SCOMM

#48:31

HOUSE SPECIAL COMMITTEE
ON FISHERIES
May 6, 1985
12:30 p.m.

Members Present:	Representative Peter Goll, Chair Representative Katie Hurley Representative Andre Marrou Representative Dave Thompson Representative Mike Navarre
Members Absent:	Representative Johne Binkley Representative Roger Jenkins

COMMITTEE CALENDAR

HJR 38 — Relating to fisheries enhancement by the Department of Fish and Game within the Andy Simons Wilderness Unit, Kenai National Wildlife Refuge.

WITNESS REGISTER

No witnesses.

PREVIOUS ACTION

HJR 38: Read the first time 04/29/85 and referred to Fish, Res and Rules; no previous committee action to record. Today Fish reported out with 6DP.

ACTION NARRATIVE

TAPE #18 SIDE ONE

Recording Number 001	The meeting was called to order at 12:30 p.m. Chairman Goll noted the presence of Representatives Marrou, Thompson, Hurley and Navarre and announced HJR 38.
Number 007	Representative Thompson moved for the passage of HJR 38 and asked individual recommendations. There were no objections. Representatives Navarre, Thompson, Hurley, Marrou and Goll signed DO PASS. Representative Johne Binkley later signed DO PASS.
Number 010	The meeting was adjourned at 12:31 p.m.

Introduced: 4/29/85
Referred: House Special Committee
on Fisheries and Resources

IN THE HOUSE BY NAVARRE AND MARROU

HOUSE JOINT RESOLUTION NO. 38

IN THE LEGISLATURE OF THE STATE OF ALASKA

FOURTEENTH LEGISLATURE - FIRST SESSION

Relating to fisheries enhancement by the Department of Fish and Game within the Andy Simons Wilderness Unit, Kenai National Wildlife Refuge.

BE IT RESOLVED BY THE LEGISLATURE OF THE STATE OF ALASKA:

WHEREAS the U.S. Fish and Wildlife Service is preparing a comprehensive conservation plan for the Andy Simons Wilderness portion of the Kenai National Wildlife Refuge; and

WHEREAS the final draft for the comprehensive conservation plan states that fisheries enhancement will not be permitted in wilderness areas; and

WHEREAS THE Alaska Department of Fish and Game has had a fisheries enhancement program in operation on Tustumena Lake; and

WHEREAS the fisheries enhancement program on Tustumena Lake has resulted in an increase in the total production of fish from the lake without negative results on wild stocks or the rearing environment; and

WHEREAS the Tustumena fishery enhancement program has resulted in the production of at least 300,000 additional adult salmon, with a value to Central Cook Inlet fishermen of $1,600,000; and

WHEREAS the comprehensive conservation plan, if implemented, would put the state fisheries enhancement program in jeopardy; and

WHEREAS the Alaska Department of Fish and Game has recommended to the U.S. Fish and Wildlife Service that the comprehensive conservation plan permit fisheries enhancement in special situations under cooperative agreements; and

WHEREAS the Department of Fish and Game has also recommended that the

Tustumena Lake sockeye stocking be continued until the U.S. Fish and Wildlife Service and the Department of Fish and Game jointly determine that these projects have been completed or that they no longer achieve their stated objectives;

BE IT RESOLVED that the Alaska State Legislature respectfully requests the U.S. Fish and Wildlife Service to continue to permit the stocking of fish and the enhancement of the fishery resources within Tustumena Lake of the Kenai National Wildlife Refuge.

COPIES of this resolution shall be sent to the Honorable Donald P. Hodel, Secretary of the Interior; to Robert A. Jantzen, Director of the U.S. Fish and Wildlife Service; to Robert Gilmore, Director, Alaska Region, U.S. Fish and Wildlife Service; to W. Vernon Wiggins and Robert Grogan, Co-Chairman, Alaska Land Use Council; and to the Honorable Ted Stevens and the Honorable Frank Murkowski, U.S. Senators, and the Honorable Don Young, U.S. Representative, members of the Alaska delegation in Congress.

MEMORANDUM State of Alaska

TO: Pat Malone
Administrative Assistant
to Representative Navarre
Alaska State House - Juneau

DATE: April 24, 1985

FILE NO:

TELEPHONE NO: 267-2166

FROM: Dave Daisy
Regional Program Manager
FRED Division - Anchorage
Department of Fish and Game

SUBJECT: Tustumena Sockeye Enhancement Program

Enclosed are two documents that should help explain the Tustumena Lake Sockeye Enhancement Program. One is Sockeye Salmon Investigation, Tustumena Lake System, Alaska - Progress Report Number 3 which is the latest progress report on the studies to determine the effects of sockeye salmon enhancement on Tustumena Lake, and the other is the abstract of two presentations given by Loren Flagg, the area biologist in charge of the Tustumena program, explaining the enhancement program and the Tustumena sockeye investigation project. You will note the the U.S. Fish & Wildlife Service is involved in the investigation project. A quote from Flagg's presentation sums it up best - "Our studies to date indicate that the Tustumena Lake stocking program has resulted in an increase in total production from the lake without any negative effects."

It should be noted that the Tustumena stocking program involves no habitat manipulation, no permanent structures, and utilizes stocks native to the Tustumena system. It takes advantage of plankton (sockeye food) production that is surplus to the needs of sockeye produced naturally in the system.

Tustumena Lake is totally within the Andy Simons Wilderness portion of the Kenai National Wildlife Refuge (KNWR). The final draft of the KNWR Comprehensive Conservation Plan (CCP) defines fisheries enhancement as "actions taken to increase fishery stocks above historic levels. Includes lake fertilization, stocking, building hatcheries and fish passages, and artificially incubating fish in streams." The CCP states that fisheries enhancement will not be permitted in wilderness areas as well as areas where minimal management techniques or traditional management techniques will be applied. This in effect eliminates fishery enhancement from 87% of the KNWR. We object to this outright prohibition on the bulk of the KNWR. Fishery enhancement encompasses a broad range of activities. We believe that some forms of enhancement are compatible within all management categories and should be allowed pending an activity-specific review.

To accomplish this the permitting level indicated for fisheries enhancement in Table 21 of the final draft of the KNWR CCP needs to be changed. The suggested wording is: Table 21, Fisheries Enhancement - Change all categories to: "Permitted in special situations with cooperative agreements."

I hope the above and the enclosed documents are of use to you. If you have any questions please do not hesitate to contact me. My home phone is 243-8544 and my work phone is 267-2166.

Good luck.

Enclosures

cc: Moberly
Flagg

STATE OF ALASKA

S. A. (STAN) MOBERLY
DIRECTOR

DIVISION OF FISHERIES REHABILITATION,
ENHANCEMENT AND DEVELOPMENT (FRED)
DEPARTMENT OF FISH AND GAME

CAPITAL OFFICE PARK
P.O. BOX 3-2000
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OFFICE: (907) 465-4160
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Abstract of Presentation to Kenai Peninsula Borough
Resource Development Commission (3/18/85) and
Cook Inlet Aquaculture Association (3/23/85)
on Tustumena Lake Sockeye Salmon Enhancement Program

by

Loren B. Flagg
Area Biologist
Alaska Department of Fish and Game
Division of Fisheries Rehabilitation,
Enhancement, and Development

The Crooked Creek Hatchery, located at Kasilof, was constructed in 1974. Additions to the facility in the late 1970's and early 1980's brought the capacity of the hatchery to 20 million salmon eggs.

The primary purpose of the facility is to increase the sockeye (red) salmon production at Tustumena Lake. Lake rearing studies in the early 1970's indicated that the system was spawning limited, as opposed to rearing limited, and that the lake was capable of producing more salmon fry than the spawning grounds could supply. Recent studies verify that this assumption was correct - we have demonstrated through the stocking and evaluation program that the lake can produce more fish.

Production stocking was initiated in 1979 at a level of 7.8 million sockeye fry. From 1982 to 1984 we reached the full production level of about 16-17 million fry annually.

Most sockeye salmon fry rear for one year in Tustumena Lake before migrating to sea as smolt. Since 1980 the number of smolt migrating from Tustumena Lake has increased (1-14 million) as has the hatchery contribution (3%-25%).

Our evaluation studies have addressed the questions: (1) "are the smolt being produced from the lake in good condition, and (2) are we in any way harming the natural stock or the environment". Our studies to date indicate that the Tustueman Lake stocking program has resulted in an increase in total production from the lake without any negative effects. The smolt coming out of the lake are in excellent condition and we have observed no adverse impacts on wild stocks or the rearing environment. In 1984, the year of the largest smolt migration (14.2 million), age 1.0 smolts were the largest we have observed. The plankton population has held up strongly, in fact the plankton index was higher in 1984 than it was in 1980.

The additional salmon smolt being produced from the system will mean more adults available for commercial, sport, and subsistence fishermen. At a minimum, 300,000 additional adult salmon will be available on an annual basis for harvest as a direct result of the enhancment program. The ex-vessel value estimated to commercial fishermen in Central Cook Inlet is 1.6 million dollars. When added to the annual value of $400,000 for fish produced from Leisure Lake, which are harvested by Lower Cook Inlet seiners, we estimate that 2.0 million dollars annually will go directly to commercial fishermen from our stocking program starting next year.

The first wholesale value, or value produced from the fish pack, is generally considered to be about 2 times the ex-vessel value ($4.0 million). There are other multipliers, as the dollar rolls over in the community, however, I'll leave that analysis for the economists.

Since the Tustumena Lake sockeye salmon stocking program accounts for over 90% of the Crooked Creek Hatchery production, the loss of this stocking program would in all likelihood mean closure of the hatchery. The hatchery also provides king salmon, coho salmon, and steelhead for sport fishermen. Last year over 5,000 adult king salmon were caught at Crooked Creek. This fishery ranked second behind the Kenai River in king salmon catch on the Kenai Peninsula in 1984. This program and the others, coho and steelhead, would be in jeopardy if the hatchery is closed.

We ask only that the future stocking progam at Tustumena Lake be directed based on the merits of the program; that is the agreement we had with the U. S. Fish and Wildlife Service when we initiated our 5 year cooperative study in 1981. The State has recommended to the USFWS to change the Fisheries Enhancement section of the Kenai National Wildlife Refuge Plan to read: "Fisheries enhancement permitted in special situations with cooperative agreements". The State also recommended that the "Tustumena Lake sockeye salmon stocking be continued until the Service and ADF&G jointly determine that these projects have been completed or no longer achieve their stated objectives".

The KNWR plan will be available soon for a 60 day public comment period. We would encourage you, as individuals or as a group, to review this plan and provide comments to the USFWS. The State would appreciate your support on the Tustumena Lake issue. Thank you.

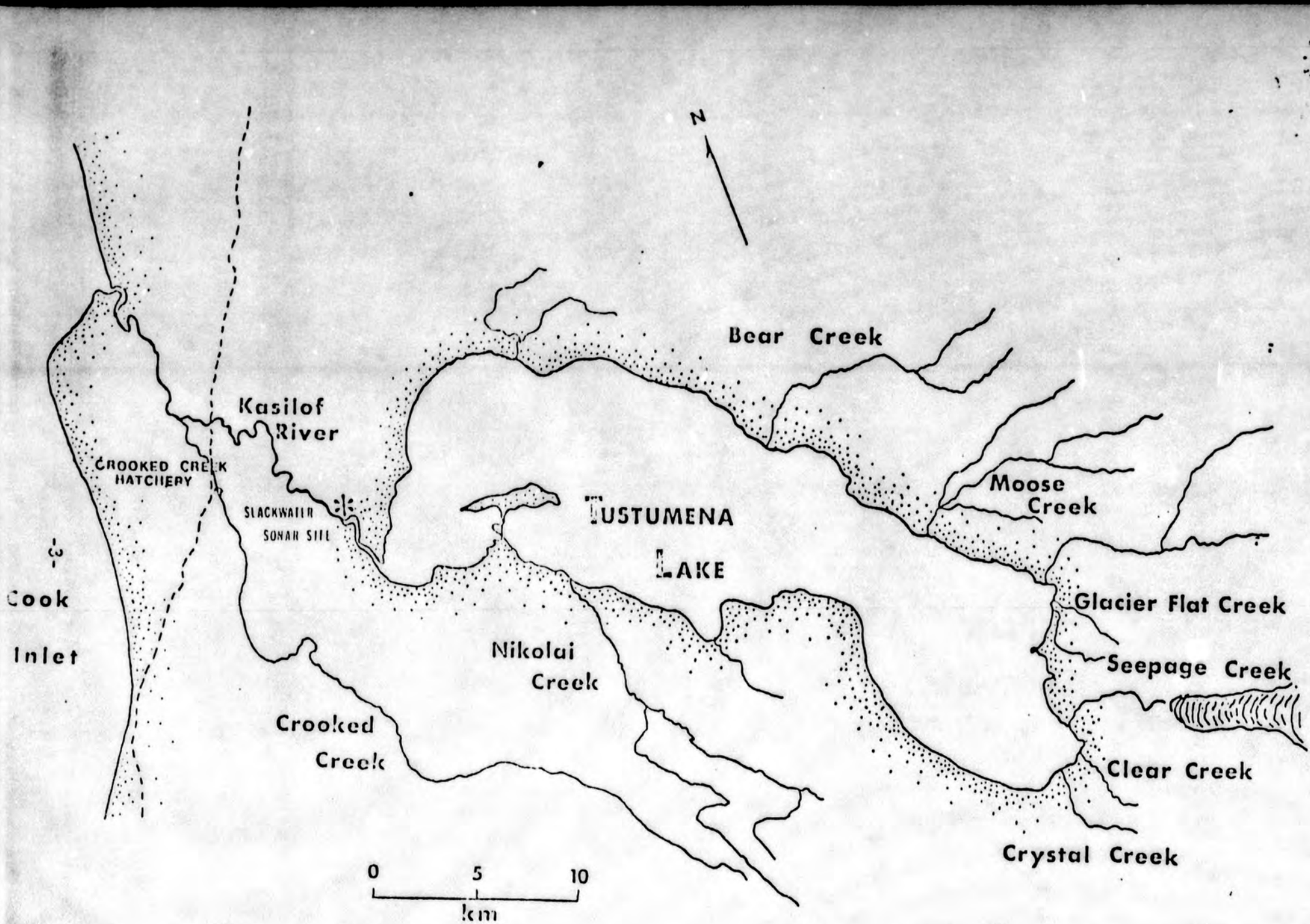
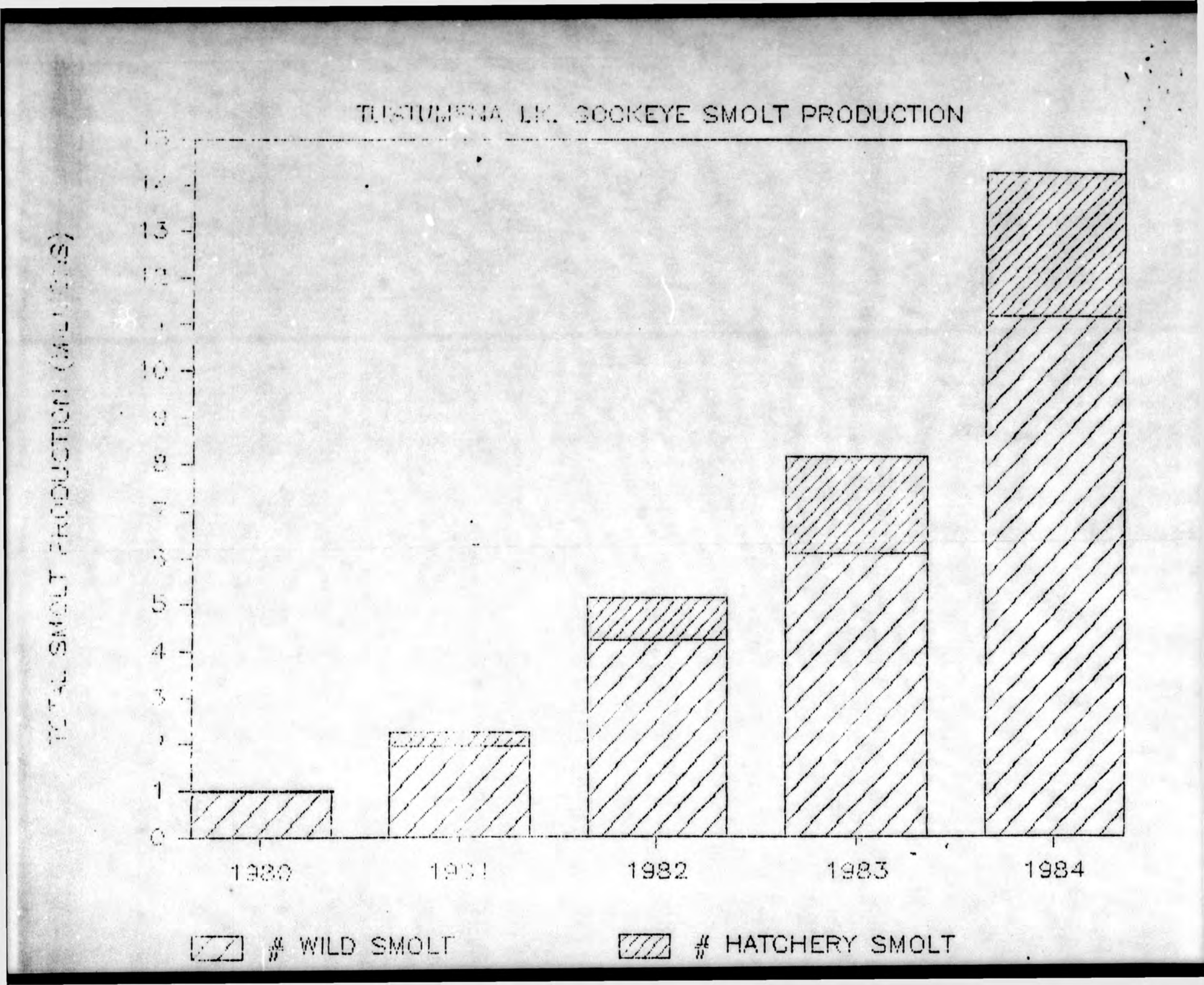


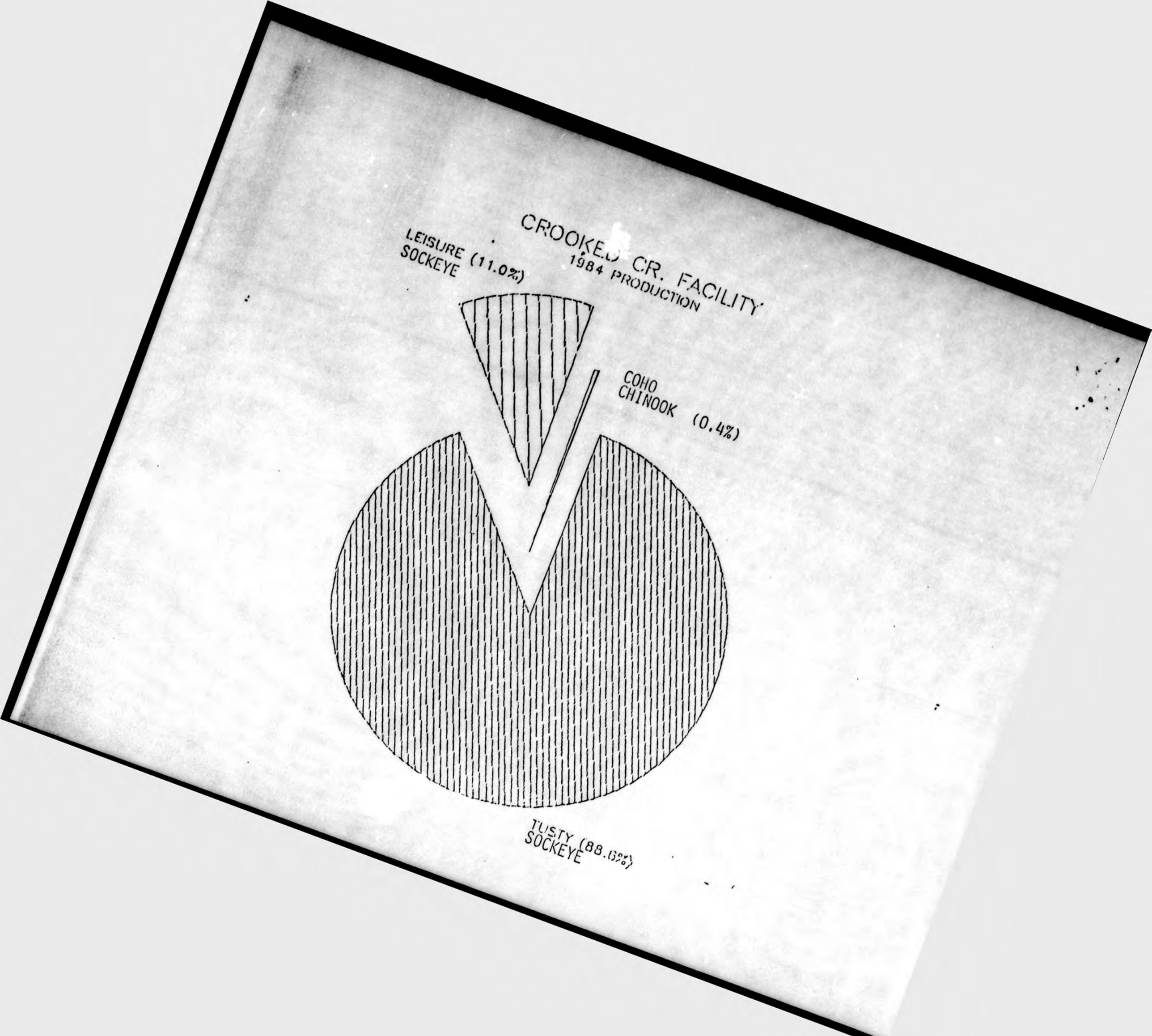
Figure 1. Kasilof River drainage and major sockeye salmon rearing lake.

Appendix A. Kasilof River smolt migration summary, 1980-1984.

Sample year	Total smolt migration (millions)	Percent age composition		Mean size of age 1.0 smolt		Percent hatchery contribution
		1.0	2.0	Length (mm)	Weight (g)	
1980	1.0	91	9	68	2.7	3
1981	2.3	82	18	70	2.8	13
1982	5.1	80	20	69	2.9	17
1983	8.3	84	16	70	2.9	25
1984	14.2	80	20	73	3.3	22


TUSTUMENA L.K. SOCKEYE SMOLT PRODUCTION
TOTAL SMOLT PRODUCTION (MILLIONS)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1980
1981
1982
1983
1984
WILD SMOLT
HATCHERY SMOLT

CROOKED CR. FACILITY
1984 PRODUCTION



COMMITTEE REPORT

HOUSE

5/17

(7)

4/29/85

FURTHER RESOURCES

Date: May 6, 1985

The Committee on HOUSE SPECIAL COMMITTEE ON FISHERIES has had HJR 38

Relating to fisheries enhancement by the Department of Fish and Game within the Andy Simons Wilderness Unit, Kenai National Wildlife Refuge.

under consideration and recommends:

[X] do pass [ ] do not pass

[ ] do pass with attached amendments(s)

[ ] replace with CS for _____ [ ] same title [ ] new title

and recommends _____

[ ] AND attaches a "Letter of Intent" [ ] New Fiscal Note [ ] Zero Fiscal Note Attached

[ ] reports it back without recommendation

[ ] referred to the _____ Committee

MEMBERS SIGNING DO PASS

Peter Joe

Andy Ott

David W. Thompson

Katie Hurley

Mike Isaac

MEMBERS HAVING OTHER RECOMMENDATIONS:

Peter Joe
CHAIRMAN

SOCKEYE SALMON INVESTIGATION, TUSTUMENA LAKE SYSTEM, ALASKA

PROGRESS REPORT NUMBER 3

Upper Cook Inlet Data Report
Number 85-1

by

Loren B. Flagg - Alaska Department of Fish and Game - Soldotna, Alaska
Kenneth E. Tarbox - Alaska Department of Fish and Game - Soldotna, Alaska
Jack Dean - U .S. Fish and Wildlife Service - Kenai, Alaska

Alaska Department of Fish and Game
Divsion of Commercial Fisheries
Division of Fisheries Rehabilitation, Enhancement and Development
P. O. Box 3150
Soldotna, Alaska 99669

Don W. Collinsworth
Commissioner

February 1985

PREFACE

The Tustumena Lake sockeye salmon investigations project was funded in 1984 by the Alaska Department of Fish and Game and U. S. Fish and Wildlife Service. Project components and their respective sources of funding are listed below.

Alaska Department of Fish and Game

Fisheries Rehabilitation, Enhancement and Development Division (FRED): Kasilof River smolt enumeration, Limnology (lab analysis), sockeye salmon egg takes, and fry stocking.

Commercial Fisheries Division (CFD): stock separation and adult sonar.

U. S. Fish and Wildlife Service

Anadramous Fish Conservation Act: sockeye salmon spawning ground surveys and juvenile salmon tow net surveys.

Fisheries Resource Program: Tustumena Lake hydroacoustic surveys.

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INTRODUCTION

Since 1976, the natural sockeye salmon (*Oncorhynchus nerka*) stocks of the Kasilof River system have been augmented with hatchery-incubated sockeye salmon fingerling reared at the State of Alaska Crooked Creek Hatchery (Table 1). Eggs taken for this purpose have been collected from the Kasilof River drainage, predominately Bear and Glacier Flats creeks (Figure 1). Stocking began under the assumption that the availability of spawning streams surrounding Tustumena Lake was limiting sockeye salmon production in the system.

In 1981, the Alaska Department of Fish and Game (ADF&G) and the United States Fish and Wildlife Service (USFWS) cooperatively proposed and implemented two fishery studies which complemented sockeye salmon studies already being conducted by ADF&G in the Tustumena Lake system, Alaska. Collectively, these studies are providing a better understanding of the life history stages of sockeye salmon, and the effect freshwater environmental conditions have on young sockeye salmon.

The fishery studies initiated in 1981 are proposed to continue for five years (1981-1985). During this period, findings generated by these studies and the ADF&G studies which were already "in-place" will be reported annually in a single progress report under the title "Sockeye Salmon Investigation, Tustumena Lake System, Alaska." This report is the third progress report in that series. Material in this report is not intended for publication and can only be used with written permission from the

Table 1. Tustumena Lake sockeye salmon fry stocking and marking history, 1976-84.

Release year	Glacier Flats Creek			Bear Creek			Total		
	Number fry stocked	Number marked RV	Percent	Number fry stocked	Number marked LV	Percent	Number fry stocked	Number marked	Percent
1976	1,137,784	--	--	--	--	--	1,137,784	--	--
1977	--	--	--	--	--	--	--	--	--
1978	400,000	--	--	--	--	--	400,000	--	--
1979	4,864,193	30,502	.62	2,899,785	36,095	1.24	7,763,978	66,597	.86
1980	2,706,610	32,669	1.20	2,499,232	32,758	1.31	5,205,842	65,427	1.26
1981	4,967,526	198,409	3.99	3,809,045	253,947	6.67	8,776,571	452,356	5.15
1982	8,299,560	210,114	2.53	7,648,602	248,639	3.25	15,948,162	458,753	2.88
1983	9,760,100	201,800	2.07	7,174,800	218,400	3.04	16,934,900	420,200	2.48
1984	9,750,000	202,400AD 202,100RV	2.08 2.07	7,300,000	29,400	0.40	17,050,000	433,900	2.54
		404,500	4.15						

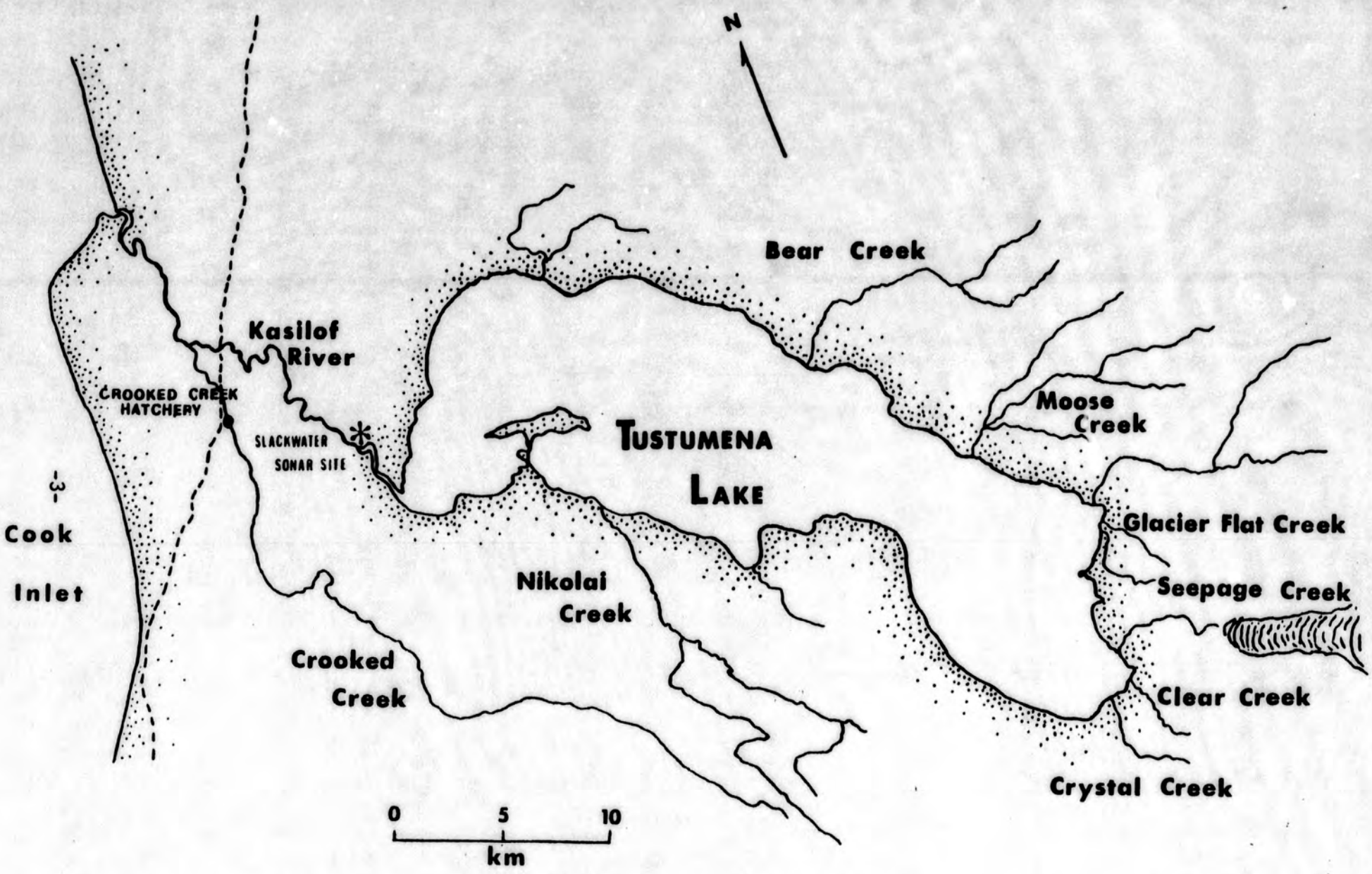

Figure 1. Kasilof River drainage and major sockeye salmon rearing lake.

authors. Data and conclusions are preliminary, pending completion of the investigations.

METHODS

For the purpose of this report, the detailed methods of each component study will not be described. They are available in individual study reports and may be obtained upon request from ADF&G or the USFWS office in Soldotna and Kenai, Alaska, respectively.

Some component studies of the project have been operative for several years, while others were initiated as recently as 1981. These studies, their general function, timing, and the year they were initiated are listed in Table 2.

The project objective implies the need to look for changes (responses) in selected population characteristics of natural and stocked sockeye salmon in the Kasilof River system. The objective additionally implies that, if changes do occur, an attempt must be made to determine what factors influenced the change (i.e., to establish cause-effect relationships). Selection of the population characteristics and the potential influencing factors which needed to, and could, practically, be measured was essential to achieving the objective. These characteristics and factors constitute the project's evaluation criteria (Table 3). As practicality permits, criteria measurements will be made frequently enough to evaluate within,

Table 2. Tustumena Lake Project, component investigations and activities.

Title	General Description	Year Initiated
Tow Netting	Provide estimates of sockeye fry abundance, distribution, and condition in Tustumena Lake. Three surveys per year, June-September.	1972
Stock Separation	In-season sampling of commercial catches in various aspects of Cook Inlet, and apportionment of the catch to respective river systems on the basis of scale analysis and age, weight length characteristics.	1977
Hydroacoustic Surveys	Provide estimates of sockeye fry abundance and distribution. (Note: employs echosounder to obtain number estimates). Incorporates tow netting for ground truth purposes and collection of specimens for analysis of condition, hatchery marks, etc. Three surveys per year, June-September.	1981
Adult Sonar	Sonar enumeration of adult escapement to the Kasilof River. Includes sampling of fishwheel catches at sonar site for age, weight, length and sex composition. Continuous, annually, from mid-May through mid-August.	1968
Spawning Ground Surveys	On-ground surveys of index areas in seven tributary streams to determine contributions of individual streams to total-system sockeye production. Three surveys per stream, August-September.	1975[1/]
Smolt Enumeration	Employment of traps in Kasilof River to capture smolt for determination of out-migration magnitude, timing, age-weight-length composition and % hatchery stocks. May-June, annually.	1980
Limnology	Sampling at three permanent stations on Tustumena Lake to measure primary and secondary productivity (nutrient/phytoplankton/zooplankton), monitor population trends and species composition of phyto- and zooplankton, and measure parameters such as temperature, dissolved oxygen, alkalinity and light penetration. Periodic sampling, May-October.	1980
Fry Marking Technique	Development and evaluation of an analysis technique to detect oxytetracycline (otc) in hatchery-reared fish. This method, if it can be developed, would be much more efficient than the presently used fin clip method. Technique development will continue through 1983.	1981

Table 3. Evaluation criteria for Tustumena Lake Project.

Criteria	Corresponding Investigation	Remarks
Sockeye (natural and stocked)		
Survival & Growth & Age Structure		
Egg - June fry	Spawning Ground Surveys	Within- and between-year evaluations relative to total fry; comparisons to literature and historic levels.
June fry - Sept. fry	Hydroacoustic/Tow Netting	
Sept. fry - Age 1 smolt	Smolt Enumeration	
Sept. fry - Age 2 smolt	Smolt Enumeration	
Smolt - Adult	Adult Sonar/Stock Separation	
Spawning Characteristics		
Spawning Ground Distribution	Spawning Ground Surveys	Seven Streams
Fecundity	Egg-take Data	Bear & Glacier Flat Creeks
Environmental Factors		
Limnological	**Field Sampling/Lab Analysis**	
Primary Production	Phytoplankton Abundance & Species Composition. Includes C-14 and Chorophyll-a Analysis	Within- and between-year evaluations relative to environmental conditions and total fry; comparisons to literature
Secondary Production	Zooplankton Abundance & Species Composition	
Chemistry/Nutrients	D.O., alkalinity, phosphorus, nitrogen, pH conductivity, calcium, magnesium, iron, silica	
Physical Parameters	Temperature, light penetration	

and between, year variations and to make comparisons with historic levels and/or reported values for similar investigations in other areas.

RESULTS

Results presented in earlier progress reports were preliminary. In some cases numbers have been revised following final biometrics review. New data (1984) presented for each evaluation criteria is preliminary.

Sockeye Salmon Survival

Following is a discussion by brood year:

1978, 1979:

Preliminary allocation of the 1982 commercial, sport, and personal use harvest of sockeye salmon as to stream of origin was completed. Approximately 240,000 adult sockeye salmon (age 1.2) were allocated to the Kasilof River in the 1982 return (1978 brood year, Figure 2). Data for 1983 and 1984 returns are not complete at this time (1979 brood; Figure 3).

1980:

A total of 5,468,000 sockeye salmon smolt were produced from the 1980 hatchery and natural spawning population (Figure 4). Of these 1,081,400

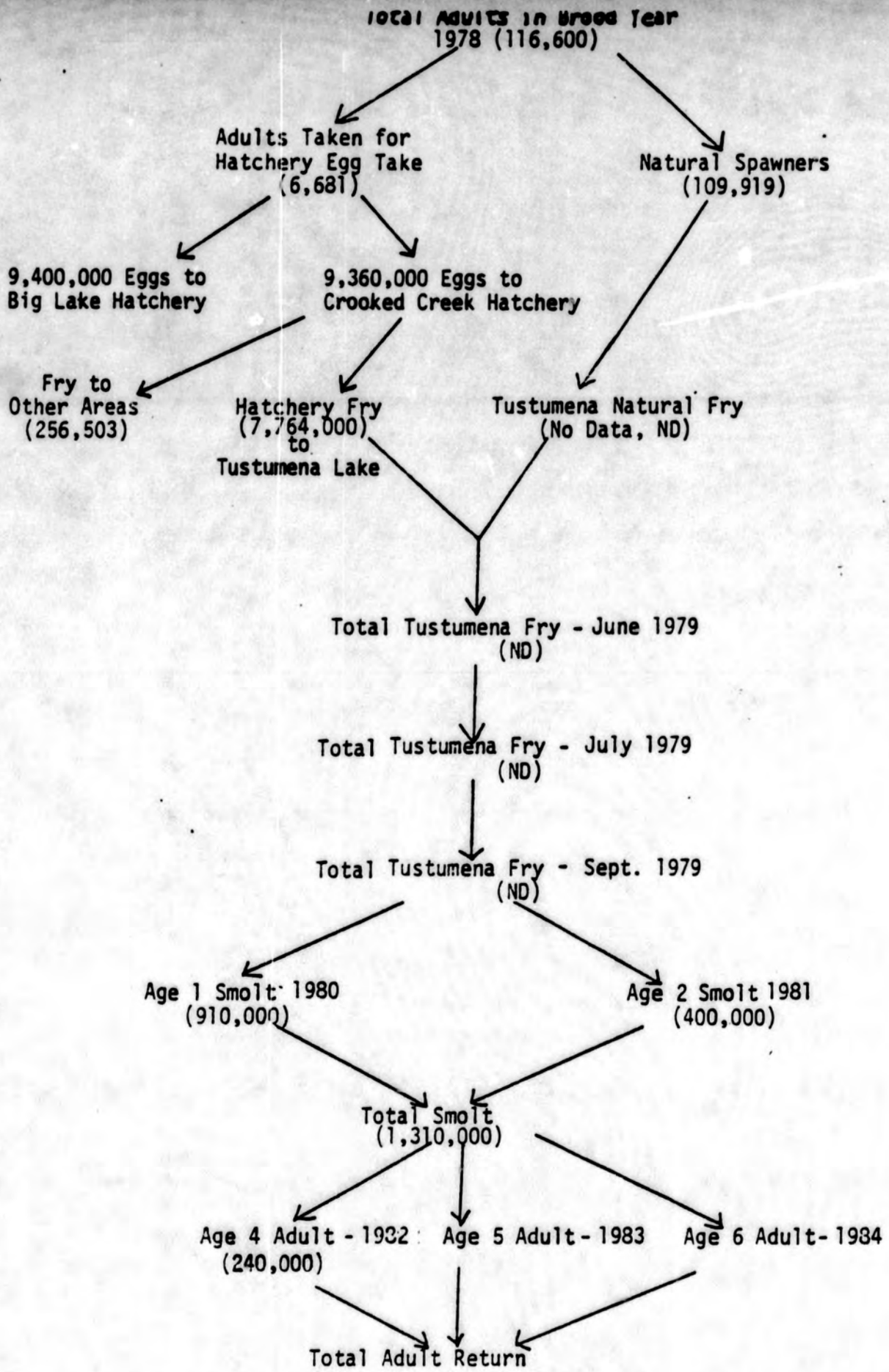

Figure 2. Production of sockeye salmon in the Tustumena Lake system, Alaska, by life history stage, brood year 1978.

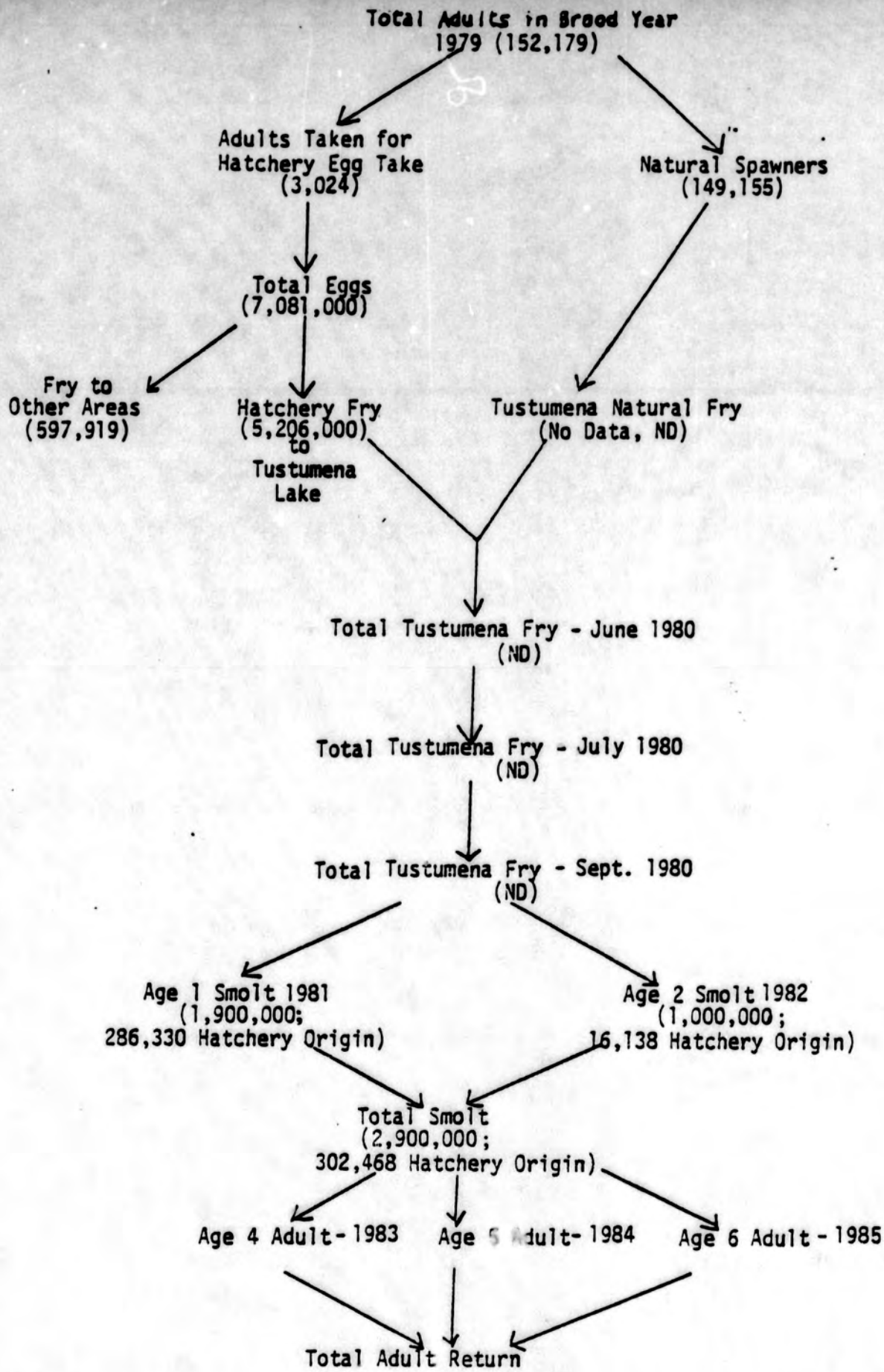

Figure 3. Production of sockeye salmon in the Tustumena Lake system, Alaska, by life history stage, brood year 1979.

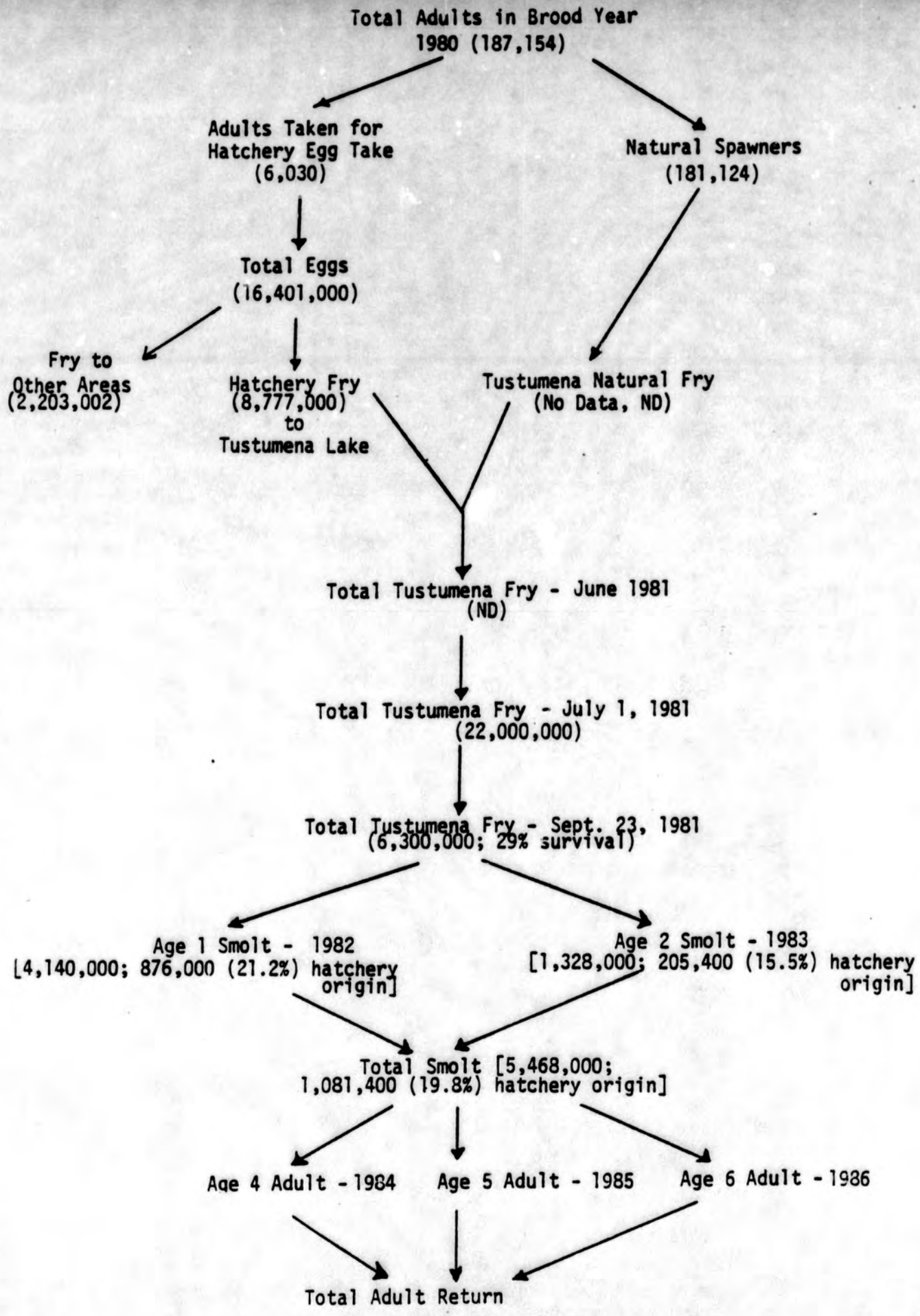

Figure 4. Production of sockeye salmon in the Tustumena Lake system, Alaska, by life history stage, brood year

fish, or 19.8%, were of hatchery origin. Hatchery reared fish survived from the initial plant (8,777,000 fry in June 1981) at the rate of 12.3% (9.98% to age 1.0 smolt and 2.34% to age 2.0 smolt).

1981:

A total of 9,685,000 sockeye salmon smolt were produced from the 1981 hatchery and spawning population (Figure 5). Of these, 2,242,000 fish, or 23.1% were of hatchery origin. Surivival of hatchery reared fry to smolt was 14.1% (11.6% to age 1.0 smolt and 2.5% to age 2.0 smolt.

1982:

A total of 16.9 million sockeye fingerling were stocked into Tustumena Lake in June 1983. The fall hydroacoustic estimate for age 0 sockeye rearing in the lake was 20.8 million. An estimated 11.4 million age 1.0 sockeye smolt (24.2% hatchery) migrated in 1984 (Figure 6). Preliminary survival to age 1.0 smolt for hatchery stocked fry was 16.3%.

1983:

A total of 17.0 million sockeye fingerlings were stocked into Tustumena Lake in June, 1984. The fall hydroacoustic estimate for age 0 sockeye rearing in the lake was 21.9 million (Figure 7). Age 1.0 smolt from the 1983 brood year will migrate in 1985.

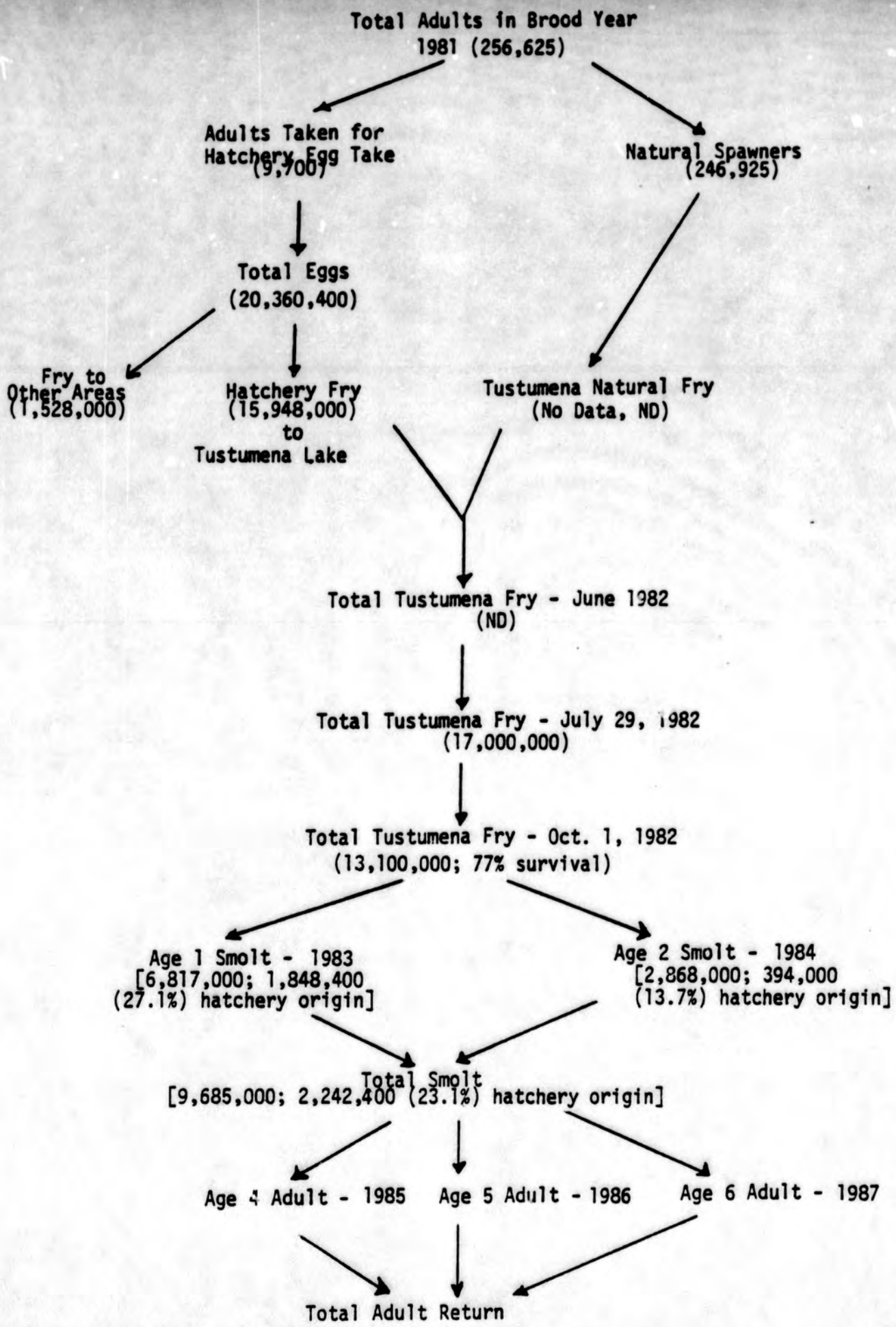

Figure 5. Production of sockeye salmon in the Tustumena Lake system, Alaska, by life history stage, brood year

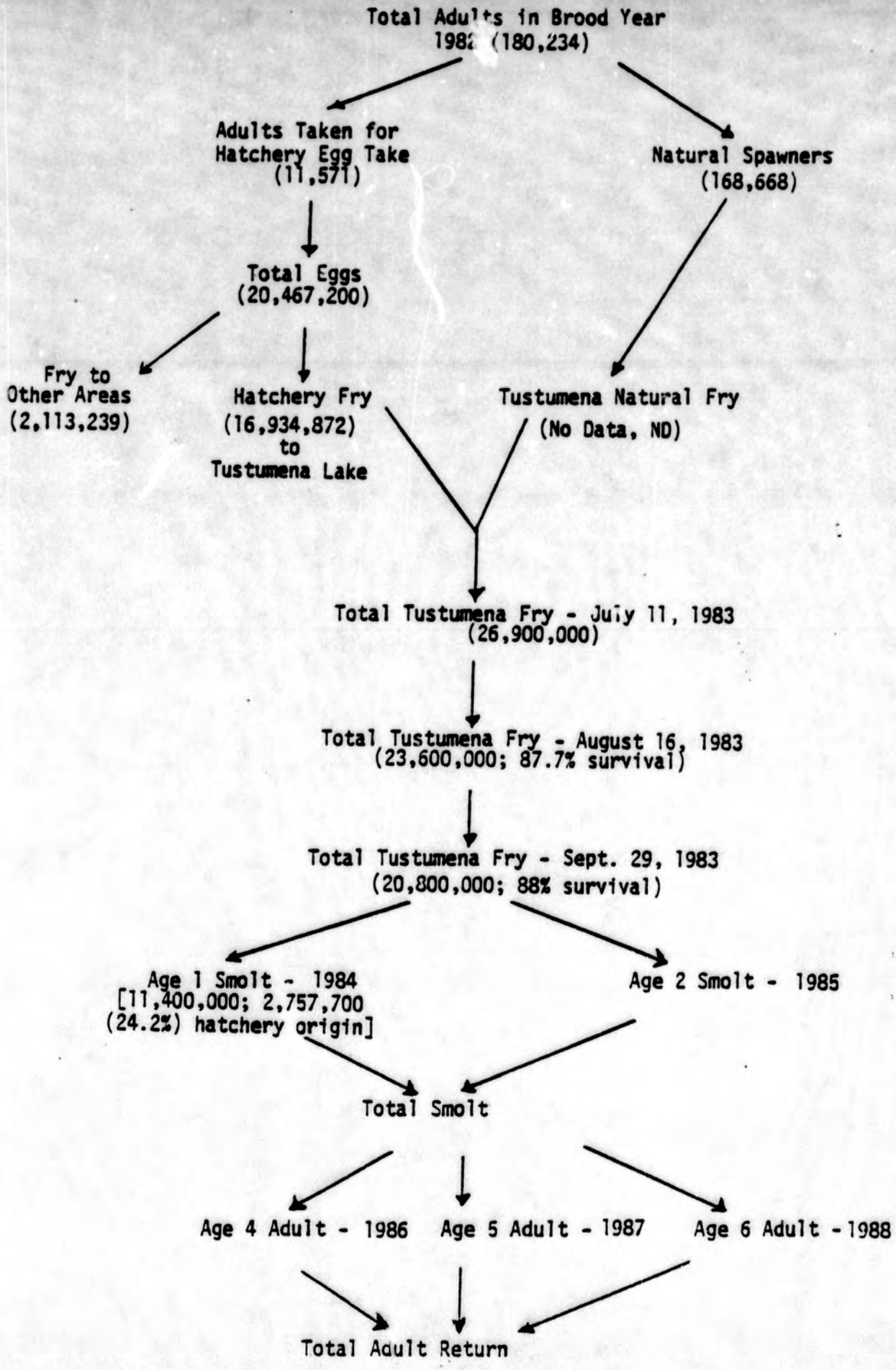

Figure 6. Production of sockeye salmon in the Tustumena Lake system, Alaska, by life history stage, brood year

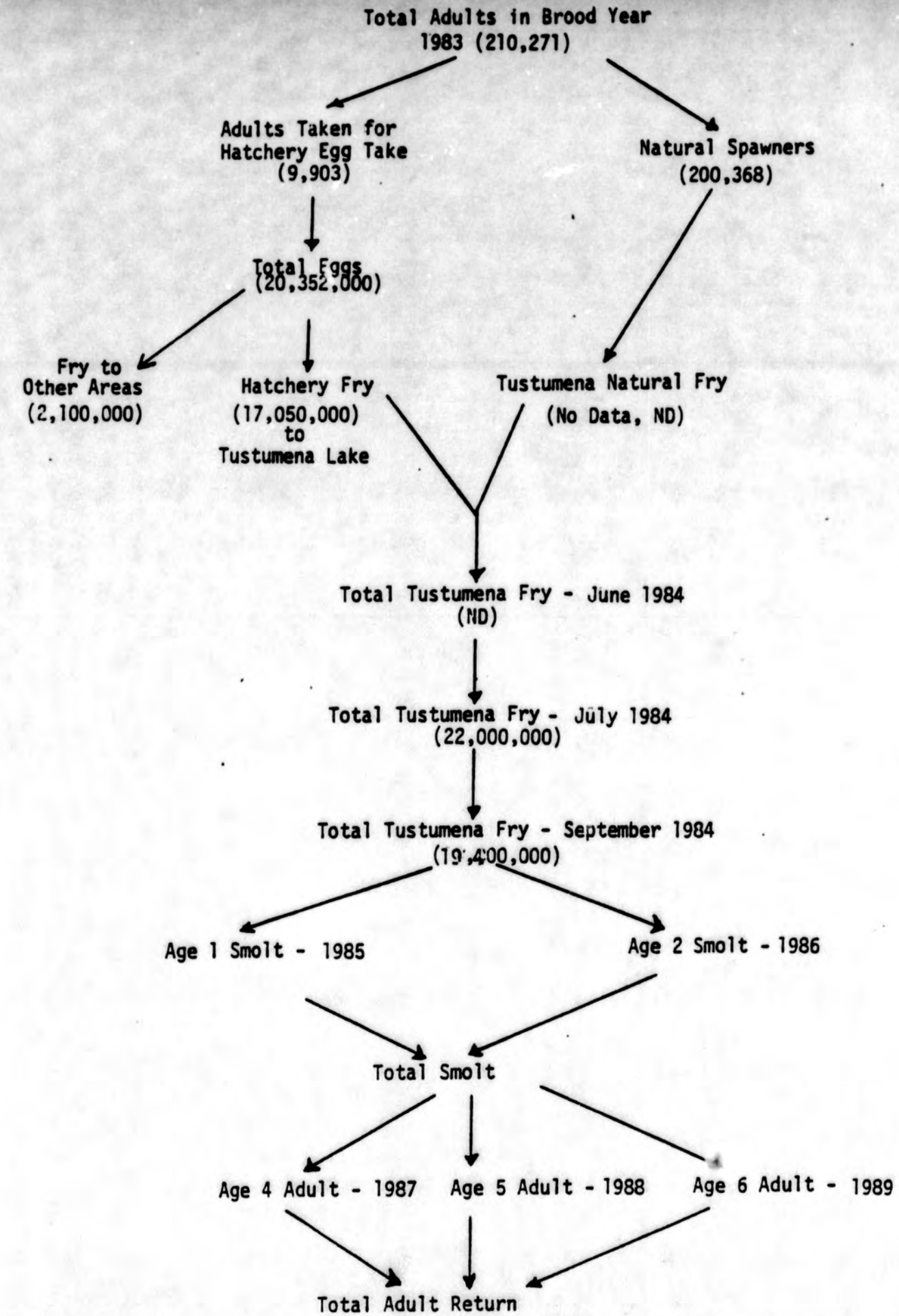

Figure 7. Production of sockeye salmon in the Tustumena Lake system, Alaska, by life history stage, brood year .

1984:

The pattern of relatively large escapements of sockeye salmon to the Kasilof River system continued in 1984. A total of 231,685 adult sockeye, the second largest escapment on record, entered the river in 1984 (Table 4). Of these, 10,861 fish were used for egg take. A total of 20.4 million eggs were taken.

Sockeye Salmon Growth

Comparison of the size of hatchery versus natural sockeye salmon fry in June 1984 followed the same trend as observed in previous years. Data indicated that hatchery fry from Bear Creek and Glacier Flat Creek stocks weighed 0.22 g (Table 5). In contrast, naturally produced fry weighed 0.16 g or 76% of the weight of hatchery reared fry. Mean weight for age 0.0 and 1.0 sockeye salmon collected in Tustumena Lake in September 1984 were 3.2 and 5.0 g, respectively (Table 6). Mean weights of age 0.0 sockeye salmon captured during September tow netting have ranged from 1.6 g to 3.7 g (Figure 8). For age 1.0 sockeye salmon, the mean weights have ranged from 3.8 to 10.0 g (Figure 9). Length of age 0.0 and 1.0 sockeye salmon in September 1984 were 66.2 and 76.1 mm, respectively. Mean lengths of age 0.0 sockeye salmon captured during September tow netting have ranged from 54.1 mm to 66.2 mm (Figure 8). For age 1.0 sockeye salmon, the mean lengths have ranged from 73.2 mm to 86.0 mm (Figure 9).

Size of sockeye salmon smolt, collected from the Kasilof River drainage, have varied little during the previous four years (Figures 10 and 11).

Table 4. Kasilof River sockeye salmon escapement summary, 1968-1984.

Year	Sonar Count[1/]	Fish Used for Artificial Propagation of Tustumena Lake	Sonar Count Less Egg Take[3/]
1968	89,000		
1969	46,000		
1970	38,000		
1971	--		
1972	113,000		
1973	40,000		
1974	70,000	205[2/]	69,795
1975	48,000	3,365[2/]	44,635
1976	139,000	5,463[2/]	133,537
1977	155,300	1,794[2/]	153,506
1978	116,600	6,681[2/]	109,919
1979	152,179	3,024[2/]	149,155
1980	187,154	6,030[2/]	181,124
1981	256,625	9,700[4/]	246,619
1982	180,239	11,571[4/]	168,668
1983	210,271	9,903[4/]	200,368
1984	231,685	11,141[4/]	220,544

1/ Multiple transducer sonar counts rounded to the nearest thousand (1968-1977) from Namtvedt et al. (1979). Side scan sonar counts (1978-1981) from Tarbox et al. (1983).
2/ From Cross et al. (1983).
3/ Considered estimate of natural spawners above sonar site.
4/ Waite, personal communication.

Table 5. Size of Crooked Creek Hatchery reared sockeye salmon fry at time of release compared to natural fry size in Tustumena Lake, Alaska, 1979-1984.

Brood year	Release date	Stock	Weight (g)	Fork length (mm)
1979	12-13 June 1980	Bear Creek	.22	29
		Glacier Flat	.22	29
	12 June 1980	Natural	.14	28
1980	16-18 June 1981	Bear Creek	.21	29
		Glacier Flat	.21	29
	4 June 1981	Natural	.15	28
1981	14-18 June 1982	Bear Creek	.21	28
		Glacier Flat	.21	28
		Natural	N.A.	N.A.
1982	13-17 June 1983	Bear Creek	.22	29
		Glacier Flat	.20	28
		Natural	.16	27
1983	18-21 June 1984	Bear Creek	.22	29
		Glacier Flat	.23	30
		Natural[1]	.16	27

[1]Only 6 fish collected from Glacier Flat Creek.

Table 6. Sizes of sockeye salmon fry collected from Tustumena Lake tow netting, 1984.

	Age 0		Age 1	
	07/23-08/14	09/18-10/04	07/23-08/17	09/18-10/04
Sample size	413	388	287	186
Mean length (mm)	49.28	60.68	74.03	78.03
(S.D.)	(6.81)	(4.58)	(3.37)	(3.70)
Mean weight (g)	1.48	2.47	4.66	5.28
(S.D.)	(0.69)	(0.56)	(0.79)	(0.77)

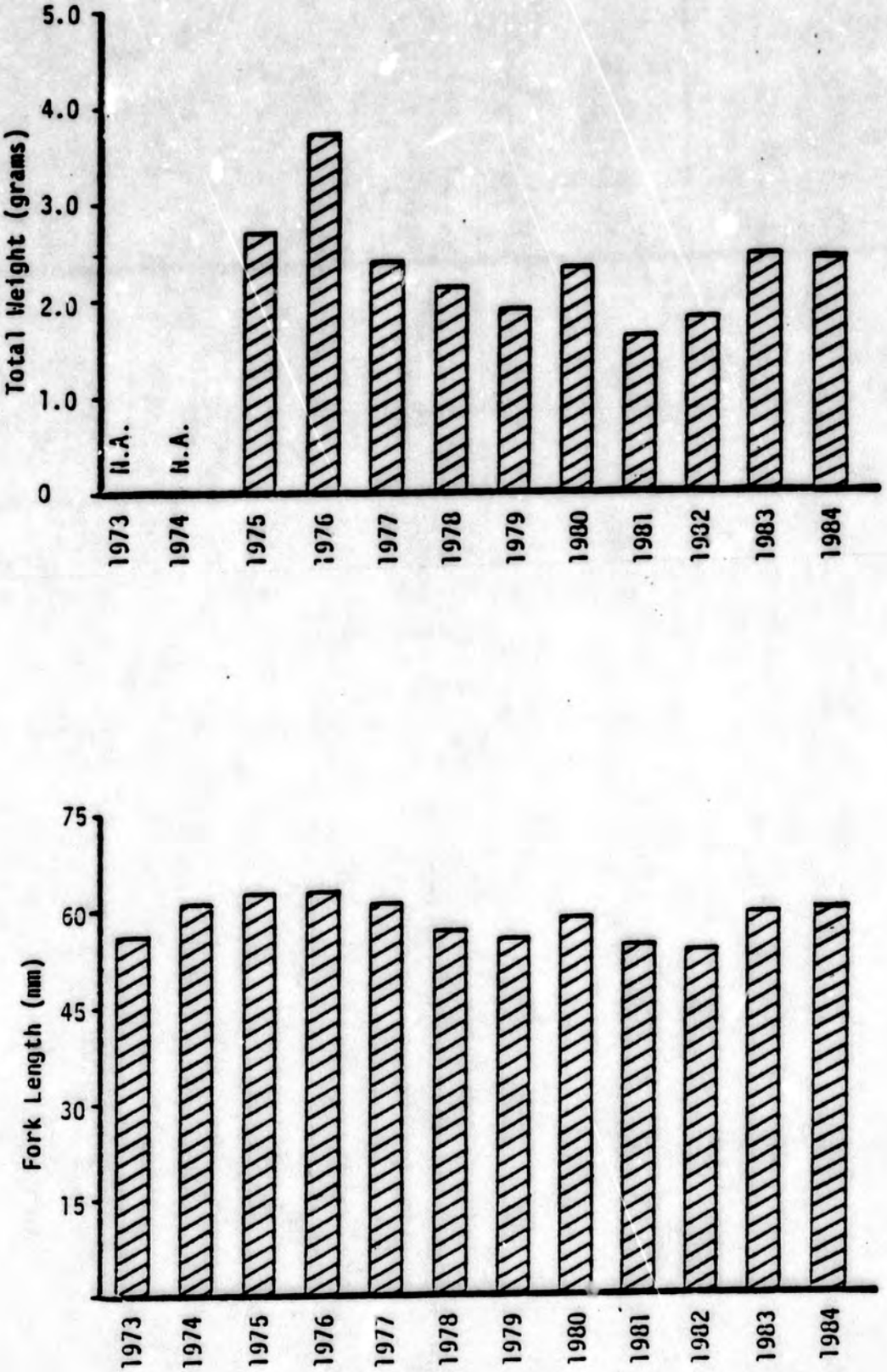

Figure 8. Length and weight of Age 0.0 sockeye salmon in Tustumena Lake, Alaska, 1973-1984 (September sampling via tow net).

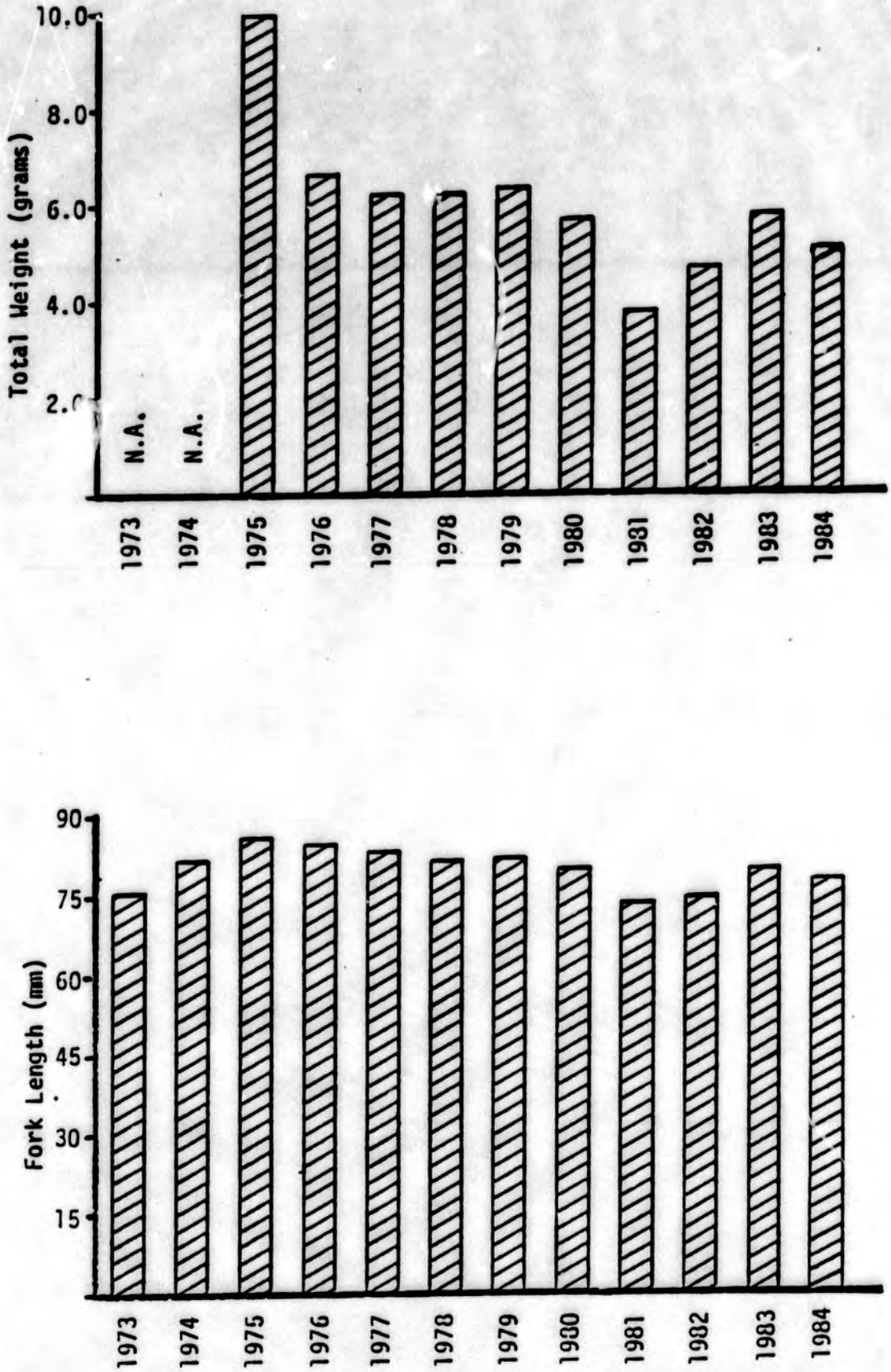

Figure 9. Length and weight of Age 1.0 sockeye salmon in Tustumena Lake, Alaska, 1973-1984 (September sampling via tow net).

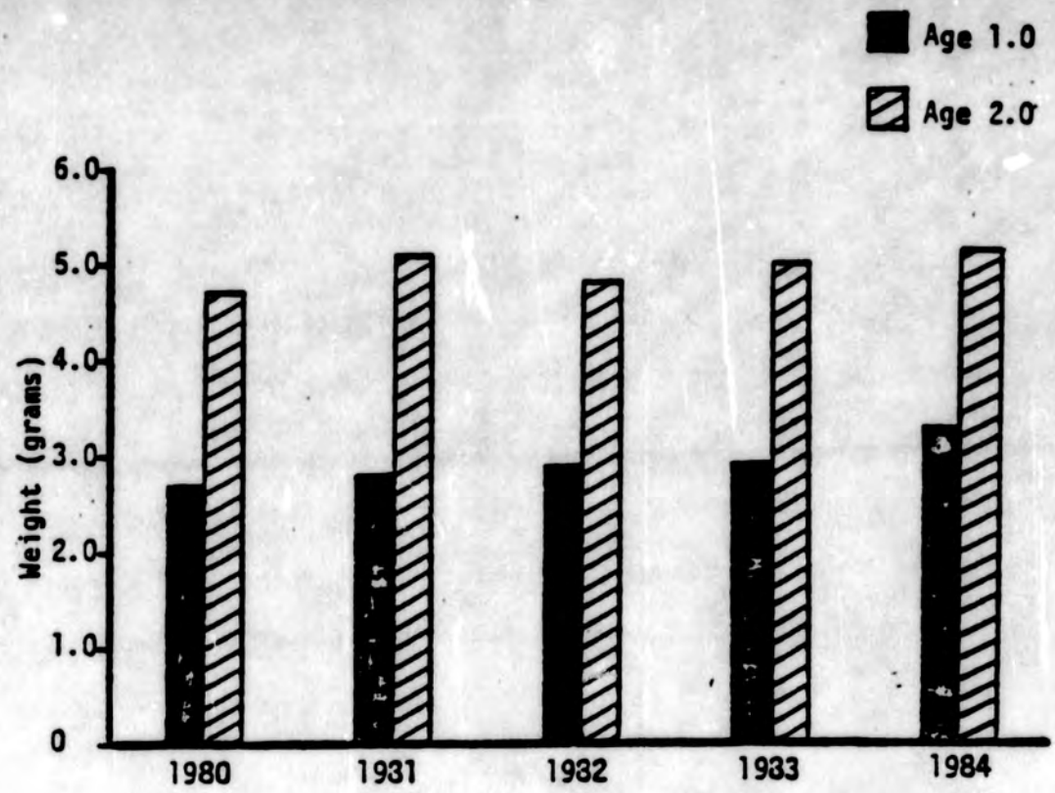

Figure 10. Mean weight (grams) of Age 1.0 and Age 2.0 sockeye salmon smolt in Kasilof River, Alaska, sampling years 1980-1984.

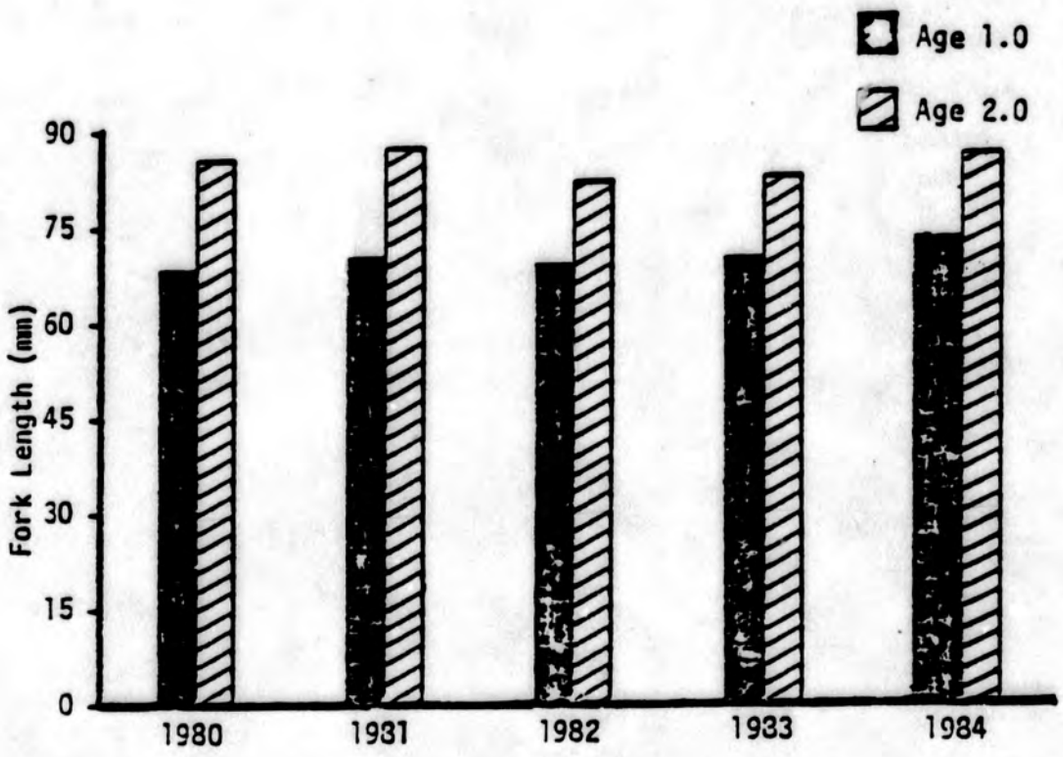

Figure 11. Mean fork length of Age 1.0 and Age 2.0 sockeye salmon smolt in Kasilof River, Alaska, sampling years 1980-1984.

In 1984, age 1.0 and 2.0 sockeye salmon weighed 3.3 and 5.2 g, respectively. Mean fork lengths were 72.7 and 84.5 mm for the same age classes.

Comparison of adult sockeye salmon length data collected during 1976-1984 indicated very little year to year variation within age class or by sex (Table 7). The average lengths for age 1.2 fish in 1984 were 480 mm for males and 478 mm for females. For age 1.3 fish average lengths were 539 mm for males and 533 mm for females. Weights of the major age classes of sockeye salmon collected in 1984 are presented in Table 8. Average weights for male 1.2 and 1.3 were 1.86 and 2.67 kg, respectively.

Sockeye Salmon Age Composition

Within Tustumena Lake, age 0.0 sockeye salmon have comprised greater than 90% of the September tow net catches since 1976. However, in 1973, 1974 and 1975, this age class accounted for 49%, 62%, and 86% of the catch, respectively. Age 1.0 sockeye salmon constitute the remainder of the tow net catches. In 1984, age 0.0 sockeye salmon comprised 91.4% of the tow net catches (Figure 12). However, it should be noted that tow nets may be selective against age 1.0 sockeye salmon and, therefore, the percentage of this class may be low (Thorne and Thomas 1982).

Examination of data on sockeye salmon smolt age composition indicates that 80% of the smolt migrating in 1984 were age 1.0 and 20% were age 2.0. This age composition was similar to previous years, especially the 1981 and 1982 smolt years (Figure 13). Examination of smolt production by brood

Table 7. Length composition of the major age classes of sockeye salmon collected in the Kasilof River, 1976-1984.

Year	Age Class	Male			Female			Total			Ratio Male-Female
		Average Length (mm) 1/	Standard Error	Sample Size	Average Length (mm) 1/	Standard Error	Sample Size	Average Length (mm) 1/	Standard Error	Sample Size	
1976	1.2	486	3.9	26	472	10.9	40	478	--	66	0.7:1
1978		--	--	69	--	--	70	501	3.1	139	1.0:1
1979		489	2.0	175	487	2.0	139	488	1.5	314	1.3:1
1980		474	2.4	189	464	1.2	376	467	--	565	0.5:1
1981		503	2.0	241	492	2.5	146	499	--	387	1.7:1
1982		481	2.2	285	466	1.8	235	474	2.0	475	1.2:1
1983		493	1.9	113	491	2.5	78	492	1.5	191	1.4:1
1984		480	1.2	544	478	1.1	428	479	0.8	972	2.6:1
1976	1.3	528	13.4	5	547	7.5	4	536	--	9	1.3:1
1978		--	--	47	--	--	55	554	2.4	102	0.9:1
1979		578	3.2	82	562	3.3	99	569	2.4	181	0.8:1
1980		531	6.8	35	516	2.4	115	520	--	150	0.3:1
1981		566	1.2	422	558	1.4	369	562	--	791	1.1:1
1982		549	1.4	377	542	1.1	428	545	1.2	805	0.9:1
1983		558	1.9	170	547	1.9	187	552	1.3	357	0.9:1
1984		539	1.4	304	533	1.3	383	535	0.9	687	0.8:1

1/ Lengths are mid-eye to fork of tail (ME-FT).

Table 7, continued. Length composition of the major age classes of sockeye salmon collected in the Kasilof River, 1976-1984.

Year	Age Class	Male			Female			Total			Ratio Male-Female
		Average Length (mm) 1/	Standard Error	Sample Size	Average Length (mm)	Standard Error	Sample Size	Average Length (mm)	Standard Error	Sample Size	
1976	2.2	485	6.1	12	487	3.1	34	486	--	46	0.4:1
1982		479	3.2	65	472	2.7	81	475	2.9	146	0.8:1
1984		484	1.8	202	482	1.4	223	483	1.1	425	0.9:1
1982	2.3	548	4.3	41	543	3.8	40	546	4.1	86	1.0:1
1984		533	2.6	102	526	3.0	80	530	2.0	182	1.3:1

1/ Lengths measured from mid-eye to fork of tail.

Table 8. Weight composition of the major age classes of sockeye salmon collected in the Kasilof River, 1981-1984.

Year	Age Class	Male			Female			Total		
		Average Weight (kg)	Standard Error	Sample Size	Average Weight (kg)	Standard Error	Sample Size	Average Weight (kg)	Standard Error	Sample Size
1981	1.2	2.2	0.05	241	1.9	0.03	146	2.1	--	387
1982		1.8	0.03	235	1.5	0.02	240	1.7	0.03	475
1983		2.04	0.06	113	1.84	0.03	78	1.96	0.04	191
1984		1.86	0.03	101	1.81	0.04	39	1.85	0.02	140
1981	1.3	3.0	0.04	422	2.9	0.03	369	3.0	--	791
1982		2.7	0.02	377	2.44	0.02	428	2.56	0.02	805
1983		2.78	0.03	168	2.47	0.02	187	2.62	0.02	355
1984		2.67	0.03	146	2.53	0.03	182	2.59	0.02	328
1981	2.2	2.3	0.08	40	2.0	0.07	33	2.2	--	73
1982		1.7	0.05	65	1.6	0.04	81	1.7	0.04	146
1984		2.07	0.10	31	1.79	0.05	27	1.95	0.06	58
1982	2.3	2.6	0.07	41	2.3	0.5	34	2.5	0.06	75
1984		2.72	0.10	32	2.63	0.14	31	2.68	0.09	63

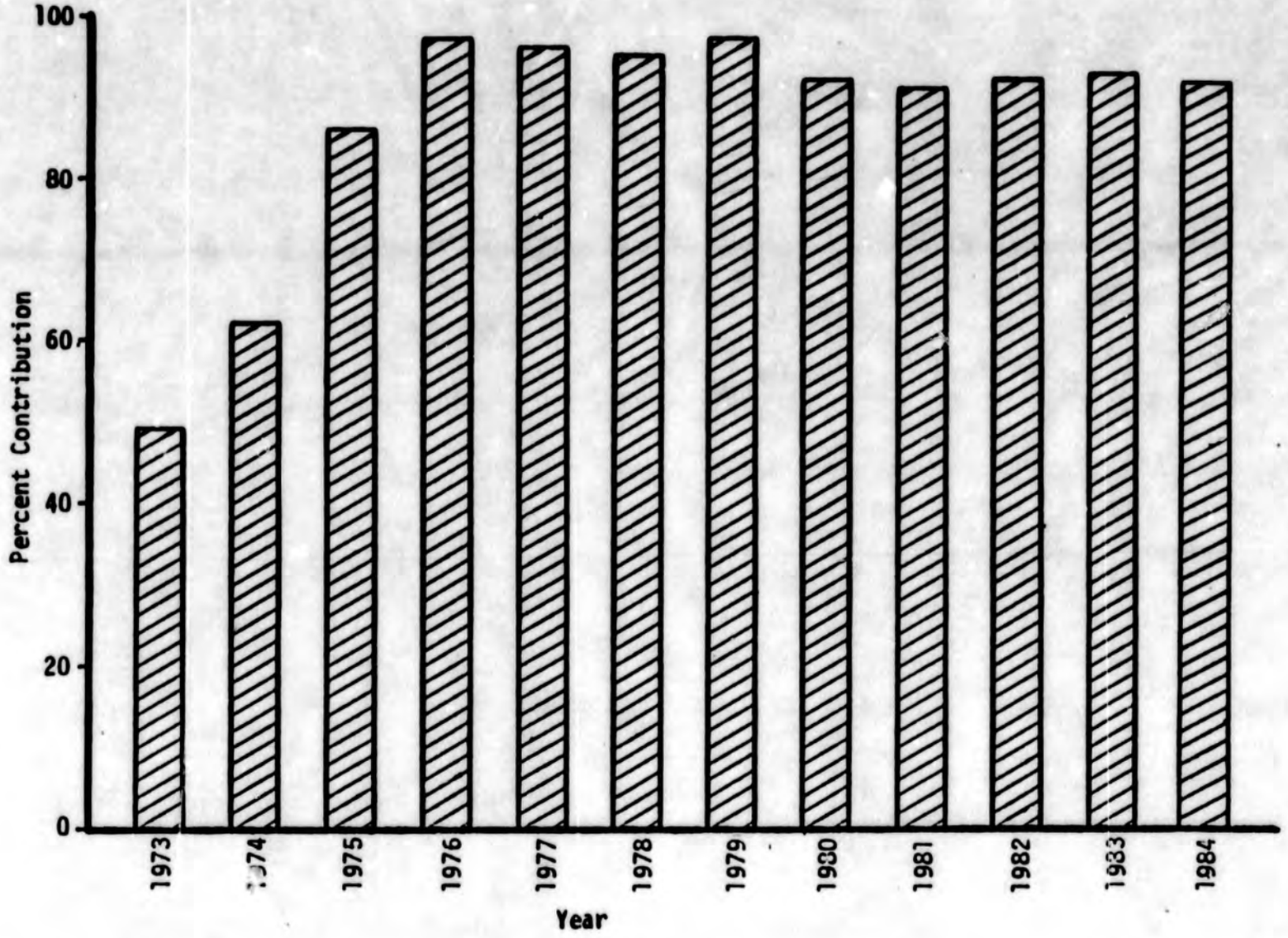

Figure 12. Percent contribution of Age 0.0 sockeye salmon in September tow net survey of Tustumena Lake, Alaska, 1973-1984.

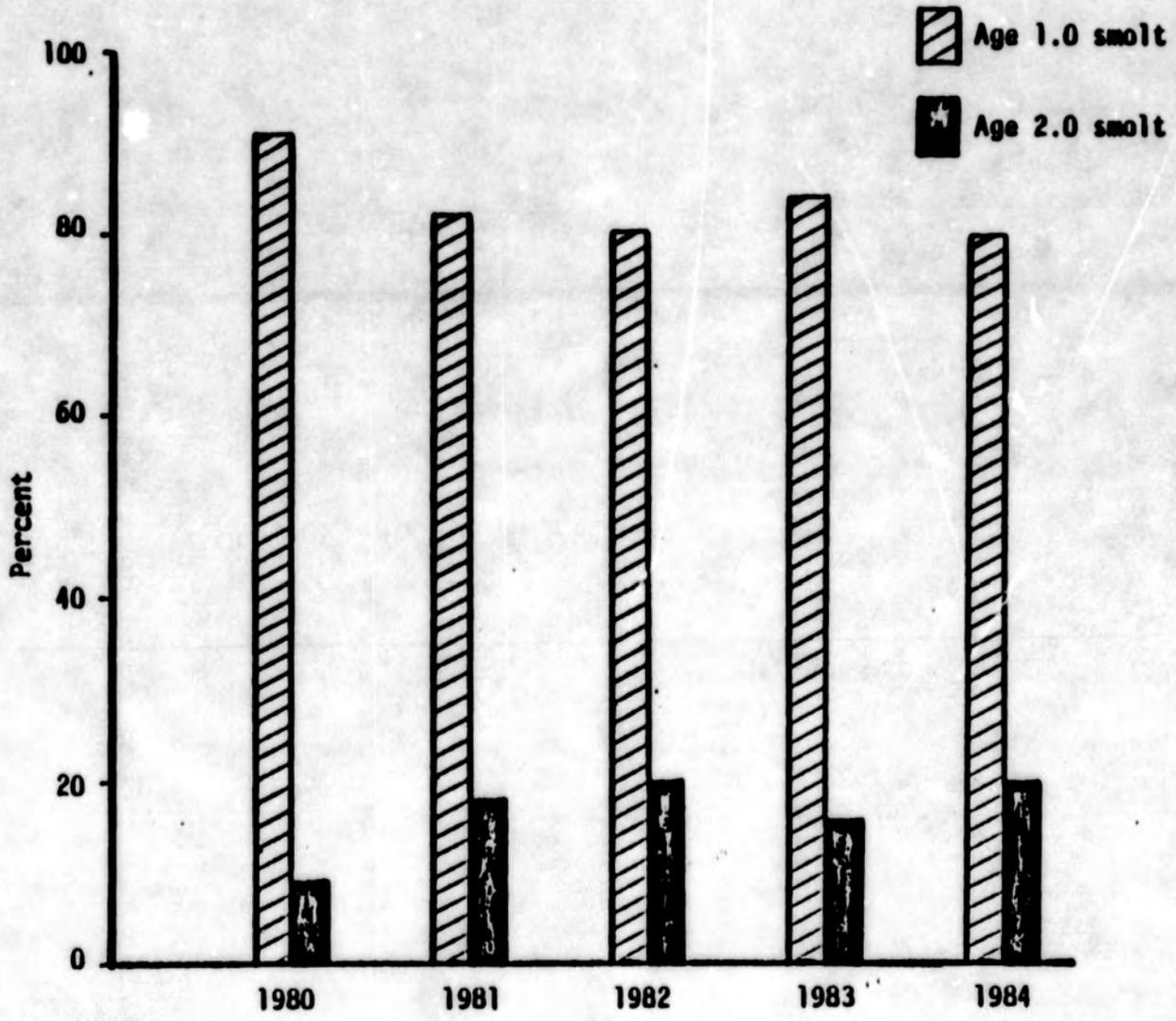

Figure 13. Percent age composition of sockeye salmon smolt in the Kasilof River, Alaska, 1980-1984.

year.indicated that 31%, 34%, 24%, and 30% of the total smolt produced by the 1978, 1979, 1980, and 1981 brood years, respectively, are age 2.0 fish.

There appears to be a difference in age composition between hatchery and naturally produced sockeye fry by brood year. Hatchery reared sockeye from the 1979, 1980, and 1981 brood years smolted at a ratio of 17.1:1, 4.3:1, and 4.7:1, age 1.0 to age 2.0, respectively. In contrast, naturally produced sockeye smolted at a ratio of 1.6:1.0, 2.1:1, and 2.0:1 for the same years, respectively. These differences may be due to the fact that all hatchery released fry enter the lake in mid-June while wild fry input occurs over a broader range of time. Also, hatchery fry at time of release tend to be slightly larger than wild fry (Table 5).

Five-year old sockeye salmon have been the predominant or codominant age class in the total adult return since 1968. Age 1.3 fish comprise the greatest percentage of the returns in 50% of the years; age 2.2 in 25% of the years; and age 1.2 in 25% of the years. In 1984, age 1.2 fish comprised 48.7% of the escapement (Table 9).

Spawning Ground Distribution of Sockeye Salmon

The distribution of spawning adults between the tributary streams has varied considerably during the period of record (Table 10). Bear Creek, a significant sockeye salmon spawning area, has accounted for 33.6% to 73.1% of index area counts since 1975. Nikolai Creek contribution has ranged from 5.1% in 1984 to 34.3% in 1978. Glacier Flats and Moose Creeks have

Table 9. Age composition of sockeye salmon collected in the Kasilof River, 1969-1984.[1]

Sample Period	Percentage by age group								Sample Size
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	Other	
6/18 - 7/04/84		27.3	48.3			12.7	11.7		945
7/05 - 7/15/84		42.3	28.1			21.4	8.0		477
7/16 - 7/18/84		53.3	12.7			29.2	4.8		520
7/19 - 7/25/84		71.9	9.2			15.6	2.7		327
Seasonal Summary									
1969		14.0	39.0	1.0		30.0	16.0		399
1970	tr	32.0	37.0	2.0		16.0	11.0	1.0	297
1971		6.0	69.0			8.0	16.0		153
1972	tr	42.0	36.0	1.0	tr	3.0	18.0	tr	668
1973		20.0	57.0			19.0	4.0		374
1974		35.0	59.0		tr	4.0	2.0		254
1975	1.0	29.0	7.0			53.0	4.0	1.0	931
1976	tr	32.0	20.0		tr	35.0	12.0		755
1977	tr	30.0	30.0		1.0	28.0	11.0		1,209
1978		42.0	35.0			14.0	9.0		967
1979[1]		52.2	37.2		tr	8.4	1.7	tr	590
1980[1]		58.7	27.8			8.0	4.5	1.0	899
1981[1]		30.2	62.2			6.0	1.6		1,479
1982[1]	1.0	34.0	49.5		0.1	10.7	4.7	0.1	1,518
1983[1]		48.4	34.3			12.8	4.5		1,997
1984[1]		48.7	24.6	tr	0.2	19.7	6.8		2,269

1/ Percentages weighted by total numbers in escapement.

Table 10. Distribution (percent)[1] of sockeye salmon in the major index tributary systems of Tustumena Lake. 1975-1984.

Year	Nikolai	Moose	Bear	Glacier Flats	Other
1975	10.2	5.9	49.9	25.9	8.1
1976	13.8	16.2	59.8	8.2	2.0
1977	25.8	14.7	51.5	5.1	2.9
1978	34.3	15.9	43.5	4.7	1.6
1979	27.1	11.5	51.0	7.9	2.5
1980	5.8	9.1	73.1	9.0	3.0
1981	21.0	7.6	43.8	23.3	4.3
1982	15.8	12.6	48.2	16.3	7.1
1983	12.0	13.5	43.4	27.1	4.0
1984	5.1	8.6	33.6	47.1	5.6

[1]Percent of total index count.

exhibited similar variations. In 1984, 33.6% of the peak escapement counts was recorded in Bear Creek, 47.1% in Glacier Flats, 8.6% in Moose Creek, 5.1% in Nikolai Creek, and the remainder in minor systems. Actual peak escapement counts are presented in Table 11.

Adult Run Timing

Daily escapement and seasonal entry pattern of sockeye salmon varied considerably during the period 1968-1984. The midpoint (50 percent date) of the run varied from 2 July in 1969 to 23 July in 1972, and averaged 13 July. In 1984, the mid point of the run was 15 July and the run duration was typical of previous years (Table 12).

Spawning ground tag recovery data collected in 1984 are summarized on Figure 14. When the number of tags recovered in each tributary was expressed as a percentage of the total recovered and grouped into tagging periods, some general trends were noted (tag recovery effort was variable due to weirs on Bear and Glacier Flats Creeks). It appears that individual tributary returns generally overlap in timing at the sonar site, but peaks may vary slightly with a sequence of Nikolai, Bear, and Glacier Flats Creeks as the season progresses.

Tag recovery data in 1984 were also analyzed for mean residence time of fish in the lake bound for Bear and Glacier Flats Creeks (Table 13). There was a trend of shorter residence time for fish entering the river as the season progressed. For example, Bear Creek sockeye salmon tagged 10 June-6 July averaged 33.4 days between the sonar site and weir while those fish

Table 11. Peak sockeye salmon escapement counts in seven index areas, Kasilof River drainage, 1975-1984[1].

Year	Nikolai	Crystal	Clear	System Flats	Seepage	Moose	Bear	Total index count
1975	5,700	400	300	14,400	3,700	3,300	27,700	55,500
1976	12,000	800	300	7,100	800	14,000	51,800	86,800
1977	29,100	600	1,800	5,800	800	16,600	58,000	112,700
1978	34,200	200	200	4,700	1,100	15,900	43,400	99,700
1979	19,100	500	400	5,600	800	8,100	35,900	70,400
1980	10,000	1,000	2,100	15,500[2]	1,800	15,600	125,000[2]	171,400
1981	36,000	860	2,978	40,071[2]	3,376	12,968	75,117[2]	171,400
1982	16,800	1,785	4,183	17,348[2]	1,638	13,400	51,350[2]	106,500
1983	17,100	1,657	860	38,776[2]	3,305	19,245	61,957[2]	142,900
1984	8,300	140	2,600	76,200[2]	6,250	14,000	54,300	161,800

[1]Counts standardized to common unit for years entire stream was not surveyed. Relative abundance per section (when entire stream system surveyed) was used to extrapolate for years when only a portion of stream was surveyed. Numbers rounded to nearest hundred fish.
[2]FRED Division weir count.

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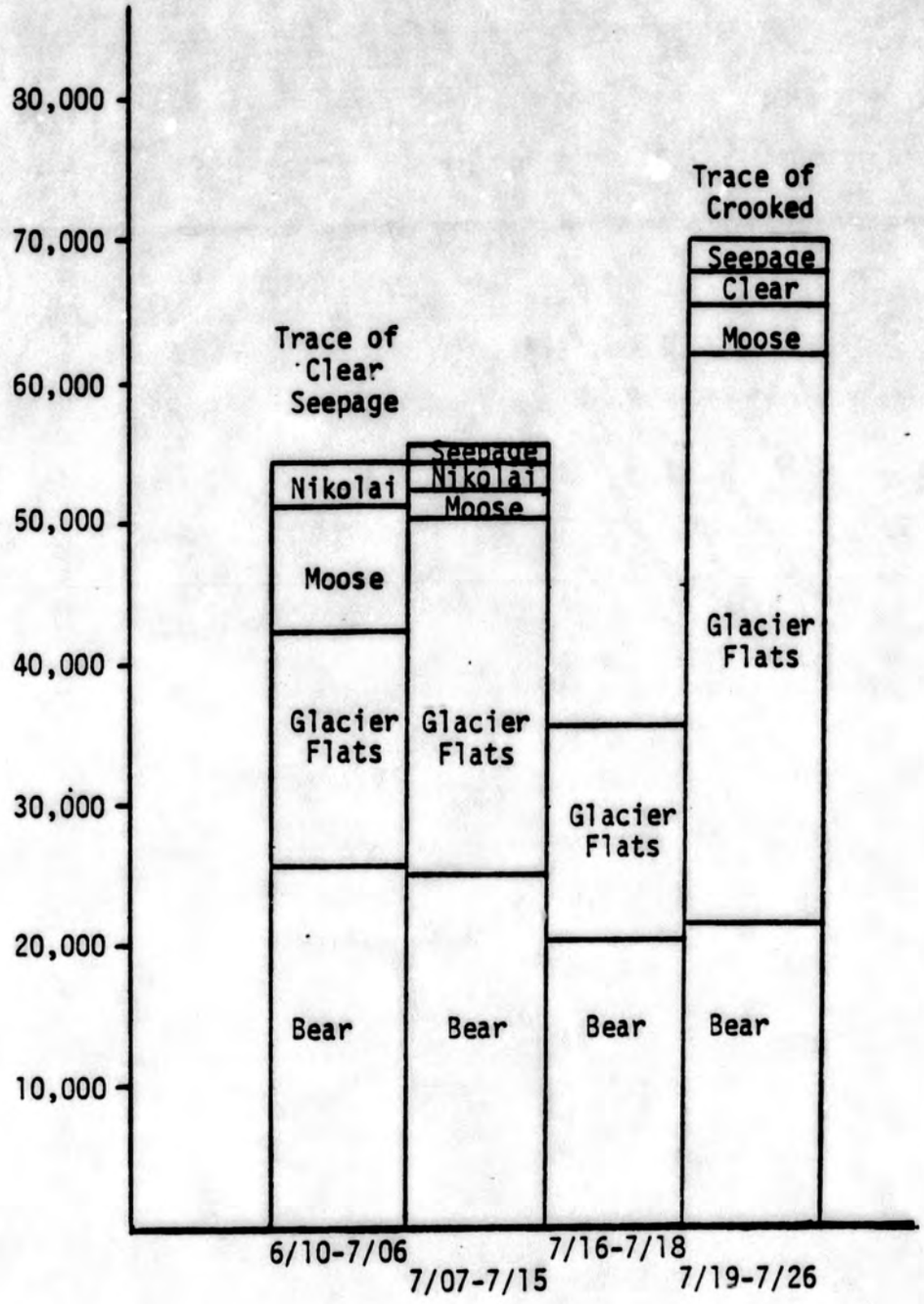

Figure 14. Percent of total tags recovered by spawning area (grouped by date of tagging at the Kasilof River sonar site) expressed in the number of fish enumerated by sonar during each tagging period. Note: a small proportion of tags were recovered in spawning areas outside of Tustumena Lake. (1984)

Table 12. Date of cumulative percent of sockeye salmon counts recorded in the Kasilof River, 1968-1984.

Year	Date by 10% Interval									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
1968	7/04	7/06	7/08	7/11	7/12	7/14	7/17	7/20	7/23	7/31
1969	6/25	6/25	6/30	7/02	7/02	7/06	7/11	7/18	7/25	8/09
1970	6/27	7/03	7/07	7/09	7/12	7/14	7/17	7/23	7/27	8/06
1972	7/15	7/21	7/22	7/22	7/23	7/23	7/24	7/24	7/25	8/03
1973	7/04	7/09	7/11	7/13	7/15	7/18	7/20	7/23	7/26	8/05
1974	7/04	7/05	7/06	7/08	7/11	7/13	7/17	7/23	7/28	8/07
1975	7/05	7/07	7/09	7/13	7/16	7/19	7/21	7/24	7/28	8/07
1976	7/06	7/07	7/10	7/13	7/16	7/19	7/20	7/22	7/28	8/09
1977	7/04	7/08	7/11	7/12	7/14	7/15	7/17	7/20	7/25	8/04
1978	6/30	7/03	7/06	7/09	7/16	7/17	7/17	7/18	7/20	8/06
1979	6/28	7/02	7/05	7/07	7/12	7/15	7/19	7/23	7/27	8/14
1980	6/30	7/02	7/05	7/11	7/16	7/18	7/21	7/25	8/03	8/14
1981	6/18	6/24	6/28	7/01	7/04	7/07	7/10	7/14	7/20	2/
1982	7/03	7/13	7/16	7/17	7/19	7/20	7/21	7/27	3/	
1983	7/01	7/07	7/12	7/14	7/16	7/17	7/18	7/22	4/	
1984	6/29	7/05	7/08	7/10	7/15	7/17	7/19	7/21	7/24	7/31 5/

1/ Date on which percentage level equaled or exceeded.
2/ Estimated 2% of the escapement occurred after 31 July (end of enumeration period).
3/ Estimated 11% of the escapement occurred after 3 August (end of enumeration period).
4/ Estimated 12% of the escapement occurred after 31 July (end of enumeration period).
5/ Estimated 6% of the escapement occurred after 31 July (end of enumeration period).

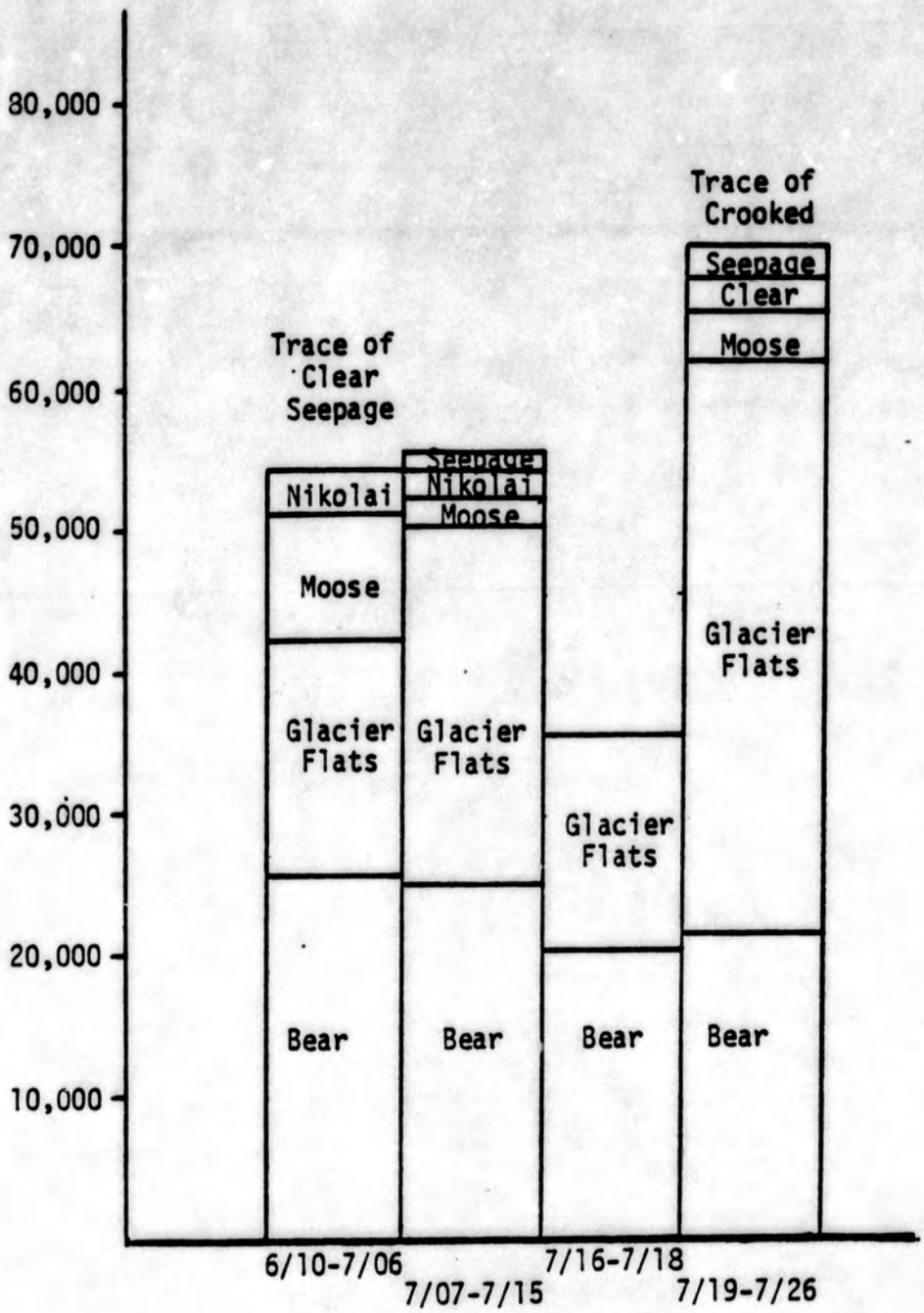

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Table 13. Mean residence time in Tustumena Lake of sockeye salmon bound for Glacier Flats and Bear Creek, 1982-1984.1/

Year	Tributary	Tagging Period	Tags Recovered	Mean Residence Time	Range
1982	Glacier Flats Creek	7/01-7/12	6	36.2	
		7/13-7/24	54	28.3	
		7/25-8/03	17	21.7	
1983		6/17-6/30	0	--	--
		7/01-7/12	9	32.1	24-41
		7/13-7/18	41	25.2	19-37
		7/19-7/27	13	19.4	7-28
1984		6/10-7/06	33	48.6	33-62
		7/07-7/15	76	37.9	24-48
		7/16-7/18	6	33.2	25-39
		7/19-7/26	60	26.5	15-37
1982	Bear Creek	6/19-6/30	3	32.3	
		7/01-7/12	26	25.7	
		7/13-7/24	154	21.7	
		7/25-8/03	8	18.5	
1983		6/17-6/30	26	34.8	31-40
		7/01-7/12	52	27.8	22-39
		7/13-7/18	30	23.3	14-30
		7/19-7/27	9	18.6	12-24
1984		6/10-7/06	55	33.4	23-51
		7/07-7/15	77	26.8	13-48
		7/16-7/18	8	22.9	12-33
		7/19-7/26	33	24.2	13-32

1/ Fish tagged at Kasilof River slackwater sonar site in 1982 and at Kasilof River Bridge sonar site in 1983 and 1984.

tagged between 19 July and 26 July had a mean residence time in the lake of 24.2 days. This is consistent with results observed in 1983.

Sockeye Salmon Fecundity

Since 1974, fecundity data has been gathered on Kasilof River sockeye salmon as part of the Crooked Creek Hatchery operation. A low of 2,857 eggs per female was recorded in 1974 from Glacier Flats Creek spawners while the high of 3,710 eggs per female was also of Glacier Flats Creek origin in 1977 (Table 14). Average fecundity for the system since 1974 is 3,308 eggs per female. Glacier Flats and Bear creek sockeye salmon had a fecundity of 3,164 and 2,994 eggs per female in 1984, respectively.

Table 14. Fecundity of sockeye salmon in the Tustumena Lake system, Alaska, as determined during eggs takes for the Crooked Creek Hatchery.

Brood year	Source	Fecudnity
1974	Glacier Flats Creek	2,857
1975	Glacier Flats Creek	3,499
1976	Glacier Flats Creek	3,134
	Bear Creek	3,095
	Seepage Creek	3,291
1977	Glacier Flats Creek	3,710
1978	Glacier Flats Creek	3,523
	Bear Creek	3,502
1979	Glacier Flats Creek	3,522
	Bear Creek	3,503
1980	Glacier Flats Creek	N.A.
	Bear Creek	N.A.
1981	Glacier Flats Creek	3,233
	Bear Creek	3,071
1982	Glacier Flats Creek	3,246
	Bear Creek	3,123
1983	Glacier Flats Creek	3,530
	Bear Creek	3,226
1984	Glacier Flats Creek	3,164
	Bear Creek	2,994

APPENDIX

Appendix A. Kasilof River smolt migration summary, 1980-1984.

Sample year	Total smolt migration (millions)	Percent age composition		Mean size of age 1.0 smolt		Percent hatchery contribution
		1.0	2.0	Length (mm)	Weight (g)	
1980	1.0	91	9	68	2.7	3
1981	2.3	82	18	70	2.8	13
1982	5.1	80	20	69	2.9	17
1983	8.3	84	16	70	2.9	25
1984	14.2	80	20	73	3.3	22

Appendix B. Tustumena Lake stream surveys, 1984.

Date	Stream	Total[2] observed	Clips	Numbers of fish			
				Dead	Bear killed	Live	Total
08/06	Moose	1,700	2 RV	996	577	13,003	13,999
08/29[1]	Moose	1,184	0	3,019	--	2,485	5,504
08/08	Crystal	71	0	3	3	138	141
08/21	Crystal	61	0	16	3	92	108
08/08	Clear	97	0	116	35	673	789
08/21	Clear	215	0	286	--	2,333	2,619
08/09	Seepage	0	0	2	84	1,657	1,743
08/21	Seepage	629	1 RV	1,719	--	4,531	6,250
08/30	Shantatalik	0	0	0	0	0	0
08/30	Canyon	4	0	0	4	0	4
08/30	Pipe	75	0	2	978	19	999
08/09	Nikolai	0	0	229	21	1,229	1,479
08/30	Nikolai	50	0	75	--	13	88

[1]Heavy flooding the previous week flushed live and dead fish out of creek into lake.
[2]Observed for fin clips.

Appendix C. Tustumena Lake, Glacier Flats Creek sockeye salmon weir escapement, egg take, and number number of ventral fin clips observed, 1984.

Date	Passed weir	Observed fin clips	Number fin clips LV	Number fin clips RV	Egg take Females	Egg take Males	Egg take Green females	Egg take Number[1] of eggs
08/07	Weir installed							
08/08	17,000[2]	0	--	--				
08/09	2,700	1,000	0	2				
08/10	1,000	1,000	0	1				
08/11	3,346	1,000	0	0				
08/12	2,700	2,700	0	3				
08/13	500	0	--	--				
08/14	500	0	--	--				
08/15	500	0	--	--				
08/16	2,500	0	--	--				
08/17	0	1,105	0	7	660	430	15	2,112,000
08/18	0	1,204	0	5	660	523	21	2,112,000
08/19	0	1,125	0	6	660	445	20	2,112,000
08/20	0	1,209	0	4	660	535	14	2,112,000
08/21	9,615	1,000	0	1	540	450	10	1,728,000
08/22	5,782	0	--	--				
08/23	4,588	116	0	0				
08/24	2,365	408	0	3				
08/25	5,610	0	--	--				
08/26	2,279	0	--	--				
08/27	1,464	0	--	--				
08/28	1,635	855	0	2				
08/29	4,200[3]	232	0	2				
	68,284	12,954	0	36	3,180	2,383	80	10,176,000

[1]Number of eggs based on average of 3,200 eggs per female.
[2]Surveyed from above weir on August 08.
[3]Estimated when weir was removed.

Appendix D. Tustumena Lake, Bear Creek sockeye salmon weir escapement, egg take, and number of ventral fin clips observed, 1984.

Date	Passed weir	Observed for ventral fin clips	Number fin clips		Egg take			
			LV	RV	Females	Males	Green females	Number[1] of eggs
07/27	Weir installed							
07/28	2,000[2]	0	--	--				
07/29	646	500	0	0				
07/30	3,736	500	0	0				
07/31	1,000	1,000	1	0				
08/01	3,214	1,000	0	0				
08/02	2,968	1,000	2	0				
08/03	1,000	1,000	2	0				
08/04	3,343	1,000	1	0				
08/05	2,002	1,000	2	0				
08/06	2,850	1,000	3	0				
08/07	1,500	500	4	1				
08/08	2,500	1,000	5	0				
08/09	708	708	5	0				
08/10	0	0	--	--				
08/11	0	639	6	1	337	282	20	1,078,400
08/12	0	785	11	0	450	300	35	1,440,000
08/13	0	1,011	3	1	660	315	36	2,112,000
08/14	0	1,096	7	0	630	450	46	2,016,000
08/15	0	1,141	7	0	660	440	41	2,112,000
08/16	1,522	796	9	1	450	324	22	1,440,000
08/17	9,507	500	2	0				
08/18	4,850	500	2	1				
08/19	0	0	--	--				
08/20	4,188	0	--	--				
08/21	4,773	19	--	--				
08/22	700[3]	0	--	--				
	44,523	16,695	72	5	3,187	2,111	200	10,198,400

[1]Number of eggs based on average of 3,200 eggs per female.
[2]Aerial survey above weir on July 28.
[3]Estimated when weir was removed.

Appendix E. Tustumena Lake tow net results, 23 July to 14 August 1984 survey.

Date	Tow number	Transect number	Time	Depth	Number of sockeye Age 0	Number of sockeye Age 1	Marks Age 0	Marks Age 1	Other
07/23	1	--	11:05	S	88	16		1 RV	2 pink fry, 2 coho fry
	2	--	12:00	S	136	40			White fish larvae
	3	--	13:18	S	94	27			White fish larvae
	4	--	14:15	S	176	40			1 pink fry
07/24	5	--	10:14	S	156	10			
	6	--	11:50	S	260	23	1 AFC		
	7	--	13:25	S	229	39	1 RV		
07/25	8	--	12:05	S	141	5	1 AFC		
	9	--	13:24	S	200	7	1 RV, 1 AFC		1 lake trout
	10	--	15:15	S	46	13			
07/26	11	--	14:39	S	146	24	1 AFC		
07/27	12	--	12:02	S	225	32			
	13	--	14:09	S	64	11			
07/30	1 A	8	20:00	2 F	39	4			
	2 A	7	21:53	2 F	36	2			
	3 A	6	22:55	4 F	44	2			
	4 A	5	23:59	2 F	34	1			
07/31	5 A	5	00:34	6 F	50	1			
	6 A	4	01:51	4 F	20	1			
	7 A	3	02:37	2 F	20	2			
	8 A	2	03:41	2 F	54	6			
	9 A	2	04:12	6 F	37	0			
	10 A	1	05:25	2 F	68	2			
	11 A	1	19:55	6 F	21	1			
	12 A	2	21:00	S	49	6			1 coho smolt

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Appendix E continued. Tustumena Lake tow net results, 23 July to 14 August 1984 survey.

Date	Tow number	Transect number	Time	Depth	Number of sockeye Age 0	Number of sockeye Age 1	Marks Age 0	Marks Age 0	Other
07/31	13 A	2	21:40	4 F	89	6	1 RV		
	14	2	22:20	2 F	79	10	1 AFC		
	15	3	21:21	S	12	1			1 adult sockeye
08/01	16	3	00:05	4 F	54	2			
	17	4	03:19	S	23	5			
	18	4	03:59	4 F	12	6			
	19	4	04:43	2 F	19	9	1 AFC		2 sculpin
	20	5	05:28	2 F	33	9			1 sculpin
	21	5	05:58	S	57	12	1 AFC		
	22	7	07:07	S	102	36			
	23 A	7	07:47	6 F	16	1			16 sculpin
	23 B	--	20:00	S	10	1			
	24 BL	--	21:21	S	34	5			
	25 BL	--	21:52	2 F	32	0			
	26 BL	--	22:22	6 F	10	1			
	27 BN	--	23:19	S	22	3			
	28 BN	--	23:46	2 F	40	2			
08/02	29 BN	--	00:16	6 F	26	3			
	30 DN	--	02:23	S	29	2			
	31 DN	--	02:55	2 F	27	5			
	32 DN	--	03:35	6 F	28	0			
	33 DL	--	04:08	S	36	1			
	34 DL	--	04:41	2 F	40	2			
	35 DL	--	05:20	6 F	35	4	1 LV		
	36 CL	--	21:19	S	4	2			
	37 CL	--	21:48	2 F	3	4			
	38 CL	--	22:21	6 F	4	0			
	39 CN	--	23:14	S	4	0			
	40 CN	--	23:43	2 F	4	2			

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Appendix E continued. Tustumena Lake tow net results, 23 July to 14 August 1984 survey.

Date	Tow number	Transect number	Time	Depth	Number of sockeye Age 0	Number of sockeye Age 1	Marks Age 0	Marks Age 0	Other
08/03	41 CN	--	00:14	6 F	5	1			
	42 AN	--	01:47	S	4	0			
	43 AN	--	02:22	2 F	16	2			
	44 AN	--	02:55	6 F	41	2	1 RV		4 sculpin
	45 AL	--	04:34	S	14	2	1 AFC		1 sculpin
	46 AL	--	05:09	2 F	44	5			
	47 AL	--	05:38	6 F	24	4			
08/08	48	--	17:31	S	4	3			1 stickleback
08/09	49	--	13:44	S	93	20			1 coho smolt
08/13	50	--	15:11	S	60	20			
	51	--	16:18	S	126	20			
	52	--	17:29	S	150	25	2 AFC, 1 LV		
08/14	53	--	10:43	S	237	52	1 RV		
	54	--	10:50	S	300	45	1 LV		
		Totals			4,435	650	10 AFC 5 RV	1 RV	
					5,085			3 LV	

Tow numbers 24 through 47 indicate tows done in specific areas during light or darkness. A, B, C, D designate area, L represents light, and N represents darkness. S represents surface, F represents fathoms.
AFC - Adipose fin clip; RV - right ventral; LV - left ventral.

Appendix F. Tustumena Lake tow net results, 18 September to 04 October 1984 survey.

Date	Tow number	Transect number	Time	Depth	Number of sockeye Age 0	Number of sockeye Age 1	Marks Age 0	Marks Age 1	Other
09/18	55	--	09:44	S	281	21	0	0	
	56	--	11:14	S	183	27	1 AFC	0	
	57	--	12:49	S	99	23	0	0	1 Dolly Varden
	58	--	13:57	S	167	20	0	0	
	59	--	15:15	S	114	7	0	0	
09/19	60	--	09:12	S	186	21	0	0	
	61	--	10:34	S	196	14	0	0	2 stickleback
	62	--	12:27	S	145	8	0	0	
	63	--	13:55	S	133	17	0	0	
	64	--	15:02	S	29	1	0	0	
09/20	65	--	09:56	S	42	13	0	0	
	66	--	11:12	S	24	9	0	0	
	67	--	12:35	S	78	24	0	0	
09/21	68	--	09:07	S	156	12	1 AFC	0	
	69	--	10:16	S	185	17	0	0	
	70	--	11:25	S	199	18	0	0	
	71	--	12:32	S	214	18	0	0	1 stickleback
	72	--	14:27	S	116	13	1 AFC, 1 RV	0	
09/25	73	8	20:24	6 F	27	4	0	0	2 stickleback, 1 sculpin
	74	7	21:49	12 F	1	1	0	0	
	75	7	22:30	6 F	35	7	2 AFC	0	1 sculpin
	76	7	23:05	S	9	1	1 RV	0	
09/26	77	5	00:42	8 F	14	2	0	0	
	78	4	01:50	S	3	1	0	0	1 sculpin
	79	3	03:30	8 F	0	0	0	0	
	80	3	04:08	4 F	3	0	0	0	
	81	2	04:48	S	3	3	0	0	

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Appendix F continued. Tustumena Lake tow net results, 18 September to 04 October 1984 survey.

Date	Tow number	Transect number	Time	Depth	Number of sockeye Age 0	Number of sockeye Age 1	Marks Age 0	Marks Age 1	Other
09/26	82	1	05:35	6 F	0	0	0	0	
	83	1	20:02	6 F	3	2	0	0	
09/27	84	3	01:55	6 F	2	0	0	0	
	85	4	02:56	S	14	0	0	0	
	86	5	03:58	8 F	9	0	0	0	
	87	6	05:19	3 F	14	2	1 AFC	0	
	88	6	06:06	6 F	5	1	0	0	
	89	7	06:50	S	42	5	0	0	1 stickleback
	90	8	07:30	6 F	5	1	0	0	
	91	--	17:12	S	34	0	1 AFC		2 stickleback
	92	--	17:44	3 F	21	1			1 stickleback
	93	--	18:13	8 F	2	1			
	94	--	18:40	S	15	1			
	95	--	20:42	S	4	0			1 stickleback, 1 lake trout
	96	--	21:16	3 F	20	4			4 stickleback, 12 sculpin
	97	--	21:47	8 F	23	1			21 sculpin, 1 stickleback
10/02	98	--	09:43	S	125	9	1 AFC	0	1 stickleback
	99	--	10:49	S	11	0			
	100	--	12:28	S	41	4			1 stickleback
	101	--	13:39	S	45	6	1 RV	0	3 stickleback
	102	--	14:46	S	66	1			1 coho
10/03	103	--	09:23	S	140	19			1 Dolly Varden, 1 sticklebac
	104	--	11:24	S	96	6			1 coho, 1 stickleback
	105	--	13:03	S	91	4			
	106	--	14:15	S	196	11	1 RV		9 stickleback

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Appendix F continued. Tustumena Lake tow net results, 18 September to 04 October 1984 survey.

Date	Tow number	Transect number	Time	Depth	Number of sockeye Age 0	Number of sockeye Age 1	Marks Age 0	Marks Age 1	Other
10/04	107	--	10:10	S	121	8	1 RV		6 stickleback
	108	--	11:23	S	220	8	2 AFC		4 stickleback
	109	--	12:35	S	224	8			5 stickleback
	110	--	13:42	S	94	5			2 stickleback
	111	--	14:43	S	58	0			
		Totals			4,393	411	10 AFC 5 RV		
					4,804				

Tow numbers 91 through 97 were conducted in same area. Tow numbers 91 through 94 were done during light, and tow numbers 95 through 97 were done in darkness. S represents surface, F represents fathoms.
AFC - adipose fin clip; RV - right ventral; LV - left ventral.

Appendix G. Seasonal mean densities of macro-zooplankters at two stations in Tustumena Lake, 1980-1984.

Year (May-October)	Station	*Cyloops columbianus* (No/m²)	Percent	*Diaptomus pribilofensis* (No/m²)	Percent	*Nauplii* (No/m²)	Percent	Total
1980	B	35,041	56.6	13,237	21.4	13,584	22.0	61,862
1981	B	20,858	24.8	30,078	35.7	33,254	39.5	84,190
1982	B	53,736	76.7	720	1.0	15,597	22.3	70,053
1983	B	37,448	60.7	8,609	14.3	15,450	25.0	61,707
1984	B	34,380	43.0	19,601	25.0	25,535	32.0	79,516
1980	C	34,096	73.2	4,853	10.4	7,600	16.4	46,549
1981	C	24,086	39.8	6,828	11.3	29,624	48.9	60,538
1982	C	43,172	83.1	1,618	3.1	7,125	13.8	51,915
1983	C	49,848	60.6	9,091	11.0	23,380	28.4	82,319
1984	C	26,868	56.0	3,078	6.0	18,060	38.0	48,006