RESEARCH PROJECT SEGMENT

State: Alaska

Project No.: F-9-4 *Name:* Sport Fish Investigations of Alaska.

Study No.: G-II *Study Title:* Sport Fish Studies.

Job No.: G-II-F *Job Title:* Evaluation of Sport Fish Stocking on the Kenai Peninsula-Cook Inlet Areas.

Period Covered: July 1, 1971 to June 30, 1972.

ABSTRACT

Growth and relative survival rates were determined for stocked silver salmon, Oncorhynchus kisutch, in five Kenai Peninsula lakes. Mean lengths ranged from 197.1 - 256.9 mm after two years of lake residency. Possible relationships between stocking densities and silver salmon growth are discussed.

Relative survival and growth data for stocked rainbow trout, Salmo gairdneri, in four rehabilitated lakes is presented. Rainbow trout and sockeye salmon, O. nerka, plants in a lake containing threespine stickleback, Gasterosteus aculeatus, are compared.

An evaluation of transplanted sockeye salmon was continued in seven landlocked lakes. Gill net catch rates, mean lengths, and weights are compared for various years. Data concerning sexual maturity and feeding habits are presented.

The reliability of gill nets for estimating growth and comparative abundance of stocked salmonids is discussed. Examination of accumulated catch data indicates that current sampling techniques require refinement.

A study was initiated to compare growth and survival of stocked rainbow trout in a lake containing threespine stickleback and in a lake where stickleback have been eliminated.

RECOMMENDATIONS

1. Continue sampling stocked lakes to determine proper stocking rates; including sizes and species of fish.

2. Evaluate the survival and growth of rainbow trout in Musick and Stickleback lakes.

3. Evaluate and refine current methods of sampling stocked lakes.

4. Include research activities of this project in the area of the Kenai Peninsula cataloging and inventory project.

OBJECTIVES

1. To determine comparative survival and growth of stocked rainbow trout in lakes containing threespine stickleback and in waters where this species has been chemically controlled.

2. To ascertain those aspects of the threespine stickleback's life history which relate to their control with fish toxicants.

3. To determine duration of toxicity in lakes which have been chemically treated to control threespine stickleback populations.

4. To determine the success of introduced grayling, lake trout, and red salmon (kokanee) in waters of the job area.

5. To provide recommendations for the management of stocked lakes and to direct the course of future studies.

TECHNIQUES USED

Monofilament and multifilament gill nets (125' x 6') having five mesh sizes ranging from 3/4- to 2-inch bar measure were used to collect specimens and measure relative abundance. Nets were set for approximately 24 hours in each lake.

The age of planted salmonids was determined, when necessary, by examining scales with a microprojector. Fork lengths were recorded to the nearest millimeter and weights to the nearest 0.01 pound.

FINDINGS

Hatchery-reared salmonids are being used in increasing numbers to supplement native game fish populations on the Kenai Peninsula. Fall gill

net sampling has been employed to evaluate these introductions. This investigation is a continuing attempt to determine proper initial and supplementary stocking rates, including sizes and fish species.

Silver Salmon

Growth and relative survival rates were measured by gill net sampling in five lakes stocked with silver salmon, Oncorhynchus kisutch. Three of these lakes, Upper Jean, Centennial, and Scout lakes, were planted in the fall of 1969 with salmon of Bear Lake origin averaging 144 per pound. In addition, Centennial Lake received a supplementary plant during June, 1971. Threespine stickleback, Gasterosteus aculeatus, are present in each lake, and Scout Lake also contains a few rainbow trout, Salmo gairdneri, from a 1968 plant.

A comparison of the plants after one year of lake residency suggested a correlation between growth and stocking density. After one year, plants of 300 per surface acre in Scout Lake, 250 in Upper Jean Lake, and 220 in Centennial Lake averaged 167.5, 179.3, and 230.4 mm in length, respectively. In 1971, after two years of lake residency, gill net sampling indicated the mean lengths of the salmon in Scout and Upper Jean lakes increased to 217.0 and 256.9 mm, respectively; whereas the average size of the Centennial Lake salmon dropped to 197.1 mm.

The apparent reduced size of the Centennial Lake fish is not clearly understood. It seems unlikely that spawning mortality could have significantly altered the size structure because only 5% of the 1970 catch were sexually mature. Although the catches in 1970 (75 fish) and 1971 (85 fish) were relatively large, it is possible that sampling error caused the discrepancy. Previous studies show that larger individuals within landlocked silver salmon populations have a tendency to mature earlier than smaller fish. With the onset of sexual maturity definite segregation frequently occurs in areas of suitable spawning substrate (natural reproduction has never been recorded in the area's landlocked silver salmon populations). Lack of uniform distribution may increase the chance of error in fall gill net sampling, i.e., the smaller, more motile immature fish are more vulnerable to capture than the concentrated larger salmon.

Redick (1970) also noted unexpected reductions in the average size of stocked silver salmon in several Matanuska Valley lakes. He attributed the phenomenon to either gill net sampling error or a differential mortality affecting larger members of an age class during the winter months.

Relative abundance, as measured by gill net catches, has no apparent relationship with stocking density. The survival in each lake, however, was adequate enough to afford an acceptable catch rate for sport fishermen. The results of the gill net sampling for both years are summarized in Table 1.

TABLE 1 Growth and Relative Survival of 1969 Silver Salmon Plants in Three Kenai Peninsula Lakes.

Lake	Year Sampled	No. Fish	Length (mm) Range	Length (mm) Mean	Mean Weight (lbs.)	Catch/ Net Hr.
Scout	1970	103	142-234	167.5	0.12	1.78
	1971	112	162-288	217.0	0.28	1.39
Upper Jean	1970	43	150-262	179.3	0.17	0.56
	1971	46	170-460	256.9	0.54	1.00
Centennial	1970	75	143-294	230.4	0.39	1.27
	1971	85	163-274	197.1	0.19	1.23

During June, 1971, silver salmon averaging 391 per pound were planted in Rock, Centennial, and Sunken Island lakes at 500, 220, and 200 fish per surface acre, respectively. Rock Lake is barren and Sunken Island Lake contains stickleback and a small introduced sockeye salmon, O. nerka, population.

Sampling during the fall, 1971, suggested relatively good survival in Sunken Island and Centennial lakes, whereas the catch was poor in Rock Lake. Length, weights, and catch rate data for the three plants is presented in Table 2,

TABLE 2 Growth and Relative Survival of 1971 Silver Salmon Plants in Three Kenai Peninsula Lakes.

Lake	Date Sampled	No. Fish	Length (mm) Range	Length (mm) Mean	Mean Weight (lbs.)	Catch/ Net Hr.
Sunken Island	10/5/71	73	100-150	114.0	0.05	1.22
Centennial	9/27/71	44	103-123	113.2	0.04	0.63
Rock	10/13/71	19	135-162	145.9	0.08	0.19

Rainbow Trout

Rainbow trout growth and relative survival rates were evaluated by examination of gill-net caught fish from four rehabilitated lakes. Rotenone was used to eliminate stickleback from each lake. Physical characteristics and stocking histories for each lake have been discussed by Engel (1970).

Prior observations have provided considerable background information on the growth and survival of trout planted during mid-summer and fall. The primary objective of this investigation was to compare the success of spring plants to midsummer and fall stocking. Rainbow trout ranging from 114 to 158 per pound were planted in each lake from June 4-11, 1971. Cabin and Jerome lakes were previously stocked with rainbow trout on September 11, 1970. Stocking rates and numbers of fish planted are presented in Table 3.

TABLE 3 Stocking Rates for Rainbow Trout in Kenai Peninsula Lakes.

Lake	Date Stocked	Fish/ Lb.	Fish/ Surface Acre	Fish/ Acre-Foot	Total Planted
Cabin	9/70	165	450	41	24,000
	6/71	114	270	25	14,300
Jerome	9/70	106	200	23	3,200
	6/71	158	225	26	3,600
Sport	6/71	114	410	38	29,600
Arc	6/71	158	315	36	5,000

Sampling approximately 3 1/2 months after introduction suggested that spring plants had obtained mean lengths of about 164 mm. Although no attempt was made during this phase of the study to separate the fall and spring plants in Cabin and Jerome lakes, it was apparent that growth rates did not differ greatly. The relatively low catch rates in some of the waters may reflect sampling deficiencies rather than low survival. Many of the trout may have been too small to be vulnerable to the mesh size employed. Continued sampling during succeeding years will be necessary to develop a true picture of growth and survival. Sampling results are shown in Table 4.

TABLE 4 Mean Lengths, Weights, and Catch Per Gill-Net Hour of Rainbow Trout in Four Kenai Peninsula Lakes.

Lake	Date Sampled	No. Fish	Length (mm) Range	Length (mm) Mean	Mean Weight (lbs.)	Catch/ Net Hr.
Cabin*	9/21/71	117	137-215	175.9	0.15	2.63
Jerome*	10/17/71	29	119-204	170.8	0.14	0.66
Sport	9/30/71	5	155-183	163.5	0.12	0.06
Arc	9/29/71	18	112-193	164.3	0.14	0.38

*Includes trout from the 1970 and 1971 plants.

Island Lake, with a surface area of about 270 acres and a maximum depth of 31 feet, was sampled by gill net to evaluate sockeye salmon and rainbow trout plants in a common environment. Threespine stickleback are indigenous to the lake.

Sockeye salmon smolts were stocked at 64 per surface acre during June, 1968. The salmon averaged 70 per pound and were primarily age II. Rainbow trout averaging 132 per pound were initially stocked at a rate of 390 per acre in September, 1969. A supplemental plant, averaging 117 per pound, was introducted in June, 1971, at a density of 200 fish per surface acre.

Fall gill net sampling in 1970 and 1971 yielded good sockeye salmon catches but very few rainbow trout. Included in the 1970 sample were 57 sockeye salmon and 5 rainbow trout. The 1971 catch consisted of 86 sockeye salmon, 7 trout from the 1969 plant and 2 trout from the 1971 introduction. Length, weight, and catch information is presented for both years in Table 5. This data supports prior observations that domestic trout have satisfactory growth but low survival in lakes containing stickleback.

TABLE 5 Mean Lengths, Weights, and Catch Per Gill-Net Hour of Sockeye Salmon and Rainbow Trout in Island Lake.

Date Sampled	Species	Length (mm) Range	Length (mm) Mean	Mean Weight (lbs.)	Catch/ Net Hr.
10/8/70	RS	124-337	231.5	0.36	0.66
	RT	194-311	258.6	0.56	0.07
9/22/71	RS	126-315	232.0	0.33	1.11
	RT*	375-469	406.7	2.66	0.09
	RT**	163-165	164.0	0.16	0.02

*Stocked in 1969.
**Stocked in 1971.

Sockeye Salmon

In June, 1965, 1966, 1967, and 1968, sockeye salmon smolts were collected from Bear Creek near Seward, and transported to various landlocked lakes on the Kenai Peninsula. The purpose of the plants was two-fold: first, to reduce competition between sockeye and silver salmon in Bear Lake, which is intensively managed for anadromous silver salmon; and second, to establish game fish populations in barren roadside lakes.

Smolts were captured at the Bear Creek weir during their seaward migration. The 1965 and 1966 transplants were predominantly age I, whereas the 1967 and 1968 plants were primarily age II smolts. A total of 233,750 smolts were released into seven lakes during the four years (Table 6).

TABLE 6 Number of Sockeye Salmon Stocked in Kenai Peninsula Lakes, 1965-1968.

Lake	Date Stocked*	Fish/ Surface Acre	Total Fish Planted
Upper Jean	1965	25	1,150
	1966	754	34,670
	1967	196	9,020
Sunken Island	1966	224	31,350
	1967	94	13,140
Portage	1966	644	18,670
	1967	378	10,950
Rock	1966	1,038	8,300
	1967	1,279	10,230
Bernice	1966	127	18,500
	1967	152	22,160
Bottinentin	1967	137	38,220
Island	1968	64	17,390

*All lakes were stocked in June of the year indicated.

Inadvertently, a few silver salmon smolts were also planted with the sockeye because of the simultaneous migration of the two species. Identification problems occasionally occurred at night when it was necessary to rapidly separate and enumerate large numbers of fish.

The lakes chosen for the transplants were selected because: (1) they have varied physical and chemical characteristics which afford opportunities for comparative growth and survival studies, (2) they were landlocked or have negligible outlets which prevent seaward migration, and (3) they are located on public land that is accessible by road. The physical and chemical features of the recipient waters have been described by Engel (1968, 1969, 1970). Upper Jean, Portage, Island, and Sunken Island lakes have similar characteristics, each exceeds 30 feet in depth and is thermally stratified during the summer. Bottinentin, Bernice, and Rock lakes, all less than 18 feet deep, exhibit homoiothermous summer conditions. With the exception of Rock Lake, threespine stickleback are abundant in all waters.

Each of the study lakes was sampled annually with gill nets during late September or early October to obtain comparative growth and survival data. The transplanted fish were initially aged and identified solely on the basis of length. After 1968 this procedure became increasingly subject

to error in some lakes because of length overlap among salmon of different introduction dates. Identification by scale analysis was impossible because of the age disparity in the transplanted smolts.

The size and relative survival of the transplanted fish from 1967 through 1971 are presented in Table 7. The data shown for 1967 and 1968 includes fish from the 1966 plant, whereas after 1968 the catches also contain salmon from the 1967 transplant (Island Lake was stocked in 1968). As expected, the diverse environments and stocking densities produced considerable variation in growth. Apparently, environmental conditions exert a stronger influence on growth than the stocking rates employed in the study.

Rock Lake, despite the heaviest stocking density, produced the most rapid growth while Portage Lake, also heavily stocked, yielded relatively small fish. Moderate growth was recorded for Island Lake salmon where the stocking rate was the lowest.

TABLE 7 Growth Comparisons for Sockeye Salmon Transplants in Kenai Peninsula Lakes.

Lake	Year Sampled	No. Fish	Length (mm) Range	Length (mm) Mean	Mean Weight (lbs.)	Catch/ Net Hr.
Rock	1967	67	218-291	256.2	0.51	1.37
	1968	32	238-380	312.3	0.93	1.39
	1969	--	--	No fish collected		--
Upper Jean	1967	26	164-285	223.9	0.32	0.27
	1968	14	193-293	243.9	0.42	0.21
	1969	183	168-312	179.7	0.14	3.27
	1970	11	184-215	200.5	0.19	0.14
	1971	--	--	No fish collected*		--
Sunken Island	1967	107	151-278	190.1	0.17	1.34
	1968	38	204-283	232.8	0.31	0.58
	1969	75	228-328	248.4	0.39	0.81
	1970	29	277-326	297.6	0.73	0.45
	1971	6	270-350	318.7	0.88	0.10
Portage	1967	13	153-211	180.7	0.14	0.20
	1968	41	181-321	207.3	0.22	0.81
	1969	97	210-305	229.0	0.27	2.38
	1970	141	222-294	245.0	0.36	3.03
	1971	40	257-306	277.2	0.57	0.53
Bernice	1967	10	162-204	185.0	0.18	0.08
	1968	--	--	Not sampled	--	--
	1969	19	220-368	282.4	0.67	0.26
	1970	4	278-357	325.0	1.07	0.04
	1971	--	--	No fish collected		--

TABLE 7 (Cont.) Growth Comparisons for Sockeye Salmon Transplants in Kenai Peninsula Lakes.

Lake	Year Sampled	No. Fish	Length (mm) Range	Length (mm) Mean	Mean Weight (lbs.)	Catch/ Net Hr.
Bottinentin	1968	12	135-216	160.0	0.11	0.15
	1969	26	205-280	233.2	0.36	0.24
	1970	27	247-343	298.2	0.83	0.42
	1971	--	--	No fish collected		--
Island	1970	57	124-337	231.5	0.36	0.66
	1971	86	126-315	232.0	0.33	1.11

*Creel census of the winter sport fishery (1971-72) revealed that a few sockeye salmon were still present in Upper Jean Lake.

The vast differences in growth rates prevented a meaningful year-to-year comparison of relative abundance because of mesh selectivity. Populations consisting of slow growing salmon were initially less vulnerable to gill net capture than populations containing faster growing fish. Data from Portage and Rock lakes illustrates the sampling bias (Table 7). The slow growing Portage Lake salmon did not show strongly in the 1967 and 1968 catches but by 1969, as the fish became larger, the catch rates increased substantially. On the other hand, the faster growing salmon in Rock Lake showed strongly in the catches shortly after introduction. Based on the 1967 and 1968 data it appeared that Rock Lake contained a more abundant population than Portage Lake; however, the high catch rates during subsequent years in Portage Lake cast considerable doubt on this assumption.

Of the lakes stocked with red salmon, Sunken Island, Island, Portage, Upper Jean, and Rock lakes developed into successful sport fisheries that were particularly popular during the winter months. With the exception of Rock Lake, all successful fisheries developed in relatively deep lakes that maintain cool water temperatures during the summer. Rock Lake, prior to a 1969 winter-kill, produced salmon of exceptional size despite summer bottom temperatures in excess of 60°F. An absence of stickleback coupled with a dense population of amphipods, Gammarus sp, is believed responsible for this superior growth.

The principle food groups consumed during the fall by salmon in Upper Jean, Sunken Island, Island, and Portage lakes were cladocerans and copepods. Insects, emphipods, stickleback, and leeches comprised the bulk of the salmon diet in Bottinentin and Bernice lakes.

Mortality due to sexual maturity varied considerably within the study waters (Table 8). The high percentage of mature fish in the Rock Lake samples suggests a possible relation between accelerated growth and early sexual development. Males mature earlier than females in all populations. In

most cases the transplanted salmon had a greater life span than their anadromous parents. Bear Lake red salmon normally return to spawn in their fourth or fifth year of life.

TABLE 8 Sexual Maturity of Sockeye Salmon in Seven Kenai Peninsula Lakes.

Lake	Year Sampled	Sample Size	No. Mature Salmon Male	No. Mature Salmon Female	Mean Length Mature Fish (mm)	% Mature
Rock	1967	103	14	0	266.6	13.6
	1968	42	14	2	336.0	38.1
Upper Jean	1967	39	10	0	253.3	25.6
	1968	21	0	0	--	--
	1969	183	2	1	259.3	1.6
	1970	11	5	0	203.4	4.5
Sunken Island	1967	144	1	0	278.0	0.9
	1968	38	4	0	229.2	10.5
	1969	75	13	1	258.5	18.7
	1970	29	5	2	291.0	24.1
	1971	6	1	4	318.7	83.3
Portage	1967	33	0	0	--	--
	1968	43	2	1	246.0	7.0
	1969	97	38	0	230.6	39.2
	1970	141	71	21	244.7	66.0
	1971	40	21	7	279.2	70.0
Bernice	1967	10	0	0	--	--
	1968	--	--	--	Not sampled	--
	1969	19	1	0	294.0	5.0
	1970	4	0	0	--	--
Bottinentin	1968	11	1	0	174.0	9.1
	1969	26	2	0	251.0	7.7
	1970	27	8	0	306.6	29.6
Island	1970	57	5	0	242.0	8.8
	1971	86	6	1	252.9	8.1

Silver salmon that were inadvertently transplanted with the sockeye salmon displayed strikingly better growth in most lakes (Table 9). Accelerated growth presumably resulted from the silver salmon's superior ability to utilize and/or compete for available food. Reduced demand on the silver salmon preferred habitat because of low stocking densities may also have influenced growth rates. Maximum recorded weights for silver salmon in

Sunken Island, Portage, and Upper Jean lakes were 7.75, 4.88, and 4.50 pounds, respectively. Stomach analysis indicates that the growth of the larger fish was accelerated by the consumption of sockeye salmon.

TABLE 9 Growth Comparisons for Silver and Sockeye Salmon in Common Lake Environments.

Lake	Year Sampled	Species	No. Fish	Length (mm) Range	Length (mm) Mean	Catch/ Hr.
Portage	1967	Sockeye	13	153-211	180.7	0.20
		Silver	13	156-554	279.3	0.20
	1968	Sockeye	41	181-321	207.3	0.81
		Silver	9	272-467	350.0	0.18
Sunken Island	1967	Sockeye	107	151-278	190.1	1.34
		Silver	3	435-641	509.3	0.04
	1968	Sockeye	38	204-283	232.8	0.58
		Silver	5	227-290	272.0	0.08
Upper Jean	1967	Sockeye	26	164-285	223.9	0.27
		Silver	15	187-529	433.4	0.17
	1968	Sockeye	14	193-293	243.9	0.21
		Silver	3	311-510	418.0	0.04

A rapid decline in silver salmon occurred after 1968 and by 1969 very few remained in the study waters. The 1967 net samples from Portage and Upper Jean lakes surprisingly suggested that silver salmon were as or nearly as abundant as sockeye salmon. Sampling during succeeding years, however, indicated that sockeye salmon were the dominant species in both lakes. The netting discrepencies apparently occurred because the larger silver salmon were vulnerable to a wider range of mesh sizes than the smaller sockeye salmon.

Rainbow Trout - Stickleback Studies

Musick and Stickleback lakes were chosen for research on rainbow trout-threespine stickleback because of their similar chemical, physical, and biological characteristics. Although they were separated by a low, narrow neck of land, a sand and gravel barrier was erected between the lakes to prevent interchange of fish in the event of high water.

Musick Lake was treated with rotenone on September 15, 1970 to eliminate sticklebacks. During the 1971 spring runoff a crushed culvert allowed Musick Lake to fill to such an extent that some water backed over the

barrier into Stickleback Lake. Although the level of the lake was restored to normal by replacing the damaged outlet culvert, it is likely that stickleback re-entered Musick Lake.

Both Musick and Stickleback lakes were stocked with 2,500 rainbow trout averaging 326 to the pound on June 11, 1971. Survival and growth will be evaluated for both plants during succeeding years and the severity of stickleback reinfestation will be determined.

Sampling Problems

Variable mesh gill nets have been used, largely because of practical necessity, to determine growth and relative survival of stocked salmonids. It was generally accepted that the catch of a standard net was somewhat representative of the size of a lake's fish population. Such catch data, expressed as catch per net hour, has been compared to catches of the same species from other lakes and to catches from the same lake during different years. It was further assumed that gear selectivity remained fairly constant for a species in all waters.

Whenever catches were evaluated on a comparative basis it was a standard procedure to fish the nets at identical locations each year during similar seasonal periods. All nets were fished for approximately 24 hours.

Examination of catch records from the same populations over a period of years indicates that short-term gill net sampling is often an unreliable method of estimating growth and indices of abundance. Substantial error appears to be associated with the selectivity of the variable mesh nets. Although no quantitative evaluations or comparisons were conducted, field observations suggest that smaller mesh sizes have lower catch efficiencies than the larger meshes.

Samples collected from populations containing relatively small fish commonly reflect a mean size larger than the populations actual mean. Disproportionate sampling of the populations length frequency range not only affects an assessment of growth but also complicates a reliable evaluation of relative abundance.

The practice of sampling stocked salmon during the fall has also yielded data of questionable value. To obtain representative samples with stationary nets, members of the population must be randomly distributed and have similar movements. Sexually mature salmon, which normally comprise only a portion of the population, frequently congregate in spawning areas whereas nonspawners are more randomly distributed throughout the lake. Positioning of the nets under these circumstances not only affects the composition of the catch but also influences catch rates.

In view of the many netting discrepancies that have been encountered during the investigation, it is obvious that current sampling methods require refining. Behavioral patterns of the various species must be given

greater consideration in the development of sampling schemes if reliable data are to be obtained. It is equally important that the selectivity of various mesh sizes be better understood. The number of net sets required to adequately sample various size lakes is another question deserving study.

Recent developments in electrical methods of capturing fish suggest that this type of sampling may be applicable to the area's stocked lakes. The effectiveness of electro-fishing should be evaluated and compared to gill net sampling.

LITERATURE CITED

Engel, Larry J. 1968. Inventory and Cataloging of the Sport Fish and Its Waters on the Kenai-Cook Inlet-Prince William Sound Areas. Alaska Department of Fish and Game. Federal Aid In Fish Restoration, Annual Report of Progress, 1967-1968, Project F-5-R-9, 9:95-116.

_____. 1969. Inventory and Cataloging of Kenai Peninsula, Cook Inlet and Prince William Sound Drainages and Fish Stocks. Alaska Department of Fish and Game. Federal Aid In Fish Restoration, Annual Report of Progress, 1968-1969, Project F-9-1, 10:111-130.

_____. 1970. Evaluation of Sport Fish Stocking on the Kenai Peninsula-Cook Inlet Areas. Alaska Department of Fish and Game. Federal Aid In Fish Restoration, Annual Report of Progress, 1969-1970, Project F-9-2, 11:109-127.

Redick, R. Russell. 1970. Inventory, Cataloging and Population Sampling of the Sport Fish and Sport Fish Waters of the Cook Inlet Drainage. Alaska Department of Fish and Game. Federal Aid In Fish Restoration, Annual Report of Progress, 1969-1970, Project F-9-2, 11:189-211.

Prepared by:

Larry J. Engel
Fishery Biologist

Date: April 30, 1972

Approved by:

s/Howard E. Metsker
D-J Coordinator

s/Rupert E. Andrews, Director
Division of Sport Fish