Fishery Investigation of the Moose River

Kenai National Wildlife Refuge, Alaska, 1985 and 1986

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Fishery Investigation of the Moose River Kenai National Wildlife Refuge, Alaska, 1985 and 1986

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Abstract -An inventory of fishery resources in the Moose River watershed, Kenai National Wildlife Refuge, Alaska, was conducted during the summers of 1985 and 1986 Information on species composition, abundance, distribution, run timing, migrational movements, and use of spawning areas was obtained Water quality and discharge measurements were taken, and a limited recreational use survey was conducted

The watershed supports 16 species of fish, including four species of Pacific salmon *Oncorhynchus* spp , rainbow trout *O mykiss*, Dolly Varden *Salvelinus malma*, round whitefish *Prosopium cylindraceum*, threespine stickleback *Gasterosteus aculeatus*, ninespine stickleback *Pungitius pungitius*, coastrange sculpin *Cottus aleuticus*, slimy sculpin *C cognatus*, Pacific lamprey *Lampetra tridentata*, Arctic lamprey *L japonica*, longnose sucker *Catostomus catostomus*, eulachon *Thaleichthys pacificus*, and northern pike *Esox lucius*

The early-run of sockeye salmon *O nerka* numbered 690 fish in 1985 and 2,071 fish in 1986. Early-run sockeye migrated upstream in June and July and spawned in the mainstem Moose River Late-run sockeye salmon escapement numbered 2,088 in 1985 and 847 in 1986, sockeye moved upriver in July and August and spawned in headwater lakes Coho salmon *O kisutch* numbered 1,657 in 1985 and 3,969 in 1986, coho salmon began arriving at the weir in August and continued through early October when the weir was dismantled. Rainbow trout were found throughout the watershed and spawned from May to early June in the mainstem, East and West Forks of the Moose River

Sockeye and coho salmon smolts outmigrated in May and early June. Young-of-the-year of both species moved downstream in large numbers during August and September. The highest densities of juvenile salmon were found in the lower three kilometers of the river

A total of 781 and 883 boaters were interviewed at the weir in 1985 and 1986, respectively In 1986, 398 anglers fished a total of 275 hours and caught 87 rainbow trout

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Introduction

The Kenai River is one of the most productive salmon streams in Southcentral Alaska, supporting substantial runs of chinook *Oncorhynchus tshawytscha*, sockeye *O. nerka*, pink *O gorbuscha*, and coho salmon *O kisutch*. These salmon runs support the state's most popular sport fishery and contribute one to three million salmon each year to the Cook Inlet commercial fishery (Mills 1986; Ruesch 1986).

The Moose River is the largest watershed within the Kenai River drainage and lies almost entirely within Kenai National Wildlife Refuge (Refuge) boundaries (Figure 1). Studies of the Moose River drainage prior to this investigation are limited to. (1) a survey of 37 lakes in the watershed (U.S. Fish and Wildlife Service, *unpublished data*); (2) the collection of rainbow trout *O mykiss* eggs in the East Fork of the river (Lawler 1964); and, (3) an evaluation of sampling methods for fish population assessment (Lorenz 1984).

These studies indicate that the Moose River drainage provides spawning and rearing habitat for salmon, rainbow trout and Dolly Varden *Salvelinus malma*. However, the limited fishery data base for the watershed has prevented formulation of management strategies to insure protection and conservation of its fish populations. The Refuge Comprehensive Conservation Plan classified the land area of the Moose River watershed into the following management categories. Intensive Management 4%, Moderate Management 31%, Traditional Management 25%, Wilderness 36%, and off-Refuge 4%

An inventory of fishery resources in the Moose River watershed was conducted during 1985 and 1986 to provide information for management of the resource. The study objectives were to:

1. Determine species composition, abundance and distribution of selected resident and anadromous species;
2. Determine run timing, migrational movements, and spawning sites of selected species;
3. Determine outmigration timing of juvenile salmon,
4. Describe water quality and discharge characteristics; and,
5. Determine recreational angling and boat use on the Moose River.

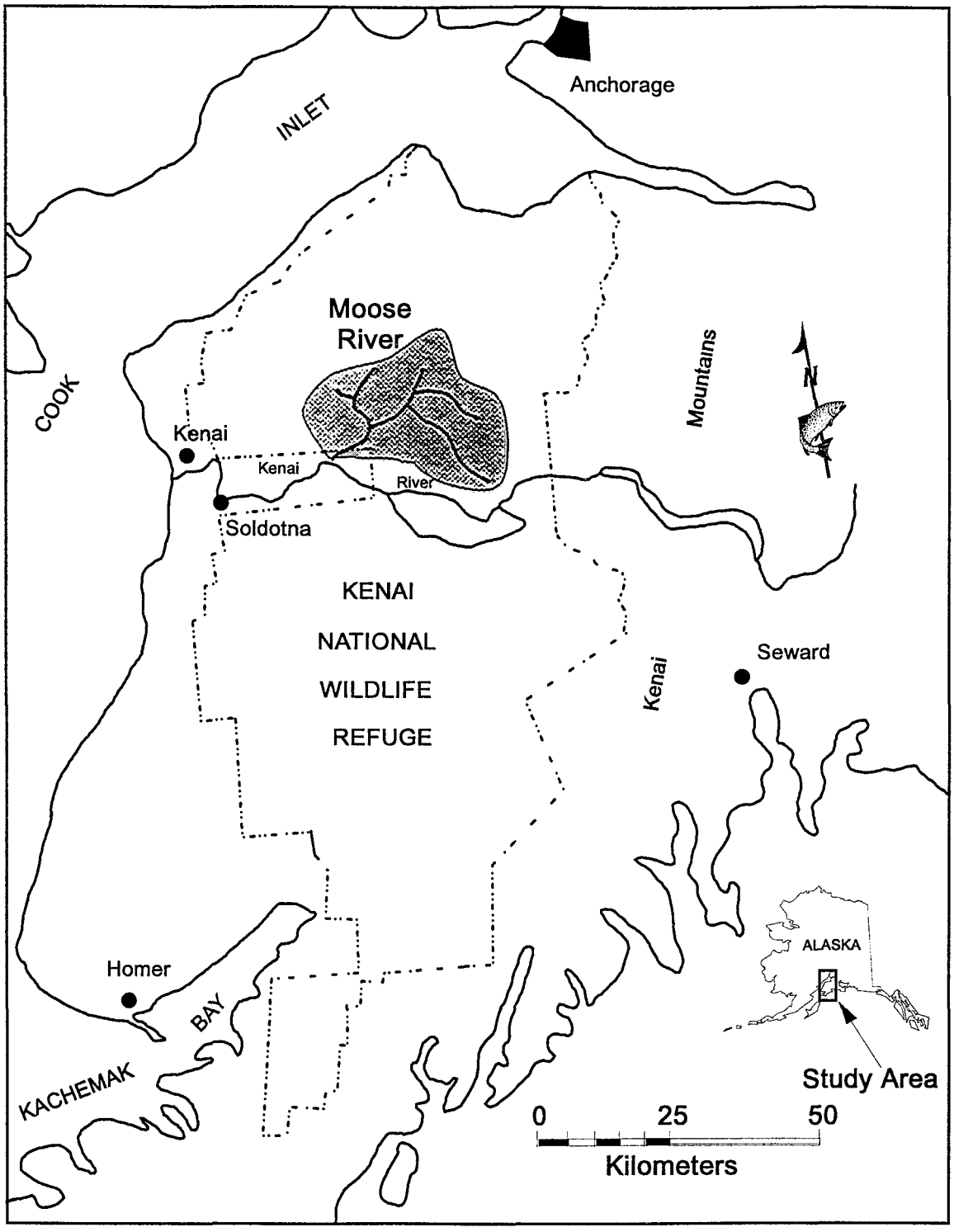

FIGURE 1.–Location of the Moose River watershed, Kenai National Wildlife Refuge, Alaska.

Study Area

The Moose River watershed consists of 3,456 km^2 of lowland habitat which drains into the Kenai River at river kilometer (rkm) 58.4 near the town of Sterling, Alaska (Figure 2) The watershed contains approximately 188 km of streams, 60 named lakes, and over 200 unnamed lakes and ponds All but about 3 km of the river (4% of the watershed) lies within the Refuge.

The Moose River originates at the outlet of Bear Lake (elevation 82 m), and is joined by six tributaries before entering the Kenai River 39 rkm from its source. The upper section begins at the outlet of Bear Lake and continues downstream to just below the confluence with Browse Creek (rkm 22 8). Border, Pipeline and Browse creeks, and the Coyote Lake basin contribute flow to this section of the river

The middle section of the Moose River watershed flows from rkm 22.8 through rkm 9 0. Three major tributaries enter the system in this section: Moosehorn Creek, and East and West forks of the Moose River

The lower section of the Moose River watershed lies between rkm 9 0 and the Kenai River. The upper 5 8 km of this river section is characterized by slow current, a meandering channel, moderately bog stained water and extensive aquatic vegetation. The lower 3 km section is straight, wide and shallow It also has an abundance of aquatic vegetation. At summer water levels the Kenai River acts as a dam and backs water into this lower section.

Forested areas in the Moose River watershed are comprised primarily of white *Picea glauca* and black spruce *P. mariana*, aspen *Populus tremuloides*, and birch *Betula sp* Much of the watershed is composed of swampy forests of black spruce intermixed with boggy lowlands and grassy meadows White spruce is found in the drier areas on low ridges and hills. Both spruce types intermix throughout the basin and co-occur with birch and aspen.

Methods

Adult Salmon

Abundance and run timing.—To determine composition, abundance and run timing of adult salmon, a weir (Anderson and McDonald 1978) was constructed at rkm 7.4 and operated 9 June to 3 October, 1985 and 7 May to 2 October, 1986. Adult fish were identified to species and counted after being trapped in a 2-m^2 holding area built into the weir face. After fish were counted they were passed upstream. The weir was monitored 24 h/day Salmon passage was stratified by week (Mon.-Sun.) to determine peaks of escapement

In 1986, weir escapement totals for sockeye salmon included counts at the weir and estimates derived from spawning ground counts because of undetected escapement through the weir. These estimates were calculated using the area under-the-curve (AUC) method (Ames

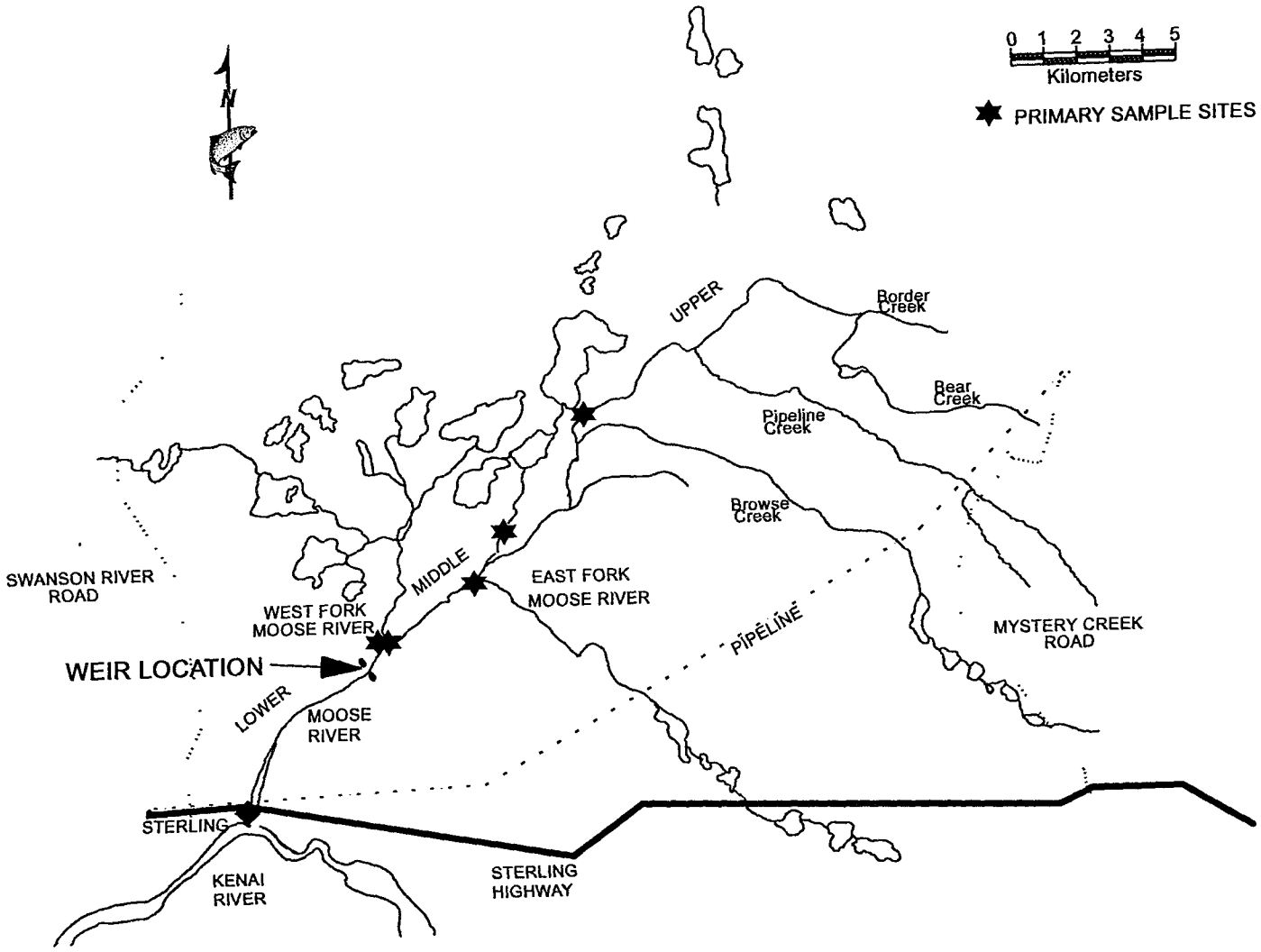

FIGURE 2.–Location of the weir in the Moose River watershed, Alaska.

1984) During parts of August and September in 1985, when the weir was inoperable due to high water, fish passage was estimated by·

$$\text{Escapement} = DxF$$

D = the number of days inoperable
F = the mean number of fish passed/day for a period 2 d before and 2 d after the inoperable period

Sockeye salmon were divided into an early and late-run based on external morphology Late-run fish were bright silver in color, had loose scales, and less kype development than early-run fish. The beginning of the late-run was determined when fish showing these external characteristics first appeared in the weekly escapement.

Age, length and weight —A random sample of up to 10 salmon of each species was measured (mid-eye fork length) to the nearest mm, weighed to the nearest 25 g, sexed and sampled for scales each day. Four scales were removed from the preferred area (Ambrose 1983). Scale impressions were made on acetate sheets and examined using a microfiche reader. Ages were assigned using the European Method (Koo 1962). The age composition of adult salmon was stratified into bi-weekly periods to evaluate changes throughout the run.

Spawning distribution —Adult salmon distribution was determined by radiotelemetry, ground and aerial surveys in 1985 and 1986 Ground surveys were conducted by foot and canoe on the Moose River and three tributaries Aerial surveys were conducted from a Cessna® 206 at an altitude of 100 m and an airspeed of approximately 80 knots. Fish abundance, species present and location were recorded on 1·63,000 scale topographic maps and plotted over time. Fish distribution in lakes was obtained from data collected during lake surveys conducted by the Alaska Department of Fish and Game (Department) and the U S. Fish and Wildlife Service (Service)

Five sockeye salmon captured at the weir in June 1985 were fitted with Advanced Telemetry Systems (ATS®) radio transmitters (90 day, 25g, 167 mHz) to locate spawning areas Transmitters were <2% of the body weight (out of water) of all fish tagged. Transmitters were secured with stainless steel pins (epoxied to the transmitters) inserted through the interneural bones below the dorsal fin. Peterson disc tags were threaded over the pins on the opposite side of the fish and held in place by twisting the pins against the discs. Fish were released into a live box to test transmitter operation and allow them to recover from handling before release into the river To minimize stress to fish, transmitters were attached without using an anaesthetic (Wedemeyer 1970).

Radio-tagged fish were monitored using a Telonics® receiver and H-antennae. Aerial tracking was conducted over the entire watershed while ground tracking was limited to the mainstem between the weir site and East Fork of the Moose River. Tracking occurred on a weekly basis in July. Telemetry flights were conducted at an altitude of 500 m and an air speed of approximately 80 knots.

Juvenile Salmon

Outmigration timing —An inclined plane trap was installed in the Moose River approximately 20 m downstream from the weir to determine the timing of outmigrating salmon smolts The trap was operated from 20 May to 2 October, 1986; its design was similar to models previously built by the Department (Flagg et al. 1985). The trap was operated 24 h/d and checked daily at 0900 hours All fish in the holding box were identified and counted.

Age and length —A random sample of up to 20 juveniles of each salmonid species was removed from the inclined plane trap each day and anesthetized with tricaine methane sulfonate (MS-222) to facilitate handling. Fish were measured (fork length) to the nearest mm and sampled for scales. Scales were taken from the preferred area (Ambrose 1983). Scales were mounted between glass slides and examined with a microfiche reader to determine age.

Distribution.—The distribution of juvenile salmonids was investigated by sampling the mainstem Moose River, major tributary streams, and the inlets and outlets of headwater lakes connected to the mainstem Moose River. Sampling was conducted with overnight sets of minnow traps baited with preserved salmon eggs. A fyke trap (0.9 m in diameter, 2 7 m long, with two 2.7 m wings and 5 mm mesh) was also used in the lower river The number of trap hours was recorded for each water body sampled; all fish were identified, counted and released.

Resident and Other Fish Species

Migration patterns —Rainbow trout and round whitefish were tagged in 1986 to determine migrational patterns Rainbow trout (>200 mm fork length) captured at the weir and by hook and line during stream surveys, were tagged with numbered Floy® FD68B anchor tags. Information obtained from tagged fish recovered at the weir or by anglers included tag number, date, location and length of fish.

Five round whitefish captured at the weir were tagged with ATS® transmitters (external 30-day, 11 g, 40 mHz) to track their migrational patterns Tagging and tracking procedures were similar to those previously described for sockeye salmon

Age, length and weight.—Resident fish species captured at the weir were measured to the nearest mm (fork length) and weighed to the nearest 25 g with the exception of stickleback, sculpin and Arctic lamprey which were weighed to the nearest g. Sex was determined by external morphology of live fish and gonadal examination of dead fish Scales were collected from the preferred area (Ambrose 1983) and were used to back-calculate mean annual growth of rainbow trout and round whitefish using the formula (Hile 1970):

$$\frac{FL}{SL} = \frac{X}{A}$$

FL = Fork length of fish
SL = Scale length
X = Fish length at age
A = Scale length at annulus formation

Distribution —Distribution of resident and other species was determined by hook and line, minnow traps, visual observations and historical data Sampling was conducted at five primary sites in the Moose River watershed (Figure 2): l) weir (rkm 7.4); 2) West Fork of the Moose River (rkm 9.0); 3) East Fork of the Moose River (rkm 15.8); 4) Moosehorn Creek (rkm 17.2); and 5) Swan Lake portage (rkm 23 6). Tributary sampling was conducted 100 to 200 m upstream of their respective confluences with the mainstem. In addition, sampling occurred at Bear Lake outlet, Border, Pipeline and Browse creeks and Moose River (rkm 17.0).

Water Quality and Discharge

Physical and chemical parameters were measured during stream surveys on the mainstem Moose River and tributaries. Water samples and stream flows were taken on seven occasions during 1985 and 1986. A Hach® test kit Model 17-F was used to measure pH. Conductivity and temperature were measured with a YSI® 33 S-C-T meter. Water samples from each sampling site were analyzed in the laboratory using Hach® titration kits to determine total hardness and total alkalinity.

Discharge measurements were calculated with a velocities measured from a Marsh McBirney® Model 201D and width and depth measurements. Stream widths were divided into cells with no cell equaling more than 10% of the total width of the stream. Current velocities were measured at six-tenths of the depth below the surface (Orth 1983).

Recreational Use

Boaters were interviewed at the weir site to estimate recreational boating use and angling in the Moose River drainage. All boats passing the weir were counted and occupants were interviewed to determine type of watercraft, number of people per boat, number of anglers, trip origin and angling activities.

Results

Sixteen species were identified at the weir (Table 1). They included four species of Pacific salmon spp., rainbow trout, Dolly Varden, round whitefish, threespine stickleback, ninespine stickleback, coastrange sculpin, slimy sculpin, Pacific lamprey, Arctic lamprey, longnose sucker, eulachon and northern pike. Run timing and escapement estimates were obtained for the salmon spp. (sockeye, coho, pink and chinook salmon).

TABLE 1.— Fish species composition and distribution, Moose River, Alaska, 1985 and 1986

	Moose River			Tributaries				Lakes[a]
Species	rkm 7 4	rkm 17 0	rkm 23 6	West Fork	East Fork	Moosehorn Creek	Browse Creek	
Anadromous								
Sockeye salmon	X	X		X	X	X	X	
Coho salmon	X	X	X	X	X	X	X	
Chinook salmon	X							
Pink salmon	X						X	
Arctic lamprey[b]	X	X		X	X	X		
Pacific lamprey	X			X				
Eulachon	X							
Resident								
Rainbow trout	X	X		X	X	X		X
Round whitefish	X			X				X
Dolly Varden	X	X	X		X	X		X
Longnose sucker	X				X	X		X
Northern pike	X							
Slimy sculpin	X	X	X	X	X	X	X	X
Coastrange sculpin	X							
Threespine stickleback[b]	X	X	X	X	X	X	X	X
Ninespine stickleback	X							X

[a] See Appendix 1 for individual lakes.

[b] Anadromous and freshwater forms identified.

Adult Salmon

Sockeye salmon.—In 1985, 690 early-run fish were passed through the weir between 9 June and 7 July (Appendix 1). This is a conservative estimate because sockeye were observed prior to weir installment. The weir was installed 17 May and operated until 21 July, 1986. The first sockeye salmon was observed on 17 May; a total of 445 fish were passed through the weir (Appendix 2). Again this estimate is conservative due to escapement in June during high water over the weir In 1985, the estimated peak passage of early-run sockeye salmon occurred during the second week of June. In 1986, peak passage of early run fish occurred during the second week of July

Five early-run sockeye salmon were radio tagged during the last week of June, 1985. These fish were tracked to a spawning area in the mainstem Moose River near rkm 17.0. Early-run sockeye salmon used three distinct spawning sites in this vicinity (Figure 3). In 1986, a large group of early-run sockeye salmon spawned between rkm 16.5 and 17.0 in the Moose River while another group spawned between rkm 15.0 and 15.3 A smaller group of fish spawned in the lower 0 5 km of the East Fork of the Moose River Expansion (by AUC method) of spawning ground counts indicated a spawning population of 2,071 early-run sockeye salmon in 1986 Peak spawning in the Moose River occurred in mid-July for both the 1985 and 1986 early-run sockeye salmon.

Late-run sockeye salmon were first observed at the weir on 8 July, 1985 and on 21 July, 1986. Late-run sockeye passage in 1985 was 3,440, this includes an estimated 662 during high waters when the weir was inoperable. In 1986, 847 fish were passed. Peak numbers of late-run sockeye salmon occurred at the weir the last week of July 1985 and the first week of August 1986

Visual observations and lake surveys indicated that late-run sockeye salmon spawned from late July to mid-September in Camp Island, Grebe, Watson, Peterson and Swan lakes (Figure 3). Scale analyses indicated that early-run sockeye salmon were predominantly age 2 3, while late-run salmon were dominated by age 2 2 fish in 1985 and 1986 (Appendix 7) Early-run salmon with three winters in salt water were generally larger (525-542 mm) than late-run sockeye salmon (478-498 mm) with two winters in salt water (Appendix 8).

Coho salmon —Adult coho salmon first appeared at the weir during early August in both 1985 and 1986 (Appendix 1 and 2). Between 10 August and 3 October 1985, 970 coho salmon were passed through the weir (Appendix 8). In 1985, coho salmon escapement was 1,657, this included an estimated 687 coho which passed over the weir during high water periods. In 1986, 3,969 coho salmon passed through the weir between 2 August and 2 October. Coho salmon were still passing in low numbers when the weir was removed in October, 1985 and 1986.

Based on aerial and ground surveys, coho salmon spawning occurred in October and densities of spawning fish were greatest in the East Fork of the Moose River (Figure 4).

In 1985, coho salmon ranged from 470 to 670 mm in length and were predominately age 3 1. In 1986, coho salmon ranged in length from 420 to 635 mm and were predominantly age 2.1 (Appendices 9 and 10).

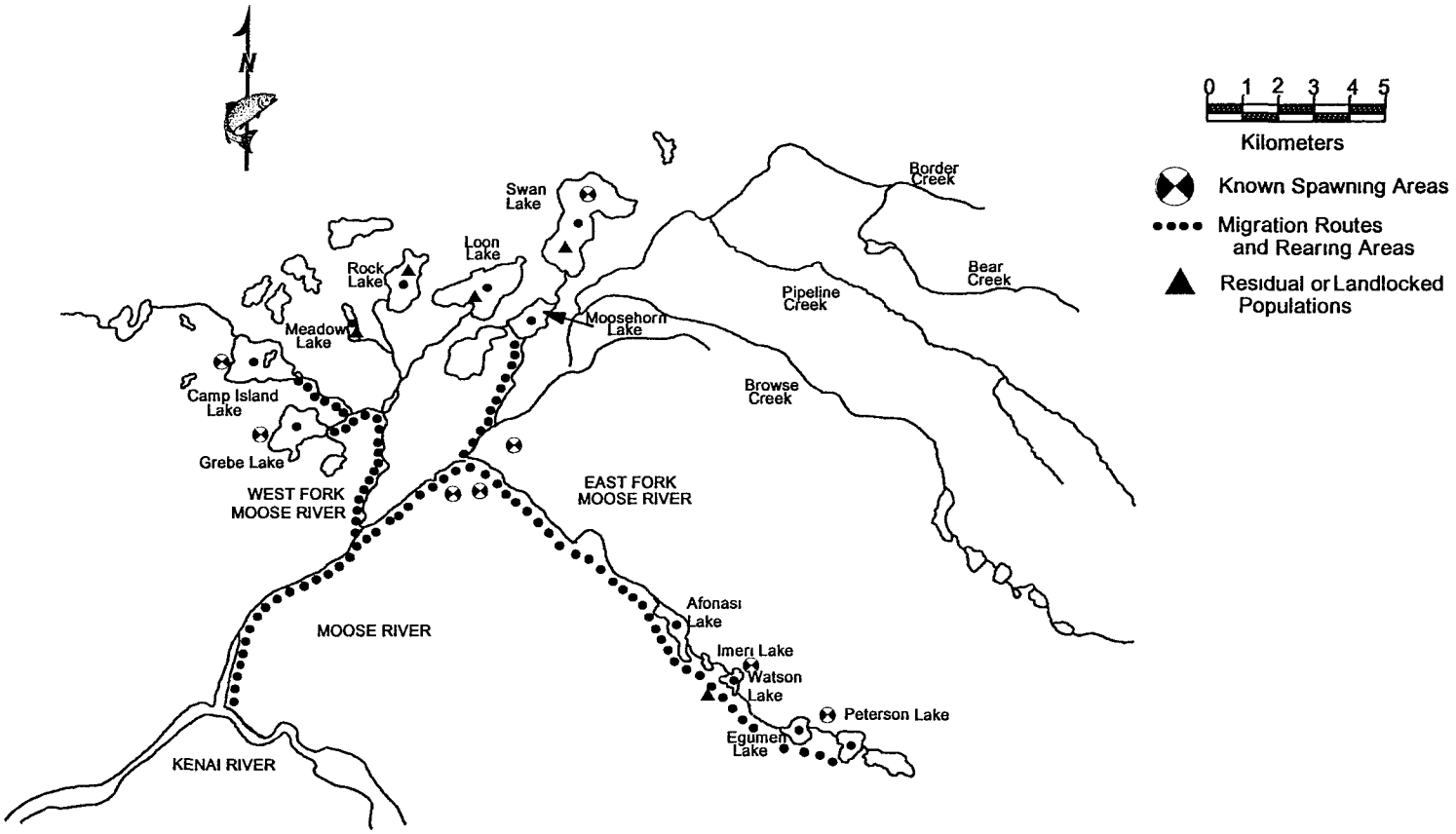

FIGURE 3.–Sockeye salmon distribution, Moose River, Alaska.

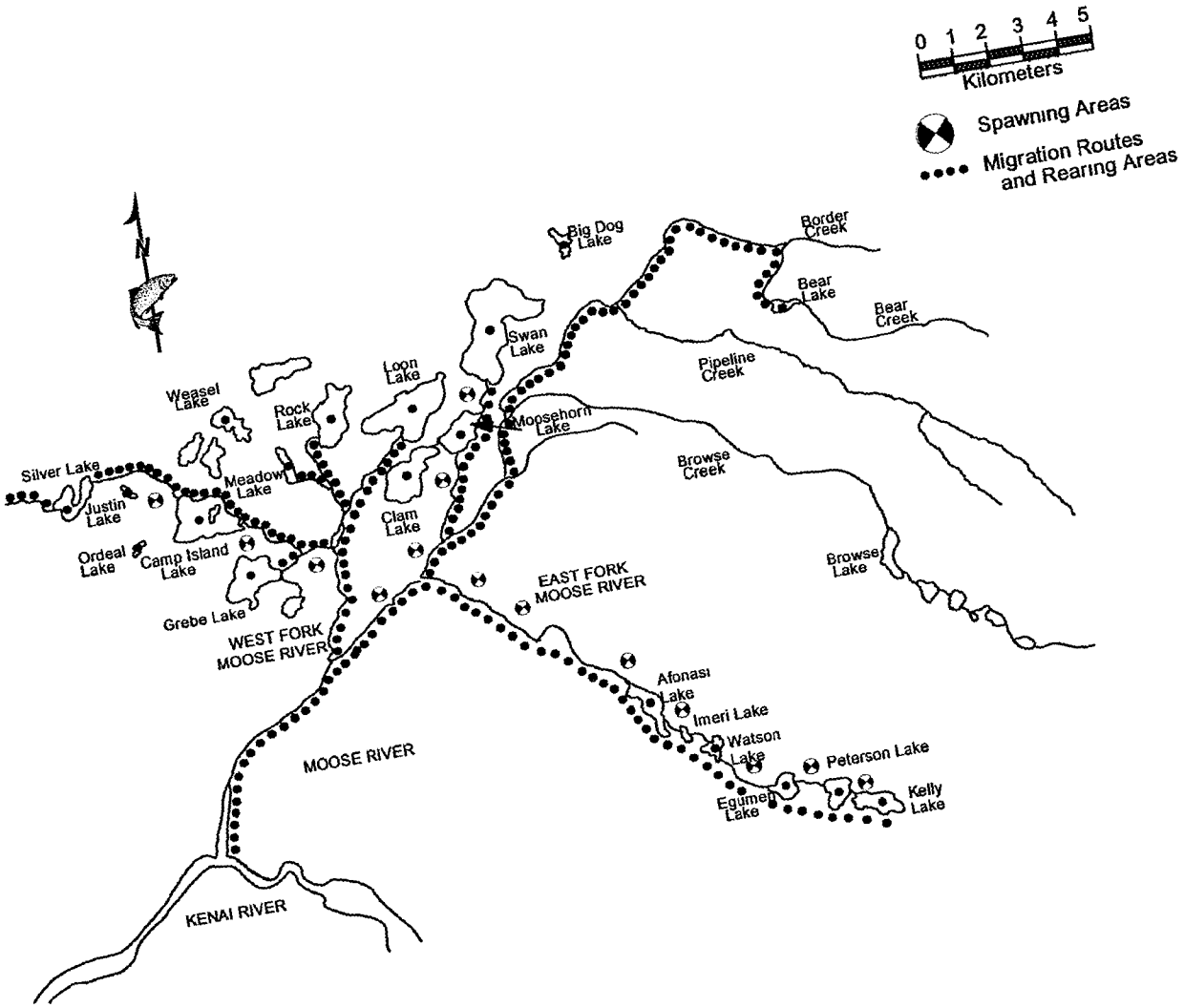

FIGURE 4.–Coho salmon distribution, Moose River, Alaska.

Chinook salmon.—Only two adult chinook salmon were counted at the weir in 1985. One of these fish was found dead below a beaver dam at the outlet of Bear Lake on 6 August Adult chinook salmon were not observed at the weir in 1986

Pink salmon.—Thirteen pink salmon were passed upstream in 1985 (mean length = 478 mm) and four in 1986 (mean length = 411 mm)

Juvenile Salmon

Sockeye salmon.—The inclined plan trap captured 3,237 juvenile sockeye salmon in 1986 (Appendix 3) The peak of smolt outmigration for age 2 fish occurred during the last week of May. During this time smolts comprised 100% of the juvenile sockeye salmon catch These two year old fish had a mean length of 112 mm and ranged from 91-136 mm (Appendix 11). Age 0 sockeye salmon were the most abundant age class captured (>74%). These Age 0 fish were first captured in June but their abundance remained low until August and September when they made up more than 95% of the total catch. Age 0 fish had a mean length of 46 mm and ranged from 25-56 mm.

Two juvenile sockeye salmon were caught in minnow traps over the two-year period, both at the same site (rkm 1 8). A fyke net set in this same vicinity captured 58 juveniles (Appendix 4) Juvenile sockeye salmon were also caught in fine mesh gill nets set in 16 lakes within the Moose River watershed (Appendix 5).

Coho salmon.—Juvenile coho salmon were the most abundant fish captured in the inclined plane trap A total of 7,223 coho salmon were captured in 1986 (Appendix 3) The peak of smolt outmigration for age 2 and 3 fish occurred the last week in May. Two and three year old smolts ranged in length from 81 to 160 mm in length (Appendix 12) Age 0 coho salmon were the most abundant age class captured (>75%) in the inclined plane trap. These young-of-the-year fish first appeared in July and peaked in September.

Juvenile coho salmon were captured in minnow traps and fyke nets throughout the basin (Figure 4). A total of 437 juveniles were captured in minnow traps placed at three tributary and four mainstem locations in the Moose River drainage (Appendix 4). The highest catch rate for juvenile coho salmon occurred in the lower 3 km of the Moose River Minnow traps and a fyke net set in this area captured over 360 juvenile coho in a 24/h period. Juvenile coho salmon have also been documented in 17 lakes within the Moose River watershed (Appendix 5)

Chinook salmon —A total of 120 juvenile chinook salmon were captured in the inclined plane trap and fike net in 1986. Sixty-four percent of the 58 juveniles sampled were age 1; they ranged from 66-101 mm in length Age 0 juveniles ranged from 30-65 mm in length. The highest density of juvenile chinook salmon was found in the lower Moose River near rkm 1.8

Pink salmon —No juvenile pink salmon were captured in 1985 or 1986.

Resident and Other Fish Species

Rainbow trout —No rainbow trout were counted upstream past the weir in 1985. In 1986, the first fish was passed on 12 May with the majority (51%) of upstream migrants passing the weir during its first full week of operation (12-18 May). Downstream migrants were most abundant from the end of May until mid-June, 1986.

Rainbow trout collected in the Moose River averaged 442 mm and 446 mm in length during 1985 and 1986 respectively, with females generally larger than males (Appendix 13) The mean annual growth rate was 41 mm/year in 1985 (N=18) and 48 mm/year in 1986 (N=46)

Concentrations of spawning rainbow trout were found in the mainstem Moose River near rkms 15.0 and 17 0, and in its East and West Fork tributaries (Figure 5). Isolated pairs and smaller groups of spawning rainbow trout were also observed throughout the mainstem Moose River above the weir and near the outlet of Grebe Lake. Rainbow trout have also been documented in 15 lakes within the Moose River watershed (Appendix 5).

Data on post spawning movements of rainbow trout are limited because only four of 95 tagged fish were recaptured (Appendix 6). Of 28 upstream migrants tagged at the weir, six were recaptured after spending an average of 8 days above the weir. Spawning success was not determined

Round whitefish.—Adult round whitefish were observed at the weir from May through September with the majority (91%) passing upstream in September. Only 14 round whitefish were counted in 1985 and 20 in 1986, however, many were small enough to pass upstream between weir pickets suggesting a larger run than counts indicate

Round whitefish collected at the weir ranged from 291 to 535 mm in length and 225 to 1,000 g in weight (Appendix 13) Mean annual growth was 50 mm/yr in 1985 (N = 8) and 43 mm/yr in 1986 (N =16)

Five adult round whitefish were radio-tagged at the weir in 1986. Four of these fish were tracked to the West Fork of the Moose River before they eventually moved back downstream into the Kenai River four weeks later (Appendix 14). Round whitefish have also been documented in Camp Island Lake, a headwater lake to the West Fork of the Moose River (Appendix 5). No juvenile round whitefish were collected in the watershed.

Dolly Varden.—Six adult Dolly Varden were captured at the weir during the two year sampling period. These fish ranged from 293 to 575 mm in length and 600 to 1,350 g in weight (Appendix 13).

Juvenile Dolly Varden were captured in the mainstem Moose River and several tributaries. Adult and juvenile Dolly Varden have also been found in three lakes (Appendix 5)

Longnose sucker.—Eleven longnose suckers were passed upstream through the weir These fish ranged from 390 to 515 mm in length and 600 to 1,400 g in weight (Appendix 13) One

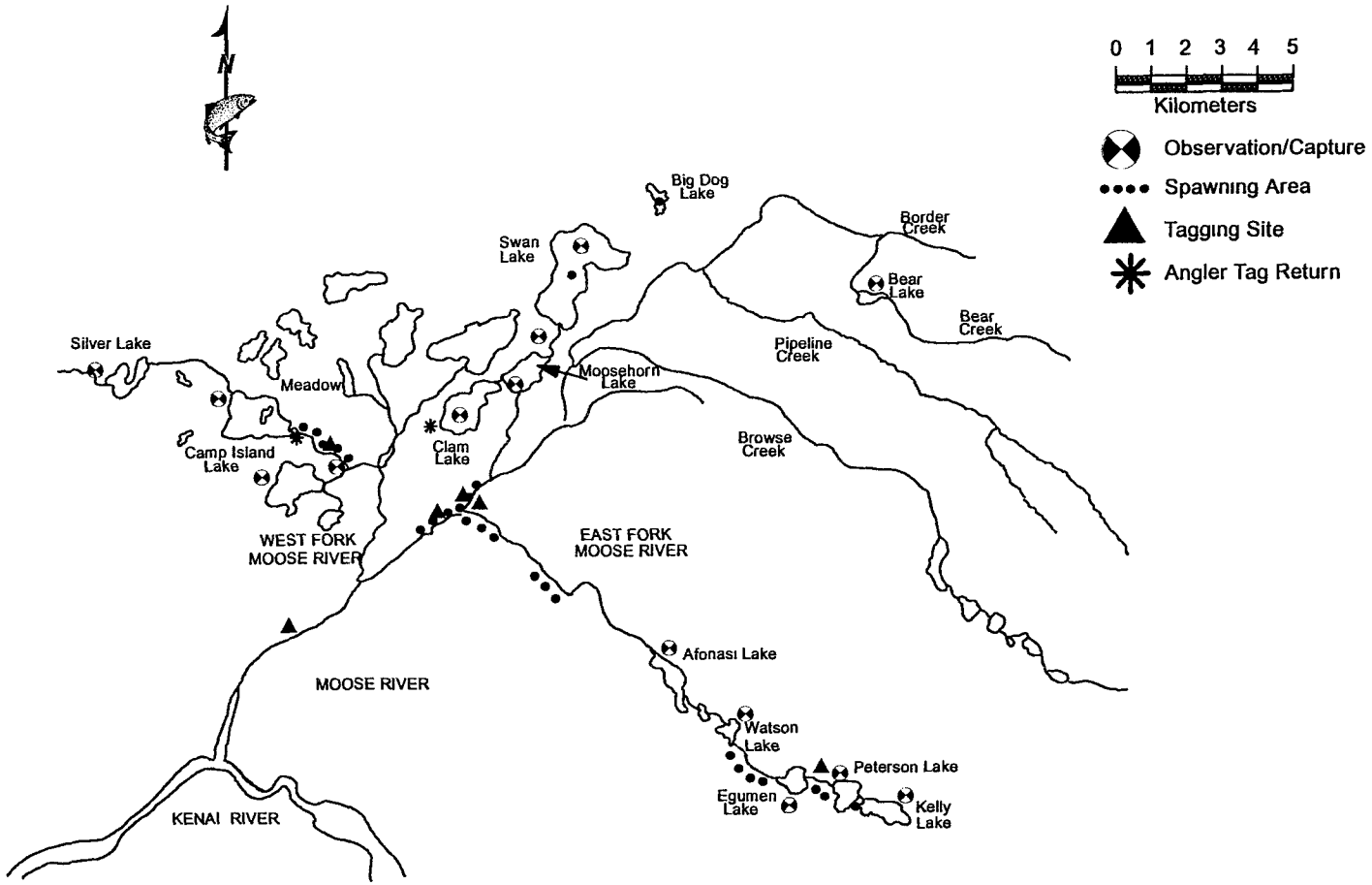

FIGURE 5.–Rainbow trout distribution, Moose River, Alaska.

longnose sucker was captured in the inclined plane trap This species is common in Moose River watershed lakes (16 lakes) but appears to be uncommon in the Moose River (Appendix 5).

Northern pike.—A northern pike estimated at 750 mm in length was observed at the weir on several occasions. It was first seen on 24 May, 1986 as it tried to move downstream past the weir. A northern pike was also observed on 27 May, 6 July and 30 July above the weir

Arctic lamprey —Arctic lamprey were abundant in the mainstem Moose River and three tributaries and are believed to be freshwater residents in this watershed. In 1986, 1,391 Arctic lamprey were captured in the inclined plane trap with 89% of the catch occurring in June Arctic lamprey were also captured in minnow traps set in the mainstem Moose River and two tributaries (Appendix 4). Average length and weight of 173 Arctic lamprey was 147 mm and 6.0 g, respectively (Appendix 13).

Pacific lamprey —This large anadromous lamprey was observed in the Moose River and one of its tributaries. Because they easily swam between the pickets of the weir their abundance was not determined. This species was observed spawning at the weir and 39 were captured with dip nets for length and weight measurements in 1985 The Pacific lamprey was larger than the Arctic lamprey with a mean length of 537 mm and a mean weight of 399 g (Appendix 13).

Slimy sculpin —This species was the most abundant (N=202) sculpin found in the Moose River watershed in 1986 Slimy sculpins were captured in the inclined plane trap and minnow traps set in the Moose River and Browse Creek (Table 1). Length measurements taken from seven fish ranged from 35 to 90 mm.

Coastrange sculpin —Thirty-four coastrange sculpin were collected in the inclined plane trap in 1986 Coastrange sculpin were not collected at any other location in the watershed. Nineteen coastrange sculpin were measured and ranged from 30 to 135 mm in length with a mean of 65 mm.

Threespine stickleback.—Threespine stickleback were highly abundant throughout the Moose River watershed. This species was captured in every location sampled except Pipeline Creek (Table 1) In 1986, 5,832 threespine stickleback (freshwater and anadromous forms) were captured in the inclined plane trap, 1,067 were collected in minnow traps and 131 were caught in fyke nets.

We measured and weighed 102 threespine stickleback, 88 (86%) were of the freshwater form and 14 (14%) were anadromous. The freshwater form had a mean length of 46 mm and a mean weight of 0.8 g. The anadromous form was larger with a mean length of 82 mm and a mean weight of 4.0 g.

Ninespine stickleback.—The ninespine stickleback was less abundant than the threespine stickleback in the Moose River watershed, only 310 ninespine stickleback were captured in the inclined plane trap in 1986. The mean length and weight of 35 of these fish was 45 mm and 0 6 g, respectively

Eulachon.—Four eulachon were captured in the inclined plane trap between 30 May and 2 June, 1986 These fish ranged in length from 205 to 223 mm Eulachon were not captured at any other location in the watershed.

Water Quality and Discharge

The water temperatures recorded at the weir ranged from 2 to 17°C in 1985 and 1986. The lowest water levels occurred in late July and early August, 1985 and in late June, 1986. The highest water levels were recorded in late August and early September, 1985 and late September, 1986. Water chemistry and stream discharge from all waters surveyed are presented in Appendix 7.

Recreational Use

Recreational boat use on the Moose River was similar in 1985 and 1986 We counted 354 boats at the weir site in 1985 and 400 in 1986 (Appendices 15 and 16). Ninety-five percent of these boats were canoes and 5% were power boats. The boats carried 781 people in 1985 and 883 people in 1986, with an average of 2.2 people per boat.

Most boat use originated at Canoe and Portage lakes on the Swan Lake Canoe System. Upstream passage from Sterling accounted for 13% of the boat use in 1985 and 19% in 1986. Seventy-four percent of the people interviewed were on their first trip down the Moose River Seven percent of the boaters had been on the Moose River more than ten times.

Information obtained from boaters in 1985 showed that the mainstem Moose River, above rkm 7 4, received very little fishing effort and that the greatest amount of angling activity by boaters occurred on Swan Lake. In 1986, we interviewed 106 anglers at Swan Lake (Table 2). The average number of hours fished was 2.59 hours with a total catch rate of 0 34 fish/hour.

TABLE 2.—Summary of creel census information on Swan Lake, Kenai National Wildlife Refuge, Alaska, 1986.

Month	anglers (N)	Hours fished	Rainbow trout		Other species		Catch rate
			catch	harvest	catch	harvest	
May	2	4.1	0	0	0	0	0 0
June	30	68.5	37	15	0	0	0.54
July	46	137 5	26	14	3	3	0 21
August	22	43 5	14	5	1	1	0 34
September	6	21.0	10	10	1	1	0.52
Totals	106	274.6	87	44	5	5	0.34

Discussion

Adult Salmon

Sockeye and coho salmon were the most abundant salmon found in the Moose River These fish were similar to several other Kenai Peninsula salmon stocks in size, migrational timing and age composition (King and Tarbox 1988, Faurot and Jones 1990; Faurot and Palmer 1992; Jones et al. 1993). Too few chinook and pink salmon were collected at the weir to make comparisons with other stocks.

The run timing of sockeye salmon in the Moose River is comparable to runs returning to the Russian and Swanson rivers (Athons 1986, Athons and McBride 1987, Nelson et al. 1987, Jones et al. 1993). In each of these rivers, the early-run generally peaks between late June and early July and the late-run peaks between late July and early August.

Our results showed a considerable difference in the peak of run-timing for early-run sockeye salmon returning to the Moose River in 1985 and 1986 The 1985 run-timing data are probably more representative of early-run fish than the 1986 data During June 1986, sockeye salmon were able to pass through the weir uncounted via an undetected hole. This effectually created a false peak in early July after the hole was repaired and counts reflected total passage.

Our results show that the age composition of adult sockeye salmon in the Moose River was similar to other Kenai Peninsula stocks. The majority of sockeye salmon from the Moose, Russian, and Chickaloon rivers spend two years in fresh water and at least two years in the ocean (Athons 1986; Faurot et al , *in preparation*) In contrast, most sockeye salmon from the Fox, Kenai, and Kasilof rivers spend only one year in fresh water (King and Tarbox 1989; Faurot and Palmer 1991, Jones et al. 1993)

Although our data are limited (five early-run fish tagged in one week, limited aerial and ground surveys), it appears that early and late-run sockeye salmon spawned in different locations in the Moose River drainage. Early-run fish spawned in the mainstem whereas late-run fish spawned in headwater lakes Distinctive differences in spawning areas used by bimodal runs are not uncommon (Burger et al 1985).

It is unlikely that fish passage during high water periods was accurately represented by averaging the daily passage for the two days on either side of the inoperable period. In retrospect, it may have been more appropriate to collect spawning ground counts over time to estimate over the weir passage using the AUC method, as was done with sockeye salmon Spawning ground counts for coho salmon would have been difficult to obtain, however, because their spawning areas were more dispersed than sockeye salmon.

A creel census conducted by the Department indicated an increased catch rate of coho salmon in the Kenai River sport fishery near the Moose River confluence at about the same time peak numbers of coho salmon were passed through the weir (Hammarstrom and Larson 1986; Conrad and Hammarstrom 1987) A weir operated in the Swanson River in 1988 and 1989

indicated the run-timing for coho salmon was nearly identical to the Moose River (Jones et al. 1993).

The age composition of Moose River coho salmon in 1986 was similar to that of coho salmon collected in the Kenai River recreational fishery, and the neighboring Swanson, Fox and Chickaloon rivers (Hammarstrom and Larson 1986, Faurot and Palmer 1992, Jones et al. 1993; Faurot et al., *in preparation*). The majority of fish from each of these three drainages was age 2 1, compared to 1985 Moose River coho salmon which were predominantly age 3.1. The difference in the dominant age class of coho salmon in the Moose River between 1985 and 1986 is probably related to our inability to count and sample fish during the lengthy high water period in 1985.

Only two chinook salmon were observed at the weir during this study suggesting these were strays into the system However, juvenile chinook salmon were captured in the inclined plane trap, fyke nets and minnow traps set in the lower river indicating that the Moose River may be used as a rearing area by this species. Juvenile chinook salmon are known to migrate up other lower Kenai River tributaries between June and October (Elliott and Finn 1984)

Large returns of Kenai River pink salmon occur during even numbered years (Ruesch 1986). We observed few pink salmon at the weir in 1985. However, even fewer pink salmon passed the weir in 1986, though a strong run returned to the Kenai River (Ruesch 1987). Also, no pink salmon fry were captured in the inclined plane trap in 1986. These data suggest either the few pink salmon in the Moose River were strays, or the inclined plane trap installation date of 20 May was too late to catch the outmigrating smolts of what appears to be a very small run of pink salmon Peak outmigration for pink salmon occurs during early May on other Kenai Peninsula streams (Faurot et al 1989).

Residual or landlocked populations of pink salmon have been found in Rock and Swan lakes (U S. Fish and Wildlife Service, unpublished data). These populations probably originated from adults accessing the lakes during high water Normal water levels may have prevented juvenile outmigration and established residual populations.

Juvenile Salmon

Outmigration of coho and sockeye salmon from the Moose River began in mid-May and continued into early June This outmigration timing of coho and sockeye smolts is comparable to other Kenai Peninsula streams (Todd and Kyle 1987; Flagg et al. 1985; Litchfield and Flagg 1986; Jones et al. 1993). The emigration of young-of-the-year (age 0) coho and sockeye salmon in August and September is well documented in other streams (Hoar 1958; Chapman 1962, Brannon 1972, Hartman et al. 1982, Elliott and Finn 1984)

Juvenile coho and sockeye salmon were similar in length to fish collected in the Kenai River and several tributaries (Elliott and Finn 1984, Tarbox and King 1987) In contrast, outmigrating coho and sockeye salmon smolts in Hidden Creek, a tributary adjacent to the Moose River drainage, were much longer in length (Flagg and Litchfield 1987).

Juvenile coho salmon were the most abundant species captured, which infers the significance of the Moose River's contribution to the overall production of coho salmon in the Kenai River drainage. The highest densities of juvenile coho salmon occurred in the lower river, suggesting that immigration of juveniles spawned elsewhere in the Kenai River drainage may be occurring. Catch data from the inclined plane trap also suggest that juvenile chinook salmon not produced in the Moose River are using it as a rearing area The same may be true for coho salmon, which emphasizes the importance of the Moose River to Kenai River drainage salmon production.

Resident and Other Fish Species

Nine resident fish species were identified in the Moose River. This diversity is comparable to other tributaries of the Kenai River (Elliott and Finn 1984) Threespine stickleback were the most abundant and widely dispersed resident species captured in minnow traps.

We collected four anadromous species in the Moose River in addition to the salmonids; these included eulachon, Pacific and Arctic lamprey and threespine stickleback. It appears that the Arctic lamprey and threespine stickleback in the Moose River occur as both resident and anadromous forms. This observation has been made in other Alaskan streams as well (Morrow 1980). All four of these species have been observed in other tributaries of the Kenai River (Elliot and Finn 1984).

Based on passage times at the weir, rainbow trout in the Moose River appear to migrate to upstream spawning areas in May and return downstream during late May and early June However, the weir may not have been installed early enough to determine initial upstream movements.

The mean length of rainbow trout in this study (1985 = 442 mm, 1986 = 446 mm) is larger than the 386 mm mean length reported by Lawler (1964) for fish sampled in the East Fork of the Moose River. This disparity is at least partially explained by our differences in sampling techniques. The weir used in our study undoubtedly selected larger fish while allowing smaller fish to escape between pickets. Conversely, beach seines such as those used by Lawler may be biased towards smaller fish.

The mean annual growth rate of rainbow trout in the Moose River was 41 mm/year in 1985 and 48 mm/year in 1986 This growth rate is within the range observed during previous collections of rainbow trout in the Kenai National Wildlife Refuge (U.S. Fish and Wildlife Service, unpublished data).

Round whitefish radio tagged at the weir initially moved upstream to the West Fork of the Moose River, several then were tracked back to the Kenai River No spawning was observed during tracking surveys and no juvenile whitefish were captured during sampling efforts. Round whitefish are thought to spawn sometime between late-September and December in Alaska (Morrow 1980). Because we were unable to document reproduction, our data on the movements of round whitefish in the Moose River may not reflect their use of spawning areas.

Three other species of fish were identified at the weir including. eulachon, coastrange sculpin and northern pike However, their low numbers at the weir and their absence from

upstream collections suggest either their populations within the watershed are small or they simply avoided detection by our sampling methods.

Water Quality and Discharge

Water quality and discharge in the Moose River drainage have not been previously sampled. Thus, our data represent the initial baseline for future comparative studies or evaluations.

Recreational Use

Our creel survey indicated that angler effort within the Moose River Watershed was greatest in the lakes of the Swan Lake Canoe System. Most anglers interviewed were satisfied with their fishing experience

A Department postal survey estimated higher numbers of anglers fishing the Moose River than we recorded at the weir (Mills 1987). The postal survey estimated that 759 anglers fished 1,208 days in 1986, whereas we recorded only 398 anglers passing the weir. These data illustrate that many anglers on the Moose River remain below the weir site at the confluence with the Kenai River where large numbers of sockeye salmon congregate before migrating upstream.

Management Implications

This study makes available for future comparisons important baseline data on the age composition, adult run timing and smolt outmigrational timing of three salmon stocks (two sockeye, one coho) from the Moose River drainage. These data may become useful in the management of individual stocks composing the intensive mixed stock commercial and sport fisheries operating in Cook Inlet and the lower Kenai River, respectively.

Our observation of northern pike in the mainstem Moose River may become important. Managers have suggested that the spread of northern pike through the Susitna River drainage may have played a role in the decline of that system's fishery (Whitmore et. al. 1994). If northern pike spread throughout the Kenai River drainage, the area's resident and anadromous fish resources could be negatively impacted. Monitoring the status and distribution of northern pike in the Kenai River drainage may be warranted.

The high densities of juvenile salmon we found in the lower Moose River suggest its importance in providing rearing habitat. Protection of this area may be instrumental to the overall production of salmon in the Kenai River drainage.

Increased law enforcement activity may be necessary during the rainbow trout spawning period to assure compliance with seasonal closures, particularly in the mainstem and East Fork of the Moose River. Notices indicating that the Moose River is closed to rainbow trout fishing during spawning should be posted on the bulletin boards at all entrances to the river system

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APPENDIX 1.—Daily fish counts, Moose River, Alaska, 1985.

	Sockeye salmon		Pink salmon		Coho salmon		Chinook salmon		Rainbow trout	
									Downstream	
Date	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum
6/9	0	0	0	0	0	0	0	0	0	0
6/10	2	2	0	0	0	0	0	0	0	0
6/11	167	169	0	0	0	0	0	0	0	0
6/12	0	169	0	0	0	0	0	0	4	4
6/13	170	339	0	0	0	0	1	1	5	9
6/14	62	401	0	0	0	0	0	1	1	10
6/15	13	414	0	0	0	0	0	1	5	15
6/16	16	430	0	0	0	0	0	1	4	19
6/17	15	445	0	0	0	0	0	1	1	20
6/18	28	473	0	0	0	0	0	1	0	20
6/19	41	514	0	0	0	0	0	1	1	21
6/20	2	516	0	0	0	0	0	1	0	21
6/21	1	517	0	0	0	0	0	1	2	23
6/22	2	519	0	0	0	0	0	1	1	24
6/23	3	522	0	0	0	0	0	1	4	28
6/24	0	522	0	0	0	0	0	1	0	28
6/25	0	522	0	0	0	0	0	1	0	28
6/26	11	533	0	0	0	0	0	1	1	29
6/27	4	537	0	0	0	0	0	1	0	29
6/28	6	543	0	0	0	0	0	1	1	30
6/29	110	653	0	0	0	0	0	1	0	30
6/30	3	656	0	0	0	0	0	1	2	32
7/1	4	660	0	0	0	0	0	1	0	32
7/2	2	662	0	0	0	0	0	1	0	32
7/3	1	663	0	0	0	0	0	1	0	32
7/4	27	690	0	0	0	0	0	1	0	32
7/5	0	690	0	0	0	0	0	1	0	32
7/6	0	690	0	0	0	0	0	1	0	32
7/7	0	690	0	0	0	0	0	1	0	32
7/8	1	691	0	0	0	0	0	1	2	34

APPENDIX 1.—(Continued).

	Sockeye salmon		Pink salmon		Coho salmon		Chinook salmon		Rainbow trout	
									Downstream	
Date	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum
7/9	0	691	0	0	0	0	0	1	1	35
7/10	0	691	0	0	0	0	0	1	1	36
7/11	0	691	0	0	0	0	0	1	0	36
7/12	6	697	0	0	0	0	0	1	1	37
7/13	4	701	1	1	0	0	0	1	0	37
7/14	13	714	0	1	0	0	0	1	0	37
7/15	49	763	4	5	0	0	0	1	1	38
7/16	54	817	0	5	0	0	0	1	0	38
7/17	19	836	1	6	0	0	0	1	0	38
7/18	52	888	1	7	0	0	0	1	0	38
7/19	12	900	0	7	0	0	0	1	0	38
7/20	3	903	1	8	0	0	0	1	0	38
7/21	32	935	0	8	0	0	0	1	0	38
7/22	16	951	0	8	0	0	0	1	0	38
7/23	6	957	0	8	0	0	0	1	0	38
7/24	8	965	1	9	0	0	0	1	0	38
7/25	60	1,025	0	9	0	0	0	1	0	38
7/26	45	1,070	0	9	0	0	1	2	0	38
7/27	495	1,565	1	10	0	0	0	2	0	38
7/28	120	1,685	0	10	0	0	0	2	0	38
7/29	5	1,690	0	10	0	0	0	2	0	38
7/30	60	1,750	0	10	0	0	0	2	1	39
7/31	105	1,855	3	13	0	0	0	2	1	40
8/1	29	1,884	0	13	0	0	0	2	0	40
8/2	44	1,928	0	13	0	0	0	2	0	40
8/3	70	1,998	0	13	0	0	0	2	0	40
8/4	169	2,167	0	13	0	0	0	2	0	40
8/5	65	2,232	0	13	0	0	0	2	0	40
8/6	54	2,286	0	13	0	0	0	2	0	40
8/7	88	2,374	0	13	0	0	0	2	0	40

APPENDIX 1.—(Continued).

	Sockeye salmon		Pink salmon		Coho salmon		Chinook salmon		Rainbow trout	
									Downstream	
Date	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum
8/8	5	2,379	0	13	0	0	0	2	0	40
8/9	3	2,382	0	13	0	0	0	2	0	40
8/10	3	2,385	0	13	1	1	0	2	0	40
8/11	53	2,438	0	13	0	1	0	2	0	40
8/12	54	2,492	0	13	1	2	0	2	0	40
8/13	6	2,498	0	13	2	4	0	2	1	41
8/14	Weir pickets pulled at 0800				-	-	-	-	-	-
8/15	-	-	-	-	-	-	-	-	-	-
8/16	-	-	-	-	-	-	-	-	-	-
8/17	-	-	-	-	-	-	-	-	-	-
8/18	-	-	-	-	-	-	-	-	-	-
8/19	0	2,498	0	13	0	4	0	2	0	41
8/20	3	2,501	0	13	3	7	0	2	0	41
8/21	178	2,679	0	13	137	144	0	2	1	42
8/22	56	2,735	0	13	108	252	0	2	-	42
8/23	Weir pickets pulled at 1700				-	-	-	-	-	-
8/24	-	-	-	-	-	-	-	-	-	-
8/25	-	-	-	-	-	-	-	-	-	-
8/26	-	-	-	-	-	-	-	-	-	-
8/27	-	-	-	-	-	-	-	-	-	-
8/28	-	-	-	-	-	-	-	-	-	-
8/29	-	-	-	-	-	-	-	-	-	-
8/30	-	-	-	-	-	-	-	-	-	-
8/31	-	-	-	-	-	-	-	-	-	-
9/1	0	2,735	0	13	0	252	0	2	0	42
9/2	32	2,767	0	13	156	408	0	2	0	42
9/3	1	2,768	0	13	31	439	0	2	0	42
9/4	0	2,768	0	13	44	483	0	2	0	42
9/5	0	2,768	0	13	47	530	0	2	0	42
9/6	0	2,768	0	13	0	530	0	2	0	42

APPENDIX 1.—(Continued).

Date	Sockeye salmon		Pink salmon		Coho salmon		Chinook salmon		Rainbow trout Downtream	
	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum
9/7	0	2,768	0	13	0	530	0	2	0	42
9/8	0	2,768	0	13	8	538	0	2	0	42
9/9	5	2,773	0	13	33	571	0	2	0	42
9/10	0	2,773	0	13	27	598	0	2		
9/11	0	2,773	0	13	6	604	0	2	0	42
9/12	0	2,773	0	13	5	609	0	2	0	42
9/13	1	2,774	0	13	7	616	0	2	0	42
9/14	1	2,775	0	13	54	670	0	2	0	42
9/15	2	2,777	0	13	63	733	0	2	0	42
9/16	0	2,777	0	13	37	770	0	2	0	42
9/17	0	2,777	0	13	22	792	0	2	0	42
9/18	0	2,777	0	13	8	800	0	2	0	42
9/19	0	2,777	0	13	8	808	0	2	0	42
9/20	1	2,778	0	13	15	823	0	2	0	42
9/21	0	2,778	0	13	10	833	0	2	0	42
9/22	0	2,778	0	13	17	850	0	2	0	42
9/23	0	2,778	0	13	13	863	0	2	0	42
9/24	0	2,778	0	13	13	876	0	2	0	42
9/25	0	2,778	0	13	5	881	0	2	0	42
9/26	0	2,778	0	13	3	884	0	2	0	42
9/27	0	2,778	0	13	28	912	0	2	0	42
9/28	0	2,778	0	13	31	943	0	2	0	42
9/29	0	2,778	0	13	10	953	0	2	0	42
9/30	0	2,778	0	13	11	964	0	2	0	42
10/1	0	2,778	0	13	2	966	0	2	0	42
10/2	0	2,778	0	13	1	967	0	2	0	42
10/3	0	2,778	0	13	3	970	0	2	0	42

APPENDIX 2.—Daily fish counts, Moose River, Alaska, 1986.

	Sockeye salmon		Pink salmon		Coho salmon		Chinook salmon		Rainbow trout	
Date	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum	Upstream/Downstream	
5/7										
5/8	0	0	0	0	0	0	0	0	0	0
5/9	0	0	0	0	0	0	0	0	0	0
5/10	0	0	0	0	0	0	0	0	0	0
5/11	0	0	0	0	0	0	0	0	0	0
5/12	0	0	0	0	0	0	0	0	3	0
5/13	0	0	0	0	0	0	0	0	1	0
5/14	0	0	0	0	0	0	0	0	2	0
5/15	0	0	0	0	0	0	0	0	3	0
5/16	0	0	0	0	0	0	0	0	4	0
5/17	1	1	0	0	0	0	0	0	0	0
5/18	0	1	0	0	0	0	0	0	5	0
5/19	1	2	0	0	0	0	0	0	1	0
5/20	1	3	0	0	0	0	0	0	1	0
5/21	1	4	0	0	0	0	0	0	3	1
5/22	1	5	0	0	0	0	0	0	0	0
5/23	1	6	0	0	0	0	0	0	0	3
5/24	5	11	0	0	0	0	0	0	2	5
5/25	0	11	0	0	0	0	0	0	2	0
5/26	0	11	0	0	0	0	0	0	0	1
5/27	0	11	0	0	0	0	0	0	0	5
5/28	0	11	0	0	0	0	0	0	0	2
5/29	0	11	0	0	0	0	0	0	0	3
5/30	0	11	0	0	0	0	0	0	1	0
5/31	0	11	0	0	0	0	0	0	0	1
6/1	0	11	0	0	0	0	0	0	0	1
6/2	0	11	0	0	0	0	0	0	0	1
6/3	0	11	0	0	0	0	0	0	2+	2
6/4	0	11	0	0	0	0	0	0	0	4
6/5	0	11	0	0	0	0	0	0	0	0

APPENDIX 2.—(Continued).

	Sockeye salmon		Pink salmon		Coho salmon		Chinook salmon		Rainbow trout	
Date	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum	Upstream	Downstream
6/6	0	11	0	0	0	0	0	0	0	3
6/7	1	12	0	0	0	0	0	0	0	1
6/8	0	12	0	0	0	0	0	0	0	0
6/9	0	12	0	0	0	0	0	0	0	0
6/10	0	12	0	0	0	0	0	0	0	0
6/11	0	12	0	0	0	0	0	0	1	0
6/12	0	12	0	0	0	0	0	0	1	0
6/13	0	12	0	0	0	0	0	0	0	0
6/14	1	13	0	0	0	0	0	0	0	0
6/15	0	13	0	0	0	0	0	0	0	0
6/16	0	13	0	0	0	0	0	0	0	0
6/17	0	13	0	0	0	0	0	0	0	0
6/18	0	13	0	0	0	0	0	0	0	0
6/19	0	13	0	0	0	0	0	0	0	0
6/20	1	14	0	0	0	0	0	0	0	0
6/21	0	14	0	0	0	0	0	0	1	0
6/22	0	14	0	0	0	0	0	0	0	0
6/23	0	14	0	0	0	0	0	0	0	0
6/24	0	14	0	0	0	0	0	0	0	0
6/25	2	16	0	0	0	0	0	0	0	0
6/26	16	32	0	0	0	0	0	0	0	0
6/27	1	33	0	0	0	0	0	0	0	0
6/28	17	50	0	0	0	0	0	0	0	0
6/29	14	64	0	0	0	0	0	0	0	0
6/30	19	83	0	0	0	0	0	0	0	0
7/1	2	85	0	0	0	0	0	0	0	0
7/2	14	99	0	0	0	0	0	0	0	0
7/3	0	99	0	0	0	0	0	0	0	0
7/4	0	99	0	0	0	0	0	0	0	0
7/5	19	118	0	0	0	0	0	0	0	0
7/6	67	185	0	0	0	0	0	0	0	0

APPENDIX 2.—(Continued).

	Sockeye salmon		Pink salmon		Coho salmon		Chinook salmon		Rainbow trout	
Date	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum	Upstream/Downstream	
7/7	10	195	0	0	0	0	0	0	0	0
7/8	79	274	0	0	0	0	0	0	0	0
7/9	58	332	0	0	0	0	0	0	0	0
7/10	7	339	0	0	0	0	0	0	1	0
7/11	58	397	0	0	0	0	0	0	0	0
7/12	12	409	0	0	0	0	0	0	0	0
7/13	8	417	1	1	0	0	0	0	0	0
7/14	4	421	0	1	0	0	0	0	0	0
7/15	3	424	0	1	0	0	0	0	1	0
7/16	1	425	0	1	0	0	0	0	0	0
7/17	3	428	1	2	0	0	0	0	0	0
7/18	5	433	0	2	0	0	0	0	0	0
7/19	8	441	0	2	0	0	0	0	0	0
7/20	0	441	2	4	0	0	0	0	0	0
7/21	4	445	0	4	0	0	0	0	0	0
7/22	0	445	0	4	0	0	0	0	0	0
7/23	0	445	0	4	0	0	0	0	0	0
7/24	0	445	0	4	0	0	0	0	0	0
7/25	0	445	0	4	0	0	0	0	0	0
7/26	0	445	0	4	0	0	0	0	0	0
7/27	0	445	0	4	0	0	0	0	0	0
7/28	4	449	0	4	0	0	0	0	0	0
7/29	0	449	0	4	0	0	0	0	0	0
7/30	3	452	0	4	0	0	0	0	0	0
7/31	0	452	0	4	0	0	0	0	0	0
8/1	0	452	0	4	0	0	0	0	0	0
8/2	0	452	0	4	9	9	0	0	0	0
8/3	0	452	0	4	18	27	0	0	0	0
8/4	3	455	0	4	14	41	0	0	0	0
8/5	355	810	0	4	0	41	0	0	0	0
8/6	113	923	0	4	0	41	0	0	0	0

APPENDIX 2.—(Continued).

	Sockeye salmon		Pink salmon		Coho salmon		Chinook salmon		Rainbow trout	
Date	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum	Upstream	Downstream
8/7	0	923	0	4	2	43	0	0	0	0
8/8	0	923	0	4	3	46	0	0	0	0
8/9	3	926	0	4	5	51	0	0	0	0
8/10	0	926	0	4	1	52	0	0	0	0
8/11	3	929	0	4	2	54	0	0	0	0
8/12	2	931	0	4	0	54	0	0	0	0
8/13	12	943	0	4	31	85	0	0	0	0
8/14	12	955	0	4	13	98	0	0	0	0
8/15	21	976	0	4	24	122	0	0	0	0
8/16	0	976	0	4	1	123	0	0	0	0
8/17	9	985	0	4	0	123	0	0	0	0
8/18	27	1,012	0	4	24	147	0	0	0	0
8/19	12	1,024	0	4	30	177	0	0	0	0
8/20	9	1,033	0	4	33	210	0	0	0	0
8/21	16	1,049	0	4	4	214	0	0	0	0
8/22	48	1,097	0	4	12	226	0	0	0	0
8/23	30	1,127	0	4	334	560	0	0	0	0
8/24	0	1,127	0	4	1,263	1,823	0	0	0	0
8/25	5	1,132	0	4	207	2,030	0	0	0	0
8/26	6	1,138	0	4	463	2,493	0	0	0	0
8/27	7	1,145	0	4	422	2,915	0	0	0	0
8/28	16	1,161	0	4	53	2,968	0	0	0	0
8/29	4	1,165	0	4	20	2,988	0	0	0	0
8/30	1	1,166	0	4	19	3,007	0	0	0	0
8/31	1	1,167	0	4	2	3,009	0	0	0	0
9/1	39	1,206	0	4	159	3,168	0	0	0	0
9/2	41	1,247	0	4	82	3,250	0	0	0	0
9/3	11	1,258	0	4	45	3,295	0	0	0	0
9/4	16	1,274	0	4	91	3,386	0	0	0	0
9/5	1	1,275	0	4	8	3,394	0	0	0	0
9/6	0	1,275	0	4	15	3,409	0	0	0	0

APPENDIX 2.—(Continued).

	Sockeye salmon		Pink salmon		Coho salmon		Chinook salmon		Rainbow trout	
Date	Daily	Accum	Daily	Accum	Daily	Accum	Daily	Accum	Upstream/Downstream	
9/7	0	1,275	0	4	12	3,421	0	0	0	0
9/8	0	1,275	0	4	60	3,481	0	0	0	0
9/9	2	1,277	0	4	112	3,593	0	0	0	0
9/10	0	1,277	0	4	9	3,602	0	0	0	0
9/11	3	1,280	0	4	11	3,613	0	0	0	0
9/12	0	1,280	0	4	0	3,613	0	0	0	0
9/13	0	1,280	0	4	10	3,623	0	0	0	0
9/14	0	1,280	0	4	18	3,641	0	0	0	0
9/15	0	1,280	0	4	19	3,660	0	0	0	0
9/16	1	1,281	0	4	65	3,725	0	0	0	0
9/17	2	1,283	0	4	70	3,795	0	0	0	0
9/18	1	1,284	0	4	47	3,842	0	0	0	0
9/19	0	1,284	0	4	9	3,851	0	0	0	0
9/20	1	1,285	0	4	44	3,895	0	0	0	0
9/21	6	1,291	0	4	55	3,950	0	0	0	0
9/22	0	1,291	0	4	6	3,956	0	0	0	0
9/23	1	1,292	0	4	1	3,957	0	0	0	0
9/24	0	1,292	0	4	0	3,957	0	0	0	0
9/25	0	1,292	0	4	0	3,957	0	0	0	0
9/26	0	1,292	0	4	1	3,958	0	0	0	0
9/27	0	1,292	0	4	0	3,958	0	0	0	0
9/28	0	1,292	0	4	0	3,958	0	0	0	0
9/29	0	1,292	0	4	0	3,958	0	0	0	0
9/30	0	1,292	0	4	4	3,962	0	0	0	0
10/1	0	1,292	0	4	3	3,965	0	0	0	0
10/2	0	1,292	0	4	4	3,969	0	0	0	0

APPENDIX 3.—Inclined plane trap catch summary, Moose River, Alaska, 1986.

Species	May	June	July	Aug.	Sept.	Total	%
Sockeye salmon	386	338	173	1,066	1,274	3,237	17.5
Coho salmon	722	1,053	91	1,600	3,757	7,223	38.9
Chinook salmon	4	11	17	15	4	51	0.3
Rainbow trout	2	0	18	6	0	26	0.1
Dolly Varden	0	1	1	7	22	31	0.2
Threespine stickleback	690	184	846	1,534	2,578	5,832	31.4
Ninespine stickleback	49	26	62	53	120	310	1.7
Arctic lamprey	0	1,391	95	24	46	1,556	8.4
Slimy sculpin	7	4	7	60	100	178	1.0
Coastrange sculpin	8	10	2	3	9	32	0.2
Pacific lamprey	6	50	0	0	8	64	0.3
Eulachon	3	1	0	0	0	4	0
Round whitefish	0	0	1	0	3	4	0
Longnose sucker	0	0	0	1	0	1	0
Total	1,877	3,069	1,313	4,369	7,921	18,549	100.0

APPENDIX 4.—Minnow trap and fyke net catch summary, Moose River, Alaska, 1985 and 1986.

Date	Location	Gear type[a]	Trap hours	Catch[b]/hour CO	CS	SS	RB	DV	TS	NS	AL	SL
						1985						
5/30	East Fork of the Moose River	MT	(48)	1.40	0	0	0	0.13	0.81	0	0.06	0.02
6/13	Moose River (rkm 23.6)	MT	(48)	0	0	0	0 02	0.02	0.04	0	0	0
6/13	Moosehorn Creek	MT	(48)	0.40	0	0	0.40	0.02	3.46	0.15	0	0
6/14	Moosehorn Creek	MT	(24)	0.08	0	0	0	0	1.42	0.04	0.17	0
8/7	Moosehorn Creek	MT	(36)	0.28	0	0	0	0	1.33	0	0.06	0
6/25	Browse Creek	MT	(96)	0	0	0	0	0	0.14	0	0	0.21
6/25	Pipeline Creek	MT	(108)	0	0	0	0	0	0	0	0	0
	Totals		408	0.24	0	0	0.05	0.02	0.74	0.02	0.02	0.05
						1986						
5/22	Moose River (rkm 17.0)	MT	(36)	0.08	0	0	0	0	8.86	1.17	0.33	0.08
5/25	Moose River (rkm 17.0)	MT	(36)	0.28	0	0	0.03	0	5.36	0	0.36	0
6/5	Moose River (rkm 23.6)	MT	(36)	0.14	0	0	0	0	0.25	0.28	0	0
7/1	Moose River (rkm 17.0)	MT	(36)	0.14	0	0	0	0.08	0.03	0	0.03	0

APPENDIX 4.—(Continued).

Date	Location	Gear type[a]	Trap hours	Catch[b]/hour								
				CO	CS	SS	RB	DV	TS	NS	AL	SL
8/29	Moose River (rkm 4.8)	MT	(48)	1.10	0.02	0	0	0	6.23	0	0	0
10/24	Moose River (rkm 1.8)	MT	(120)	2.19	0.16	0.01	0	0.02	2.05	0.04	0	0
	Totals		312	1.09	0.06	0.01	0.03	0.10	3.42	0.19	0.08	0.01
10/24	Moose River (rkm 1.8)	FN	(24)	4.20	1.60	2.42	0	0.21	4.38	0.42	0.08	0

[a] MT = minnow trap; FN = fyke net.

[b] CO=coho salmon; CS=chinook salmon; SS=sockeye salmon; RB=rainbow trout; DV= Dolly Varden; TS=threespine stickleback, NS=ninespine stickleback; AL=Arctic lamprey; SL=slimy sculpin.

APPENDIX 5.—Physical and chemical characteristics of selected lakes, Moose River watershed, Alaska (U.S. Fish and Wildlife Service, unpublished data).

Lake	Location[a] T	R	S	Elevation (m)	Size (hectare)	Maximum depth (m)	Alkalinity ($mgCaCO_3/L$)	Basic[b] productivity	Land[c] status	Fish Abundance[d,f] CO	SS	KS[e]	RB	DV	WH	LS	TS	NS	SL
Afonasi	5	7	3	81	45	1	43	H	Mo				C			C	C		U
Bear	7	6	29	81	20	6	42	M	T	C			C	U		C	C	C	
Beaver Pond	6	8	16	62	17	4	41	-	W								C		
Big Dog (lower)	7	7	22	65	14	7	35	-	W	U							C		
Big Dog (middle)	7	7	15	68	0 4	3	35	-	W								C		
Big Dog (upper)	7	7	15	66	17	4	23	-	W										
Brattle	7	7	2	81	9	-	16	L	I										
Brood	6	7	36	114	18	-	-	-	Mo										
Browse	6	6	34	129	15	-	70	H	Mo										
Camp Island	6	8	2	53	163	17	61	M	W	C	C		C	C	C	C	C	U	U
Campsite	5	6	8	137	14	13	80	-	Mo								C		
Clam	6	8	1	62	128	10	58	M	W	C			C	U		U	C	U	
Coyote	8	7	35	79	84	-	15	-	I										
Duckbill	7	8	28	69	9	-	66	-	W										
Egumen	5	7	13	83	43	10	58	-	I	C	U		C			C	C		
Frank	7	6	7	91	10	-	32	-	Mo										
Freeway	6	9	1	81	3	-	10	-	W										
Grebe	6	8	16	59	136	12	88	M	W	C	C		C			C	C	U	
Hikers	5	6	21	102	14	4	13	-	Mo								C		
Imeri	5	7	10	81	8	1	49	H	Mo				C			C	C		
Jay	7	6	8	74	23	-	20	-	W										
Jigsaw				-	-	-	15	L	Mo										
Justin	6	8	6	56	10	3	37	M	W	C			U						
Kelly	5	6	20	92	56	12	59	M	Mo	C			C			C	C		
Lill	7	9	35	78	25	8	28	-	I								C		
Lilly	5	7	9	104	8	8	20	-	Mo										
Little Silver	6	9	2	72	4	3	55	H	I	U							C		
Long	7	7	30	74	22	11	3	L	W										
Loon	7	8	36	64	242	19	32	-	W			C				U	C		
Mallard	7	7	17	60	24	26	5	-	W								C		
Meadow	6	8	3	62	24	4	53	-	W	C		U	U				C		
Mink (Big)	7	8	32	65	39	9	8	L	W								C		
Mink (Little)	7	8	32	65	22	13	66	-	W				C			U	C		
Moosehorn	6	7	6	68	117	8	65	H	W				U			U	C	U	
Mosquito	6	9	2	83	28	12	16	L	I								C		
Muskrat	7	6	7	74	37	8	2	L	W								C		
Nosnhoj	7	6	18	66	5	-	-	-	W										
Ordeal	6	8	7	69	12	11	17	L	W	C							C		
Otter	7	8	27	68	76	9	18	L	W								C		
Peterson	5	6	18	89	38	12	67	M	Mo	C	U		C			C	C	U	
Picnic	5	6	2	140	-	-	-	-	Mo										
Raven	7	7	17	68	15	9	4	L	W								C		

APPENDIX 5.—(Continued).

Lake	Location[a] T	R	S	Elevation (m)	Size (hectare)	Maximum depth (m)	Alkalinity ($mgCaCO_3/L$)	Basic[b] productivity	Land[c] status	Fish Abundance[d,f] CO	SS	KS[e]	RB	DV	WH	LS	TS	NS	SL
Regelin	8	7	26	81	16	5	19	L	Mo										
Rifle	8	7	23	88	18	16	14	-	W								C		
Rock	7	8	35	65	132	16	51	M	W	C		C				C	C		U
Schwartz	8	7	26	80	14	-	-	-	Mo										
Silver	6	9	2	69	53	10	29	M	T	U			C				C		
Swan	7	7	29	63	334	13	67	M	W	U	U	C				U	C	U	U
Takukak	8	7	25	89	-	-	20	L	W										
Teal	7	7	9	71	40	4	2	L	W										
Try	8	7	22	84	22	15	19	L	W										
Trumpeter	6	7	36	117	-	-	-	-	MO										
Unnamed (S. of Rock)	6	8	2	63	13	-	40	H	W								U	C	
Unnamed (W of Frank)	7	6	7	91	16	-	18	L	Mo										
Unnamed (S. of Frank)	7	6	7	81	16	-	19	L	Mo										
Unnamed (N. of Frank)	7	6	5	77	18	-	24	-	Mo										
Ursus	8	7	29	89	-	18	29	-	W										
Vixen	7	7	1	84	-	-	25	-	I										
Yearling	6	8	4	66	20	5	20	-	W								C		
Watson	5	7	11	81	24	4	68	H	I	C	U	U	C			C	C		
Weasel	7	8	33	74	44	8	73	-	W	U						U	C		
Total					2,374 4														

[a] T=township; R=range; S=section.
[b] H=high, M=medium, L=low
[c] I=intensive; Mo=moderate; T=traditional, Mi=minimal, W=wilderness.
[d] CO=coho salmon, SS=sockeye salmon, KS=kokanee salmon, RB=rainbow trout, DV=Dolly Varden, WH=whitefish; LS=longnose sucker, TS=threespine stickleback, NS=ninespine stickleback, SL=slimy sculpin.
[e] Includes residual sockeye salmon.
[f] C=common; U=uncommon.

APPENDIX 6.—Rainbow trout floy tagging summary, Moose River, Alaska, 1986.

Tag number	Tagging date	Tagging location[a]	Sex[b]	Length (mm)	Weight (g)	Recapture Date	Recapture Location[a]
Orange Tags							
00126	5/22	rkm 17.0	M	480	980		
00127	5/22	rkm 17.0	F	430	800		
00128	5/22	rkm 17.0	M	350	460		
00129	5/22	rkm 17.0	M	460	660		
00130	5/22	rkm 17.0	M	450	960		
00131	5/22	rkm 17.0	F	500	1220		
00132	5/22	rkm 17.0	M	510	1380		
00133	5/22	rkm 17.0	F	450	960		
00134	5/22	rkm 17.0	M	440	760		
00135	5/22	rkm 17.0	M	400	580		
00136	5/22	rkm 17.0	M	510	1310		
00137	5/22	rkm 17.0	F	440	830		
00138	5/23	rkm 17.0	F	500	1290		
00139	5/23	rkm 17.0	M	610	2100		
00140	5/23	rkm 17.0	M	330	320		
00141	5/23	rkm 17.0	M	500	1250		
00142	5/23	rkm 17.0	M	500	1090		
00143	5/23	rkm 17.0	F	500	1680		
00144	5/23	rkm 17.0	M	470	1200		
00145	5/23	rkm 17.0	M	350	410		
00146	5/23	rkm 17.0	M	440	1800		
00147	5/23	rkm 17.0	M	450	710		
00148	5/23	rkm 17.0	F	450	1120		
00149	5/23	rkm 17.0	F	410	640		
00150	5/23	rkm 17.0	M	410	700		
00151	5/23	rkm 17.0	M	210	180		
00152	5/23	rkm 17.0	M	410	800		
00153	5/23	rkm 17.0	M	410	760		
00154	5/23	rkm 17.0	M	410	600		
00155	5/23	rkm 17.0	M	540	1480		
00156	5/23	rkm 17.0	M	500	1120	6/8/87	rkm 7.4
00157	5/23	rkm 17.0	M	460	1190		
00158	5/23	East Fork	M	560	1820		
00159	5/23	rkm 15.0	M	480	1080		
00160	5/23	rkm 15.0	F	450	920		
00161	5/23	rkm 15.0	M	560	1760		
00162	5/23	rkm 15.0	M	430	860		
00163	5/23	rkm 15.0	M	460	1020		
00164	5/23	rkm 15.0	M	250	200		
00165	5/23	rkm 15.0	F	490	1240		
00166	5/25	East Fork	M	480	920		

APPENDIX 6.—(Continued).

Tag number	Tagging date	Tagging location[a]	Sex[b]	Length (mm)	Weight (g)	Recapture Date	Recapture Location[a]
Orange Tags (Continued)							
00167	5/25	East Fork	F	500	1300		
00168	5/25	East Fork	M	490	920		
00169	----------		Void		----------		
00170	5/25	East Fork	F	230	400		
00171	5/25	East Fork	M	540	1390		
00172	5/25	East Fork	M	490	1200		
00173	5/25	East Fork	M	470	820		
00174	5/25	East Fork	M	500	940	6/3/87	rkm 7.4
00175	5/25	East Fork	M	520	1220		
00176	5/25	East Fork	M	460	780		
00177	5/25	rkm 17.0	M	520	1250		
00178	5/25	rkm 17.0	M	330	320		
00179	5/26	rkm 17.0	M	580	1950		
00180	5/26	rkm 17.0	F	520	1120		
00181	5/26	rkm 17.0	M	480	1100		
00182	5/26	rkm 17.0	M	410	700		
00183	5/26	rkm 17.0	F	420	780		
00184	5/26	rkm 17.0	M	350	460		
00185	5/26	rkm 17.0	?	280	200		
00186	5/26	rkm 17 0	?	350	400		
00187	5/26	rkm 17.0	F	460	850		
00188	5/26	rkm 17.0	M	380	550		
00189	----------		Void		----------		
00190	5/26	rkm 17.0	M	560	1600		
00191	5/26	rkm 17.0	M	300	320		
00192	5/26	rkm 17.0	M	290	240		
00193	5/26	East Fork	M	300	320		
00194	5/26	East Fork	F	460	1000		
00195	5/26	rkm 15.0	F	480	1100		
00196	5/26	rkm 15.0	M	310	260		
00197	5/26	rkm 15.0	M	470	1050		
00198	5/26	rkm 15.0	M	480	1230		
00199	5/26	rkm 15.0	F	490	740		
00200	5/26	rkm 15.0	M	280	240		
00201	5/26	rkm 15.0	F	500	1320		
00202	5/26	rkm 15.0	F	490	1100		
00203	5/26	rkm 15.0	F	440	750		
00204	5/26	rkm 15.0	M	340	300		
00205	5/26	rkm 15 0	F	570	1700		
00206	5/26	rkm 15.0	M	420	650		
00207	5/28	West Fork	F	450	840		
00208	5/28	West Fork	M	450	850		

APPENDIX 6.—(Continued).

Tag number	Tagging date	Tagging location[a]	Sex[b]	Length (mm)	Weight (g)	Recapture Date	Recapture Location[a]
Orange Tags (Continued)							
00209	5/28	West Fork	M	540	1350		
00210	5/28	West Fork	F	510	1300		
00211	5/28	West Fork	F	500	1200		
00212	5/28	West Fork	F	450	800		
00213	5/28	West Fork	M	450	950		
00214	5/28	West Fork	?	260	200		
00215	5/28	West Fork	M	510	1120	6/28/87	Clam Lake
00216	5/28	West Fork	?	300	250	6/18/87	West Fork
00217	5/29	East Fork	?	260	150		
00218	5/29	East Fork	F	460	1150		
00219	6/5	rkm 17.0	?	250	160		
00220	6/5	rkm 17.0	M	525	1260		
00221	6/5	rkm 17.0	M	530	1260		
00222	6/5	rkm 17.0	M	460	900		
Yellow Tags							
01101	5/12	rkm 7.4	F	483	-		
01102	5/12	rkm 7.4	M	477	-		
01103	5/12	rkm 7.4	M	481	-		
01104	5/13	rkm 7.4	F	480	-	6/2/87	rkm 7.4
01105-6	5/14	rkm 7.4	F	495	-		
01107	5/14	rkm 7.4	M	490	-		
01108	5/15	rkm 7.4	F	370	-	5/24/87	rkm 7.4
01109	5/15	rkm 7.4	F	531	-		
01110-1	5/15	rkm 7.4	F	540	-		
01112	5/16	rkm 7.4	F	450	-		
01113	5/16	rkm 7.4	F	443	-		
01114	---------- Void ----------						
01115-16	5/16	rkm 7.4	F	444	-		
01117	5/18	rkm 7.4	F	511	-		
01118	5/18	rkm 7.4	M	484	-		
01119	5/18	rkm 7.4	M	472	-		
01120	5/18	rkm 7.4	F	454	-		
01121	5/19	rkm 7.4	M	483	-		
01122	5/20	rkm 7.4	M	330	-	5/24/87	rkm 7.4
01123	5/20	rkm 7.4	M	530	-		
01124	5/23	rkm 7.4	F	495	-	5/28/87	rkm 7.4
01125	5/23	rkm 7.4	M	470	-	5/30/87	rkm 7.4
01126	5/23	rkm 7.4	M	430	-		
01127	5/24	rkm 7.4	F	470	-		
01133	5/24	rkm 7.4	F	485	-		

APPENDIX 6.—(Continued).

Tag number	Tagging date	Tagging location[a]	Sex[b]	Length (mm)	Weight (g)	Recapture Date	Recapture Location[a]
Yellow Tags (Continued)							
01135	5/25	rkm 7.4	M	505	-		
01150	5/25	rkm 7.4	F	465	-		
01137	5/27	rkm 7.4	F	420	-		
01138	5/27	rkm 7.4	M	485	-		
01141	5/27	rkm 7.4	F	440	-		
01142	5/27	rkm 7.4	M	445	-		
01143	5/27	rkm 7.4	M	470	-		
01144	5/28	rkm 7.4	F	430	-		
01145	5/28	rkm 7.4	M	510	-	6/2/87	rkm 7.4
01146	5/29	rkm 7.4	M	335	-		
01147	5/29	rkm 7.4	M	420	-		
01148	5/29	rkm 7.4	M	510	-		
01149	5/30	rkm 7.4	F	450	-		
01500	5/30	rkm 7.4	F	500	-		
01502	5/30	rkm 7.4	F	465	-		
01503	6/2	rkm 7.4	M	470	-		
01504	6/3	rkm 7.4	M	530	-		
01505	6/4	rkm 7.4	F	405	-		
01506	6/5	rkm 7.4	F	385	-		
01507	6/5	rkm 7.4	M	430	-		
01508	6/5	rkm 7.4	F	430	-		
01509	6/6	rkm 7.4	M	450	-		
01510	6/6	rkm 7.4	F	490	-		
01515	6/11	rkm 7.4	M	460	-		
01516	6/12	rkm 7.4	M	450	-		
01517	6/13	rkm 7.4	F	470	-		
01518	6/21	rkm 7.4	M	440	-		
01519	6/21	rkm 7 4	M	465	-		
01521	6/22	rkm 7.4	F	392	-		
01522	6/22	rkm 7.4	F	383	-		
01523	7/10	rkm 7.4	F	308	-		

[a] rkm 17.0 = Main spawning grounds (Upper Bluff).
rkm 7.4 = Weir site.
East Fork = East Fork of the Moose River.
rkm 15.0 = Spawning grounds (Lower Bluff).
West Fork = West Fork of the Moose River.

[b] M=male, F=female.

APPENDIX 7.—Stream discharge and water chemistry summary, Moose River, Alaska, 1985 and 1986.

Location	Date	Discharge (m^3/s)	Temp. (°C)	pH	Conductivity[a] (μmhos/cm)	Alkalinity ($mgCaCO_3/L$)	Hardness ($mgCaCO_3/L$)
Bear Lake Outlet	6/4/86		8	6.9	102	47	47
Border Creek (pipeline crossing)	6/4/86		5	6.8	117	53	50
Pipeline Ck. (mouth)	6/25/85	0.2	7	6.9	59	23	13
	6/4/86	0.2	6	7.0	88	45	46
	7/3/86	0.2	10	7.0	55	27	37
Browse Creek (pipeline crossing)	6/25/85	0.4	9	7.4	164	75	66
Moose River (rkm 23.6)	6/12/85	1.3	-	-	111	53	59
	7/18/85	1.2	17	7.3	143	71	64
	8/5/85	1.1	14	7.2	147	73	74
	8/20/85	-	13	7.1	134	62	62
	5/22/86	-	7	7.0	102	38	42
	6/5/86	1.1		7.1	117	53	55
	7/1/86	1.0	15	7.3	129	65	71
	7/24/86	-	14	7.5	144	70	80
	9/3/86	1.2	11	7.2	131	59	56
	9/14/86	1.1	9.5	7.3	133	63	57
	9/24/86	2.3	4	7.0	116	53	58
Moose River (rkm 17.0)	7/10/86	1.4	14	7.3	134	63	79
	7/18/86	2.0	15	7.0	143	68	74
Moosehorn Ck. (mouth)	6/12/85	0.1	18	7.4	152	69	66
	8/5/85	0 1	12	7.0	-	-	-
	8/20/85	-	15	7.0	138	60	60
	5/22/86	-	8	7.1	137	60	63
	6/5/86	0.2	-	7.2	135	67	65
	7/1/86	0.1	16	7.2	152	73	82
	7/10/86	0.1	15	-	144	71	89
	7/17/86	0.1	17	7.3	148	76	80
	7/24/86	0.1	16	7.1	146	70	81
	9/11/86	0.2	13.5	7.0	147	62	57
East Fork of the Moose River (mouth)	6/12/85	-	-	-	-	-	-
	7/19/85	0.5	15	7.2	140	69	66
	8/6/85	0.5	14	7.3	123	60	60
	8/21/85	-	12	7.1	119	54	54

APPENDIX 7.—(Continued).

Location	Date	Discharge (m^3/s)	Temp. (°C)	pH	Conductivity[a] (μmhos/cm)	Alkalinity ($mgCaCO_3/L$)	Hardness ($mgCaCO_3/L$)
East Fork (continued)	5/24/86	0.7	14	7.1	100	53	53
	6/5/86	0.5	13	7.3	111	56	59
	7/2/86	0.3	14	7.3	135	70	80
	7/10/86	0.3	18	7.3	132	56	77
	7/17/86	0.4	18	7.4	133	60	69
	7/24/86	0.4	10	7.3	127	51	63
	9/4/86	0.5	11	7.4	137	58	60
	9/10/86		12	7.3	131	59	59
	9/15/86	0.4	11.5	7.4	137	64	64
	9/24/86	0.8	7	7.3	134	64	66
West Fork of the Moose River (mouth)	6/13/85	-	15	7.2	137	58	57
	7/19/85	0.2	14	7.3	144	66	66
	8/6/85	0.2	14	7.4	137	62	65
	8/21/85	-	11	7.0	110	47	47
	5/23/86	0 8	11	7.1	105	45	44
	6/5/86	0.5	11.5	7.4	121	54	53
	7/2/86	0.2	14.5	7.4	134	69	85
	7/18/86	0.2	15.5	7.35	-	63	87
	7/25/86	0.2	12	7.2	134	66	71
	8/26/86	0.5	12	7.3	126	56	58
	9/4/86		11	7.1	123	61	47
	9/10/86		12	7.3	119	52	48
	9/15/86	0.5	11	7.2	129	60	50
	9/24/86	1 2	7	7.0	104	47	48
Moose River (rkm 7.4)	6/10/85	3.7	-	7.3	-	-	-
	6/20/85	-	7	7.2	128	59	59
	7/19/85	2.6	15	-	137	69	70
	8/6/85	-	15	-	140	70	70
	8/21/85	-	11	7.1	127	56	57
	2/5/86		1	6.7	180	99	79
	4/7/86		1	6.9	186	75	-
	5/24/86		8	7.1	111	48	50
	6/5/86	3.2	10.5	7.4	119	55	56
	7/2/86	2.3	14	7.6	119	68	90
	7/18/86	2.6	16	7.5	139	70	85
	7/25/86	2.8	12	7.4	144	64	76
	9/4/86	3.0	11	7.3	132	59	54
	9/10/86		9	7.1	131	56	55
	9/15/86	4.1	10	7.3	133	60	60

[a] Corrected to 25°C.

APPENDIX 8.—Escapement and age composition of adult sockeye salmon by sample period, Moose River, Alaska, 1985 and 1986.

Sample period	Total escapement	N	Age group 1.2	1.3	2.2	2.3	3.2	Estimated escapement by age group 1.2	1.3	2.2	2.3	3.2
1985												
June 1-15	414	70	2	3	14	51	0	12	18	83	301	0
16-30	242	130	1	5	32	92	0	2	9	59	172	0
July 1-15	107	59	0	0	26	33	0	0	0	54	53	0
16-31	1092	130	8	1	102	9	10	74	13	800	115	90
Aug 1-15	643[a]	103	12	3	67	13	8	67	19	405	93	59
16-31	237[a]	20	5	2	10	3	0	59	24	118	36	0
Sept 1-15	43[b]	9	1	0	7	1	0	1	0	7	1	0
16-30	0	0	-	-	-	-	-	-	-	-	-	-
Totals	2,778	521	29	14	258	202	18	215	83	1,526	771	149
1986												
May 24-31	11	2	0	0	0	2	0	0	0	0	11	0
June 1-15	2[c]	0	-	-	-	-	-	-	-	-	-	-
16-30	70[b]	30	3	3	3	21	0	7	7	7	48	0
July 1-15	341	131	2	14	3	112	0	7	38	9	287	0
16-31	28	4	0	0	2	2	0	0	0	14	14	0
Aug 1-15	524	91	14	2	59	10	6	80	14	334	59	37
16-31	191	90	10	2	66	6	6	21	4	140	13	13
Sept 1-15	113[a,b]	62	4	2	43	6	7	7	4	75	10	12
16-30	12	2	0	0	2	0	0	0	0	12	0	0
Totals	1,292	412	33	23	178	159	19	123	66	591	442	62

[a] Incomplete count.
[b] Not all fish sampled were aged.
[c] No scales were analyzed.

APPENDIX 9.—Sockeye salmon mean length (mm) by sex and age, Moose River, Alaska, 1985 and 1986.

		1985 Age group					1986 Age Group				
Characteristic	Sex	1.2	1.3	2.2	2.3	3.2	1.2	1.3	2.2	2.3	3.2
Early Run											
Mean length	M	512	534	549	549		487	543	486	553	
SD		-	57	33	42		18	14	63	35	
Range		488-541	420-635	515-600	460-625		451-501	501-565	400-550	400-615	
N		2	4	34	105	0	4	8	4	81	0
Mean length	F	507	520	482	514		472	520	478	527	
SD		-	31	32	40		-	25	108	38	
Range		-	495-543	430-560	455-550		-	496-562	300-557	455-600	
N		1	3	21	60	0	1	9	5	52	0
Mean length	All	510	525	549	535		475	535	482	542	
SD		26	44	33	42		18	20	85	38	
Range		483-541	420-635	515-600	455-625		451-501	496-565	300-557	400-615	
N		3	7	55	165	0	5	17	9	133	0
Late Run											
Mean length	M	482	551	499	583	530	489	546	493	575	553
SD		60	12	29	20	22	27	-	50	39	14
Range		410-520	532-571	450-560	565-605	490-560	448-556	-	425-595	525-620	530-576
N		14	5	108	10	7	13	1	79	21	8
Mean length	F	475	520	472	568	477	461	538	503	552	533
SD		52	-	38	36	15	36	36	47	23	25
Range		412-507	-	400-550	525-590	460-490	406-559	476-590	390-570	525-585	500-570
N		10	1	69	20	11	20	5	86	11	5
Mean length	All	478	541	487	576	490	485	540	498	567	545
SD		54	21	36	28	29	34	33	48	35	20
Range		410-520	520-571	400-560	565-605	460-530	406-559	476-590	390-595	525-620	500-575
N		24	6	177	30	18	33	6	165	32	13

APPENDIX 10.—Escapement and age composition of adult coho salmon by sample period, Moose River, Alaska, 1985 and 1986.

Sample period	Total escapement	N	Age group 2.1	Age group 3.1	Estimated escapement by age group 2.1	Estimated escapement by age group 3.1
			1985			
Aug 1-15	4[a]	1	0	1	0	4
16-31	248[a]	49	18	31	92	156
Sept 1-15	481	131	55	76	200	281
16-30	231	96	42	54	102	129
Oct 1-2	6	1	0	1	0	6
Totals	970	278	115	163	394	576
			1986			
Aug 1-15	122[b]	20	10	10	61	61
16-31	2,887	122	73	49	1,732	1,155
Sept 1-15	651	111	64	47	378	273
16-30	302[b]	61	38	23	187	115
Oct 1-2	7[c]	0	-	-	-	-
Totals	3,969	314	185	129	2,358	1,604

[a] Incomplete counts.
[b] Not all fish sampled were aged.
[c] No scales were analyzed.

APPENDIX 11.—Coho salmon mean length (mm) by sex and age, Moose River, Alaska, 1985 and 1986.

		1985 Age group		1986 Age group	
Characteristic	Sex	3.1	2.1	3.1	2.1
Mean length	M	583	574	591	521
SD		60	34	48	57
Range		470-670	530-650	530-690	420-610
N		84	77	82	106
Mean length	F	577	549	570	549
SD		41	22	61	67
Range		500-630	520-590	445-665	435-635
N		79	38	47	79
Mean length	All	580	565	583	534
SD		51	32	54	57
Range		470-670	520-650	445-690	420-635
N		163	115	129	185

APPENDIX 12.—Catch and age composition of juvenile sockeye salmon by sample period in an inclined plane trap, Moose River, Alaska, 1986.

Sample period	Catch	Age 0 N	Age 0 Length range (mm)	Age 1 N	Age 1 Length range (mm)	Age 2 N	Age 2 Length range (mm)
May 20-25	30					10	91 - 115
26-6/1	529					70	94 - 129
June 2-8	134	1	25			26	99 - 136
9-15	8					4	102 - 112
16-22	2[a]						
23-29	17	4	32 - 41				
30-7/6	15	6	30 - 43	1	60		
July 7-13	29	11	40 - 49	1	61		
14-20	19	6	39 - 50	1	81		
21-27	37	14	41 - 52				
28-8/3	119	43	38 - 53	1	79		
Aug 4-10	269	61	32 - 52	2	70 - 82		
11-17	364	59	39 - 55				
18-24	179	70	43 - 49	1	84		
25-31	212	56	46 - 52	2	71 - 79		
Sept 1-7	471	60	41 - 51				
8-14	263	58	44 - 55	1	85		
15-21	228	64	40 - 56				
22-28	249	42	43 - 54	2	69 - 76		
29-10/2	63	26	46 - 56				
Totals	3,237	581	25 - 56	12	60 - 85	110	91 - 136
Mean			46		75		112
SD			± 5.0		± 8.5		± 11.0

[a] No scale samples taken.

APPENDIX 13.—Catch and age composition of juvenile coho salmon by sample period in an inclined plane trap, Moose River, Alaska, 1986.

Sample period	Catch	Age 0		Age 1		Age 2		Age 3	
		N	Length range (mm)	N	Length range (mm)	N	Length range (mm)	N	Length range (mm)
May 20-25	23					2	82 - 119	3	132 - 151
26-6/1	826					37	81 - 120	33	141 - 160
June 2-8	292					47	89 - 128	23	131 - 154
9-15	69					4	88 - 115	1	136
16-22	522			28	60 - 71	28	92 - 130	14	136 - 139
23-29	40					15	91 - 140	10	130 - 142
30-7/6	6			3	56 - 80	1	106	2	136 - 151
July 7-13	11	1	38	4	63 - 70				
14-20	16	1	40	3	66 - 78	1	96		
21-27	47	9	38 - 41	6	65 - 76				
28-8/3	39	4	41 - 42	8	69 - 81				
Aug 4-10	295	35	39 - 46	1	64				
11-17	334	51	39 - 51						
18-24	342	46	43 - 49	1	66				
25-31	606	65	42 - 51						
Sept 1-7	1,020	68	40 - 56	2	63 - 68	1	82		
8-14	1,268	70	41 - 54						
15-21	734	52	40 - 52	1	69				
22-28	588	60	43 - 56	2	76 - 87				
29-10/2	145	21	43 - 54						
Totals	7,223	483	38 - 56	59	56 - 87	136	81 - 140	86	131 - 160
Mean			46		69		107		144
SD			± 3.0		± 7.0		± 15.1		± 8.1

APPENDIX 14.—Lengths (mm) and weights (g) of selected fish species by sex, Moose River, Alaska, 1985 and 1986.

Species	Year	Sex	N	Mean length ± SD (range)	Mean weight ± SD (range)
Rainbow trout	1985	M	10	440 ± 72 (320-555)	839 ± 373 (350-1675)
		F	9	444 ± 31 (410-500)	772 ± 201 (700-975)
		M&F	19	442 ± 55	784 ± 302
	1986	M	93	439 ± 85 (210-610)	873 ± 485 (200-1950)
		F	56	458 ± 55 (310-570)	1,043 ± 299 (400-1700)
		M&F	149	446 ± 76	921 ± 445
Round whitefish	1985	M&F	11	371 ± 23 (335-425)	607 ± 196 (350-1000)
	1986	M&F	20	387 ± 50 (291-535)	616 ± 162 (225-900)
Dolly Varden	1985	?	1	470 - -	1,100 - -
	1986	M&F	5	416 ±105 (293-575)	1,039 ± 329 (600-1350)
Longnose sucker	1985	M&F	4	423 ± 28 (390-455)	906 ± 153 (800-1125)
	1986	M&F	7	464 ± 35 (400-515)	1,053 ± 286 (600-1400)
Arctic lamprey	1985	M	105	146 ± 15 (119-220)	5 ± 2 (2-16)
		F	68	148 ± 14 (123-224)	6 ± 3 (2-18)
		M&F	173	147 ± 14	6 ± 2
Pacific lamprey	1985	M	29	552 ± 42 (450-615)	425 ± 93 (200-625)
		F	10	491 ± 17 (460-500)	320 ± 21 (300-350)
		M&F	39	537 ± 47	399 ± 94

APPENDIX 15.—Movements of 5 round whitefish radio-tagged at the weir, Moose River, Alaska, 9/22/86.

Frequency	Fork length (mm)	Location			
		9/30	10/9	10/14	10/23
40.810	395	Weir	Weir	Moose River Mouth	Moose River Mouth
40.820	400	[a]	Middle West Fork	[a]	Lower Kenai River Bridge
40.830	350	West Fork Mouth	Camp Island Lake Outlet	[a]	Upper Kenai River Bridge
40.840	390	West Fork Mouth	West Fork Mouth	West Fork Mouth	Lower Kenai River Bridge
40.850	345	West Fork Mouth	[a]	[a]	[a]

[a] Not located.

APPENDIX 16.—Boat use by sample week, Moose River, Alaska, 1985.

Month	Sample week[a]	Canoes	Power boats	People	Anglers	Trip origin: Canoe Lake	Portage Lake	Watson Lake	Sterling
June	1[b]	6	0	14		[b]	[b]	[b]	[b]
	2	12	0	29		[b]	[b]	[b]	[b]
	3	28	0	59		1[b]	1[b]	1[b]	[b]
	4	20	1	42		14	3	1	3
	Total	66	1	144		15	4	2	3
July	1	57	6	139		39	18	0	6
	2	23	0	49		10[b]	2[b]	1[b]	2[b]
	3	17	0	39		11	5	0	1
	4	20	0	48		15	4	0	1
	Total	116	6	275		75	29	1	10
Aug	1	76	0	180		25	51	0	0
	2	28	0	60		9[b]	5[b]	0[b]	1[b]
	3[b]	2	0	3		0	1	0	1
	4[b]	1	0	2		0	0	0	1
	Total	107	0	245		34	57	0	3
Sep.	1	27	4	58		10	3	4	14
	2	5	4	22		2	3	0	4
	3	5	2	15		2	2	0	3
	4	11	0	22		9	2	0	0
	Total	48	10	117		23	10	4	21
Oct.	1	0	0	0		0	0	0	0
Grand total		337	17	781		147	100	7	37

[a] Sample week 1 = 1-7; 2 = 8-15; 3 = 16-23; 4 = 24-30/31
[b] Incomplete trip origin data.

APPENDIX 17.—Boat use by sample week, Moose River, Alaska, 1986.

Month	Sample Week[a]	Canoes	Power boats	People	Anglers	Trip origin: Canoe Lake	Portage Lake	Watson Lake	Sterling
May	1	Not in Operation							
	2	3	0	4	4	-	-	-	3
	3	0	-	-	-	-	-	-	-
	4[b]	36	0	87	21	11	21	-	-
Total		39	0	91	25	11	21	0	3
June	1[b]	7	0	14	0	3	2	-	1
	2[b]	14	1	28	20	9	3	-	2
	3[b]	31	1	69	60	24	3	2	2
	4	32	4	79	63	21	8	-	7
Total		84	6	190	143	57	16	2	12
July	1	40	0	89	56	9	23	-	8
	2[b]	25	0	64	8	10	9	-	5
	3[b]	20	0	48	39	4	5	-	10
	4	30	0	65	29	19	8	-	3
Total		115	0	266	132	42	45	0	26
Aug	1	48	0	118	22	21	26	-	1
	2	14	0	29	14	10	4	-	0
	3	17	0	36	15	8	8	-	1
	4	11	3	32	13	5	1	-	8
Total		90	3	215	64	44	39	0	10
Sept	1[b]	25	7	68	21	8	4	6	13
	2[b]	12	1	20	6	3	1	5	3
	3	11	2	23	7	3	1	2	7
	4	5	0	10	0	5	0	-	0
Total		53	10	121	34	19	6	13	23
Oct	1	0	0	0	0	0	0	0	0
Grand total		381	19	883	398	173	127	15	74

[a] Sample week 1 = 1-7; 2 = 8-15; 3 = 16-23; 4 = 24-30/31

[b] Incomplete trip origin data.