77)

[a] For all birds.
[b] For all birds with 1 or more ingested shot in gizzard.
[c] For all birds with no ingested shot in gizzard.

Table 6. Mean levels of absorbed lead (parts per million on a wet weight basis) in livers of mallards in Cook Inlet in 1985 and 1986 by time period.

Area	September 1 - 15 mean ± stand dev (range) Mallards	September 16 - 30 mean ± stand dev (range) Mallards	October mean ± stand dev (range) Mallards	Totals mean ± stand dev (range) Mallards
Palmer Hay Flats				
All Birds[a]	4.57 ± 7.25 (0.22 - 36.40)	0.72 ± 0.36 (0.26 - 1.11)	2.47[d] ---	4.37 ± 7.09 (0.22 - 36.40)
With Shot[b]	10.18 ± 8.64 (0.38 - 36.40)	--- ---	2.47[d] ---	9.96 ± 8.61 (0.38 - 36.40)
Without Shot[c]	0.89 ± 2.06 (0.22 - 15.05)	0.72 ± 0.36 (0.26 - 1.11)	--- ---	0.89 ± 2.06 (0.22 - 15.05)
Susitna Flats				
All Birds[a]	2.71 ± 6.28 (0.25 - 34.29)	0.79 ± 0.53 (0.33 - 1.80)	4.69 ± 10.39 (0.23 - 41.64)	2.92 ± 7.22 (0.23 - 41.64)
With Shot[b]	9.71 ± 12.47 (0.35 - 34.29)	1.71[d] ---	7.80 ± 12.05 (0.66 - 41.64)	8.28 ± 11.69 (0.35 - 41.64)
Without Shot[c]	1.55 ± 3.65 (0.25 - 23.23)	0.74 ± 0.50 (0.33 - 1.80)	2.96 ± 9.26 (0.23 - 39.37)	1.69 ± 5.10 (0.23 - 39.77)
Redoubt Bay				
All Birds[a]	1.27 ± 1.68 (0.25 - 6.41)	--- ---	3.38 ± 9.01 (0.22 - 34.39)	2.19 ± 6.06 (0.22 - 34.39)
With Shot[b]	2.51 ± 0.35 (2.12 - 2.78)	--- ---	10.7 ± 15.86 (1.52 - 34.39)	7.19 ± 12.04 (1.52 - 34.39)
Without Shot[c]	1.02 ± 1.74 (0.25 - 6.41)	--- ---	0.45 ± 0.22 (0.22 - 0.97)	0.79 ± 1.37 (0.22 - 6.41)
TOTALS				
All Birds[a]				3.40 ± 7.03 (0.22 - 41.64)
With Shot[b]				9.12 ± 9.93 (0.35 - 41.64)
Without Shot[c]				1.28 ± 3.87 (0.22 - 39.77)

[a] For all birds.
[b] For all birds with 1 or more ingested shot in gizzard.
[c] For all birds with no ingested shot in gizzard.
[d] One sample only.

Table 7. Mean levels of absorbed lead (parts per million on a wet weight basis) in livers of pintails in Cook Inlet in 1985 and 1986 by time period.

Area	September 1 - 15 mean ± stand dev (range) Pintails	September 16 - 30 mean ± stand dev (range) Pintails	October mean ± stand dev (range) Pintails	Totals mean ± stand dev (range) intails
Palmer Hay Flats				
All Birds[a]	2.64 ± 6.89 (0.16 - 56.01)	1.21 ± 1.15 (0.40 - 2.02)	0.57 ± 0.33 (0.37 - 1.07)	2.53 ± 6.70 (0.16 - 56.01)
With Shot[b]	6.06 ± 11.45 (0.46 - 56.01)	--- ---	0.42[d] ---	5.87 ± 11.30 (0.42 - 56.01)
Without Shot[c]	1.23 ± 2.76 (0.25 - 6.41)	1.21 ± 1.15 (0.40 - 2.02)	0.62 ± 0.39 (0.37 - 1.07)	1.20 ± 2.67 (0.16 - 17.26)
Susitna Flats				
All Birds[a]	1.06 ± 1.89 (0.24 - 12.93)	0.77 ± 0.88 (0.24 - 4.94)	0.57 ± 0.45 (0.18 - 2.49)	0.92 ± 1.58 (0.18 - 12.93)
With Shot[b]	3.42 ± 3.34 (0.59 - 12.93)	2.07 ± 1.84 (0.53 - 4.94)	0.73 ± 0.67 (0.20 - 1.48)	2.83 ± 3.00 (0.20 - 12.93)
Without Shot[c]	0.67 ± 1.15 (0.24 - 10.95)	0.57 ± 0.38 (0.24 - 1.55)	0.55 ± 0.44 (0.18 - 2.49)	0.63 ± 0.95 (0.18 - 10.95)
Redoubt Bay				
All Birds[a]	1.54 ± 5.52 (0.26 - 37.00)	0.29 ± 0.12 (0.21 - 0.38)	0.36 ± 0.06 (0.31 - 0.47)	1.36 ± 5.09 (0.21 - 37.00)
With Shot[b]	2.70 ± 0.21 (2.53 - 2.94)	--- ---	0.47[d] ---	2.15 ± 1.13 (0.47 - 2.94)
Without Shot[c]	1.45 ± 5.72 (0.26 - 37.00)	0.29 ± 0.12 (0.21 - 0.38)	0.34 ± 0.03 (0.31 - 0.39)	1.29 ± 5.29 (0.21 - 37.00)
TOTALS				
All Birds[a]				1.47 ± 4.36 0.16 - 56.01)
With Shot[b]				4.30 ± 0.31 (0.20 - 56.01)
Without Shot[c]				0.89 ± 2.65 (0.16 - 37.00)

[a] For all birds.
[b] For all birds with 1 or more ingested shot in gizzard.
[c] For all birds with no ingested shot in gizzard.
[d] One sample only.

lead-poisoning monitoring program reports 14.8% of dabbling ducks collected in 1983-4 in the Pacific flyway had liver lead concentrations greater than or equal to a wet weight of 2 ppm, (Brand, In U.S. Fish and Wildlife Service 1986). Only northern pintails from Susitna Flats and Redoubt Bay were below these averages. All areas sampled in Cook Inlet exceeded the FWS criteria for percentage of livers with lead levels greater than or equal to 2 ppm.

Longcore et al. (1974) found that lead levels between 6 and 20 ppm in the liver indicate recent acute lead exposure and are diagnostic of active lead intoxication. Over 8% of the birds collected in this study had levels over 6 ppm. Bagley and Locke (1967) found background levels of lead averaged 0.5 to 1.5 ppm in the livers of 11 different species of waterfowl with no known history of lead exposure. Birds from this study with no ingested shot had average liver lead values in the middle of the range reported by Bagley and Locke (1967).

Timm (1980) reported 15.1% of duck gizzards collected in Cook Inlet from 1974 to 1979 contained ingested lead shot. Ducks collected from the Palmer Hay Flats and Susitna Flats had the highest ingestion rates, 31.7% and 17.3%, respectively. For ducks collected during the summer and on 1 September opening day), 22.2% of duck gizzards contained ingested shot. Overall ingestion rates from the present study correspond closely with Timm's results, although in the present study no birds were collected during the summer.

The proclivity of a given species of waterfowl to ingest spent lead shot depends on its feeding habits and habitat preferences. Among dabbling ducks, mallards and pintails have high ingestion rates (Sanderson and Bellrose 1986). The percentage of waterfowl that ingest shot depends upon hunting pressure and other variables such as pond bottom firmness, water depths, size of pellets, ice cover, and season (Bellrose 1959).

Many factors determine the lethality of shot once it has been ingested. These include the type and quantity of food and grit consumed and the rate of passage through the digestive tract. The intake of protein, calcium, and phosphorus have reduced lead toxicosis in experiments with penned waterfowl (Sanderson and Bellrose 1986). Timm (1980) speculated that diet may have a mollifying effect on lead levels in Cook Inlet birds.

The high percentage of birds with elevated liver lead levels above 2 ppm and 6 ppm in the present study is of considerable concern, even with any amelioration from diet that may have reduced lead absorption. Birds with ingested shot present in the gizzard averaged much higher values for lead residues in the liver than birds without ingested shot. Comparisons of birds having 5 or more shot with those having 1 or 2 shot show that an increase in the amount of ingested shot causes a corresponding increase in liver lead levels. Additionally, elevated liver lead levels in birds with no shot may have resulted from prior ingestion but complete erosion or passage of pellets. Similarly, birds with ingested shot but low liver lead values may have ingested shot only recently. Further analysis will be done to confirm the latter.

The sublethal effects of elevated lead levels in waterfowl are not well known. Lead is a systemic poison, and it is suspected that long-term exposure to sublethal amounts can suppress immunological responses causing increased susceptibility to other pathogens (Wobeser 1986). Dieter and Finley (1979) found that elevated lead levels reduce delta-aminolevulinic acid dehydratase (ALAD) enzyme activity, and this can cause brain damage before other symptoms characteristic of more severe lead poisoning are manifested. Reduced ALAD levels inhibit hemoglobin production, the oxygen-carrying pigment in red blood cells, causing abnormal red blood cell formation. Anemia may result, causing a decrease in the amount of oxygen to various tissues. If prolonged, it can result in progressive weakness, increased susceptibility to illness (and also harvest), neurological abnormalities, and death.

Once all gizzards are analyzed for shot-in versus ingested shot, results for ingestion rates will be recalculated. Incidence of shot-in pellets for 13,236 mallards collected in Illinois from 1979 to 1983 were 5.8% (Anderson and Havera 1985). As a portion of this percentage has been accounted for and assuming similarity to our study, the total ingestion rate for mallards and pintails in all 3 Cook Inlet locations may be reduced slightly. Liver lead levels will not be affected.

Acknowledgements

We are grateful to all the waterfowl hunters of southcentral Alaska who provided us with the samples necessary for this study. Assistance from Enid Goodwin and John Matthews in the collection and analysis of data was greatly appreciated, and Jim Faro was especially helpful in collecting samples from Redoubt Bay. Dr. Clyde Odum of the Diamond Animal Clinic generously allowed us use of his X-ray facilities. We thank Dr. Joe Offner, Steve Blake, Pat Bates, and Julie Moore of the State of Alaska Agricultural Experiment Station for their work analyzing liver samples. Appreciation is extended to Drs. Kathy Converse and Milt Smith of the USFWS National

Wildlife Health Lab for all the helpful information they provided.

Literature Cited

Anderson, W.L., and S.P. Havera. 1985. Blood lead, protoporphyrin, and ingested shot for detecting lead poisoning in waterfowl. Wildl. Soc. Bull. 13:26-31.

Bagley, G.E., and L.N. Locke. 1967. The occurrence of lead in tissues of wild birds. Bull. Environ. Contam. Toxicol. 2(5):297-305.

Bellrose, F.C. 1959. Lead poisoning as a mortality factor in waterfowl populations. Illinois Natural History Survey Bull. 27:235-288.

Campbell, B.H., D.H. Rosenberg, and T.C. Rothe. 1987. Annual report of survey and inventory activities - waterfowl. Alaska Dept. of Fish and Game. Federal Aid in Wildl. Restoration. Vol. XVII, Part XIII, Proj. W-22-5, Job 11.0. 55 pp.

Dieter, M.P., and M.T. Finley. 1979. Delta-aminolevulinic acid dehydratase: inhibition in ducks dosed with lead shot. Environ. Res. 12;243-249.

Longcore, J.R.,L.N. Locke, G.E. Bagley, and R. Andrews. 1974. Significance of lead residues in mallard tissues. U.S. Dept. of Interior, U.S. Fish and Wildl. Serv. Spec. Sci. Rept.- Wildl. No. 182. Washington, D.C. 24 pp.

Montalbano, F., and T.C. Hines. 1978. An improved X-ray technique for investigating ingestion of lead by waterfowl. Proc. Annu. Conf. Southeastern Assoc. Fish and Wildl. Agencies 32:364-368.

Sanderson, G.C., and F.C. Bellrose. 1986. A review of the problem of lead poisoning in waterfowl. Illinois Natural History Survey, Special Publication 4. Champaign. 34 pp.

Timm, D. 1980. Annual report of survey and inventory activities - waterfowl. Alaska Dept. of Fish and Game, Proj. Prog. Rept. Federal Aid Wildl. Vol. XI. Restoration Project W19-1, Job No. 10. Juneau 35pp.

U.S. Fish and Wildlife Service. 1986. Final Supplemental Environmental Impact Statement - Use of lead shot for hunting migratory birds in the United States. Washington, D.C.

Wobeser, G. 1986. Interaction of lead and other disease agents. In Lead Poisoning In Wild Waterfowl-A Workshop-. J.S. Feierabend and A.B. Russell (Eds.) Natl. Wildl. Fed. Washington, D.C. 109-112.

MONITORING OF VANCOUVER CANADA GEESE TRANSPLANTED TO KODIAK AND SURVEYS IN SOUTHEAST ALASKA

GAME MANAGEMENT UNITS: 1-5, 8

GEOGRAPHICAL DESCRIPTION: Southeast Alaska, Kodiak

PERIOD COVERED: 1 July 1986-30 June 1987

Introduction

In July 1986 the Alaska Department of Fish and Game transplanted 209 Vancouver Canada geese (*Branta canadensis fulva*) from Southeast Alaska to Kodiak and Shuyak islands (Campbell et al. 1987). This paper presents the results of monitoring efforts associated with the transplant. Aerial surveys were also conducted in Southeast Alaska to locate additional flocks of Vancouver Canada geese for possible subsequent relocation to Kodiak. Results of these surveys are also reported.

Study Area and Methods

Kodiak:

Attempts to locate birds by aerial survey and boat were conducted throughout the year in Kodiak and adjacent islands. In addition, residents reported many sightings of geese. Resightings became more difficult after March 1987, when all radio transmitters had been shed by birds or radioed birds had died.

Southeast:

On 21-23 and 29 July aerial surveys were conducted in Southeast Alaska in an attempt to locate molting flocks for possible subsequent transplants to Kodiak. Surveys were flown in a Cessna 185 with two observers seated on the right side of the plane. Flocks were photographed with a 35-mm camera, a 200-mm telephoto lens was used, and numbers were counted from photographs. Differentiation of adults and immatures was difficult; consequently, the numbers of immatures may be underrepresented. Numbers from Icy Bay and the Bering Glacier are visual estimates. Only about one-half of the meltwater lakes along the face of Bering Glacier were surveyed. Many of the smaller meltwater lakes along the face of the Malaspina Glacier were not surveyed because of the additional time and fuel required. Time, weather, and cost precluded surveys in many areas.

Results and Discussion

Kodiak:

Resightings of transplanted geese are presented in Table 1. No evidence of nesting has been reported. Evidence of molting (i.e., concentrations of feathers and feces) were found in Big Bay, Shuyak Island, in early August 1987.

Some sightings are presumably from a previous transplant of 16 Vancouver Canada geese released at Terror Bay in 1975. Canada geese at Twin Lakes (Latitude 57°45', Longitude 153°05'), located five miles west of Kizhuyak Bay on Kodiak Island, have been observed prior to this transplant. Roger Smith (pers. comm.) observed 5 geese from 4 to 9 June 1984, and at least 1 goose was seen in the same area in July 1985. Geese also use beaver ponds in the vicinity of Twin Lakes. Personnel of the USFWS have records of sighting between 7 and 9 Vancouver Canada geese in Zachar Bay during the winters of 1980-1982 and 1985.

A bird released on Shuyak Island returned to Southeast Alaska. A band return was reported on 22 September 1987 from the vicinity of Duncan Canal (Latitude 56°40', Longitude 133°10'). We do not know whether other birds have returned to Southeast Alaska.

Southeast:

Over 4400 geese were located; these were primarily adults that failed in their nesting efforts or nonbreeding birds (Table 2). The large majority (3,800) were found from Glacier Bay to the Bering Glacier. The largest concentrations were in Adams Inlet (1,327 geese), Malaspina Lake (468), Icy Bay (575), and the Bering Glacier (430). No immatures were observed in these areas.

Five hundred and fifty-five geese were located on Kupreanof, Kuiu, and Admiralty Islands, including 341 birds in Fool Inlet, the site of the 1986 capture. Three flocks totaling 154 birds were observed on the west side of Kuiu, Island and a flock of 60 birds was sighted in Duncan Canal.

Canada geese have been observed in Neka Bay on Chichagof Island. An aerial survey conducted on 15 July 1986 located 20 adults and 6 young. The same survey located 14 adults on Thayer Lake and about 24 adults and 6 young at an area locally referred to as "hole-in-the-wall," which is about 2 miles due

Table 1. Resightings of Vancouver Canada geese on Kodiak, Shuyak, and Afognak Islands following the 21 July 1986 translocation.

Location	Date	Number of geese
Kodiak Island		
Spiridon Bay	July 31,1986	104
Spiridon Bay	August 6, 1986	90
Twin Lakes **	August 6, 1986	7
Chiniak	August 9, 1986	2
Long Island	August 11, 1986	20
Spiridon Bay	August 12, 1986	65
Karluk Lake	August 14, 1986	15
Spiridon Bay	August 16, 1986	46
Ugak Bay		
Saltery Cove	August 17, 1986	13
Brown's Lagoon	August 20, 1986	24
Kalsin Bay	August 23, 1986	17
Chiniak Lagoon	August 23, 1986	12
Zachar Bay	August 28, 1986	22
Zachar Bay	September 4, 1986	22
Kalsin Bay	September 5, 1986	8
Zachar River Valley	October 16, 1986	13
Zachar Bay	October 23, 1986	13
Zachar Bay	October 25, 1986	7
Zachar River Valley	November 5, 1986	*
Spiridon Bay	November 7, 1986	21
Zachar Bay	November 7, 1986	20
Zachar Bay	November 16, 1986	1
Spiridon Bay	November 18, 1986	3
Zachar Bay	November 18, 1986	1
Zachar Bay	December 17, 1986	20
Shearwater Bay	December 27,1986	3
Pasagshak River	February 1, 1987	3
Kalsin Bay	May 10, 1987	2
Kalsin Bay	May 12, 1987	1
Spiridon Bay	May 15, 1987	8
Spiridon Bay	May 19, 1987	5
Middle Bay	May 25, 1987	2
Kodiak NWR		
Headquarters	May 31, 1987	4
Twin Lakes**	July 9, 1987	5
Zachar Bay	August 28, 1987	85
Zachar Bay	September 8, 1987	4

Table 1. Continued

Location	Date	Number of geese
Afognak Island		
Pauls Bay	August 7, 1986	11
Perenosa Bay	August 7, 1986	14
Afognak Bay	August 10, 1986	5
2 miles NW of Kitoi Bay	October 27, 1986	*
Izhut Bay	November 11, 198612	
2 miles NW of Kitoi Bay	December 24, 1986	15
Paramanof Bay	March 15, 1987	2
Izhut Bay	March 18, 1987	*
Kitoi Bay	April 10, 1987	9
Pauls Lake	August 25, 1987	35
Shuyak Island		
Skiff Passage	July 29, 1986	9
Western Inlet	September 5, 1986	1
Skiff Passage	September 5, 1986	78
1 mile east of Shangin Bay	October 27, 1986	*
Big Bay	November 3, 1986	30
Shangin Bay	December 15, 1986	40
Skiff Passage	January 22, 1987	40
Big Bay	August 10, 1987	1

* radio location only, no sighting of bird
** Geese from 1975 transplant have been observed at Twin Lakes prior to this transplant

Table 2. Number of molting Vancouver Canada geese observed by area and date from aerial surveys in Southeast Alaska during July 1987.

Area Surveyed	Date	Number of geese: Adults	Number of geese: Immatures
Taku River	July 21		
Glory Lake		-0-	-0-
Grizzly Bay		-0-	-0-
Twin Glacier Lake		-0-	-0-
Lynn Canal	July 21		
St. James Bay		-0-	-0-
Glacier Bay	July 21		
Adams Inlet		1327	-0-
Wachusett Inlet		180	-0-
Scidmore Bay		-0-	-0-
Dundas Bay (All coves)		-0-	-0-
Chichagof Island	July 21		
Mud Bay		-0-	-0-
Neka Bay		-0-	-0-
Humpback Creek (mouth)		-0-	-0-
Admiralty Island			
Seymour Canal	July 21		
Fool Inlet		341	-0-
Swan Cove		-0-	-0-
Hole-in the-wall (S. of Fool Inlet)		-0-	-0-
Windfall Harbor	July 22	-0-	-0-
King Salmon Bay		-0-	-0-
Little Pybus Bay		-0-	-0-
Pybus Bay		-0-	-0-
Donkey Bay		-0-	-0-
Cannery Cove		-0-	-0-
Gambier Bay		-0-	-0-
Pleasant Bay Lake		-0-	-0-
Mole Harbor		-0-	-0-
Kupreanof Island	July 22	-0-	-0-
Duncan Canal		-0-	-0-
Woewodski Island		-0-	-0-
Whiskey Pass		-0-	-0-
Harvey Lake		-0-	-0-
Reecher Pass		-0-	-0-
Mitchell Slough		-0-	-0-
Ohmer Slough		-0-	-0-
McDonald Arm		-0-	-0-

Table 2. Continued

Area Surveyed	Date	Number of geese Adults	Immatures
Salt Chuck		-0-	-0-
Towers Arm		-0-	-0-
Taylor Creek & Tide Flats		45	15
Towers Lake		-0-	-0-
Castle River Tide Flats		-0-	-0-
Bains Cove		-0-	-0-
Little Duncan Bay		-0-	-0-
Big John Bay		-0-	-0-
Portage Bay		-0-	-0-
Kuiu Island		-0-	-0-
Port Camden		-0-	-0-
Kadak(e) Bay		-0-	-0-
Security Bay		55	-0-
Bay of Pillars		-0-	-0-
Piledriver Cove		-0-	-0-
Petrof Bay		9	1
Beaver Pond (1½ miles W. of head of Petrof Bay)		70	-0-
Thetis Bay		19	-0-
Cape Spencer--Icy Bay	July 23		
Crillon Lake		-0-	-0-
Lituya Bay		-0-	-0-
Fairweather Glacier Lake		-0-	-0-
Grand Plateau Glacier--Meltwater Lakes		232	-0-
Alsek Glacier Lake		48	-0-
Tanis Lake		25	-0-
Ustay Lake		-0-	-0-
Akwe Lake		-0-	-0-
Harlequin Lake		207	-0-
Malaspina Glacier Lakes	July 23		
Malaspina Lake		468	-0-
Osar Stream to Sitkagi Bluffs		296	-0-
Fountain Stream to Yahtse River		86	-0-
Icy Bay*	July 28	575	-0-
Bering Glacier at Seal River	July 28	430	-0-
TOTAL		4,413	16

* Surveyed only half of bay.

south of the head of Fool Inlet; the latter two locations are both on Admiralty Island.

Groups with broods were located in forested areas of Southeast and tended to have fewer birds than the large flocks of presumably failed or nonbreeding birds that were mostly found in water associated with recent deglaciation. These latter flocks, which located in glacial meltwater lakes and near tidewater glaciers, were more conspicuous.

The secretive behavior of the birds in the forested areas (i.e., seeking cover in the woods) and the inherent disturbance of the survey method makes locating them a time-consuming, costly, and "hit or miss" process. Broods use the forest interior as escape cover, and use of open water by geese with broods is uncommon. In a study conducted in Seymour Canal on Admiralty Island, Lebeda and Ratti (1983) found that 85% of all radio locations of goslings were in forest habitats averaging a distance of 183 m from the forest edge. We undoubtedly missed many small groups of geese.

We cannot identify with certainty the subspecies of geese located west of Cape Spencer. The range of molt migrations, as well as the limits of the breeding range, of Vancouver Canada geese are not well delineated. Vancouver Canada geese are known to inhabit coastal forest areas from Vancouver Island to Glacier Bay (Hansen 1962, Ratti and Timm 1979). Robards (1960) observed approximately 1,200 flightless Canada geese in Adam's Inlet in mid-July 1956, and Ratti et al. (1977) mentioned the Glacier Bay area as the largest known molting concentration of Vancouver Canada geese estimated at 2,000 to 3,000 birds.

Further, several observations of Canada geese, including the subspecies <u>fulva</u> come from the Yakutat area. Hansen (1962) reported nonbreeding Vancouver Canada geese utilizing a few bays near Yakutat for molting. Thirty-five Canada geese (no subspecies given) were observed in July 1975 on a meltwater lake at the face of Fourth Glacier, which drains via Beasley Creek into Russell Fjord. During that same period, 201 Canada geese were observed on Harlequin Lake (B. Dinneford, pers. comm.). Petersen et al. (1981) observed 70 flightless adult Vancouver Canada geese on the Dangerous River on 11 July and 6 August. Patten (1981) observed at least 90 geese on Harlequin Lake and the Dangerous River on 22 June 1980, and Bruce Dinneford, ADF&G, (pers. comm.) sighted about 50 Canada geese on Harlequin Lake and a "few" birds on Ustay Lake between 11 and 16 July 1984. He believed all birds to be nonbreeding molters.

Patten (1982) reported a small population of Canada geese (no subspecies given) breeding on Malaspina Lake. This is the most northerly breeding population of Vancouver Canada geese identified. No records are available for goslings observed or captured at Glacier Bay (Ratti et al. 1977), although Gary Vequist (pers. comm.) of the National Park Service reported finding goose eggs but no indication of successful nesting. Molting and breeding ranges of Vancouvers may be extending northwest, following the retreat of glaciers.

The eastern extent of the breeding range of dusky Canada geese is in the vicinity of the Bering Glacier (Hansen 1962). A small population of Canada geese showing morphological and behavioral characteristics of both Vancouver and dusky Canada geese inhabit Prince William Sound (Isleib and Kessel 1973). It is unknown where these geese molt. Molting geese west of Cape Spencer are probably of the subspecies _fulva_, because they exhibit behavioral characteristics similar to nonbreeding, molting Vancouver Canada geese inhabitating areas further east. Molting Vancouver Canada geese in the area of Yakutat and Glacier Bay also use recently deglaciated areas. Observations, as well as returns from geese banded while molting at Glacier Bay, indicate they migrate north to molt from other parts of Southeast Alaska. Molting and breeding range of Vancouvers may be extending northwest, following the retreat of glaciers; however, the relationship between these Canada geese and those inhabitating Prince William Sound is unclear.

Acknowledgements

We appreciate the services of Jim King who acted as an observer throughout the surveys in Southeast Alaska and Bruce Conant of the U.S. Fish and Wildlife Service who flew surveys in Icy Bay and at the Bering Glacier. The efforts of Denny Zwiefelhofer of the Kodiak National Wildlife Refuge and Larry Van Daele of the ADF&G in monitoring the birds have been invaluable. The efforts of all the Kodiak citizens who reported sightings are also much appreciated.

Literature Cited

Campbell, B.H., D.H.Rosenberg, and T.C. Rothe. 1987. Annual report of survey and inventory activities. Waterfowl. Alaska Dept. of Fish and Game. Federal Aid in Wildl. Restoration. Vol. XVII, Part XIII, Proj. W-22-5, Job 11.0. 55pp.

Hansen, H.A. 1962. Canada geese of coastal Alaska. Trans. North Am. Wildl. and Nat. Resour. Conf. 27:301-320.

Isleib, M.E., and B. Kessel. 1973. Birds of the north gulf coast -- Prince William Sound region, Alaska. Biological Papers of the Univ. of Alaska. No. 14. 151 pp.

Lebeda, C.S. and J.T. Ratti. 1983. Reproductive biology of Vancouver Canada geese on Admiralty Island, Alaska. J. Wildl. Manage. 47(2):297-305.

Petersen, M.P., J.C. Grelich, and N.M. Harrison. 1981. Spring and fall migration, and habitat use by water birds in the Yakutat Forelands, Alaska - 1980. USFWS, Marine Bird Section, Nat'l Fishery Res. Cntr. Anchorage. 106pp.

Patten, S.P. 1981. Seasonal use of coastal habitat from Yakutat Bay to Cape Fairweather by migratory seabirds, shorebirds, and waterfowl. Outer Continental Shelf Environmental Assessment Program, NOAA. Juneau. 138pp.

Ratti, J.T., D.E. Timm, and F.C. Robards. 1977. Weights and measurements of Vancouver Canada geese. Bird Banding, 48(4):354-357.

___________, and D.E. Timm. 1979. Migratory behavior of Vancouver Canada geese: recovery rate bias. Pages 208-212, In R.L. Jarvis and J.C. Bartonek, eds. Biology and management of Pacific flyway geese. Oregon St. Univ., Corvallis.

Robards, F.C. 1960. Construction and operation of a portable goose trap. J. Wildl. Manage., 24:329-331.

CREAMER'S FIELD WATERFOWL NESTING PROJECT

GAME MANAGEMENT UNIT: 20

GEOGRAPHIC DESCRIPTION: Fairbanks

PERIOD COVERED: 1 July 1986-30 June 1987

Introduction

In 1987 the Alaska Department of Fish and Game (ADF&G) constructed a series of 6 waterfowl nesting ponds on the Creamer's Field Migratory Waterfowl Refuge in Fairbanks (ADF&G 1986). The Creamer's Field Waterfowl Enhancement Project is designed to increase nesting habitat for waterfowl endemic to interior Alaska, test the use of waterfowl enhancement methodologies in the interior, and increase wildlife viewing, hunting, and educational opportunities for residents and visitors.

Construction costs were funded by the Alaska Waterfowl Conservation Stamp (duck stamp) program and by matching funds from Ducks Unlimited, Inc. (DU); DU's funds were provided through their Matching Aid to Restore State's Habitat (MARSH) program. This is the first cooperative MARSH project between the ADF&G and DU.

Study Area

The project, located in the northeastern portion of the refuge (T1N, R1W, NE1/4 S34 and NW1/4 S35), is contained within an approximate rectangular 0.5-mile-long (from north to south) by 0.25-mile-wide area (Figure 1). Natural drainage patterns flow southward; the elevation change within the project (i.e., from the northern refuge boundary to the southernmost point of pond No. 6) is approximately 12.2 feet (Figure 2). Private agricultural land borders the project to the north and provides much of the surface runoff to the project.

Tussock low-shrub bog is the characteristic habitat type for the majority of the project area (Spindler 1976). Smaller areas of herbaceous bog and tall shrub-habitat types are interspersed within the tussock low-shrub bog type. Soil samples taken from excavated material during construction were analyzed for hydrogen ion concentration (pH); available nitrogen, phosphorous, and potassium; percent organic matter (loss on ignition); and total nitrogen. Analysis was performed by the University of Alaska, Agriculture and Forestry Experiment Station, Palmer Research Center. Soil pH

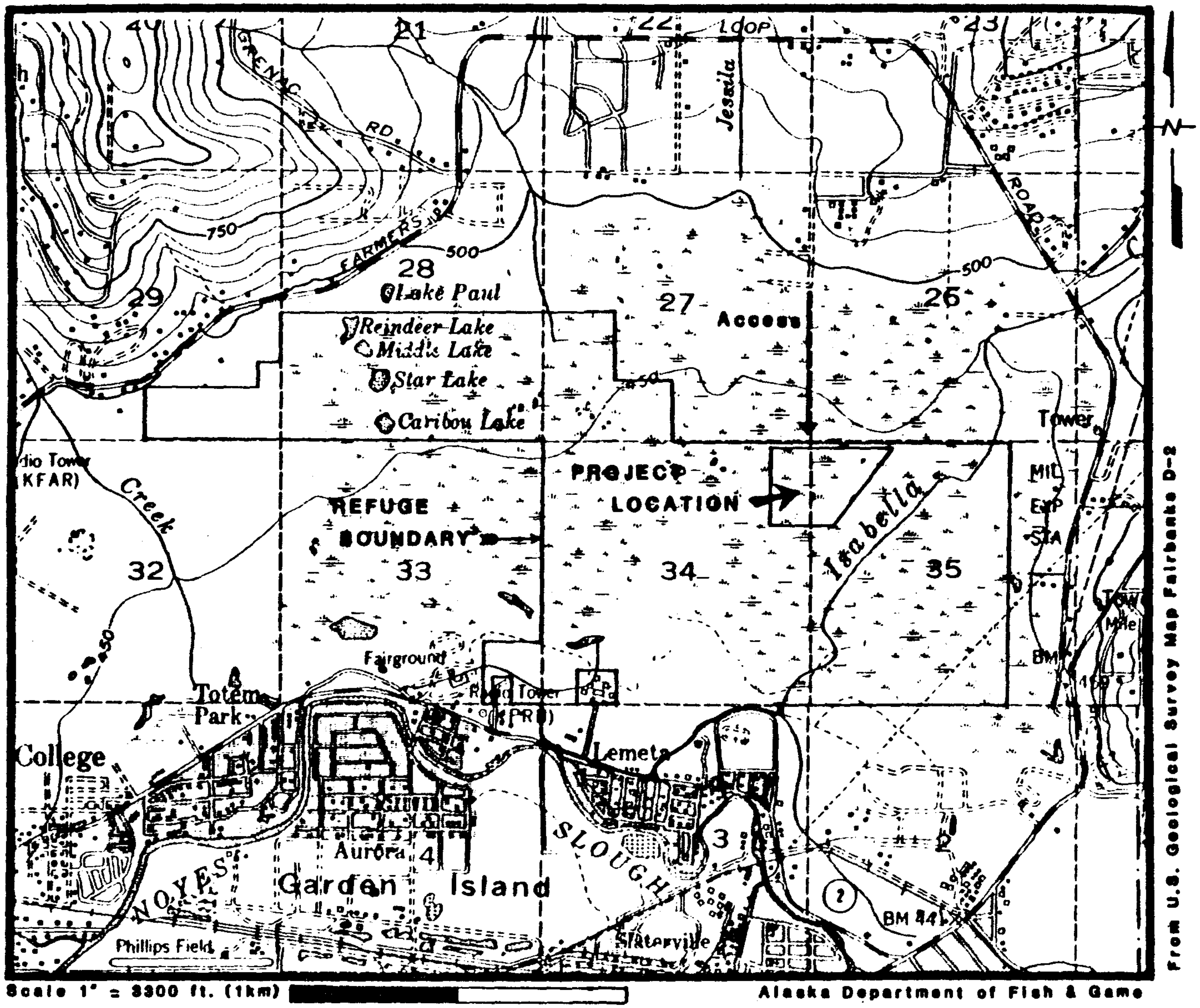
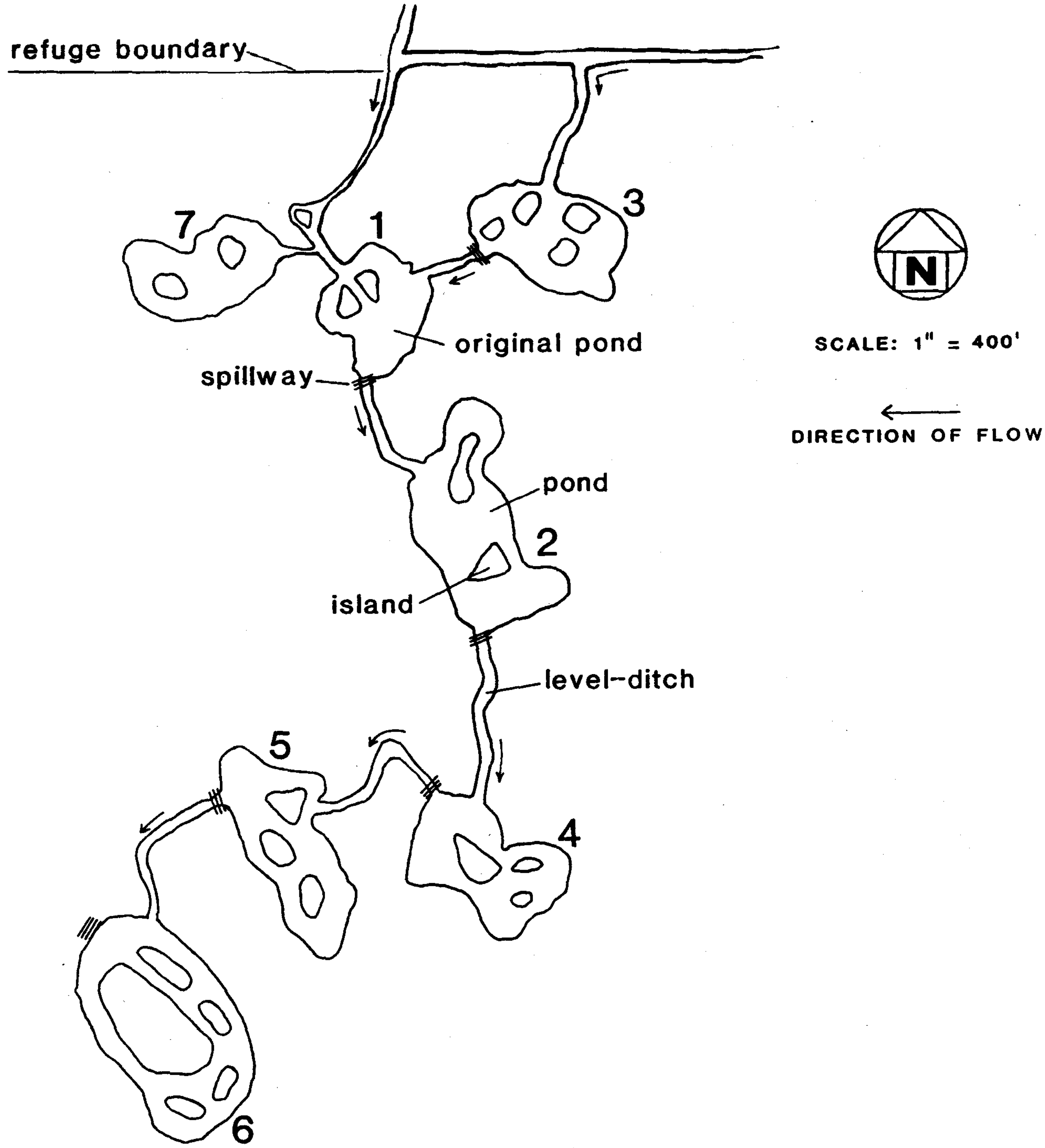


Figure 1. Location of Creamer's Field waterfowl enhancement project within the Creamer's Field Migratory Waterfowl Refuge, Fairbanks.



CREAMER,S FIELD
MIGRATORY WATERFOWL REFUGE
WATERFOWL ENHANCEMENT PROJECT

Figure 2. As-built design of waterfowl enhancement project showing ponds, islands, level-ditches, and spillways.

ranged from 5.16 to 6.58. Phosphorous concentrations ranged from 4 to 100 ppm, potassium concentrations from 16 to 205 ppm, and total nitrogen from 4 to 210 ppm (all ammonium ions). Percent total nitrogen ranged from 0.11 to 1.72. Loss on ignition varied greatly, ranging from 3.5% to 78%.

Methods

Construction:

Construction began 26 March 1987 and was completed 19 April 1987. Mike Motsko of Evergreen Construction, Inc. (P.O. Box 10105, Fairbanks, Alaska 99710) was the contractor. Komatsu D155A and D65A bulldozers with ripper bars and U-blades were the two primary pieces of construction equipment. A Komatsu PC220 backhoe was used to excavate level ditches. The bulldozers operated 24 hours/day for most of the construction period. Excavated material was distributed around pond perimeters and along level ditches and acted as a dike at the lower end of ponds where original ground elevations were below desired water levels. Excavated material covered 15.3 acres.

Revegetation:

On 15 and 16 June 1987, 16 acres of excavated material (berms around ponds and islands) were revegetated. Approximately 6,700 lbs of 20-20-10 fertilizer and 600 lbs of grass seed were spread by two tractors with spin spreaders. Fertilizer and seed were hand broadcast on islands and in spillways. Fertilizer was distributed at an approximate rate of 400 lbs per acre, and seed was distributed at an approximate rate of 30 lbs per acre. Harrowing followed fertilizing and seeding.

The seed mix consisted of 15% tundra bluegrass (*Poa glauca*), 32% "arctared" red fescue (*Festuca rubra*), and 53% "norcoast" Bering hairgrass (*Deschampsia beringensis*). About 50 lbs of *Beckmania syzigachne* was hand broadcast around pond margins and in spillways. Islands in the two most southern ponds (i.e., pond Nos. 5 and 6) received the following mix: 50% *Beckmania syzigachne*, 10% polar grass (*Arctagrostis latifolia*), 2% bluejoint (*Calamagrostis canadensis*), 20% "norcoast" Bering hairgrass, 8% tundra bluegrass, and 10% "arctared" red fescue.

Results and Discussion

Six ponds were excavated. The ponds are linked by level ditches to a 1.25-acre pond excavated in 1984. Ponds vary from 1.5 to 3.4 acres and slope to 4 feet deep. Open-water areas are reduced by nesting islands. Water surface area, including the existing pond, totals 11.1 acres. Ponds are linked by approximately 2,150 feet of meandering level ditches. Level ditches are 20 feet wide and 2 to 3 feet deep and provide an additional acre of surface area. Ponds contain from 2 to 4 islands; the total island area is 2.75 acres. The 21 islands range in size from 0.04 acres to 1.0 acre. Where original ground elevation exceeded water surface elevations, existing island vegetation was left intact; otherwise, spoil material was added to islands to increase elevations from 1 to 2 feet above water levels.

Surface runoff began to flow into the project on 14 April 1987. Leakage prevented filling of all ponds; however, sufficient runoff was available to fill all ponds had no leakage occurred. This was in spite of relatively low snowpack in the Fairbanks area. The Fairbanks Daily News Miner (14 July 1987) reported that the Chena River had the lowest recorded flow in 40 years, which was attributed to low snow pack and a dry summer.

Twenty species of birds were identified within the project the first spring and summer following construction (Table 1). Canada geese (_Branta canadensis_) and northern pintails (_Anas acuta_) were the most abundant species during spring migration. On 25 April 1987 approximately 150 geese and 250 pintails were using the project. Seventy-five sandhill cranes (_Grus canadensis_) were observed on 15 June and 60 were observed on 30 June. Northern pintails, mallards (_A. platyrnychos_), American wigeon (_A. americana_), northern shovelers (_A. clypeata_), and green-winged teal (_A. crecca_) were commonly observed throughout the summer; northern shovelers and American wigeon were the most abundant species. A brood of mallards, green-winged teal, northern shovelers, northern pintails, and common goldeneyes (_Bucephala clangula_) and 3 broods of American wigeon were observed. Nest searches were not conducted in 1987.

The north-south elevation gradient necessitated the use of spillways at the outlet of each pond. Erosion in spillways during filling necessitated maintenance. In November following the growing season and freeze-up, spillways were lined with approximately 6-inch rip rap to retard erosion. During initial filling of ponds, the dike in the southwest corner of pond No. 4 leaked water at original ground, arresting the filling of that pond and thwarting the filling of pond Nos. 5 and 6. Maintenance personnel repaired the damaged dike in November.

Construction cost $47,250. Additional expenditures include the following: (1) Subsurface soil investigations prior to construction, $650.00; (2) grass seed and fertilizer

Table 1. List of bird species observed in the Creamer's Field Waterfowl Enhancement project in the spring and summer of 1987 following construction.

Horned grebe (*Podiceps auritus*)
Sandhill crane (*Grus canadensis*)
Tundra swan (*Cygnus columbianus*)
Canada goose (*Branta canadensis*)
Mallard (*Anas platyrynchos*)*
Green-winged teal (*A. crecca*)*
American wigeon (*A. americana*)*
Northern pintail (*A. acuta*)*
Northern shoveler (*A. clypeata*)*
Common goldeneye (*Bucephala clangula*)*
Bufflehead (*B. albeola*)
Lesser yellowlegs (*Tringa flavipes*)
Solitary sandpiper (*T. solitaria*)
Spotted sandpiper (*Actitis macularia*)
Red-necked phalarope (*Phalaropus lobatus*)
Long-billed dowitcher (*Limnodromus scolopaceus*)
Common snipe (*Gallinago gallinago*)
Least sandpiper (*Calidris minutilla*)
Merlin (*Falco columbarius*)
Sharp-tailed grouse (*Tympanuchus phasianellus*)

* Reared broods in project

$5,540.00; (3) use of Future Farmer's of America tractor for revegetation, $240.00; (4) sand bags for erosion control during initial pond filling, $135.00; and (5) berm and spillway maintenance, $1,710.00. Total project cost split equally between ADF&G and DU was $53,813.40.

Acknowledgements

We gratefully acknowledge Pam Bruce of the ADF&G for all her help during construction, revegetation, and monitoring. John Wright's assistance during revegetation and monitoring is also much appreciated. We thank Stony Wright of the State of Alaska Plant Materials Center for providing grass seed and revegetation advice. Dr. Jay McKendrick of the University of Alaska Agricultural Experiment Station also provided technical assistance that was much appreciated. Ann Rippy of the USDA Soil Conservation Service helped with the initial survey and design phase and provided information on surface runoff.

Literature Cited

Alaska Department of Fish and Game. 1986. Creamer's Field Migratory Waterfowl Refuge--Waterfowl Enhancement Project. Project Proposal. Anchorage. 24pp.

Spindler, M. A. 1976. Ecological survey of the birds, mammal, and vegetation of the Fairbanks wildlife management area. M.S. thesis, Univerity os Alaska, Fairbanks. 239pp.

WILDLIFE RESTORATION

Federal Aid Project
funded by your purchase of
hunting equipment