ANNUAL NARRATIVE REPORT
Calendar Year 1989

KOYUKUK NATIONAL WILDLIFE REFUGE
GALENA, ALASKA

REVIEW AND APPROVALS

KOYUKUK AND NORTH UNIT INNOKO NATIONAL
WILDLIFE REFUGES

Galena, Alaska

ANNUAL NARRATIVE REPORT

Calendar Year 1989

Complex Manager Date 10/3/90

Associate Manager Date

Assistant Regional Director, ARW Date

This Annual Narrative Report is dedicated to the memory of Greg Rost, who contributed much to the refuge and it's staff. He died doing what he loved, flying, on June 20, 1989.

DEDICATION

This annual narrative is dedicated to the memory of Greg Rost our friend and comrade. Greg's sudden and tragic departure in June filled our hearts with great sorrow and has had a lasting impact on our lives and on the refuge. He was a hard working and caring man and is sorely missed. The passage of time has begun to ease the pain and Greg's vacant position has been filled, but it is clear Greg will never be replaced on this refuge. The great memories he left behind will never fade.

It is hard to describe in words what Greg's loss has meant to us but the following poem comes very close. The poem was written by Jason Nunn, son of Refuge Manager Mike Nunn, and was a Christmas present to Mike this past December. Thank you Mike for sharing this with us.

Poem to Dad: Goodbye Greg

A drum, mighty it was, fitted snug in the C-185
This, is but a dream I dream't while Greg was alive.
It was he, saying, "Why not three?" before the caribou fell.
Was he, hunched up front, helmetted blue, a 'cub flew well.
A dutch oven; like a woodsman master chef; stomachs wept.
Ham, 'tators, hungry men gather, the best he never kept.
A man; of the sky, of the woods, of life was he -
A giver, a flyer, a hunter, a trier, a model to me.
If ever a man, of all men, could be made not to die...
A man he was, great, wonderful, yet mortal as you and I.
To him, we rock our wings, a home-brew salute, goodbye.
Goodbye, friend, goodbye.
Goodbye Greg, goodbye.
No, goodbye's don't do - it'll be in a cloud I'll see you.
And I remember it all, slippin' in on the slough.
Watching you, countless hours, loading mountains into a plane.
Sometimes go under, over treetops, sometimes going around rain.
Yes, sir...I'll never forget those, therefore you are here-

In my heart, while I'm living, hunting, flying, you're always near.
Immortal, no. A man yet more - I'm looking forward to my final leg,
When my cross-country life is over, to seeing you Greg.
Right now friend, you're flying on in hearts upon the ground.
And we'll see you again, upon our mortal memories we're bound.
See you around friend, see you around...

- Jason Nunn 12/89

INTRODUCTION

The Koyukuk National Wildlife Refuge was established December 2, 1980 with passage of the Alaska National Interest Lands Conservation Act. Purposes for which the refuge was established are:

1. To conserve the fish and wildlife populations and habitats in their natural diversity including, but not limited to, waterfowl and other migratory birds, moose, caribou, furbearers and salmon;

2. To fulfill international treaty obligations of the United States with respect to fish and wildlife and their habitat;

3. To provide the opportunity for continued subsistence uses by local residents; and

4. To ensure water quality and necessary water quantity within the refuge.

The Koyukuk National Wildlife Refuge is located in west central Alaska, about 270 air miles west of Fairbanks and 330 air miles northwest of Anchorage. The exterior boundaries encompass 4.6 million acres, an area slightly smaller than the state of New Jersey. After the conveyance of native allotments, village and native regional corporation (Doyon, Inc.) lands, the refuge will contain 3.69 million acres.

The refuge is situated in a roughly circular floodplain basin of the Koyukuk River just north of its confluence with the Yukon River. The extensive forested floodplain is surrounded by the Nulato Hills, elevation 1500' - 3000' on the west; the Purcell Mountains and Zane Hills, elevation 3100 - 4000' on the north; the Galena Mountains, elevation 1500' - 3000' on the east and the Yukon River on the south.

The Koyukuk Refuge has also been delegated responsibility for managing the upper unit of the Innoko NWR (Kaiyuh Flats). This unit consists of 750,800 acres located south of the Yukon River with its eastern upper boundary starting directly across the river from Galena. After the conveyance of native allotments, village and native regional corporation (Doyon, Inc.) lands, this unit will contain approximately 351,000 acres. This unit was also established by ANILCA. The majority of the flatland is dominated by a maze of sloughs, creeks, and lakes. The foothills of the Kaiyuh Mountains run along the southeastern border of the unit.

Vegetation types are typical of the boreal forest or taiga of interior Alaska. White spruce occurs in large pure stands along rivers where soils are better drained. Numerous fires have set birch and willow. Black spruce muskegs or bogs are a dominant feature and develop on the poorly drained permafrost soils. Dense willow and alder stands are common along the rivers and sloughs. The most conspicuous characteristic of the vegetation is the complex interspersion of types.

The refuge achieves national and international significance through its contribution to waterfowl populations using all four flyways. Thousands of waterfowl, primarily wigeon, pintail, scaup, white-fronted geese and Canada geese are joined by both tundra and trumpeter swans on the Koyukuk's lush breeding grounds each spring.

Fish abound in refuge streams and lakes supporting subsistence and sport fisheries.

Refuge headquarters is located in Galena, on the Yukon River approximately 6 miles south of the southernmost point of the refuge. Galena, Alaska was established about 1919 as a supply point for the mining of galena (lead sulphite ore) deposits south of the Yukon River.

The City of Galena is now a "regional center" and not considered a typical Alaskan village. Life in Galena resembles a village more than a city, yet it has advantages of direct air service to Anchorage and Fairbanks, modern communications, river access, and such amenities as two general stores, hotel, health clinic, and a retail outlet for boats, motors, snowmachines and generators. Galena's population of approximately 1,000 is bolstered by the approximately 330 military personnel stationed at the Galena Air Base where two F-15 Eagle intercept aircraft are kept on 24 hour alert.

Management of the refuge for the first ten years has consisted primarily of field investigation to quantify significant bird and mammal resources by habitat type on a seasonal basis. The goal of this effort has been to learn as much as possible in order to maintain refuge habitats in their present pristine condition in the face of development of lands within and adjacent to the refuge and to maintain healthy wildlife populations. This work will continue. In addition to the field investigations, emphasis is currently being placed on information and education in the eight villages and schools in the proximity of the Koyukuk and Nowitna Refuges. Several major FWS programs including prescribed burning, wildfire control, subsistence management, and the implementation of a spring waterfowl hunting policy require support from the 2,500 residents in and surrounding the refuge.

INTRODUCTION

TABLE OF CONTENTS

A. HIGHLIGHTS

B. CLIMATIC CONDITIONS 8

C. LAND ACQUISITION 9

1. Fee Title. . . . . Nothing to Report
2. Easements. . . . . Nothing to Report
3. Other. 9

D. PLANNING

1. Master Plan. . . . . Nothing to Report
2. Management Plan. 9
3. Public Participation . . . . . Nothing to Report
4. Compliance with Environmental and Cultural Resource Mandates. . . . . Nothing to Report
5. Research and Investigations. 9
6. Other. . . . . Nothing to Report

E. ADMINISTRATION

1. Personnel. 10
2. Youth Programs . . . . . Nothing to Report
3. Other Manpower Programs. . . . . Nothing to Report
4. Volunteer Program. 12
5. Funding. 13
6. Safety 13
7. Technical Assistance 15
8. Other. 15

F. HABITAT MANAGEMENT

1. General. 16
2. Wetlands 17
3. Forests. 18
4. Croplands. . . . . Nothing to Report
5. Grasslands . . . . . Nothing to Report
6. Other Habitats . . . . . Nothing to Report
7. Grazing. . . . . Nothing to Report
8. Haying . . . . . Nothing to Report
9. Fire Management. 19
10. Pest Control 23
11. Water Rights 23
12. Wilderness and Special Areas 23
13. WPA Easement Monitoring. . . . . Nothing to Report

G. WILDLIFE

1. Wildlife Diversity 23
2. Endangered and/or Threatened Species 23
3. Waterfowl. 24
4. Marsh and Water Birds. 46
5. Shorebirds, Gulls, Terns and Allied Species. 46
6. Raptors. 47
7. Other Migratory Birds. 47
8. Game Mammals 47
9. Marine Mammals . . . . . Nothing to Report
10. Other Resident Wildlife. 59
11. Fisheries Resources. 60
12. Wildlife Propagation and Stocking. Nothing to Report
13. Surplus Animal Disposal. . . . . Nothing to Report
14. Scientific Collections . . . . . Nothing to Report
15. Animal Control . . . . . Nothing to Report
16. Marking and Banding. 60
17. Disease Prevention and Control . . Nothing to Report

H. PUBLIC USE

1. General. 63
2. Outdoor Classrooms - Students. 64
3. Outdoor Classrooms - Teachers. . . Nothing to Report
4. Interpretive Foot Trails . . . . . Nothing to Report
5. Interpretive Tour Routes . . . . . Nothing to Report
6. Interpretive Exhibits/Demonstrations 65
7. Other Interpretive Programs. 65
8. Hunting. 65
9. Fishing. 67
10. Trapping 68
11. Wildlife Observation . . . . . Nothing to Report
12. Other Wildlife Oriented Recreation Nothing to Report
13. Camping. . . . . Nothing to Report
14. Picnicking . . . . . Nothing to Report
15. Off-Road Vehicling . . . . . Nothing to Report
16. Other Non-Wildlife Oriented Recreation Noth. to Rep.
17. Law Enforcement. 68
18. Cooperating Associations . . . . . Nothing to Report
19. Concessions. . . . . Nothing to Report

I. EQUIPMENT AND FACILITIES

1. New Construction 69
2. Rehabilitation 69
3. Major Maintenance. 70
4. Equipment Utilization and Replacement. 73
5. Communications Systems 73
6. Computer Systems . . . . . Nothing to Report

7. Energy Conservation. . . . . Nothing to Report
8. Other. . . . . Nothing to Report

J. OTHER ITEMS

1. Cooperative Programs 74
2. Other Economic Uses. . . . . Nothing to Report
3. Items of Interest. . . . . Nothing to Report
4. Credits. 74

K. FEEDBACK

Most of the Koyukuk NWR is pristine wild and remote, it's only access by floatplane and boat in summer and skiplane and snowmobile in winter. Here the refuge aircraft, a Piper Super Cub is parked on a wetlaned shore during the duck production survey.

A. HIGHLIGHTS

1. Year begins with near record cold spell.

2. Assistant Refuge Manager/Pilot, Greg Rost killed in June while on annual leave.

3. Refuge complexed with Nowitna National Wildlife Refuge.

4. No wildfires occur on refuge in 1989.

5. Waterfowl production down by 66% on the refuge.

6. Refuge-wide moose survey completed in 1989 with over 11,000 moose estimated to inhabit the area.

B. CLIMATIC CONDITONS

When highlighting the climatic conditions for 1989 only one occurrence would occupy top billing and it began only 12 days into the new year. The month of January 1989 went down as one of the coldest experienced in recorded history in Galena. A progression of sub-zero days climaxed on January 27 with an unofficial recording of -88°F which would be a new North American record low. The official all-time record low temperature recorded at the Galena Air Force Base weather station was a balmy -70°F on the same day. For the last 18 days of the month the high temperature did not rise above -36◦F and averaged -47°F. The low for the same period averaged -57°F.

The cold spell began on January 12 and did not break until February 2. Not only did this weather phenomena outdo anything experienced by FWS staff in Galena, but even the oldest Athabaskan Indians could not remember such intense cold for this long a period. Needless to say the temperature took a severe toll on vehicles, buildings, and morale which is discussed in Section I.3. The fortunate people were those who chose to forego driving their vehicle and had the least complicated home heating and water systems. The cold snap was followed by a period which included several snowstorms that left an unusually deep snowpack by spring.

Severe flooding occurred with spring runoff on many portions of the refuge associated with the Koyukuk River. The flooding resulted in a dramatic reduction in waterfowl production as discussed in Section G.3.

Breakup of the Yukon River at Galena occurred at 7:30 PM on May 7 and the river froze up during the evening of October 25. June was mostly sunny and warm, as usual, but after the Fourth of July weekend, the summer weather turned unusually cloudy and rainy through September as the airflow pattern was southwesterly off

the Bering Sea. October snowfall was slight, until late in the month when several inches fell, allowing the aerial moose census to be accomplished.

C. LAND ACQUISITION

3. Other

Representatives from the Regional Realty Office visited the refuge in February to discuss the land acquisition priority process utilized to fulfill requirements of the 1988 Submerged Lands Act. The Act requires prioritization of native, native corporation, and State lands within refuge boundaries for possible acquisition. Refuge staff spent the better part of two days supplying wildlife and public use information to be used in the process. By September a draft report was out for review and public informational meetings were held in Anchorage, Fairbanks and Juneau.

The acquisition priority system identified 391,330.9 acres of high, 284,398.4 acres of medium, and 134,439.9 acres of low priority inholdings on the Koyukuk. This process was done in response to Congressional direction and no specific authority or funding exists for acquisition.

D. PLANNING

2. Management Plan

The Koyukuk fisheries management plan was prepared in draft form by the end of the year. This plan, initiated in 1986, was prepared by the Fairbanks Fishery Assistance office and is expected to go the State for comment by April 1990. The document is uncontroversial.

5. Research and Investigations

Wetland Ecology and Sightability Correction for Waterfowl Productivity Surveys on the Koyukuk NWR.

In 1989 the physical and chemical characteristics on a variety of wetlands were quantified in an attempt to identify key factors that could be used to classify waterbodies as to probable waterfowl productivity. This was the first year of a three year study aimed at improving our habitat stratification abilities and brood survey accuracy. Results are reported in Section G.3E, and a progress report will be completed in early 1990.

The Effects of Fire on Wildlife Populations.

This five-year study was initiated in 1986 and was continued in 1989. The objectives are to:

1. Determine vegetation changes and successional sequences caused by fire.

2. Determine small mammal, furbearer, avian, and moose population changes caused by fire.

Results of 1989 progress are reported in section F.9, and a final report will be prepared at the end of the five years.

The following study proposals were submitted to the regional office for consideration in 1989:

Relative abundance, comparative brood production, and nesting habitat requirements of trumpeter and tundra swans on the Koyukuk/Nowitna NWR.

An evaluation of the impact of the spruce bark beetle on National Wildlife Refuges along the Yukon River valley.

In addition an amendment was submitted to the wolf telemetry study which proposes collaring up to twenty wolves in the spring of 1990. The amendment was approved.

E. ADMINISTRATION

1. PERSONNEL

Permanent

1. Michael L. Nunn, Refuge Manager, GS-485-12, EOD 5/26/84, PFT
2. Gregory R. Rost, Assistant Refuge Manager/Pilot, GS-485-12, EOD 9/28/86, Deceased 6/20/89, PFT
3. Mark R. Bertram, Wildlife Biologist, GS-486-7, EOD 4/10/88, PFT
4. Michael N. Granger, Fire Management Officer, GS-401-11, EOD 4/10/88, PFT
5. Jim Bodkin, Wildlife Biologist, GS-486-11, EOD 5/31/89, PFT
6. Diana White, Secretary, GS-318-5, EOD 2/7/86, LWD 2/13/89, PFT

Temporary

1. Mary Ann Sam, Secretary, GS-318-4, EOD 6/12/89
2. Lisa Joyal, Biological Tech, GS-404-5, EOD 6/19/89, LWD 8/18/89

Major changes occurred on the staff of the Koyukuk NWR during 1989. The most tragic of these occurred on June 20 when Assistant Refuge Manager Greg Rost along with his wife Joy and

Refuge Manager Mike Nunn presented Wildlife Biologist Jim Bodkin with a Special Acheivement Award for his sea otter work on the Exxon Valdez Oil Spill.

Arctic NWR Administrative Officer Paul Liedberg was detailed to the Koyukuk/Nowitna Complex to alleviate the staff shortage. He functioned as Assistant Refuge Manager and also increased the station's efforts in Environmental Education and Public Involvement. Here he and Biological Technician Pete DeMatteo prepare a wildlife exhibit for the Koyukon Jamboree in Galena. (MRB)

Fire Management Officer Mike granger (forground) and Wildlife Biologist Mark Bertram (background) assisted with the white fronted goose capture and banding.

Mary Ann Sam, a resident of Huslia, was Refuge Secretary from July 1989 to January 1990. She left because she missed home and village life.

the Nowitna NWR Assistant Refuge Manager Tim Patton were killed in the crash of Greg's private aircraft when on annual leave. The accident occurred in Idaho where the three were in the process of aerially scouting the Salmon River for an upcoming float trip. Assistant Manager Rost had been with the refuge since September of 1986, first as the Wildlife Biologist and more recently as the Assistant Manager. Throughout his tenure he had also assumed the dual function piloting duties for the station. This void was partially covered by detailing Administrative Officer Paul Liedberg from the Arctic NWR in Fairbanks to the Koyukuk NWR on July 10. Paul continued this detail through the end of the year at which time a list of candidates to fill the position permanently had been received.

To assist with our piloting need OAS pilots Dale Moore (7/10/89 through 7/19/89) and Carl Lind (7/24/89 through (9/24/89) were assigned to the station.

In early June a decision was made to complex the Koyukuk and Nowitna stations under Refuge Manager Mike Nunn. This issue has been raised in the past and was now acted on because of the impending move of Nowitna Refuge Manager Daryl Lons to the Anchorage Regional Office.

Organizational structures were negotiated between Personnel, the Associate Manager and the refuge until early October when staffing decisions were made and recruitment began for two assistant manager positions, one of which included dual function piloting duties. Through the end of the year the complex was left with only Refuge Manager Nunn and AO Liedberg (still on detail) to function for the four manager positions that had been on the station until June.

In brief, the new structure will have the GS-12 Refuge Manager supervising two assistant managers - one for administration, public use and environmental education, and one for resources/biological operations. The two assistant managers will in turn supervise the remainder of the staff positions.

Jim Bodkin entered on duty May 21 as the station wildlife biologist. Jim moved up from Santa Cruz, California where he had worked with the sea otter program for Region 8.

Refuge secretary Diana White resigned effective 2/13/89 to take another position in Galena. With the difficulty of recruiting clerk/secretary positions in the Galena area through the federal hiring process, the position was vacant until June when it was temporarily filled by Mary Ann Sam. Through the end of the year she remained in the position on a temporary appointment.

Wildlife Biologist Mark Bertram was upgraded to GS-7 effective April 23. FMO Granger was upgraded to full performance level GS-

11 effective April 10. Gregory Rost was converted from a Wildlife Biologist/Pilot to an Assistant Refuge Manager/Pilot effective January 29.

The following training was received by the staff during the year:

Rost	Law Enforcement	FLETC	1/3-3/16
Bertram	Statistics	U of Idaho	1/16-20
	Arctic Survival	Eielson AFB	2/20-25
	Wildl. immobilization	Univ. of Ak.	5/16-17
Granger	Intermediate Fire Behavior	BIFC	2/13-17
	Fuel Oil Management	Galena AFB	2/1
	Fire in Natural Resources	NARTC	3/27-4/5
	S-353 Mixmaster	AK Fire Svc, Fairbanks	5/22-25
	Arctic Survival	Eielson AFB	2/20-25
Liedberg	FWS/OAS Ground-school	Anchorage FWS/OAS,	12/5-8

Wildlife Biologist Bodkin was presented a $300 special achievement award for his work in Prince William Sound with sea otters during the Exxon Valdez oil spill.

Refuge Manager Nunn received a special achievement award in November based upon his performance for the rating period ending June 30.

4. Volunteer Programs

Two volunteers contributed a total of 100 hours valued at $1,024 for the refuge. This work consisted of assisting with brood surveys during July and early August.

Due to housing shortages, logistical complications, and a limited number of available candidates in the local area, the use of volunteers has been limited on the Koyukuk in the past. We anticipate that this will change somewhat in the future as the complexing of the Koyukuk and Nowitna Refuges facilitates more unified projects and now that a bunkhouse is available to assist with housing individuals who may be interested in traveling to Galena to serve as volunteers.

5. Funding

Station funding for the last five years is shown in Table 1.

Table 1. Koyukuk National Wildlife Refuge Funding

Program	FY85	FY86	FY87	FY88	FY89
1260	336,000	375,000	430,000	440,000	
1261					273,000
1262					190,000
8610	13,000	22,000	40,000	39,100	20,589
Totals	349,000	397,000	470,000	479,100	483,000

FY89 funding represents a 5% increase in funding (1260-2). Of the 1260-2 operations funds, $68,000 was dedicated to the fire management program - $60,000 non-additive toward a fire management officer and $8,000 to continue a multi-year fire study. In addition the Regional Fire Management Coordinator provided non-station funding to cover the FMO's salary from approximately May through August totaling $13,400 and OAS availability for the station aircraft from June through September totaling $3,294.

We have long advocated incorporating all fire management funds into our operations budget to simplify what is already a confusing budget. We have some hope that this may come about in FY90 or 91 based on discussions in fire management meetings held late in 1989.

Approved maintenance management system projects totaled $45,000 consisting of the following projects:

Moose census on northern half of refuge	$26,000
Start pintail study	$9,000
Start goose banding	$10,000

6. Safety

No reportable accidents occurred during the year. This record goes back to 1985.

A radon test was conducted in the office building with results of 0.6 pCi/L indicating an average indoor level.

A station safety and health inspection was completed and submitted on May 15 along with a field crew emergency plan for the field season.

A CPR refresher course was attended by staff members in June.

A station safety and health inspection was completed and submitted on May 15 along with a field crew emergency plan for the field season.

A CPR refresher course was attended by staff members in June. Regional Safety Officer Hyatt along with WO Chief of Safety Earl Markwell visited the headquarters and housing facilities on August 23 for a review of the station safety program and an orientation to bush Alaska operations for Markwell.

Safety meetings held during the year covered a variety of topics including review of OAS survival bags, aircraft crash emergencies, proper use and care of floatation vests and suits, and a review of emergency backup heating equipment in the residences. Safety meetings during the summer concentrated on mini-meetings in the field to continually assess how to conduct operations in an atmosphere of safety-consciousness. All meetings were held in conjunction with the Nowitna staff.

Six Browning .375 H&H magnum rifles were purchased during the year to aid in compliance with the regional bear safety policy. The firearms arrived in time to be used for the 1989 field season. Permanent and temporary field staff practiced with the rifles shortly after arrival. The bear safety policy itself has come under critical review and, as written, requires this station to at least double the manpower required to conduct field operations. Many of our waterfowl surveys are optimally conducted by single individuals dropped on a lake by a single passenger Super Cub aircraft. While the intent of the policy is good, the requirements for additional staff and logistics to carry out the policy makes policy compliance difficult and expensive.

Although bears were often seen in the conduct of field operations, only one close encounter occurred in 1989. A curious black bear offered his help with the supper dishes in a remote camp. Two shots fired over his head changed his mind.

The radio system installed in 1988 finally provided a safety network for both the Nowitna and Koyukuk Refuges, but at times it performed only moderately well. The system was finally up and operational in July and when it was up it functioned very well. However, by mid-Novemeber it was down again due in part to lack of sun on the solar panels. We had partial coverage via a direct link to the office but repeaters or the base station were not functioning. The radio system is further discussed in Section I.5.

A contract for $20,000 was let to have asbestos removed from the office and residence 109 (bunkhouse) in May. When inspection of the work took place on June 14 by the Regional Engineer, soil samples were taken under the office (the contract did not include

7. Technical Assistance

In July the refuge provided assistance to the Fairbanks District Office of the Bureau of Land Management in accomplishment of brood surveys on areas adjacent to the Koyukuk Refuge. Assistance was in the form of helping to set up the brood plots and in orientation and conduct of the surveys. In the end we traded assistance from BLM. We used their chartered aircraft to complete our refuge brood surveys in exchange for two days of the refuge survey crew time working on BLM lands.

Late in the year we received a request by BLM to review and comment on a moose study proposal in BLM areas adjacent to the refuge. At year's end comments were being prepared.

As in past years the refuge cooperated with, received, and provided technical assistance to Alaska Department of Fish and Game Area Game Biologist Tim Osborne stationed in Galena. On most of our work we encourage participation by Osborne and the same is true of our involvement in projects conducted by him.

Local Fish and Game Advisory Committees were attended by various staff throughout the year to provide information and advice as requested. With the refuge now functioning as a complex, we have three Advisory Committees to coordinate with: Ruby, Koyukuk and Middle Yukon.

8. Other

Wildlife Biologist Bertram and Nowitna Pilot Brown conducted a search for a downed aircraft just outside the boundary of the northern unit of the Innoko Refuge in February. Although nightfall prevented a landing to drop off survival gear, radio contact was made to confirm that the pilot and his passenger were in good shape. They had apparently stalled the aircraft prior to landing and it had flipped. They were picked up the following day by State Search and Rescue personnel.

Wildlife Biologist Bertram received an award from the local Boy Scout troop in appreciation for all his efforts at making the troop active and successful. Bertram was also nominated for a Good Neighbor award in conjunction with the Koyukon Jamboree in October.

Associate Manager Elison visited the refuge on June 16 to discuss the immediate complexing of the Koyukuk and Nowitna Refuges.

Assistant Regional Director Rogers and Acting Associate Manager Heuer conducted a station review July 10-12. Included in the review were discussions with most of the staff, assistance with a white-fronted goose banding effort, an aerial tour of the Koyukuk Refuge and a refuge slide program.

Associate Manager Constantino visited Galena on August 30 to review operations, meet staff, and consult on various personnel matters relating to complexing of the Nowitna and Koyukuk Refuges.

Incidental flight status was requested for Acting Assistant Manager Liedberg in August. Ground school was attended in late August and check rides took place from September to early December on floats, wheels and skis.

Regional realty appraisers were in Galena in September to conduct a five year appraisal of housing lots for revenue sharing purposes and to evaluate office space utilization.

F. HABITAT MANAGEMENT

1. General

Located 270 miles northwest of Fairbanks in west central Alaska, the Koyukuk Refuge lies within a roughly circular basin and connects the floodplain and the Koyukuk River just north of its confluence with the Yukon River. The extensive floodplain is a forested basin surrounded by high hills and characterized by many lakes. The terrestrial vegetation is typical of the boreal forest or taiga of interior Alaska and northwestern Canada.

The most conspicuous characteristic of vegetation on the refuge is the complex interspersion of types. Differences in vegetation are caused by soil types, erosion by streams and rivers, permafrost exposure, flooding and fire. There are four broad vegetation types on the refuge:

1. Closed spruce-hardwood forests are found mainly along the major water courses and on warm, dry south-facing hillsides where drainage is good and permafrost absent. This type consists of tall to moderately tall stands of white and black spruce, paper birch, aspen and balsam poplar.

2. Open, low growing spruce forests are found in the northwestern quarter of the refuge and scattered throughout the central portion. This type is composed primarily of black spruce but is often associated with tamarack, paper birch and willows and locally interspersed with treeless bog. They are found on north facing slopes and poorly drained lowlands usually underlain by permafrost.

3. Treeless bogs make up the bulk of the vegetation type in the center of the refuge. The vegetation of these bogs consists of various species of grasses, sedges, and moss, especially sphagnum.

4. Shrub thickets of willow, alder and resin (scrub) birches occur in riparian and subalpine areas. The refuge also includes a few small scattered areas of tundra, mostly on alpine ridges or windswept valleys in the northern half.

2. Wetlands

Several species of sedge, bluejoint grass, foxtail, and fleabane provide cover on receding shorelines and dry basins. After flooding, sedges and occasionally bluejoint grass survive as emergent vegetation to water depths exceeding four feet. Shore-lines of bog lakes vary in character but nearly always contain buckbean, wild calla, and various species of sedge. Cattails and burreeds are found in only a few lakes.

Waterfowl use is related to both type and density of aquatic and shoreline vegetation. Preference is given to lakes with abundant submerged pondweeds, water milfoil, and coontail and having shore-line vegetation that is moderately dense and interspersed with openings. These are either closed basin type lakes maintained by infrequent flooding and long periods of gradually receding water levels, or lakes connected to river systems that are more frequently flooded but also experience gradually receding water levels.

Cotton grass commonly occurs on wet bogs and shorelines. (MRB)

The rivers in the refuge lowlands are characterized by a low gradient, tortuously meandering courses and spring flooding.

Flooding during spring is typical and subsidence of the waters frequently continues through much of the summer. The rivers, in particular the Koyukuk, carry a heavy silt load at flood stage. Creeks are typically shallow, slow, and meandering with steep banks. Narrow bands of white spruce line the higher banks, while willow and alder thickets predominate in the lower areas.

Some off-refuge placer mining occurs on several streams that flow into the refuge. Initial investigations were undertaken in 1986 to determine the extent of detrimental effects placer mining has on the water quality of these rivers and to establish baseline data for all refuge rivers (Table 2).

Table 2. Results of contaminant analysis of Northern Pike, Koyukuk NWR, Alaska. Samples with concentrations of mercury in tissue that exceed the FDA action level of 1 ppm. wet weight are listed.

Date	Location	Weight (gm)	Tissue	Hg-ppm wet wt.
06/04/87	Hogatza River	1850	muscle	1.010
			liver	1.760
			kidney	2.040
07/18/87	Camp Creek	2750	liver	1.200
07/18/87	Camp Creek	2475	liver	1.200
08/10/87	Caribou Creek	5220	liver	1.800
			kidney	1.100
			muscle	1.320

Results of samples collected in 1987 indicate that some northern pike from refuge waters contained mercury concentrations that exceeded U.S. Food and Drug Administration (FDA) standards. One of three pike from Hogotza river, two of five pike from Camp Creek, and one of three pike from Caribou Creek exceeded these levels. Other results from around the state show that mercury poisoning has the potential of being a major problem. Plans are to post warning signs at the confluence of these locations in the spring of 1990, and continure sampling and analysis in 1991.

3. Forests

A general description of forest types is given in Section F.1. Infestations of spruce bark beetle are not new to Alaska. Since

1986, beetle infestations have erupted along the lower Yukon River resulting in an estimated 225,000 acres (2.5 billion board feet) affected between Galena and Anvik. Much of the infestation is within the boundaries of the Innoko and Koyukuk Refuges although most of the land is in native corporation ownership. The accelerated expansion of the beetles up the Yukon River prompted Gana 'A Yoo, Ltd, a native village corporation based in Galena, to hold a conference in Galena in late October to discuss the problem and possible alternatives to solving the problem among landowners. By the conference end, Gana 'A Yoo, Ltd. had decided that commercially harvesting the infested timber was the answer. The refuge used this opportunity to propose prescribed burning program that would use fire as a means of regenerating large tracts of infested forest. A plan has been written to burn approximately 7,000 acres near the village of Kaltag during the summer of 1990.

9. Fire Management

The 1989 fire season can be summed up in one word - WET! No fires occurred on the Koyukuk Refuge during the summer of '89. In comparison, eighteen fires burned 31,885 acres on the refuge last year.

The two prescribed fires (cloverleaf and almost-an-island) planned for the Three Day Slough area never materialized. A final blow was dealt to this summer's prescribed fire plans on July 19th when reconnaissance of both sites indicated that they were under about two feet of water as a result of the Koyukuk River flooding. These two burns plus a hazardous fuel reduction burn near the village of Kaltag are planned for 1990.

On 7 August, FMO Granger departed for Idaho to assist suppressing wildfires throughout the state. His assignments as a helicopter crewmember were on the Sawtooth, Boise and Payette National Forests. Twenty-one days later, Granger arrived in Galena just in time to depart for the field cabin for five more days to complete the fire effects study!

A beautiful scenic overlook of Galena Summit. Unfortunately it's in Idaho. (MNG)

An "Optimum Fire Management Program" budget was submitted to the Fire Management Coordinator in July.

Three moose browse surveys along Three Day Slough were conducted on 12 April. The objectives of these surveys are to determine the extent to which browse species are being utilized by moose, the density of animals that the area can support, and the preferred browse plants. Data collected shows an extremely high (99%) utilization ofcurrent annual growth of willow by moose within the Three Day Slough area.

A new policy regarding wildfire protection of cabins on the refuge was signed by the Regional Director in June. The policy states; "Subject to available suppression resources, all permitted cabins and allotment cabins will be protected from wildfires, to the extent possible, on lands managed by Department of Interior agencies. During the 1989 and 90 fire seasons, unpermitted cabins on U.S. Fish and Wildlife Service and Bureau of Land Management lands will be evaluated on a case by case basis with the final decision on protection to be made by the federal manager responsible for the land in question." To publicize the policy, notices were sent to each cabin permittee and a broadcast was made on the local radio station (KIYU) to inform outlying villages.

Fire suppression on the refuge is provided by BLM's Alaska Fire Service. Initial attack is achieved with smoke jumpers and retardant bombers such as C-119's, DC-6's and 7's, Catalina PBY's and a Navy version of the B-24, the PB4Y. Helicopters are used to pick up smoke jumpers and to ferry emergency fire fighter crews as needed.

Fire suppression activities on the refuge are guided by the Alaska Interagency Fire Management Plan. The Seward/Koyukuk Planning Area encompasses the entire refuge. Under this plan, refuge land is put into one of four management options; critical protection, full protection, modified action and limited action (Figure 1).

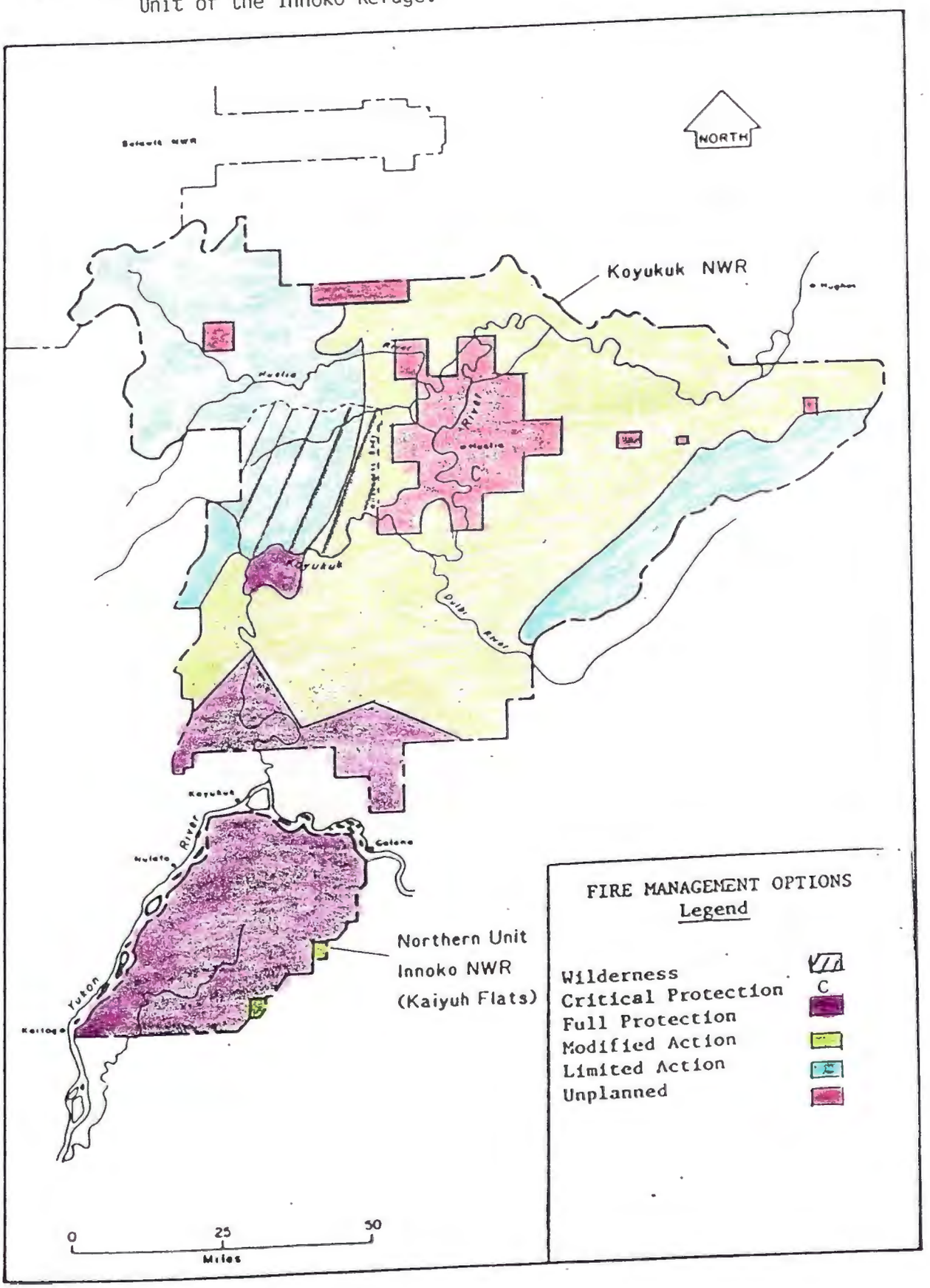
The critical protection option is for those areas where fire presents a real and immediate threat to human and physical developments. These areas or sites are occupied areas such as villages and fish camps. The highest priority in the allocation of suppression forces is given to sites in this option.

The full protection option is for those areas designated to receive initial attack and suppression efforts until the fire is declared out. This option is designed for the protection of cultural and historical sites, high resource value areas which require fire protection, but do not involve the protection of human life and habitation. Only fires in the critical protection area receive a higher priority for suppression resources.

The modified action option is designed for those areas that require a relatively high level of protection during critical burning periods, but a lower level of protection during the non-critical burning periods when a risk of large, damaging fires is diminished. During the critical burning periods, fires in "modified action" areas receive aggressive initial attack. If a fire escapes initial attack and requires more than a modest commitment to contain it, an Escaped Fire Analysis is conducted to determine the level of suppression needed in relation to the values at risk. Lands in this category are suited to indirect attack, the intent being to balance the acres burned with suppression costs. During the non-critical burning period, "modified action" areas do not receive initial attack of suppression; the intent being to reduce suppression cost and achieve resource management objectives through limited fire activity.

The limited action option recognizes areas where a natural fire program is desirable, or the values at risk do not warrant the expenditures of funds. Suppression actions are undertaken only to the extent necessary to keep a fire within the management unit or to protect higher classified sites within the area. The

Figure 1. Fire Management Options on the Koyukuk NWR and the Northern Unit of the Innoko Refuge.



careful monitoring of fire behavior and fire weather conditions is essential on all fires in limited action areas.

These plans are designed on the premise that prior to man's interruption, the fire cycle in interior Alaska ranged from 40 to 120 years. The forests are adapted to this type of burning cycle and wildlife depend on it. Without periodic fire, forests will become unproductive and the soil will become increasingly ice-laden.

Blueberries are abundant in burned areas and are an important food source for wildlife and people. (MRB)

The effects of fire on wildlife populations.

This five year study, initiated in 1986 and continued in 1989, has three sites. Two are in an area burned in 1986, one in the center and one along the perimeter. The third site is an unburned control site. Surveys of the sites included small mammal trapping (1480 trap-nights), bird transects (15 miles), and vegetative transects (120 plots surveyed in June and September). Data collected in 1989 indicated a reduction in rodent populations on both the burned and control sites. The reduction can be attributed to the harsh winter of 88-89. One species, the yellow-cheeked vole, is absent from both the burn and control sites. Vegetation surveys indicated, as expected, increasing abundance of willow, blueberry, and Equisetum throughout the burn.

In addition to the above three sites in the 1986 burn, some new sites were surveyed for the first time in 1989 on the 1988 Bear Mountain Burn, just south of the Koyukuk administrative cabin.

10. Pest Control

The spruce bark beetle which has occurred in other parts of the state and has worked its way up the Yukon River in the past 10 years has now invaded significant portions of the Yukon and Koyukuk River corridors of the Innoko and Koyukuk NWR's. Refer to section F.3. for this discussion.

11. Water Rights

No progress occurred on securing water rights for the Koyukuk NWR in 1989. The request was filed with the State in 1988 and eventually a step down water plan will be developed detailing current water resources and future needs for the refuge. This program is being handled by the Enhancement office in the Regional Office and is on hold until funding is secured.

12. Wilderness and Special Areas

The 400,000 acre Koyukuk Wilderness was established by Public Law 96-487 (Alaska National Interest Lands Conservation Act) on December 2, 1980, in accordance with subsection 3(c) of the Wilderness Act (Section 892). The Koyukuk Wilderness surrounds the geologically unique Nogahabara Sand Dunes and also includes the Three Day Slough area. Since the Koyukuk area is unglaciated it is theorized that the dunes are wind-blown deposits of sand that originated in glaciated areas to the northwest. No active management is conducted on this wilderness area.

G. WILDLIFE

1. Wildlife Diversity

The Koyukuk National Wildlife Refuge has a history ofintense fire. The frequency of fires on the refuge has resulted in rich and diverse habitats for wildlife. Baseline data continues to be collected to determine which species listed as numerous and casual to interior Alaska occur on the refuge. Presently, over 145 bird species, 30 mammal species and 19 fish species are thought to occur on refuge lands.

2. Endangered and/or Threatened Species

The American Peregrine Falcon is the only endangered species known to occur on the refuge. ADFG Area Biologist Tim Osborne conducted an aerial survey of the Koyukuk River corridor and located two active nests within the Koyukuk NWR. Each nest site had two young but only two of the four young observed were

banded. Refuge staff located another inactive nest site; the adults were in the area but did not nest.

Swans, especially trumpeters, are common on the refuge. Nest success was about 3 birds per nest in 1989. (JLB)

3. Waterfowl

A. Waterfowl Breeding Pair Count

For the fourth consecutive year, a waterfowl pair count was conducted in five trend areas on May 25 and 30 in the Koyukuk Refuge. The five trend areas and 30 water bodies were surveyed by a pilot and an observer in a Piper Super Cub, flying 60 to 80 mph approximately 150 feet above ground level. The species, number of individuals, and number of duck pairs observed were recorded. Lone drakes were counted as pairs.

A total of 289 pairs representing eleven species were estimated for the five trend areas (Table 3). This represents a 172% increase over the number of pairs estimated during the 1988 survey and 240% over the four year average. The increase was 177% for dabblers and 165% for divers. The increase in dabblers is attributed to a nearly seven-fold increase in pintail pairs. All dabbler pairs increased with the exception of mallard and shoveler. The increase in divers is attributed to a 128%

increase in scaup and an increase in canvasback from one pair in 1988 to 25 pairs in 1989. A total of 396 birds was observed during the trend survey, an increase of 146% over 1988 and 169% over the four year average.

Two species were observed for the first time during breeding pair surveys in trend areas in 1989; green-winged teal and redhead.

In addition to the trend area survey, a total of 260 pairs representing thirteen species was estimated for 30 water bodies included in 16 study plots associated with the wetland ecology/sightability study. Gadwalls were seen for the first time during this survey on Beszivit Lake.

Table 3. Numbers of waterfowl by species observed on five waterfowl trend areas, Koyukuk NWR, 1986-1989.

	# Pairs Observed				Total Birds Observed			
	1986	1987	1988	1989	1986	1987	1988	1989
Mallard	4	17	13	1	10	21	14	6
Wigeon	9	24	13	21	28	38	21	31
Northern Shoveler	10	24	16	8	10	22	28	15
Northern Pintail	5	27	21	144	10	47	26	152
Green-winged Teal	0	0	0	1	0	0	0	2
Dabbler Total	28	92	63	175	58	128	89	206
Redhead	0	0	0	2	0	0	0	4
Scaup spp.	1	16	32	73	37	27	52	122
Canvasback	2	0	1	26	4	0	2	39
Bufflehead	2	0	5	1	2	0	9	2
Surf Scoter	0	5	0	8	0	10	0	15
Black Scoter	0	1	4	4	0	1	8	8
White-winged Scoter	0	2	1	0	10	4	1	0
Diver Total	5	24	43	114	53	42	72	190
GRAND TOTAL	33	116	106	289	111	170	161	396

B. Waterfowl Brood Surveys

For the sixth consecutive year, a duck brood survey was conducted between 15 July and 8 August, 1989 within the Koyukuk Refuge and the Kaiyuh Flats Unit of the Innoko Refuge. Forty square mile plots on the Koyukuk NWR and fifteen square mile plots on the Kaiyuh Flats were surveyed. Duck production estimates were 38,214 for the Koyukuk and 24,327 on the Kaiyuh Flats (Table 3). These estimates, when compared to 1988 waterfowl production

figures, indicate a production decrease of 66% on the Koyukuk and an increase of 36% on the Kaiyuh Flats. It should be noted that only a single production survey was conducted in 1989. Two surveys were conducted in previous years. Although breeding pair counts conducted earlier in the spring indicated a much higher than average presence of waterfowl on the refuge, Mother Nature did not cooperate since heavy spring runoff during June flooded the majority of nesting habitat within the Koyukuk River floodplain.

Goldeneye broods such as this one were rare on the Complex. (Refuge Files)

To estimate refuge waterfowl production, habitat was divided into three strata: key, moderate, and poor. The criteria used to separate strata were the amount of water contained in a section and the presence of bog or non-bog water bodies. Acreage estimates were taken from 1:63,360 topographical maps using a dot grid. Designation into bog and non-bog categories was made with prior knowledge of the area. Plots were then randomly selected. The Koyukuk NWR contains 401square miles of key strata, 675 square mile of moderate strata, and 2,059 square miles of poor strata.

The Kaiyuh Flats was not stratified. Based on the variance sampling of the Koyukuk key strata was increased from 17 plots in 1988 to 27 in 1989. Sampling in the moderate and poor strata remained the same as 1989, 7 plots and 6 plots, respectively. Fifteen square mile were surveyed in the Kaiyuh Flats, however, only five of these plots were used for production estimates.

Plots were surveyed by canoe or walking, with the exception of the poor strata on the Koyukuk NWR and the Kaiyuh Flats Unit which were surveyed by helicopter. Due to the late nesting and staff shortages plots were only surveyed once in 1989.

An average number of young per plot was calculated in each stratum on the Koyukuk and on the Kaiyuh Flats. The average young per square mile multiplied by the size of the stratum provided estimates of total young produced in each stratum. The sum of the estimates for each stratum yielded the total production for the Koyukuk NWR. The product of the average young per square mile and the size (in square mile) of the waterfowl habitat on the Kaiyuh Flats is the estimate of total production for the Kaiyuh Flats Unit of the Innoko Refuge.

In each stratum on the Koyukuk, and on the Kaiyuh Flats, the average number of young per square mile was calculated for each species. These averages were used to compute weighted species totals for the Koyukuk NWR and unweighted species totals for the Kaiyuh Flats. Broody hens without observed young were assigned broods equal to the average brood size (rounded to the nearest whole bird) for that species for the stratum.

During the 1989 waterfowl brood survey, 758 young contained in 156 broods from 13 species were classified on the Koyukuk. On the Kaiyuh Flats, 125 young contained in 23 broods from three species were classified. Due to the difficulty in distinguishing between female lesser and greater scaup, and between common and Barrow's goldeneye,these young were classified simply as scaup and goldeneye, respectively.

Estimated Koyukuk production was 38,214 (se=36%); and the Kaiyuh Flats production was 24,327 (se=66%) (Table 4). Variance did not decrease within the key strata in 1989 in spite of the addition of 10 key strata plots. This was due to the amount of water being overestimated.

Table 4. Estimated total duck production - Koyukuk NWR and Kaiyuh Flats Unit of the Innoko NWR - 1989.

Koyukuk	Ave Young per mi^2	Total Young All Species	Standard Error	Ave Brood Size
Poor	10.33	21,269	62%	2.83
Moderate	11.57	7,810	40%	2.86
Key	22.78	9,135	28%	4.41
TOTAL	12.19	38,214	36%	3.04
Kaiyuh Flats*	24.4	24,327	66%	4.60

*This area was not stratified.

On the Koyukuk NWR wigeon and green-winged teal accounted for nearly two-thirds of total production (63%) (Table 4). Overall, dabblers contributed 62% to total production and divers the remainder. On the Kaiyuh Flats dabblers accounted for 100% of observed production on the five plots used for production estimates: Mallard (28%), wigeon (35%), and green-winged teal (37%) (Table 5).

Estimated production for most species on the Koyukuk dropped severely (65%) in 1989 although increases were noted in redhead and black scoter (Table 5). Above average snowpack coupled with a June thaw produced severe flooding over much of the Koyukuk River corridor and hundreds of square miles of prime nesting habitat was flooded during nest initiation. Very little nesting was observed.

It should be noted that when comparing yearly totals (Tables 5, 6, and 7) an important source of bias is the manner in which broody hens broods were handled. In 1986, and earlier surveys, broody hens were estimated to have a brood size equal to the overall average brood size for the species for the refuge for that year. In the 1987-89 broody hens for each species were estimated to have a brood equal to the average brood size for that species in that stratum. Consequently brood sizes were significantly smaller this year. Note columns a and b for 1987-1989 in Table 7.

Table 5. Estimated young for the Koyukuk NWR, 1988-1989.

Species	Total Young[1]			% of Total Production	
	1988	1989	% Change	1988	1989
Mallard	5,209	1,149	-88	4	3
Wigeon	33,328	13,845	-58	29	37
Northern Shoveler	1,759	505	-71	2	1
Northern Pintail	14,960	1,448	-90	13	4
Green-winged Teal	16,537	9,867	-40	14	26
Dabbler subtotal	71,793	26,814	-63	62	71
Redhead	116	297	+156	<1	<1
Ringneck	4,926	-----	----	4	--
Canvasback	1,030	290	-72	<1	<1
Scaup spp	17,825	3,634	-80	15	10
Bufflehead	1,289	691	-46	1	2
Goldeneye spp	1,631	-----	---	1	--
Oldsquaw	1,398	60	-96	1	<1
Black Scoter	3,291	4,816	+46	3	13
White-winged Scoter	4,281	505	-88	4	1
Surf Scoter	8,114	373	-94	7	<1
Diver subtotal	43,901	10,666	-71	38	29
Unidentified	877	243	-72	<1	<1
TOTAL	116,571	37,723	-68	100	100

[1] Total Young = Total poor + Total moderate + Total key, where Ti = {[total observed young + (broody hens X stratum average brood size)] / square miles observed in stratum} X total miles in stratum.

Table 6. Estimated young - Kaiyuh Flats Unit Innoko NWR, 1988-1989.

Species	Total Young[1]			% of Total Production	
	1988	1989	% Change	1988	1989
Mallard	2,193	6,979	+218	6	28
Wigeon	14,756	5,505	-41	38	35
Green-winged Teal	4,586	6,577	+100	12	37
TOTAL	24,925	38,684	+36	56	100

[1] Total Young = {[total observed young + (broody hens X average brood size)] / square miles observed} X total square miles of habitat.

Table 7. Comparison of estimated waterfowl production Koyukuk NWR, 1984-1989.

Species	1984	1985	1986	1987a	1988a	1989a	% Change 1988-89a	1987b	1988b	1989b	% Change 1988-89b
Mallard	4,015	1,547	7,034	8,937	5,209	1,149	-88	10,337	5,427	1,135	-79
Wigeon	39,997	22,389	23,654	31,608	33,328	13,845	-58	38,430	34,540	16,956	-51
Northern Shoveler	8,125	2,159	1,523	6,443	1,759	505	-71	7,222	1,711	534	-69
Northern Pintail	18,775	11,850	10,880	13,695	14,960	1,448	-90	15,994	12,617	1,136	-91
Green-winged Teal	15,434	22,261	28,354	18,838	16,537	9,867	-40	18,543	16,584	6,444	-61
Dabbler subtotal	86,346	60,206	71,445	79,521	71,793	26,814	-63	90,526	70,879	26,205	-63
Redhead	753	------	24	473	116	297	+156	400	120	300	+150
Ringneck	------	------	------	2,211	4,926	------	----	1,774	2,813	------	----
Canvasback	------	------	------	------	1,030	290	-72	------	1,050	285	-73
Scaup	25,498	4,622	12,330	18,400	17,825	3,634	-80	19,908	21,840	5,704	-74
Bufflehead	4,329	320	3,357	1,632	1,289	691	-46	2,314	1,128	1,060	-6
Goldeneye spp.	1,506	2,963	534	561	1,631	------	----	640	2,813	------	----
Oldsquaw	5,458	4,486	705	1,955	1,398	60	-96	1,523	1,632	64	-96
Black Scoter	1,255	1,907	1,577	12,064	3,291	4,816	+46	8,104	3,898	6,444	+65
White-winged Scoter	878	320	253	2,446	4,281	505	-88	2,265	2,730	380	-86
Surf Scoter	4,066	------	3,529	12,191	8,114	373	-94	11,563	9,063	380	-96
Diver subtotal	43,743	14,618	22,309	51,933	43,901	10,666	-76	48,491	47,087	14,617	-69
Unidentified	94	------	1,994	1,893	877	243	-72	2,040	1,327	492	-63
TOTAL	130,183	74,824	95,748	133,347	116,571	37,723	-68	141,057	119,293	41,314	-65

a Calculated directly from young observed on each plot X total square miles.
b Calculated as done exclusively in 1984-86, broods/mi^2 X total mi^2 X average brood size.

A hatching date was estimated for each brood. Mean hatching dates were calculated for each species (Tables 8 and 9). Dates for most dabblers in the Koyukuk and the Kaiyuh Flats averaged slightly later (3 days) in 1989 compared to 1988 (Figure 2). Conversely, earlier 1989 hatching dates were recorded for Northern shoveler (1 day) (Koyukuk NWR) and mallard (9 days) (Kaiyuh Flats). Because hatching dates for most dabblers were comparable in 1988 and 1989, and very few young dabbler broods were observed late in the brood survey, it is likely little renesting occurred in 1989. Mean hatching dates for divers were about seven days later in 1989, possibly due to the high water in June or the late thaw.

Table 8. Mean hatching dates - Koyukuk NWR, 1989.

Species	Mean Date	Range	Standard Error (Days)	N
Mallard	6/27/89	6/07 - 7/13	4	10
Wigeon	6/29/89	6/06 - 7/23	2	50
Northern Shoveler	6/22/89	6/14 - 7/12	5	6
Northern Pintail	6/13/89	5/29 - 7/07	3	13
Green-winged Teal	7/03/89	6/16 - 8/01	3	16
Redhead	7/17/89	7/07 - 7/22	5	3
Canvasback	no data			
Scaup spp	7/17/89	6/27 - 8/02	3	12
Bufflehead	6/30/89	6/17 - 7/08	7	3
Oldsquaw	6/30/89	----------	-	--
Black Scoter	7/19/89	7/06 - 7/24	2	12
White-winged Scoter	7/22/89	7/14 - 7/25	2	5
Surf Scoter	7/06/89	6/14 - 7/25	7	5

Table 9. Mean hatching dates - Kaiyuh Flats Unit, of Innoko NWR 1989[1].

Species	Mean Date	Range	Standard Error (Days)	N
Mallard	6/22/89	6/15 - 7/05	4	9
Wigeon	7/03/89	6/17 - 7/13	2	21
Green-winged Teal	7/04/89	6/27 - 7/24	9	17
Scaup	7/26/89	----------	-	--

[1] Unlike all other population information generated on the Kaiyuh Flats unit, hatch dates are calculated from information gathered from an additional 10 plots surveyed by helicopter.

A new sampling approach has divided the state into major waterfowl production areas which are clones of the breeding pair survey strata initiated by the Migratory Birds Division in the late 1950's. The Koyukuk NWR (and Kaiyuh Flats Unit) are included in a production area with the Kanuti NWR and Pah River Flats(BLM). A refined stratification method has been applied to the production area and a random sample of 350 water bodies will be drawn soon. Color infra-red photographs are being used to measure water in square mile plots to tighten existing stratification of the refuge. The draft Standard Operating Procedures and the other areas of the new program outlined above are to be tested out in 1990 and then further refined for 1991. Although this revised brood survey program involves a great amount of initial work and coordination within and between agencies we expect the end product to be a sound standardized waterfowl survey procedure.

Two float trips were conducted July 13 and 14 primarily to document goose production, but duck production information was also recorded. Dulbi River and Dulbi Slough were both surveyed by motorized canoe. On 56.75 miles of Dulbi River, 203 young (43 broods, 5 species) were seen with 53% pintail. On 69 miles of Dulbi Slough, 191 young (32 broods, 5 species) were seen; again with pintail predominating (56%). With a minimum of 445 miles of Dulbi River type and 106 miles of Dulbi Slough type, at least 1,888 young should be added to the total production figures for the Koyukuk NWR. These estimates for Dulbi River are up 269% from 1988. Estimates for Dulbi Slough are down 59% from 1988. Combined, the estimated production for these two areas is up 60%. Its unknown why June flooding, which reduced white-fronted goose production by 70% on the Dulbi River, did not affect duck production on the Dulbi River.

A negative disease report was received in March from the National Wildlife Health Research Center in Madison regarding a dead oldsquaw found on the refuge in summer, 1988. The cause of death was a fractured skull.

White-fronted goose production was another casualty of late flooding in 1989; production was down 77%. (MNG)

C. Goose Surveys

On July 13 and 14 goose production surveys for white-fronted geese and Canada geese were conducted along the Dulbi River and Dulbi Slough. White-fronted goose production was drastically down (77%) compared to 1988 figures and no Canada goose broods were observed. Flooding throughout the Dulbi Flats during June had a major impact on nesting this year. Due to inclement weather and reduced aerial support a fall goose production survey was not completed.

D. Swan Surveys

For the fifth consecutive year, swan surveys were conducted to develop trend data on the breeding population on each of two swan species using Koyukuk NWR. Both tundra and trumpeter swans breed on the refuge.

Regional Botanist Steve Talbot and Volunteer Sandy Talbot spent a few weeks on the refuge performing vegetation analysis for the Wetland Ecology Study.

It takes a staff with stamina, endurance, patience, and stubbornness, in addition to special equipment like bug jackets, headnets and aircraft, to count ducks in July on the Koyukuk. Some people have been known to say that "it is no place for humans to exist... only moose and ducks."

Trumpeter sightings have increased on the refuge in the last several years. Swan clutch sizes averaged four in 1989. (JLB)

Surveys of swan nests were conducted on June 9, 12-15, and during the first week of September on six quads in the refuge. A total of 66 swan pairs, 37 singles, and 27 nests were identified during the June survey. Confirmed trumpeter sightings were made on 29 pairs, 15 singles, and 14 nests. In general trumpeter sightings are increasing yearly on the refuge.

Data entry and analysis of the 1989 swan survey was completed. Production averaged 2.94 cygnets/brood. Nest density averaged one per 60.3 square miles, while brood density averaged one per 70.2 square miles.

E. Waterfowl Related Studies

Wetland Ecology and Sightability Correction for Waterfowl Productivity Surveys on the Koyukuk NWR.

1. Physical-chemical characteristics

Water chemistry and physical wetland data were collected from 26 July to 16 August, 1989 from each of 24 randomly selected waterbodies. Waterbodies varied in size, hydrologic characteristics, and brood production, and were assigned to each of four strata. Strata were based on mean numbers of broods per waterbody observed in 1987 and 1988 brood surveys. Waterbody

size was not a classification criteria. Waterbodies were classified as: non-active, no broods observed; low, one brood observed; medium, two to fourteen broods observed and high those with fifteen or greater broods. Six waterbodies were randomly selected from each stratum for a total of 24.

The mean, maximum, and minimum values for all physical and chemical parameters measured are presented in Table 10. Mean values for other refuge wetlands are shown in Table 11.

No range of color was detected. Every waterbody was moderately stained, indicating some organic content. Surface water temperatures ranged from 12.5 to 20° C with a mean of 15.7° C. It was assumed that temperature measurements taken at the surface generally reflected ambient conditions.

Transparency measurements ranged from 0.13 meters to 2.06 meters with a mean of 1 meter. Transparency equalled or exceeded depth in 50% of the 24 waterbodies. Waterbodies with Secchi depth transparency measurements of less than 2.5 to 3.0 meters is considered productive or eutrophic by Wetzel (1975) and Goldman and Horne (1983). Using this criteria, all waterbodies in this study would then be classified as productive.

A wetland ecology study was initiated in 1989 to determine chemical and physical characteristics of wetlands and their relation to waterfowl production. (CL)

Table 10. Minimum, maximum, and mean values for physical and chemical variables measured on the Koyukuk National Wildlife Refuge, Galena Alaska - 1989.

	VARIABLES										
	TP	TN	Chla	Pheo	Cl	SO4-S	Ca	Mg	Na	K	VSS
Minimum	12.00	.50	1.00	0.00	1.20		.42	.21	.65	.06	.90
Maximum	163.00	1.09	59.60	40.10	10.00		22.19	5.51	3.97	.80	47.60
Mean	**52.50**	**.72**	**6.78**	**2.88**	**2.62**		**6.72**	**1.57**	**1.29**	**.32**	**4.53**
Stand.Dev.	46.22	.17	11.74	7.97	1.79		6.09	1.27	.76	.20	9.35

TP = Total Phosphorous as ug/L
Ca = Calcium as mg/L
TN = Total Nitrogen as mg/L
Chla = algal chlorophyll as ug/L
Pheo = algal pheophytin as ug/L
Cl = Chloride as mg/L
SO4-S = Sulfate as mg/L
Mg = Magnesium as mg/L
Na = Sodium as mg/L
K = Potassium as mg/L
VSS = Volatile Suspended Solids as mg/L

Table 10. continued

	Temp	Ph	Color	Trans	Depth	Cond	Turb	Alk	Substrate
Minimum	12.50	4.75	0.00	.13	.43	9.00	0.00	0.00	6.38
Maximum	20.00	8.68	21.00	2.06	2.29	1600.00	59.00	76.00	88.69
Mean	**15.77**	**6.12**	**20.13**	**1.00**	**1.36**	**159.97**	**6.44**	**17.88**	**55.89**
Stand.Dev.	1.80	.92	4.29	.46	.51	381.26	11.44	20.88	27.39

Temp = Temperature as ^{o} C
Ph = Concentration of free hydrogen ions
Color = color comparater, no units
Trans = Transparency as meters
Depth = Depth as meters
Cond = Conductivity as micromhos/cm
Turb = Turbidity as normal turbidity units
Alk = Alkalinity as mg/L
Substrate = Percent organic matter

Mean depth of waterbodies was 1.35 meters with a range of 0.43 meters to 2.29 meters. Only three depth measurements were taken per waterbody; a basin profile was not taken.

Turbidity was extremely low and indicates water movement in these waterbodies was lacking at the time of sampling (26 July to 16 August). Turbidity range was 0 NTU (National Turbidity Unit) to 59 NTU with a mean of 6.4 NTU. Water movement was likely not a transport mechanism for nutrient exchange. However, some of these waterbodies are in the floodplains of drainages and are

likely much more turbid during spring and early summer. Flood water is likely an important transport medium for nutrients.

Conductivity values were generally below 100 umhos/cm^2 (micromhos) although the mean, 160 umhos/cm^2, was above 100 umhos/cm^2 due to one very high value. Values ranged from 9 to 1600 umhos/cm^2. Only three waterbodies had values over 100 umhos/cm^2. Much higher values have been recorded on the Yukon Flats NWR with values ranging from 26.9 to 8983 and with a mean of 480.9 umhos/cm^2 (Heglund 1988). Koyukuk Refuge results are more comparable to studies done on the Selawik Refuge where values ranged from 4 to 243 with a mean of 57.6 umhos/cm^2 (Doyle and Spindler 1987) (Table 11). These results indicate that salinity was low and that fresh waters dominated the refuge. Absence of salinity indicated production was not inhibited by salinity.

Table 11. Mean values for physical and chemical variables measured on three National Wildlife Refuges.

Variable	Koyukuk NWR	Selawik NWR[1]	Yukon Flats NWR[2]
TP (ug/L)	52.5	55.0	243.0
TN (mg/L)	.2	1.2	1.3
Chla (ug/L)	6.8	---	12.3
VSS (mg/L)	4.5	---	4.1
TN/TN (wt/wt)	22.0	32.2	20.1
Cond (Umhos/cm^2)	160.0	57.6	480.9
Total Cations (mg/L)	9.9	8.6	---
Cl (mg/L)	2.6	---	---
Temp (^{o}C)	15.8	---	15.1
pH	6.1	6.1	7.8
Alkalinity (mg/L)	17.9	18.2	---

[1] values from Doyle and Spindler 1987
[2] values from Heglund 1988

Alkalinity measurements generally can indicate productivity. Alkalinity values on the Koyukuk Refuge were low and comparable to results found at the Selawik Refuge. Alkalinity values found on the Yukon Flats Refuge were comparatively higher.

PH values ranged from 4.8 to 8.7 with a mean of 6.1. The highest pH value of 8.7 was found in waterbody #14 which also had high

concentrations of calcium, magnesium, sodium, and ducks. Only three waterbodies had pH values above 7.0 and the remaining waterbodies were on the acidic side. The mean value on the Koyukuk Refuge was most similar to the Selawik Refuge (6.2) and much more acidic than mean value on the Yukon Flats Refuge (7.8 pH).

Total phosphorous values ranged from 12 ug/L (micrograms/liter) to 163 ug/L with a mean of 53 ug/L. According to Wetzel (1975), phosphorous is the least abundant nutrient in many waterbodies and yet most commonly limits biological productivity. Dr. Jack Jones, a University of Missouri limnologist, indicates that waterbodies with total phosphorous levels above 30 ug/L can be considered productive. Sixty-three percent of the waterbodies sampled can be labeled productive based on this criteria. Generally, these productive waterbodies were divided equally among bog and non bog habitats. These results are very similar to those found on the Selawik Refuge.

Total nitrogen values ranged from 0.5 to 1.09 mg\L with a mean of 0.7. All waterbodies had values above 0.5 mg\L and are considered productive. The ratio of total nitrogen over total phosphorous is calculated to determine if nitrogen or phosphorous is limiting productivity or more specifically algae biomass. Ratios less than ten imply that nitrogen is limiting productivity (Doyle and Spindler 1987); four waterbodies (17%) were nitrogen limited. Ratios greater than 17 imply phosphorous limitation; thirteen waterbodies (54%) were phosphorous limited. The remaining seven waterbodies (29%) had values greater than ten but less than 17 and are likely limited by both nitrogen and phosphorous. The mean ratio was 22 which implies that phosphorous limitation dominated the data set. Mean ratios on the Selawik and Yukon Flats refuges also implied phosphorous limitation.

Chlorophyll a is another index to a waterbodie's productivity. Generally values over three ug/L imply a productive waterbody (Heglund 1988, Forsberg and Ryding 1980). However, this method greatly underestimates production on waterbodies dominated by aquatic vegetation (Heglund 1988, Canfield et al. 1983). Values on the Koyukuk Refuge ranged from one to 59.6 ug/L with a mean of 6.8 ug/L. Although the mean value is above three ug/L, over 40% of waterbodies had values less than three ug/L. However, many of the waterbodies falling within this 40% were also dominated by aquatic vegetation and chlorophyll a likely underestimated productivity at these sample sites.

According to Wetzel (1975) world waters have cation concentration contents in the following descending order: calcium, magnesium, sodium, and potassium. This order of cation concentration was found on 54% of waterbodies on the Koyukuk Refuge; an additional 33% generally followed this order except magnesium and sodium

concentrations were reversed. Mean cation concentrations did follow the world order. Total cation mean values equal 9.9 mg/L and are slightly higher than values found on the Selawik Refuge but still indicate dilute waters.

Volatile suspended solids values, a measure of organic materials in the water, ranged from 0.9 mg/L to 47.6 mg/L with a mean of 4.5 mg/L.

Vegetation and invertebrate analyses are incomplete at this time. Results, when tabulated, will be reported in subsequent narratives.

In summary, limnological results indicate that water regimes on the Koyukuk Refuge are productive and very similar to waters on the Selawik Refuge. Positive relationships likely exist between waterfowl brood density and waterbody area, chlorophyll a, and conductivity. Of these variables, area was most strongly correlated (Table 12). Studies done in Interior Alaska suggest that waterbird density may also be influenced by other variables such as total nitrogen and phosphorous, cations, salinity, shoreline length, and water depth (Heglund 1988, Murphy et al. 1984). However, no one variable has proven to be a strong predictor of waterfowl density independent of other variables. There appear to be many subtle relationships between variables which are related to waterfowl density.

Table 12. Stepwise multiple regression results showing relative importance of chemical and physical variables to waterfowl brood density on the Koyukuk NWR, Alaska.

Variable	R^2 value
Area (hectares)*	.756
Chlorophyll a	.795
Conductivity	.831

*N = 24

One of the purposes of this study is to identify factors which can most readily be used to predit waterfowl productivity. This information would help to refine stratification of wetlands on the Koyukuk Refuge and produce more accurate waterfowl production estimates. It is apparent that a physical characteristic must be identified to accomplish this.

Area was the only physical variable identified in this study as likely having influence on waterfowl production. This lends support to current stratification methods being used on the Koyukuk Refuge (Table 13). Area has been used as a

stratification criterion on the Koyukuk Refuge since 1987 (including the Pah River Flats in 1989) and has produced acceptable levels of variation between and within strata in obtaining waterfowl production estimates (Table 4). A second criterion currently used for stratification is habitat type, (bog or non bog). In general bog habitat types lack nutrients and are less productive for waterfowl species although they are preferred by diver species. As a result the area requirement in bog habitat is greater to achieve a moderate or key stratification as compared to non-bog habitat. In general this scheme has worked but several large bog waterbodies were identified in this study which are highly productive. Nutrient inflow on these waterbodies appears to be related to a nutrient transport mechanism, likely fire. Another likely nutrient transport mechanism is annual flooding on refuge flood plains. Most non-bog waterbodies are located on the flood plain and it is assumed this is the source of nutrient exchange.

Table 13. Stratification criteria to separate areas of waterfowl density on the Koyukuk Refuge, Alaska 1990.

Strata	Habitat Type	
	Bog (acres of water)	Non Bog (acres of water)
Poor	< 100	<60
Moderate	> 100 - < 200	> 60 - < 100
Key	> 200	> 100

Vegetation analysis, when completed, may provide another means of identifying productive waterbodies. Many plant species have been associated with productive waterbodies. However, this method will necessitate the need for plant identification from aerial photography. Presently, it is not possible to accurately identify emergent vegetation from color infra-red photos or LANDSAT imagery.

The water quality information gathered in 1989 can be viewed as baseline wetlands information for the Koyukuk Refuge. Findings from this study and other similar studies indicate a complex relationship exists between waterfowl density, productivity, and chemical characteristics. It is recommended that a bathymetric profile be considered for future investigations. Currently new waterbodies are being selected for brood surveys on the Koyukuk and Nowitna refuges and on the Pah River Flats. The stratification procedure described earlier has been slightly refined for 1990 using area as a criterion for strata separation.

2. Sightability Study

In 1989 a sightability study was initiated on 24 waterbodies to examine the number of broods that go undetected during standard waterfowl brood surveys.

Sightability correction data were collected from 15 July to 8 August. Waterbodies varied in size, hydrologic characteristics, brood productivity, and were drawn from each of three strata of production (low, medium, and high). Strata were defined by the same criteria as the Wetland Ecology Study. The total sample size was 24, or eight from each of three strata.

Most observations were made between 1800 hours the evening before and 1100 hours the day of the standard brood survey. In most cases one observer was placed on each waterbody. Larger waterbodies required two personnel linked by two-way radio. If more than one waterbody (not large waterbodies) were to be observed at a study site the observation team would split up for the evening shift. The following day the team would switch observation sites and later compare and finalize data for each waterbody observed.Observations were made from the ground at the best vantage points which was usually an elevated bank. Spotting scopes and binoculars were used to aid in brood identification.

A sightability study was initiated in 1989 to determine what percentage of broods were going undetected during standard waterfowl brood surveys. (SB)

A total of 38 broods was observed prior to standard brood surveys on waterbodies (n=8) in the key stratum (Table 14). Standard

brood surveys observed 40 broods, a difference of 5%. However, 16% more young were observed prior to standard brood surveys. All variability between brood counts can be assigned to two waterbodies in this stratum; both are over 50 hectares and contain dense shoreline vegetation (Equisetum sp.). Three waterbodies in the key stratum contained no observed broods. Combined observation time ranged from one to nine hours per waterbody with a mean of 5.6 hours. Waterbodies ranged from 0.04 hectare to 125.2 with a mean size of 46.6 ha. Fifty percent of waterbodies were classified as bog and 50% as non-bog.

Four broods were observed prior to standard broods surveys in the moderate stratum, while standard brood surveysshowed eight broods. More young were also observed during the brood survey (7%). All variability between brood counts was encountered on two waterbodies. One waterbody accounted for 75% of brood variability and again contained dense stands of Equisetum sp.. Three waterbodies contained no observed broods. Combined observation time ranged from 1.3 to 5.8 hours per waterbody with a mean of 3.4 hours. Waterbody size ranged from 0.4 ha to 28.3 with a mean of 10.5 ha. Over 62% of waterbodies were classified as bog and the remaining non-bog.

The poor stratum was the only stratum that included more observations of broods prior to standard brood surveys. Six broods were observed prior to brood surveys and 5 broods were later noted in the brood survey, a difference of 17% In addition, 30% more young were observed prior to the brood survey. All variability between brood counts was assigned to a single waterbody which was again characterized by dense stands of Equisetum sp.. Five waterbodies contained no observed broods. Combined observation time ranged from one to nine hours per waterbody with a mean of 3.8 hours. Waterbody size ranged from 0.008 ha to 26.3 with a mean of 5.4 ha. Eighty percent of the waterbodies were classified as bog.

The combined results of all strata were most similar to the key stratum. Forty eight broods were observed prior to brood surveys and 53 broods were observed during brood surveys, an increase of 9%. Fifteen percent more young were observed prior to brood surveys. All variability of broods between counts was attributed to 5 waterbodies out of the sample size of 24 (21%). Over 45% (n=11) of the waterbodies sampled contained no observed broods. Combined observation time ranged from one to nine hours per waterbody with a mean of 4.2 hours. Waterbody size in all strata ranged from 0.008 ha to 125.2 ha with a mean of 20.8 ha. Fifty-five percent of waterbodies were classified as bog and the remaining non-bog.

Table 14. Comparison of sightability and standard waterfowl brood survey observations on 24 waterbodies, Koyukuk Refuge, Alaska, 1989.

			Sightability Survey			Standard Brood Survey	
Strata/wetland	Size (ha)	Habitat	Broods	# Young	Observ.Time (hr)	Broods	#Young
Low							
K-1-4	.40	Bog	0	0	5.5	0	0
K-4-7	11.31	Bog	1	0	3.0	0	0
K-14-12	2.02	Bog	0	0	2.0	0	0
M-1-6	.008	Bog	0	0	2.8	0	0
M-3-3	1.21	Bog	0	0	2.8	0	0
M-5-1	26.26	Non Bog	4	19	9.0	4	12
P-1-2	2.02	Non Bog	1	1	4.0	1	1
P-5-4	.04	Bog	0	0	1.0	0	0
N=	43.27		6	20	30	5	13
Mean	5.40				3.8		
Moderate							
K-4-5	10.10	Bog	0	0	3.8	0	0
K-4-6	16.16	Bog	0	0	3.3	3	5
K-6-3	28.28	Non Bog	1	6	4.3	1	1
K-7-4	7.27	Bog	0	0	3.5	0	0
K-8-3	.40	Non Bog	0	0	3.3	1	1
K-10-2	4.85	Non Bog	2	13	2.0	2	14
P-5-1	16.16	Bog	1	6	5.8	1	6
P-5-11	.80	Bog	0	0	1.3	0	0
N=	84.02		4	25	27.1	8	27
Mean	10.50				3.4		
Key							
K-4-4	40.40	Bog	6	22	3.3	6	32
K-6-1	58.57	Non Bog	5	21	4.7	10	39
K-7-1	40.40	Bog	3	11	7.0	3	20
K-7-3	11.31	Bog	0	0	3.5	0	0
K-9-3	28.28	Non Bog	2	12	9.0	2	8
K-13-1	125.24	Bog	22	173	8.0	19	202
M-5-4	.04	Non Bog	0	0	1.0	0	0
P-3-1	68.68	Non Bog	0	0	8.0	0	0
N=	372.90		38	239	44.5	40	201
Mean	46.60				5.6		
Total							
N=	500.19		48	284	101.5	53	241
Mean	20.84				4.2		

The results of the sightability study were somewhat perplexing. Although more total young were observed prior to brood surveys fewer broods were observed. These results do not support the assumption that broods are being missed during standard waterfowl brood surveys. There are, however, several observations which may explain the results:

1. Combined observation time for each waterbody was well under the recommended 12 hour minimum suggested. Although observation time increased with waterbody size the mean combined observation time on each waterbody was only 4.2 hours.

2. Most of the brood variability between counts was assigned to waterbodies with dense stands of shoreline vegetation, primarily Equisetum sp.. Most emergent bands were 5 - 30 meters wide and were found in both bog and non bog habitats. It was not unusual for broods to spend the entire day in these dense stands and go undetected during morning and evening observation periods.

3. Although spotting scopes (15X-45X) were used on larger waterbodies to make brood identifications, observers had difficulty making accurate observations on waterbodies larger than 50 hectares.

4. Waterbodies with elevated banks provided the best observation posts for observers. Many waterbodies situated in the floodplain offered an inadequate angle of view and observers were required to make observations from a canoe or the flooded shoreline. This handicapped observations even on waterbodies less than two hectares. A portable climbing tree stand was taken into the field but could not be used due to the scarcity of trees.

Brood production on the Koyukuk NWR was down 66% in 1989. We believe that the sample of 48 observed broods is of marginal size to perform a valid statistical analysis to test for variables affecting the sightability of broods.

Recommendations can be made at this point to improve sampling and survey methods for the upcoming two field seasons:

1. Sampling effort should be concentrate in the key or high brood density stratum.

2. The number of waterbodies sampled in 1990 should be reduced 50% from the 1989 sample size (from 24 to 12). This will allow more observation time on each waterbody and prevent logistical headaches with standard brood survey crews.

3. A maximum size restriction of 50 hectares should be placed on waterbodies selected. A sightability correction estimate cannot

be effectively made from broods not seen during the sightability observation period.

4. Reconnaissance flights of selected waterbodies should be made in late May to monitor ice conditions, truth the size and strata classification based on breeding pairs present, and check for availability of adequate observation points and camping spots.

5. A 16 foot elevated tripod shooting stand should be used wherever firm ground permits. Waterbodies with adequate trees should employ climbing tree stands. If waterbodies are without an elevated shoreline, or prohibit the use of an elevated stand and restrict adequate viewing, the waterbody should be dropped from the sample.

6. The minimum amount of combined observation time spent on each waterbody in the key stratum should be 12 hours, 8 hours in the moderate stratum, and 4 hours in the poor stratum. Sightability surveys should not be conducted in environmental conditions such as heavy precipitation or winds greater than 12 m.p.h.. If these conditions occur during a survey the observation time should be extended equal to the period of poor weather.

7. Sightability surveys should not be conducted in environmental conditions such as heavy precipitation or winds greater than 12 m.p.h.. If these conditions occur during a survey the observation time should be extended equal to the period of poor weather.

8. Access to sample waterbodies should be from adjacent waterbodies.

9. A Questar spotting scope will be used on large waterbodies.

4. Marsh and Water Birds

Common, Pacific and red-throated loons; red-necked and horned grebes; and sandhill cranes are common on the refuge. Yellow-billed loons are occasional.

5. Shorebirds, Gulls, Terns, and Allied Species

Numerous species of shorebirds inhabit the refuge. Those species observed in 1989 include: lesser and greater yellowlegs, Arctic tern, glaucous gull, mew gull, Bonaparte's gull, herring gull, long-tailed jaegar, semipalmated plover, common snipe, spotted sandpiper, least sandpiper, pectoral sandpiper, solitary sandpiper, northern phalarope, Hudsonian godwit, and whimbrel.

6. Raptors

The refuge has nesting populations of rough-legged hawks, merlins, sharp-shinned hawks, northern harriers, red-tailed hawks, goshawks, great horned owls, great gray owls, boreal owls, northern hawk owls, peregrine falcons, and bald eagles.

7. Other Migratory Birds

Common and hoary redpolls, common raven, black-capped and boreal chickadees, and pine grosbeaks are common winter residents. Species commonly seen in the spring and summer include alder flycatcher, olive-sided flycatcher, tree swallow, gray jay, robin, gray-cheeked thrush, Bohemian waxwing, yellow warbler, rusty blackbird, Savannah sparrow, dark-eyed junco, tree sparrow, white-crowned sparrow, fox sparrow, Lincoln sparrow, and song sparrow.

Yellowlegs are a commmon taiga shorebird.

8. Game Mammals

A. Moose

Moose are presently the most important game and subsistence mammal on the Koyukuk NWR. They are found in almost all refuge habitats, but are most numerous in the riparian habitat along the Koyukuk River and its major tributaries. Historically, moose

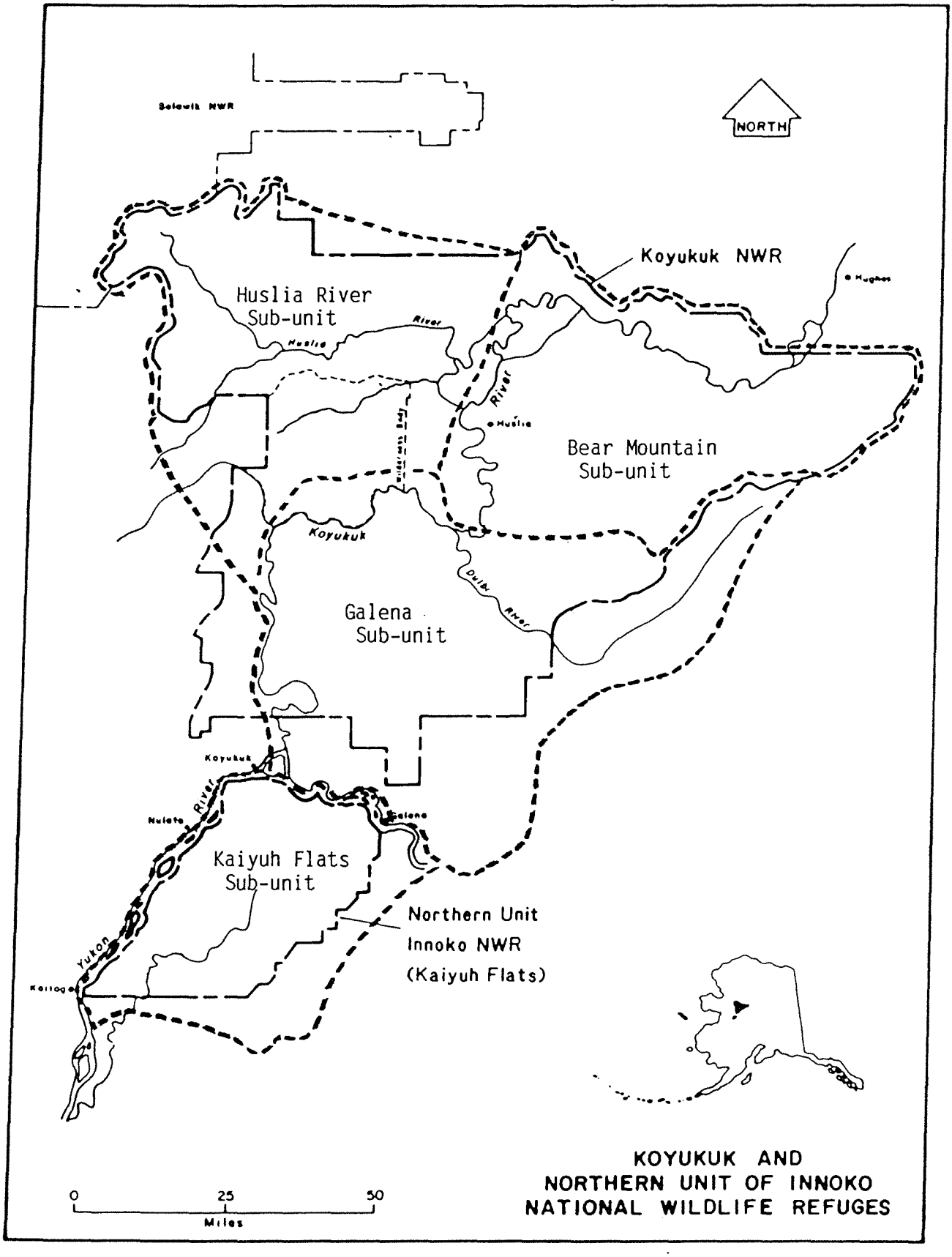
arrived in the early 1940's. They have been abundant during the past 30 years following federal wolf control.

Two major projects concerning refuge moose populations were conducted during the year. A hunter check station was operated on the lower Koyukuk River during the September hunting season and a moose census of the Bear Mountain subunit in the northeastern corner of the refuge was completed in November. Moose hunting and the hunter check station are discussed in Section H.8. The Bear Mountain subunit in this year's moose census was the final subunit to be surveyed in a refuge-wide moose census initiated in 1987. The following is a summary of moose census surveys since 1987 and a description of the abundance, distribution, and population structure of moose on the Koyukuk NWR.

The study area encompasses four sub-units totaling 10,056 square miles that includes the entire Koyukuk NWR and the northern unit of the Innoko NWR (Figure 2). When the moose census was initiated in 1987, the refuge area was partitioned into four sub-units to facilitate sampling within discrete blocks. Dividing the study area into several sub-units resulted in a greater sampling effort, but avoided the possibility of abandoning the project due to an incomplete data set. Each sub-unit was in turn divided into approximately 200, 10 to 15 square mile sample units. Areas of the four sub-units are presented in Table 15.

Estimates of moose population parameters were obtained using a stratified random sampling procedure. The Galena and Kaiyuh sub-units were sampled in November 1987, the Huslia River sub-unit in November 1988, and the Bear Mt. sub-unit in 1989. Each sub-unit was treated as a complete census, with estimates from each sub-unit combined into a total for the refuge. Each of the sample units was classified as either low, medium, high, or very high based on the number of moose and moose tracks observed by a team of four observers flying in a Cessna 185 aircraft about 450 ft. AGL (above ground level) at about 125 mi./hr. A random sample was then drawn from each of the strata with sample sizes selected to optimally allocate effort among strata based on within-strata variances. Observer/pilot teams flew in Super-cub aircraft at about 60-70 mile per hour at about 300-400 ft. AGL to identify and enumerate moose within sample units. Search effort was based on a minimum of 4.0 minutes per square mile and varied according to habitat, topography, and density of moose. Observers and pilots were briefed concerning sampling methods before the start of the survey. A sightability correction factor (SCF) was determined by flying intensive searches (9.8-12.0 minutes per square mile) in randomly selected two square mile sections of the surveyed sample units. Intensive search areas were pre-selected by the observer and made known to the pilot only after the standard search was completed. All sample units were surveyed within two to four days of stratification.

Figure 2. Location of moose census sub-units, Koyukuk NWR.



A refuge-wide moose census, completed in 1989, estimated that over 11,000 moose inhabit the refuge. (MRB)

A population estimate, corrected for sightability, with appropriate confidence limits, was calculated for each census sub-unit. A total estimate for the Koyukuk NWR and the Northern Unit of the Innoko NWR was calculated from the sum of sub-unit estimates. Certain assumptions were made in calculating sex and age ratios. Numbers of yearling bulls and yearling cows in the population were assumed to be equal. Thus, the number of adult cows is the total cows minus those assumed to be yearlings, based on the number of yearling bulls observed. The number of adult bulls is the total bulls minus those identified as yearlings. Table 15 provides a summary of the effort, from 1987 through 1989. This does not include preliminary mapping or fuel caching. Each sub-unit required 5 Piper Super-cubs, a Cessna 185, and 15 people. The sample effort in each sub-unit was determined by a desired confidence interval of less than 20% or by adverse weather conditions which forced the early completion of the Bear Mt. sub-unit. Under ideal survey conditions (e.g., clear, calm weather and early and complete snow cover) the four sub-units could be stratified and surveyed over two field seasons.

Twenty-one percent (2,108 square miles) of the 10,056 square mile study area was surveyed. The samples provided an estimate of 11,740 (90% CI 11%) moose. Moose density estimates by strata and sub-unit are presented in Table 15.

Table 15. Estimated moose density by sub-unit and stratum, Koyukuk NWR, Alaska, 1987-89.

Sub-unit stratum	Total Area (mi^2) (#units)	Surveyed area (mi^2) (# units)	Expanded Population Estimate	Density (moose/mi^2)
Galena				
very high	198 (14)	198 (14)	1,839.1	9.3
high	353 (28)	161 (13)	935.5	2.6
medium	1,213 (97)	273 (22)	1,283.9	1.0
low	1,543 (126)	88 (7)	328.3	0.2
Total	3,306 (265)	721 (56)	4,386.8[1]	1.3
Huslia River				
high	125 (10)	125 (10)	450.8	3.6
medium	1,767 (144)	321 (26)	1,380.1	0.8
low	526 (42)	79 (6)	33.7	0.1
Total	2,418 (196)	525 (42)	1,864.6[2]	1.3
Bear Mountain				
high	405 (32)	178 (14)	2,181.9	5.2
medium	1,064 (85)	160 (13)	1,496.1	1.4
low	1,288 (103)	62 (5)	137.7	0.1
Total	2,757 (220)	525 (32)	3,815.8[3]	1.4
SUBTOTAL (Koyukuk NWR)	8,483 (681)	1,646 (130)	10,067.1	1.2
Kaiyuh Flats[4]				
high	177 (15)	123 (10)	703.0	4.0
medium	591 (48)	240 (19)	732.1	1.2
low	807 (64)	99 (8)	238.3	0.3
Total	1,575 (127)	462 (37)	1,673.4[5]	1.1
TOTAL (Koyukuk NWR and Kaiyuh Flats)	10,056 (808)	2,108 (167)	11,740.6[6]	1.2

1 Expanded population estimate is corrected by a sightability correction factor (SCF) = 1.04; the confidence interval at the 90% level is plus or minus 14%.
2 Expanded population estimate is corrected by a SCF = 1.02; the confidence interval at the 90% level is plus or minus 17.9%.
3 Expanded population estimate is corrected by a SCF = 1.33; the confidence interval at the 90% level is plus or minus 22.2%.
4 The Kaiyuh Flats sub-unit is the Northern Unit of the Innoko NWR.
5 Expanded population estimate is corrected by a SCF = 1.12; the confidence interval at the 90% level is plus or minus 20%.
6 The 90% confidence interval for the total moose population and density estimate is plus or minus 11.4%.

Mean densities were generally consistent between sub-units, within strata. The greatest densities (9.3 per square mile) were found in the Three-day Slough area (Figure 3), situated in the Koyukuk Wilderness Area. While moose were distributed throughout the study area, highest densities occurred along the Koyukuk and Yukon rivers and their major tributaries (Figure 3). Fifty-two percent of the moose occurred in the high and very high strata which comprised 12.5% of the study area. Lowest densities were found between the rivers floodplains and the mountains and foothills (6.3% of the moose occurred in the low strata which comprised 49% of the study area). Moose occurred in moderate densities in the foothills and mountains surrounding the flood plain (41% of the moose occurred in the moderate strata which comprised 47% of the study area).

The age and sex structure of the moose population within the study area is presented in Table 16. With few exceptions, sex and age compositions was similar between sub-units. The Bear Mt. sub-unit had a relatively low calf and yearling component in 1989 while the Galena sub-unit had a relatively low bull component. The Huslia River sub-unit had a relatively large yearling and bull moose component while the Kaiyuh Flats sub-unit had a relatively high calf component.

Using the criteria of density, percentage of adult bulls, and calf and yearling recruitment, the Koyukuk moose population appears to be healthy (Table 16). Calf production (12%) and yearling recruitment (9%) were low within the Bear Mt. unit, in comparison to other sub-units sampled on the refuge but are similar to values presented elsewhere (Table 17). The percentage of adult cows in the population was stable, averaging 43% throughout the study area. The percentage of adult bulls and large bulls (antler spreads > 50 in.) was consistent between sub-units and in general high compared to other populations (Table 17). Overall density was comparable to two other interior Alaska areas (Selawik and Nowitna) and greater than Kanuti. Otherwise, density was less than the Kenai Peninsula, Newfoundland, and Alberta.

A helicopter was used to sling barrels of jet fuel in preparation for winter collaring of wolves and moose calves. By the time fuel is staged in the proper place it cost over $6.00 per gallon.

Table 16. Sex-age ratios and population structure as determined from aerial surveys, 1987-1989, Koyukuk NWR, Alaska.

	SUB-UNIT					
	Galena	Huslia River	Bear Mountain	Refuge[1] Average	Kaiyuh Flats	Average[2]
Twins[3]	9.0	12.0	11.0	10.6	15.0	11.7
Calves[3]	46.0	51.4	24.5	40.6	57.4	44.8
Yearlings[3]	27.3	60.0	18.4	35.2	32.3	34.5
Total Bulls[3]	48.7	101.8	70.4	73.6	71.4	73.1
Adult Bulls[3]	34.8	71.4	61.2	52.5	53.1	55.1
Large Bulls[3,4]	16.4	28.6	26.5	23.8	28.0	24.9
Large Bulls[4,5]	47.0	40.0	43.3	43.4	52.7	45.8
% Calves[6]	22.0	18.0	12.0	17.3	24.0	19.0
% Yearlings[6]	13.0	21.0	9.0	14.3	13.0	14.0
% Adult Cows[6]	48.0	36.0	49.0	44.3	41.0	43.5
% Adult Bulls[6]	17.0	25.0	30.0	24.0	22.0	23.5
% Large Bulls[6]	8.0	10.0	13.0	10.3	11.0	10.5

1 Refuge average is the Koyukuk NWR and includes the Galena, Huslia River, and Bear Mountain sub-units.
2 Average includes all sub-units surveyed from 1987-89.
3 Ratio per 100 cows
4 Those bulls with antler spreads > 50 inches.
5 Ratio per 100 adult bulls
6 Percent of total population

Table 17. Densities and demographics of selected moose populations in North America.

Abundance (#/mi^2)			Sex Ratio (M/F)	% Bulls in herd	% Cows in herd	% Calves in herd	Cit./Site
Mean	High	Low					
1.66	NA	NA	25 : 75[1]	15	46	39	Mytton & Keith 1981 Alberta, Canada
2.1	NA	NA	26 : 74	20	56	24	Albright & Keith 1987 Newfoundland, Canada
0.52	1.71	0.41	44 : 55	26	66	8	Wilk R. (pers. com 1989) Kanuti NWR, Alaska
3.6[2]	NA	NA	17 : 83	14	66	20	Bishop & Rausch 1974 Kenai Peninsula, Alaska
1.06	2.15	0.03	28 : 72	21	54	25	Loranger 1986 Nowitna NWR, Alaska
1.18	2.1	0.90	36 : 64	32.3	56.7	11	Larsen, Spindler & James 1985 Selawik NWR, Alaska
1.19	9.3	0.10	39 : 61	30.5	50.5	19	This study 1989 Koyukuk NWR, Alaska

1 Values averaged from 1975 through 1977 surveys.
2 Values averaged from 1965 through 1971 surveys.

Staff also assisted the Kanuti and Innoko refuges with moose censuses in 1989.

A serology report was received from the State in regard to 20 adult moose collared on the refuge in 1984. All reports were normal.

Fourteen cow moose were observed by staff during a waterfowl breeding pair survey flight on May 30. Fifty percent of the cows had calves, four had singles, and three had twins, for a twinning rate of 42%.

Moose browse surveys were conducted in Three-Day-Slough during April to supplement browse data collected by the Alaska Department of Fish and Game. In addition, moose urine (frozen snow) samples were collected at the browse transect sites for determination of moose herd health.

Cotton grass, Eriophorum vaginatum, is an important caribou food source in spring as it is often the first green vegetation to appear.

Cloudberry, Rubus Chamaemorous, or locally called salmonberry, is an important subsistence berry that is most aboundant in areas that have burned recently.

B. Caribou

The ranges of two caribou herds include portions of the refuge. The Galena Mountain Herd, a small herd that calves in the mountains of the Melozitna River drainage, winters on the southern Koyukuk Flats. Currently the southern edge of the winter range of the Western Arctic Herd, the largest caribou herd in Alaska, includes the northern and western section of the refuge. The Western Arctic herd has been growing steadily since its crash in the 70's, and is presently estimated at about 350,000. In early 1989 the Western Arctic Herd shifted migration patterns and caribou bands travelled through areas in the southwestern and southern regions of the refuge normally only occupied by the Galena Mountain Herd. Current distribution patterns may change if the herd size continues to increase. Figure 4 displays recent caribou distribution on the refuge.

As follow-up to a cooperative Galena Mountain Herd study with the Bureau of Land Management, refuge staff made caribou relocation flights on March 10 and 28 and again in April. Four caribou, of the original nine collared from the Galena Herd in 1986 and 1987, were still on the air. Repeated relocation attempts in December failed to locate the other four. Nearly 800 caribou were observed in the Hozatka Lake area on March 10. It is suspected that several hundred animals from the Western Arctic Herd were mixed in with the Galena Mountain Herd.

C. Wolves

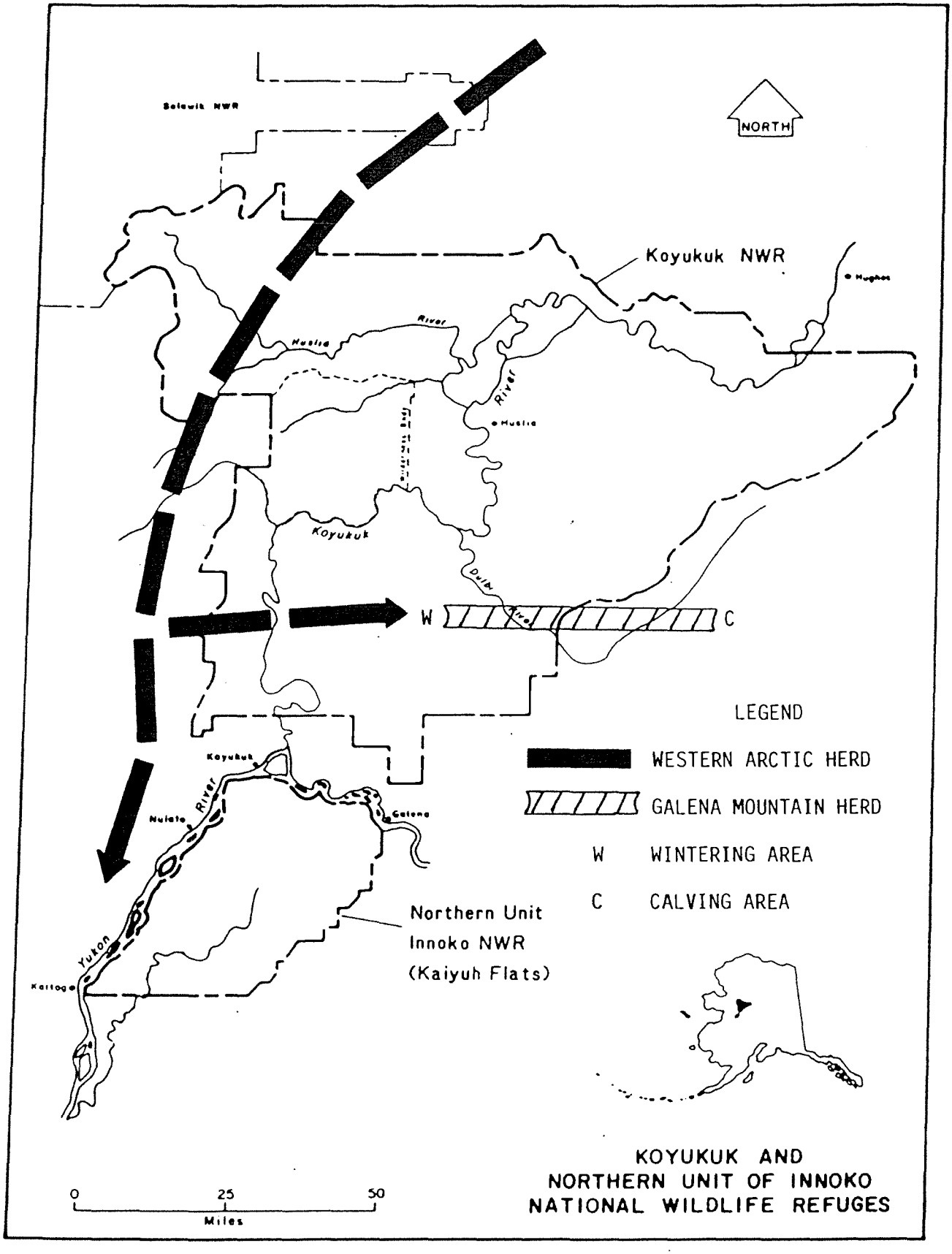
Wolves range through the Koyukuk NWR and the Kaiyuh Flats Unit. Though wolves prey on a variety of species, they are primarily dependent on large ungulates. Their numbers tend to respond to population fluctuations of the large ungulates. In addition to prey numbers, harvest intensity of wolves is another factor determining the wolf population of an area. Koyukuk NWR and the Kaiyuh Flats Unit currently have both healthy moose and wolf populations.

Wolf track surveys were attempted in March and April but due to poor snow conditions the survey was not completed. Word was received in January that one of the wolves collared in 1986 was still on the air. The wolf, a gray female, was last located by Arctic Refuge staff east of the Lupine River. This wolf was collared on the Kaiyuh Flats and had moved over 450 miles.

D. Bears

Black bears are abundant in the forested lowland habitat of the refuge. Hunting pressure is low and habitat quality is excellent. About 40% of the refuge is rated as good habitat for black bears.

Figure 4. General caribou migration patterns - Koyukuk NWR - 1989



Grizzly bears, while uncommon, can be found on the refuge in open upland areas. No grizzly bears were sighted by the staff on the refuge in 1989, although residents of Hughes, Huslia, and Koyukuk reported recent increases in sighthings.

E. Furbearers

Many furbearers occur on the refuge. Marten and beaver particular are highly sought after by trappers. Other important furbearers include lynx, wolverine, red fox, mink, river otter, and low numbers of muskrat and coyotes. Little is known about the distribution and population trends of these species.

A beaver cache survey was attempted throughout October but due to poor snow conditions and time constraints the survey was not completed.

Over 40% of the refuge land cover is rated good to excellent for black bear. Based on staff and local observation the population is estimated to be healthy. (MRB)

10. Other Resident Wildlife

Willow and rock ptarmigan occur on the refuge. Willow ptarmigan numbers have increased tremendously during recent years. Hundreds of ptarmigan could be observed on any given morning in Galena during the 88-89 winter. Apparently the severe weather of winter 88-89 took its toll on ptarmigan however, and few ptarmigan were observed near Galena during the 89-90 winter.

Rock ptarmigan occur at higher elevations of the refuge. Spruce and ruffed grouse are also common inhabitants of the refuge. Porcupine, short-tailed weasel, snowshoe hare, red squirrel and other small mammals occur here. Muskrat numbers have been extremely low in recent years. Little is known about population levels or geographic distribution of the aforementioned animals.

The only known amphibian present is the boreal frog, or wood frog. This species is numerous in shallow refuge ponds and marshes throughout the refuge.

11. Fishery Resources

Anadromous species found in the Koyukuk River include chum, chinook and coho salmon. Chum salmon, summer and fall runs, and chinook salmon are the primary subsistence fish of the refuge. Coho and sockeye are occasionally taken while pinks are rarely harvested.

Fresh water species found on the refuge include sheefish and burbot, both of which are important subsistence species. Other species which occur are broad whitefish, humpback whitefish, Alaska blackfish, least cisco, Arctic grayling, longnose sucker, northern pike, and ninespine stickleback.

16. Marking and banding

A limited banding effort this year resulted in the banding of 232 white-fronted geese and 140 pintails. Drive nets were used on the Dulbi River to capture molting white-fronted geese during the second week of July. Nets were positioned on the inside turn of oxbow bends in the river and were attended by at least 3 personnel with two canoes. The capture sites were carefully chosen from the air and positioned about 1-2 miles downstream from molting flocks of white-fronted geese. The Cessna 185 then ferried another person and canoe above the flocks. While the canoeist slowly pushed the flocks downstream the pilot attempted to stop the birds so they did not escape by running up the banks. As the birds swam past the capture site personnel on the opposite bank pushed the birds into the leading edge of the drive net and into the holding pen. A total of 232 birds were banded which included four banded adults. Sex and age-ratio information are in Table 18 (one bird was not sexed).

Table 18. Sex and age class composition of white-fronted geese banded in 1989, Dulbi River, Koyukuk NWR.

Males	Females	Local	Second Year	After Second Year
127	104	8	53	171

Sex Ratios: 55:45 Age ratio: 3:97

Over 230 white-fronted geese were captured using drive nets in 1989. This capture site was located about six miles up from the mouth of the Dulbi River. (MRB)

On August 14 and 16 we captured and banded 140 northern pintails on Boat Lake with the use of rocket nets. The capture site was prebaited daily with about 50 pounds of barley and corn daily for four days. It is estimated that several thousand ducks were in the vicinity at the time of baiting - primarily wigeon. The location of the capture site, which was on a grassy knoll about 30 yards up the bank, attracted primarily pintails. Over 90% of the catch was pintail. In addition, about 15 green-winged teal were captured and released unbanded. We were only able to make two rocket net shots over a three day period as birds became extremely wary. We will likely set up rocket nets on alternative

sites in the future in an attempt to reduce disturbance to a single site. Walk-in traps were also constructed but had no success. Table 19 is a summary of the sex and age class composition of the banded birds (one bird was not sexed).

Table 19. Sex and age class composition of banded Northern Pintails, Boat Lake, Koyukuk NWR, 1989.

Males	Females	Hatch Year	After Hatch Year
38	101	40	100
Sex Ratios:	27:73	Age ratio:	29:71

The hatch year to after hatch year ratio favored adult birds which reflected a poor reproductive year for pintails in 1989. Waterfowl brood surveys on the Koyukuk and Nowitna refuges, likewise, indicated a poor reproductive year for waterfowl in general (see Section G.3.)

This year 140 pintails were captured by firing a cannon net twice over a site pre-baited with corn. (MRB)

A funnel trap baited with corn was also used for banding, but was not as successful as the rocket net. (MRB)

H. PUBLIC USE

1. General

One major public use activity on the Koyukuk complex is subsistence which is conducted by people living near or within the exterior boundaries of the refuge. This includes residents of Galena, Huslia, Ruby, Hughes, Koyukuk, Kaltag and Nulato. In addition to hunting, fishing and trapping, other subsistence activities include berry picking and wood cutting. Sport hunters and fishermen from Anchorage and Fairbanks use the refuge to a lesser but rapidly increasing degree.

Access to approximately 60% of the refuge is limited by State regulation to non-aircraft modes of transportation for moose hunting in September and this allows collection of good data at the hunter check station on the Koyukuk River.

An increased effort to reach local residents was initiated this year. We began active EE programs in the schools with 15 programs presented to and monthly radio programs starting in November. The Refuge's first public exhibit appeared in Galena in October also, we made significant progress toward publication of what we anticipate will be a semi-annual leaflet discussing refuge programs and events. The brochure is scheduled to be published in April, 1990 and will be tailored to the 2,000 plus residents in local villages.

Materials for National Wildlife Week were mailed to Hughes, Huslia, Nulato, Kaltag and Galena schools in February. Wildlife Biologist Bertram gave a presentation to high school students at the Huslia school on February 21.

6. Interpretive Exhibits/Demonstrations

The staff prepared and staffed a refuge display at the Koyukon Jamboree held on October 15-16 in Galena. The exhibit featured a refuge map, slide shows, wildlife mounts, literature, and raffles for adults and kids. In addition to agency and organization exhibits, this first-ever jamboree featured Native sewing exhibits, workshops for young people, Native games, two potlatches and two fiddle dances.

7. Other Interpretive Programs

Two radio programs were taped in November and December to assist with another mode of providing information on refuge activities to the public. Fortunately the radio station in Galena broadcasts to all of the villages in or near the refuge. The first program dealt with a variety of issues but centered on the new policy of fire protection for permitted cabins on the refuge. The second program provided an overview of the moose populations and the past hunting season. Both programs repeated several times over the course of the two days.

8. Hunting

Moose and black bear are the major sport and subsistence species hunted on the refuge. However, ducks, geese, snowshoe hare, grouse, ptarmigan, sandhill cranes, caribou and grizzly bears are also taken. While total take for most species is unknown, subsistence studies in Huslia, Hughes, and Koyukuk during the last several years have given us a general estimate for the subsistence harvest.

Most of the refuge is also covered by the Koyukuk Controlled Use Area established by the Game Board which closes the area "during all open moose hunting seasons to the use of aircraft in any manner for hunting moose, including transportation of moose hunters into or within this area, and the transportation of moose parts to or from this area."

In November of 1988 the Alaska Department of Fish and Game, over the objections of the Refuge, opened Game Management Unit (GMU) 21D within portions of the Refuge by emergency order to the taking of caribou. This was in response to several thousand caribou of the Western Arctic herd unexpectedly occupying a portion of GMU 21D which is closed to caribou hunting at this time of year. The refuge opposed the idea because of our concern that the potential to kill caribou in the small resident Galena

Mountain herd was too great. The season was closed - again by emergency order - on January 11. To our knowledge no animals from the Galena Mountain herd were harvested. Harvest of Western Arctic herd caribou was signigicant only in areas where the herd winters near villages-- north of Huslia and west of Nulato.

An emergency order was issued on January 5 by the Alaska Department of Fish and Game to prohibit moose hunting in the February subsistence season within 1/2 mile of the Yukon River. This requirement has been a regulation for several years but somehow failed to be incorporated into the State's regulation book this year.

The request for special use permits to conduct guided hunts on the refuge increased dramatically this year when four new requests were received. One individual was from the local area (Ruby) and the three others from the Anchorage vicinity. Because of the regional policy limiting guides to the same level of activity as in 1988 all four were denied permits. The policy stems from a State Supreme Court decision (Owsichek vs State of Alaska) that ruled exclusive guide areas unconstitutional. Until the State settles this issue commercial hunting guides will be authorized only at the 1988 level.

The only permit issued for commercially guided hunts was provided to Jake's Alaska Wilderness Outfitters for guiding moose hunters. Jake Gaudet had requested an increase in clients from 4 in 1988 to ten this year but this request was denied due to the same regional policy as discussed above. All four clients were successful in taking a moose.

Hunter Check Station. Area Game Biologist Osborne has operated a hunter check station on the Koyukuk River just south of the refuge boundary for the past seven years. Because the entire Koyukuk River within the Refuge boundary is part of a controlled use area baring aircraft access for moose hunting, the check station provides a good source of harvest information for the majority of refuge hunters that gain access from the Yukon River. This includes many of the local residents and virtually all hunters that do not reside in the local area.

A total of 158 moose were checked this year. This compares to total of 181 moose and 143 moose in 1987 and 1986, respectively. There has been, however, a significant increase in the number of non-local hunters in recent years (Table 20). Of the 302 hunters, 154 were local game management unit 21D residents, 125 were non-local state residents, and 23 were out of state residents. Although the increased hunting pressure is not currently affecting growth of the moose population, a moose management plan is being considered to address future management considerations.

Table 20. Number of moose hunters by residency class checked through the Koyukuk River Check Station*.

Year	Non-Local	Non-Res.	Unit Res.	Total Hunters
1983	29	3	132[1]	164
1984	67	9	92[1]	168
1985	74	4	117[1]	195
1986	80	9	140[1]	229
1987	92	21	151[2]	264
1988	121	17	158[3]	299
1989	125	23	154[4]	302

* checking in and out is not mandatory and compliance was lower during the first year, 1983.

1 includes every trip made by hunter

2 Hunters counted only once. By city - Galena 84, Koyukuk 40, Nulato 23, Huslia 4.

3 By city - Galena 82, Koyukuk 45, Nulato 29, Ruby 1, Kaltag 1.

4 By city - Galena 84, Koyukuk 40, Nulato 23, Huslia 4.

One transporter (Tundra Air) was permitted to fly clients into the Koyukuk - primarily for moose hunting. He reported transporting no clients into the refuge.

Wolf hunting is done both with the use of snowmachines and airplanes. The wolf hunting season runs from August 10 through April 30 with a limit of 10 wolves. Most wolf hunting with the use of aircraft occurs in March when a combination of warming temperatures, adequate daylight (approximately 14 hours), and deep snow for tracking and limiting wolf movement, all combine to make land-and-shoot hunting possible.

Legal aerial hunting of wolves which was historically done as a State sanctioned population control method or as a legal sport hunting method, does not now occur in any form on the Koyukuk. However, illegal aerial hunting of wolves does occur in the State and especially the northern reaches of boreal forest and open tundra of which the Koyukuk is a part. Each year in late winter several land-and-shoot wolf hunters come to Galena. Although legal land-and-shoot wolf hunting does occur, the temptation also exists to shoot while airborne, communicate between aircraft, or herd animals into large lakes or openings suitable for landing. The number of wolves taken with the use of aircraft in 1989, legal or illegal, is not known.

9. Fishing

Fishery resources provide a very important source of protein for local residents. The subsistence studies done in Huslia, Hughes,

and Koyukuk in the past several years show an annual harvest from 14,000 to 22,000 salmon. The summer chum salmon run accounts for the bulk of fish harvested for subsistence. Most are preserved by drying or smoking. King salmon and fall chums are also important but runs are smaller. Sheefish, whitefish, grayling and pike are also harvested by local subsistence users. There is no commercial fishing on the refuge.

Most fish harvested for subsistence are taken in set nets. Fish wheels are not used on the Koyukuk River. Blackfish are taken in funnel traps and burbot are taken with nets or trot-lines set under the ice in the winter.

In addition to being eaten by people, summer chums are also commonly fed to dogs and used as trapping bait.

Sport fishing is usually done in conjunction with hunting trips by non-local residents, however, there is some sport fishing by residents of Galena. Northern pike, grayling and sheefish are the primary species caught.

10. Trapping

Trapping provides an important source of cash for residents of the villages of Hughes, Huslia, Koyukuk, Nulato, Kaltag and Galena. The reported take of furbearers in these villages is as follows: Beaver 508, Lynx 8, Otter 22, Wolf 19, and Wolverine 11.

Traplines are not registered but are generally passed down from generation to generation within a family. Thus, claim for a certain area for trapping is recognized and respected by other local residents and disputes are not common, however, they can be very heated when they do occur.

Beaver trapping is treated slightly different from other trapping in that beaver areas are often shared by several people, perhaps because of their importance as a food item.

Snowmobiles are the primary means of transportation for trapping with a few individuals traveling up to 200 miles round trip on the trapline. Dog teams are used by a few trappers and some simply walk their traplines. Marten are taken using pole sets and cubby sets. Beaver are taken with snares through the ice. Most wolves are shot rather than actually trapped.

17. Law Enforcement

The station had two commissioned Refuge Law Enforcement Officers during 1989, Manager Nunn and ARM/P. Rost. Required refresher training and handgun qualifications were attended. Informal and opportunistic patrols were made in conjunction with other field

WLB Mark Bertram presents an environmantal education program to a village class. Presentations were made in Galena, Kaltag, Hulato, Koyukuk, Huslia and Ruby during the year. (PEL)

The staff commented on a draft report of the public use management review conducted in August, 1988. By year's end a final of this report which outlines goals and objectives had not been received from the regional education, interpretation and information division.

2. Outdoor Classrooms - Students

Regional EE Specialist Ady visited the refuge on January 17 and 18 to interview staff in regard to the refuge public use management plan. An additional purpose was to assist the staff in launching our program of visits to local schools to make EE presentations. Although we were able to capitalize on Janet's expertise and ideas, all village school trips had to be postponed due to the cold snap which curtailed aircraft travel.

In March, Wildlife Biologist Bertram and Yukon Delta NWR pilot Walters made visits and presented EE programs to schools in Koyukuk, Kaltag, and Nulato schools. In April Bertram and Johnson gave a presentation to the Galena 7th grade class.

Eleven EE programs were presented by four staff members in December to classes in Galena, Kaltag, Ruby and Koyukuk. Topics included predation, refuges, and spring waterfowl hunting. Poor weather during the month prevented visits to Huslia, Hughes and Nulato.

activities throughout the year. Separate patrols were conducted during the September moose season. Also, Special Agent Gary Mowad, from Anchorage, spent several days on patrol on the refuge.

I. Equipment and Facilities

1. New Construction

Plans remain on hold for a new office/shop/hangar complex in Galena. The 65% preliminary design was completed in 1988 and we are now awaiting construction funding which is 5-6 years away based on our priority within the region. Even a coat of paint will not create a conference room and 4-5 more work stations spaces,or just one maintenance garage.

2. Rehabilitation

Refuge headquarters received a much needed facelift this year. We spent many hours preparing and painting the building in June. The results are obvious!

Finally, the headquarters received a much needed dose of paint. MG

Former Quarters #9, commonly known as the "little house", was converted into a bunkhouse in August. This dwelling is cramped for large families, but makes a great bunkhouse. Contractors arrived on June 6 to remove asbestos covering from pipes underneath the office and beneath the bunkhouse. The job was quickly completed and the contractors were on their way back to

Anchorage the next day. Unfortunately, the soil samples that were taken indicated asbestos particles were interspersed throughout the crawl spaces. Funds are not currently available to remove this contaminated soil. Asbestos signs have been posted and the staff made aware of the situation. Fluorescent lights were installed in the shop/storage rooms in quarters 1-6.

3. Major Maintenance

The winter of '88-89 will always be a vivid memory for those members of the staff lucky enough to be in Galena! On 17 January, Joy Rost returned from a weekend trip to Anchorage to find that the outside and inside temperature was a chilly -66°F. The furnace had tripped the breaker sometime during the night, allowing Quarters #2 to freeze. The house had frozen so quickly that the plants didn't even have a chance to wilt. The remainder of the week was spent repairing plumbing. The final tally was 47 breaks, 3 fractured valves, 1 broken water pump and $4,300.00. This was an expensive lesson to learn! Sensaphones have since been purchased for all quarters and have prevented similar occurrences.

On 18 January, as the temperature continued to drop, a water pipe in the office burst and was quickly repaired. The furnace was running continuously and could only maintain a temperature of 45°F. A little known fact that was discovered during this cold spell is that paraffins in fuel oil gel at temperatures colder than -60°F. causing furnaces to quit! It was at this time that RM Nunn coined the term "using heaters to heat heaters". As the temperature plummeted to -88°F on 27 January (new unofficial North American record low), refuge operations came to a standstill. Everyone stood vigil over their furnaces praying that they wouldn't quit. The cold also took a severe toll on refuge trucks which included frozen batteries, broken gear shifts, u-joints, fan belts and circulating pumps. A gallon of anti-freeze was found in one truck frozen solid. In retrospect, it would have been much simpler if everyone would have stayed at home, watched their furnaces and weathered the storm. By months end, the temperature had risen to a scorching -45°F., but the residual cold had frozen the sewer pipe buried underneath the office. Eventually, this was unplugged with a strong dose of hot water.

High noon over the Yukon River on the winter solstice. Low sun angle, clear skies, and lack of winds allow night time temperatures to drop to -80°F during the night. Record cold in January 1989 caused numerous vehicle and building maintenance problems.

On 9 May, while waiting in the dark for contractors to repair a severed underground power cable caused by frost heave, a D-8 Cat hit the side of the building, or so we thought! A quick inspection produced nothing but confusion. Reports indicated we had experienced an earthquake that measured 4.8 on the Richter scale and was centered "130 miles north of McGrath", which puts it about <u>in the middle of Galena</u>! Later that day, contractors turned the power back on only to have a main circuit breaker blow, literally. Pieces of hot breaker started a small grass fire beside the transformer behind the office and was extinguished immediately in compliance with the new DOI Fire Management Policy. While all this was going on, the Yukon River was threatening to flood! Eventually, the ice trickled slowly past Galena but not before flooding several hundred square miles of the Nowitna National Wildlife Refuge 60 miles upstream. A power outage, a grass fire, an earthquake and an impending flood, coupled with the coldest winter on records, sounds like the makings of a great country and western song! Stand by for words and music.

Koyukuk NWR aircraft, a Super Cub (left), and the Nowitna NWR aircraft, a Cessna 185 (right), are docked in summer at in front of Quarters No. 3 on Alexander Lake in Galena. Both refuges exhange aircraft when jobs require differing capability. The dock makes loading and unloading of aircraft easier and safer. Winter storage and re-installation of the heavy wood dock, however, each year is hazardous and unsafe. We hope to replace it with a lighter floating plastic dock.

Near record winter precipitation, combined with a cold spring, and an ice-jam, caused the Yukon to nearly overflow it's banks at Galena in 1989.

The local automotive shop completed repairs on the Chevy suburban that was driven off the dike road by a contractor in October of 1988. The bill was $7,200.00! The grief and headaches resulting from this accident were free!

Twenty-three loads of gravel were delivered to the six residences to widen driveways and fill holes caused by frost heave and snow melt.

4. Equipment Utilization and Replacement

Major equipment received during 1989 included a 1988 Chevy S-10 Blazer, six sensaphones, one Anthes forced air heater, four Reddy forced air heaters, eights pairs of binoculars and a fax machine.

5. Communications

A new telephone system was ordered in December. The fight for an adequate radio system has been exhausting. It was learned in November of 1988 that the existing system was inoperable with existing equipment. The Regional Office informed us that we were given top priority and would have the system functional by mid-April. By early June, the repeater at Purcell Mountain was working, giving us partial coverage of the north end of the refuge. Still, no communication from headquarters to the field was available. At month's end, our system was interfering with the Innoko N.W.R.'s radio system. This problem was remedied and by the end of July the repeater on Totson Mountain was working

although Purcell and Hill 2321 repeaters had failed. On the 3rd of August, all three repeaters were serviced and we finally had communications to the field. The battle had been won, or so we thought until the base radio malfunctioned in November! Another field season had come and gone and radio communications was far from adequate.

J. OTHER ITEMS

1. Cooperative Programs

The Refuge provided aircraft support for an Alaska Department of Fish and Game Fisheries Biologist and an Alaska Fish and Wildlife Research Center Geneticist on July 15. Two trips were made to the Gisasa River where they were conducting work on the salmon fishery as part of the U.S./Canada Yukon River treaty negotiations.

4. Credits

ARM Liedberg wrote sections A., B., C., E., H., J., parts of D. and compiled and the report. WB's Bertram and Bodkin wrote section G. and parts of D. FMO Granger wrote section F. RM Nunn provided the Feedback comments. RM Stearns and ARM/P Spindler did the editing. Maudrey Honea and Donna Bodkin helped with typing and assembly.

K. FEEDBACK

Nineteen hundred and eighty-nine was a year of extremes at Galena. The year began with new record low temperatures established for the North American Continent (-88 F if you can believe an unofficial thermometer). During that two week period, every day life was very basic - first order of the day was survival. Oh well, that's life on the tundra.

Spring came and waterfowl pairs were everywhere. Shortly after the peak of waterfowl nesting began in June, however, the best waterfowl nesting habitat flooded and thousands of nests were destroyed.

Later in June, tragedy struck when a plane crash claimed the lives of Greg & Joy Rost and Tim Patton. The entire refuge crew was devastated by this loss, but somehow managed to pull together and complete a successful field season.

On a more positive note, the Nowitna and Koyukuk Refuges were finally combined as a complex under one administration. This change has seemed inevitable for some time and it is a relief to have it accomplished. We are sure that it will be a more efficient way of doing business and will better serve the resource and the public.

Advertisements for vacant positions early in the year resulted in 7-9 qualified candidates each. We think that this is largely the result of the new Administrative Return Rights for Alaska Duty Stations which assures applicants that they won't get "stuck" in Alaska. Our thanks to the Regional Office for a policy that is responsive to the needs of field stations and one that appears to be the solution to a long standing problem.

After 5 years of effort we finally have a radio system installed that works most of the time. Thanks again!

There is still at least one problem in the area of recruitment that needs to be solved for the long term benefit of Region 7. Somehow, the pool of qualified candidates for dual function pilots must be increased. Regional Aircraft Manager Sarvis' recent issue paper identified many alternatives that at least partially solve the problem. The only long term solution is, of course, to provide pilot training for biologists and assistant managers that, already in Alaska, have an interest in learning to fly and are willing to make some commitment to use their piloting skills for some minimum amount of time after completing the training. Hopefully, the R.O. and W.O. will agree with Sarvis and take this opportunity to solve another serious problem. Good luck!