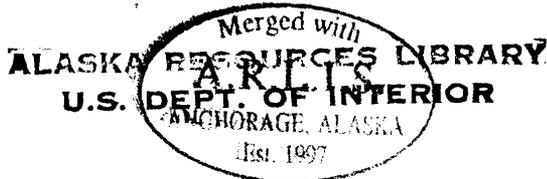


Volume 8



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STATE OF ALASKA
Walter J. Hickel, Governor

ANNUAL REPORT OF PROGRESS, 1966 - 1967
FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-8
SPORT FISH INVESTIGATIONS OF ALASKA

ALASKA DEPARTMENT OF FISH AND GAME
Urban C. Nelson, Commissioner
Wallace H. Noerenberg, Deputy Commissioner

Alex H. McRea, Director
[Alaska Department of Fish and Game] Sport Fish Division

Louis S. Bandirola, Coordinator

INTRODUCTION

This report of progress consists of findings and work accomplished under the State of Alaska Federal Aid In Fish Restoration Project F-5-R-8, "Sport Fish Investigations of Alaska."

The project during this report period is composed of 20 separate studies. Some are specific to certain areas, species or fisheries, while others deal with a common need for information. Each job has been developed to meet the needs of various aspects of the State's recreational fishery resource. Seven jobs are designed to pursue the cataloging and inventory of the numerous State waters. These are divided into logical utilization areas and are jobs of a continuing nature. It will be many years before an index of the potential recreational fishing waters is completed. Six jobs are directed toward specific sport fish studies. These include special efforts toward the anadromous Dolly Varden of Southeastern Alaska, silver salmon in Resurrection Bay, king salmon stocks on the lower Kenai Peninsula, king and other salmon stocks in Upper Cook Inlet, and Arctic grayling and sheefish in Interior Alaska. Special reports have been prepared on specific phases of the Dolly Varden life history and appear in the Department's special "Research Report" series.

The Statewide access evaluation remains one of the most important jobs conducted under this Federal Aid Program. It provides the Department with a tool to recommend withdrawal of suitable access sites on potential recreational fisheries throughout the State.

The remaining jobs include creel census efforts on specific fisheries in high use areas of the State, an egg-take program directed toward locating suitable indigenous stocks, perfecting advanced techniques in taking, handling and rearing species that are not normally associated with standard fish cultural practices, and continuation of the evaluation of the Fire Lake System.

The material contained in this report is often fragmentary in nature. The findings, evaluations and interpretations contained herein are subject to re-evaluation as the work progresses and additional data are collected.

RESEARCH PROJECT SEGMENT

STATE: ALASKA Name: Sport Fish Investigations of Alaska.

Project No: F-5-R-8 Title: Inventory and Cataloging of the Sport Fish and Sport Fish Waters in the Bristol Bay and Lower Kuskokwim Drainages.

Job No: 12-A

Period Covered: May 1, 1966 to April 15, 1967.

ABSTRACT

The commercial fishery on king salmon, Oncorhynchus tshawytscha, in the Naknek-Kvichak district and the subsistence fishery on king salmon in the Naknek River are described, and catch estimates for 1966 are compiled.

King salmon escapement counts in King Salmon Creek, Big Creek, the Alagnak River, and the Nonvianuk River totaled 633, 979, 532, and 933, respectively. Many spawning king salmon were found in the Naknek River but numerical estimates were not obtained.

The commercial fishery on silver salmon, O. kisutch, in the Naknek-Kvichak district is briefly discussed. Catch and escapement totals for the commercial fishery and the Brooks River weir are summarized.

Age determinations were made on 264 rainbow trout, Salmo gairdneri, from the Naknek River. Average lengths and length ranges of the various age groups are summarized.

Adult rainbow trout are believed to migrate from Naknek Lake outlet to downriver spawning sites by mid-May and return to the lake outlet area after mid-July. Rainbow trout were found spawning in eight distinct locations in the Naknek River. These locations were recorded on permanent maps maintained at King Salmon. Immature rainbow trout are also believed to migrate to downriver forage areas during the summer months. The possible presence of anadromous rainbow trout in the Naknek River is discussed and the belief is stated that anadromous rainbow do not occur in the Naknek River.

A series of tributaries to Naknek Lake and Naknek River was surveyed and results are listed:

RECOMMENDATIONS

1. That studies be continued to determine the magnitude, timing, and distribution of king salmon stocks in the Naknek and Kvichak drainages. Specific data needed are:
 - (A) Continued enumeration of spawning king salmon in Big Creek, King Salmon Creek, the Alagnak River System, and the Naknek River.
 - (B) Surveys of Pauls Creek and Smelt Creek to determine the presence, magnitude and timing of king salmon migrations.
 - (C) An estimate of the subsistence catch of king salmon in the Naknek River.
2. That the study of rainbow trout migrations, spawning areas and spawning behavior in the Naknek River be continued.
3. That aerial enumeration of rainbow trout be conducted at known spawning sites in the Naknek River and in Lower Talaric Creek.
4. That catalog and inventory of Naknek Lake inlets be continued.
5. That investigations of the trophy grayling, Thymallus arcticus, stocks of the

Ugashik Lakes and the "golden" Dolly Varden, Salvelinus malma, stocks of Idavain Lake be initiated as time and manpower permit.

6. That winter commercial fishing on Naknek Lake and Tikchik Lakes be monitored to determine the magnitude, the species composition and population characteristics of the catch.

OBJECTIVES

1. To assess the environmental characteristics of the existing and potential fishery waters of the job area and, where practicable, obtain estimates of angler use and sport fish harvest.
2. To evaluate application of fishery restoration measures and availability of sport fish egg harvest.
3. To assist as required in the investigations of public access status to the area's fishing waters, and to provide recommendations for acquiring specific sites.
4. To evaluate multiple water use development projects (public and private) and their effects on the area's streams and lakes for the proper protection of the sport fish resources.

TECHNIQUES USED

Data relating to commercial catches and escapement of salmon were compiled from unpublished manuscripts of the Brooks Lake Biological Field Station and records of the Commercial Fisheries Division, Alaska Department of Fish and Game.

Subsistence salmon catches were estimated from completed subsistence permit forms and from personal contacts with subsistence and commercial fishermen.

King salmon escapement counts were conducted from rubber boats in Big Creek and King Salmon Creek. Both aerial and float counts were made of spawning king salmon in the Alagnak River and Nonvianuk River.

Ingress to Big Creek and King Salmon Creek was made by military helicopter (H-21). To define king salmon spawning areas, each stream was divided into five, nearly equal index areas. Each area was delimited by white plastic markers set atop steel posts which were located at prominent streambank locations, clearly visible from both the air and the stream. The posts were located from the air, by H-21, and recorded and described on permanent maps on file at the Fish and Game office at King Salmon. Index areas were numbered consecutively from the source to the mouth. Separate salmon counts were made in each index area.

King salmon fry were sampled by small-mesh dip nets. Gill-net sampling was conducted with 125 X 6-foot, variable mesh (3/4- to 2-inch bar measure), monofilament nets. Rainbow trout were sampled with pole and line, a 50 X 6-foot, 1/4-inch bar measure seine, and in angler creels.

Age determination of rainbow trout scales was made using a microprojector after the scales had been impressed into 0.02-inch-thick cellulose acetate.

FINDINGS

King Salmon Studies

King salmon entering the Naknek-Kvichak fishing district pass through an intense red salmon, *O. nerka*, gill net fishery. Some unknown percentage of the surviving king salmon enter the Naknek River, where they are utilized in sport and subsistence fisheries. King salmon not entering the Naknek River ascend the Kvichak River, then the Alagnak River system where it is believed the majority spawn.

The commercial king salmon catch is chiefly incidental to the red salmon harvest. The first kings enter the commercial catch in early June, just prior to the arrival of the red salmon. However, fishing effort remains light until about June 20 when significant numbers of red salmon enter the catch. Figure 1 summarizes the timing and magnitude of the commercial king salmon catch in the Naknek-Kvichak district for the years 1963 through

1966. Figure 1 presents a slightly biased description of the timing of the king salmon migration through the fishing district, because less fishing gear is operating at the beginning of the run and the amount of gear in use varies from year to year.

Paddock (1965) reported the Naknek-Kvichak commercial king salmon catch has historically ranged from 1,600 to 23,000 with an average of 7,350. More recently, from 1951 through 1966, the catch has ranged from 4,713 to 17,778 with an average catch of 9,388.

During the five-year cycle from 1962 through 1966, only the 1964 catch of 12,267 has exceeded the 1951-1964 average. Since statehood, the amount of commercial fishing gear used in Bristol Bay has nearly doubled. The amount of gear registered to fish specifically within the Naknek-Kvichak district changes not only from year to year but also between fishing periods. Thus, it is impossible to determine exactly the gear in use in the Naknek-Kvichak fishing district. However, it is reasonable to assume that the amount of gear has significantly increased as the Naknek-Kvichak district is the most intensively fished area in Bristol Bay.

Fishing time during most of the run is regulated by field announcement. The length and timing of fishing periods depend upon the status, at that particular time, of the red salmon escapement. Commercial king salmon catches were compared to the annual total hours the fishery operated during the period of field announcements for the years 1960 through 1966. No correlation between total operating hours and total catch was evident. A summary of king salmon catches and the annual total operating hours for the Naknek-Kvichak district is shown in Table 1. Hours in which only set nets were operated are omitted since set nets typically take only about 20 percent of the catch made by drift gill net boats.

The data presented allow the following conclusions to be made:

- (1) Since no correlation between the operating hours of the commercial fishery and the total king salmon catch is evident, the size of the catch is primarily dependent upon the magnitude of the run.
- (2) Increases in the amount of fishing gear in the Naknek-Kvichak district infer that recent king salmon catches must consist of an increased percentage of the run.
- (3) Since the average king salmon catch during the last five years has declined, the number of king salmon entering the fishing district must also have declined.

TABLE 1. Summary of Commercial King Salmon Catches and Hours of Operation, Naknek-Kvichak Fishing District, 1960-1966.

Year	Hours of Operation		King Salmon Catch
	Naknek Subdistrict	Kvichak Subdistrict	
1960	154	154	17,778
1961	294	294	10,206
1962	231	231	8,816
1963	166	48	4,713
1964	240	108*	12,267
1965	201**	395	8,047
1966	180***	204	5,497

* Omits 120 hours when subdistrict was open only to set net fishing.

** Omits 72 hours when subdistrict was open only to set net fishing.

*** Omits 24 hours when subdistrict was open only to set net fishing.

It was noted during 1966 that a significant portion of the commercial king salmon catch went unreported. Small kings (10-8 pounds) are worth slightly less than a red salmon to the fisherman. Therefore, fishermen tend to mix small kings with red salmon when trans-

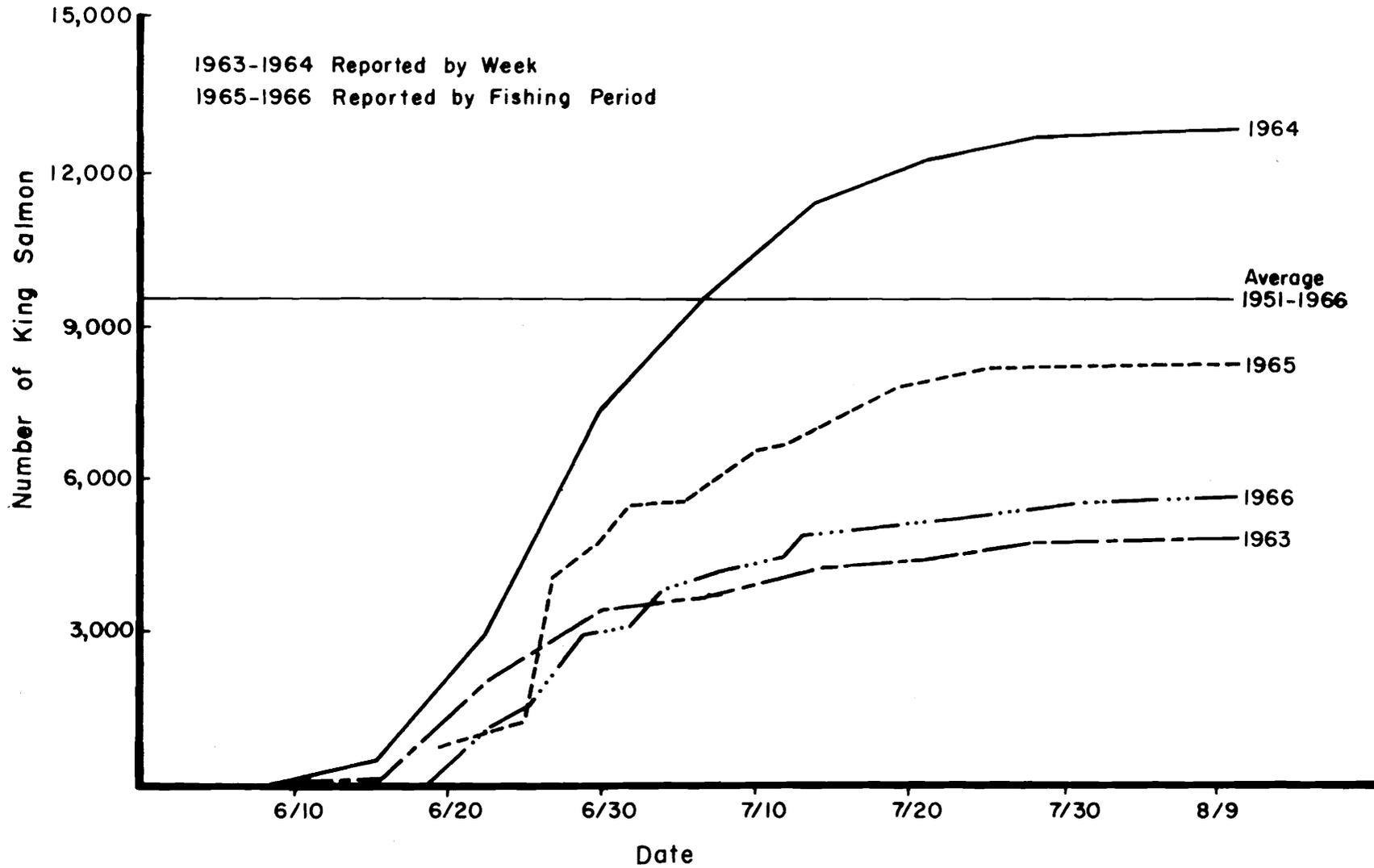


Figure 1. Timing and Magnitude of the Commercial King Salmon Catch, Naknek-Kvichak Fishing District, 1963-1966.

ferring them to cannery scows. Several commercial fishermen reported that small kings are traditionally sold as red salmon in the Naknek-Kvichak area. In view of the high percentage of precocious males in this run, the unreported portion of the commercial catch could total several thousand fish.

An intense subsistence fishery exists in the Naknek River. Sixty-seven permits were issued during 1966 with each permittee allowed 50 fathoms of gillnet. Of the 67 permits issued, 37 were returned with a reported catch of 279 king salmon. By direct extrapolation, the 67 total permittees are estimated to have caught 519 kings. This figure should be considered a minimum harvest as some permittees hesitate to fully report their catch.

Attempts were made to estimate the number of subsistence gill nets in use on several different occasions and to census catches. Enough nets could not be censused at any one time to allow estimates of total catch. However, more nets were in the river during days when the commercial fishery was closed than when the fishery was operating. Apparently some nets are commercially fished during open periods and used for personal use when the commercial fishery is closed.

The reported subsistence catch also excludes those kings taken for personal use from commercial fishing boats. King salmon are preferred to any other species for personal use in Bristol Bay and many commercial fishermen "put down a keg" before selling any king salmon.

Regulations have been amended to prohibit subsistence fishing after 1966 in all areas of the Naknek River except for several miles near the river mouth. How much this regulatory change will reduce the subsistence catch of king salmon is unknown, but protection will be afforded to resident species.

Salmon bound for spawning areas in the Kvichak drainage are fished for subsistence only at Levelock Village.

The sport fishery for salmon in the Naknek River is described under Job 12-D of this report. Salmon spawning in the Kvichak system are not fished for sport to any measurable degree.

Enumeration of king salmon was undertaken at principal spawning areas within the Naknek and Kvichak drainages. A float count on King Salmon Creek was made from July 31 through August 3. A summary of counts obtained, by index area, is shown in Table 2. Water and weather conditions were generally good except in the lower areas of the stream and it is believed a reliable count was obtained. King salmon were seen at the start of the survey; therefore, additional spawning undoubtedly occurred farther upstream. All fish were over spawning redds and it appeared that spawning was at or near a peak. This float count was the first to be conducted during the peak spawning period on King Salmon Creek. Paddock (1965) listed all prior counts and the only comparable count was an aerial (H-21) count in 1964 when 378 kings were observed.

TABLE 2. Numbers of King Salmon Observed by Index Area, King Salmon Creek, 1966.

Index Area	King Salmon		Counting Conditions
	Live	Dead	
1	118	2	Excellent
2	160	1	Excellent
3	193	2	Good-some deep pools
4	125	2	Poor-many deep pools
5	28	2	Fair-rainy with turbid water
Total	624	9	

A float count was conducted on Big Creek from August 13 through August 16. King salmon spawning appeared to be at a peak as all fish were over spawning redds. A total of 971 live and 8 dead king salmon was counted. A summary of counts, by index area, is presented in Table 3. Some kings were undoubtedly missed because turbid water and rain reduced visibility. No king salmon were found near the float starting point and apparently little if any, king salmon spawning occurs upstream from that site. A total of 578 king salmon was enumerated in Big Creek during 1965 (Andrews, 1966). The 1965 count began at a point coinciding with the upstream end of the second index area. In 1966, fifty-three king salmon were observed in the first index area located upstream of the 1965 float starting point.

TABLE 3. Numbers of King Salmon Observed, by Index Area, Big Creek, 1966.

Index Area	King Salmon		Counting Conditions
	Live	Dead	
1	51	2	Poor-heavy clouds, turbid water
2	447	3	Good-light clouds, water clearing
3	306	1	Poor-heavy clouds and rain
2	134	0	Poor-heavy clouds, deep pools
1	<u>33</u>	<u>2</u>	Poor-heavy clouds, turbid water
Total	971	8	

On August 26, the upper Naknek River was checked for spawning king salmon. Concentrations of kings were found between the "smolt camp" site and the red salmon counting towers, a distance of approximately two miles. Due to the extreme width and turbulence of the river in this area, a quantitative estimate of king salmon was not obtained. However, approximately 300 king salmon were counted merely by running a skiff up the middle of the river. This figure undoubtedly represents a minor portion of the actual number of salmon present. Numerous kings were seen in deep pools; this behavior and the physical condition of the fish indicated spawning activities had not yet peaked.

Unknown numbers of king salmon also spawn from the "smolt camp" site downstream as far as the town of King Salmon. A partially spawned out female king salmon was checked in a subsistence gill net, one-half mile above King Salmon on August 28. Dr. Charles De Constanzio, of the Bureau of Commercial Fisheries, reported seeing numerous kings spawning in this area while doing red salmon spawning surveys with scuba equipment (personal communication).

No attempt was made to enumerate king salmon in Pauls Creek or Smelt Creek, both tributaries of the Naknek River. Kings are known to spawn in Pauls Creek but nothing is known of Smelt Creek. Also, unknown numbers of king salmon apparently move into inlet tributaries of Naknek Lake as a few king salmon are seen each year at the Brooks River Weir.

During the current reporting period, enumeration of king salmon was initiated in the Alagnak (Branch) River and its principal tributary, the Nonvianuk River. Little is known of the timing and magnitude of the Alagnak River king salmon run, and 1966 activities were concerned primarily with establishing the peak spawning period and secondarily with enumeration of the run.

A summary of the total numbers of king salmon counted in the Alagnak River system is shown in Table 4.

TABLE 4. A Summary of King Salmon Counts in the Alagnak (Branch) River System, 1966.

<u>Area</u>	<u>Date</u>	<u>Type of Count</u>	<u>Total King Salmon Counted</u>	<u>Counting Conditions</u>
Alagnak River*	8/6	Aerial	13	Poor
Nonvianuk River	8/6	Float	216	Good
Alagnak River**	8/6-8/10	Float	238	Rain, heavy clouds, some turbidity
Nonvianuk River	8/11	Aerial	933	Excellent
Alagnak River**	8/11	Aerial	532	Excellent

* From Nonvianuk River confluence to Kukaklek Lake outlet.
 ** From Nonvianuk River confluence to ADF&G red salmon counting tower.

The 1966 Alagnak River king salmon counts were conducted too early to coincide with peak spawning as the majority of salmon were still migrating upstream. A group of 100-200 king salmon was seen at the outlet on Nonvianuk Lake on August 11. The ultimate destination of these fish is unknown. However, NCA camp operators at Kulik Camp report that a few king salmon pass the camp each year, indicating that some king salmon spawn in the inlets of Nonvianuk Lake.

The Alagnak River is typically braided into two or three parallel stream channels without sharp meanders. Except for the area near the red salmon counting tower, most of the stream is shallow and the water is extremely clear. Two aerial observers could adequately count salmon in this river as king salmon were typically found only in the one or two channels having the greatest water flows. Due to the physical characteristics of this river, aerial counts should consistently be more accurate than float counts. In 1966, the larger aerial count must also be partially due to immigration of king salmon between August 6 and August 11.

King salmon migrating past the red salmon counting towers on the lower Alagnak River are recorded by personnel of the Commercial Fisheries Division. The effectiveness of the tower in allowing accurate enumeration of king salmon is uncertain. In 1965, no kings were seen from the towers despite low, clear water conditions. The tower crew reported, however, that kings could readily be taken by pole and line upstream from the tower.

In 1966, approximately 1,800 kings were counted before the tower was abandoned on July 24 due to the conclusion of the red salmon migration. Furthermore, 1,440 kings were tallied from July 20 through July 24 and the highest daily count (396 kings) was attained on the final day of the count. Apparently the peak of king salmon migration in the lower Alagnak River had not yet been attained when the tower was abandoned.

Large numbers of king salmon fry were found in the Naknek River near the town of King Salmon. On August 28 a sample of 20 king salmon fry collected from the Federal Aviation Agency Dock ranged from 82 to 100 mm with a mean of 89.4 mm. On September 25 an additional sample of 26 king salmon fry collected at the same site ranged from 83 to 100 mm with a mean of 89.7 mm. Scales from both samples were examined and no annuli were found on any scales. Despite their large size all individuals were apparently progeny of 1965 spawn. The large average lengths of the fry indicate a rapid growth rate. It is unusual that samples collected nearly one month apart in August and September should have nearly identical average lengths; sampling techniques are assumed responsible.

Silver Salmon Studies

Commercial and sport fishing for silver salmon in the Naknek area is gradually becoming more intense. Table 5 summarizes reported commercial catches in the Naknek-Kvichak fishing district for the years 1954 through 1966. Catches have fluctuated widely but the average harvest appears to be rising. Of the four largest reported annual catches, three have occurred since 1963. Annual catches are sharply influenced by fishing effort. During years of large red salmon catches, such as 1965, little effort is directed toward silver salmon. Also, the presence of alternate-year pink salmon, *O. gorbuscha*, runs

which can be harvested simultaneously with silver salmon tend to increase commercial fishing efforts during even-numbered years.

Nothing is known of the magnitude of the spawning run or spawning areas of silver salmon which enter the Naknek River. However, Table 5 shows that significant numbers of silver salmon cross Naknek Lake and ascend Brooks River.

TABLE 5. Numbers of Silver Salmon Caught in the Naknek-Kvichak Commercial Fishery and Silver Salmon Counted at the Brooks River Weir, 1954-1966.

<u>Year</u>	<u>Commercial Catch*</u>	<u>Brooks River Weir Count**</u>
1954	111	135
1955	123	58
1956	887	366
1957	1,619	461
1958	3,624	1,844
1959	40	163
1960	197	398
1961	426	370
1962	1,169	451
1963	6,816	120
1964	1,762	392
1965	78	558
1966	4,096	319
Average	1,611	433

* Data from Commercial Fisheries catch records, King Salmon office.

** Data from annual unpublished manuscripts of the Brooks Lake Biological Field Station, Bureau of Commercial Fisheries.

Rainbow Trout Studies - Naknek River

During the current reporting period an attempt was made to learn more of the migration, spawning habits, and age and growth characteristics of the rainbow trout of the Naknek River. The Naknek River was selected for study because it sustains a greater angler utilization than any other Bristol Bay stream, because the rainbow trout in the Naknek appear to be typical of the extremely large rainbow trout found in a number of Bristol Bay rivers, and because quarters and facilities are available for personnel at the town of King Salmon.

Age determinations were made from scales of 264 rainbow trout from the Naknek River to assess age and growth rate characteristics. Average lengths and length distribution of various age groups are summarized in Table 6. Growth appears to be somewhat slower than for rainbow trout from the Kvichak River (Andrews, 1966). Mean lengths of the various age groups are biased by growth during the current growing season. Scale samples were collected from May 10 to August 11. Therefore, some individuals had completed more growth during the current growing season than had others. This bias tends to be of lesser importance in older age groups.

Extreme differences in average lengths were evident in age-group I (one annulus) rainbow trout captured in different areas of the Naknek River. Forty age group I rainbow trout seined approximately 10 miles downstream from Naknek Lake outlet between June 2 and June 29 averaged 68.8 mm fork length. However, 40 age-group I rainbow trout seined at the Officers Lake Camp at Naknek Lake outlet between July 22 and August 11 averaged 138.9 mm fork length. This extreme difference in average length cannot be attributed solely to growth between the sampling intervals. Apparently the Naknek Lake outlet area is significantly more fertile than downstream areas of the Naknek River and may at least partially account for the large variation in size attributed by Paddock (1965) to a prolonged period of emergence from the gravel. No size segregation of older age groups by river area was apparent, indicating a mixing of the stocks between the first and second years of life.

Definite migrations of rainbow trout were observed to occur within the Naknek River. As yet these migrations are poorly understood, but may be closely associated with spawning activities and predation upon migrating red salmon smolts.

TABLE 6. Length Distribution by Age Groups of Rainbow Trout from the Naknek River, 1966.

Fork Length (mm)	Age Groups								
	I	II	III	IV	V	VI	VII	VIII	IX
50 - 69	33	--	---	--	-	--	---	----	--
70 - 89	6	--	---	--	-	--	---	----	--
90 - 109	--	--	---	--	-	--	---	----	--
110 - 129	13	--	---	--	-	--	---	----	--
130 - 149	17	--	---	--	-	--	---	----	--
150 - 169	9	--	---	--	-	--	---	----	--
170 - 189	2	1	---	--	-	--	---	----	--
190 - 209	--	2	1	--	-	--	---	----	--
210 - 229	--	6	4	--	-	--	---	----	--
230 - 249	--	10	6	--	-	--	---	----	--
250 - 269	--	4	12	3	-	--	---	----	--
270 - 289	--	1	20	3	-	--	---	----	--
290 - 309	--	--	7	2	-	--	---	----	--
310 - 329	--	--	2	--	-	--	---	----	--
330 - 349	--	--	4	9	3	--	---	----	--
350 - 369	--	--	---	7	6	--	---	----	--
370 - 389	--	--	---	6	7	--	---	----	--
390 - 409	--	--	---	3	3	--	---	----	--
410 - 429	--	--	---	--	1	1	---	----	--
430 - 449	--	--	2	2	4	--	---	----	--
450 - 469	--	--	1	1	3	1	---	----	--
470 - 489	--	--	---	1	-	5	1	----	--
490 - 509	--	--	---	--	-	1	---	----	--
510 - 529	--	--	---	--	-	--	---	----	--
530 - 549	--	--	---	--	1	2	1	----	--
556 - 569	--	--	---	--	-	2	---	----	--
570 - 589	--	--	---	--	-	--	2	----	--
590 - 609	--	--	---	--	-	--	---	----	--
610 - 629	--	--	---	--	-	3	---	----	--
630 - 649	--	--	---	--	-	1	1	----	--
650 - 669	--	--	---	--	-	1	3	----	--
670 - 689	--	--	---	--	1	--	---	3	--
690 - 709	--	--	---	--	-	1	1	1	--
710 - 729	--	--	---	--	-	--	1	----	1
730 - 749	--	--	---	--	-	--	---	----	--
750 - 769	--	--	---	--	-	--	---	----	3
Average Length (mm)	103	233	286	343	408	545	620	680	745
Inches	4.1	9.2	11.3	13.5	16.1	21.5	24.4	26.8	29.3
No. Fish	80	24	59	37	29	18	10	4	4

Prior to the arrival of the biologist in May, local residents reported "quality" fishing for very large rainbow in the outlet of Naknek Lake. The quality of rainbow fishing in that area dropped very abruptly about mid-May.

Sampling throughout the lake outlet area by pole and line from May 20 to May 24 and by monofilament gill nets on May 21 and May 22 failed to catch a single rainbow trout. It appeared that a major downstream migration of adult trout from the lake outlet to the river spawning sites occurred about mid-May.

On May 24, the first rainbow were located over spawning redds at a site known locally as Production Point. Production Point is the uppermost sharp bend in the Naknek River and is approximately four miles downstream from the Officers Lake Camp at the lake outlet. Subsequently, spawning rainbow were found visually or captured by pole and line in eight separate areas as far downstream as a point 1/2-mile downstream from the commercial fisheries smolt trapping site. A map denoting known rainbow trout spawning areas in the Naknek River is shown in Figure 2. No attempt was made to enumerate spawning rainbow. No rainbow trout were observed spawning after June 6.

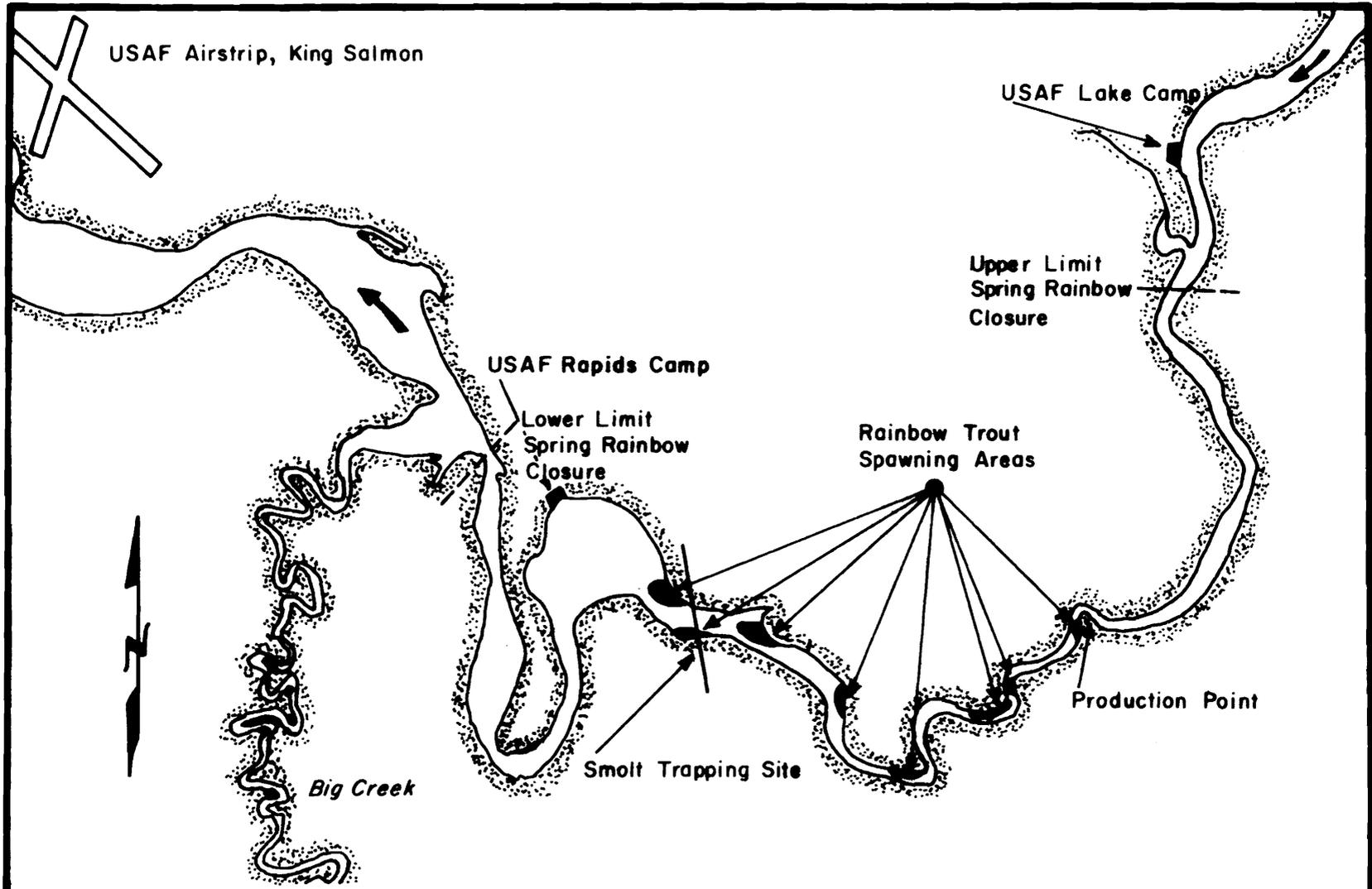


Figure 2. Observed Rainbow Trout Spawning Areas, Naknek River, 1966.

No female rainbow trout smaller than 483 mm (19 in.) fork length was observed to be sexually mature while all females larger than 534 mm (21 in.) that were examined were observed to be sexually mature.

Rainbow were found to be very aggressive during spawning and could be readily captured on any bright lure. This aggressive behavior is undoubtedly one of the principal reasons for the increased military catch of large rainbow during the late spring.

After the cessation of spawning, the adult trout appeared to remain adjacent to spawning areas but in deeper water. Large rainbow were more difficult to capture after spawning was completed. However, sport fish personnel were able to catch rainbow over 508 mm (20 in.) in length at any time throughout the summer.

Data indicate few rainbow range downstream from the mouth of Big Creek during summer months. During the 1966 field season, only four rainbow were creel checked below the mouth of Big Creek.

It should be noted that as spawning terminates, the annual red salmon smolt migration begins. This smolt migration reaches a peak between June 5 and June 10, after which it gradually declines. Although a few smolts continue to migrate from Naknek Lake until September, the bulk of the migration is complete by mid-July.

Commercial fisheries personnel manning the red salmon counting towers were asked to watch for and record any increased or unusual rainbow movement past the towers. On July 13, tower operators reported increased numbers of rainbow moving both up and downstream. By July 19, a definite upstream migration was reported.

By July 25, personnel at the USAF Lake Camp reported increased catches of large rainbow in the lake outlet area.

Increased catches of large rainbow after July 25 are not borne out by past creel census records from the lake camp (Andrews, 1961). However, an increase could be masked by reduced angling effort and/or poor creel census techniques.

Such a migration does account, however, for the late summer and fall "steelhead run" reported by several observers (Allin, 1959; Andrews, 1961; Stefanich, 1962).

An upstream migration after mid-July may be correlated with the termination of the red salmon smolt migration.

A separate and distinct migration of immature rainbow also appeared to occur in the Naknek River. Prior to mid-June few rainbow less than 457 mm (18 in.) fork length were seen or captured. Rainbow, ranging from 203 mm (8 in.) to 305 mm (12 in.), were found only at a single location approximately one mile above the red salmon counting towers. Also, age-group I trout were found in a slough at the red salmon smolt trapping site on June 2.

During the latter half of June, many rainbow ranging up to 407 mm (16 in.) arrived at the Lake Camp site and by July 1, several hundred rainbow could be seen at any time from the Lake Camp dock. Most of these fish ranged from 203 mm (8 in.) to 305 mm (12 in.).

Subsequent sampling revealed apparent large increases in the number of immature rainbow in many areas of the river as far downstream as the military rapids camp. These immature rainbow may represent a spring downstream migration from Naknek Lake.

Due to the press of other duties no sampling was conducted after August 11 to determine subsequent changes in rainbow availability.

Migratory information gathered in 1966 on the Naknek River is supported by information collected by Bureau of Commercial Fisheries personnel stationed at the Brooks River Biological Field Station. Brooks River is the principal inlet to Naknek Lake and shares many ecological features in common with the Naknek River.

Personnel reported, on the basis of observations made during boat and scuba surveys and at the Brooks River weir, that mature rainbow appear at the mouth of Brooks River in late April. These fish subsequently move to spawning sites and spawning commences, depending on water temperatures, usually around mid-May.

Immature rainbow appear at the mouth of Brooks River by mid-June and then migrate upstream.

In the fall all rainbow migrate back to Naknek Lake with all fish out of the river by November 1. The immature rainbow that arrive last are the first to return to Naknek Lake.^{1/}

It is believed that the rainbow population in the Naknek River is supported to some degree by fish recruited from Naknek Lake. No biological information is available on rainbow trout within the lake area. Large rainbow are periodically captured by commercial gill nets fished in the lake, principally during the winter months. Catches to date have been too small and scattered to yield information on movements or relative densities within the lake.

A party of anglers reported taking and releasing 17 rainbow ranging from 6 to 8 pounds on July 31 and August 1 in the Bay of Islands. These anglers fished near the mouth of a stream located at Lat. 155° 34'W, Long. 58° 37'N. Time did not permit a subsequent investigation of this area by Sport Fish personnel.

A total of 17 rainbows was tagged with Peterson disc tags in the Naknek River. These tags were installed primarily to observe the effect of tagging large rainbow which had been exhausted by capture with pole and line. No anesthetic was used. Larger fish appeared to be in poorer condition after tagging than did smaller fish. Also, fish tagged during or shortly after spawning appeared to be in very poor condition. The level of post-tagging mortality is unknown.

One individual tagged at the outlet on Naknek Lake on June 29 was recaptured at the same location on July 18.

The question of the presence of anadromous rainbow in the Naknek River has long existed. Several writers have mentioned the presence of steelhead in this river, (Allin, 1959; Andrews, 1961; Stefanich, 1962) while others have questioned their existence (Greenbank, 1954; Paddock, 1964).

The principal reasons advanced for the belief that anadromous rainbow are present in the Naknek River are their large size, their steelhead like coloration and a scale pattern which shows an accelerated growth rate after the first or second year of life.

All evidence collected during 1966 indicates that the large rainbow of the Naknek River belong to a non-anadromous population which migrate from Naknek Lake outlet area to spawning grounds in the Naknek River in May and then return to the lake outlet in summer or fall.

The following evidence is advanced to support the belief that rainbow in the Naknek River are not anadromous:

1. No post-spawning downstream migration occurred. Post-spawning adults could be captured throughout the summer and the return to a steelhead-like color pattern could be followed. By mid-July all evidence of spawning coloration was gone.
2. No smolt migration was noted. Personnel of the Commercial Fisheries Division operated a red salmon smolt trapping facility directly downstream from the principal rainbow spawning and rearing areas, yet no catches of smolt-sized rainbow were made.
3. All size and age groups of rainbow are present within the Naknek Lake-River complex throughout the year, indicating that rainbow do not migrate after attaining smolt size. Those anglers willing to fish the lake outlet area during the inclement winter months reported fine catches of rainbow to 813 mm (32 in.).
4. Rainbow do not occur in the commercial gillnet catches in the Naknek-Kvichak fishing district or in subsistence nets in the lower Naknek River. Some gillnet fishing is being done from early May through September, yet rainbow trout very rarely enter the catch. If spawned-out rainbow migrated back to salt water from the Naknek, as would be expected from a steelhead population, they would be intercepted by the intense red salmon net fishery in the Naknek-Kvichak district.

^{1/} Robert Dewey, 1966, Personal Communication

5. Large rainbow are not found in any of the tributaries of the Naknek. Paddock (1965) reported no rainbow exceeding 508 mm (20 in.) in either King Salmon Creek or Big Creek. If steelhead were present in the system, Big Creek and King Salmon Creek should contain a portion of the run. It should also be noted that throughout Bristol Bay, trophy sized rainbow are reported only from rivers tributary to large lakes containing extensive red salmon populations. Commonly, the best catches and largest fish are caught near lake outlets.
6. Rainbow trout in the Naknek River have a slower growth rate than anadromous rainbow. Sexual maturity of females was observed to occur typically between 483 mm (19 in.) and 534 mm (21 in.). Table 6 shows fish of this size to be an average of six years old.
7. The length-frequency distribution of rainbow trout reported by military anglers is not typical of an anadromous population. Length frequencies reported by Allin (1959), Andrews (1961), Stefanich (1962) and in Table 6 show a consistent decrease in numbers as the average size increases. A bimodal length distribution, more typical of an anadromous rainbow population was reported only by Dotson (1963).
8. The increase in growth rate described by Paddock (1965) for rainbow trout in the Kvichak River appears also to occur in the Naknek rainbow stock. However, this increase is not the abrupt change seen on the typical steelhead scale, but rather a gradual increase in growth rate. Numerous rainbow in their third and fourth years of life were captured that were currently laying down the scale pattern previously called "marine growth." Also, average lengths of each age group shown in Table 6 do not reveal an abrupt change in growth rate. Despite Paddock's (1965) statement that an increase in growth rate of Kvichak River rainbow trout occurs after one or two years, data presented by Andrews (1966) shows an almost constant growth rate from age II through VII.
9. Superficial examination of numerous large rainbow, during 1966, did not reveal marine parasites. However, almost all large rainbows in the Naknek River carried numerous Salmonicola, a freshwater copepod, attached to their gill filaments.

In summary, any anadromous rainbow would have to enter the Naknek River after salmon gill nets are removed in late September. Subsequently, they would either have to: (1) spawn under the ice and leave the river before the following May and before the known rainbow spawning period in late May and early June. Rainbow trout exhibiting this behavior would not enter the sport fishery, and (2) remain in the river a full year, returning to sea during the following winter. Scale patterns do not indicate this behavior.

The only evidence to support the conclusion that anadromous rainbow are present is a tag recovery reported by Paddock (1965). Paddock reported a 381 mm (15 in.) rainbow tagged in the Kvichak River on September 13, 1964 was recovered in the Naknek River on April 27, 1965. However, due to the small size of the fish, the relatively short time between release and recovery, and because the mouths of the two rivers are adjacent in a common estuary, the behavior of this trout is believed to be atypical and not to represent a true anadromous migration.

Fifteen unnamed inlet tributaries to Naknek Lake were surveyed, primarily to determine to what extent rainbow trout utilize these streams. All of these streams, located on the southwest, west and northwest lake shores, are considered too small to be used by anglers.

Immature rainbow trout were found in four of the streams. Most rainbow were from age-groups I and II with a few individuals from age-group III. No individuals were captured that were over 254 mm (10 in.) fork length and none were sexually mature. These rainbow may be spawned by a lake dwelling population from Naknek Lake which enters the tributaries only during the spawning season. Grayling and Dolly Varden were found in two of the tributaries.

Miscellaneous Activities

While investigating Naknek Lake tributaries, an unsuccessful attempt was made to capture Arctic char, Salvelinus alpinus, and lake trout, Salvelinus namaycush, by trolling. Water temperature was 54° F. on the surface and char were probably suppressed into cooler water. The shoreline along the northwest arm of the lake, known locally as "the char hole," apparently provides better fishing during the fall and spring when surface water temperatures are lower. The presence of red salmon in the lake precluded the use of gill nets for sampling.

Pike Lake, on the USAF Lake Camp road, was sampled with two variable mesh monofilament gill nets on August 19-20. Twenty-eight northern pike, *Esox lucius*, averaging 496 mm (19.5 in.) and ranging from 404 mm (15.9 in.) to 584 mm (23.0 in.) were caught in 46 net hours for a catch-per-net-hour of 0.61.

A series of lakes located along the Naknek-King Salmon highway was visually checked from the air. No fish were seen and all lakes appeared too shallow to support fish.

Eskimo Creek, tributary to the Naknek River and passing through the USAF airbase and the town of King Salmon, was surveyed on August 23. This small stream was found to contain small Dolly Varden and a few small grayling. There is no evidence that either salmon or rainbow utilize this stream.

A partial stream survey was completed on the lower portion of American Creek (River) from July 23 to July 26. This stream originates at Hammersley Lake and flows approximately 30 miles before emptying into the northwest end of Colville Lake. The mouth and approximately one mile of stream channel are located within the boundaries of Katmai National Monument. The survey covered the area from the stream mouth to a point approximately eight miles upstream.

The Bureau of Commercial Fisheries has operated a weir on the American River each year since 1962, from about July 9 until August 11. The weir, located four miles above the mouth, is used in red salmon studies but migration information on other species is recorded.

The American River contains an excellent population of rainbow trout ranging to about 600 mm (23.5 in.). Large aggregations of Dolly Varden with a maximum size of about 545 mm (21.5 in.) are available in the lower stream, but diminish abruptly about seven miles above the mouth. A few lake trout also reside in the stream, chiefly below the weir site.

Stream flow in the upstream areas of the American River is reported to be quite fast and turbulent, precluding float trips. No survey was attempted in this area.

Sport fishermen are guided to the American River by the NCA Grosvenor Camp from late May to late August. An NCA fishing guide indicated that Dolly Varden constitute the bulk of the sports catch but that good catches of rainbow can be made either with flies or lures.

Gunbarrel Creek (155° 11'W, 58° 41'N), tributary to Grosvenor Lake, was surveyed on July 27. This stream is about 20 feet wide and 2 feet deep at the mouth. No flow information was collected. The stream contains few Dolly Varden but many small rainbow. Occasional guests of the NCA Grosvenor Camp, desiring fast fly fishing, are guided to this stream.

During the float count of king salmon spawners in the Alagnak (Branch) River and the Nonvianuk River, resident sport fishes were sampled with pole and line.

In the Alagnak River, grayling were found to be abundant throughout the stream while small groups of rainbow were only found downstream of spawning chum salmon, *O. keta*. No Dolly Varden were seen. Rainbow to 559 mm (22 in.) were taken but the majority were less than 305 mm (12 in.). Andrews (1961) noted that catches of large rainbow are often made in the spring and fall, but that rainbow fishing drops off after the red salmon enter the system. Sampling during 1966 was conducted shortly after the conclusion of a large red salmon run and tended to support this information.

In the Nonvianuk River, small rainbow to 305 mm (12 in.) were common but no grayling and only one Dolly Varden were observed. Prior sampling by Sport Fish personnel at the Nonvianuk Lake outlet in early June, 1965, revealed many rainbow to 661 mm (26 in.). Stefanich (1962) reported rainbows to 762 mm (30 in.) taken by guests of the NCA fish camp at the outlet of Nonvianuk Lake. These streams, like the remainder of the Kvichak River complex, apparently provide the best fishing for large rainbow during spring and fall.

The Alagnak and Nonvianuk Rivers have excellent potential for recreational float trips. The adjacent scenery is excellent and both hunting and fishing are available. Float trips should follow the Nonvianuk River, however, as the Alagnak River, between the outlet of Kukaklek Lake and the confluence of the Nonvianuk River, contains dangerous rapids.

A shipment of commercially caught fish from Tikchik Lakes was sampled to determine species composition and average weights. The data are summarized in Table 7.

TABLE 7. Population Data from a Commercial Gill Net Catch, Tikchik Lakes, 1966.

<u>Species</u>	<u>Number</u>	<u>Average Weight (Lbs.)</u>	<u>Approximate Weight Range (Lbs.)</u>
Lake Trout	86	4.6	3-8
Arctic Char	1	3.5	---
Humpback Whitefish*	107	3.7	2-9

* Coregonus pidschian

The fishermen stated the catch was typical of Tikchik Lake gillnet catches in terms of both size and species composition and that few lake trout in excess of 10 pounds are caught.

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Prepared by:

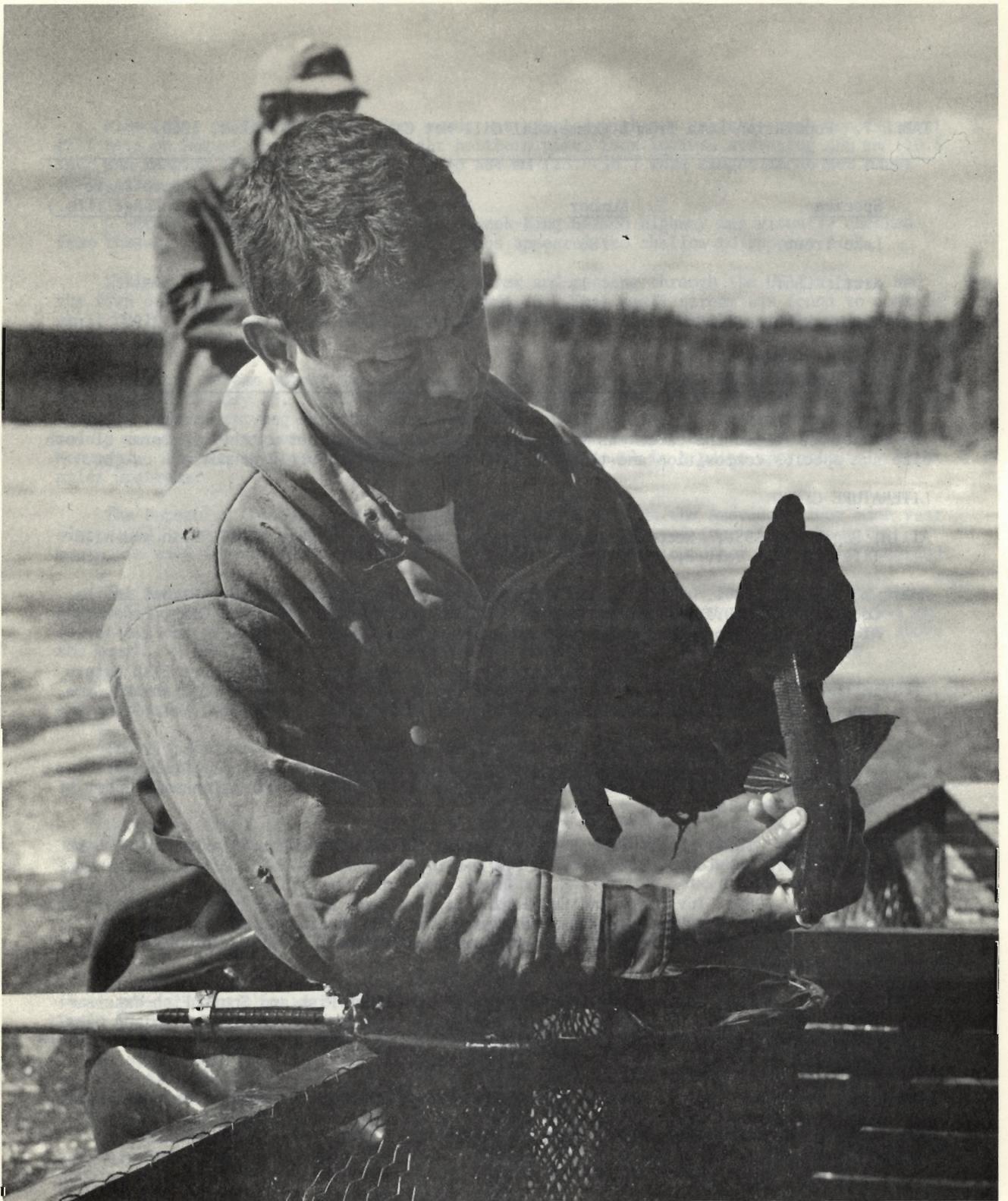
R. Russell Redick
Fishery Biologist

Approved by:

s/ Louis S. Bandirola
D-J Coordinator

Date: April 15, 1967

s/ Alex H. McRea, Director
Sport Fish Division



Wild Arctic Grayling are Sorted into Holding Pens Prior to the Egg-Take, Tagging and Release at Tolsona Lake.