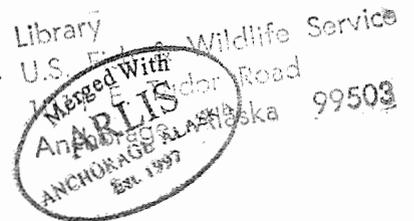


Yukon Delta National Wildlife Refuge
Bethel, Alaska

Annual Narrative Report
Calendar Year 1991



U.S. Department of the Interior
Fish and Wildlife Service
National Wildlife Refuge System





Left to right; standing: Strom, Jensen,
Baccus, Morgart, Hunt, Winkelman, Tony,
Ernst, McCaffery, Wege; sitting: Davis,
Prince, M. Perry, R. Perry, Andrew, Harwood.
(Morgart)

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1.	Ronald L. Perry	Refuge Manager (EOD 4/84)	GM-14
2.	Dennis W. Strom	Dep. Refuge Manager (EOD 8/83)	GS-12
3.	Michael B. Rearden	Asst. Refuge Mgr./Pilot (Trans. 7/91)	GS-12
4.	John R. Morgart	Supv. Wildl. Bio. (EOD 8/87)	GS-12
5.	George Walters	Pilot (EOD 7/87)	GS-12
6.	Richard D. Ernst	Wildl. Bio./Pilot (EOD 4/85)	GS-12
7.	Robert B. Winkelman	Refuge Oper. Spec. (EOD 12/91)	GS-11
8.	Vicki J. Davis	Outdoor Rec. Planner (EOD 3/91)	GS-11
9.	Charles F. Hunt	Interpreter (EOD 1/79)	GS-11
10.	Michael L. Wege	Wildl. Bio. (EOD 4/83)	GS-11
11.	Ramone Baccus	Wildl. Bio. (EOD 3/91)	GS-11
12.	Eugene Peltola, Jr.	Wildl. Bio. (EOD 5/84) (Transferred 11/91)	GS-05
13.	Paschal L. Afcan	Asst. Interpreter (EOD 8/85)	GS-09
14.	Mildred F. Prince	Budget Assistant (EOD 8/86)	GS-07
15.	Carlie Andrew	Refuge Info. Tech. (EOD 2/91) (Resigned 5/91)	GS-06
16.	David Evan	Refuge Info. Tech. (EOD 11/89) Napaskiak (Resigned 2/91)	GS-06
17.	Abraham Andrew	Refuge Info. Tech. (EOD 11/91) Bethel	GS-06
18.	Michael Jimmy	Refuge Info. Tech. (EOD 11/84) Emmonak	GS-06
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22.	Jimmy Slats	Bio. Tech., Chevak (EOD 4/84)	GS-05
23.	Brian McCaffery	Wildlife Biologist (EOD 10/86) (Conv. from Clerk Typist 10/90)	GS-05
24.	Martha Perry	Clerk Typist (EOD 2/87)	GS-04
25.	Elena Hames	Clerk Typist (EOD 11/86) (Resigned 6/90, reins. 11/90)	GS-03
26.	Charlotte Wilson	Clerk Typist (EOD 11/90) (Resigned 8/91)	GS-03
27.	Michael Jensen	Maintenance Mechanic (EOD 12/88)	WG-09
28.	Palmer Olrun	Maintenanceman (EOD 5/90) (Resigned 6/91)	WG-09
29.	Jack Paniyak	Maintenanceman (EOD 9/74)	WG-08
30.	Peter Tony	Maintenanceman (EOD 8/91)	WG-09

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Steve Kendall	Biological Technician (Extended)	GS-05
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Robin McCartney	Biological Technician (Summer)	GS-05
Diana May	Biological Technician (Summer)	GS-05
Christine Moran	Biological Technician (Summer)	GS-05
Tauni Rodgers	Biological Technician (Summer)	GS-05
Phillip Paniyak	Biological Technician (Summer)	GS-05
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Glenn Raphael

Volunteers

Christine McCaffery
Martin Schulz

Reviews and Approvals

Submitted by: Ronald L. Pitzer Date: 4/23/92
Refuge Supervisor Review: Greg M. ... Date: 12/15/92
Regional Office Review: Rowan W. Gould Date: 3/23/93

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Introduction

The Yukon Delta National Wildlife Refuge, largest of Alaska's 16 refuges (Figure 1), encompasses over 26 million acres of land and water on the Yukon-Kuskokwim Delta in southwestern Alaska. Approximately 19.6 million acres are federal land. Both the Yukon and Kuskokwim Rivers, major salmon migration rivers, traverse the refuge. Over the course of time, these rivers have created one of the largest river deltas in the world. The Mississippi Delta is the only comparable river delta in North America. The delta, a generally flat marshland containing innumerable lakes and ponds, is the dominant landform on the refuge. Water was the primary element in the creation of this landscape, and remains a major feature today. Upland areas, the Nulato Hills in the northern part of the refuge, and the Kilbuck Mountains along the refuge's eastern boundary, contain peaks of 2,000 to 4,000 foot elevations.

The abundance of water in lakes, ponds, streams, inlets, bays, and coastal areas provides habitat for waterfowl from all four North American flyways. The refuge supports a varied population of mammals, fish, and birds which are important in maintaining the traditional subsistence way of life of local residents. However, it is the nesting and rearing habitats of four goose species (cackling Canada goose, Pacific white-fronted goose, emperor goose, and black brant) and other waterfowl, shorebirds, and seabirds which are of national significance.

Lands in the Yukon Delta were first set aside as a preserve and breeding ground for native birds by President Theodore Roosevelt in 1909. In 1929, Nunivak Island was set aside as a refuge and breeding ground for wild birds, game, and furbearing animals. In 1930, the small islands and all lands under the waters surrounding Nunivak Island were added to the reservation. Additional lands were reserved by President Franklin D. Roosevelt in 1937 when Hazen Bay Migratory Waterfowl Refuge was established. The Kuskokwim National Wildlife Range, established in 1960, was enlarged in 1961, and its name changed to the Clarence Rhode National Wildlife Range.

On December 2, 1980, President Jimmy Carter signed the Alaska National Interest Lands Conservation Act (the Alaska Lands Act). With the enactment of the Alaska Lands Act, these existing ranges and refuges were combined and enlarged to establish the Yukon Delta National Wildlife Refuge. Two areas within the new refuge were also designated as wilderness by the Alaska Lands Act: the Andreafsky Wilderness Area (1.3 million acres) and the Nunivak Wilderness Area (600,000 acres).

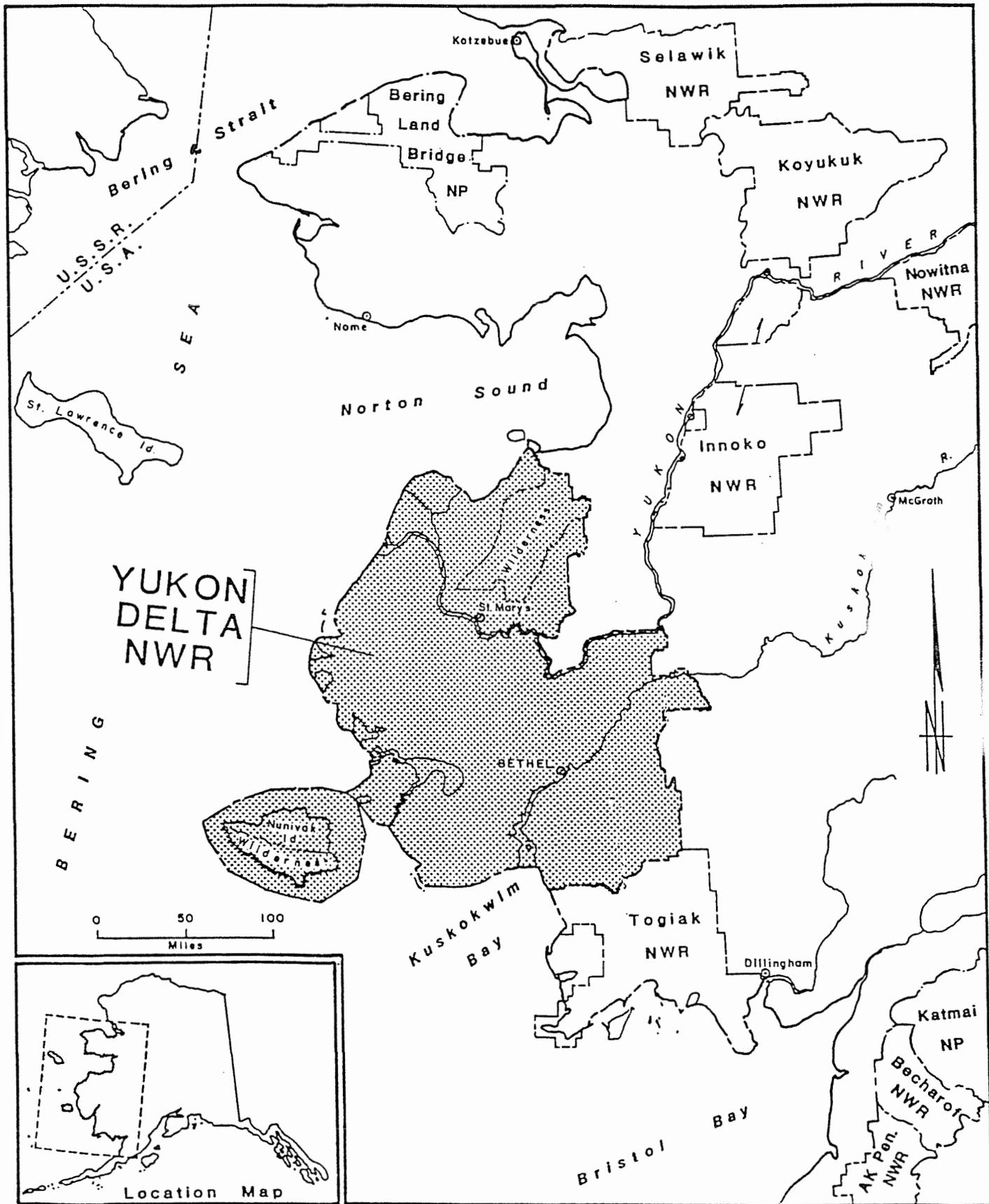


Figure 1. Yukon Delta National Wildlife Refuge.

A. HIGHLIGHTS

Land Protection Planning efforts start on the delta. C.3

Goose populations are still on the rise. D.5

The long awaited visitor center and associated displays are completed. H.6

A new VHF radio system is installed on the refuge. I.5

Near record snowfall in 1991. B.

Kenai Fisheries Assistance Office erects fish weirs in Tuluksak River. D5b

Columbia and Canyon Creek mine sites cleaned up. F.1a

Draft Fisheries Management Plan completed in January. H.9

B. CLIMATIC CONDITIONS

The Yukon Delta National Wildlife Refuge is located in western Alaska on the Yukon and Kuskokwim River deltas. The refuge stretches from Nunivak Island in the Bering Sea to Aniak, nearly 200 miles inland. The region is part of the transitional climatic zone, influenced by continental and maritime climates. Summer is cooler than interior Alaska, due to coastal clouds and cold seas. Conversely, this region is warmer than interior Alaska in winter due to the effects of the Bering Sea. Coastal areas freeze last, due to the warming effect of the Bering Sea, and thaw later than the interior due to the cooling effect of Bering Sea ice. Caliginous conditions can occur year-round.

The winds at Bethel average over 13 miles per hour throughout the year. The maximum recorded high and low temperatures are 84 degrees and -48 degrees Fahrenheit, respectively. Freeze-up normally occurs in mid-October and ice breakup in early to mid-May.

Climatic conditions started out mild in January with several thaws early in the month that melted a lot of snow and left the country-side looking like one big sheet of ice. The lowest temperature of the year (-32 degrees F.) was recorded in late January (Table 1). Both January and February had little snow, but March recorded over 30 inches.

April was dry and warm with major melting during the last two weeks. The warm-up continued in May with break-up occurring on the Kuskokwim River in early May. Precipitation for June and July was below normal and the high temperature of the year (77 degrees F.) was recorded in July.

Dry, warm weather continued in August and extended into early September. The fall season rains were below normal for September and refuge rivers were low going into October. No frost was recorded for the month of September.

Extremely mild weather continued into October with only one day recording below freezing temperatures. Wet weather returned in October--nearly six inches of rain was recorded. Atypically, the Kuskokwim River was still being used for boat travel the first few days of November. Measurable snow was not recorded until mid-November, unlike December which had over 19 inches. Except for a couple of cold spells, 1991 went out on a mild note.



Blizzard conditions and large quantities of snowfall occurred in December. (Winkelman)

Table 1. Climatological data for Bethel, Alaska, 1991.

Month	Temperature (Degrees F.)		Dates with Measurable Precipitation	Snowfall (Inches)	Total Precipitation (Inches)
	High	Low			
Jan	37	-32	9	2.6	0.23
Feb	45	-27	5	4.6	0.15
Mar	55	-21	20	30.6	3.06
Apr	55	1	6	1.5	0.30
May	72	28	10	0.3	0.79
Jun	76	30	14	T	1.20
Jul	77	38	17	0.0	1.51
Aug	69	36	12	0.0	1.94
Sep	67	35	21	0.0	1.72
Oct	54	26	19	0.0	5.83
Nov	48	-16	9	9.1	0.72
Dec	34	-22	12	19.2	0.91
Total			154	67.90	18.74

C. LAND ACQUISITION

3. Other Items

a. Land Protection Planning

The U.S. Fish and Wildlife Service is developing a Land Protection Plan for the Yukon Delta National Wildlife Refuge. A Land Protection Plan is the Service's method of identifying, to land owners and the general public, the interest the Service has in conserving wildlife resources on privately owned land within refuge boundaries.

The Yukon Delta National Wildlife Refuge was reorganized and established by Congress in 1980. The purposes of the refuge listed in the Alaska National Interest Lands Conservation Act are to conserve fish and wildlife populations and habitats in their natural diversity; fulfill international treaty obligations (migratory birds); provide opportunities for continued subsistence uses by local residents; and ensure necessary water quality and quantity within the refuge.

The Yukon Delta Refuge Land Protection Plan will further the goal of conserving wildlife and their habitat by setting priorities for resource protection or acquisition of refuge inholdings. Some of the most valuable goose, duck and other wildlife habitat is found on private lands within the Yukon Delta National Wildlife Refuge.

Some landowners like the concept of maintaining their lands and other natural resources in their present state. Land protection by the Service can be accomplished through different means, such

as conservation easements, land bank agreements, and acquisition by exchange and purchase. These means would also include benefits to the landowner.

The Service wanted to involve all landowners in the development of the Yukon Delta Land Protection Plan. All people or village corporations who own land within the boundaries of the Yukon Delta National Wildlife Refuge were encouraged to learn more about development of this plan.

In late 1990, the Regional Office Land Protection Planning team, with Interpreter Afcan, visited 14 Yukon-Kuskokwim Delta villages to present the plan. At year's end (1991), the Land Protection Planning team continued work on the Draft Land Protection Plan, due out in August 1992.

D. PLANNING

1. Master Plan (Comprehensive Conservation Plan)

The comprehensive conservation plan was completed, accepted, printed, and distributed in January, 1988. Step-down management plans, such as the Kisaralik River Management Plan and Nunivak Island Reindeer/Muskox Management Plan were drafted and expected to be finalized in 1992.

2. Fire Management Plan

This year marked the eighth operating season under the interagency fire management plan by the state, private owners, Bureau of Land Management, and the refuge. This system has allowed the refuge to accomplish land management objectives and saved the government money. The plan incorporates four management options for wildfire, ranging from immediate suppression to no suppression. Approximately 50% of the refuge is contained in the modified category, which dictates suppression during the critical burning dates, but allows less suppression after those dates.

3. Public Participation

a. Yukon-Kuskokwim Delta Goose Management Plan

On October 8-9, 1991, Refuge Manager Ron Perry, Chief of Migratory Birds Management Bob Leedy, and Interpreter Chuck Hunt attended the Association of Village Council Presidents (AVCP) Convention at Quinhagak, Alaska. During this convention Mr. Leedy gave a report on the status of the Goose Management Plan and population status of the four goose species. Also at this convention, Refuge Manager Perry gave AVCP, Inc., a Certificate of Appreciation Award for supporting the Yukon-Kuskokwim Delta Goose Management Plan.

Beginning May 6, 1991, law enforcement personnel from the Regional Office and refuges throughout Alaska, along with Refuge Information Technicians of the Yukon Delta Refuge, travelled throughout the Delta and informed the people of the Yukon-Kuskokwim Delta Goose Management Plan and the Closed Season Policy. This was the first of its kind in the Delta in which law enforcement personnel went out to the villages and conducted information and education programs on the goose management plan and the closed season policy. These meetings ended about May 31, 1991.

On November 13, 1991, Assistant Interpreter Paschal Afcan and the refuge's Refuge Information Technicians went to Anchorage to attend a meeting with the Regional Subsistence Management Division on the Draft Environmental Impact Statement. Upon completion of the meeting, Subsistence Division staff and Refuge Information Technicians travelled throughout the state of Alaska to gather comments on the Draft Environmental Impact Statement (DEIS). These meetings on the DEIS were completed sometime during the first week in December 1991.

On August 11 and 12, 1991, Tom Roster, an expert on the use of steel shot, came to Bethel to conduct a Steel Shot Seminar and Shooting Clinic. The seminar was held on Sunday evening, August 11, at the Fish and Wildlife Service office conference room. Tom Rothe of the Alaska Department of Fish and Game assisted with a presentation entitled "Lead Poisoning in Waterfowl" during the seminar. The next day, August 12, Mr. Roster gave training on how to use steel shot with flying clay targets and shotgun shooting techniques. Tom Rothe and Refuge Interpreter Chuck Hunt, who had attended steel shot training in Alton, Illinois, from March 25-29, 1991, assisted Mr. Roster during the Bethel training. Only seven people attended the actual shooting clinic--two were from Yukon-Kuskokwim Delta villages. It was concluded that there were too many other activities such as commercial salmon fishing and berry-picking that conflicted with the steel shot training which resulted in few attendees. There were other steel shot seminars and shooting clinics throughout the state of Alaska during this time.

b. Kisaralik River Management Plan

A final draft of this plan was nearly completed by year's end. The need for this step-down plan for public use recreational management on the Kisaralik River is apparent. Twenty-one commercial river guides have applied to operate on the river and have all been tabled until the plan is complete. Private use of the river, primarily for rafting, has increased annually for several years. This draft will receive Regional Office review, public review and then should be instituted by the 1992 season

5. Research and Investigations

a. Arctic Nesting Goose Studies

Population changes showed mixed results in 1991. Cacklers and whitefronts showed slight decreases: 104,500 (5%) and 236,500 (2%), respectively, while brant had the greatest decrease: 127,400 (13%). Emperors increased slightly: 71,000 (5%). Mixed signals also occurred for breeding ground surveys. While indices of total birds within the coastal zone decreased for emperors, whitefronts, and cacklers by 17%, 17%, and 13%, respectively; breeding pair indices decreased only for emperors (19%). Cacklers and whitefronts increased slightly (13%) and (11%), respectively. Cacklers continue to show the longest and most steady increase in breeding pairs. Whitefront breeding pairs are up slightly since 1985 while emperors are down slightly.

An Overview of 1991: For the first time in recent memory, nest sites were generally available before most geese arrived. In addition, migration arrival was gradual and peak arrival periods were difficult to identify. This resulted in protracted nest initiation. In general, break-up was "early"; while, migration arrival and nesting chronology were considered "average" when compared with previous years. Water levels in sloughs were high and tides resulted in brief flooding of some nesting areas during incubation. A period of rainy and windy weather also occurred during the latter part of hatch, but the negative impact of these factors is believed to be minor.

The following data come from the annual assessment of nesting success of geese in the coastal tundra region of the refuge. Sampling for nest density and success utilized single searches of randomly located 1/4 x 1/2-mile rectangular plots. The coastal region of the Yukon-Kuskokwim Delta was divided into 15 strata defined by general physiographic regions and results of 1985 and 1986 aerial surveys of geese. A total of 98 plots were searched by crews from field camps located at Kokechik Bay, Old Chevak, Tutakoke River, Hoch Slough, and Kigigak Island as well as four mobile crews based at Kanagyak field station. Float angles of eggs indicated average predicted hatching dates were June 22, 20, and 21 for cacklers, emperors, and whitefronts. These dates averaged slightly earlier than both 1988 and 1990 which were also early years. The survey estimated that 36,056 cackler, 21,659 emperor, and 14,086 whitefront nests were initiated on the 1,560 square miles of coastal habitat that contains about 90% of all geese on the Yukon-Kuskokwim Delta.

The early chronology, in part, resulted in increased clutch size from 1990 for all four species: brant - 3.9 eggs (n = 227), cacklers - 5.0 eggs (n = 216), emperors - 5.9 eggs (n = 127), and whitefronts - 5.0 eggs (n = 140). Nest success also increased for brant (90%), cacklers (68%), and emperors (89%), but whitefronts (83%) declined slightly.

The Alaska Fish and Wildlife Research Center, Anchorage, conducted several projects on the refuge:

First, development of an aerial videography procedure to census brant on staging and nesting areas was continued. To field test the procedure, systematically spaced flight lines were established perpendicular to the gradient of nesting densities, which generally also was perpendicular to coastlines. A camcorder was placed in the photographic port of a Cessna 206. Sixty transects were flown at 500 feet over three of four major colonies. About five hours were required to record 30-40 minutes of video at each colony. Resolution of images was sufficient to identify brant on nests, unattended nests with eggs, and flying brant, cacklers, and emperors. Results indicated the Tutakoke River colony (5,100 pairs) increased nearly five-fold since 1986, but remained 31% below the 1981 estimate. The decline which began in 1982 continued for the Kokechik Bay colony (5,800, -9%). The Baird Inlet Island colony estimate (7,500 pairs) was a pleasant surprise since a quantitative estimate has not been made due to difficulty in accessing the colony. The refuge breeding population is about 23,000 pairs.



This black brant nest was one of many found in the Baird Inlet Island colony, now the refuge's largest with 7,500 pairs.

(C. Harwood)

Second, this was the fourth year of a study investigating the demographics of cacklers nesting along the Kashunuk River.

Nesting plots in this area were first established in 1974 and the continuing work provides some of the best long-term information available on the nesting ecology of this species. Nearly 1,500 cacklers have been neck collared on the study area since 1986, including 300 in 1991. Approximately 130 different collared cacklers were observed in 1990; 50% of these were of known age (marked as locals). Resighting rate of adult geese the year after marking varied from 26 to 38% and 36 to 44% for males and females, respectively. Approximately 13% of yearlings and eight percent of two-year olds were resighted on the study area, roughly half as many as last year. Two yearlings (one of each sex) were known to have bred in 1991, and 40%, 60%, and 90%, respectively, of two, three, and four-year olds were observed either with a nest or brood. Nearly all geese two years of age and older were paired; 36% of yearlings were associated with an adult-plumaged bird. Yearling and two-year old females were more likely to be observed than males (a four-year average of 25% vs. 10% and 19% vs. 3%, respectively); this is probably indicative of male-based dispersal as reported for most waterfowl species. During the next season (1992), observations of older geese will allow us to better interpret the proportion of different age classes which nest. A reasonable return of nest-trapped females, especially those carrying radio packages, should enable us to more closely examine nest site fidelity.

Third, work was initiated to assess brood survival of pintails on the lower Kashunuk River. The study is intended to complement current duck production surveys and has the following objectives:

1. determine rate of total brood mortality by age class.
2. estimate rate of duckling mortality.
3. describe habitat use and movement by brood-rearing and post-breeding females.
4. estimate survival rate of brood-rearing and postbreeding females.

The median nest initiation date for 144 nests was June 2 (May 14 through July 1). Clutch size averaged 7.5 eggs and declined during the season (eight to nine eggs for nests initiated prior to June 2 and six to seven eggs afterward). Nest success was 39% (n=124 nests). Nest success for 36 nests located on the nearby Old Chevak study area was reduced to four percent primarily by arctic fox depredation.

Back-mounted transmitters were attached to 50 females one to five days prior to hatch. Forty-seven percent of broods survived ≥ 30 days. Broods moved a median distance of 2.6 km with 90% of movements < 4.2 km and the maximum 8.2 km.

Brood loss and duckling mortality was monitored by attaching back-mounted transmitters to 18 of 35 ducklings from five broods. Ducklings were marked while still wet and unradioed brood mates

were web-tagged. High tides, heavy predation, and radio failure plagued the duckling study. None of the radioed ducklings and only two of the web-tagged ducklings survived to fledge.

A similar effort is planned for 1992 using fixed locations to monitor movements and an improved duckling transmitter design.

The University of Alaska, Fairbanks, continued a study of brant ecology at Tutakoke River. Color marking in 1991 included 2,500 brant at Tutakoke River and 950 at Kokechik Bay. A total of 1,763 marked birds at Tutakoke River were observed and an additional 43 individuals that had been banded at other locations. Recruitment rates may be declining as only 2.5% of the females from the 1989 cohort were observed in 1991 compared to 6.4% and 5.6% of the 1986 and 1987 cohorts, respectively, when they were two years old. For the 1988 and 1989 cohorts about 30% as many males banded as goslings as females were recruited into the breeding population. Under an hypothesis of random dispersal, about 15% as many males as females would be expected to return to Tutakoke as breeders. Thus male goslings appear more likely to return to Tutakoke as breeders than expected by chance.

This was the second season of a three to four-year effort to measure exchanges among refuge colonies (Kokechik Bay, Tutakoke River, Kigigak Island, and Baird Inlet Island). During two days at the Kokechik Bay colony, 26 color-banded brant were observed, including five males and one female that were banded at Tutakoke as goslings. An additional six individuals banded at Tutakoke as adults were also observed. Nine individuals marked at Kokechik in 1990 and individuals marked in Canada, Wrangell Island, and on Alaska's north slope were also observed. Results were similar on Kigigak Island. Three males and one female marked as goslings at Tutakoke were observed in addition to six individuals marked as adults at Tutakoke. Individuals marked at Kokechik Bay, Wrangell Island, and the north slope of Alaska were also observed at Kigigak.

The refuge again maintained a field camp at Kokechik Bay. Field personnel monitored goose production and assessed the number and impact of resident fox on nesting success. With generally favorable weather conditions, nest success was above average for brant (71%, n=126), cacklers (71%, n=116), and emperors (90%, n=61), and down slightly for whitefronts (72%, n=6). Only one resident pair of arctic fox was present on the study area this year and they produced at least three pups, two of which were eartagged. Otherwise the area appeared to be a singles mecca with five aparous females and two males trapped. Three of the females and one male were radio-collared and their movements monitored via radio-telemetry. The three females occupied home ranges of 4.7 km², 9.7 km², and 11.2 km², respectively. All four radio-collared foxes were still present on the study area as of

18 December 1991, as determined by aerial surveys. As was the case in 1989 and 1990, their impact on goose production was minimal.

b. Kwethluk and Tuluksak Salmon Migration Studies.

Concern over the status of depressed lower Kuskokwim River drainage salmon stocks prompted several research projects. Chinook and chum salmon have remained below aerial escapement objectives for refuge rivers for several years (Figure 2). This concern over run status was identified in the refuge Comprehensive Conservation Plan and the recently completed Fishery Management Plan. Because of the identification of this important resource problem, congressional add-on monies were available to Fisheries to study the escapement levels. The Kenai Fishery Assistance Office planned the operation of fish weirs to determine the run timing, number, age and sex composition of fish migrating into two lower Kuskokwim River drainages on the refuge.



Assembling fish weir panels in refuge hanger. (Ken Harper, Kenai FAO)

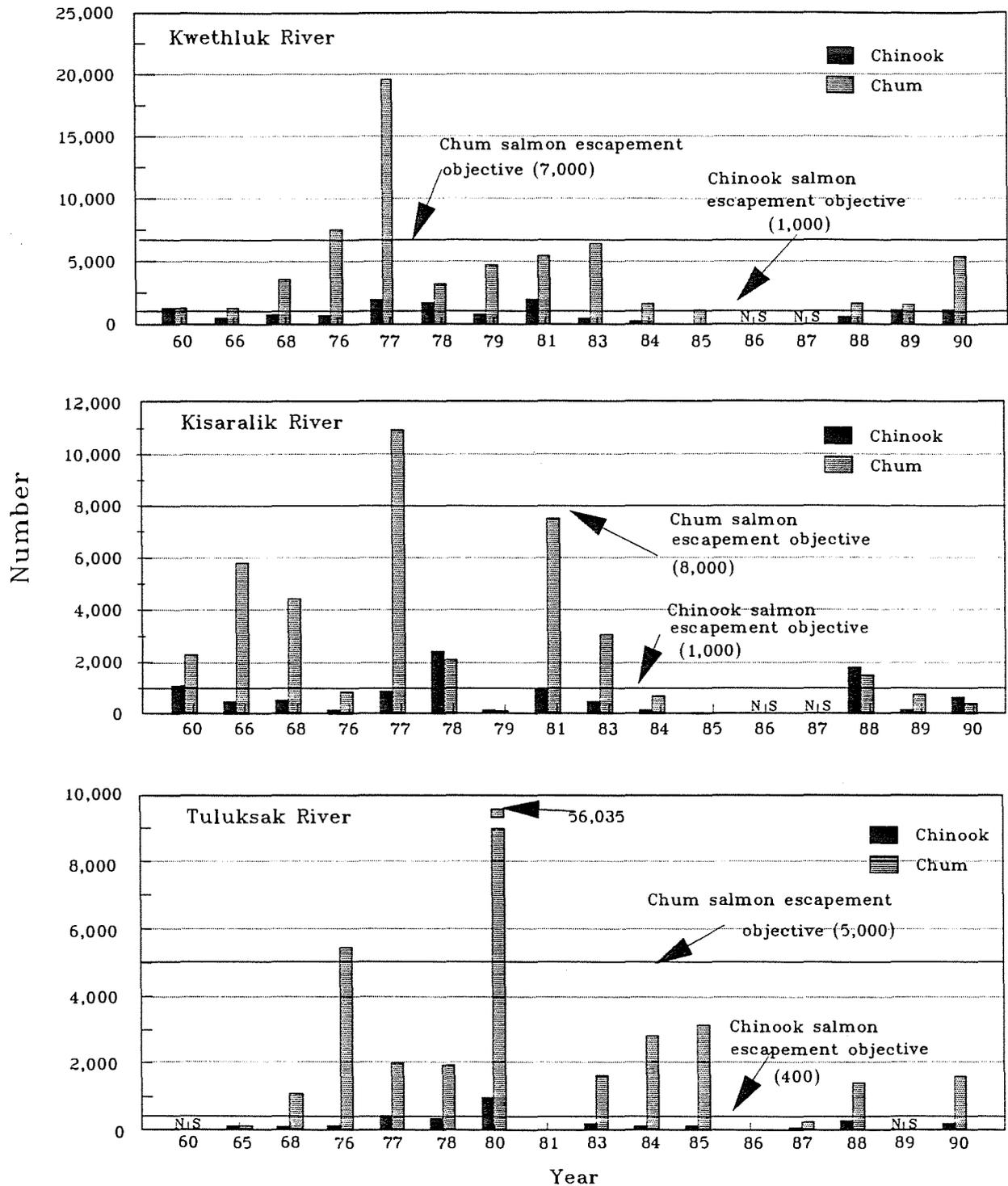


FIGURE 2. —Peak aerial survey salmon escapement estimates for chinook and chum salmon, in the Kwethluk, Kisaralik and Tuluksak rivers, Alaska, 1960-1990. Surveys conducted by the Commercial Fisheries Division of the Alaska Department of Fish and Game. Aerial index counts do not represent total escapement.

Work on the weirs in Bethel started in early April when the refuge allowed a fisheries crew to take over the refuge hanger and start assembling weir panels. In late May and early June, weir panels were flown out of Bethel to Tuluksak. Panels were then slung via a helicopter from Tuluksak and Bethel to the two remote river locations. The Tuluksak River weir was in place by early June and operated until September 19, 1991. A total of 697 chinook, 7,675 chum, 391 pink, 34 sockeye and 4,651 coho were passed through the weir. This represents 100% of the chinook, chum, pink and sockeye runs and approximately 95% of the coho run. Less than 25 fish per day were passing when the decision was made to pull the weir. This is the first data on coho salmon from this system and several years of data will be needed to determine trends. The chinook salmon escapement was above the aerial index goal of 400, however the 1991 aerial survey was close to the 400 goal.



Tuluksak River weir. (Brad Benter, Kenai FAO)

The Kwethluk River weir was not operated due to high waters. A camp site was selected and established. Age, weight and length data was collected by drifting gill nets and collecting dead fish from the banks. Gill nets were drifted for short distances and entangled fish were immediately removed to avoid mortality.

c. Subsistence Waterfowl Harvest Survey - Research and Development Effort

For the third consecutive year, the refuge staff and the

Migratory Bird Management division of the Service cooperatively conducted a household survey of subsistence waterfowl harvests. Migratory Bird Management harvest coordinator Cynthia Wentworth worked with refuge field coordinator Hansel Mathlaw and with the refuge interpreters and refuge information technicians to carry out the survey. This survey has been conducted on the refuge since 1980; previously it was conducted by Dr. John Copp through a contract with Oregon State University.

Yukon-Kuskokwim Delta residents harvested approximately 106,000 birds for subsistence in 1991 (Table 2), including 40,000 ducks, 22,000 geese, and 33,000 ptarmigan. The reported ptarmigan harvest was about twice as high as any previous year since ptarmigan first appeared on the survey form in 1986.

About one out of every four birds taken was a goose: Pacific whitefronts were the most common goose taken in 1991, as in 1990. About four out of every ten birds taken in 1991 were ducks; pintails were taken in largest numbers in 1991, followed by black scoters. Swans and cranes were also taken in significant numbers.

Harvest figures for 1991 are not directly comparable with figures for the previous five years due to a revision of household numbers in the 1990 U.S. Census. Since we survey households rather than individuals, data from the randomly sampled households is multiplied by the total number of households in the village rather than by the village's population. As a result of the 1990 census information, the estimated numbers of households on the Delta increased by several hundred (429) between 1989 and 1990. However, the estimated population increased by only 75 during the same time period. What this means is that there are fewer people living in each house now than in 1980, when the previous estimates of household size were made.

The 1991 harvest estimates are based on the new, larger household numbers. Therefore, 1991 harvest estimates are higher than if previous years' household estimates had been used. However, except with geese, these differences are not enough to affect overall harvest trends (if the difference is not enough to affect overall harvest trends, only the "new" number will be given in this analysis: for a comparison of "old" and "new" numbers, see Table 3).

In 1991, 22,413 geese were estimated taken based on the new household numbers; an increase of almost 3,000 geese compared with the late 1980's. However, the estimate based on old household numbers is 19,357, which is about equal with late 1980's goose harvests. Either way, however, 1991 total goose harvest was substantially below 1990's harvest of 26,000 geese. To put this figure in a longer term perspective, in the 1960's total goose harvest was estimated at 83,000, or over three times

TABLE 2 . MIGRATORY BIRD SUBSISTENCE HARVEST ESTIMATES, YUKON KUSKOKWIM DELTA, 1985 - 1991.

	1985	1986	1987	1989	1990	1991	6 YR AVG
GEESE							
Whitefronted Geese	3803	2806	3722	5324	8287	6263	5034
Cackling Canada Geese	1485	2067	3218	3584	5903	5362	3603
Emperor Geese	4031	3091	1352	1616	3440	2598	2688
Black Brant	2168	1483	1030	2372	3133	2492	2113
	-----	-----	-----	-----	-----	-----	-----
Total GMP Species	11487	9447	9322	12896	20763	16715	13438
Taverner's Canada Geese	4060	3649	4497	5455	4066	4732	4410
Lesser Snow Geese	1206	2102	5201	889	1284	966	1941
	-----	-----	-----	-----	-----	-----	-----
TOTAL GEESE	16753	15198	19020	19240	26113	22413	19790
TUNDRA SWANS							
TUNDRA SWANS	3531	5363	6721	6034	5399	5085	5356
SANDHILL CRANES							
SANDHILL CRANES	3289	3477	2191	3193	2159	3466	2963
DUCKS							
Pintails	8090	9934	17540	6893	8267	8210	9822
Mallards	4818	8907	9073	6908	12486	3963	7693
Unidentified ducks	1827	2514	2627	2171	1621	2234	2166
Wigeons	1356	1199	2799	824	2886	2099	1861
Shovelers	560	1381	2395	806	821	826	1132
Green wing teals	2195	2353	4264	1605	2529	1625	2429
Buffleheads	153	298	281	514	231	244	287
Harlequins	11	179	242	393	141	89	176
Greater Scaup	1783	4554	6256	2237	1394	2610	3139
Goldeneyes	310	774	2332	1129	1797	1963	1384
Oldsquaws	2680	2783	2691	4638	1476	2659	2821
White wing scoters	767	1136	2143	630	4027	2317	1837
Black scoters	3163	5079	5987	4629	4397	6284	4923
Surf Scoters	256	342	956	462	1848	650	752
Common Eiders	571	971	322	634	417	479	566
King Eiders	4258	1816	3360	3107	2243	3058	2974
Spectacled Eiders	297	321	296	493	272	319	333
Common Mergansers	32	304	304	118	75	15	141
Red breasted mergansers	61	203	299	187	230	444	237
	-----	-----	-----	-----	-----	-----	-----
TOTAL DUCKS	33188	45048	64167	38378	47158	40088	44671
PTARMIGAN							
PTARMIGAN	*	8926	15092	13371	12579	33300	16654

TABLE 2. MIGRATORY BIRD SUBSISTENCE HARVEST ESTIMATES, YUKON KUSKOKWIM DELTA, 1985 - 1991.

	1985	1986	1987	1989	1990	1991	6 YR AVG
OTHER BIRDS							
Yellow billed loons	132	381	143	88	89	112	158
Red throated loons	50	133	44	463	90	92	145
Common loons	362	662	1179	689	352	755	667
Arctic loons	127	91	42	96	32	36	71
Common murre	51	242	354	228	21	0	149
Small shorebirds	1975	604	225	101	48	167	520
Large shorebirds		75	124	19	140	346	141
Mew gulls	5	21	14	0	11	27	13
Sabines gulls	30	7	35	0	0	30	17
Glaucous gulls	412	217	287	21	574	44	259
Arctic terns	21	193	42	0	12	11	47
	<hr/>						
TOTAL OTHER BIRDS	3165	2626	2489	1705	1369	1620	2162
TOTAL EXCL. PTARMIGAN	59926	71712	94588	68550	82198	72672	74941
TOTAL INCL. PTARMIGAN	*	80638	109680	81921	94777	105972	91595 **

*Not included in the survey

**The sum of the 5 year average for ptarmigan (16,654) and the 6 year average for all other birds (74,941).

TABLE 3. MIGRATORY BIRD SUBSISTENCE HARVEST ESTIMATES, YUKON KUSKOKWIM DELTA, 1991.

	1990 CENSUS, NEW HOUSEHOLD NUMBERS 1991	PRE 1990 CENSUS HOUSEHOLD NUMBERS 1991
GEESE		
Whitefronted Geese	6263	5425
Cackling Canada Geese	5362	4685
Emperor Geese	2598	2263
Black Brant	2492	2098
	-----	-----
Total GMP Species	16715	14471
Taverner's Canada Geese	4732	4084
Lesser Snow Geese	966	802
	-----	-----
TOTAL GEESE	22413	19357
TUNDRA SWANS	5085	4262
SANDHILL CRANES	3466	3041
DUCKS		
Pintails	8210	7223
Mallards	3963	3417
Unidentified ducks	2234	1858
Wigeons	2099	1845
Shovelers	826	741
Green wing teals	1625	1444
Buffleheads	244	220
Harlequins	89	81
Greater Scaup	2610	2437
Goldeneyes	1963	1913
Oldsquaws	2659	2428
White wing scoters	2317	2108
Black scoters	6284	5816
Surf Scoters	650	598
Common Eiders	479	409
King Eiders	3058	2807
Spectacled Eiders	319	290
Steller's Eiders	23	20
Common Mergansers	15	13
Red breasted mergansers	444	417
	-----	-----
TOTAL DUCKS	40111	36085
PTARMIGAN	33300	29633

TABLE 3 . MIGRATORY BIRD SUBSISTENCE HARVEST ESTIMATES, YUKON KUSKOKWIM DELTA, 1991.

	1990 CENSUS, NEW HOUSEHOLD NUMBERS 1991	PRE 1990 CENSUS HOUSEHOLD NUMBERS 1991
OTHER BIRDS		
Yellow billed loons	112	99
Red throated loons	92	81
Common loons	755	667
Arctic loons	36	32
Common murre	0	0
Small shorebirds	167	151
Large shorebirds	346	271
Mew gulls	27	25
Sabines gulls	30	26
Glaucous gulls	44	38
Arctic terns	11	9
	-----	-----
TOTAL OTHER BIRDS	1620	1399
TOTAL EXCL. PTARMIGAN	72695	64144
TOTAL INCL. PTARMIGAN	105995	93777

as many geese as were estimated taken in 1990.

Harvests of all four of the Goose Management Plan species geese (pacific whitefront, cackling Canada, emperor, and brant) were below those of 1990 (Figure 3). Whitefront and cackler harvest estimates in 1991 were both above mid and late 1980's harvests, but below the 1990 harvests, whether "new" or "old" household numbers are used. Using the "new" household numbers, 6,263 whitefronts and 5,362 cacklers were estimated taken in 1991. Emperor harvests in 1991 were slightly below the six-year average (2,598 compared with 2,688). Brant harvests were roughly equal to the six-year average (2,492 compared with 2,113).

The overall harvest of ducks in 1991 was down compared with 1990 and compared with the six-year average (Figure 4). About 40,000 ducks were taken in 1991, compared with a six-year average of 45,000 ducks. This was mainly due to an unusually low mallard harvest in 1991. Mallard harvest in 1991 fell to about 4,000 birds after being unusually high at over 12,000 birds in 1990. Harvest of green-winged teals also fell substantially in 1991: only 1,600 were taken compared with a 1990 harvest and six-year average of 2,500. The 1991 pintail harvest was similar to 1990 at about 8,200 pintails. Whereas pintails and mallards usually comprise 40% of total duck harvest, in 1991 only 30% of all ducks taken were pintails and mallards.

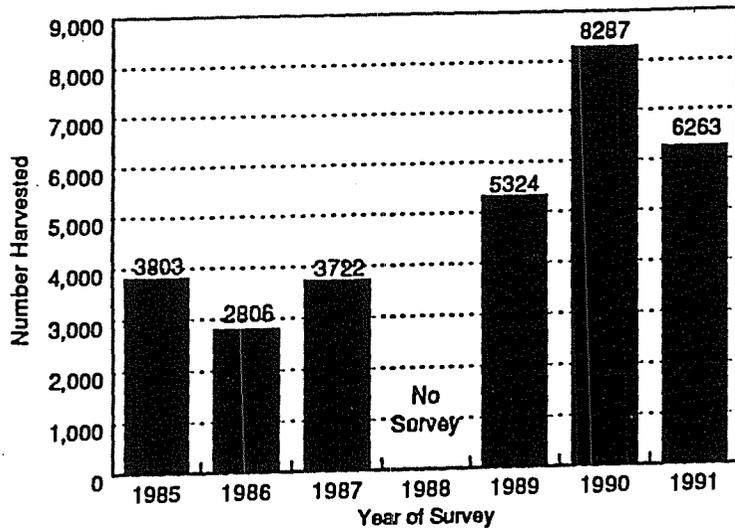
Seaducks made up half of 1991's total duck harvest, whereas in most years seaducks have comprised only 40% of total annual duck harvest. Harvests of most species of seaducks increased in 1991 compared with 1990. However, only goldeneyes, white-winged and black scoter harvests were above their six-year averages. Eider harvests were all close to the six-year averages: about 3,000 king eiders, 500 common eiders, and 300 spectacled eiders were taken in 1991. Spectacled eider harvests have stayed relatively constant at around 300 birds per year since 1985. Stellar's eiders were added to the survey form for the first time in 1991, but the expanded harvest estimate was only 23 Stellar's eiders.

Tundra swan harvest in 1991 was about 5,000, a few hundred birds below 1990 and the six-year average. The estimated 1991 sandhill crane harvest was over 3,000, which was higher than the 2,000 taken in 1990 but close to the six-year average of about 3,000 cranes annually.

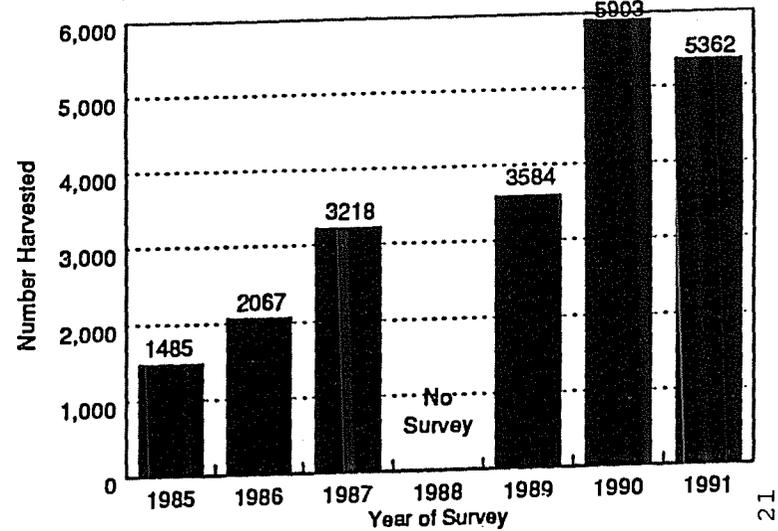
In 1991, 741 households in 20 delta villages (Figure 5) participated in the harvest survey. This was a lower level of participation than in 1990, when 871 households and 23 villages participated. Newtok dropped out of the survey after permission had been obtained but before any forms were collected, and Toksook Bay and Eek turned in all zeros on their forms even though survey workers reported that goose and other waterfowl hunting was occurring. Chefornak participated in the survey in

Goose Management Plan Species

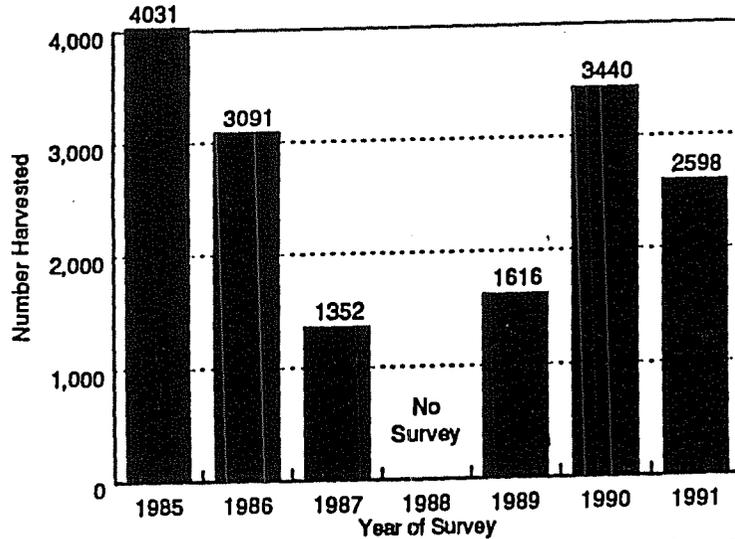
White-Front - Leqleq Harvest



Cackler - Tuutangayak Harvest



Emperor - Nacaullek Harvest



Brant - Neqlernaq Harvest

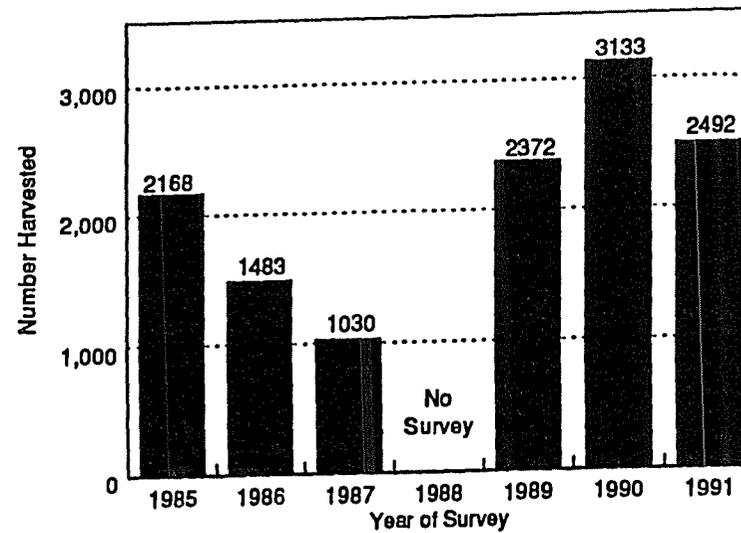
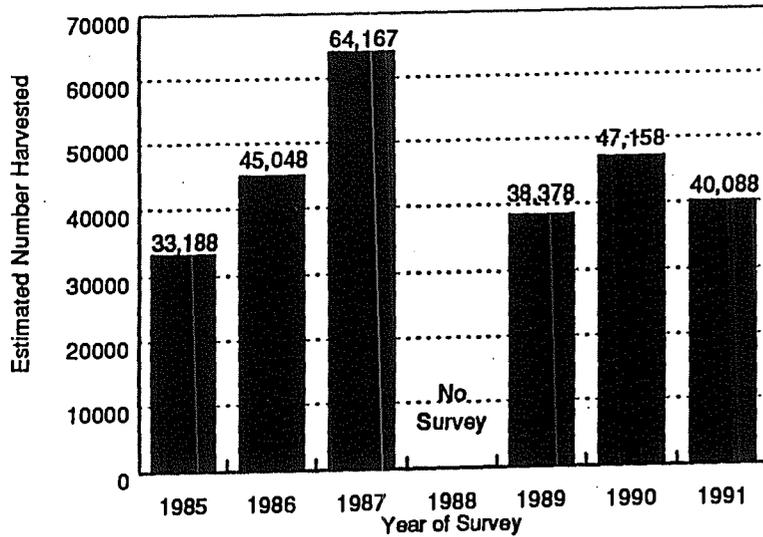


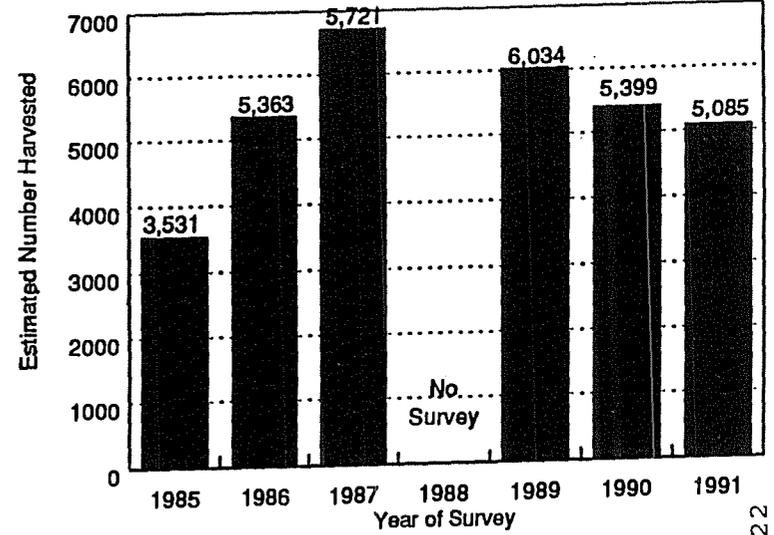
Figure 3. Waterfowl subsistence harvest, Yukon Delta National Wildlife Refuge, 1985-91.

Subsistence Waterfowl Harvest Survey

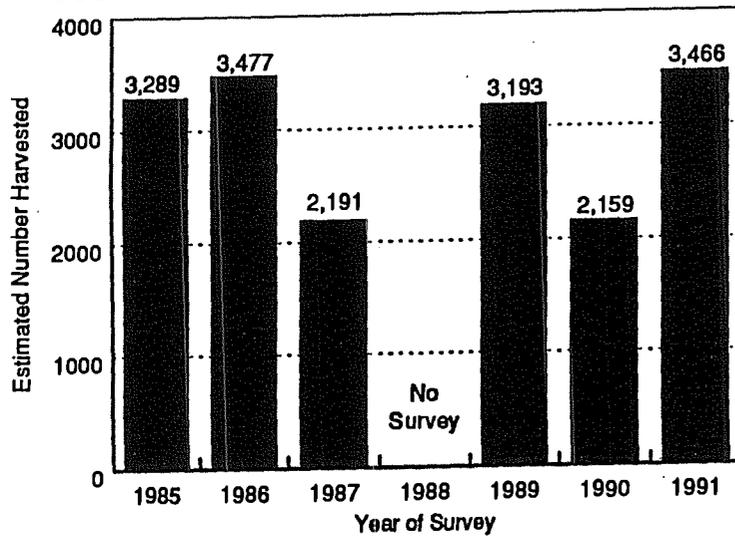
Duck - Uqsuqat Harvest



Swan - Qugyuut Harvest



Crane - Qut'raat Harvest



Ptarmigan - Qangqiiret Harvest

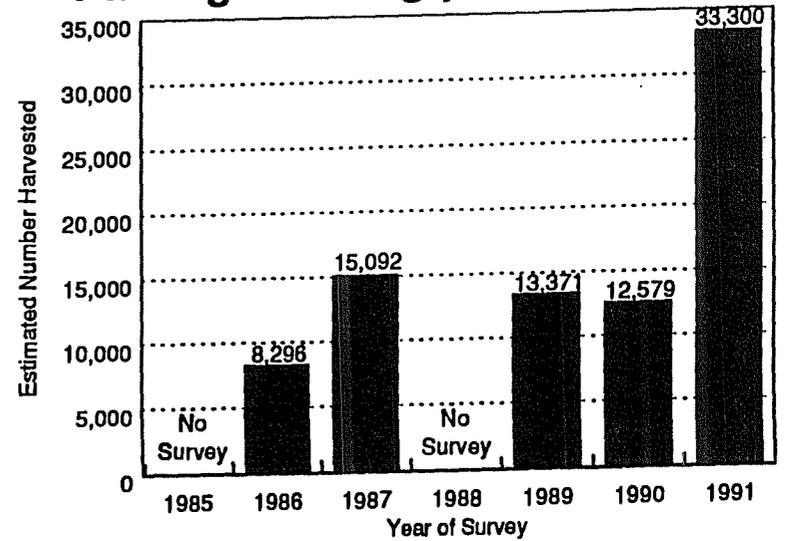
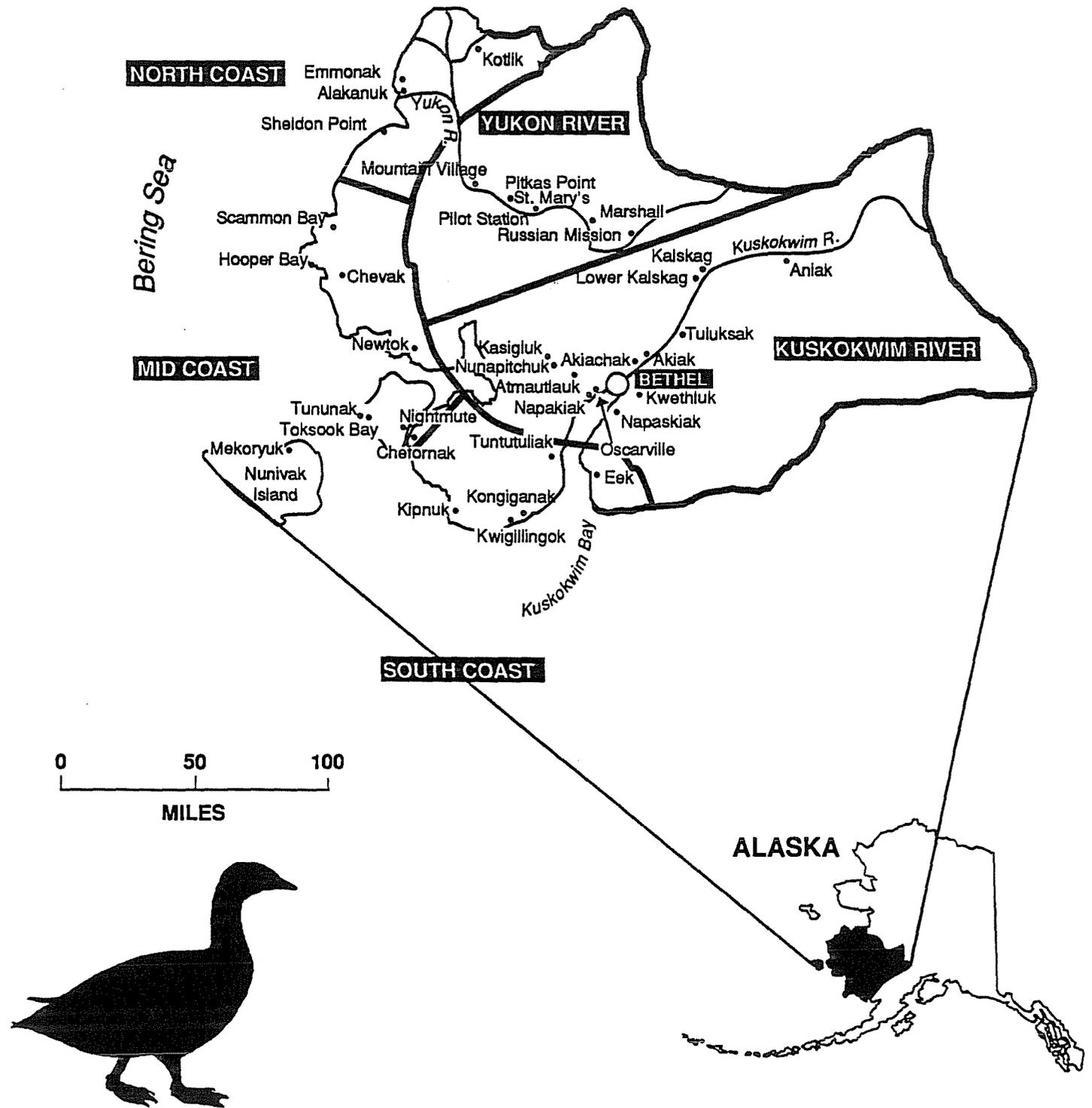


Figure 4. Waterfowl, crane, and ptarmigan subsistence harvest, Yukon Delta NWR, 1985-91.

Figure 5 : Communities and Regions Yukon Delta National Wildlife Refuge



spring only, and only three households turned in forms (compared with 18 households in 1990). This decline in participation in 1991 was reported by the survey workers to be related to the law enforcement activities which occurred in the area in May 1991.

The following villages participated in the survey in 1991: Alakanuk, Bethel, Chefornak (spring only), Chevak, Emmonak, Hooper Bay, Kasigluk, Kotlik, Kwethluk, Lower Kalskag, Marshall, Mountain Village, Napakiak, Nightmute, Nunapitchuk, Russian Mission, Scammon Bay, St. Mary's, Tuntutuliak, and Tununak.

The refuge employed 33 local village survey workers to obtain household permission for the survey, and pass out and collect survey forms in 1991. These workers were hired as contract employees. Ten of these left the job without finding and training their own replacement. Data collection suffered somewhat in Aniak, Kasigluk, Marshall, St. Mary's, Mt. Village, Scammon Bay and Upper Kalskag as a result. However, most survey workers completed their assignments successfully. The following survey workers successfully completed the job for the entire 1991 survey season: Shelby Edmund, Alakanuk; Connie and Henry Peter, Bethel; Berni Jones Boyscout and Monica Friday, Chevak; Lawrence Yupanik, Emmonak; Nita Aketachunak and Laurie Prince, Kotlik; Elizabeth Uruvak, Lower Kalskag; Agnes Carl and Jerry Moses, Hooper Bay; Tim Michael, Kwethluk; Anna Middleton, Napakiak; Joe Mochin, Nunapitchuk; Herman Nick, Russian Mission; Elsie Albrite, Tuntutuliak; and Nora Albert, Tununak.

A total of about \$39,000 went directly into local village economies, in the form of payments to survey workers. Each survey worker earned an average of about \$1,300.

Survey results for 1990 showed, as they have every year, that spring is the most important time for waterfowl hunting. In 1991, spring played an even more significant role than usual in the overall harvest pattern: three out of every four birds were taken in the spring (in most years, about half of all birds are taken in the spring). Part of this was due to the unusually high ptarmigan harvest in 1991, practically all of which occurs during spring (or earlier). However, in 1991, 70% of all geese and 67% of all ducks were taken in the spring, whereas in an average year, just over one-half of all geese and only 35% of all ducks are taken in the spring. In some ways, 1991's seasonal harvest pattern was a contrast from 1990's pattern, when unusually high numbers of birds were taken in late summer and fall. However, in both 1990 and 1991, the numbers of birds taken in early and mid summer was significantly below the previous year's spring.

The major weakness of the 1991 survey was, as in 1989 and 1990, the lack of participation of key villages in the south coast region: Kipnuk, Kongiganak, and Kwigillingok; and the loss of participation of Eek in the south coast region and Toksook Bay,

Newtok, and Chefornak in the mid-coast region due to fears related to waterfowl enforcement activities in these areas. Most of these villages which did not participate in the survey are located in areas of prime emperor goose habitat, and it is known that many geese are taken. Therefore, we are least confident with our emperor data. Harvest data for other geese and waterfowl are also less accurate than in 1990 due to the participation of fewer villages from these prime nesting areas.

d. Spectacled and Common Eider Nesting on Kigigak Island



This centrally located lake is the only one large and deep enough on Kigigak to support float plane landings and takeoffs.

(C. Harwood)

Renewed interest in the population status of spectacled eiders (*Somateria fischeri*) and common eiders (*S. mollissima*) prompted the refuge to monitor eider nesting on Kigigak Island. Field work was conducted in conjunction with surveys of goose production plots and observations to document the presence of color-marked black brant (Section D.5a). A field camp was staffed by two biological technicians from June 7 to July 11. A total of 69 nests were located, including 24 spectacled, 42 common, and three unknowns. Nests were revisited, minimally, near the end of incubation period to monitor hatch. Eight of the nests were not revisited because they were either hatched or inactive (i.e. abandoned and/or depredated). Nearly half (n=34) were found totally depredated or hatched on the second visit.

The remaining 27 nests were revisited two to six times, with 70% of those revisited two or three times. Sixteen of 24 (67%) spectacled eider nests and 19 of 42 (45%) of common eider nests were located within brant and/or gull colonies.



The costs and benefits of eiders nesting within gull colonies was just one topic explored on Kigigak. (C. Harwood)

Most nests for both species were on shorelines or islands. Mean clutch size was 4.7 and 4.4 eggs for spectacled and common eiders, respectively. Nest success was higher for spectacled eiders (61%) than for common eiders (43%) and success of "early" nests was significantly higher than "late" nests for both species. Unlike spectacled eiders, nest success for common eiders was significantly higher within brant/gull colonies than outside. Avian predation was suspected in most cases of the 38% and 57% of nests destroyed for spectacled and common eiders, respectively. Mean brood sizes were 4.3 and 3.2 ducklings for spectacled and common eiders, respectively. Spectacled eider broods (n=28) were observed for an average of 4.2 hr (range = five min to 22 hr). After the initial nest dispersal movement which may be up to 2.4 km, broods tended to remain in a localized area, usually a small freshwater pond, lake, or waterbody complex. A formal study plan has been submitted for an expanded work to begin in 1993.

e. Kilbuck Mountain Caribou Study

Caribou were once abundant over much of the Yukon-Kuskokwim Delta. The species had seriously declined in the area by the 1900's, however, as a result of overharvesting, competition with introduced reindeer, wildfire, and a possible shift in caribou migration patterns. By the mid-1900's, caribou all but disappeared from the area with the exception of a small, remnant herd in the Kilbuck Mountains. This herd was thought to contain as few as 200 animals in 1984. Heavy harvests during winter and early spring 1985 led to an emergency closure of the hunting season in 1985.

The refuge began an inventory of Kilbuck Caribou in September 1985. Due to the extensive search times for finding animals, it was decided to radio-collar several caribou. A management study entitled "Populations, Movements and Potential Range of Caribou in the Kilbuck Mountains" was initiated in 1987. The objectives of the study plan included determining caribou population size and density, population dynamics, movement patterns, seasonal habitat requirements, and mortality factors. Other objectives included determining the extent of suitable, unoccupied habitat in the Kilbuck Mountains, compatibility of reindeer herding with caribou management objectives, and if caribou from adjacent herds were migrating into the area. To assist in this process, a capture and radio-collaring operation was conducted in Spring 1987, Spring 1988 and Fall 1990. A total of 37 caribou (11 bulls and 26 cows) were captured and radio-collared. Currently only 22 collars are still active. These animals are located monthly (weekly during calving) to determine individual home ranges, movement patterns, and range fidelity.

Caribou have more than tripled their area of use since monitoring was initiated. The refuge, in cooperation with Alaska Department of Fish and Game and Togiak refuge, conducted a census in November 1991. A total of 2,584 caribou were counted. After the census, a composition count on 715 caribou was made. There were 253 bulls, 322 cows and 140 calves.

f. Bristle-thighed Curlew Studies

In 1991, the refuge's bristle-thighed curlew program continued at Curlew Lake for the fourth consecutive year. Biological Technician Harwood and Susi Kalxdorff (Region 7 Realty clerk-typist) spent three weeks at the study site in May. Eleven of 12 known individuals returned to the area, again demonstrating the extremely high survivorship and/or breeding site fidelity of this species. Three males retained their mate of the previous year. A fourth male, mating for the first time, paired with the female he was last seen consorting with in 1990. Two other males switched mates in an example of serial mate-swapping which left a third unknown male without a female. Harwood discovered a completed four-egg clutch on May 20, the earliest nesting on record.

The geographic distribution and curlew population survey was finally completed in the southern Nulato Hills. Three two-person crews visited a total of 11 randomly selected townships in search of curlews during the last week of May. Crews were based at St. Mary's Mission, and access to sampled townships was via helicopter. A total of 221 point counts was completed. Overall, 0.24 curlews/point were detected. Considering only townships where curlews were located (n=6), 0.47 curlews/point were detected. In the heart of the curlews's breeding range south of Allen Creek, the detection rate climbed to 0.92 curlews/point. The survey indicated that the species' distribution is more restricted than we had previously realized, being limited to the western two-thirds of the Andreafsky watershed. In addition, the bulk of the breeding population occurs south of Allen Creek. This concentration renders the small population more susceptible to environmental perturbations.

g. Lower Yukon Moose Study

The seasonal movements of moose along the lower Yukon River is the subject of a project initiated by the refuge and Marshall School. This cooperative project was funded by both participants through the Challenge Grant Program and allowed high school students to participate in an actual field research project. The objectives of the study include determining population size, age and sex composition, movements and seasonal distributions, and mortality factors of this small, but growing population of animals. Another major objective of the project is to increase local understanding of wildlife management objectives.

Two cows and one bull were captured and collared with satellite transmitters (PTT's) in March 1989. Three cows were also collared with conventional VHF beacons supplied by Alaska Department of Fish and Game. One satellite collar had dead batteries and was retrieved in March 1990. Pilot Station school became involved with the project in 1990. In November 1990, four more bulls and one cow were captured and outfitted with conventional radio collars. The two moose with satellite collars were recaptured and their collars replaced as well. All conventional collars are aerially tracked on a bi-monthly basis. Students from Marshall and Pilot Station accompany refuge biologists on a rotating basis during these tracking flights.

The school and refuge receive monthly location and sensor data on each satellite-collared moose. Approximately three to five locations per moose are received every four days. The students are plotting the locations of the moose using a computer mapping system and will follow the movements of each animal for the next couple of years, depending on battery life of the transmitters.

Students will learn about the home range, seasonal migration patterns, and habitats used by each moose. In addition, they are

gaining experience in the use of computers, and have created public service announcements for the local newspaper and radio.

h. Kuskokwim Moose and Caribou Study

The Kuskokwim moose and caribou study was developed and approved during 1989, and funded for implementation during 1990. This was another Challenge Grant project that was funded by the refuge, Association of Village Council Presidents, Bureau of Land Management, Kuskokwim Community College, Yupiit and Kuspuuk School Districts. The purpose of the study is to estimate numbers, age and sex composition, recruitment, movements, and seasonal distribution of moose, and movements and seasonal distribution of caribou in the lower Kuskokwim River drainage. Another primary objective is to improve students' understanding of the principles of wildlife management through active participation in an ongoing field study that has practical applications for them and their subsistence lifestyle.

Fifteen moose (14 cows, one bull) were captured and outfitted with radio-collars in March 1990. Seven caribou (five cows, two bulls) were captured and radio-collared at the same time. In addition to conventional radio transmitters, five of the caribou collars were fitted with satellite transmitters (PTT's) as well. Unfortunately, three of the PTT's proved faulty. Telonics, the manufacturer, put the wrong transmitters in three of the five PTT's. While Telonics was not willing to pay the cost of retrieving the three faulty PTT's, they did agree to refurbish three additional collars so the refuge could recapture the three animals and replace the collars. The capture of the three animals took place in April 1990.

The moose are radio-tracked aerially on a monthly basis by refuge biologists and students from the two cooperating school districts. In addition, the refuge and schools receive tracking locations on a monthly basis for the satellite-collared caribou. Approximately three to five locations per caribou are received every six days. The students plot the daily movements of these animals using a computer mapping program. Data generated by this study are used by the students in their science, math, computer, and journalism curricula.

6. Other Items

a. Fishery Management Plan

The Kenai Fishery Assistance Office completed the Fishery Management Plan with the help of the refuge during the course of the year. A public review was completed, comments were addressed and the final plan was published in January 1992. The plan provides management direction to ensure conservation of fish species and habitat while, at the same time allowing the users

some level of harvest. The Plan identifies management objectives and specific tasks designed to address fishery problems on the refuge.

E. ADMINISTRATION

1. Personnel

We experienced our normal high turnover of personnel in 1991.

Michael B. Rearden	Asst. Refuge Mgr./Pilot	(EOD 7/79) (Trans. 7/91)
Eugene Peltola, Jr.	Wildl. Bio.	(EOD 5/84) (Trans. 11/91)
Carlie Andrew	Refuge Info. Tech.	(EOD 2/91) (Resigned 5/91)
David Evan	Refuge Info. Tech.(Napaskiak)	(EOD 11/89) (Resigned 2/91)
Alice Lee	Refuge Info. Tech.(Aniak)	(EOD 12/89) (Resigned 5/91)
Billy Lincoln, Jr.	Refuge Info. Tech.(Toksook Bay)	(EOD 11/88) (Resigned 12/91)
Charlotte Wilson	Clerk Typist	(EOD 11/90) (Resigned 8/91)
Palmer Olrun	Maintenanceman	(EOD 5/90) (Resigned 6/91)
Kara Clavien	Clerk Typist	(EOD 9/91) (Resigned 9/91)

3. Youth Programs

Two Youth Conservation Corp (YCC) enrollees were hired during the summer of 1991. Ben Chinn and Glen Raphael worked directly with the maintenance program for the better part of the summer. To a lesser degree, they were also involved in public use related activities. The brunt of their work consisted of labor-intensive projects such as painting and other rehabilitative work. Their contribution to our program is valuable and stands to be commended. Our permanent maintenance staff simply does not have the time to conduct many of the projects YCC does. As a result, these projects would not have been completed, or at least completed in such a timely manner, without the YCC program.

4. Volunteer Programs

Two volunteers, Martin Schulz and Christine McCaffery, worked on the refuge this summer. Martin aided in the shorebird survey which took place on Nunivak Island from August 21 through October 1. During the study, refuge personnel conducted Steller's eider and shorebird investigations. McCaffery participated in teaching a field course in marine and wetlands ecology on Nunivak Island, September 3 through 13. She team-taught the course with Dr. Polechla and Wildlife Biologist McCaffery (see H.11).

5. Funding

In the last four years, the Fiscal Year 1992 budget was the best for both amount and timeliness (Table 4). The Fiscal Year 1991 budget vacillated widely in the planning period, which made our planning nearly impossible. The Fiscal Year 1992 budget was the best and also allowed us to select three projects that were refuge priority and not the regions priority. The refuge spent the monies on a raptor study on the Kisaralik River, upgraded the computer system, and started a cabin survey.

Table 4. Funding for Yukon Delta NWR, 1989-92.

Activity Code	FY89	FY90	FY91	FY92
1111 (Endangered)	32K	--	17K	--
1230	--	--	--	17K
1241 (Fire)	--	16K	--	--
1260	1,538K	1,566K	1,709K	1,746K
1411	--	35K	87K	122K
1221 (Subsistence)	--	--	--	61K
TOTAL	1,570K	1,617K	1,813K	1,946K

6. Safety

The refuge safety officer conducted monthly safety meetings on various subjects related to safety in the home, office, and field. Fire extinguishers in the office building were tagged and periodically inspected for proper content and function. Refuge staff residing in refuge housing were also given inspection tags for self-inspection of fire extinguishers in their residence each month. All fire extinguishers were inspected for proper content and function. Those fire extinguishers needing refill or not functioning properly were immediately replaced.

In the event a monthly safety meeting was not conducted, the refuge safety officer wrote a monthly safety reminder on safety items related to work, home, and field operations. Arctic survival was featured in the monthly reminders during the year.

Prior to winter, an awning was built along the walkway on the southwest side of the refuge office building by the refuge maintenance crew. This awning was built to prevent any injury to persons walking along the walkway by falling snow or ice from the roof of the refuge building.

There were no major safety incidences in 1991. It was a very safe year for the staff in the office, at home, and in the field.

8. Other Items

Special Use Permits were issued to the following individuals and organizations in 1991:

Alaska Fish & Wildlife Research Center	Collect Northern Pintails
Alaska Maritime Agencies, Inc.	Sightseeing
Bering Sea Fisherman's Association	Salmon Enhancement
Bering Sea Reindeer Products	Reindeer Grazing
Bering Sea Reindeer Products	Helicopter Herding
Bureau of Indian Affairs	14h1 site investigations
Bureau of Land Management	Native Allotment Fieldwork
Bureau of Land Management	Native Allotment Surveys
Charlie Spud	Transporting
Ed Shavings, Sr.	Guiding
Fred Don	Guiding
Larsen King	Outfitting
Nunivak Fisherman's Association	Commercial Fishery Support
United Utilities	Gravel Removal
U.S. Department of Agriculture	Vegetation Inventory
Washington State University, Anthropology Department	Surveys, excavation, etc.

F. HABITAT MANAGEMENT

1. General

The Yukon Delta National Wildlife Refuge encompasses approximately 26.3 million acres within the northern boreal subzone of southwestern Alaska. About 70% of the refuge is below 100 feet in elevation and consists of a broad, flat delta created by the Yukon and Kuskokwim Rivers and their tributaries. The refuge is primarily subarctic tundra, underlain by permafrost, and includes a variety of scrub, peatland, heath meadow, marsh, and bog habitats. Tall scrub and forest habitats are found inland, in the eastern interior areas of the refuge. Alpine tundra occurs in the mountainous areas at higher elevations. Most of these habitats remain essentially untouched by humans. Virtually no habitat management as practiced in the lower 48 states occurs. Habitat related activities involve mapping and inventory efforts associated with specific wildlife studies.



Berry-producing plants, such as crowberry and bearberry, provide an important food resource for migratory waterfowl, shorebirds, and passerines. (C. McCaffery)

a. Contaminants

Two mining claims in the Kilbuck Mountains were surrounded by Service lands in 1980 when the Alaska National Interest Lands Conservation Act established the Yukon Delta National Wildlife Refuge. Canyon Creek and Columbia Creek mines were closed in 1980 and 1986, respectively, and both sites were classified as abandoned and vacant in 1987 by the Bureau of Land Management. The land on which the mines were located reverted to the public domain and became part of the refuge at that time.



Abandoned dwellings at the lower mine site,
Canyon Creek. (Rick Hubbell)

Canyon Creek and Columbia Creek mines are located in remote, isolated areas accessible only by fixed-wing aircraft or helicopter for most of the year. In the winter, they can be reached (with some difficulty) by driving tracked vehicles over the frozen, snow-packed tundra.

Both areas contained several dilapidated buildings, tons of scrap metal and wood, assorted rubbish, and various pieces of mining machinery. In addition to being substantial eyesores, there were contaminants, public safety, and law enforcement concerns as well. Numerous empty, partially-filled, and full drums of petroleum-based wastes were scattered about both sites. Several cases of explosives (kinepak) were found at Columbia Creek. Finally, it was suspected that caribou and moose poachers were using the old buildings to stage out of in the winter. The refuge, in cooperation with Ecological Services, Anchorage, began formulating strategies in 1989 when it was determined that the liability for cleanup rested with the Service.



A derelict derrick decays on a declivity--
Canyon Creek. (Mike Jensen)



An old sluice box, pipe, and mining rubble
at Canyon Creek. (Mike Jensen)

A general study plan was developed in 1989 to conduct an environmental contaminants investigation and cleanup of Canyon Creek and Columbia Creek. A total of \$75,000 was appropriated in Fiscal Year 1990 for this purpose. An environmental consulting firm was contracted to sample the contents of all drums and containers. Due to contracting and logistics problems, only Columbia Creek was done. Samples were separated into drums whose contents could be burned as "used oil fuel" according to federal energy recovery regulations and those requiring additional handling/sampling for proper disposal. Requests for bids to cleanup the two sites in 1990 were solicited but cancelled because bids were far in excess of remaining funds allocated to accomplish the project.

A total of \$118,000 was appropriated in Fiscal Year 1991 for contaminants cleanup work at Canyon Creek and Columbia Creek. It was learned that all drums containing fuel and other oil-based waste products had to be physically removed and disposed of off-site at an EPA-approved disposal site. Furthermore, removal from the area could only be accomplished by certified professionals specializing in hazardous waste removal and transportation. Approximately \$43,000 was earmarked for sampling and analyzing approximately 13 drums at Canyon Creek and additional sampling of five drums at Columbia Creek. Contracted services were to include removal as well. The contract was not awarded until fairly late in the field season, however, and the work was not performed due to logistical difficulties. The contract for this work has been extended to the Fiscal Year 1992 field season.

The remaining \$75,000 was to be spent on a contract to cleanup and dispose of the "non-hazardous" debris. Similar to the previous year, the estimates submitted substantially exceeded available funds. At least one bid was in excess of \$1,000,000! At this point it was decided the refuge would conduct its own cleanup operation. Refuge maintenanceman Mike Jensen was detailed to the project crew leader position and placed in charge of identifying equipment needs.



Old bulldozer restored to life and used to accomplish the mine site cleanup at Canyon Creek. A makeshift cart built by the original owners was used to haul tools and gear. (Rick Hubbell)



Necessity is the mother of invention. An old conibear trap was used to splice a wheel on a homemade cart. (Mike Jensen)

As an accomplished diesel mechanic, Jensen was also assigned the task of reviving an old bulldozer at Canyon Creek. No mean feat given the fact that this cat had not been turned over in at least five years. Furthermore, it had also been diagnosed as terminally dead by a factory representative Caterpillar mechanic. With a modest expenditure of funds, it took Jensen a single day to breathe new life into the old beast.

A five-person crew was hired as temporary laborers to conduct the actual cleanup.



The cleanup crew from left to right:
Stephen Olrun, Hultman Kiokun, Henry
Ivanoff, Andrew Bergeson, and crew leader
Mike Jensen. Not pictured: Rick Hubbell.
(Rick Hubbell)

On August 11, Jensen, his crew, their equipment, and fuel to operate the bulldozer were transported to Canyon Creek by chartered Skyvan. In spite of (or due to?) freezing rain, clouds of mosquitoes, and bone-chilling cold nights, cleanup was accomplished in ten short days. With the exception of drums containing waste fuel products, everything that could be burnt was torched and the remainder buried. Disturbed areas were contoured with the bulldozer.



Before: Upper site at Canyon Creek prior to cleanup.
(Rick Hubbell)



Buildings at the upper mining site on Canyon Creek were pushed into an old borrow pit and torched.
(Rick Hubbell)



Bulldozer being used to flatten and then bury drums at the Canyon Creek mine cleanup site.
(Rick Hubbell)



After: Upper site at Canyon Creek following removal of buildings and other materials, and re-contouring of the site. (Rick Hubbell)



Before: Lower site at Canyon Creek prior to cleanup. The cleanup crew lived in these two buildings until the very last.

(Mike Jensen)



After: Lower site at Canyon Creek immediately following cleanup.

(Mike Jensen)

On 23 August the crew was moved to Columbia Creek by helicopter and a similar process repeated in six days. Materials that could not be burned at Columbia Creek were piled for later burial, however. It is anticipated that drums containing waste fuel products will be removed from Canyon Creek and Columbia Creek by contract in Fiscal Year 1992.



Before: Old cabin being burned in place at Columbia Creek minesite. (Mike Jensen)



After: A scorched mark on the tundra was all that remained after burning at Columbia Creek.
(Mike Jensen)

Plans for Fiscal Year 1992 include driving snowmobiles into Canyon Creek during the winter and "walking" the bulldozer over to Columbia Creek. The cat would be left there until summer when the remaining materials would be buried. The cat would then be "walked" out to Bethel and sold the following winter.



Aftermath: Some close friendships were made by the end of the project, however, in retrospect we may have left these guys in the field too long. (Rick Hubbell)

2. Wetlands

Most of the refuge is a vast, flat wetland/tundra complex dotted by countless ponds, lakes, and meandering rivers. Some of the most critical wetland habitat on the refuge is the coastal region bordering the Bering Sea. This narrow strip of land is unquestionably the most productive goose nesting habitat in Alaska. As a result of the Alaska Submerged Lands Act, additional acres on and adjacent to this coastal strip may be selected from refuge lands by native corporations in the years ahead.



Nelson Island provides some "relief" from
the flatness of the coastal tundra!

(C. Harwood)

3. Forests

Less than five percent of the refuge is considered to be forested. Narrow bands of riparian, black spruce-hardwood, mixed black spruce-balsam poplar, and balsam poplar woodlands extend onto the delta along the Yukon and Kuskokwim Rivers and their tributaries. In addition, pockets of black spruce and white spruce are interspersed throughout the Kilbuck and Andraefsky Mountains. None of the wooded areas on the refuge contains commercially harvestable timber.

6. Other Habitats

The refuge is primarily composed of subarctic wetland/tundra, scrub, forest, and alpine tundra habitats.



Well-camouflaged in this habitat, rock ptarmigan prefer the alpine tundra and talus slopes. (C. Harwood)

Another habitat is the intertidal mudflats which are extremely important feeding, resting, and staging areas for numerous species of shorebirds and waterfowl. Coastal cliffs provide important nesting habitat for seabirds on Nunivak and Nelson Islands, and at Cape Romanzof.

7. Grazing

Reindeer were introduced onto the Yukon-Kuskokwim Delta in 1901 when 176 animals were released near Bethel. The mainland reindeer population peaked at 176,000 animals in the late 1930's. A sharp population decline in the early 1940's, however, resulted in a complete breakdown of reindeer herding and the gradual loss of all herd animals on the mainland.

The only active reindeer operation remaining on the refuge is on Nunivak Island. Reindeer were introduced to Nunivak Island in 1920. Nunivak was considered to be ideal habitat because it had lush forage conditions, lacked major competitors and predators, and restricted reindeer movements to a controllable area. The island was set aside as a Department of Agriculture reservation in 1929 partly to conduct experiments in the crossing and propagation of reindeer and caribou. This herd grew to approximately 30,000 by 1944; declined precipitously the

following year, and has fluctuated widely ever since. The April 1991 population estimate was 6,200. Reindeer on Nunivak Island are owned and managed by Bering Sea Reindeer Products, a Native-owned corporation based at Mekoryuk. This herd is extremely important as a red meat source and to the cash economy of Native residents of Nunivak Island.

A study conducted by the Soil Conservation Service in the mid-1980's determined that reindeer had severely overgrazed lichen ranges on Nunivak Island. A series of permanent range-monitoring plots were established in 1989-90 and indicated that range condition and trend continued to decline as a result of continued overgrazing.



Lichen provides critical winter forage for Nunivak's reindeer population.

(C. McCaffery)

Positive steps were taken in 1990 to reverse this trend through

the construction of a slaughter house. More than 2,000 animals were processed through the slaughterhouse in 1991. Proper handling in a State-inspected slaughter facility will allow access to an unlimited exotic meat market. At the projected rate, it will take approximately five years to reduce the herd to a level for range recovery to begin and still allow for a commercial harvest of reindeer. A draft management plan was reviewed and revised in 1991 to provide formal direction for the proper management of reindeer range on Nunivak. It is anticipated the plan will be signed in 1992.

9. Fire Management

All wildland fire suppression responsibilities on Alaskan refuges have been delegated to the Alaskan Fire Service, Bureau of Land Management. Fire activity on the refuge was moderate in 1991, with nine fires reported (Table 5).

Table 5. Reported wild fires on the Yukon Delta NWR, 1990

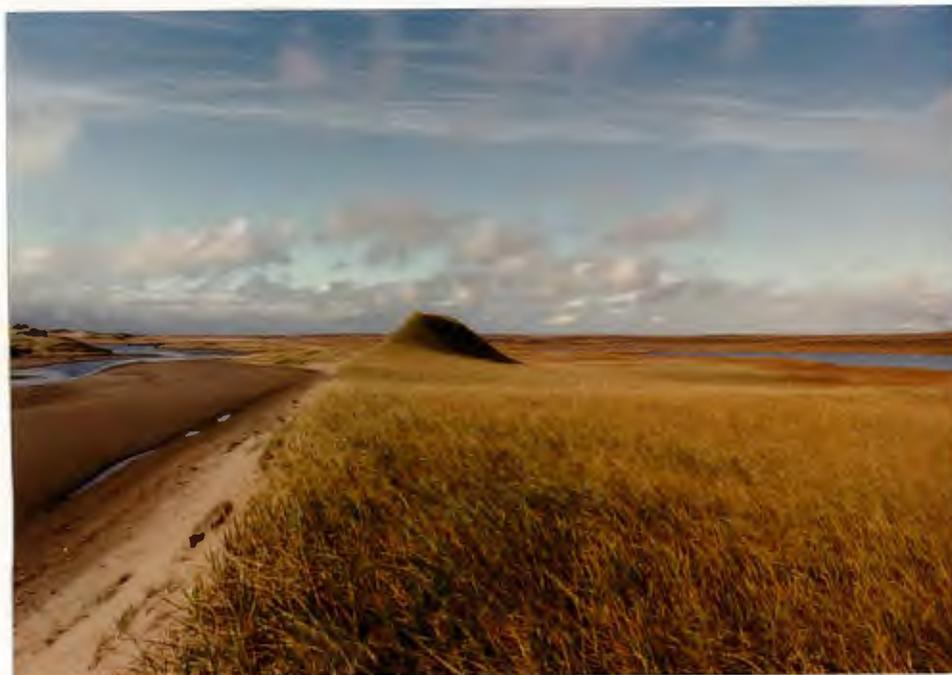
Fire Number and Cause	Acreage	Fire Date	Protection Category
7075 Lightning	0.5	06-08-91/ 06-08-91	Full
7076 Lightning	5.0	06-08-91 06-09-91	Modified
7077 Lightning	5.0	06-08-91/ 06-09-91	Modified
7020 Lightning	200.0	06-08-91/ 06-11-91	Modified
7021 Lightning	1300.0	06-08-91/ 06-11-91	Modified
7074 Lightning	450.0	06-08-91/ 06-14-91	Modified
7017 Lightning	10180.0	06-09-91/ 06-13-91	Modified
7023 Lightning	320.0	06-10-91/ 06-11-91	Modified
7087 Lightning	180.0	06-10-91/ 06-11-91	Modified

A total of 12,640.5 acres were burned. Fire number 7076 and 7077 were allowed to burn themselves out. The remaining fires were

actively suppressed.

12. Wilderness and Special Areas

Two wilderness areas occur on the refuge--the Andraefsky and Nunivak Wildernesses. The Andraefsky Wilderness is quite remote and receives little public use. Nunivak Wilderness is also remote and receives very little public use. Sport hunters seeking to fill their muskox permits and local Nunivak Island residents pursuing subsistence activities constitute virtually all the public use.



The Nunivak Wilderness includes a variety of coastal habitats, including sand dunes, estuaries, lake-dotted tundra, rocky headlands, and towering cliffs.

(C. McCaffery)

In 1989, the handout on the Andraefsky River was updated to help in responding to written requests for information on floating the river. There are presently no commercial fishing, wilderness, or float-boating guides operating on the river. The upper halves of both forks receive almost no float-boat use. The major reason for the low public use is limited aircraft access, due to a lack of suitable ridgetops or sand bars for landing aircraft on either fork.

The Andraefsky River and all its headwaters, and the East Fork, within the boundary of the Yukon Delta National Wildlife Refuge

was designated as a Wild River under the Alaska National Interest Lands Conservation Act. This designation covers approximately 265 river miles, 198 of which are within the Andreafsky Wilderness, 54 miles cross private lands, and 13 miles cross non-wilderness refuge lands. No other rivers on the refuge have been so designated.

The land within the former boundaries of the old Clarence Rhode National Wildlife Range and the Hazen Bay Migratory Waterfowl Refuge has been named the Clarence Rhode National Natural Landmark. This is the only such "Special Area" presently designated within the Yukon Delta National Wildlife Refuge. In 1987, the official plaque recognizing this status was mounted in the entrance to the refuge headquarters building in Bethel.

G. WILDLIFE

1. Wildlife Diversity

Migratory birds that utilize the Yukon-Kuskokwim Delta as a nesting place or molting area, or even as a spring or fall staging area, migrate through all flyways of North America. Of the 68 species of shorebirds recorded in Alaska, 52 occur in this region. Some 15 of these are Asiatic in origin and straggle to Alaska in small numbers. Migratory shorebirds stage over littoral and supralittoral habitats of coastal areas on the refuge where total numbers may swell into the millions. Because of the great diversity and abundance of shorebirds using the refuge, much of the coastal strip, the Andreafsky Wilderness, and the coast of the Nunivak Wilderness were nominated by the refuge for inclusion in the Western Hemisphere Shorebird Reserve Network.



Mimicking a phalarope, this rock sandpiper staged with conspecifics in habitats nominated for inclusion in the Western Hemisphere Shorebird Reserve Network.

(C. McCaffery)

In addition to the shorebirds which use the delta for breeding and foraging, large numbers of seabirds and other water birds, including gulls, jaegers, cranes, and waterfowl use the area.

The refuge hosts approximately half of the continental population of black brant. Between 40,000 and 50,000 brant nest on the refuge. Additionally, at one time the number of cackling Canada geese numbered in the hundreds of thousands. Today there are approximately 104,500. The 1991 estimates for Pacific white-fronted geese and emperor geese are 236,500 and 71,000, respectively. Undoubtedly, these species have been a significant factor in the shaping of the coastal ecosystem.

Despite the sharp reduction in geese from historical levels, the refuge still supports large numbers of ducks. The 1991 breeding pair survey estimated over 1.1 million ducks on the refuge in early June. By late summer, adult duck numbers on the Yukon-Kuskokwim Delta increased to nearly 1.9 million. The principal species were northern pintail, green-winged teal, and greater scaup. Mallards, wigeon, northern shovelers, black scoters, and oldsquaw are also regularly reported in good numbers. Common eiders are fairly common in the vicinity of brant colonies, but

the population of the formerly abundant spectacled eider has declined precipitously over the last 20 years. From an average breeding population of about 100,000 birds in the early 1970's, the population has fallen to the 1991 estimate of 2,300 breeding pairs.

With the exception of approximately 20,000 humans, large mammals are not abundant on the refuge. Muskox are found on Nunivak and Nelson Islands. Over the past few years, muskox sightings on the mainland have increased, with sightings ranging from the coast, north to Mountain Village, and east to the refuge boundary. A resident herd of caribou occurs in the Kilbuck Mountains and this population has increased dramatically since hunting was closed in 1985. Current estimates suggest the herd may exceed 2,500 animals. A small, apparently declining, population of caribou also exists in the Nulato Hills. Extensive aerial surveys conducted in 1991 only found one small group of three caribou, and no evidence (in the form of tracks in the snow) of other animals.

Moose, grizzly bear, black bear, wolves, wolverine, marten, beaver, and many small mammals occur on the refuge. One curious observation over the past few years has been the range extensions of beaver. Fifteen years ago, beaver were not known to exist in the coastal areas. Today their numbers have increased substantially and are found in the coastal zone well beyond the tree line. Fox (red and arctic) populations remain high on the delta.

The Yukon Delta National Wildlife Refuge supports an abundance of both resident and anadromous fish populations that are vital to the region's economy and subsistence way of life. Five species of salmon (chinook, chum, pink, sockeye, and coho) migrate through the refuge and also utilize many refuge streams for spawning. Other common species are smelt, northern pike, blackfish, stickleback, sheefish, burbot, five species of whitefish, rainbow trout, arctic char, and grayling. The Nunivak Island waters include many marine species such as halibut, truecod, and herring. All told, 44 fish species are known to occur in the waters of the refuge.



Although rarely recognized, an astronomical assortment of marine invertebrates contribute to the refuge's biodiversity.

(C. McCaffery)

2. Endangered and/or Threatened Species

Four listed forms occur or could occur on the refuge. The arctic peregrine falcon occurs on the refuge and is listed as threatened. The American peregrine falcon is endangered and also occurs on the refuge. In previous years, peregrine falcons (subspecies unknown) have been reported in the Kilbuck Mountains, Askinuk Mountains, Nulato Hills, and near the village of Chevak. In 1990, the Alaska Department of Fish and Game located several active eyries just off the refuge on St. Michael and Stuart Islands.

The Eskimo curlew and the short-tailed albatross may once have

occurred on the refuge, but it is unlikely they still remain. However, recent sightings of Eskimo curlews during spring migration and on the tundra of Canada's Northwest Territories have raised hopes that the species may still occur in Alaska as well. As a result, the Endangered Species program provided the refuge with funds to search for Eskimo curlews in the vast, unexplored uplands adjacent to St. Michael. Historically, this was the only site in Alaska where Eskimo curlews were seen in good numbers on an annual basis. Unfortunately, persistent inclement weather prevented the three-person crew from reaching the site, which was only accessible via helicopter.

The Service received a petition for listing of Steller's and spectacled eiders under the provisions of the Endangered Species Act in 1990. The Steller's eider no longer occurs on the refuge as a breeding species. Spectacled eiders breeding numbers are dramatically reduced from highs of as many as 100,000 birds 20 years ago.



Listing of the spectacled eider under the Endangered Species Act could put the Yukon Delta National Wildlife Refuge in the national spotlight. (C. Harwood)

A notice of petition finding for these two species was prepared by Ecological Services, Anchorage Field Office. A final listing recommendation, if any, for these two species was not made in 1991, however.

3. Waterfowl

The refuge is responsible for inventorying and monitoring perhaps the largest waterfowl production area in the system. The Yukon-Kuskokwim Delta is the exclusive nesting area for cackling Canada geese, and primary nesting area for emperor geese, black brant, and Pacific flyway greater white-fronted geese. While the populations of two other Canada goose subspecies (lesser and Taverner's) are apparently healthy, the above four species declined dramatically from the mid-60's to the mid-80's. The factors responsible for these declines are many, complex, and not completely understood; but certainly include such things as sport and subsistence hunting, loss and degradation of winter habitat, and predation. The current status of these four populations is presented in Section D.5.

The refuge's duck brood survey entered the second year of the statewide survey and cooperative study with Kanuti National Wildlife Refuge to compare observations from a helicopter to those of a ground crew. In recent years, duck production surveys in Alaska have generally been conducted on sample plots by ground crews or from the air with helicopters. Discussions addressing the merits and limitations of each procedure were the impetus for the current effort to standardize the methodology. While limited evidence indicates that ground and air surveys of breeding pairs of waterfowl produce similar results, no published studies have compared the techniques for brood surveys. A three-year study is examining the relative effectiveness of helicopter versus ground counts for production surveys in interior (Kanuti National Wildlife Refuge) and tundra (Yukon Delta National Wildlife Refuge) habitats. A total of 28, 2.6-square-kilometer plots were surveyed by both techniques. Both surveys of a plot were conducted within 48 hours of each other. Ground surveys were conducted first for 14 plots. Ground observations were larger than aerial observations for broody hens (29 vs. 15) and overall average brood size (4.4 ducklings, n = 118 vs. 3.4 ducklings, n = 245). Ground observations were 94% of the aerial observations of nonbreeding adults (2,204), 48% of total broods (245), and 62% of total ducklings (838). Despite a larger overall average brood size provided by ground data, it appears that smaller broods were again missed by this survey since ground crews observed 91% of those broods with ≥ 5 ducklings observed from the air but only 33% of broods with ≤ 4 ducklings. All species were equally visible to ground and air crews, except gadwalls and black scoters which were more visible to ground crews.



Spectacled eider ducklings are easily recognized at all ages because of their conspicuous "spectacles". (C. Harwood)

In general, the degree of dissimilarity, which raised some concern in 1990, was reduced in 1991. On only one of 28 plots, compared to seven of 19 in 1990, was a brood or broody hen observed by one survey (in this case the aerial survey) with no broods observed by the other survey. In addition, a brood or broody hen of the same species was observed by both surveys on 20 plots. This occurred at least 50% of the time for pintails, greater scaup, spectacled eiders, common goldeneyes, and gadwalls. For only red-breasted mergansers did it never occur.

Unlike 1990, it did not appear that the aerial survey affected the presence or visibility of broods to the ground survey. Each survey was conducted first for an equal number of plots. When the aerial survey was conducted first, an average of 11 broods/plot were observed from the air and six broods/plot from the ground. In addition, the only plot on which more broods were seen by the ground crew (14) than from the air (11) occurred when the aerial survey was conducted first. When the ground survey was conducted first, averages per plot decreased for both surveys (seven broods from the air and three broods from the ground). Second year's results reinforced the expectations of the efficacy of a helicopter survey: geographically broad sampling, ability to survey a large number of plots, minimal personnel requirement, and moderate cost.

In conjunction with the state-wide duck brood survey in Region 7, the refuge surveyed 63, 2.6-square-kilometer plots by helicopter. This total includes the 28 that were surveyed as part of the helicopter/ground survey comparison. Wildlife Biologist McCaffery was the observer. The number of broods/plot averaged 8.5 (range = 0-42). A computer program developed by Migratory Bird Management, Juneau, yielded a refuge-wide estimate of 250,924 total duck broods, up 33% from 1990. Species with total brood estimates exceeding 10,000 included green-winged teal (107,250), greater scaup (32,840), northern pintail (39,877), American wigeon (19,899), and northern shoveler (19,704). Since most adult ducks were flightless during the brood survey period, we were also able to derive refuge-wide estimates for this subset of the population. Northern pintails were by far the most abundant duck, comprising 46% of the total duck population (845,865 of 1,856,867). This figure represents nearly 1/2 of the continent-wide spring population estimate for 1991. Clearly, the refuge is an important, and perhaps critical, summering area for a major fraction of North America's pintails.

In light of declining pintail numbers in North America, Alaska's relatively stable population has represented a steadily increasing proportion of the continental total. During the 1990 breeding pair survey, Yukon Delta National Wildlife Refuge contained more pintails than any other Alaskan stratum; approximately 19% of the continental and 31% of the Alaskan population. Little is known regarding pintail distribution, age structure, and productivity on the refuge or subsequent winter distribution and mortality in the Lower 48. Banding and color marking are important tools which provide baseline data and allow formation of a sound waterfowl management program.

Banding was conducted in 1991 as part of a five-year cooperative program within the Pacific Flyway. Rocket-netting and swim-in trapping occurred within marshy areas of Kgun Lake, which is located in the north-central part of the refuge. Rockets were fired four times capturing 31 pintails and eight green-winged teal.

A total of 1,508 pintails and one green-winged teal were captured during 1,066 trap-days in swim-in traps baited with whole kernel corn. Twenty-six traps were used in groups of two to four at 12 sites. Adult female (566) was the most frequent age and sex class captured followed by adult male (389), local female (298), and local male (285).

Simplified logistics and the acceptable age and sex composition achieved with bait trapping make it the method of choice for future efforts.

In late September, Steller's eiders were censused along the coastline of Cape Mendenhall on Nunivak Island. 2,500-3,000

eiders were located in this area, which comprises ~ten percent of the rocky headland habitat on Nunivak. If Steller's eiders occupy all of this habitat in comparable densities, Nunivak may be supporting upwards of 30,000 molting birds in the fall, a significant fraction of the estimated world population of $\leq 100,000$.

In conjunction with our Kisaralik River raptor study, we recorded the number of harlequin ducks and mergansers (both red-breasted and common) detected while repeatedly floating a 35 km segment of the upper river. Densities of both harlequin ducks and mergansers approached 0.5 females/km, respectively. Survey intensity (n=9) was adequate to statistically detect annual population changes of 30-40% with a 90% probability ($\alpha=0.05$).

After a one-year absence, the refuge again conducted an aerial and photographic survey of Wrangel Island snow geese during fall migration. Northern Prairie Wildlife Research Field Station in California attached satellite and conventional radio transmitters to birds on the breeding grounds. Six flights were conducted in previously documented use areas in the western portion of the refuge between early September and mid-October. Signals from 20 of 29 satellite transmitters and 25 of 60 conventional transmitters were received. Additionally, 17 flocks totalling nearly 12,000 birds were photographed to estimate production. Data analysis and report preparation will be completed by research personnel in Alaska and California.

4. Marsh and Water Birds

Sandhill cranes, loons, and grebes are widely distributed on the wetland areas of the refuge. Sandhill cranes are particularly abundant and constitute an important component of the delta ecosystem, including the subsistence harvest. Population estimates obtained during the 1991 helicopter duck brood survey included 2,346 common loons, 9,852 red-throated loons, 67,087 Pacific loons, 44,569 red-necked grebes, and 38,001 sandhill cranes. Horned grebes also summer on the refuge, but none were detected during the helicopter brood survey.

5. Shorebirds, Gulls, Terns, and Allied Species

Shore and water birds visiting the refuge each year number in the millions. Many come to breed on the tundra, shorelines, and mountaintops of the refuge.



Black turnstones are locally abundant near
black brant colonies. (C. Harwood)



The black belly of the Dunlin is only
slightly lower than the black chest of the
rock sandpiper, a feature that might cause
some identification problems. (C. Harwood)

By August, shorebirds flock to coastal and riparian mudflats to build lipid reserves for long migrations, while terns have already departed south. Highest densities of shorebirds occur along the coast at Tern Mountain and Angyoyaravak Bay. Gulls are common along the entire refuge coastline from spring through autumn.

Cliffs on the southwest side of Nunivak Island provide nesting sites for an estimated 500,000 seabirds, primarily common murres and black-legged kittiwake, but also including pelagic and red-faced cormorants, glaucous-winged and glaucous-winged X glaucous hybrid gulls, horned and tufted puffins, parakeet and crested auklets, and pigeon guillemots.

In 1991, double-crested cormorants were discovered nesting on Nunivak Island for the first time. At least three active nests were located on Kaksajookalik Island off the southwest coast of Cape Mendenhall. This represents the northernmost breeding site for this species in the Bering Sea

Several unusual species were detected during field work on Nunivak Island in August and September, including terek sandpiper, gray-tailed tattler, slaty-backed gull, and red-legged kittiwake.



Rare elsewhere in North America, juvenile sharp-tailed sandpipers are regular fall migrants along the refuge coast.

(C. McCaffery)

6. Raptors

Seventeen species of raptors have been recorded on the refuge, including three natural resource species: golden eagles, bald eagles and peregrine falcons. The Kisaralik River is among the most important area on the refuge for nesting raptors. In anticipation of a completed Kisaralik River management plan, the refuge intensified its raptor monitoring effort in this region. Two helicopter surveys in early June and July, respectively, revealed an extremely high density of cliff-nesting raptors in the Kisaralik watershed. Along 74 km of river, we located 11 golden eagle nests (plus a non-breeding pair), six gyrfalcon nests, and three rough-legged hawk nests.

The density of occupied golden eagle territories (12 pairs/74 km=0.16 pairs/km) may represent one of the highest densities in western North America. The mean nearest nest distance was just 3.2 km. Productivity was also quite high, with an average of 1.83 young/successful nest. Given the assumption that subarctic environments are "less productive" than temperate environments, the density and productivity of golden eagles in the Kisaralik watershed are remarkable.

A four-person crew was stationed at Icebox Lake to assess the impact of recreational rafting on cliff-nesting raptors. Between June 22 to July 1, the crew monitored several nests in the vicinity of Icebox Lake to ascertain the rate of nest visitation by the tending adults. From July 2-20, a two-person crew floated down the Kisaralik River from Kisaralik Lake to Icebox Lake on nine occasions. The response of nesting raptors to their passage was documented, either by the float crew (one nest) or by a two-person crew monitoring each nest from the shore (three nests). On days between trial floats, the two-person shore crew continued to monitor the nests first observed during late June.

During our float trials, adult raptors were present at the nest 75% of the time. Among these, the raptors were disturbed (i.e., noticeably reacted to the passage of our raft crew) 81% of the time. Calling occurred during all documented disturbances, and flushing from the nesting cliff occurred in 77% of all disturbances. The impacts of these disturbances could not be ascertained, but during all trials, the raft merely floated past, without stopping, slowing, or in any way approaching the raptor nest. The responses of the nesting birds are therefore interpreted as minimum responses to the presence of recreational rafters.

In contrast to the rapid, transient disturbance caused by the float crew, a monitored golden eagle nest was exposed to disturbance by bona fide recreationalists. On three different dates, rafting parties camped within 50, 100, and 500 m of the nest. The party camping within 50 m of the nest stayed for two

nights, being present for a total of 36-40 hours. On their one full day at the campsite, no adult eagle went to the nest during our 15 hours of observation.

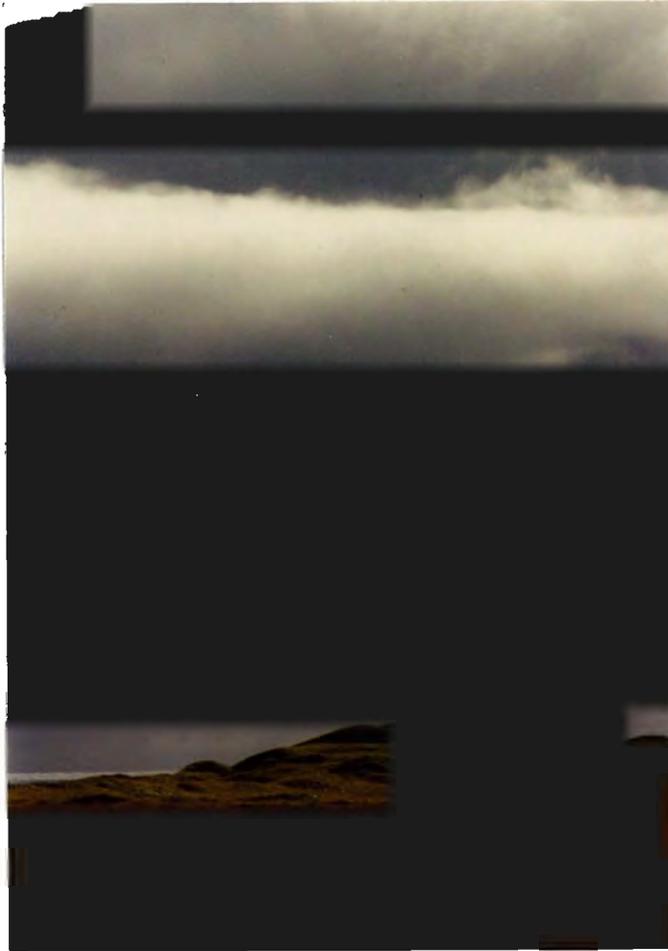
This golden eagle nest was monitored on 16 dates between June 23 and July 19. Following the day on which the observation site was established, the nest was monitored for \geq four hours on nine dates without disturbance by recreational rafters, and on five dates with disturbance by recreational rafters. On days without disturbance, adult nest visitation rates averaged 0.54 visits/hour. On days with disturbance, the visitation rate fell to 0.16 visits/hour. This three-fold decline in visitation rates was highly significant (Mann-Whitney U = 4.0, P = 0.0134).

The Andreafsky River watershed also supports high densities of nesting raptors. On May 29, a three-person crew conducted a helicopter inventory of cliff-nesting raptors along the upper East Fork of the Andreafsky. We located five gyrfalcon eyries, two rough-legged hawk eyries, a single golden eagle nest, and a tree-nesting pair of ravens.

The concentration of five active gyrfalcon eyries along only 34 km of river is extraordinary. The highest density of nesting gyrfalcons along any river during a 1977 survey of 30 rivers in western and northern Alaska was 0.056 nests/km. Among the five rivers with the highest gyrfalcon numbers, the density averaged 0.045 nests/km. By contrast, our findings in 1991 yielded a density of 0.143 nests/km, which may represent the highest density ever recorded along Alaskan rivers.

7. Other Migratory Birds

During the course of field work on Nunivak Island between August 21 and October 1, a number of unusual landbirds were observed. Vagrants appeared on the island from both east and west, including an unidentified Asian cuckoo, northern flicker, eye-browed thrush, golden-crowned kinglet, white wagtails, red-throated pipits, magnolia warbler, palm warblers, and bramblings. Fox sparrows and dark-eyed juncos from southcentral and/or southeastern Alaska also appeared on Nunivak, in addition to individuals from the locally breeding races of these species. Finally, a Eurasian bullfinch was spotted at refuge headquarters in Bethel on October 26.



A series of fall storms brought several
vagrant species to the dunes and marshes of
Nunivak Island. (C. McCaffery)

8. Game Animals

a. Muskox

Muskox are probably the refuge's most important game mammal in terms of public use. Muskox were introduced to Nunivak Island from Greenland in 1935. In 1967-68, muskox were transplanted to Nelson Island where the herd reached a high of 287 animals by 1986. Nelson Island muskox have radiated onto the delta mainland for the past 15 years, crossing frozen channels between the island and the mainland. However, the heaviest snowfall since 1976 led to a large emigration of muskox from Nelson Island in the spring of 1988. The Alaska Department of Fish and Game and the Service are attempting to promote the growth and expansion of

the mainland muskox population on the refuge and is working with local villages to obtain their support.

The annual Nunivak Island muskox census was conducted in March and included participants from the Service, Bering Sea Reindeer Products, and Alaska Department of Fish and Game. The ground count was conducted under poor to moderately good weather conditions which resulted in a total of 439 muskox being observed. There were 213 bulls, 138 cows, 64 yearlings, and 24 unclassified. In addition to the traditional ground survey from snow machines, an aerial census was conducted in April to verify ground counts and to estimate reindeer numbers. A total of 456 muskox were seen from the air. Unfortunately, this does not represent a complete count because inclement weather precluded flying the western 1/3 of the island; a high density use area by muskox. Census results seem to indicate a decrease in muskox numbers compared to the 1990 count, however. This may be in response to an increased harvest initiated by the Alaska Department of Fish and Game in 1989-90. The target population level for muskox on Nunivak Island is 500 animals, pre-calving. A proposed transplant to the Soviet Union failed to materialize, undoubtedly a victim to recent widespread changes in the social and political environments.

b. Moose

Prior to 1950, moose were rarely seen on the Yukon-Kuskokwim Delta. During the following years, their numbers increased and moose presently inhabit the eastern boundary of the refuge and the riparian forests of the Yukon and Kuskokwim Rivers. Moose are undoubtedly more common now than 40 years ago, but their densities are still very low in relation to available habitat. The greatest numbers occur along the Yukon River between Ohogamiut and Holy Cross, particularly during winter. During the summer, moose are more widespread and are occasionally found as far west as the coast. Some moose along the lower Yukon River appear to be highly migratory, as recently evidenced by the 150-mile movement of a radio-collared animal.

Overharvest (legal and illegal) of moose appears to be the primary factor limiting herd growth and range expansion. The lower Yukon River was recently closed to moose hunting for five years. This action appears to be allowing this population to increase. Upriver hunting continues to be heavy, however, and will undoubtedly slow growth.

c. Caribou

Historically, caribou occurred on the Yukon-Kuskokwim Delta in large numbers and were the most abundant ungulate in the area. Numbers peaked in the 1860's and during this period, caribou ranged over much of the refuge, even crossing the ice pack to

Nunivak Island. Caribou subsequently disappeared from the region with the exception of small, remnant herds in the Kilbuck and Andraefsky Mountains. Members of the western Arctic herd occasionally migrate south as far as the upper Andraefsky River, but remain only a short time. Thousands of caribou from the Mulchatna herd have been appearing along the Aniak River drainage in late winter since 1988. Similar to visitors from the western Arctic herd, these animals only remain for a relatively short period of time.

We have a better understanding of the population status and distribution of the Kilbuck herd after five years of study. Before 1985, Kilbuck caribou were considered part of the expanding Mulchatna herd; however, we have documented calving in the Kisaralik Lake area for the past six years. Radio-collared cows have calved in the Kilbuck study area since their capture. And all collared caribou have remained in the study area. Movements of radio-collared caribou over a five-year period has proven that the herd is expanding its range. Seasonal distribution between bulls and cows is well documented.

The Kilbuck caribou herd has increased in size over the last five years; concurrent with closing the hunting season. Our study indicates this is a distinct, resident herd. A complete aerial census in November 1991 located 2,584 animals. During early winter (October-December), Kilbuck caribou concentrate along the lower flats and foothills of the Kilbuck and western and central Kuskokwim Mountains. In late winter (January-March), they move to high, wind-blown slopes of the western Kuskokwim Mountains. Peak calving occurs mid-May on the high, rugged mountain tops and ridges of the western Kuskokwim Mountains. The majority of caribou spend the summer (June-August) in the western Kuskokwim Mountains; overlapping little with their winter range. As rut approaches, Kilbuck caribou return to their winter range.

The status and distribution of the Andraefsky caribou herd is poorly understood. Like the Kilbuck caribou herd, we believe this is a distinct, resident population and that excess hunting pressure has kept this herd at very low levels. Due to the remoteness of their range, little work on this herd has been done. Available information comes from an occasional overflight across the area or personal communication with local guides and residents. In previous years, a few cursory surveys provided some information on distribution and calving, but it has been far from adequate. Extensive aerial surveys conducted in 1991 suggest that a resident population of caribou may no longer exist in the Andraefsky Mountains.

9. Marine Mammals

Marine mammals of the Bering Sea comprise an interesting subset of refuge wildlife and a vital subsistence resource for coastal

villages. Walrus, spotted seals, ringed seals, and bearded seals are hunted on the ice in spring, and some seal hunting continues during summer in bays and estuaries. Other marine mammals include beluga, gray, killer, and minke whales.



"Thank you, storm tides!" This walrus skeleton/skull was found well inland and fairly close to camp. (C. Harwood)

Polar bears rarely range as far south as the refuge, but were reported in the spring of 1984 near the Tutakoke field camp and Hooper Bay. State and Federal regulations permit the taking of polar bears by Alaska Natives. Ecological Services, Anchorage, manages the marine mammal program. The refuge has no on-going or future marine mammal studies planned.

10. Other Resident Wildlife

Wolves have been sighted more frequently in the Kilbuck

Mountains, probably in response to increasing caribou numbers. Several wolves were found during the Kilbuck Caribou Census on two caribou kills. Four wolves were located in the upper Quicksilver Creek and a lone wolf was found on a caribou kill near Clear Creek. Although wolf and ungulate numbers are growing, densities remain low. Fur sealing certificates document an increase in wolf harvest over the last three years.



Grizzly bear grafitti! Literal translation
- "Brown bears rule!" (M. Jensen)

Beaver distribution continues to expand on the delta. There is concern by Natives that beaver dams are hindering fish and boat travel up streams. Red fox numbers continue to be high around communities, with some incidence of rabies being reported.

Our only attempt to monitor resident birds occurs on the annual Bethel Christmas Bird Count. Wildlife Biologist McCaffery coordinated the count which was held on December 17. Eight observers, including one feeder-watcher, participated. Light winds and mild temperatures (10°F) made for the most pleasant count in recent years. A total of 576 individuals of 13 species were detected. Highlights included two downy woodpeckers, two black-billed magpies, three northern shrikes, and one McKay's bunting.



Male willow ptarmigan molt head and neck plumage in the spring, but the body plumage is molted some months later.

(C. Harwood)

11. Fisheries Resources

Refuge waters are very important for fishery resources of western Alaska, supporting over 44 species of fish. Refuge streams and rivers also contribute significantly to the salmon stocks in Kuskokwim Bay and Norton Sound supporting anadromous runs of five species of Pacific salmon: chinook, chum, coho, sockeye, and pink. Other important species include herring, Pacific cod, whitefish, Alaska blackfish, burbot, northern pike, and halibut.



Still sleek and supple, spawning salmon
sometimes sail skyward. (C. McCaffery)

a. Subsistence Fishing

The aboriginal population of the Yukon-Kuskokwim Delta is among the largest of any similar native-occupied region in Alaska. The extensive fishery resources of the area was most likely a key factor in this population development. Chum, chinook, and coho salmon, respectively, are the most heavily used salmon species, while several whitefish species, northern pike, sheefish, Alaska blackfish, burbot, and Pacific herring are also harvested. A variety of marine species, such as halibut, are used around Nunivak and Nelson Islands. Historically, a large proportion of subsistence-caught fish were used to feed sled dogs and for trade. In recent years, dependence on sled dogs has decreased due to the increased use of snowmobiles and airplanes. A reduced subsistence harvest of some species in various areas reflects this phenomenon. Fish are of major importance in the subsistence economy and account for 30-60% or more of the yearly food supply in most Yukon Delta villages. In the future, subsistence harvest of fish is expected to grow annually with the increase in village populations.

b. Commercial Fishing

Commercial fisheries on the refuge are concentrated in the lower Yukon River, the lower Kuskokwim River, along the western

coastline, and Nunivak Island. The commercial harvest of salmon began in the early 1900's and has grown dramatically from 1960 to the present (Figure 6). The 1988 Kuskokwim River harvest of chum salmon was approximately 1.4 million. Coho salmon harvests have grown steadily to nearly 1/2 million. Some of these harvests have continued to grow without a comparable gain in the knowledge of timely escapement data on refuge rivers. In recent years it has become evident that the overall Kuskokwim River drainage may be meeting the escapement goal for chum and chinook, however, chinook salmon in the lower rivers on the refuge have not responded to the management efforts and have fallen behind the escapement goals set for the rivers (Figure 7). Improved efficiency of the commercial fishing fleet to harvest fish in a mixed stock inriver fishery may place refuge stocks in jeopardy of being overfished during years of low returns. Coupled with the commercial harvest is the unrestricted subsistence harvest targeting salmon during the summer months. As the population of subsistence users increases on the delta this harvest is expected to increase.

Pacific herring are harvested in three commercial districts along the refuge coast. These districts are the Cape Avinof, Nelson and Nunivak Islands. The impacts of these harvests on sea birds is not understood. The harvest of salmon from the Yukon and Kuskokwim rivers through the commercial fisheries is of economic and nutritional importance to local residents on the Delta. The estimated dollar value of the Kuskokwim (1980-87) and lower Yukon area (1978-1987) commercial salmon fisheries averaged \$5.1 and \$6.7 million dollars, respectively. This is a direct benefit to the local population and provides some of the only income to many families. Average income per commercial permit holder in the lower Kuskokwim River during the same period was only \$6,442. Because of the low incomes and the lack of other types of employment the importance of perpetuating the runs become very clear. It is also very hard to effect conservation measures when the economy and the finances of people with only one income are impacted.

c. Sportfishing

Sportfishing pressure is light on the refuge, but the tributaries feeding the Kuskokwim and Yukon rivers provide anglers with an excellent variety of trophy fish. Salmon, rainbow trout, Dolly Varden, Arctic grayling, northern pike and sheefish make up the menu of fish accessible to anglers on many of the refuge tributaries. The favorite rivers for sportfishermen include the Aniak, Eek, Kwethluk, Kasigluk, Kisaralik and Andreafsky. Because most of the river systems pass through uninhabited or remote areas, transportation becomes a major influence on the ability of sport fishermen to reach the fishing grounds. Most local residents are involved in the commercial or subsistence fishery and do not feel the need to supplement their catches by

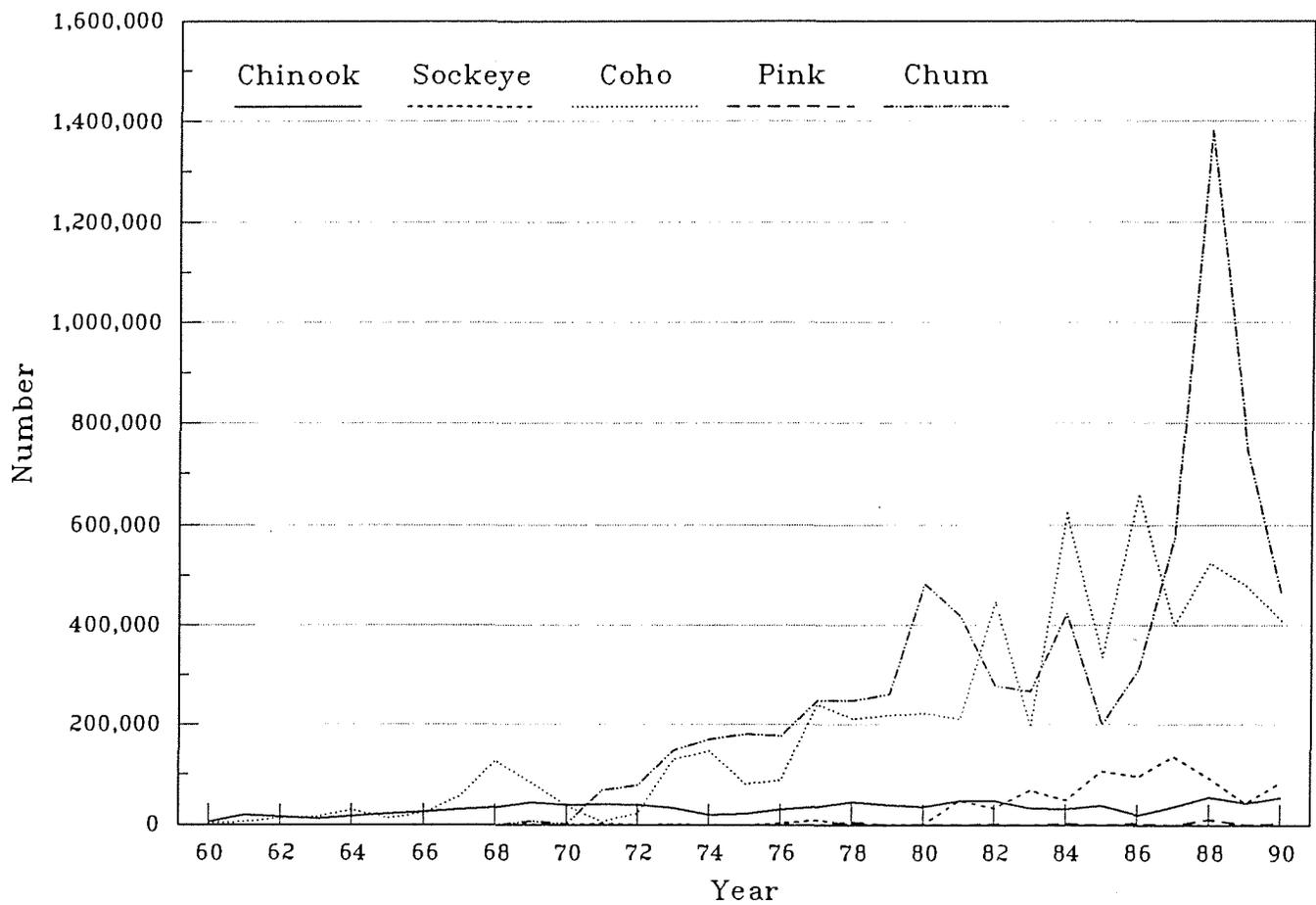


FIGURE 6. —Commercial harvest trend for five species of salmon Oncorhynchus spp. in the Kuskokwim River, Alaska, 1960-1990.

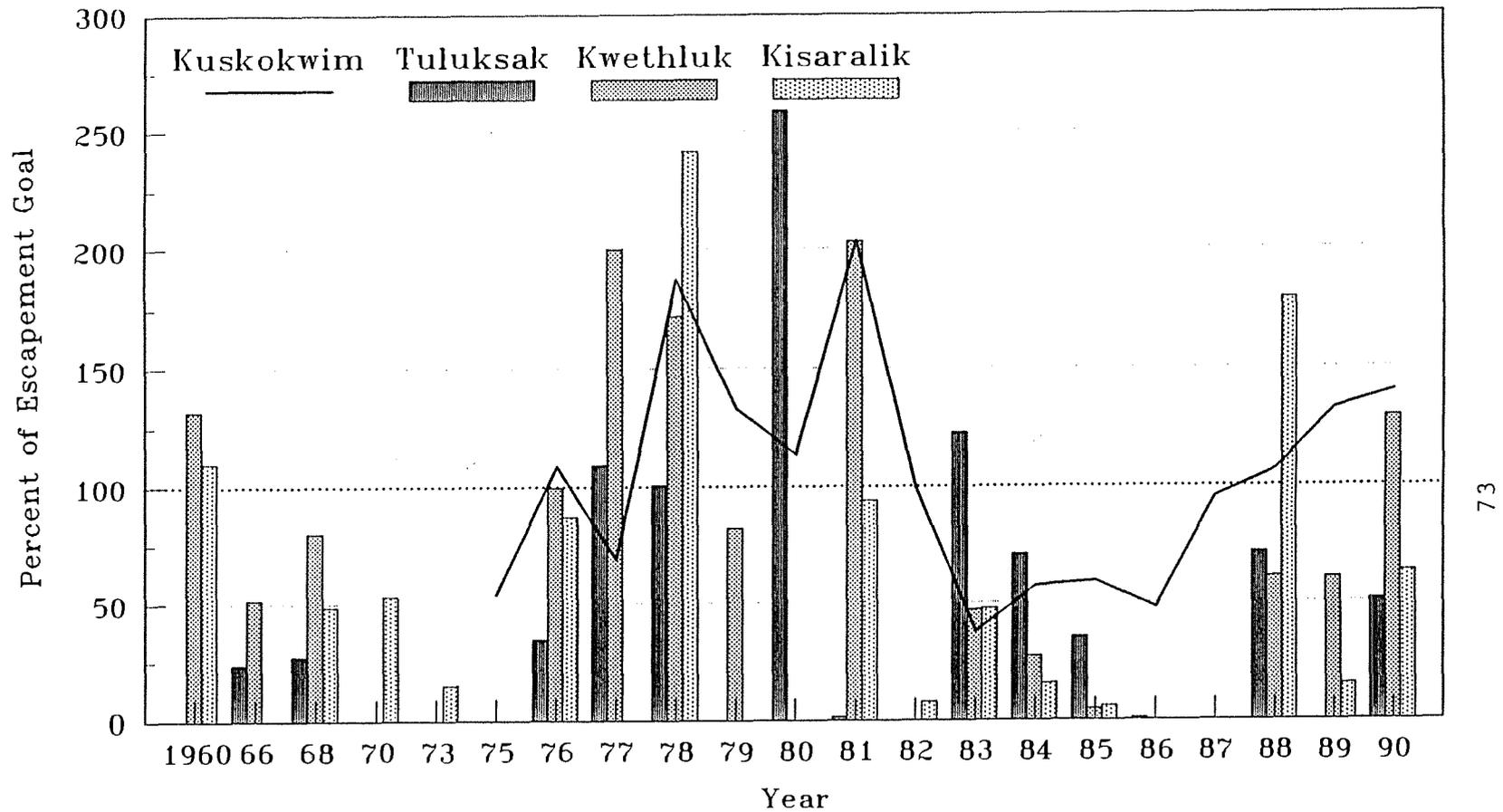


FIGURE 7.—Aerial escapement indexes for chinook salmon as measured by percent of escapement goal for the Kuskokwim River drainage (dark line) and Kuskokwim River tributaries (bars) on the Yukon Delta National Wildlife Refuge, Alaska, 1960-1990. Aerial index counts do not represent total escapement, but reflect annual spawner abundance trends when made using standard survey methods under acceptable conditions (data from Alaska Department of Fish and Game Annual Report, Kuskokwim Area, 1990).

sportfishing. However, there is evidence that interest in sport fishing is growing. The village of Akiak is the first lower Kuskokwim River village to enter into the sport fish business. They established a camp on corporation land on the Kasigluk River in 1991. As the sportfishing industry grows the impacts of this use, in conjunction with the commercial and subsistence fisheries, will have to be closely monitored to insure refuge fish stocks are maintained.

14. Scientific Collections

a. Trapping

Trapping for foxes was conducted from April 29 through August 5 in the Kokechik Bay study area. A total of ten animals, nine arctic fox (*Alopex lagopus*) and one red fox (*Vulpes vulpes*), were captured, four of which were fitted with radio-collars and eartags and two just eartagged, and released in the study area. Seven of the arctic fox were aparous females and two were males. Two of the females were littermates from the den of the single mated pair found (they whelped at least three pups). Neither adult was captured or marked.

Small mammal trapping was conducted in conjunction with the fox and goose ecology study at Kokechik Bay. A total of four animals (0.3 animals/100 trapnights) were trapped; three tundra voles (*Microtus oeconomus*) and one meadow jumping mouse (*Zapus hudsonicus*). The numbers indicate that mouse populations are in a continuation of a low density period from a high in 1988 (7.6 animals/100 trapnights).

b. Collection of Northern Pintails to Determine Genetic Differences Between Populations

Barry Grand (Alaska Fish and Wildlife Research Center) received a permit to collect northern pintails and pintail eggs in the vicinity of the Hock Slough field camp. The purpose of the collection was to assess genetic differences between individuals in this breeding population and from other breeding locations in North America. An additional 50 adult female breeders were captured and outfitted with back-mounted radio transmitters. These animals were intensively monitored to determine brood survival and duckling mortality factors.

c. Kuskokwim River Drainage Chinook Salmon Genetics Survey

Concern over the status of Kuskokwim River chinook salmon runs on the refuge prompted a sampling effort to begin in 1990. The project goal is to sample the various runs of chinook salmon in the Kuskokwim River drainage to determine if the populations can be separated using electrophoresis techniques. During July and August the collection of juvenile chinook salmon from the

Kuskokwim River drainage was completed. Two rivers within and six off the refuge were sampled. This sampling finished the collection process started in 1990. Samples will be run in the spring of 1992 and an analysis completed during the summer and fall of 1992. If fish can be separated by drainage then the commercial fishery will be sampled to determine if there is a run-timing difference that can separate the refuge stocks from other upriver stocks.

15. Animal Control

A total of 14 and three arctic foxes were removed from high density goose nesting areas at Old Chevak and Tutakoke, respectively. The objective of the trapping program was to limit egg depredation by foxes and to improve goose nesting success (in particular black brant and cackling Canada geese).

16. Marking and Banding

a. High Seas Tagging Project

A coho salmon with a high seas tag was captured at the Tuluksak River weir. The fish had been tagged by a research vessel in the Gulf of Alaska between Kodiak Island and Ketchikan, Alaska. The tag was returned to the High Seas Project, Fisheries Research Institute, University of Washington, WH-10 Seattle, WA 98195.

b. Fox/Goose Ecology Study

As part of the fox and goose ecology study at Kokechik Bay, four arctic foxes were fitted with radio-collars and released. The movement patterns of the three females were monitored over the summer field season and home ranges determined. The territory sizes ranged from 4.7 to 11.2 km². All four foxes were still in the area as of December 18, 1991 (determined by an aerial telemetry flight). Each fox was located in the general vicinity of its summer territory.

c. Waterfowl Banding

The annual goose banding/collaring project was conducted out of the Kanagyak field station from July 18-21, 1991. Refuge personnel involved included John Morgart, Leo Moses, Jack Paniyak, Jimmy Slats, and Mike Wege. Bill Butler, a pilot/biologist with the Anchorage field station of Migratory Bird Management also participated. A total of 313 molting, adult cackling Canada geese were captured in an area approximately ten km northwest of the village of Chevak. All were leg-banded and 297 were neck-collared. In addition, three tundra swans were leg-banded and neck-collared. Swans marked by the refuge and the Alaska Fish and Wildlife Research Center are being used to determine spring and summer migration paths and wintering ground

use.

Craig Ely (Alaska Fish and Wildlife Research Center) and his crew banded 337 cackling Canada geese near Old Chevak from May 12 to August 1, 1991. A total of 296 of these were neck-collared. In addition, 20 cacklers were outfitted with solar-powered radio transmitters on their neck collars. Marked cackling Canada geese will be studied to determine migration patterns, annual and seasonal mortality, individual productivity, and use of staging areas. In addition, neck-collared cacklers are used to derive the wintering ground population count. Radio-marked birds will be used to determine brood survival on the breeding grounds in 1992. Ely's group also banded and neck-collared four greater white-fronted geese and nine tundra swans. The white-fronted geese will be used in an ongoing study on wintering ground use.

Barry Grand (Alaska Fish and Wildlife Research Center) and his crew banded 67 northern pintails in the vicinity of Hock Slough on the Kashunuk River. Fifty of these (adult females that nested on the study area) were outfitted with radio transmitters mounted on a backpack harness. These birds were used in a study to determine pintail brood survival and mortality factors.

Jim Sedinger's crew (University of Alaska, Fairbanks) assisted by the refuge, banded 2,495 and 950 black brant at the Tutakoke and Kokechik colonies, respectively. All brant were secondarily marked with colored tarsi bands. These birds are for a study to determine the relationship between colonial nesting and reproductive success, to investigate dispersal from colonies, and to estimate age-specific survival and fecundity.

The refuge conducted the second year of a five-year cooperative program to band northern pintails within the Pacific Flyway. Refuge staff involved included S. Kendall, R. Baccus, T. Fitka, C. Harwood, T. Moran, and P. Paniyak. Pintails were trapped along the northwest shoreline of Kgun Lake from July 16 to August 25. Waterfowl concentration areas were baited with whole corn and birds were captured using swim-in traps and rocket nets. The rocket-net was not effective, however, because few birds (10-15) were ever in position to be caught at any one time, and netted birds became wet and muddy and were unable to fly upon release. A total of 1,605 northern pintails were banded by the refuge staff in 1991. In addition, nine non-target green-winged teal were captured and banded as well.

A summary of all waterfowl banded in 1991 on the Yukon Delta National Wildlife Refuge is included in Table 6.

Table 6. Total numbers, age and sex of all waterfowl banded on the Yukon Delta NWR, 1991.

	AHY-M*	AHY-F	HY-M	HY-F	Unk.	Total
Cackling Canada geese	175	232	138	105	0	650
Greater white-fronted geese	1	3	0	0	0	4
Black brant	720	775	983	948	19	3,445
Tundra swan	5	8	3	1	0	17
Northern pintail	389	617	292	307	0	1,605
Green-winged teal	3	4	0	0	2	9

*AHY = after hatch year; HY = hatch year; M = male; F = female.

H. PUBLIC USE

1. General

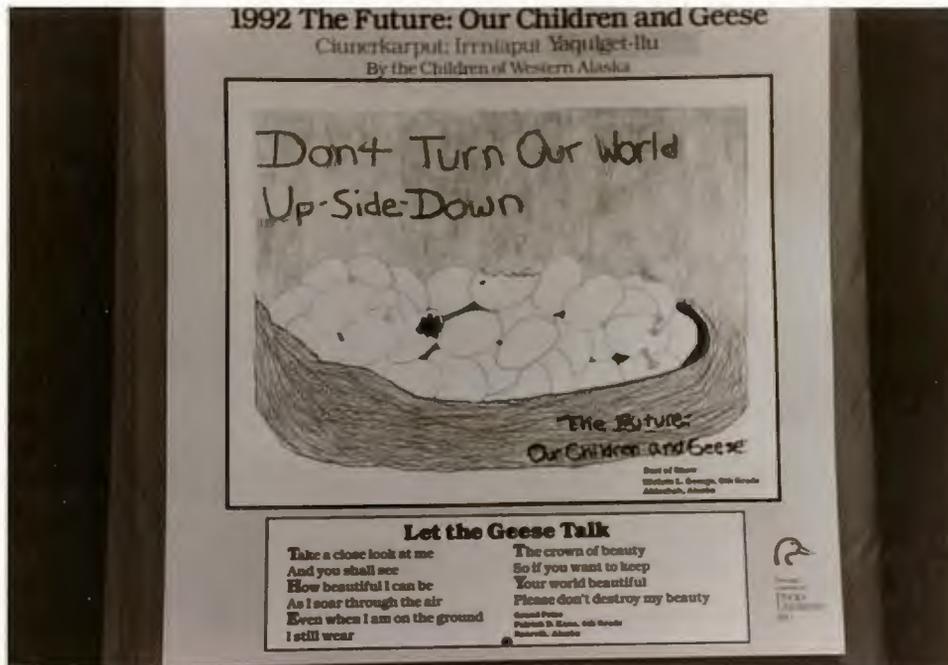
More than 90% of refuge public use involves subsistence activities (hunting, fishing, trapping, and the collection of berries). Other public use activities include sport hunting and fishing, river floating, and wildlife viewing.

The refuge is isolated from the common tourist travel routes in Alaska. Once people arrive in Bethel, they still must travel great distances to get to the mountains, coast, or river systems other than the Kuskokwim. Travel to the more scenic areas of the refuge is expensive and keeps the number of non-local visits small.



Bethel, Alaska, population approximately 4500, lies on the north bank of the lower Kuskokwim River, 397 miles southwest of Anchorage. It is accessible only by air during the winter months. (V. Davis)

The major public relations activity in 1991 continued to be the information and education effort associated with the four arctic nesting geese species. The goose calendar contest assisted in this effort. Two grand prizes were awarded this year for the best poster and best literary entry. The National Audubon Society contributed all winning prizes. Ducks Unlimited, Inc. contributed to publication of the calendar. In November, the 1992 Goose Calendars arrived at the Refuge but dissemination was delayed until a grammatical error could be amended.



The 1992 Yukon-Kuskokwim Delta Goose
Calendar. (V. Davis)

2. Outdoor Classrooms-Students

We participated in career day activities at several schools. These usually included junior and senior high students in one-day sessions. This year, we made presentations on U.S. Fish and Wildlife Service careers to the students of the Lower Kuskokwim School District.

3. Outdoor Classrooms-Teachers

One environmental education workshop was conducted for teachers during 1991. Approximately 11 teachers from various Lower Kuskokwim schools attended this workshop which was held in Bethel. During the month of September, two teachers from the Yukon-Kuskokwim Delta region and Outdoor Recreation Planner Davis attended an environmental education workshop conducted by Resource Support in Anchorage. The two attending teachers agreed to become environmental education volunteers for the Yukon Delta National Wildlife Refuge in order to provide additional workshops within their represented areas.



Beverly Farfan conducting the "Wetlands and Wildlife" workshop. (V. Davis)



Refuge Information Technician Michael Jimmy discusses his role in school programs. (V. Davis)



Workshop participants examining relief map of the Yukon-Kuskokwim Delta, located in the refuge visitor center. (V. Davis)

A survey/questionnaire was created and distributed to each Delta school during 1991. The purpose of the survey/questionnaire was to determine what the schools environmental educational needs were to assist Davis in meeting those specific needs. A lot of good information was collected from the schools. It was discovered that the Yukon-Kuskokwim Delta region has 55 schools, 5,903 students and approximately 515 teachers within seven school districts. The Yukon Delta National Wildlife Refuge contains the highest number of schools within the 16 Alaska Refuges.

In August, Davis and representatives from Alaska Department of Fish & Game, Audubon Society, Association of Village Council Presidents, and University of Alaska formalized a committee to organize and create a science camp for students of the Yukon Delta region. The hope is to have the camp operating by June 1992.

6. Interpretive Exhibits/Demonstrations

The refuge visitor center was completed in July of 1990 and by the end of that year approximately 252 people had visited the center. By the end of 1991 approximately 544 visitors representing the countries of Russia, Japan, Germany, Canada, England, Luxembourg, and Mexico had graced our center. Guests

from the United States were from the following states: southeast, Florida; northeast, New York; southwest, California; northwest, Washington, and a whole host of other states in between. Numerous refuge visitors were from Alaska.

Unfortunately, six months after the completion of the visitor center, the displays began exhibiting problems created by the drier Alaskan climate. Seams began to expand, pictures peeled, and at several 90-degree corners, cracks began to form and run. Contact was made with the contractor, Good Displays, to try and solve the problem. This resulted in the company representatives visiting the center in November. The lesson learned from all of this is to ensure corners are rounded, a non-expanding material such as acrylic is used to mount the exhibits on, and an acrylic sheet is placed over photos to secure them. This will cost the Refuge approximately \$2,500.



The arrow denotes the crack which began at the corner of the display screen.

(V. Davis)

In spite of these minor problems, the visitor center still receives favorable comments from our visitors. Numerous village schools visited the center throughout the 1990-91 school year. The "Teach About Geese" and "Alaska Wildlife Week" curriculum was used during the schools' visits along with short nature walks around the refuge headquarters. Biologist McCaffery assisted with the walks and pointed out various birds. This seemed to be the highlight for the kids as well as the teachers.

7. Other Interpretive Programs

Several events took place during 1991. In April, in conjunction with Earth Day Celebration, a series of weekend lectures and walks were given. Wildlife Biologist McCaffery, Refuge Information Technician Christine McCaffery and Outdoor Recreation Planner Davis provided background information in support of Earth Day importance, lectures about bird migrations, and equipment such as binoculars and spotting scopes to view the early avian arrivals. Even though the temperatures were quite frigid, turnout was excellent. Ages of the groups ranged from seven to 67 years old.



Wildlife Biologist McCaffery welcomes everyone to the Earth Day celebration.
(V. Davis)

On another occasion, during the summer, one of the local non-profit organizations, Pacifica Institute, in conjunction with the Association of Village Council Presidents, created a summer

training program for interested native high school students. The program was designed to introduce and improve upon work skills, learning skills and various work experiences and opportunities. Both Davis and Wildlife Biologist McCaffery assisted with the program. McCaffery provided "hands-on" experience in the field environment and Davis provided on-the-job training in the office environment. In addition to these two individuals, Biologist/Pilot Ernst demonstrated how he tracks large mammals, such as moose and caribou, and the equipment which assists him in locating such animals. The young adults thoroughly enjoyed this demonstration. Other Refuge personnel discussed job opportunities with the Fish and Wildlife Service.

Several videos were made available to the public during this year. One 28-minute tape called "Arctic Geese--A Shared Resource" was dedicated to the management of the four troubled geese species. The local public television station, KYUK, aired the tape numerous times. The tapes provided excellent film footage of the refuge and of the geese.

8. Hunting

The refuge is open to sport and subsistence hunting, subject to state and federal regulations. However, only limited information is available on hunter effort and harvest. Residents of villages within and adjacent to the refuge rely on resident and migratory wildlife for food. Two hunting guides and an outfitter are available to assist muskox hunters on Nunivak Island. Each year, a few unguided, non-local hunters travel to the refuge to hunt bear, moose, and other game.

Alaska Department of Fish & Game Wildlife Conservation Division Personnel Randy Kacyon and Brad Palach manned the moose check station at the junction of Paimiut Slough and 12-mile Slough for 22 days during September. None of the refuge staff assisted this year. A noticeable improvement in compliance with moose hunting regulations was reported and was attributed to the presence of the Fish and Wildlife Protection Officers. The Officers were active for the first time, interviewing hunters, issuing warnings and citations, and gathering some harvest information. This is the seventh season that the Moose Hunter Check Station has been in operation and every year hunter cooperation increases, as well as biological data collection from the moose harvested.

A total of 108 boats and 287 hunters were interviewed at or near the check station. Ninety-seven bull moose and three illegal cow moose were harvested during this season. It took an average of 5.3 days to bag a moose. The moose check station is located in Game Management Unit 21E, however, the majority of the hunters (92.7%) reside in Game Management Unit 18. Only 4.9% were resident hunters of Game Management Unit 21E, another 1.7% were resident hunters from another area of the state and 0.7% were

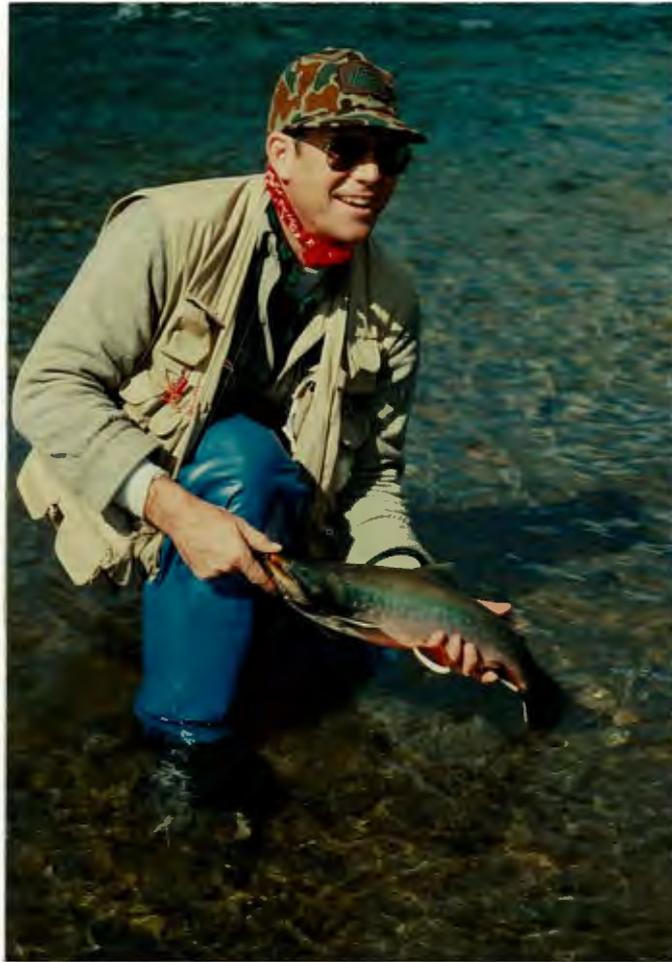
non-residents. Additional information collected from the check station was mean antler width (39.5 inches); the smallest antler width was 19 inches and the largest was 68 inches. Fifty-eight tooth extractions were taken and will be analyzed later in the year or in early 1992.

Generally, small game populations seemed to be low. Spruce grouse were not observed until mid-September and very few ruffed grouse were seen at all.

9. Fishing

Fish continue to be the most important commercial and subsistence resource on the refuge. The most important species are king, chum, and silver salmon, herring, Pacific cod, whitefish, blackfish, burbot, northern pike, and halibut. During the summer months, most major rivers are lined with fishcamps, where local residents prepare fish for the winter months. "Fishcamp" is important both nutritionally and culturally to Native Alaskans.

Only a small number of non-local residents travel to the refuge for sport fishing. Salmon, rainbow trout, dolly varden, arctic grayling, and northern pike are taken by sport fishermen. The primary rivers used for sportfishing are the Andraefsky, Aniak, Eek, Kisaralik, Kasigluk, and Kwethluk.



Dolly Varden was released after picture was taken. (V. Davis)

The Kenai Fisheries Assistance Office completed the Draft Fishery Management Plan for the refuge in January. Public comments were reviewed and incorporated. The final plan will serve as a guide to allocate and schedule resources to accomplish specific tasks. The final plan is expected to be out by early 1992.

The Kenai Fisheries staff established one weir on the Tuluksak River and had planned to erect another on the Kwethluk River. Due to unseasonably high water, the Kwethluk weir was never established. Hopefully, another attempt will be made in the summer of 1992. A lot of valuable information was collected on number and species of salmon which made it through the Tuluksak weir.



Kwethluk River weir structures. (V. Davis)



The Kwethluk River weir was not erected due to high water. (V. Davis)

10. Trapping

Furbearer trapping continues to be a major source of income for many local residents. Trappers of beaver, lynx, otter, wolf, and wolverine have mandatory sealing requirements. Table seven indicates the estimated furbearer harvested and 1991 average fur price.

Table 7. Furbearer harvest and average pelt price, 1990-91.

<u>Species</u>	<u>Harvest</u>	<u>Price (Dollars)</u>
Fox	299	11.00* 25.00**
Lynx	4	75.00
Mink	4,898	20.50
Muskrat	300	0.75
Otter	212	40.00
Wolverine	7	320.00
Beaver	1,093	18.00
Wolf	1	250.00

*Red fox

**Arctic fox

11. Wildlife Observation

In 1991, the refuge received challenge grant funding under the America the Beautiful Wetlands Initiative. In cooperation with the University of Alaska, Fairbanks (Kuskokwim College), the refuge conducted a combined research and educational effort at Duchikthluk Bay on Nunivak Island. From August 21 through October 1, refuge personnel conducted Steller's eider and shorebird investigations. From September 3 through 13, the refuge crew was joined by Dr. Paul Polechla and two Kuskokwim campus students, Marvin Kiokun of Mekoryuk and Margaret Alexie of Upper Kalskag. Dr. Polechla, Wildlife Biologist McCaffery, and Volunteer Christine McCaffery team-taught a field course in marine and wetlands ecology. The two students received a valuable hands-on experience with wildlife research and management activities.



Marvin Kiokun "hittin' the books" during his bird identification field exam. (V. Davis)

12. Other Wildlife-oriented Recreation

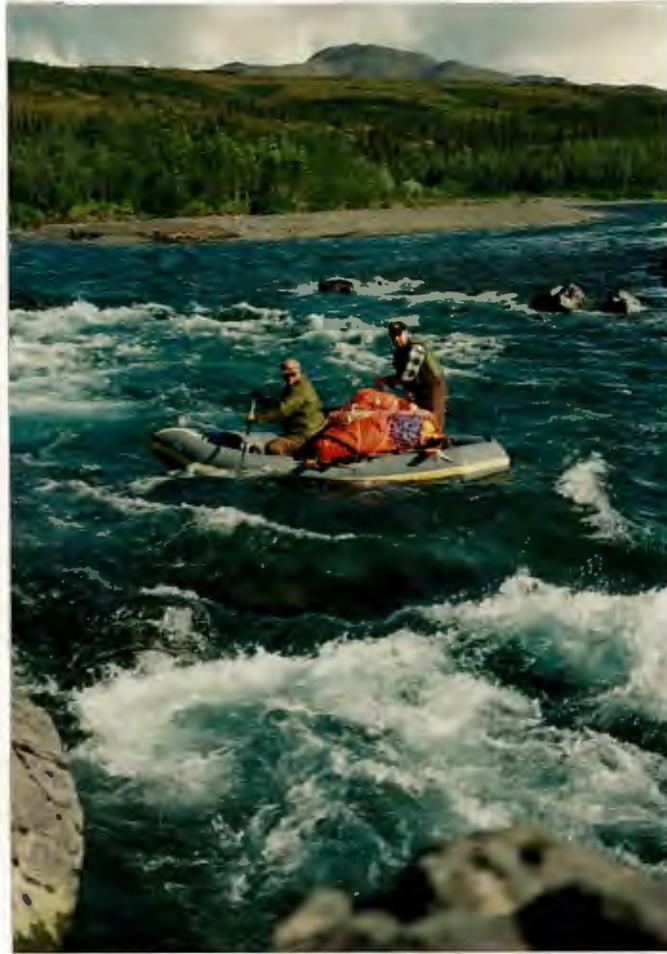
Other recreational activities, such as backpacking, boating, camping, hiking, photography, and river floating occur in small numbers on the refuge. Powerboating and camping are generally associated with subsistence hunting and fishing. There may be an increasing amount of rafting occurring on the Kisaralik River. Since the refuge is so remote and expensive to get to, this use may be small in comparison to other refuges public use. Activities associated with this rafting include camping, fishing, hiking, wildlife observation, and photography.

During August, a rafting trip down the Kisaralik River was organized to determine present status of public use and to obtain a better understanding of the issues and concerns identified by the general public. Both Regional staff and refuge personnel floated the river. The trip began at Kisaralik Lake, which is located high in the Kilbuck Mountains on State property. The river traverses the refuge for approximately 70 miles before entering native corporation lands, some twenty-seven miles from the Kuskokwim River. The trip provided a valuable insight to potential trouble spots along the river and refuge management needs. Numerous brown and black bears and several raptors species such as golden and bald eagles, gyrfalcons and several unidentified hawks were spotted. Salmon were numerous as they

made their run for the spawning grounds.



The crew decided Denny Strom and Dave
Patterson should test the rafts by going
through Golden Gate Falls. (V. Davis)



They decided to approach the falls sideways.
The crew questioned if this was a new
technique. (V. Davis)



The sweet smell of victory as they complete the falls. What a blast! (V. Davis)

In October, the Kisaralik River Management Plan alternatives were drafted and proposed to the Regional Office and the State of Alaska Department of Natural Resources for approval. By early December the draft was finally approved. The final plan should be available for public review by mid 1992.

15. Off-road Vehicling

Transportation on the Yukon-Kuskokwim Delta is limited to aircraft, boats and off-road vehicles, except in the immediate vicinity of villages. Snowmobiles are used heavily, both for recreational and subsistence uses. Most snowmachine use is not a problem, although some residents occasionally use these vehicles when there is insufficient or no snow cover. Three and four-wheeler use is common in and around villages, but is not

permitted on refuge lands. A continual effort is put forth to make the local residents aware of refuge regulations and potential damage to the resources that these vehicles can contribute.

16. Other Non-Wildlife Oriented Recreation

Sled dog racing remains a popular winter sport. The most visible race is the "Kuskokwim 300", a race which originates in Bethel, follows the Kuskokwim River to Aniak, and goes overland to Whitefish Lake and Tuluksak before rejoining the Kuskokwim on the return to Bethel. Most of this race occurs on native corporation lands, except for a short distance along the northern section of the trail which crosses refuge lands.

17. Law Enforcement

In the late afternoon of April 10, Refuge Officers Strom and Rearden responded to a call about illegal hunting of caribou in the Kilbuck Mountains. The officers flew in the refuge Super cub to the Canyon Creek area where a kill site was located along with a snowmobile in some trees in a narrow valley. Pilot Rearden landed the cub on a snowfield slope above the valley, while Alaska Department of Fish & Game aircraft provided back-up with a Cessna 185.

Upon landing, the refuge officers were approached by two individuals walking up out of the valley. The individuals were questioned and a check of the kill site revealed six caribou had been dragged into the trees and cut up. The meat was seized, taken to a nearby lake, and flown out by the state plane.

The two individuals from Goodnews Bay were issued violation notices for \$750 by the Law Enforcement office in Anchorage. Both paid their fines by the end of the year.

This spring's effort at monitoring the compliance of the closed season policy on harvest of migratory waterfowl in Alaska started on May 6, 1991. Each week in May, two crews consisting of a pilot and passenger worked out of Bethel.

These crews held meetings each week in different villages, concerning the Yukon Kuskokwim Goose Management Plan and the closed season policy. The meetings gave the villagers a chance to meet with law enforcement staff on waterfowl-related issues. Most meetings were well received and the law enforcement crews did a great job at conducting them.

Acting on a tip, Anchorage Law Enforcement agents contacted an individual at the Anchorage airport and found several geese in his luggage. The individual had been back at his home-village of Eek and was returning to his home in Anchorage. Since any taking

of emperor and cackling Canada geese is contrary to the closed season policy he was issued a notice to appear in court. There was much local interest because the individual was the chairman of the local native regional corporation.

Mr. Johnny Hawk was eventually found guilty and fined \$3,000. As part of his sentence, he appeared in a video and apologized for his actions and expressed support for the Yukon-Kuskokwim Goose Management Plan. Versions were produced in English and Yupik for distribution.

18. Cooperating Associations

The Yukon Delta National Wildlife Refuge operates a small sales outlet for the Alaska Natural History Association. Approximately \$1,200 was generated from this outlet during 1991. Expected sales for the new year should exceed this dollar amount as the public becomes more aware of the outlet.

I. EQUIPMENT AND FACILITIES

1. New Construction

Four new wooden observation towers were constructed in April. The towers were assembled in Bethel and shipped to the Kokechik Bay field camp where they were reassembled and are being used to facilitate fox radio-telemetry work.

Construction of an airplane trailer was completed in May. The trailer will be used for transporting planes between the hanger and H-marker Lake for gear changes and summer maintenance. Also, a new hoist installed in the hangar in June should come in handy for making gear changes.

In the past, we have had a problem in spring with poor runoff and flooding problems at headquarters. Washout of the access road to residences #54 and 55 occurs when the culvert freezes, preventing passage of water. To alleviate the problem, a copper pipe was placed in the culvert and connected to the headquarters heating system. We hope this will keep the culvert open sufficiently to prevent further flooding.

In September, the arctic pipe at the old headquarters site was further insulated to prepare for winter. To eliminate problems associated with cold air getting into the pipe, the poorly insulated joints were filled with foam insulation. This should minimize the chances of any problems we might have during periods of extreme cold and high winds.

In 1991, our aircraft hangar was used extensively to assemble floating fish weirs for the Kwethluk and Tuluksak rivers. The Kenai fisheries crew spent long days getting equipment ready for

the summer's work (see section D5b).

An 8'x 8' well head shed was constructed at headquarters during the latter part of summer. The shed will house our main water supply well and protect it from the elements.

2. Rehabilitation

In June, new windows were installed in three trailers. After installing triple pane Alaska windows in some of the trailers last fall and seeing how heating costs were reduced, we decided to install windows in the remaining trailers. We intend to bring the trailer residences up to suitable standards so employees can comfortably remain in them until the planned six-plex is completed.

Youth Conservation Corp enrollees worked with maintenance in July to sandbag slopes on the entrance road and around the well head building. Their efforts seem to have worked well in solving the erosion problems we were experiencing.

Along with the usual winterization tasks, new doors were installed on all the buildings at the Kanagayak field station. This should greatly help security during the off-season.

Much needed shelves were constructed in the Mekoryuk bunkhouse in November. This should enable us to better organize materials there. In addition, floors and walls were given a new coat of paint.

In September, the Chevak maintenance staff delivered the Orca boat to Bethel for major rehabilitative work. Work on the boat started in October and was unfinished at year's end. The wood/fiberglass floor was cut open, water soaked foam floatation was removed, and drain holes were placed between floatation compartments. Closed cell foam and a bilge system will be installed in March or April 1992. As a result, the boat will be considerably lighter since water buildup should not be a problem as it was in the past. In addition, a new throttle/shift assemblage and twin 100-hp outboards will be installed.

The period beginning with fall freeze-up and ending December 31 was "freeze-up free" at the new office/bunkhouse complex. This marked the first lengthy block of time since moving into the new facility that we experienced no plumbing problems what-so-ever! Minor freeze-ups of the lab drain last year were remedied by relocating a heat trace line closer to the problem area. We hope our good fortune continues into the new year.

3. Major Maintenance

A major freeze-up at residence #50 occurred during the cold spell

in early February while Wege was out of town on annual leave. Approximately 35 leaks were repaired as a result of the freeze-up. Since then, we have purchased automated systems monitoring devices that can be quickly and easily installed by plugging into the phone line. When the heat or electricity quits functioning the device systematically calls programmed phone numbers until it is acknowledged and corrective action is taken. So far, the device has performed very well.

The Lister generator at Kanagayak was overhauled in June. To remedy the low power output, new pistons, rings, seals, bearings, intake and exhaust valves and a fuel injector were installed. Reduced fuel usage, steadier electrical output and less noise makes the diesel system preferrable to gasoline powered units used in the past.

In August, the five remaining underground fuel oil storage tanks at the old headquarters site were drained and removed. The holes were tested for contamination and refilled with clean sand. The city has expressed an interest in using the tanks for above ground waste oil holding tanks. At year's end, the tanks were still awaiting disposal.

4. Equipment Utilization and Replacement

A new Honda four-wheeler was shipped to Mekoryuk in January to provide transportation there.

In March, we received four new Polaris snowmachines to replace some of our aging fleet. One remained in Bethel and, in May, three were shipped to Chevak to replace the defunct Alpine and Skandik machines.

A new Dodge Dakota pickup truck arrived on the last barge, in September. It has proven to be a valuable addition to our vehicle fleet.

5. Communications Systems

A new radio antenna for the phone patch system at Chevak was installed on top of the local FM radio station tower and has improved our communication abilities significantly. In addition, an antenna was erected on the headquarters building as an improvement to the same radio system.

6. Computer Systems

Computer acquisitions of software and hardware continued in 1991. Three ALR 386 personal computers along with a logical connection to interconnect four computers with the new HP laser printer arrived. A complete PC ARC/INFO system with chartplotter and digitizing tablet was installed and is being utilized by several

refuge projects. All computers were upgraded with WordPerfect version 5.1 software to meet Region 7's new standard guidelines. Lastly, a draft Office Automation Plan was submitted to the region for evaluation. The central element is the acquisition of a minicomputer to network all computers.

7. Energy Conservation

In 1990, all florescent light tubes on the second floor of the headquarters building were replaced with improved lower wattage tubes that provide the same amount of light. In 1991, the remainder of the low wattage florescent lights were received and installed in the office as an energy saving effort. We are also working with engineering to install ceiling fans in the shop to help warm air circulation. Hopefully we can make better use of the warm air trapped near the ceiling.

The new Alaska windows installed in trailer residences last fall were very effective in reducing drafts and ultimately heating costs (see section I2).

8. Other Items

The battle to maintain the 15'x 30' weatherport at Chevak continued in 1991. The weatherport is a quonset-hut-shaped structure, covered with reinforced vinyl where all of the summer field camp equipment is stored--over \$100,000 worth. The wind and snow ravage it fiercely and the maintenance staff at Chevak spends considerable time protecting the integrity of the structure from vandalism and the elements.

In December, lumber was delivered to Chevak to repair the back end of the weatherport, but repairs had not taken place by year's end. To date, any and all repairs have been negated by local vandals. At this point, the only solution may be to build reinforced concrete walls around the structure. Considering the money and effort put into repairing the weatherport, it would probably be easier to build a new workshop/storage/bunkhouse facility and be done with it.

J. OTHER ITEMS

1. Cooperative Programs

A cooperative agreement between the Service and the Sea Lion and Paimiut Native Corporations was established for 1991. The purpose of the agreement was to allow the refuge to continue to maintain a field camp and conduct waterfowl investigations on Native-owned land in the Kokechik Bay area and to provide employment and training to local youth in biology. Accordingly, the Service hired a Native youth from Hooper Bay for the summer. In addition, the Service, in cooperation with the Kuskokwim

College conducted a two-week biology field camp for 2 high school students from Hooper Bay. The Service provided all logistical support and living accommodations, while the college provided an instructor.

4. Credits

Chuck Hunt: C.3a, E.6

Ron Perry: D.1, E.5, K.

Biology Crew (John Morgart, Mike Wege, Brian McCaffery, Rick Ernst, Ramone Baccus): D.3d-h,5a,7, F.1-7, G.1-10,12-17, I.6, J.1

Dennis Strom: B., F.9,12, H.17

Mildred Prince: E.1 and compilation

Martha Perry: Typing

Ken Harper: D.5b,6a, G.11,14c,16b

Vicki Davis: D.3b, F.12, H.1-16,18

Bob Winkelman: C.3, D.2, E.2,4,8, I.1-5,7,8, coordinating and editing

Cynthia Wentworth: D.5c

K. FEEDBACK

This has been an eventful and busy year. This has been the first year that the headquarters buildings have not had a major freeze up and thousands of dollars spent to thaw the water and sewage lines, repair the lines, and redesign and redo the heating systems to prevent freeze ups. Also, this was the year to replace the old Data Generals which were with us from 1984. We are now somewhat compatible with four different brands of computers, five different brands of printers, and floppy drives for high density double sided and floppy drives for double sided, but not high density. Our frustration with compatibility, but not complete compatibility continues. We have wasted more time and energy trading floppies around, getting printers to work, and hopping between stations. Contracting services needs to be less concerned about computer prices and more concerned with getting a product that will make the job easier for the employee.

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