SOUTHEAST ALASKA REGIONAL COHO SALMON PROGRAM REVIEW

March 11 & 12, 1987
Juneau, Alaska

REGIONAL INFORMATION REPORT NO. 1J88-1

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The Southeast Region
Divisions of Commercial Fisheries and Sport Fish

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SOUTHEAST ALASKA REGIONAL COHO SALMON PROGRAM REVIEW

Compiled and Edited by:

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Regional Information Report[1] No. 1J88-1

Alaska Department of Fish and Game
Divisions of Commercial Fisheries and Sport Fish
Southeast Region
P.O. Box 20
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January 1988

[1]The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate needs for up-to-date information, reports in this series may contain preliminary data.

FOREWORD

A Southeast Alaska inter-divisional, inter-agency program review, the first since the spring of 1982, was held March 11 & 12, 1987, at the Super 8 Motel in Juneau. The review attracted 12 speakers and 25 invited guests. The presentations were well prepared, well received, and they generated lively discussion and solid recommendations for a unified approach to coho salmon research and management in the region.

This document is a compilation of the presentations, the more salient points of discussion following each presentation, and concluding discussion recommendations.

The review stimulated renewed interest in coho research in the region and enthusiasm for additional reviews/workshops on a more frequent basis.

Gary Gunstrom
and
Gary Sanders

January 1988
Juneau, Alaska

SOUTHEAST ALASKA INTER-DIVISIONAL COHO SALMON PROGRAM REVIEW

HELD MARCH 11-12, 1987 AT THE SUPER 8 MOTEL
IN JUNEAU, ALASKA

Final Agenda (Revised)

<u>WEDNESDAY</u>

8:15-8:30 — I. Introduction (Sanders/Gunstrom)

II. Presentation

8:30-10:00 — A. Management (Larson)
1. Historical perspective
2. Current management
3. Management problems and needs (data gaps)

BREAK

10:15-12:15 — B. Research
1. Commercial Fisheries coho salmon research review, findings and future (Shaul)
2. Sport Fish coho salmon research review, findings and future
   a. Salmon Lake (Schmidt)
   b. Yehring Creek, Chilkat Lake and Chilkoot Lake (Elliott)

LUNCH

1:30-3:30
3. Commercial Fisheries coho salmon predation studies in southern Southeast Alaska (Hofmeister)
4. NMFS: developing coho salmon stock separation technology (Short)
5. Taku River rearing Habitat Studies (Thedinga)

BREAK

3:45-5:00
6. Forest Sciences Laboratory coho studies in S.E. Alaska (Dolloff)

C. Hatchery production of coho salmon
1. FRED Division (Holland)

<u>THURSDAY</u>

8:15-10:15
2. Auke Creek coho program (Taylor)
3. NSRAA (Crone)
4. SSRAA (Amend)

BREAK

10:30-12:00 — III. General Discussion - Where do we go from here?

Southeast Alaska Coho Salmon Program Review

March 11 & 12, 1987

Attendants

Name	Agency
Gary Gunstrom	ADF&G/CF
Gary Sanders	ADF&G/SF
Dick Crone	NSRAA
Johnny Holland	ADF&G/FREDD
Leon Shaul	ADF&G/CF
Karl Hofmeister	ADF&G/CF
Doug Jones	ADF&G/CF
John Edgington	ADF&G/CF
K Koski	NMFS
Steve Hoffman	ADF&G/CF
Fred Bergander	ADF&G/CF
Andy Dolloff	FSL
Allen Bingham	ADF&G/SF
Jerry Taylor	NMFS
Jeff Short	NMFS
Don Amend	SSRAA
Steve McGee	ADF&G/FREDD
Mel Seibel	ADF&G/CF
Paul Kissner	ADF&G/SF
Dennis Hubartt	ADF&G/SF
Andy McGregor	ADF&G/CF
Norma Sands	ADF&G/CF
Artwin Schmidt	ADF&G/SF
Steve Elliott	ADF&G/SF
John Thedinga	NMFS

ADF&G - Alaska Department of Fish & Game
CF - Commercial Fisheries Division
FREDD - Fisheries Rehabilitation, Enhancement, and Development Division
NMFS - National Marine Fisheries Service
NSRAA - Northern Southeastern Regional Aquaculture Association
SSRAA - Southern Southeastern Regional Aquaculture Association
FSL - Forest Sciences Laboratory

INTRODUCTION

INTRODUCTION

Gary Sanders
Region I Research Supervisor
Division of Sportfish
Alaska Department of Fish and Game

Our last coho salmon review was held in the spring of 1982 to determine how we, as a region, wanted to proceed with coho salmon research. The path we took at the time as a result of the recommendations of a designated review committee, was to proceed with coho juvenile and smolt marking at selected index sites, with subsequent adult recoveries, to determine commercial and sport exploitation rates, run timing, areas of harvest, escapements and survival rates at various life stages. This has been the tack that we've taken since. Then in 1983-84, Gary Gunstrom and I got together to try to develop a joint coho research program wherein the Sportfish Division would concentrate its efforts in the urban areas and the Commercial Fisheries Division would focus on the rural areas. This cooperative effort took several budget cycles until it really got going on the Sportfish side, starting with efforts at Salmon Lake (Sitka) in 1985, and then a major budget increase in 1986. Presently, Sportfish has just about comparable funding to that of Commercial Fisheries for coho research.

One of the objectives of this meeting is to exchange ideas and information with those doing research on coho to determine if there are changes that we wish to make in our cooperative efforts, i.e., do we want to take a different tack? Another goal is to, hopefully, make the fisheries managers that are here aware of some of the strides we've made over the past 5 years in understanding coho salmon in Southeast Alaska. Hopefully, some of this information can be utilized in the management of our coho salmon resource.

MANAGEMENT

SOUTHEAST ALASKA INTER-DIVISIONAL COHO SALMON PROGRAM REVIEW

REVIEW OF CURRENT MANAGEMENT

PAUL LARSON
FINFISH COORDINATOR
DIVISION OF COMMERCIAL FISHERIES
ALASKA DEPARTMENT OF FISH AND GAME

A. General Resource Information and Stock Status.

1. Coho salmon are produced in some two to three thousand streams and rivers in the Southeast Alaska Region extending from Dixon Entrance to Yakutat.

2. Northern British Columbia coho salmon contribute to an unknown degree to Southeast Alaska fisheries.

3. Formal spawning escapement goals have not been established and there is limited historical spawning escapement information available.

4. The best indication of historical and current stock status may be the commercial salmon harvest record (see Fig. 1). Coho salmon catches were depressed during the 1960's and 1970's, however, at present Southeast Alaska coho salmon stocks overall are generally considered to be in a healthy condition. The all gear harvest of coho salmon for the most recent five year period (1982-1986) of approximately 2.4 million fish is as high as it has ever been. Despite the apparent overall good stock conditions, the most recent spawning escapements to some areas have been below average.

B. Allocation of Resources

1. Coho salmon are important to commercial, sport, and subsistence users in fisheries ranging from offshore to inriver. In numbers of fish, the commercial harvest far exceeds the sport and subsistence take (see Fig. 2).

2. The troll fishery, including both hand and power troll gear types, accounts for the biggest share of the harvest (see Figs. 3 and 4).

3. The allocation of the coho salmon resources has become a major management issue in recent years. The Alaska Board of Fisheries has adopted specific criteria for a ten day mid-season closure of the entire troll fishery to ensure that inside user groups allocation goals are maintained. The troll fishing periods in a portion of the Yakutat area are set according to the set gillnet periods for allocation purposes.

4. Local sport fishing groups, particularly in Juneau and Ketchikan, have initiated efforts to increase their opportunities for harvesting coho salmon.

5. Coho salmon management is directed primarily at the commercial fishery. Minimal active management is conducted in the sport or subsistence fisheries.

C. Purse Seine Fishery Management

1. The purse seine harvest of coho salmon is considered an incidentally harvested species and minimal active coho salmon seine fishery management is accomplished.

2. The recent good returns of pink is allowing more liberal seining periods and is resulting in higher incidental coho salmon catches.

D. Set Gillnet Fishery Management

1. Coho salmon predominate the Yakutat set gillnet fall fishing season. It is primarily an in-river fishery.

2. Inseason management is accomplished primarily through the analysis of fishery performance information (i.e., CPUE). Inseason enumeration of spawning escapement is difficult, however, some information is available and is useful for inseason management, particularly for the Tsiu River.

E. Drift Gillnet Fishery

1. There are six distinct drift gillnet fisheries in Southeast Alaska. They all occur in the ocean waters.

2. To a large degree the drift gillnet harvest of coho salmon is taken incidentally during summer sockeye and fall chum salmon managed fisheries. However, the fall drift gillnet seasons in both Districts 6 and 8 (Prince of Wales and Stikine) are managed specifically for harvesting coho salmon and major management considerations are given towards harvesting coho salmon in Districts 11 and 15 (Taku and Lynn Canal).

3. Inseason management is based on fishery performance information. The effectiveness of this management may be limited by recent innovations in manufacturing gillnet gear making it more effective.

4. Very little spawning escapement information is available in a timely manner for effective inseason management.

5. The difficulties of selectively harvesting fall chum and coho salmon limit the drift gillnet coho salmon management opportunities. Large returns of fall chum salmon results in increased fishing pressure on coho salmon.

6. The gillnet harvest is used as an indicator of coho salmon escapement rates to the inside areas and eventually to the spawning streams.

F. Troll Fishery

1. The troll fishery is the major harvester of coho salmon and presents the biggest challenges and opportunities for management.

2. The troll harvest occurs on mixed stocks of coho salmon. Most of the harvest occurs well in advance of the time that spawning escapement levels can be assessed. For example, the troll harvest peaks in late July, and the gillnet harvest peaks in early September, whereas spawning escapement is not assessed until October (see Fig. 5). This presents a major problem for management because, by the time stock specific run strength can be assessed, a vast majority of the harvest has already occurred, leaving little opportunity to selectively allocate the return to user groups and spawning escapement.

3. The recent trend is for increased mixed stock troll harvesting to the outside (see Fig. 6) and particularly the outside northern areas (see Fig. 7).

4. A more recent trend is for troll harvest to occur earlier in the season (see Figs. 8 and 9), which makes it more difficult to assess run strength. During the 1980's the troll harvest has peaked in mid to late July compared with the historical peak in early to mid-August.

5. The increasing presence of hatchery produced coho salmon is providing more fish to the mixed stock fishing pool which will further complicate natural stock run strength assessment (see Fig. 10).

6. The short open chinook salmon fishing periods, necessitated to maintain the harvest at levels specified by the U.S./Canada Pacific Salmon Treaty, has resulted in more fishing pressure being directed at coho salmon.

7. Current troll management is based primarily on the comparison of current season fishery performance to historical performance. The performance of the outside troll fishery provides an indication of overall run strenth. The performance of inside troll, net, and recreational fisheries provides information concerning escapement rates of more specific stock units.

8. Regulations specify a ten day mid-season closure of the troll fishery, if needed, for conservation and to maintain the historical allocation to inside user groups. The primary indicators for determining the need for the closure are specified to be the inside drift gillnet and sport fisheries compared to average 1971-80 levels. The closure has been scheduled for mid-August, the historical peak of the coho salmon troll harvest, to ensure maximum movement to the inside areas.

G. Summary

1. Inseason management of the coho salmon resources is difficult because most of the harvest occurs well in advance of the time that spawning escapements can be enumerated.

2. Most of the harvesting is accomplished on mixed stocks and recent year trends are for more mixed stock fishing.

3. All fisheries are becoming more efficient.

4. Current troll harvest rates alone do not appear to be causing conservation problems. However, when all fisheries are considered, the total impact on those stocks exposed to inside net and sport fisheries is becoming a conservation problem.

H. Management Needs

1. Continue and expand current efforts to enumerate coho salmon spawning escapements in key index streams.

2. Establish coho salmon spawning escapement goals.

3. Provide management access to timely inseason estimates of hatchery produced coho salmon catch by area and time.

4. Conduct studies to determine the increased efficiency of new center core gillnet gear.

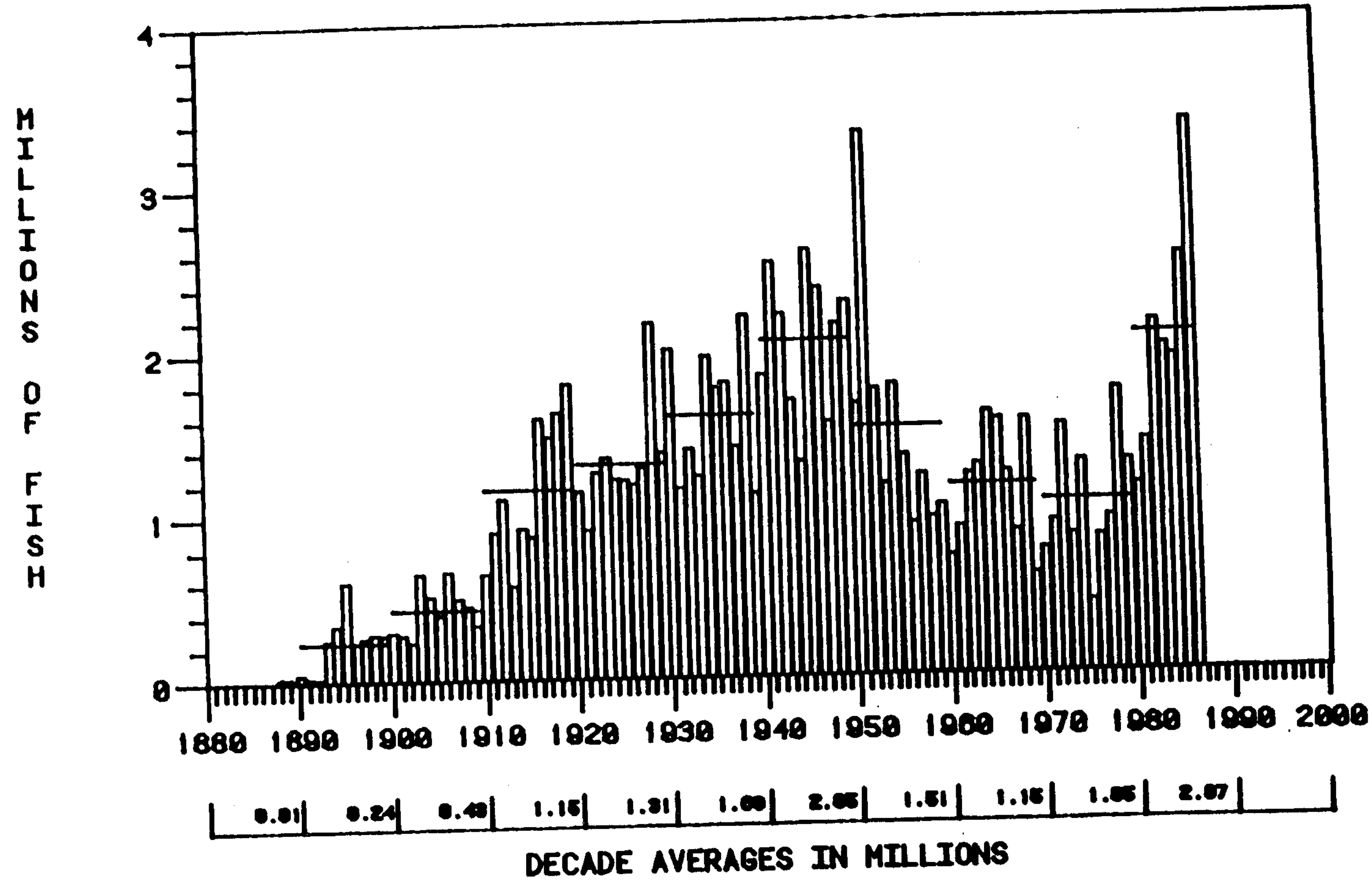

FIGURE 1 . SOUTHEAST ALASKA REGION HISTORICAL COMMERCIAL COHO SALMON CATCHES BY 29 Commercial Gear Totals , 1888 TO PRESENT.
PREPARED: ADF&G 11/21/86.

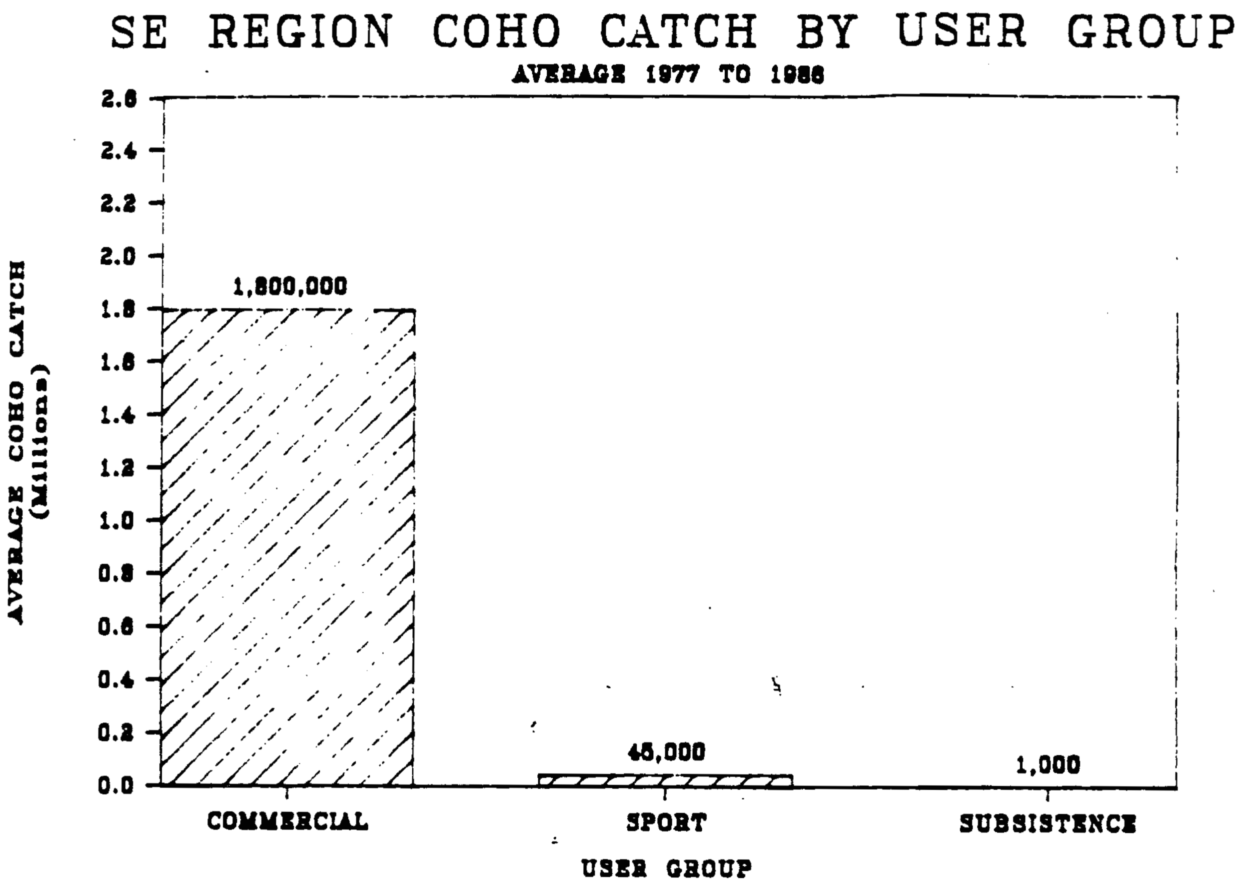

Figure 2. Southeast region coho salmon catch by user group, average 1977-86.

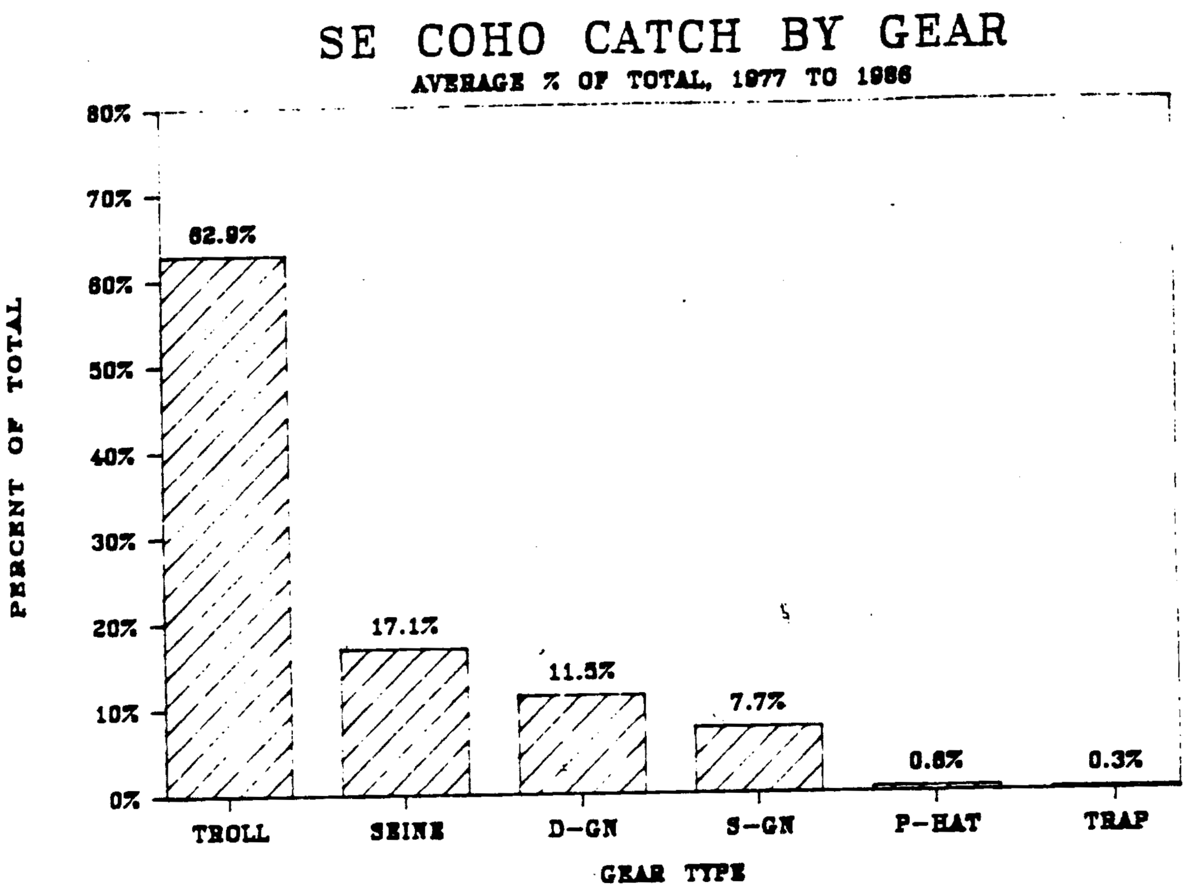

Figure 3. Southeast region commercial coho salmon catch by gear, average 1977-86.

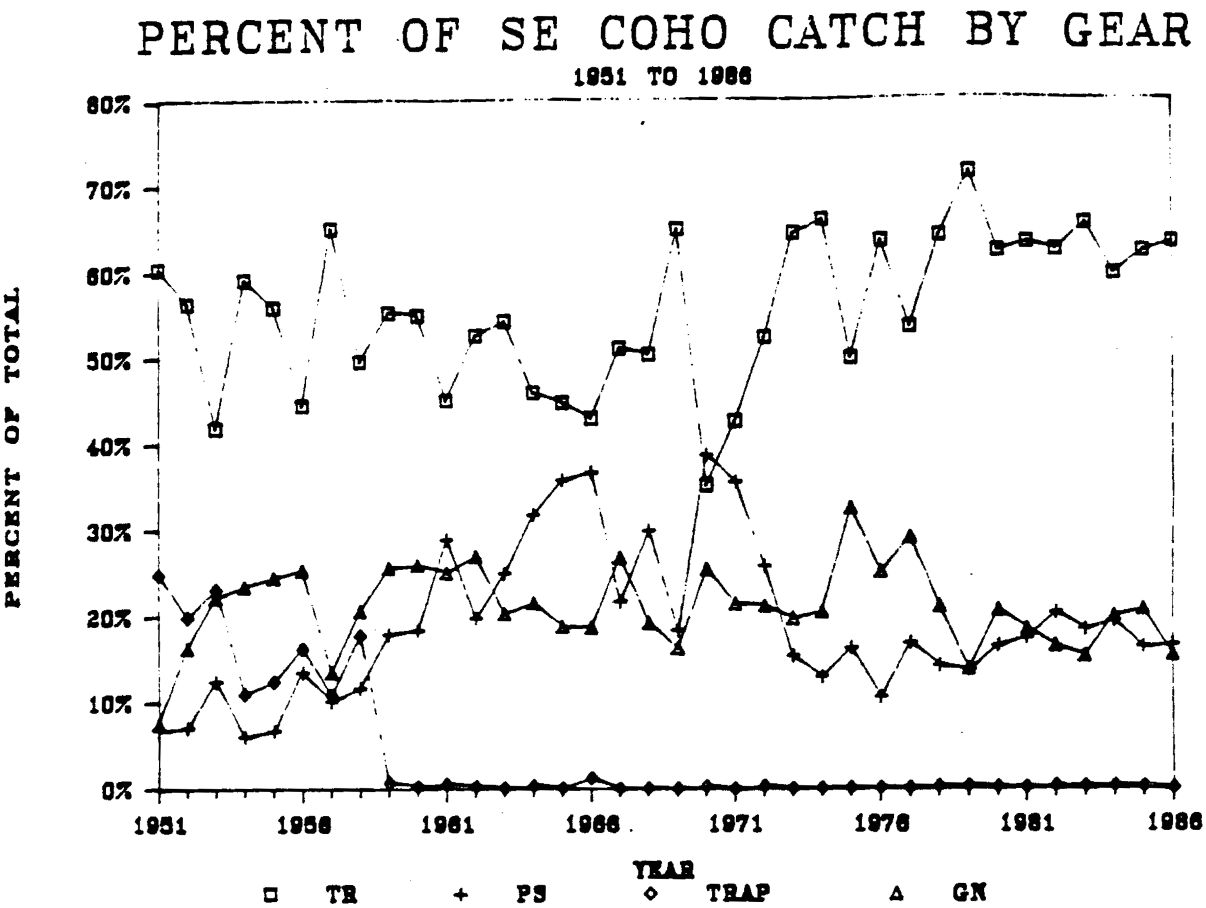

Figure 4. Southeast region coho salmon catch by gear in percent of total, 1951-86.

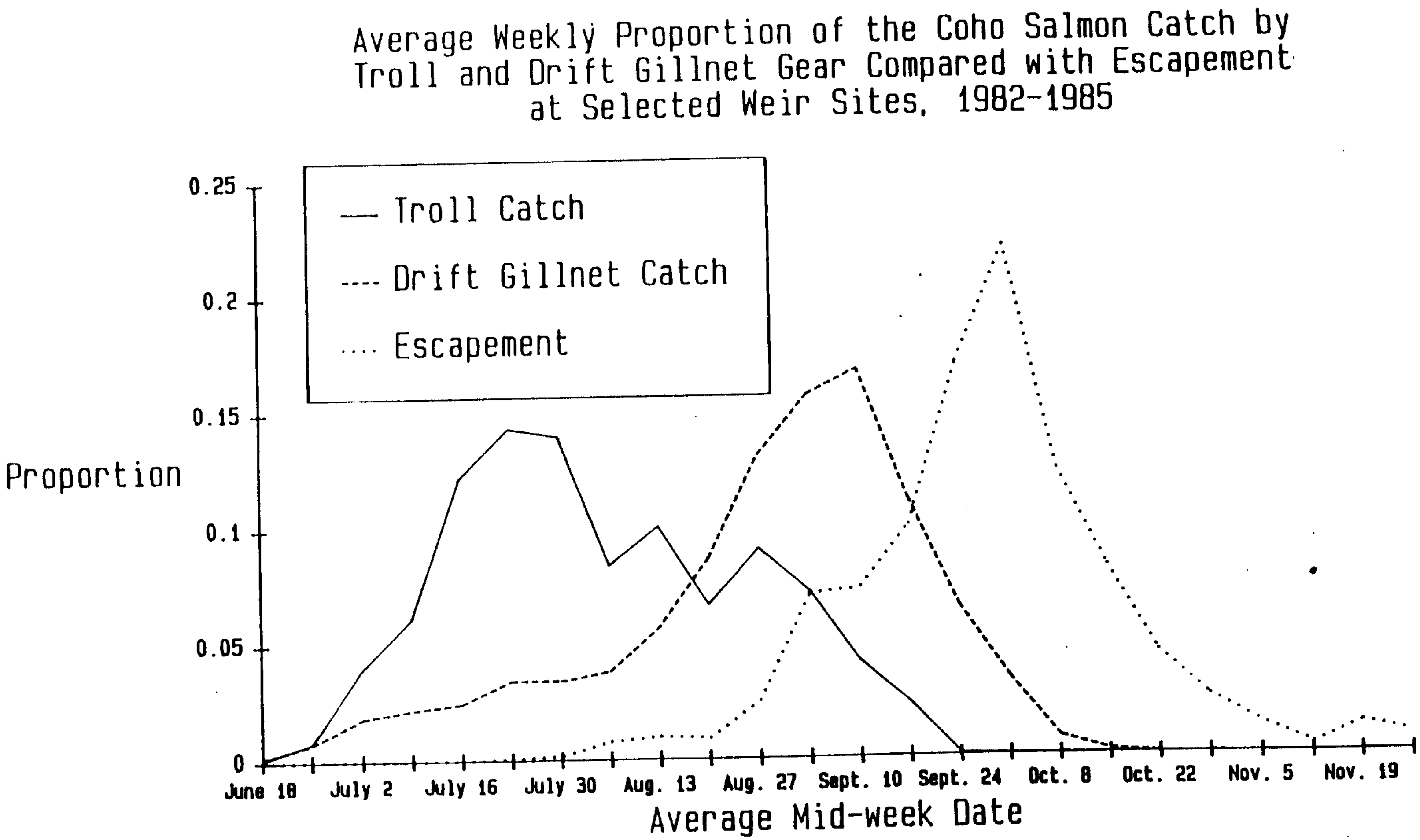

Figure 5. Average timing distribution of coho salmon in the Southeast Alaska troll and drift gillnet fisheries and at selected weir sites, 1982-1985.

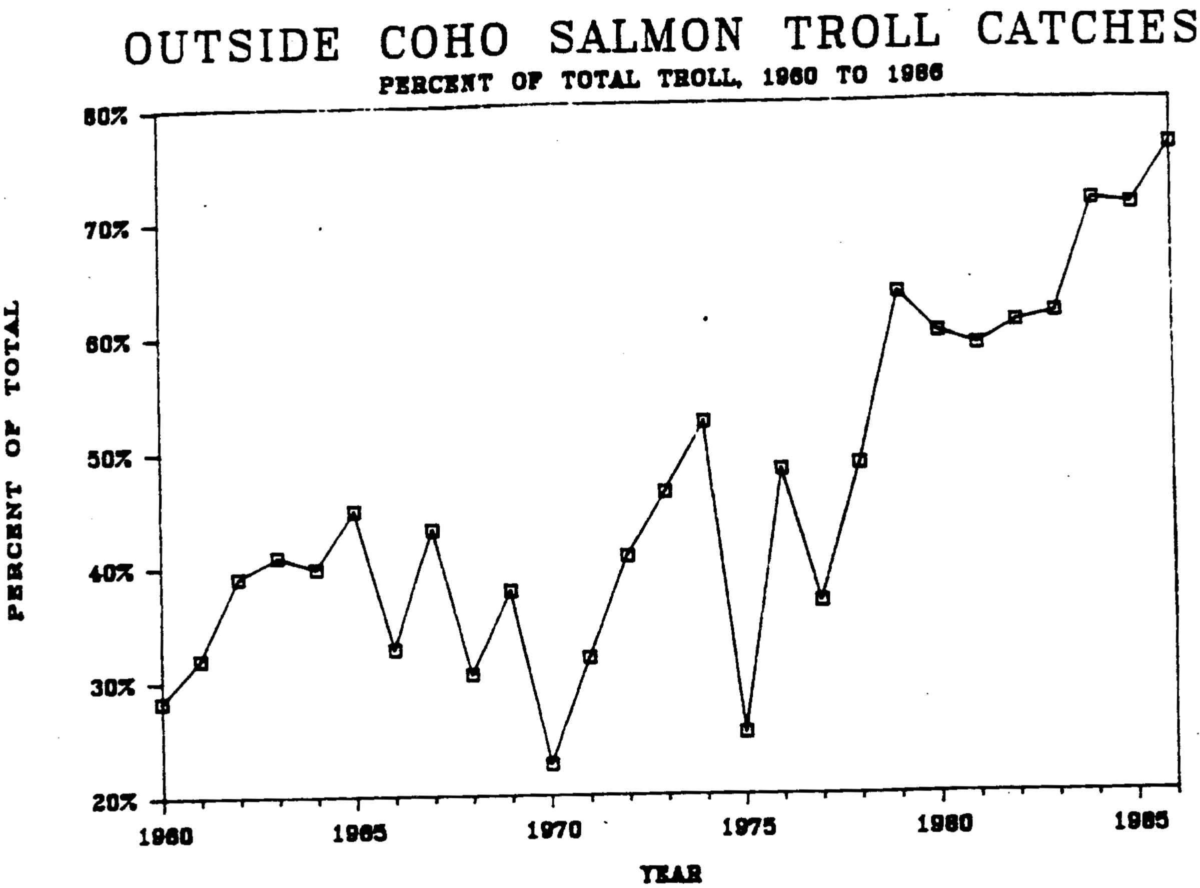

Figure 6. Southeast region coho salmon catch in outside fishing Districts (104, 113, 116, 152, 154, 156, 157, 181, 183, 186 and 189) in percent of total, 1969-86.

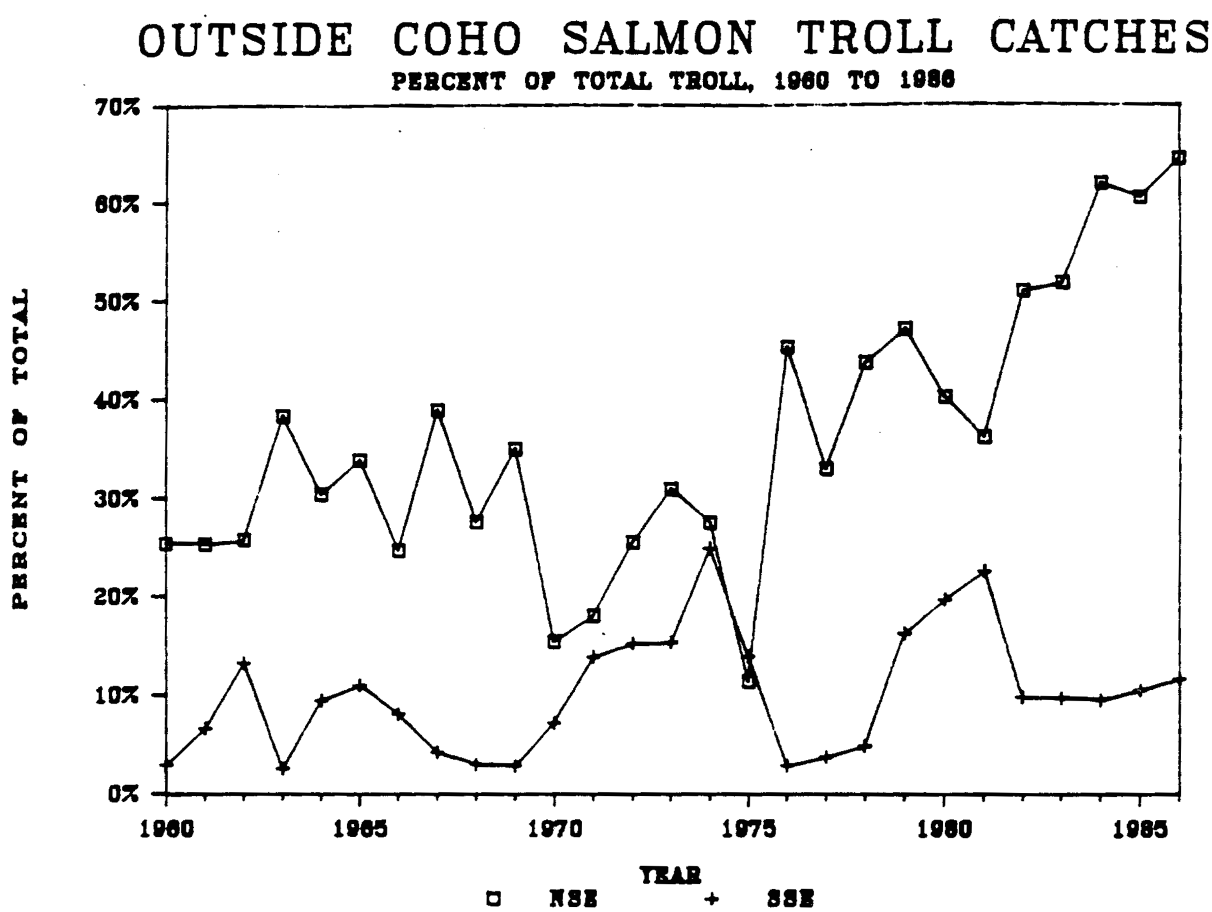

Figure 7. Southeast coho salmon catch in southern outside (104 and 152) and northern outside Districts (113, 116, 152, 156, 157, 181, 183, 186 and 189) in percent of total, 1960-86.

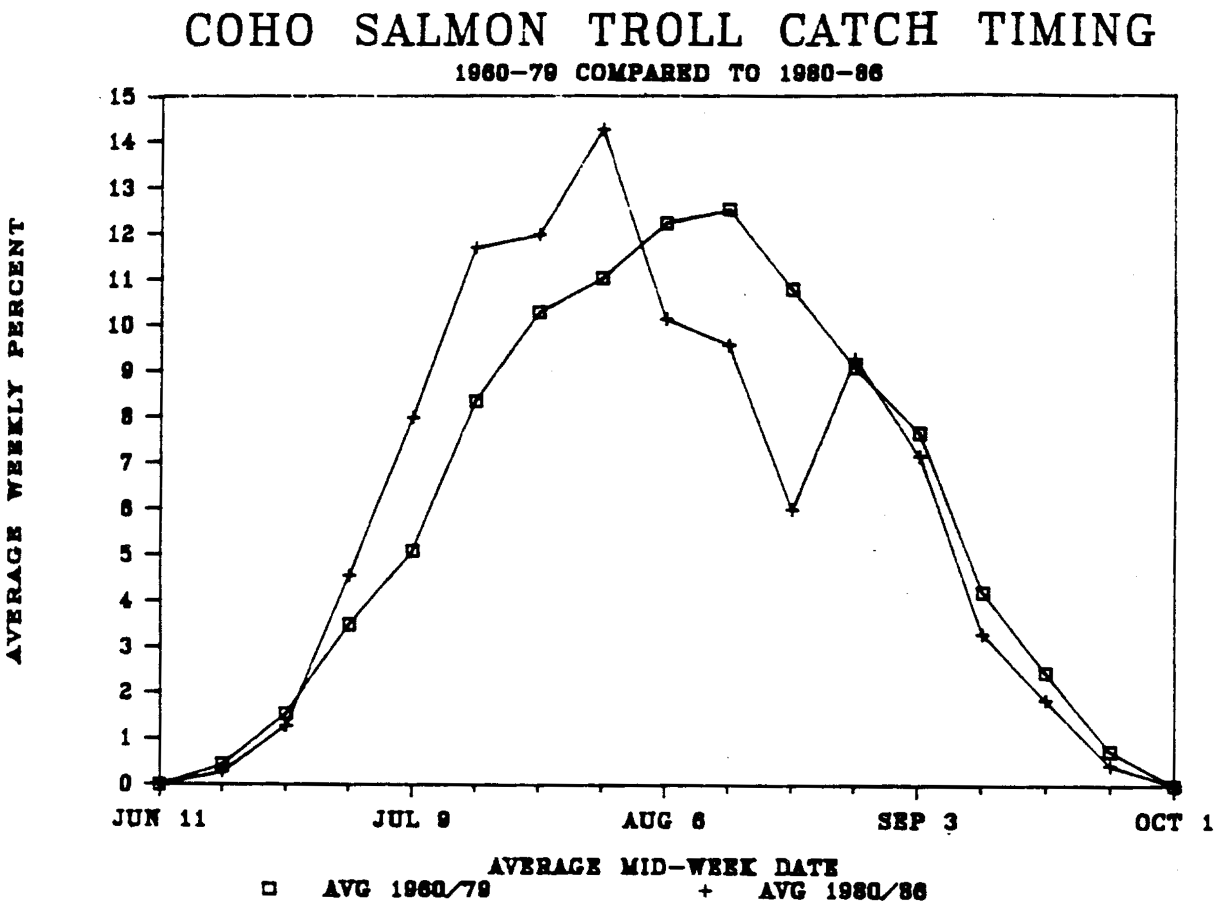

Figure 8. Southeast region coho salmon troll catch timing (1960-79 compared to 1980-86) in percent of total season catch by week.

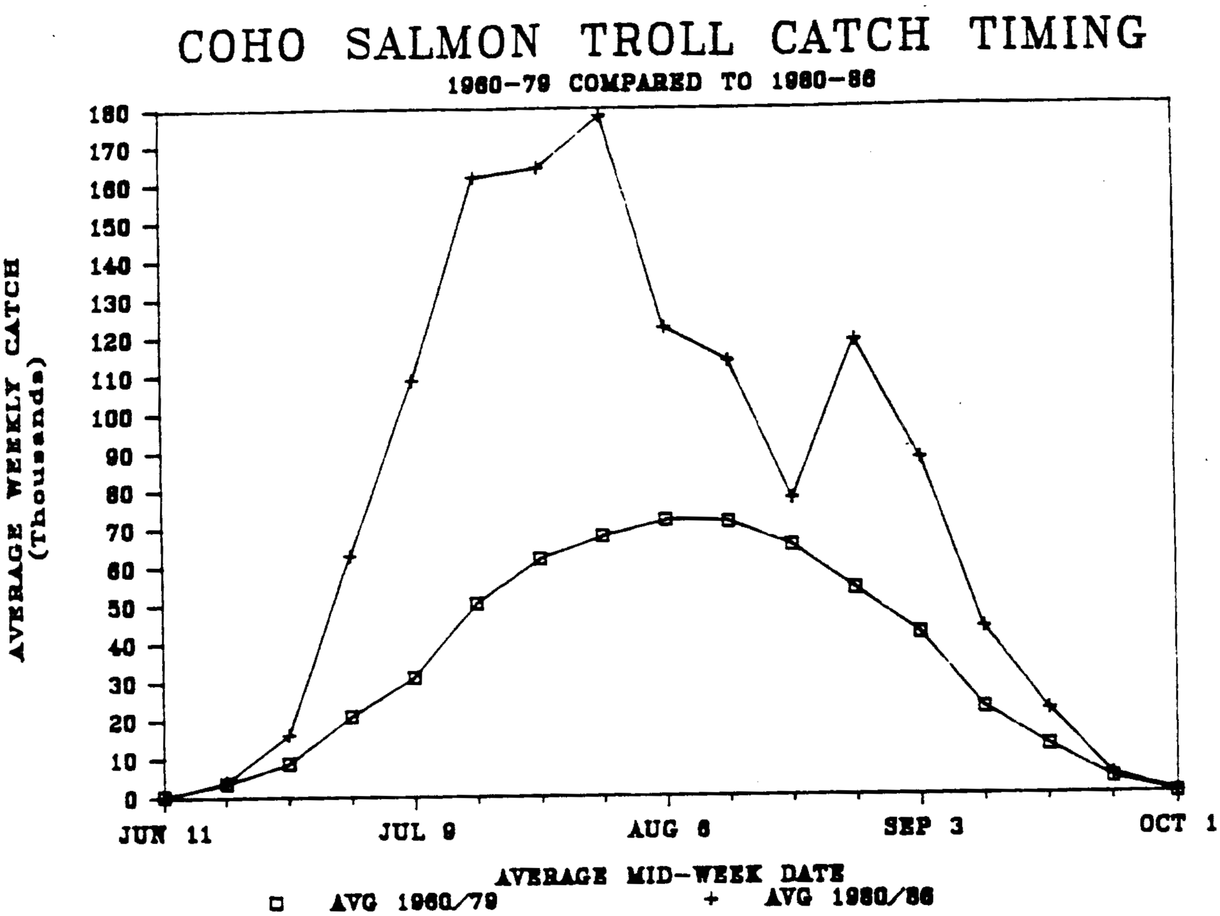

Figure 9. Southeast region average coho salmon catch by week, 1960-79 compared to 1980-86.

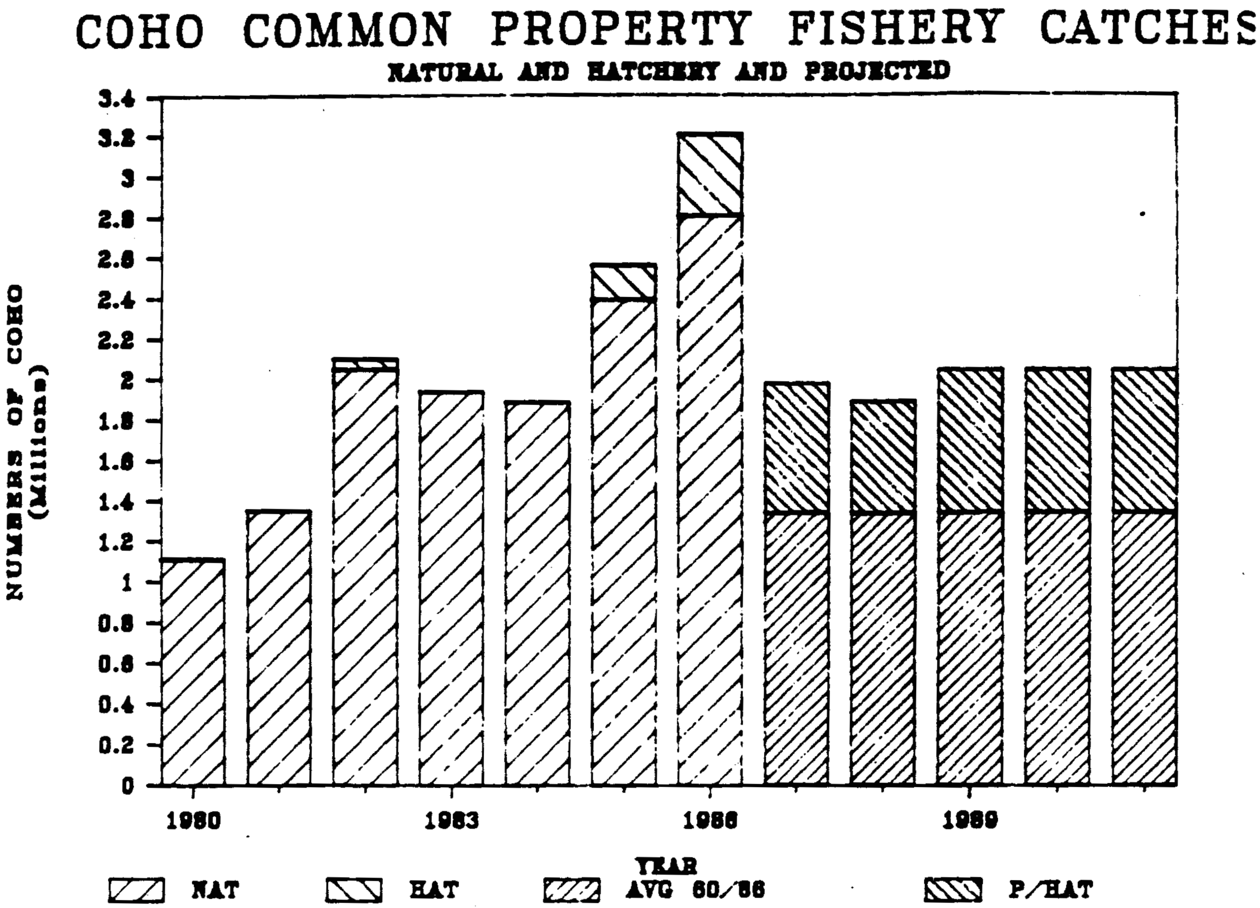

Figure 10. Southeast region coho salmon natural and hatchery commercial catches (1980-86) and projected (1987-91).

Discussion Points (Larson's presentation)

1. Coho stocks, in general, are healthy, though we have concern for some northern inside, and Petersburg/Wrangell stocks.

2. The commercial fishery has been moving offshore to intercept the coho stocks; result is that the fishery is peaking earlier in the season, especially in northern S.E. Alaska, and smaller fish are being taken. Sixty to 70% of the catch is now taken in the offshore troll fisheries compared to about 30% twenty years ago.

3. Presently, the 10-day closure is in mid-August during the highest commercial harvest. Most movement to the "inside" areas also seems to be during this period. An earlier closure, before the fish start to move, probably wouldn't help in moving fish inside.

4. It isn't clear that opening the northern S.E. Alaska outer coastal areas later would protect northern inside stocks more, as the troll fleet in the north isn't harvesting just northern stocks; tagging information has shown that southern stocks make landfall in N.S.E. before moving south. Also, some stocks, e.g., Lynn Canal stocks, don't even enter the troll fishery until after August.

5. Last summer (1986) we should have kept the season closed after the 10-day closure as we had indications that there were a lot of fish moving inside, but apparently there still weren't enough.

6. Highest harvest rates ever observed in Lynn Canal last year.

7. We really don't know what adequate escapements are for most systems. The south end is particularly lacking in escapement information. This should be one of our highest priorities for investigation.

8. Commercial landings of coho are as good as they have ever been historically, though changing fishing patterns under less favorable weather conditions might be cause for concern in the future.

9. U.S./Canada funding will benefit coho salmon resource via expanded management information and improved stock identification procedures.

10. Wild stock return strength is quite variable from year to year.

11. Hatchery production is steadily increasing and may mask problems with certain of the wild stocks.

12. How the troll fishery starts out usually indicates the trend for the season.

RESEARCH

A REVIEW OF THE
ALASKA DEPARTMENT OF FISH AND GAME
COHO SALMON RESEARCH PROGRAM
IN SOUTHEAST ALASKA

By

Leon D. Shaul

Alaska Department of Fish and Game
Division of Commercial Fisheries
Douglas, Alaska

Prepared for the
Southeast Alaska Inter-divisional Coho Salmon
Program Review

March 11-12, 1987
Juneau, Alaska

INTRODUCTION

The Southeast Alaska Coho Research Project has been in existence for 18 years. The following is a brief discussion of its beginnings, development, and potential future direction. Research results are not included because of limited space and their extensive nature. For research results and additional discussion of management and research problems, the reader is referred to reports involving Commercial Fisheries Division Coho Research personnel (see References section). Lists of reports produced by the Sport Fish Division and other Commercial Fisheries Division staff are available from the ADF&G headquarters office in Juneau.

BACKGROUND

The Commercial Fisheries Division Coho Research Project was established in 1969. The impetus for establishing this project was a large information void on the status and biological characteristics of Southeast Alaska coho salmon stocks and the effects of extensive mixed stock fisheries on those stocks. A number of management and resource problems existed including signs of a long-term decline in the stocks since the early 1950's and concern about the effects of large scale logging on future production. Research needs were clear, but the extremely scattered distribution of coho salmon stocks and the basic characteristics of the species presented formidable research design problems.

Initial studies included rearing habitat surveys of 16 watersheds (Gray and Marriott, 1986) and analysis of age-length-weight data from commercial catches (Gray et al. 1981). In 1972, juvenile coho salmon were marked with fluorescent pigment in the Taku, Berners, and Chilkat Rivers. Recovery of marked adults from the catch and escapement in 1974 provided the first information on the migratory patterns and harvest rates of Southeast Alaska coho salmon (Gray et al. 1978). Wire-mesh minnow traps baited with salmon roe were found to be very effective for capturing juvenile coho salmon for marking studies. The development of coded-wire tag technology and its adaptation to use in remote areas (Koerner 1977) greatly facilitated studies of wild coho salmon stocks. Using coded-wire tags, juvenile marking was repeated on lower Taku River tributaries and major Lynn Canal systems, and expanded to stocks in other parts of the region.

Tag recovery data from fisheries and escapements has provided extensive information on the migratory patterns, fishery contribution, harvest rates, escapement, survival rates, and smolt and rearing juvenile populations for a number of stocks distributed throughout the region. To date, wild coho salmon have been recovered that were tagged in 21 systems in the main portion of southeast Alaska (Figure 1) and in four systems near Yakutat (Figure 2). This information has aided greatly in understanding and managing Southeast Alaska coho salmon stocks.

In 1982, research supervisors and staff recognized a need to meet future information needs with a long-term research program that was both consistent and flexible. A coho salmon research and management review was convened in Juneau during 18-19 May 1982 (Alaska Department of Fish and Game 1983).

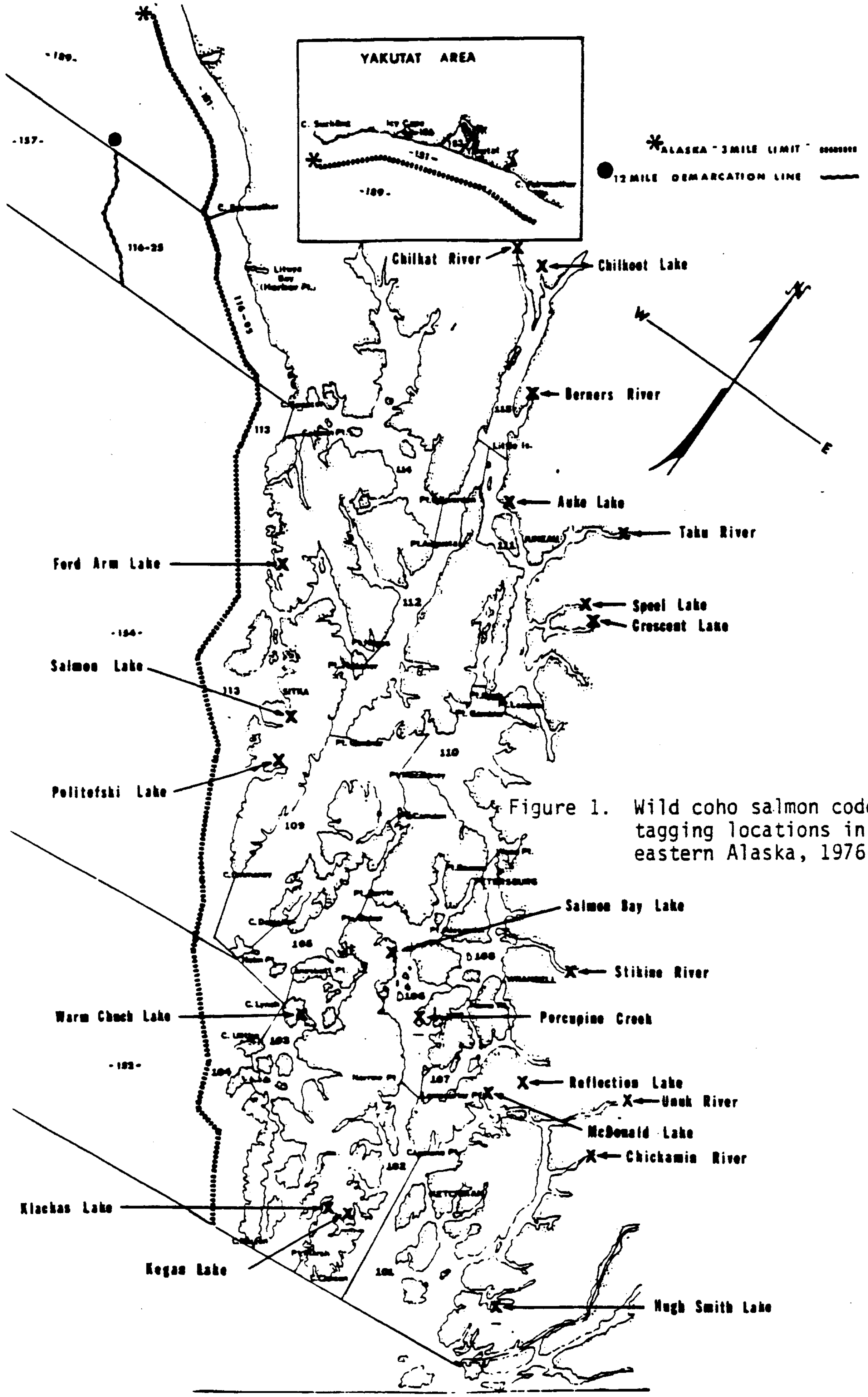

Figure 1. Wild coho salmon coded-wire tagging locations in Southeastern Alaska, 1976-1985.

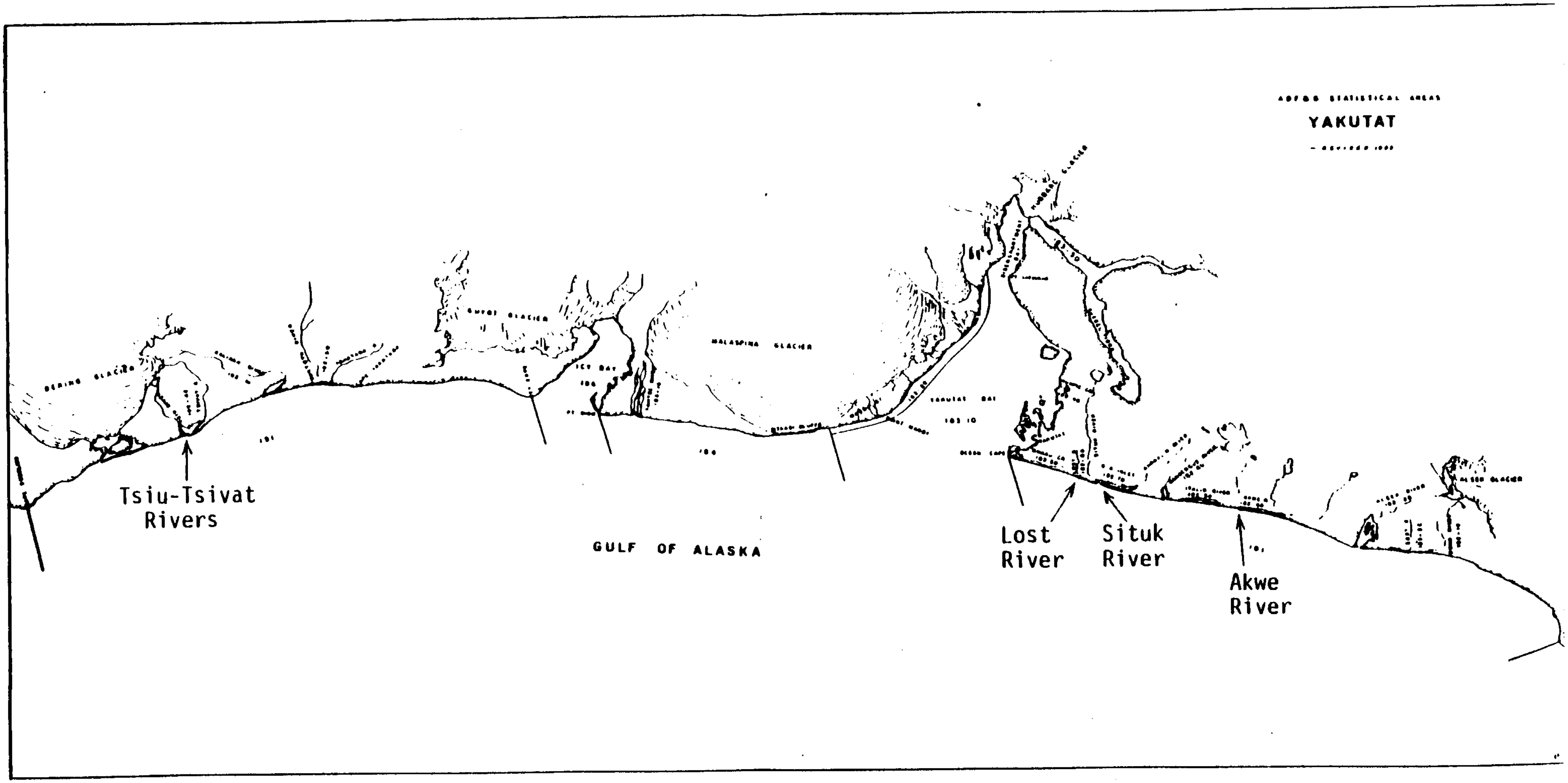

Figure 2. Yakutat area streams where wild coho salmon were coded-wire tagged, 1984.

Fishery researchers and managers from Oregon to Central Alaska discussed management and research problems and made several recommendations for the future of the Coho Research Project. The foremost recommendation was that coded-wire tagging and escapement estimation be conducted annually on a minimum of six systems to determine migration routes, timing, exploitation rates, and escapement. Additional information provided would include: juvenile production per spawner; survival rates between the juvenile and adult stages; and juvenile population estimates. Over a period of years it was anticipated that such information would be useful in determining, for these index stocks: the selectivity of fisheries among stocks; the effect of various management measures on exploitation rates; and management goals based on a objective analysis of biological characteristics and population dynamics of individual stocks. In addition to the long-term index stocks, the panel recommended that other stocks be tagged as logistics, opportunities, and available budgets allowed in order to determine their migration routes, timing, and differential time-area exploitation. The panel also recommended that: (1) historical catch, effort, and escapement data be analyzed to develop an improved basis for management; (2) a standardized catch sampling program be implemented with clearly defined objectives; (3) alternative escapement assessment techniques be investigated; (4) plans and a budget request be developed for an expanded escapement assessment program that is technically sound and fiscally reasonable; (5) alternative stock identification techniques be investigated (considered lower priority); (6) the possibility of developing a reliable technique for forecasting returns be investigated (also secondary in priority).

CURRENT STATUS AND FUTURE

The current Coho Research Program is largely in line with the review panel's recommendations. However, several objectives concerning implementation have yet to be achieved. The scope and effectiveness of the Commercial Fisheries Division portion of the program has decreased somewhat because of cuts in General Funding and matching Federal Aid money. At the same time the Sport Fish Division has initiated projects designed to compliment the work of the Commercial Fisheries Division and strengthen the region-wide Coho Research Program. In addition, some U.S./Canada Treaty related federal funding was made available beginning in 1986 for coded-wire tagging and escapement assessment in the transboundary rivers (Taku, Stikine, Alsek).

Six long-term tagging and escapement enumeration sites recommended by the panel were: Auke Creek, Speel Lake, Berners River, Hugh Smith Lake, Warm Chuck Lake, and Ford Arm Lake. Four of these (Auke Creek, Berners River, Ford Arm lake and Hugh Smith Lake) have been included in the long-term index system program. However, studies were discontinued at the two other sites. Speel Lake was dropped because of conflicts with an enhancement program while Warm Chuck Lake was dropped for budgetary and logistical reasons. Salmon Bay lake is being considered for addition as a long-term index site. It is in an important location relative to the fisheries and other major stocks, and expenses are shared with an established sockeye salmon escapement enumeration program. However, Salmon Bay Lake's future as a coho salmon index site remains uncertain because of problems in tagging a sufficient number of juveniles and enumerating or estimating the entire escapement.

Improvements can be made to alleviate some of these problems, but others will remain. A decision on future studies at this site should be made after the fall weir operation in 1987.

The Sport Fish Division has initiated studies at four sites including: Salmon Lake near Sitka; Yehring Creek on the Taku River; and Chilkoot and Chilkat Lakes in upper Lynn Canal. Salmon Lake and Chilkoot Lake are proven sites where juvenile coho salmon or smolts can be tagged and returning adults enumerated. However, Yehring Creek and Chilkat Lake suffer from some of the problems typical of tributaries of large river systems. Juvenile coho salmon are difficult to capture in Chilkat Lake while Yehring Creek is a difficult stream on which to operate a weir during the fall months. At both locations, there is the possibility that rearing juveniles from other spawning populations are present. Both of these sites represent stocks of major management concern. Therefore, they should be fully evaluated for their potential as escapement index sites even if reliable escapement tag return estimates cannot be made.

Overall, there are six established, workable combination tagging and escapement index sites in the region and three others under consideration that have varying degrees of potential. Recent increases in Sport Fish Division participation and U.S./Canada funding have strengthened much-needed escapement assessment programs for stocks in the major mainland systems. In northern Southeast, there is relatively good representation among escapement indicator sites. However, hard escapement data for southern Southeast is still very sparse (Figure 3). Opportunities should be examined to increase or reallocate funding to develop at least one or two additional long-term tagging and escapement enumeration sites in southern Southeast. Known potentially successful index sites for these studies are somewhat limited. In addition to Salmon Bay Lake, recently considered sites include Klakas Lake, Reflection Lake, and Karta River. Reflection Lake and Karta River are both known to have strong early coho salmon runs, unlike other stocks in southern Southeast that have been studied. Tagging and escapement enumeration studies on one of these two stocks would add an important contribution to our understanding of the migratory patterns, fishery contributions, and harvest rates of southern southeast stocks. Both are likely to be important contributors to the Ketchikan area marine sport fishery and may be harvested more by local fisheries, in general, compared with late run stocks that show a strong northward harvest distribution and late entry into southern waters. Juvenile tagging can be conducted successfully in Reflection Lake. However, the prospects for tagging in the Karta River system or enumerating the escapement to either system are unknown. A weir has been operated successfully throughout the adult coho salmon migration at Klakas Lake on the southern outside coast while tagging in that system has met with mixed success. Additional surveys should be conducted to identify potential index systems in southern Southeast.

No effective substitution for weirs has been found for enumerating or estimating adult coho salmon escapement. Adult tagging and recovery has been invaluable for estimating escapement in several systems where weirs have failed during the season. However, the difficulty of capturing, tagging and examining adults renders the mark-recapture technique impractical by itself for obtaining escapement estimates with good precision on most systems. It

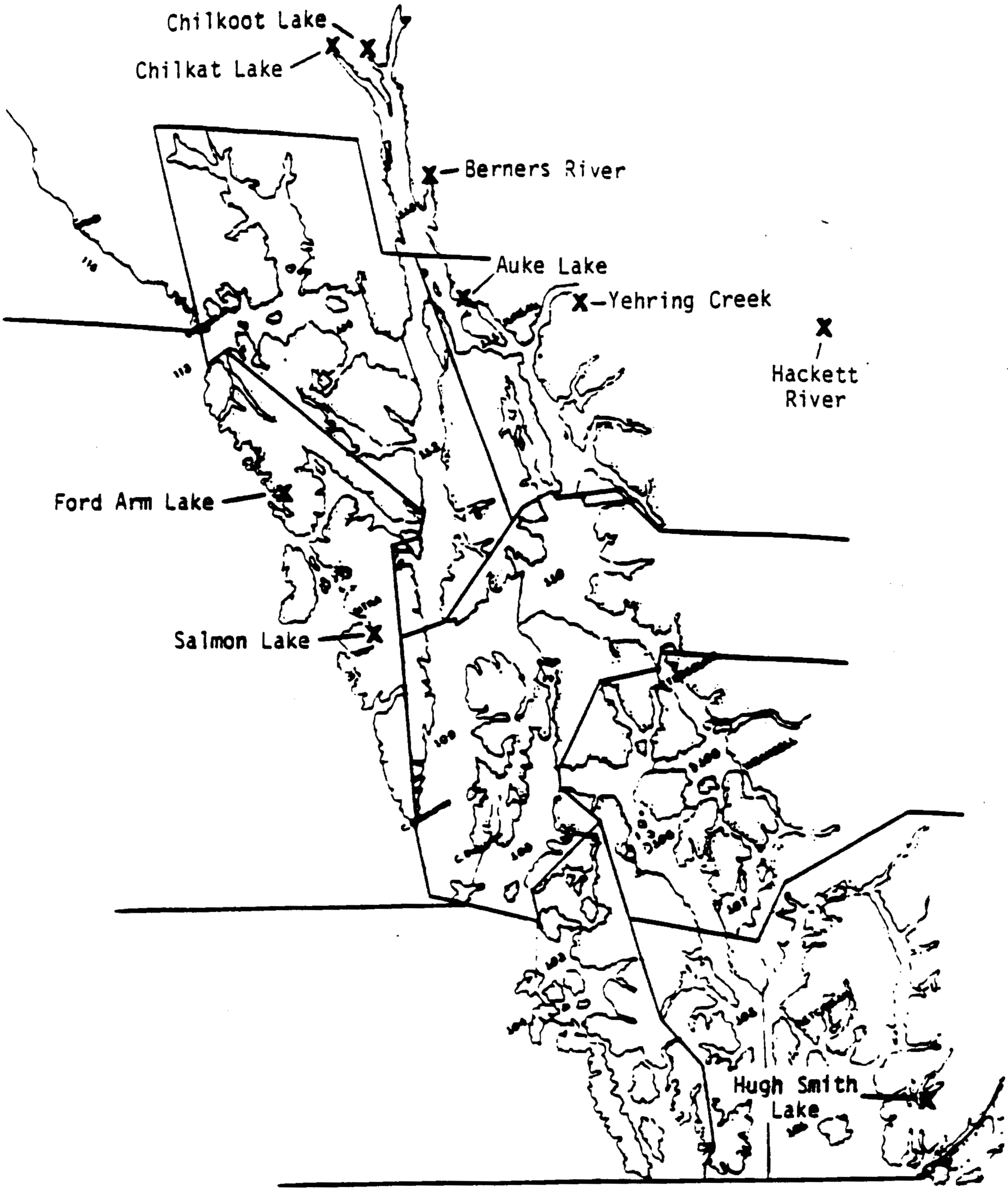

Figure 3. Index systems where total coho salmon escapement was enumerated or estimated, 1986.

is now standard practice at some weirs to tag every adult that is counted to provide an alternative method for estimating the escapement if the weir fails.

Escapement surveys are cost effective but usually suffer from inconstant sources of bias. Ground or aerial surveys do not stand well on their own for assessing escapement to a management area. However, escapement surveys for a number of systems are valuable for supplementing less extensive absolute counts or estimates and terminal fishery performance data for area wide escapement assessment. Survey index systems and methodology are well established in some management areas, but not in others. Again, data collected in northern Southeast is much more comprehensive compared with southern Southeast. More effort needs to be put into developing an escapement survey program that best balances geographic coverage and intensity, with available funding.

A standardized catch sampling program has been implemented for commercial and sport fisheries. Minimum coded-wire tag sampling objectives for the fisheries are 20% of the catch by area, gear type, and week. Minimum age-length sampling objectives are 250 samples per week from the troll fishery within four major areas, and a total of 600 samples by district and gear type for the net fisheries. Four scales per fish are taken from coho salmon because of high regeneration rates.

No alternative stock identification techniques have been developed for Southeastern alaska coho salmon stocks. The National Marine Fisheries Service (NMFS) is in the process of collecting and analyzing electrophoretic, brain parasite, and scale elemental composition data. In addition, NMFS is developing radio tagging and tracking techniques for use in the Taku River.

There has been no major effort at developing a reliable technique for forecasting coho salmon abundance in Southeast Alaska. Observations in recent years indicate that there is a great deal of variability in run strength among geographic areas in the region. Determining underlying relationships between environmental variables and production is complicated by the complex marine environment and wide variety of habitat types utilized by coho salmon in Southeast Alaska. Assessment of run strength to individual systems or areas is complicated by highly mixed stock fisheries and a lack of escapement data. It will be possible to begin addressing this problem after a sufficient data base is developed of total return estimates for individual tagged stocks. In the interim, there is sufficient data available to investigate the possibility of forecasting Yakutat area stocks. The fisheries harvesting Yakutat area stocks are generally more stable and less mixed stock in nature while the habitat and climate are less variable. This type of study has been recommended for a student seeking a graduate degree, but is considered to be a lower priority project for department staff because of the substantial amount of time required.

There has been no comprehensive published analysis of historical catch and effort data. However, I have analyzed a considerable portion of available catch and effort data for the period after 1959. Most of this has been done for comparison with coded-wire tag data or for developing inseason management data bases. I have developed most of the major data bases that are of potential use in inseason management. However, there are still potential benefits from analyzing this data in a more rigorous fashion. Also, historical trap data and much of the troll logbook data has yet to be analyzed.

Dramatic increases in hatchery production have posed serious management problems. The most acute of these to date has been in the District 106 drift gillnet fishery where several major hatchery coho salmon stocks intermingle with wild stocks and contribute a significant proportion of the total catch particularly in later weeks. This fishery is managed on the basis of comparison with historical performance data. Therefore, unless the hatchery contribution can be accounted for in a time frame of less than a week the increasing abundance of hatchery fish poses the risk of overharvesting wild stocks. The time frame for processing of tag recoveries by the tag lab is inadequate for directly estimating contribution to the fishery on a weekly basis during the season. I have developed a model incorporating tag recovery data from the troll fishery and the incidence of adipose clips observed in the District 106 fishery that enables the area biologist to estimate the hatchery contribution within about a day after each opening. This model appears to be useful but needs further testing and evaluation. Similar problems are beginning to occur in other fisheries including the region-wide troll fishery to which hatcheries contributed approximately 12% of the catch in 1986. Increasing hatchery production, in combination with shortened chinook salmon seasons, will inevitably result in increased pressure on wild coho salmon stocks over a longer period of the season in the highly mixed stock troll fishery. There is developing a critical management need to account for hatchery contributions.

Future Research Priorities

The highest priority for coho salmon research is, with available budgets, to establish an optimum blend of long-term projects that involve: (1) escapement enumeration with coded-wire tagging; (2) escapement enumeration alone; (3) escapement surveys. Escapement is the basis for future harvest and, therefore, must be the primary guideline for assessing management. The major long-term objective for those systems where tagging is conducted annually is to develop unbiased escapement objectives based on stock-recruitment relationships. Escapement to other systems will, out of necessity, be judged primarily through comparison with a continually developing historical data base of averages, extremes, etc. Although not of great short term glory, escapement assessment projects increase in value with every year that they are undertaken. Currently, the greatest need for improved escapement assessment is in southern Southeast.

Additional, short-term coded-wire tagging projects should be undertaken in any situation where a management problem or question exists and funds are available, without compromising higher priority long-term projects. Short-term tagging projects are often useful for determining the representativeness of long-term index stocks and for increasing our understanding of stocks for which long-term projects are not feasible.

Analysis of both coded-wire tag and fishery data needs to be improved and brought up to date. There have been recent improvements in both timeliness and access to the coded-wire tag data base. However, it still has a long way to go. Currently three different expansion methods are used for different years and there are no programs in the system for estimating variance. Different users have manipulated and developed the raw data base for different purposes, but none of their efforts have been coordinated with other users. There is a need for additional biometric and programming support to make the system more accessible, flexible, and consistent. The more quickly the system is organized, the better because of the large volume of data being added annually. There have been improvements in access to catch and effort data through the run-time system. However, serious problems remain that result in substantial bias in the data for some historical fishery performance indicators. Analysis of fishery data should be continued to explore questions concerning stock status, migratory behavior, and changes in fishing patterns, etc. that are important to management.

Continued efforts should be directed toward estimating hatchery contribution inseason, particularly for indicator fisheries that are used for inseason management. These include the gillnet fisheries, the Juneau sport fishery, and the troll fishery. In some cases, models can be developed that provide estimates based on presently available data rather than expending additional resources to further reduce tag recovery processing time.

Currently, alternative stock identification techniques show little potential for being applicable to Southeast Alaska coho salmon stocks. There is some interest in developing techniques to provide national contribution estimates that may be useful for resolving questions related to the U.S./Canada treaty. Resources should not be reallocated from important long-term management oriented research to pursue alternative stock identification techniques.

Forecasting and optimum escapement studies have been given lower short-term priority. There is presently not enough information to develop a realistic forecasting technique that is applicable region-wide. Neither is there enough information to develop objective escapement goals on the basis of stock-recruitment relationships or habitat characteristics. These are both objectives for the future. We should make certain now that we are collecting basic biological and physical data from catches and index stocks that may be useful for addressing these objectives in the future.

Management will necessarily lag behind research because of the long standing structure, tradition, and allocation balances among the numerous fisheries that harvest coho salmon. It is the job of the researcher to both conduct the basic information gathering programs and to synthesize new and existing data to provide the best possible understanding of the resource and fisheries. It is important that findings and ideas be continually communicated with fishery managers and the public. It is particularly important to maintain an open, inquisitive mind as the vast, complex picture is continually unfolding here and there, adding new perceptions and changing old ones. It is the complex nature of the resource and fisheries combined with the amazing adaptability and survivability of the species that makes studying Southeast Alaska coho salmon one of the most rewarding efforts that can be undertaken in the fisheries field.

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Discussion Points (Shaul's presentation)

1. Total number of active power trollers is approximately 800 vessels. Active hand trollers have declined to 700-800 from over 2,000 a few years ago.

2. Catch-per-unit-effort has increased in recent years, especially for the early season fishery.

3. Boats are fishing farther and farther off-shore, directing their efforts at concentrations of feeding fish.

4. July catch in northern coastal areas (District 13) is composed of extremely mixed stocks (Yakutat to northern B.C. stocks). Later effort is concentrated on the more local stocks.

5. Continued tagging of wild and hatchery stocks will be necessary in order to evaluate stock contributions, though the future for tagging hatchery stocks looks bleak in light of the current budget situation.

A REVIEW OF SPORTFISH DIVISION COHO SALMON RESEARCH AT SALMON LAKE, SITKA

By

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INTRODUCTION

This coho research project began in 1983 as part of a cooperative program being conducted by the Division of Commercial Fisheries and Division of Sport Fisheries. The concept was for the Division of Sport Fish to study near-urban coho populations while the Division of Commercial Fisheries would study more remote sites.

The Sport Fish study has two primary objectives and study segments.

OBJECTIVES

1. To index coho escapements in streams near Juneau, Ketchikan, Sitka, and Petersburg and establish escapement goals for coho salmon in the index streams contributing to urban area recreational fisheries in Southeast Alaska.

2. To determine immigration route, run timing, harvest rate, and areas of harvest of coho salmon from selected Index Streams in Southeast Alaska (Salmon Lake system).

RESULTS

I will limit my discussion to these two major objectives and discuss the Salmon Lake results first.

We have well documented the Salmon Lake coho stocks: 1) areas of harvest (3 years' data), 2) harvest rate (3 years' data), 3) run timing (2 years' complete data), and 4) immigration routes.

In addition, we have gained much information about population dynamics of coho in Salmon Lake. I believe this information is representative of many of the low productivity anadromous coho lakes on Baranof and Chichagof islands.

Information available for Salmon Lake includes smolt population estimates, smolt age class structure, size at age of smolt for different years, contribution of smolt by brood year, timing of smolt emigration as related to temperature, and relative contribution to jack and adult populations by age class of smolt from a given smolt year. This type of information is essential to understanding coho population biology.

We may want to discuss this information later.

Salmon Lake:

Areas of Harvest

Nearly all coho from Salmon Lake are caught on the outside coast (District 113 and north) (Figure 2) with no returns from "inside" fisheries.

Figure 3 shows tag recovery of Salmon Lake coho by area for 1985. This is the most representative annual distribution as the whole area was open to troll fishing in 1985. The northern area was closed to trolling for much of the 1986 season, so effort shifted southward with more pressure in the Sitka/Edgecumbe areas and no reported catch from Yakutat.

Harvest Rate

During the first 2 years of the study (1984 and 1985), the troll harvest rate was 35-36% of calculated total production (Figure 4).

In 1986, harvest rate by troll increased to 54.6%, while a special seine fishery in Sitka Sound harvested an additional 2% for a commercial harvest rate of 56.6%. This represents a 20% increase in harvest rate for 1986.

Run Timing

The troll harvest of Salmon Lake coho (Figure 5) begins in late June (week 26) and has peaked on week 30 (late July 1985) and week 32 in 1985.

These fish are available to commercial harvest until at least week 36 (first week of September) with some catches occurring until mid-September. Fish are available to troll harvest for a 12-week season from late June until late September.

The timing of the major harvest of Salmon Lake coho was much earlier in 1986 than 1985. Seventy-one percent of the troll harvest for Salmon Lake stock was over by the end of July during 1986, while only 46% had been taken by this time in 1985. This shift in timing of harvest was a result of direct targeting of the troll fleet on coho early in the season.

Concentrating the troll fleet in District 113 during the 1986 troll season has obviously increased catch in 113 and catch rates of outside stocks. Figure 6 shows the relative portion of the Southeast troll catch which annually occurred in District 113 and associated harvest rate of Salmon Lake coho.

Return of coho adults to Salmon Lake begins in early to mid-August (7th to 15th) and continues through mid-October. Cohos school in the intertidal and estuarine area until high stream flow. The immigration coincides directly with high flow periods and peaks in late September or the first few days of October. The peak has been on October 2 for 3 of the 4 years the weir has been operated. We often get 70-80% of total weir escapement in a 3-day period of early October.

Immigration Route

Salmon Lake coho lie offshore near the coast in District 113 from late June through mid-September. Distribution of the harvest is our best evidence of migration route (Figure 3).

Coho Escapement Indices:

A number of coho systems near Sitka, Juneau, Ketchikan, and Petersburg have been surveyed on an annual basis from 1983-1986.

Obtaining coho escapement index counts is a fun activity which gives the area biologists an opportunity to get out of the office in late September and early October and enjoy the fall weather.

Survey dates have been timed to coincide with the major immigration of adult coho and should be done early enough to observe the fish when they are schooled in the lower river areas. This timing varies by system and has been determined from repetitive surveys in each area.

Stream water level and turbidity limit visibility, so ideal conditions are a low flow period, (2- or 3-day period of no rain) in early October following a heavy rain. Getting a heavy rain in early October usually isn't a problem, but finding a 2- or 3-day period of good sunny weather is sometimes a problem.

✓ Systems with hatchery influence should be dropped from the list of index streams as they are not representative of wild stock coho systems.

Sitka Escapement Indices

The escapement counts obtained in Sitka are a result of efforts by biologists working for the Divisions of Commercial Fisheries and Sport Fish, U.S. Forest Service, NSRAA, and Sheldon Jackson College.

When we have our 2- or 3-days period of nice weather in early October, the majority of the fisheries biologists in Sitka have a picnic on some coho stream. It takes this type of cooperation to make the "index system" work.

I will discuss the Sitka Area index streams by category. Categories are: 1) small streams, 2) larger rivers, and 3) lake systems.

Small Stream Systems. Pay particular attention to years 1983-1986, as a more systematic survey has been conducted during these years.

Examine Figures 7-12 for patterns of low escapements and high escapements. These figures show high escapements in 1984 and 1985 and low escapements in 1983 and 1986. Escapement counts in 1986 are the lowest ever recorded.

Indian River didn't have the extremely low escapement in 1986 common to the other small streams but has been influenced for several years by hatchery operations of Sheldon Jackson College.

Figure 13 summarizes the escapement history of five small streams near Sitka from 1983 through 1986. Most of the stream systems in this area produce primarily age-2 smolt. Thus the adult return in 1987 will be primarily from escapement in 1983.

Larger River Systems (Nakwasina and Black River). Nakwasina River (Figure 14) shows the same pattern of low escapement in 1983 and 1986. Black River on west Chichagof Island also shows low escapement in 1986 (Figure 15). Again we assume primarily age-2 smolt, so 1987 returns will be primarily from 1983 escapements.

Lake System (Salmon Lake). Escapement counts to Salmon Lake (Figure 16) show that 1983 was the lowest escapement year, with 1986 far below the highs of 1984 and 1985. Total production in 1986 was not far below the past 2 years, but the harvest was up 20%, thereby reducing escapement.

Ketchikan Escapements Indices

Due to some money saving efforts we have continuous data on only two wild fish systems in the Ketchikan Area, Carroll River, and Hulakon River (Figure 17). Ward Creek was influenced by hatchery plants, so is not a good index system for wild stock evaluations.

These systems show the same pattern of poor escapement in 1983 with increased escapement in 1984 and 1985 followed by much reduced escapement in 1986.

Petersburg Escapement Indices

Petersburg index streams included two systems with wild stock and three systems with hatchery influence.

The wild stock systems (Petersburg and Bear creeks) had similar escapement in 1983 and 1985 with increased escapement in 1984 (Figure 18).

The 1986 data is conspicuously absent. Someone decided we didn't need a Sport Fish biologist in Petersburg, and other Petersburg biologists evidently didn't want to go for a picnic last fall.

Systems influenced by hatchery production include Ohmer, Sumner, and Falls creeks. These are not representative of wild stocks, so are unacceptable index systems.

Juneau Area

We have data from six stream systems in the immediate Juneau Area (Figure 19) which shows a very definite escapement decline in 1986.

The Juneau and Petersburg escapement indices don't show the definite low in 1983 which is evident in the outside systems (Sitka and Ketchikan).

DISCUSSION

Index systems must be studied over a continuous time stratum. Studying alternate sites on varying years is not as beneficial as picking representative systems and staying with those.

Once good representative study sites have been selected they should be maintained, i.e. the Salmon Lake system is probably representative of most lakes on Baranof and Chichagof islands. The Salmon Lake study has a continuous 4-year database with extensive smolt and adult population estimates and population biology data not available from most systems studied. We are just now seeing smolt from the adult escapements which occurred when the project was begun. Figure 20 shows the reduced smolt production from the reduced escapement in 1983.

The wild stock coho evaluation system we have at present consists of two primary entities: 1) intensively studied and weired lake systems and 2) stream systems which are evaluated only by index counts. We need to do more intensive investigations on some smaller stream systems.

COOPERATIVE CF/SF COHO SALMON RESEARCH:

CHILKAT LAKE, CHILKOOT LAKE, AND YEHRING CREEK STUDIES

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INTRODUCTION

Coho salmon are important commercial, recreational, and subsistence fish in Southeast Alaska. From 1980 - 1986, the commercial fisheries' harvest averaged 2.05 million coho salmon per year and the recreational fisheries harvest averaged 48,503 coho salmon per year (Mills 1986), for a combined annual value of over $15 million to the fishermen. Coho salmon commercial catches in Southeast Alaska have increased considerably over the levels of the 1960's-1970's. These larger catches, however, have come at the expense of near-terminal fisheries and spawner escapement (Anonymous 1985).

Coho salmon are managed by evaluating catch and harvest rate data collected from a mixed-stock fishery. These data do not provide information on harvest rates of specific stocks, which can lead to their over harvest. To illustrate: in 1986, a record harvest of coho salmon by the commercial fisheries (primarily power trollers) gave the perception that all stocks were abundant. Though this was true of southern Southeast Alaska stocks the northern area stocks were less abundant and were overharvested -- as indicated by record low escapements in Sitka and Juneau area streams and a dismal Juneau coho salmon recreational fishery.

To address these problems, the Divisions of Commercial Fisheries and Sport Fish of the Alaska Department of Fish and Game (ADF&G) have agreed to jointly develop a comprehensive, long-term data base similar to the Oregon Production Index (GAO report 1983; McGie 1986), with the goal of improving the management of specific coho salmon index stocks. Two such stocks, the Taku River and Lynn Canal, are major contributors to the Juneau marine, Haines marine, and Haines freshwater sport fisheries.

Consistent annual collection and evaluation of the following types of data will be necessary to achieve this goal: 1. Long-term data on the relationships between:

a. escapement and subsequent smolt production; and

b. escapement and subsequent adult production to establish biologically meaningful escapement goals.

2. Environmental data and coho salmon jack (i.e., age .0 males) return rate as a potential method of forecasting future coho salmon run size.

3. Information from the return of coded wire tagged fish will allow the estimation of migration routes, run timing, areas of harvest, and the harvest rates of adults from specific stocks.

The objectives for the Division of Sport Fish in fiscal year 1987 for the Juneau-Haines area, as established by the Cooperative Commercial Fisheries/Sport Fisheries Coho Salmon Research Plan (Anonymous 1986), are as follows:

1. Estimate the escapement of age .1 coho salmon to Chilkat Lake and Chilkoot Lake between 1 September and 15 November 1986.

2. Estimate the escapement of age .0 and age .1 coho salmon to Yehring Creek, Taku River, between 1 September and 15 November 1986.

3. Estimate the harvest rates, numbers caught, migration routes, run timing, and areas of harvest of Chilkat Lake, Yehring Creek, and Chilkoot Lake coho salmon in the various southeast Alaska fisheries.
4. Estimate the freshwater age composition, sex composition, and mean length at freshwater age of age .1 coho salmon returning to Chilkat Lake.
5. Estimate the age composition, sex composition, and mean length at freshwater age of age .0 and age .1 coho salmon returning to Yehring Creek.
6. Estimate the age composition and mean length at age of coho salmon smolts emigrating from Yehring Creek from May to June, 1987.
7. Estimate the coho salmon spawner distribution in Chilkat Lake and its tributaries, and in Yehring Creek.

RESULTS AND DISCUSSION

Yehring Creek

Escapement:

Between 23 August and 3 October 1,816 adult coho salmon were counted at the Yehring Creek weir. An additional 300 fish (estimated by observation) migrated upstream when the weir was flooded on 3 October giving an minimal estimated escapement of 2116 adult coho salmon. Daily counts and records of water temperature and water depth are listed in Table 1. The mean of the migratory time density occurred on 16 September ± 13 days.

A mark-recapture estimate of escapement was not conducted. Flood waters allowed fish to disperse and no concentrations of fish were available for sampling.

Age-length-sex composition:

Of the 1,816 fish counted at Yehring Creek weir, 527 (29.0%) were females and 1,289 (71.0%) were males. Analysis of scales from a sample of 362 fish found 312 scales with legible fresh and saltwater zones. Of the 312, 19 (6.1%) were age .0 (jacks), 67 (21%) were age 1.1, and 226 (72%) were age 2.1 (Table 2). Approximately 73% of the escapement came from the 1982 parent year (Table 3).

Unequal sex ratios of adult coho salmon suggest that some females were not counted, or that their sex was misidentified. Females tended to arrive later at Yehring Creek than males (Figure 1) and consequently most of the fish lost in October may have been the remainder of the expected females. On the other hand, identification procedures may have been at fault and may need to be improved.

The length frequency of the males returning to Yehring Creek was bimodal and divided at interval 595 mm (Figure 2). The lower size ranges were not represented by jacks; there were few jacks in the population. Also, the distribution was not attributed to freshwater age; e.g. values for age 1.1 and age 2.1 male coho were equally distributed across the bimodal distribution (Figure 3). The bimodal distribution may be related to run timing. Mean length of males during the period 23 August - 14 September was 544 mm (SD=88.1, n=765) and significantly different from the male mean length of 624 mm (SD=80.6, N=564) during 15 September - 3 October, (one-way Anova, $P < 0.05$). The size difference may have been related to the amount of ocean feeding time; early arriving males, having spent less time at sea, were smaller than those arriving later in the season.

All fish counted through the weir were examined for hook injuries. Of 1,816 adult coho examined, 250 (13.7%) had identifiable hook injuries on the jaw, head, or operculum (Table 4).

Harvest rates:

Harvest rates of Yehring Creek coho salmon will be estimated after the return of adults coded-wire tagged as smolt. The first adults will return as jacks in fall 1987.

Chilkat Lake

Escapement:

Between 1 September and 15 November 1986, 635 age .1 coho salmon were counted through the Chilkat Lake weir. Daily records of escapement, water temperatures, and water depth are listed in Table 5. Jacks were not counted because the large spacing between weir pickets allowed these fish to escape upstream. The peak of the escapement (mean of the migratory time density) occurred on 20 October ± 14 days.

Age-sex-length composition:

Of the 635 adult coho salmon counted at Chilkat Lake weir, 510 were sampled. Of these, 221 were females (43.3%) and 289 were males (56.7%). Analysis of scale samples found that 106 were illegible, 7 had missing data, and 8 were jacks; all were excluded from age composition estimates. Of the remaining 389 samples, 56 (14.4%) were age 1.1, 328 (84.4%) were age 2.1, and 5 (1.2%) were age 3.1 (Table 6).

All adult coho salmon captured at the Chilkat Lake weir were examined for hook injuries. Of the 510 fish examined, 30 (5.9%) had hook injuries.

Harvest rates:

Harvest rates of Chilkat Lake coho salmon will not be available until the return of adults coded-wire tagged as smolt. The first adults will return as jacks in fall 1987.

Chilkoot Lake

Escapement:

Between 1 September and 15 November 1986, 2,009 age .1 coho salmon were counted at the Chilkoot Lake weir. Jacks were not counted because the large spacing between weir pickets allowed most fish of this age class to escape upstream. Daily records of escapement, water temperature, and depth are listed in Table 8. The peak of the run (mean of the migratory time density) was 4 October ± 10.5 days.

Harvest rates:

Harvest rates of Chilkoot Lake coho salmon in the various fisheries will be available in fall 1987 after the adult return from 6,300 juveniles tagged by the Division of Commercial Fisheries in August 1985.

Coho Salmon Database: Chilkat Lake, Chilkoot Lake, Taku River

The adult coho salmon counts from Chilkat and Chilkoot weirs and aerial and foot surveys for the Taku River were summarized and compiled as a microcompter database. Chilkat and Chilkoot weir data has been collected inconsistently from 1976-1984 resulting in missing data or artifically low counts in most years (Figure 4). This was due to lack of funds needed to operate the weirs for a prescribed amount of time each year (Figure 5). Because of the inconsistency, the coho salmon database prior to 1985 is unreliable and should not be used for management of these stocks.

The accuracy of the Taku River coho salmon escapement index from 1971 to present was evaluated from 1971 to present by comparing the index data (all streams summed) to the Taku Inlet gillnet catch and the Auke

Creek weir escapement (Figure 6). From 1975 to 1982 the index follows a negative relationship to the gillnet catch -- when the catch is high, the escapement index is low -- a not unreasonable scenario. However, the same pattern exists when the escapement index is compared to the Auke Creek escapement data. This suggests that the index data collected during this time period has no relationship to number of coho salmon in the Juneau-Taku River escapement. Beginning in 1982 however, the index shadows the Auke Creek data suggesting that these surveys may be more reliable. Even so, current surveys are highly subject to error as experienced during the fall of 1986 when poor weather prevented surveys during the preferred time. To overcome these problems, surveys need to be repeated at least three times between September and October using preferably using different methods.

RECOMMENDATIONS

1. The immigration of adult coho salmon at Yehring Creek began prior to 23 August 1986. The weir should be operational no later than 10 August to capture early arriving adults.

2. A review of the 1986 coho salmon smolt timing data from the Auke Creek weir (data not presented in this report) suggests that smolt tagging should commence at Yehring Creek on 1 May and terminate on 15 June 1987. This assumes that emigration timing for the two populations is similar.

3. At Yehring Creek, adults held downstream of the weir for nearly two weeks before escaping upstream during floods. Consider moving the Yehring Creek weir about 1/2 mile downstream; this may allow most adults to pass upstream before the weir is over-topped.

4. Modify the Chilkat Lake weir during June 1987 to capture jacks by using aluminum channel drilled for pickets spaced on 4.6 cm (1-13/16 in) centers.

5. Attempt to capture and sample the age .1 adult coho salmon returning to Chilkoot Lake for age and sex composition and check for the presence of coded wire tags. Fish will be immobilized with an electro-shocking basket to reduce stress and mortality.

6. Consider using foot, dive, and additional aerial surveys to obtain escapement indices by helicopter of adult coho salmon in the Taku River and the Chilkat River. Aerial indices are expensive and highly influenced by poor weather.

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Table 1. Daily counts of adult coho salmon, water temperature and water depth at the Yehring Creek weir, Taku River, 23 August - 3 October 1986.

Date	Daily	Cumulative	Temp (C)	Depth(cm)
15 AUG		0		
16 AUG		0		
17 AUG		0		
18 AUG		0		
19 AUG		0		
20 AUG		0		
21 AUG		0		
22 AUG		0		
23 AUG	15	15 Weir operational		
24 AUG	7	22		
25 AUG	1	23		
26 AUG	0	23		
27 AUG	0	23		
28 AUG	0	23		
29 AUG	7	30		
30 AUG	1	31		
31 AUG	135	166		
01 SEP	236	402		
02 SEP	155	557		
03 SEP	20	577		66
04 SEP	55	632		56
05 SEP	28	660	11.0	56
06 SEP	21	681	10.5	53
07 SEP	0	681	11.0	52
08 SEP	34	715	11.5	50
09 SEP	39	754	10.0	48
10 SEP	45	799	10.0	46
11 SEP	49	848	9.0	44
12 SEP	38	886	9.0	43
13 SEP	37	923	8.5	39
14 SEP	1	924	9.0	39
15 SEP	60	984	10.5	38
16 SEP	57	1,041	8.5	37
17 SEP	39	1,080	6.5	36
18 SEP	37	1,117	6.0	33
19 SEP	8	1,125	7.5	33
20 SEP	9	1,134	8.0	32
21 SEP	20	1,154	9.0	33
22 SEP	91	1,245	10.0	38
23 SEP	196	1,441	9.5	54
24 SEP	95	1,536	8.0	56
25 SEP	39	1,575	8.0	57
26 SEP	89	1,664	7.0	42
27 SEP	26	1,690	7.5	39

-Continued-

Table 1. Daily counts of adult coho salmon, water temperature and water depth at the Yehring Creek weir, Taku River, 23 August - 3 October 1986.

Date	Daily	Cumulative	Temp (C)	Depth(cm)
28 SEP	12	1,702	7.5	37
29 SEP	17	1,719	7.0	33
30 SEP	12	1,731	8.0	32
01 OCT	2	1,733	8.0	33
02 OCT	39	1,772	7.9	40
03 OCT	44	1,816	8.0	64
04 OCT	300[1]	2,116	8.0	84
05 OCT	Weir out		7.0	136
06 OCT			7.5	159
07 OCT			7.0	164
08 OCT			8.0	138
09 OCT			7.5	133
10 OCT			7.0	112
11 OCT			6.0	82
12 OCT			6.5	112
13 OCT			6.5	62
14 OCT			7.0	84
15 OCT			7.0	170
16 OCT			7.0	156
17 OCT			6.5	130
18 OCT			6.5	112
19 OCT			6.0	89
20 OCT			6.0	112
21 OCT				109
22 OCT				107
23 OCT			7.0	132
24 OCT			6.5	119
25 OCT			5.0	106
26 OCT			5.0	86

[1] Estimated escapement during flood.

Table 2. Mean length (mm mid-eye to fork ± 95% C.L.) and age and sex composition of adult coho salmon sampled at the Yehring Creek weir, Taku River, 23 August to 3 October 1986.

	Female			Male			
Age	N	Length	%Comp. ± 95% C.L.	N	Length	%Comp. ± 95% C.L.	Total N
1.0				4	448 ± 58	1.3 ± 1.7	4
2.0				13	457 ± 44	4.2 ± 3.0	13
3.0				2	431 ± 247	0.5 ± 1.2	2
1.1	23	604 ± 29	7.4 ± 4.0	44	589 ± 26	14.1 ± 5.3	67
2.1	67	638 ± 15	21.5 ± 6.2	159	595 ± 15	51.0 ± 7.6	226
Total	90			222			312

Table 3. Estimated contribution by parent year to the 1986 adult coho salmon return to Yehring Creek, 23 August - 3 October 1986.

	Age Classes in 1986 Escapement						
Parent year	1.0	2.0	3.0	1.1	2.1	3.1	Total
1982			11		1534		1,545
1983		89		454			543
1984	28						28
Total	28	89	11	454	1534		2,116

Table 4. Daily counts of adult coho salmon with and without hook injuries at the Yehring Creek weir, 23 August - 3 October 1986.

Date	Not Injured	Injured	Total
23 AUG	15		15
24 AUG	7		7
25 AUG	1		1
29 AUG	7		7
30 AUG	1		1
31 AUG	130	5	135
01 SEP	220	16	236
02 SEP	143	12	155
03 SEP	20		20
04 SEP	51	4	55
05 SEP	25	3	28
06 SEP	20	1	21
08 SEP	32	2	34
09 SEP	34	5	39
10 SEP	34	11	45
11 SEP	39	10	49
12 SEP	32	6	38
13 SEP	30	7	37
14 SEP	1		1
15 SEP	46	14	60
16 SEP	46	11	57
17 SEP	35	4	39
18 SEP	30	7	37
19 SEP	6	2	8
20 SEP	8	1	9
21 SEP	13	7	20
22 SEP	76	15	91
23 SEP	160	36	196
24 SEP	81	14	95
25 SEP	32	7	39
26 SEP	75	14	89
27 SEP	16	10	26
28 SEP	9	3	12
29 SEP	13	4	17
30 SEP	7	5	12
01 OCT	2		2
02 OCT	33	6	39
03 OCT	36	8	44
Total	1,566	250	1,816

Table 5. Daily weir counts of age .1 coho salmon, water temperature, and water depth recorded at the Chilkat Lake weir, 1 Sept. - 15 Nov. 1986.

Date	Daily	Cumulative	Temp.(C)	Depth (cm)
01 SEP	0	0	12.7	25
02 SEP	0	0	12.7	19
03 SEP	0	0	12.2	16.5
04 SEP	0	0	11.6	13
05 SEP	0	0	11.6	10
06 SEP	0	0	11.6	9
07 SEP	0	0	11.6	8
08 SEP	0	0	11.1	7
09 SEP	0	0	11.6	1
10 SEP	0	0	11.1	-1.5
11 SEP	1	1	9.9	-4.5
12 SEP	0	1	9.9	-6.5
13 SEP	2	3	9.9	-9
14 SEP	2	5	9.9	-11
15 SEP	0	5	9.9	-15
16 SEP	4	9	9.4	-15
17 SEP	0	9		
18 SEP	3	12	9.4	-18
19 SEP	2	14	9.4	-19
20 SEP	1	15	9.4	-20
21 SEP	3	18	9.9	-21
22 SEP	1	19	10.5	-21
23 SEP	1	20	10.5	-18
24 SEP	0	20	7.7	-21
25 SEP	1	21	7.7	-21
26 SEP	8	29	6.6	-22
27 SEP	0	29	7.2	-23
28 SEP	2	31	7.7	-25
29 SEP	3	34	7.7	-25
30 SEP	29	63	7.7	-26
01 OCT	5	68		-26
02 OCT	14	82	8.3	-27
03 OCT	18	100	8.8	-28
04 OCT	12	112	8.8	-27
05 OCT	8	120	9.4	-25
06 OCT	20	140	9.4	-25
07 OCT	11	151	9.4	-26
08 OCT	7	158	8.8	-25
09 OCT	33	191	8.8	-26
10 OCT	8	199	8.8	-26
11 OCT	5	204	7.7	-27
12 OCT	0	204	8.3	-29
13 OCT	0	204	8.3	-26
14 OCT	0	204	8.3	-18

-Continued-

Table 5. Daily weir counts of age .1 coho salmon, water temperature, and water depth recorded at the Chilkat Lake weir, 1 Sept. - 15 Nov. 1986.

Date	Daily	Cumulative	Temp.(C)	Depth (cm)
15 OCT	0	204	8.8	-14
16 OCT	4	208	8.3	-14
17 OCT	5	213	8.3	-14
18 OCT	7	220	8.3	-17
19 OCT	6	226	7.2	-17
20 OCT	7	233	7.7	-18
21 OCT	22	255	7.7	-15
22 OCT	9	264	7.7	-12
23 OCT	19	283		
24 OCT	13	296	7.7	0
25 OCT	15	311	7.7	-2
26 OCT	20	331	6.6	-4
27 OCT	36	367	4.9	-6
28 OCT	33	400	4.9	-8
29 OCT	29	429	3.8	-12
30 OCT	15	444	2.7	-12
31 OCT	19	463	2.2	-14
01 NOV	11	474	2.7	-15
02 NOV	11	485	2.7	-17
03 NOV	9	494	2.7	-16
04 NOV	31	525	3.3	-17
05 NOV	15	540	2.7	-18
06 NOV	24	564	2.7	-20
07 NOV	36	600	2.2	-21
08 NOV	5	605	1.6	-23
09 NOV	1	606	1.6	-24
10 NOV	9	615		
11 NOV	1	616		
12 NOV	5	621		
13 NOV	8	629		
14 NOV	6	635		
15 NOV weir out		635		

Table 6. Mean length (mm mid-eye fork ± 95% C.L.) and age and sex composition of age .1 coho salmon sampled at the Chilkat Lake weir 1 September - 15 November 1986.

	Female			Male			Total
Age	N	Length	%Comp. ± 95% C.L.	N	Length	%Comp. ± 95% C.L.	N
1.1	26	640 ± 17	6.7 ± 3.3	30	628 ± 30	7.7 ± 3.6	56
2.1	148	662 ± 7	38.0 ± 6.5	180	665 ± 8	46.3 ± 6.6	328
3.1	4	677 ± 34	1.0 ± 1.3	1	705 ND	0.3 ND	5
Total	175			211			389

Table 7. Daily counts of age .1 adult coho salmon with and without hook injuries at the Chilkat Lake weir, 1 Sept. - 15 Nov. 1986.

Date	Not Injured	Injured	Total
26 SEP	1	0	1
28 SEP	2	0	2
29 SEP	3		3
30 SEP	2		2
01 OCT	4	1	5
02 OCT	8		8
03 OCT	3		3
04 OCT	8		8
05 OCT	6	2	8
06 OCT	7		7
07 OCT	9	2	11
08 OCT	7		7
09 OCT	17	1	18
10 OCT	8		8
11 OCT	5		5
17 OCT	4		4
18 OCT	6	1	7
19 OCT	6		6
20 OCT	7		7
21 OCT	22		22
22 OCT	9		9
23 OCT	18	1	19
24 OCT	12	1	13
25 OCT	12		12
26 OCT	18		18
27 OCT	34	2	36
28 OCT	30	3	33
29 OCT	27	2	29
30 OCT	14	1	15
31 OCT	17		17
01 NOV	11		11
02 NOV	11		11
03 NOV	9		9
05 NOV	15		15
06 NOV	23		23
07 NOV	35	1	36
08 NOV	4	1	5
09 NOV	1		1
10 NOV	4	4	8
11 NOV		1	1
12 NOV	4	1	5
13 NOV	7		7
14 NOV	30	5	35
TOTAL	480	30	510

Table 8. Daily counts of adult age .1 coho salmon at the Chilkoot Lake weir, water temperature, and water depth, 1986.

Date	Daily	Cumulative	Temp.(C)	Depth (cm)
01 SEP	0	4	8.8	20
02 SEP	0	4	8.3	20
03 SEP	0	4	8.8	17
04 SEP	0	4	9.4	14
05 SEP	1	5	9.3	12
06 SEP	9	14	9.4	11
07 SEP	38	52	9.4	11
08 SEP	21	73	9.4	10
09 SEP	4	77		
10 SEP	2	79		
11 SEP	4	83		
12 SEP	5	88		
13 SEP	15	103		
14 SEP	24	127		
15 SEP	31	158		
16 SEP	26	184		
17 SEP	22	206		
18 SEP	39	245		
19 SEP	23	268		
20 SEP	81	349		
21 SEP	72	421	8.8	-6
22 SEP	36	457	8.8	-3
23 SEP	110	567	8.8	2
24 SEP	68	635	8.3	2
25 SEP	131	766		
26 SEP	73	839		
27 SEP	33	872		
28 SEP	45	917		
29 SEP	16	933		
30 SEP	67	1,000		
01 OCT	70	1,070	8.8	-13
02 OCT	209	1,279	8.3	-7
03 OCT	117	1,396	8.8	3
04 OCT	54	1,450	8.3	12
05 OCT	79	1,529	8.8	20
06 OCT	120	1,649	8.3	16
07 OCT	28	1,677	8.3	11
08 OCT	19	1,696	8.3	8
09 OCT	5	1,701	7.7	9
10 OCT	22	1,723	7.7	3
11 OCT	55	1,778	8.3	2
12 OCT	19	1,797	8.3	-1
13 OCT	2	1,799	7.7	2
14 OCT	47	1,846	7.7	14

-Continued-

Table 8. Daily counts of adult age .1 coho salmon at the Chilkoot Lake weir, water temperature, and water depth, 1986.

Date	Daily	Cumulative	Temp.(C)	Depth (cm)
15 OCT	6	1,852	7.7	24
16 OCT	22	1,874		
17 OCT	4	1,878	7.7	16
18 OCT	0	1,878	7.7	9
19 OCT	0	1,878	7.7	5
20 OCT	16	1,894	7.7	5
21 OCT	45	1,939	7.7	3
22 OCT	34	1,973	8.3	6
23 OCT	18	1,991	7.7	29
24 OCT	9	2,000	7.2	28
25 OCT	9	2,009	8.3	18

Table 9. Aerial escapement indices of adult coho salmon conducted on Taku River (31 October 1986) and Chilkat River (3 November 1986) tributaries.

Stream	Escapement Index	Comments
Taku River:		
Fish Creek	40-65	May be 250 in outwash portion, turbid. Fish observed under ice in beaver ponds in headwaters.
Flannagan Slough	860-1,330	Fish in pairs and scattered.
Johnson Creek	13-37	Ice in lower sections.
Moose Creek	50-50	Fish in headwaters.
Sockeye Creek	164-183	Turbid, ice in lower section.
Yehring Creek	270-340	Visibility good- fish scattered; 2,116 counted through weir.
Chilkat River:		
Kelsall River (below bridge)	70	Fish scattered, water slightly turbid - visibility to 4 feet.
Tahini River	120	Conditions as above.
Tsirku River	13	Turbid.

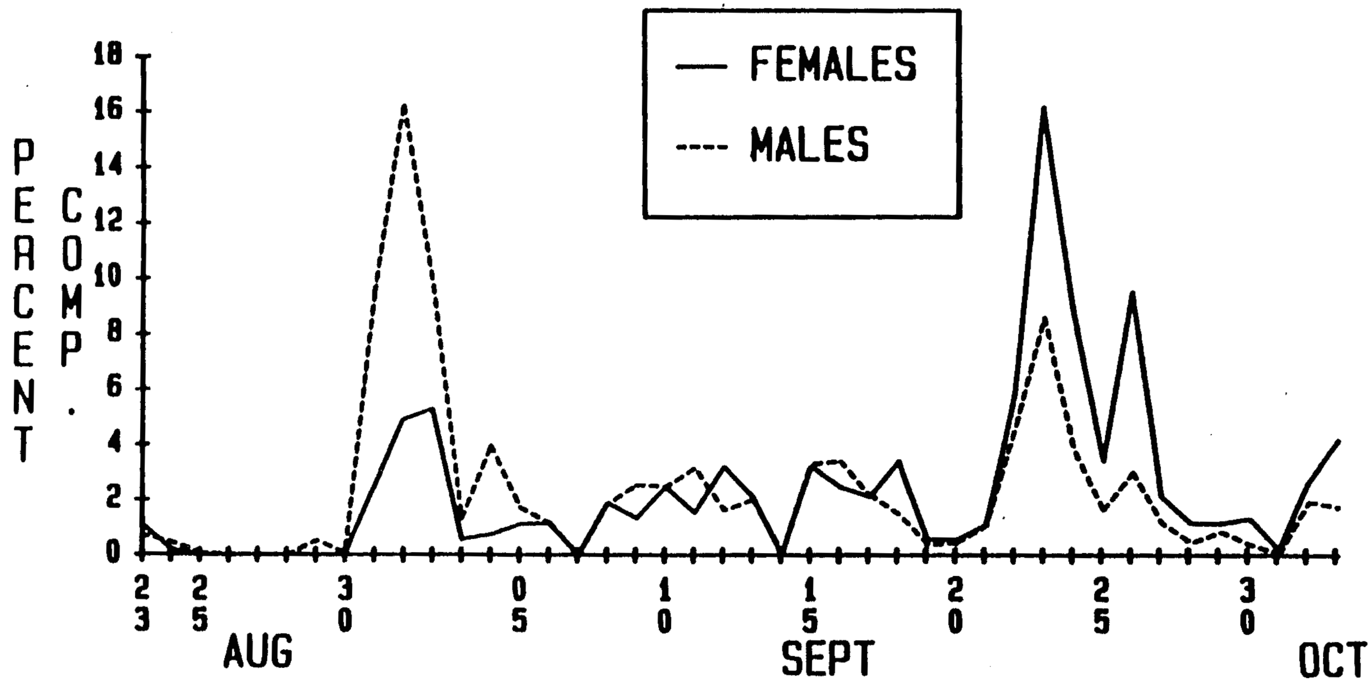

Figure 1. Timing (percent composition) of male and female adult coho salmon returning to Yehring Creek, Taku River, 1986.

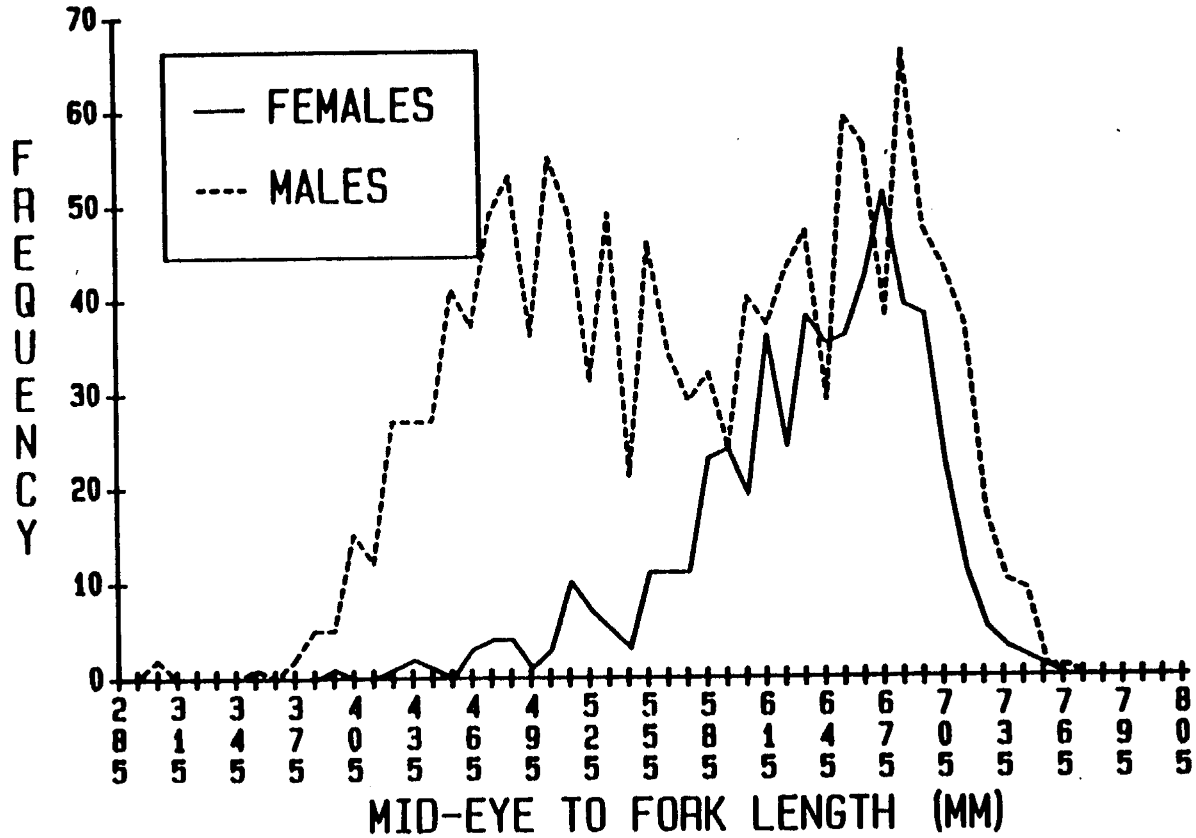

Figure 2. Length frequency of male and female adult coho salmon returning to Yehring Creek, 1986.

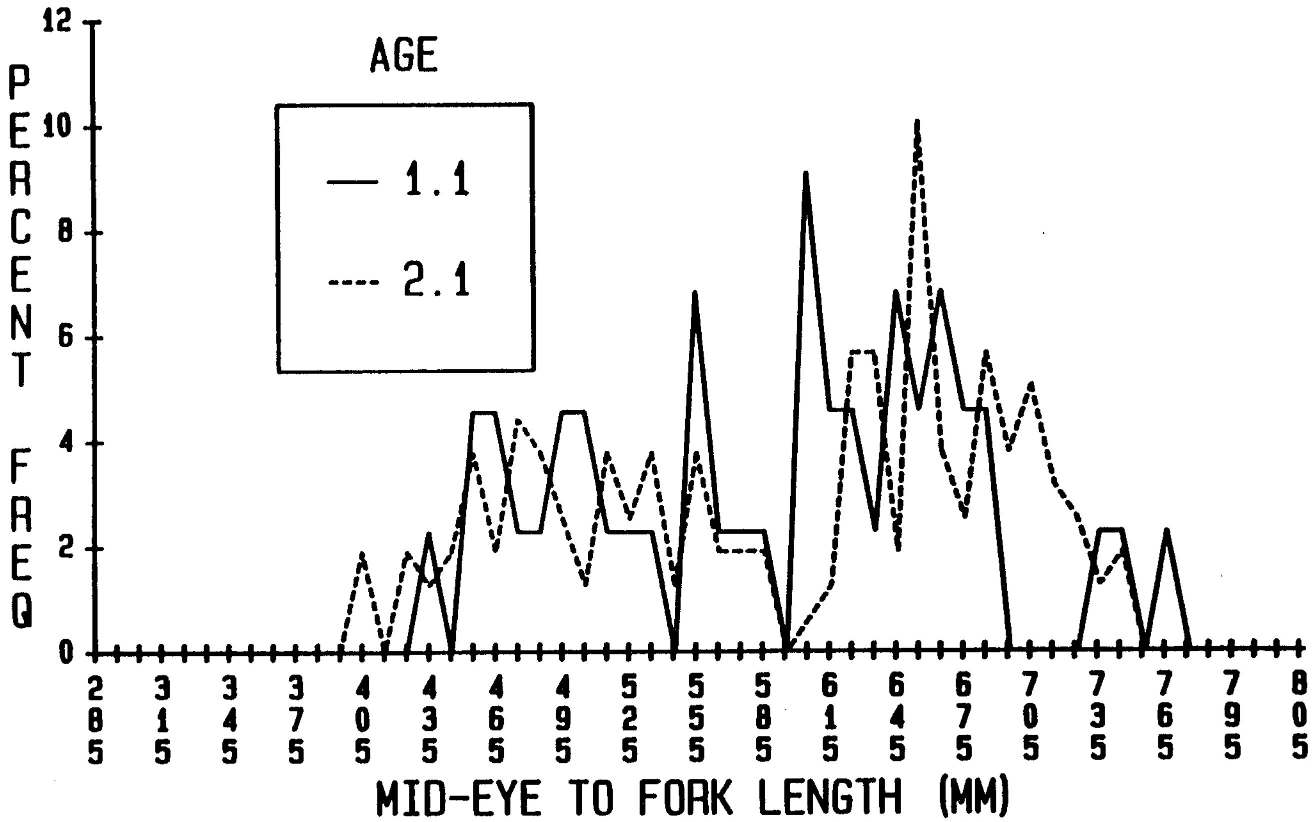

Figure 3. Length frequency of male and female adult coho salmon returning to Yehring Creek, 1986.

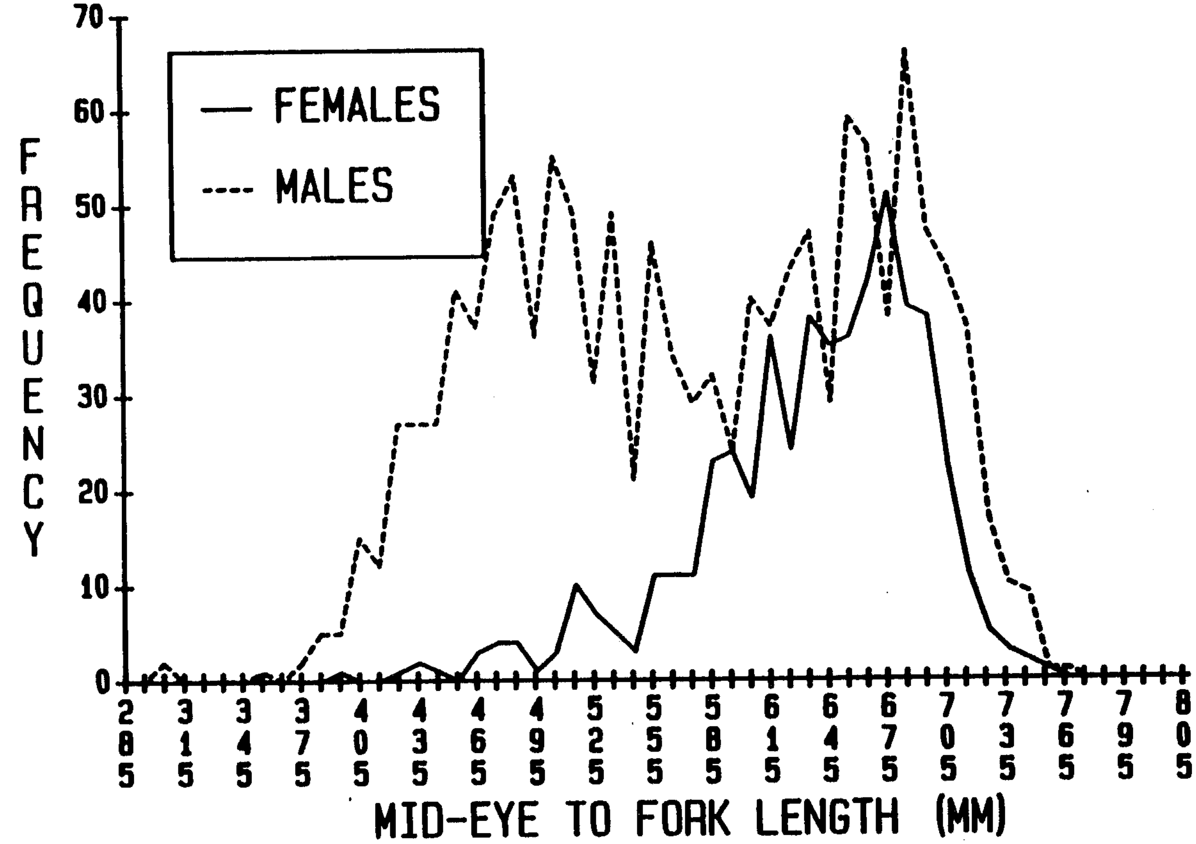

Figure 4. Length frequency of age 1.1 and age 2.1 male adult coho salmon returning to Yehring Creek, 1986.

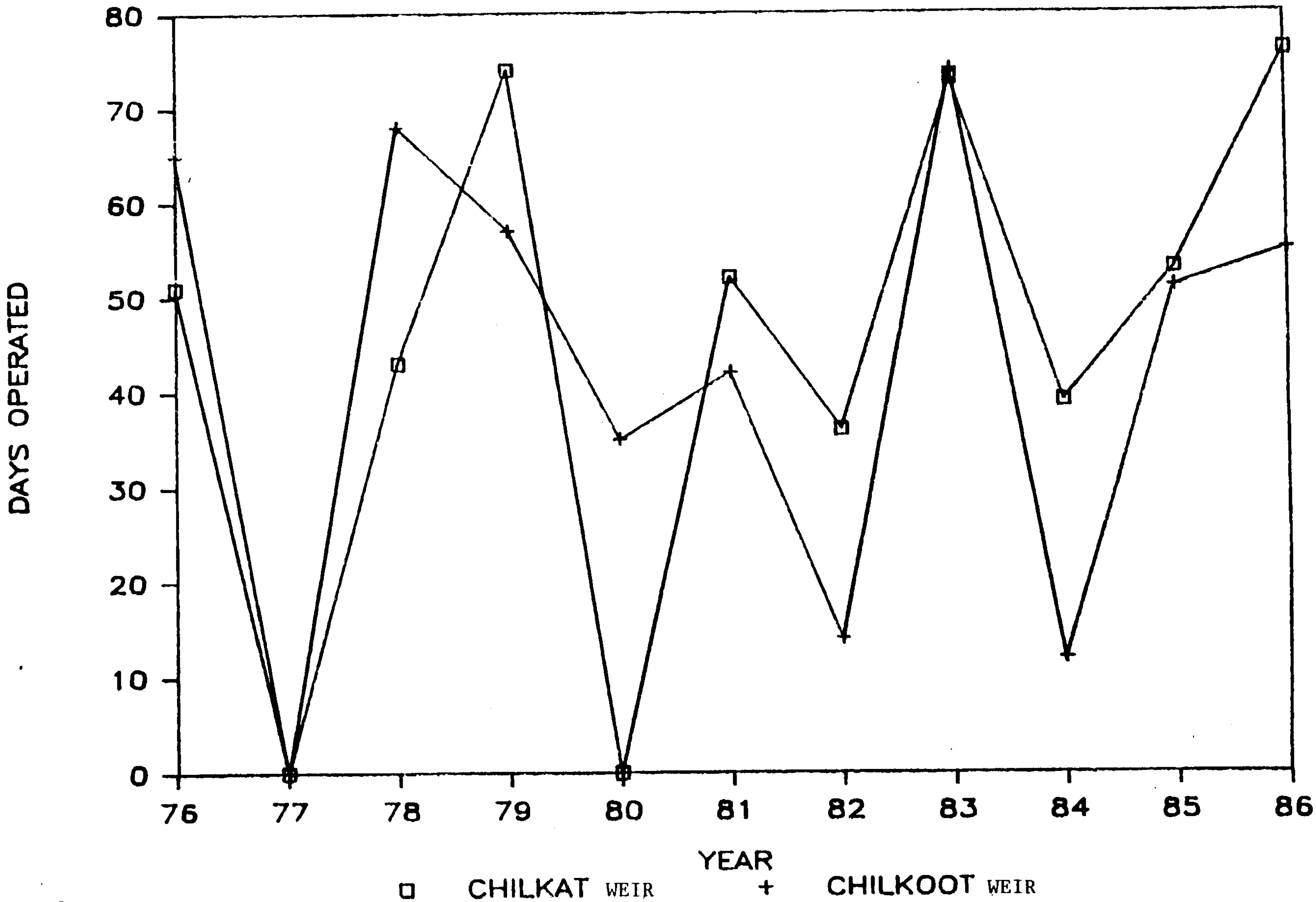

Figure 5. Number of days that Chilkat and Chilkoot weirs were operational past September 1, 1976-1986.

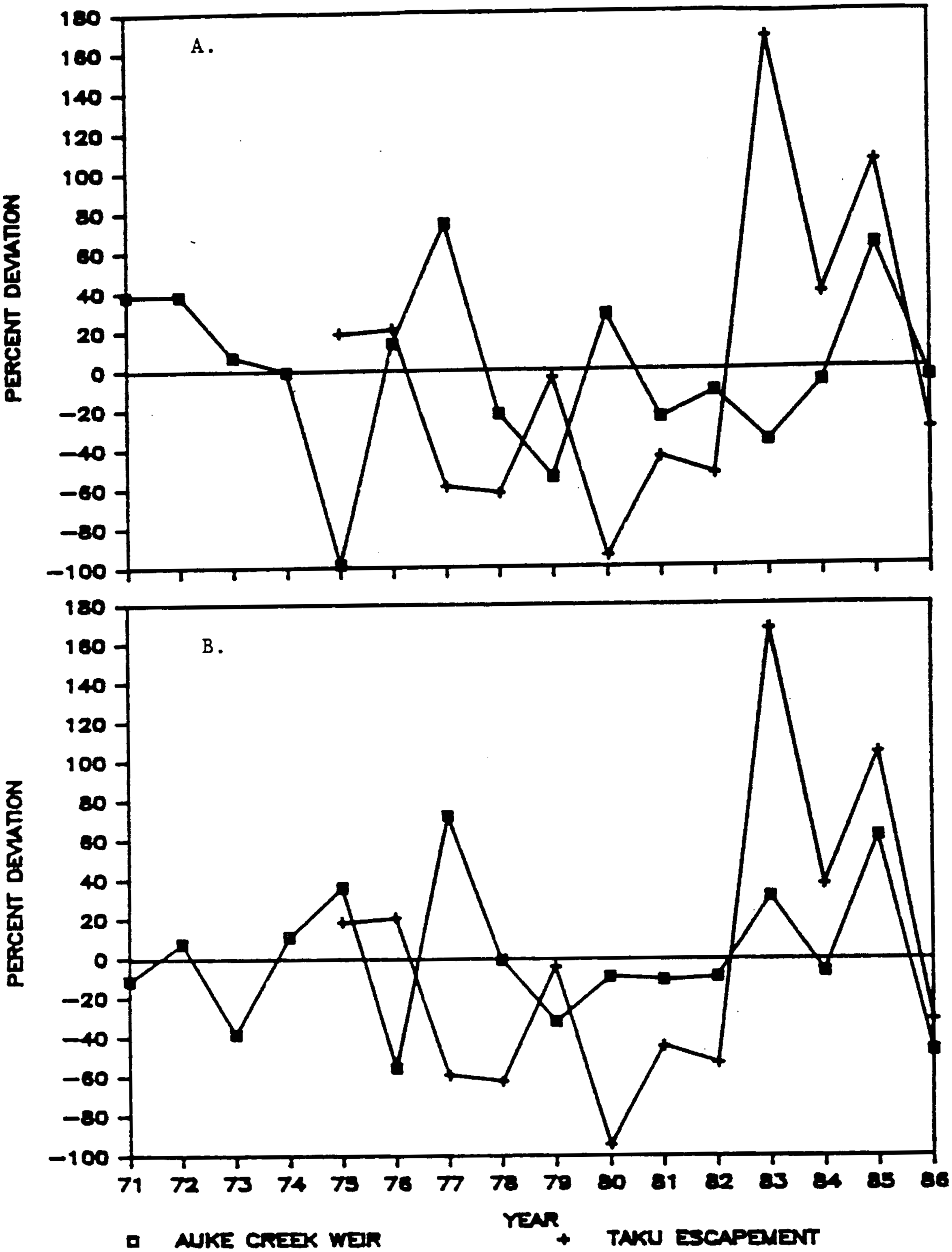

Figure 6. Percent deviation from 15 year mean: Taku River coho salmon index vs Taku inlet gillnet catch (A); Taku River index vs Auke Creek weir escapement (B), 1971-1986.

Discussion Points (Elliott's presentation)

1. If the same flood pattern exists in the future we can probably move the Yehring Creek Weir 1/2 mile down stream and pass most of the fish before the floods come.

2. Passed 2,000 + coho adults at Yehring Creek Weir, but only about 300 were later visible from the air during a helicopter survey. An earlier survey may have yielded better results, though bad weather prohibited it in 1986.

3. Taku River coho escapement is estimated at 40,000 - 70,000 with, perhaps, 25% being of U.S. origin.

King and Coho smolt predation on pink and chum salmon in nearshore saltwater nursery areas of southern Southeast Alaska

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ABSTRACT

The food habits of juvenile chinook, Oncorhynchus tshawytscha and coho, O. kisutch, salmon relative to their role as predators on pink O. gorbuscha and chum O. keta salmon was investigated near the release sights of Ketchikan area hatcheries. A decrease in the rate of predation in 1986 compared with 1985 was associated with a significant drop in the abundance of pink salmon in 1986. An increase in the number of empty stomachs found in cohos during 1986 suggested that an inadequate supply of alternate prey species were available to offset the low abundance of pink and chum salmon in 1986.

INTRODUCTION

Concern of the Alaska Department of Fish and Game (ADF&G) and Southeast Alaska seiners over the extent to which large scale releases of hatchery coho and king salmon may impact the wild stock pink and chum populations of the area lead to a small scale study of the potential problem. Neets Bay was chosen as the study area because of its proximity to existing early marine study areas; and the relative magnitude of it's releases (Table 1). Coho predation on pink and chum fry is well documented, the most dramatic example found to date was reported by Ames at the Southeast Coho Salmon Research and Management Review and Planning Workshop in 1982. Although his evidence was circumstantial, he calculated that the net effect of releasing an average of 734,000 coho per year between 1971 and 1978 from a WDF/Tribal Enhancement Project near the Stillaguamish River was a reduction of 6.5 adult pink salmon in the catch for each adult coho added to the catch.

Table 1. Coho releases from hatcheries in southern Southeast Alaska.

Hatchery	1983	1984	1985	1986	Future Goals
Crystal Lake	703,000	1,200,000	702,900	13,000	250,000
Klawock	864,000	766,000	1,181,000	1,100,000	1,100,000
Whitman Lake	208,000	308,500	860,000	150,000	150,000
Little Port Walter	29,000	0	0	0	0
Tamgas	525,000	476,000	5,900,000	5,000,000	5,000,000
Neets Bay	2,300,000	2,750,000	2,100,000	2,300,000	5,000,000

The pink salmon population in southern Southeast Alaska has in recent years been brought back to historic high levels. Consequently, the loss of a few 10's or 100's of thousands of pink salmon is not a major concern when compared to 1985 and 1986 harvest levels of 32 and 45 million respectively. A main concern of the Department is the effect of differential mortality caused by the presence of an excessive number of predators in a small area. Harvest strategies in southern Southeastern involve extensive harvesting in the mixed stock areas of District 104 (Figure 1). An extreme disparity in pink salmon survival between west Behm Canal (Neets Bay) and the remainder of southern Southeastern would necessitate a shift in harvest strategies. Reducing the harvest of fish in the mixed stock fishery of District 104 to insure adequate escapements in west Behm Canal would result in a reduction in the quality of fish caught; and greatly complicate the need to insure proper escapement distributions.

METHODS

Coho and king salmon were captured with seines along the shoreline of west Behm Canal. The 1985 study utilized a 150 by 7 foot seine set from a 17 foot skiff. Two seines were used in 1986; the first was a 300 by 7 foot seine set from a 17 foot skiff, the other a 100 fathom by 10 fathom anchovy seine set from a commercial seiner. Fry captured were preserved in 10% formalin solution, buffered to a P.H. of 7; formalin was also injected into the stomach cavity to halt digestion. All length measurements were from tip of snout to fork of tail.

RESULTS AND DISCUSSION

The length frequency distribution and number of pinks consumed per coho for 1985 is presented in Figure 2. Neets Bay released 2.1 million coho on June 1; consequently, the coho captured during the May 22 through May 29 time period were all wild stock coho. Those coho captured during the June 3 through June 11 time period were both wild and hatchery; although from the length frequency distribution it would appear the vast majority were wild stock. The line marked by squares is a length frequency distribution of the Neets Bay coho at release. Two possible explanations for the lack of hatchery coho in the catch are that the hatchery coho rapidly departed the area or that the net was size selective. Observations during the study suggested the net was size selective as on numerous occasions water hauls (0 coho captured) were made in areas were coho had been observed jumping immediately prior to the set.

An attempt to distinguish hatchery from wild stock coho is presented in Figure 3. The classification is based on scale pattern analysis with wild stock defined as all 2 check coho and 1 check coho with 12 of fewer circuli to the first check. A sample of wild stock coho from McDonald Lake was used as a known wild stock sample. Unfortunately, no known hatchery fry scales were available and consequently the accuracy of the method can not be evaluated. Figure 3 includes only those fish captured after the hatchery release. It suggests

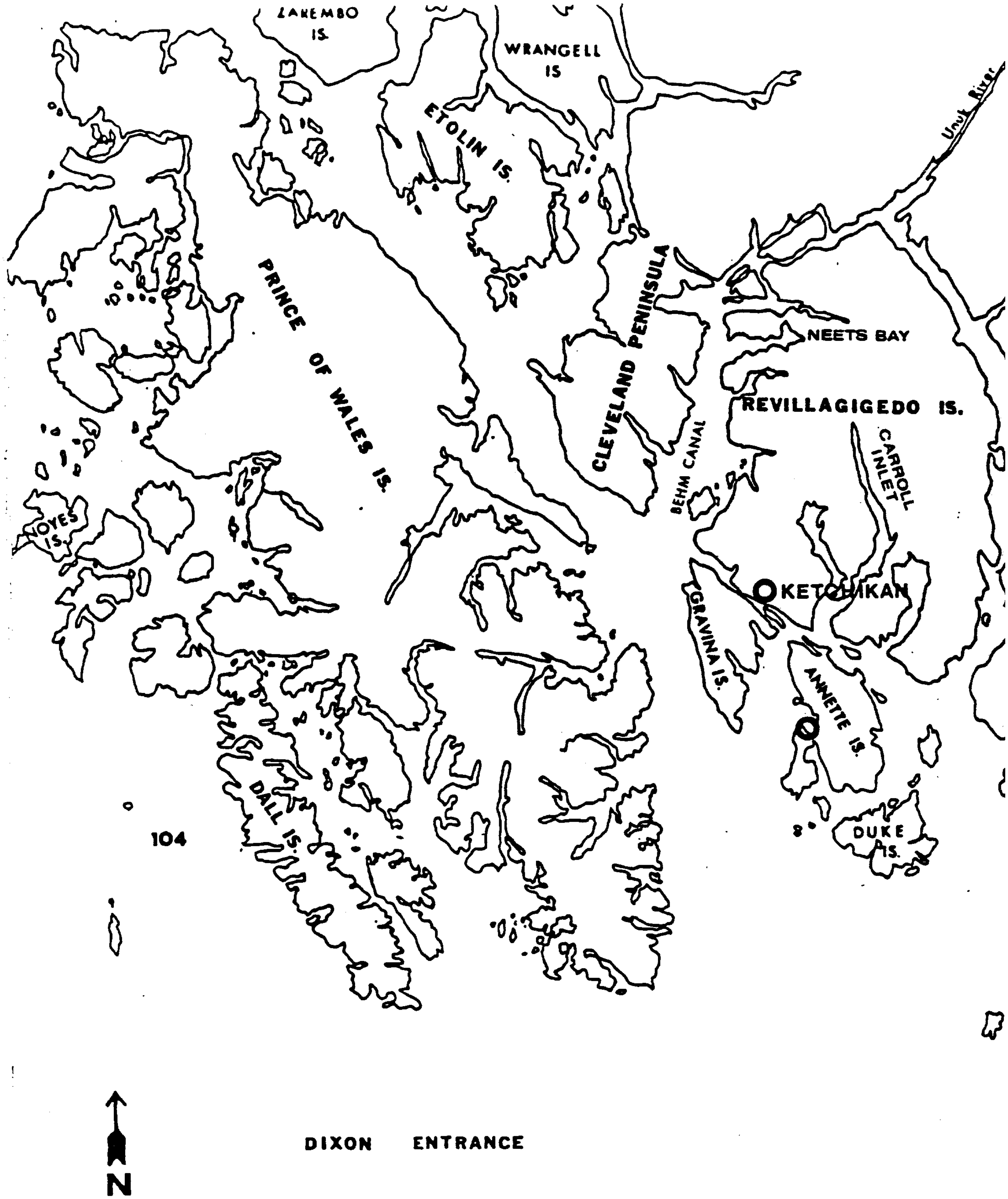


Figure 1. Southern Southeast Alaska.

Figure 2.

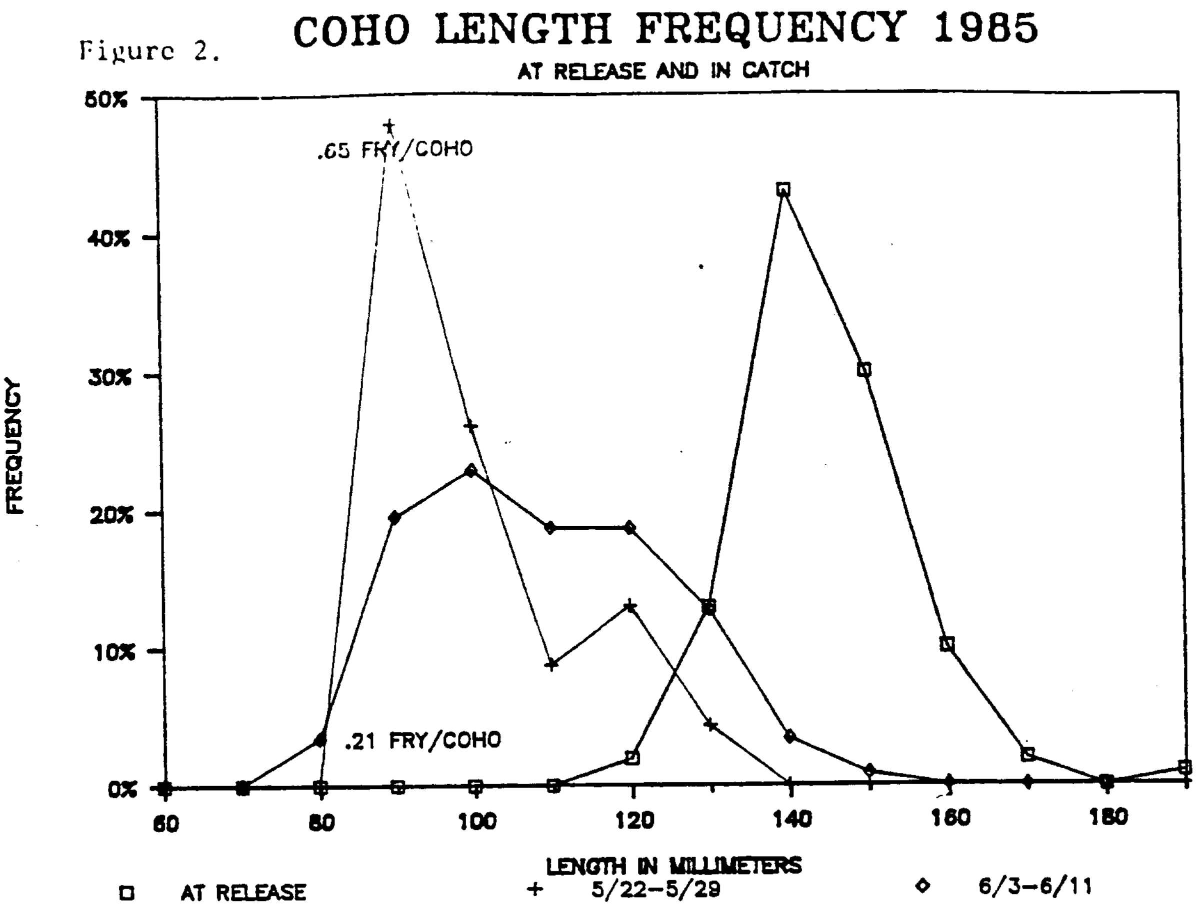
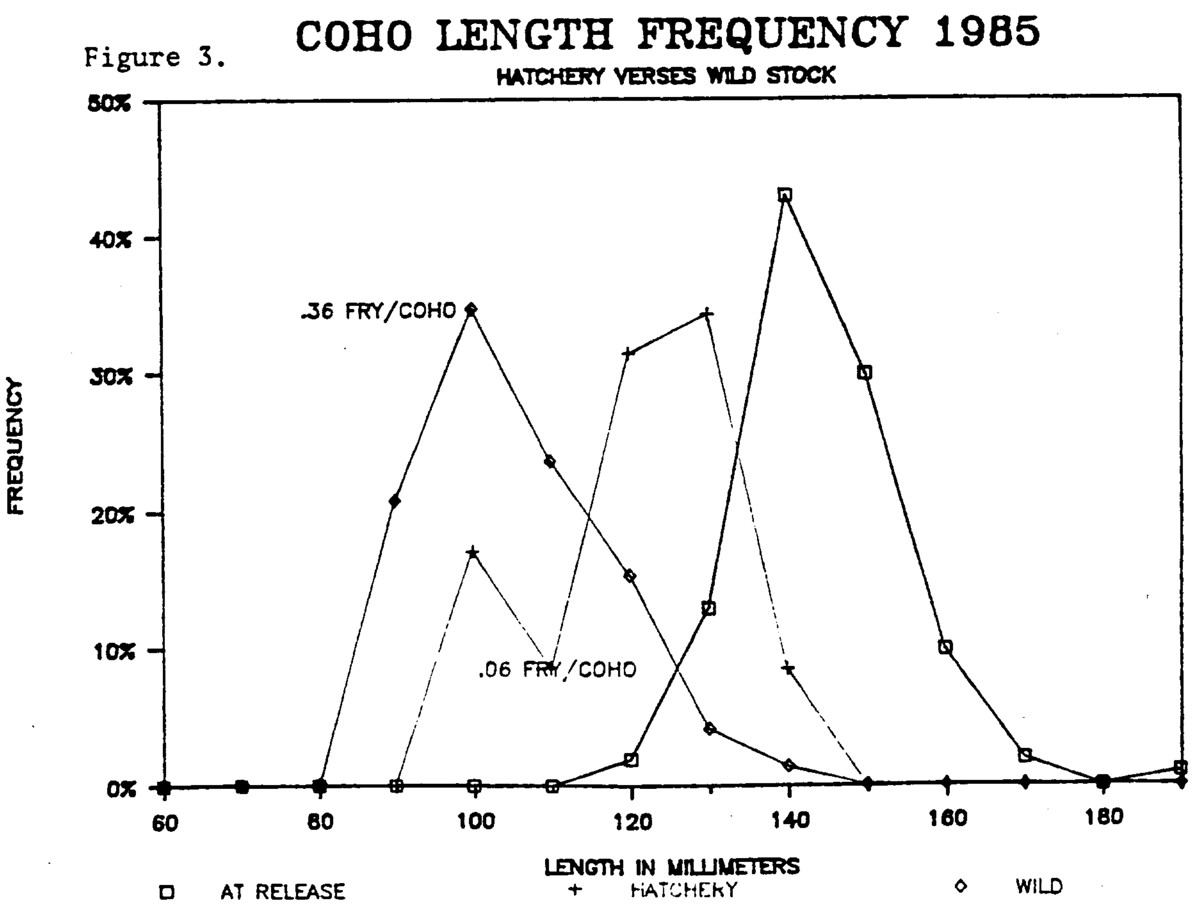


Figure 3.



both that the net was size selective capturing mostly smaller fry and that the hatchery coho utilize pink fry to a lesser degree than wild stock cohos.

Differences in the number of fry consumed per coho may have been a function of sample sizes more than any real difference in feeding behavior between hatchery and wild stock coho. The largest sample of the study period was on June 3 when 64 coho were captured; 29 were hatchery origin, 25 wild stock and 10 not classified due lack of readable scales. The number of fry consumed per coho was the lowest of the study period for both hatchery and wild stock during that sample day at .03 and .08 fry per coho respectively. Sampling during the remainder of the study resulted in capturing only 5 additional hatchery coho; one of which had consumed a pink fry. An additional 41 wild stock coho captured after the June 3 had consumed an average of .46 fry per coho. Consequently, a large part of the difference in fry consumption on Figure 3 is the result of having 85% of the total hatchery sample and only 38% of the wild stock sample come from a day when neither wild stock nor hatchery coho were consuming many pinks.

Sampling during 1986 verified that the net used in 1985 was size selective. Figure 4 gives the length frequency distribution of coho salmon captured during the 1986 study. In all cases the average size of salmon captured in the anchovy seine was significantly greater than the average size of salmon captured in the beach seine. The size selectivity of the beach seine in 1985 was probably even greater than 1986 since the length of the beach seine was doubled for the 1986 sampling.

The great difference in the number of fry consumer per coho shown in Figure 4 may be the result of both time and area differences. A commercial seiner was not available until June 11 and beach seining became ineffective after mid June; consequently, very little overlap in time is present between the two sample methods. The two seines also sampled different habitat types. Beach seining was only possible in areas of relatively gentle sloping shorelines while anchovy seining required steep almost vertical walled shorelines to insure the 10 fathom deep net did not entangle on the bottom. While both time and area of capture may affect the fry consumed per coho parameter, time of capture seems to be the most important. In both 1985 and 1986 coho captured in beach seines were relying more heavily on pinks as a food source early in the sample period than they were late in the sample period. If the 1986 anchovy seine coho are broken into time periods the results are: 1) June 11, 4 pinks consumed by 42 coho 2) June 19, 1 pink consumed by 87 coho 3) June 28, 0 pinks consumed by 12 coho.

The number of fry consumed per coho was very similar in 1985 and 1986 beach seine sampling. Pre-release (wild stock) coho captured by beach seine had consumed .65 and .68 fry per coho

Figure 4.

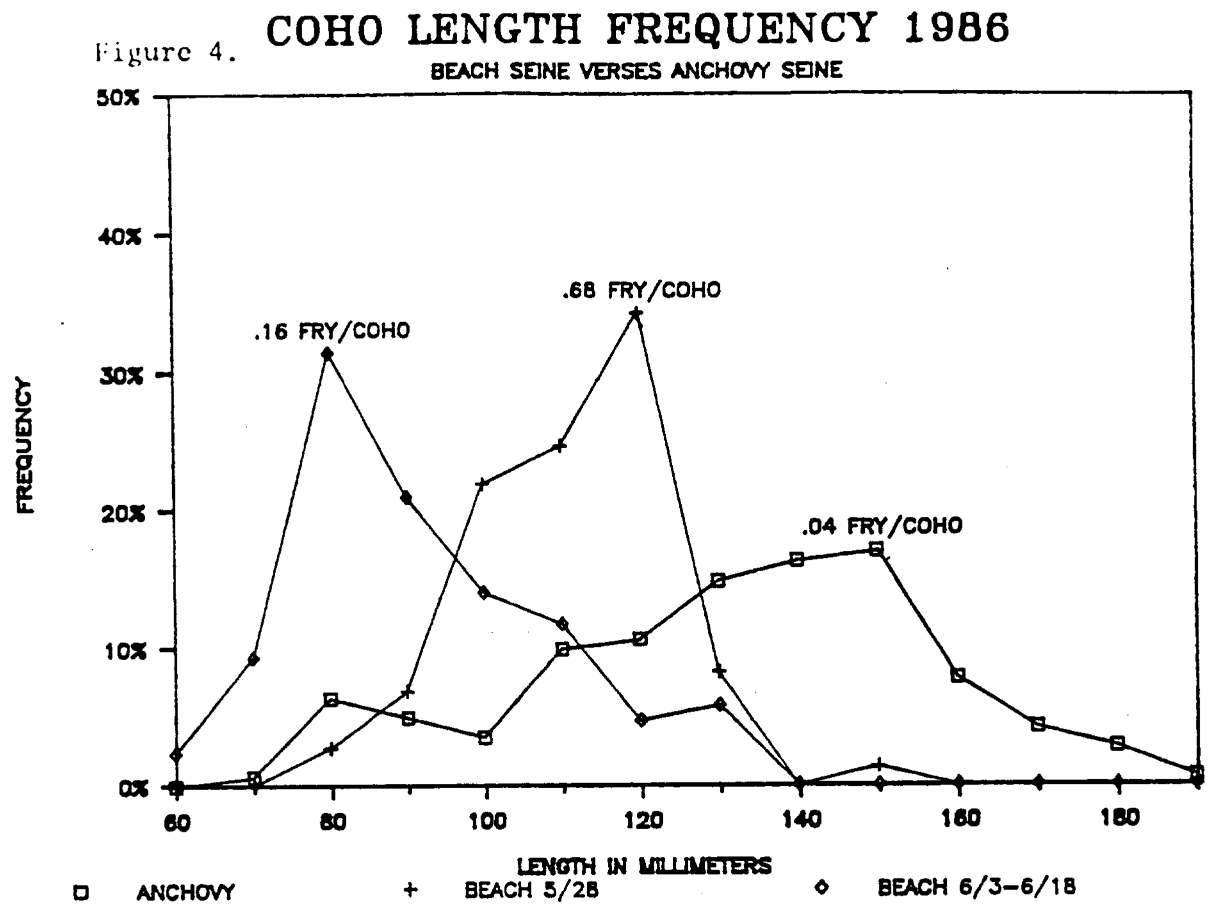
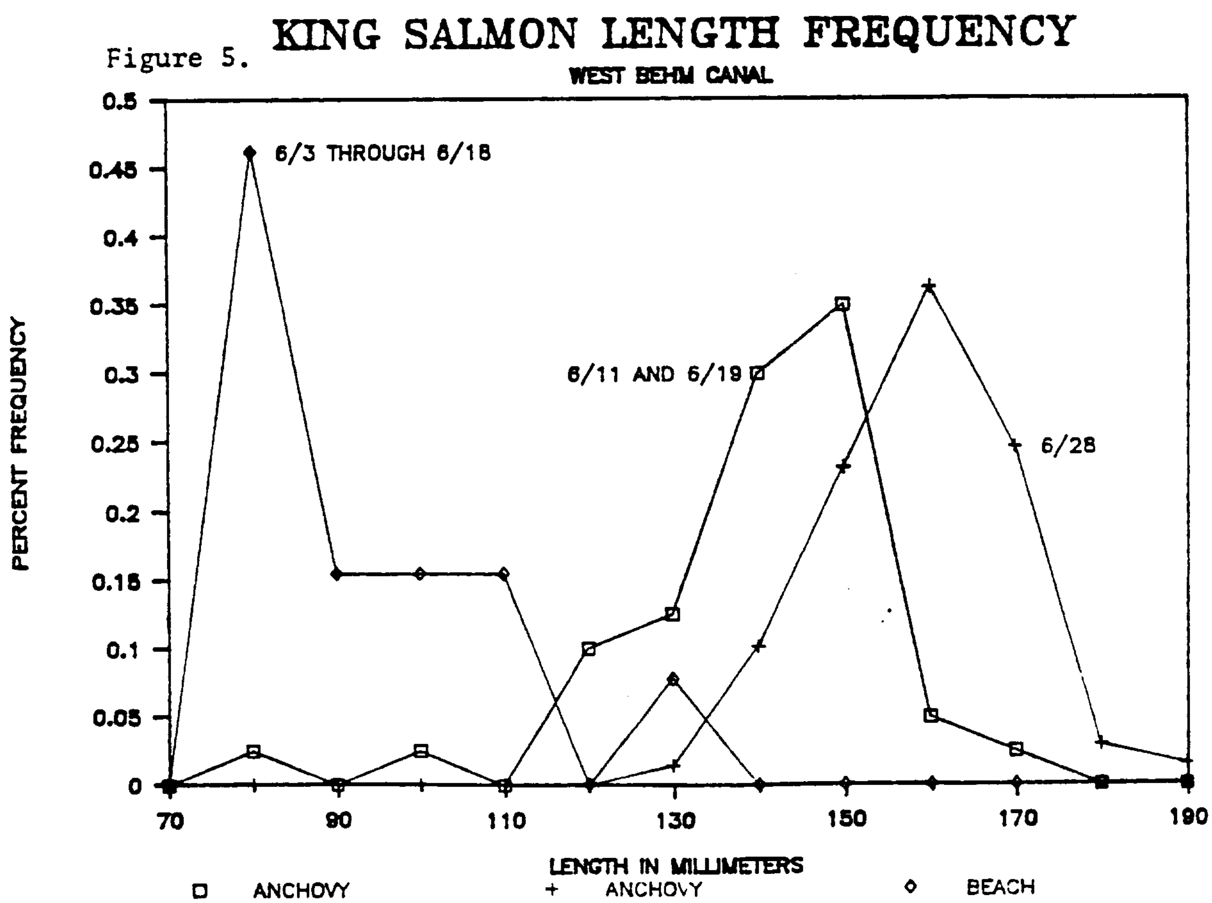


Figure 5.



in 1985 and 1986 respectively. Post-release (wild stock and hatchery) coho captured by beach seine had consumed .21 and .16 fry per coho in 1985 and 1986 respectively. The similarity of fry consumed between years is very disturbing since the number of pink salmon present in 1985 was many times greater than 1986. The number of coho released from Neets Bay in 1985 and 1986 was almost identical at 2.1 and 2.3 million respectively. This suggests that the coho may be actively seeking out pinks rather than preying on them in a density dependent fashion.

Two other important parameters would influence the above as yet unproven assumption of density independent predation by coho on pinks. They are the relative number of wild stock coho and the relative number of other prey organisms present in the two years. There is no reason to believe the population of wild stock coho was significantly different over the two years. No information is available to estimate the relative abundance of alternate prey organisms in 1985 and 1986. Information on stomach fullness however suggests that the coho were less well feed in 1986 than 1985. Stomach fullness was estimated as 0, .1, .25, .5, .75, or 1. percent full at the time of dissection. The results were that in 1985 the coho had an overall fullness index of .65 while in 1986 the index was .42. Capture method strongly influenced the above; coho captured with the anchovy seine in 1986 had a fullness index of .25 while those captured in a beach seine in 1986 had a fullness index of .57.

Figure 5 demonstrates that the beach seine was size selective in capturing king as well as coho salmon. The beach seine was actually a very ineffective means of capturing kings as a total of only 13 kings were captured. The king to coho ratio present in the anchovy seine catch suggested that coho were departing the area before the kings. A total of 42 coho and 3 kings were captured during the first day of anchovy seine sampling on June 11, for a ratio of 14 coho to each king. This was probably somewhat exaggerated since problems with the power skiff resulted in sets being made closer to shore than was the case in the last two sample days. The sample from June 19, contained 87 coho and 37 kings for a ratio of 2.35 to 1; which was very close to the actual release ratio of 2.53 to 1. Sampling during the last day on June 28, resulted in a catch of 12 coho and 69 kings for a ratio of .17 cohos per king salmon.

The information collected in 1986 indicates that at least during years of low pink salmon abundance, king salmon are not important predators on pinks. A total of 121 kings were collected and only 1 was found to contain a pink salmon. That king was a cwt tagged fish released from F.R.E.D.'s Deer Mountain Hatchery. A total of 19 kings sampled were C.W.T. tagged. Eight were from the Deer Mountain Hatchery which released at tagging intensities of from 1 to 1 to just over 2 to 1 depending on the tag lots. Nine of the recoveries were from S.S.R.A.A.'s Whitman Lake facility which released at tagging intensities similar to Deer Mountain. Two were from S.S.R.A.A's Neets Bay facility which released at tagging intensities of approximately 25 to 1. Although the sample sizes are small; two things are apparent from the C.W.T. data. First that very few wild stock king salmon were captured and second that a significant number of George and Carroll Inlet hatchery released king salmon move into West Behm to feed.

Distinguishing between pink and chum salmon after the fish has been in a coho stomach for several hours is impossible. In approximately 20% of the cases the salmon was not digested beyond recognition and in all of those cases the fish was identified as a pink salmon. Observations in the field also suggested that the coho were selecting for pink salmon. A beach seine set made in Boca de Quadra caught over 100 chum, 15 pink and 3 coho salmon. Two of the coho caught in that set had recently consumed pink salmon, no chum salmon had been consumed. Hargraves 1985 also found coho to be species selective favoring pinks over chum; although the coho in his study were utilizing chum salmon as food source to some extent.

The information obtained to date indicates that delaying releases of coho until June greatly reduced the impact of hatchery coho on wild stock pinks. It also appears that the impact of predation could be further reduced by delaying releases an additional two weeks. The rate of predation drops to almost 0 after mid June. The extent of increased coho mortality caused by delaying releases an additional two weeks while holding area water temperatures are approaching critical levels may make mid June releases economically unacceptable in most years. However, if coho predation on pink salmon is density independent as the data suggests; it would be economically and biologically unacceptable not to delay releases in years of low pink salmon abundance.

REFERENCES CITED

Hargraves, N.B., and R.J. LeBrasseur. 1985. Species selective predation on juvenile pink (Oncorhynchus gorbuscha) and chum salmon (O. Keta) by coho salmon (O. Kisutch). Can. J. Fish. Aquat. Sci. 42: 659-668

Discussion Points (Hofmeister's presentation)

1. Pink salmon stocks (fry) in West Behm Canal are thought to be of local origin. There are no indications of inward movement of pink salmon fry, only outward movement of fry that originated in the canal.

2. Neets Bay Hatchery releases 2-3 million coho smolts per year. It is permitted to release up to 5 million annually.

3. Coho predation does not appear to be density dependent; coho juveniles ate pink fry at the same rate both years, even though pink fry density was very low in 1986 as compared to 1985.

4. By June 1, most pink salmon fry had left the inshore area. By mid-June pink fry are, on the average, too large for coho smolts to consume. Similar to observations at Auke Bay.

5. Neets Bay Hatchery will be conducting delayed release experiments with coho and chinook smolts this coming season.

6. No chum fry were found in coho stomachs during the study.

Evaluation of Fourier Transform Infrared Spectrophotometry as a Method for Separating Salmon Stocks - Preliminary Study

by

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This study examined the feasibility of using the infrared (IR) spectrum of salmon scale foci as a basis for separating salmon stocks. The IR spectra of the foci of coho salmon scales were collected using an FTIR equipped with a microscope. These spectra were collected from juvenile coho salmon from four geologically distinct drainages. Spectra could be collected within five minutes total processing time per salmon scale. Using spectra from 7 to 21 salmon to define each stock of salmon, the spectra from the remaining salmon could be correctly assigned from 46% to 63% of the time using linear regression on dummy variables. The results of this feasibility study suggest that IR spectra of salmon scales collected by microscopic FTIR may provide a new set of characteristics that may be useful for the differentiation of salmon stocks.

Discussion Points (Short's presentation)

1. Once the IR technique is perfected it may be possible to automate the spectral analysis of scales such that many can be analyzed in a short time frame.

2. Scales from the same fish have been shown to be similar in spectral analysis.

3. Different parts of a fish scale have different spectral absorbance. Work so far has concentrated on the scale focus.

4. It may be possible to feed hatchery fish certain elements that could then be detected spectrally, e.g., tetracycline. Separate groups of fish from the same hatchery could even be fed tetracycline at different time periods in their development and their scale analyses would show this, as the chemical would be revealed in different sections of their scales.

5. Adult scales need to be examined to determine how well the spectra hold up over time.

6. Potentially, there are hundreds of discriminators that can be examined for stock separation.

7. Use of the reflective index may hold possibility as a stock separation technique also.

8. Near future work will focus on refining the method and determining which items to concentrate on in the spectra that will be the most useful for separating stocks. Further studies will examine how well the chosen discriminators hold up over time.

ABUNDANCE AND DISTRIBUTION OF JUVENILE COHO SALMON (*ONCORHYNCHUS KISUTCH*) IN THE LOWER TAKU RIVER, ALASKA

by

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INTRODUCTION

The large, glacial rivers traversing Canada and Southeast Alaska are important producers of Pacific salmon (*Oncorhynchus* spp.); however, little information exists on the distribution and abundance of juvenile salmon rearing in these rivers. Quantitative sampling of juvenile populations is made difficult by the large size and turbidity of glacial rivers. Information is needed on abundance, distribution, and habitat use of juvenile salmon so that salmon stocks can be jointly managed to ensure adequate escapement and determine exploitation rates.

Population estimates of juvenile salmon rearing in the U.S. portion of these rivers may be useful in estimating the U.S. contribution to salmon production and in evaluating potential enhancement opportunities. With this in mind, research on juvenile salmonids in the lower Taku River, Alaska, was conducted by the Auke Bay Laboratory Habitat Investigations Program in summer 1986. This paper summarizes our findings on abundance, distribution, age, and growth of one of the salmon species studied--juvenile coho salmon (*O. kisutch*).

METHODS

A stratified random sampling design was used to estimate the abundance of juvenile coho salmon in the lower Taku River, including off-channel sloughs, beaver ponds, and tributaries on the river terrace (Fig. 1). Habitat in the study area was divided into two broad categories: 1) river-channel habitats located within the active river channel and carrying river water, 2) and off-channel habitats on the river terrace fed from spring networks or from tributaries draining valley side slopes. Each broad category was subdivided according to water velocity regime and fluvial process, for a total of six river-channel habitats and four off-channel habitats (Table 1). Three to 10 sites of each habitat type were randomly selected from Taku Point to the Canadian border for a total of 49 sites sampled from 8 July to 18 September 1986.

At each site, 3-11 randomly selected transects, spaced at least 50 m apart, were sampled for fish. Each transect was seined at least three times on one sampling date; the type of seine used depended on habitat type. In large habitats with slow water (i.e., lake shore and some tributary mouths), a beach seine (37 m long) was set from a boat and retrieved from shore. In smaller areas (i.e., beaver ponds and tributary mouths), a smaller seine was set from a canoe and retrieved from shore. Where the water was shallow enough to wade or the current too swift for beach seining (i.e., channel edges, side sloughs, backwaters, upland sloughs, terrace tributaries), a small seine was

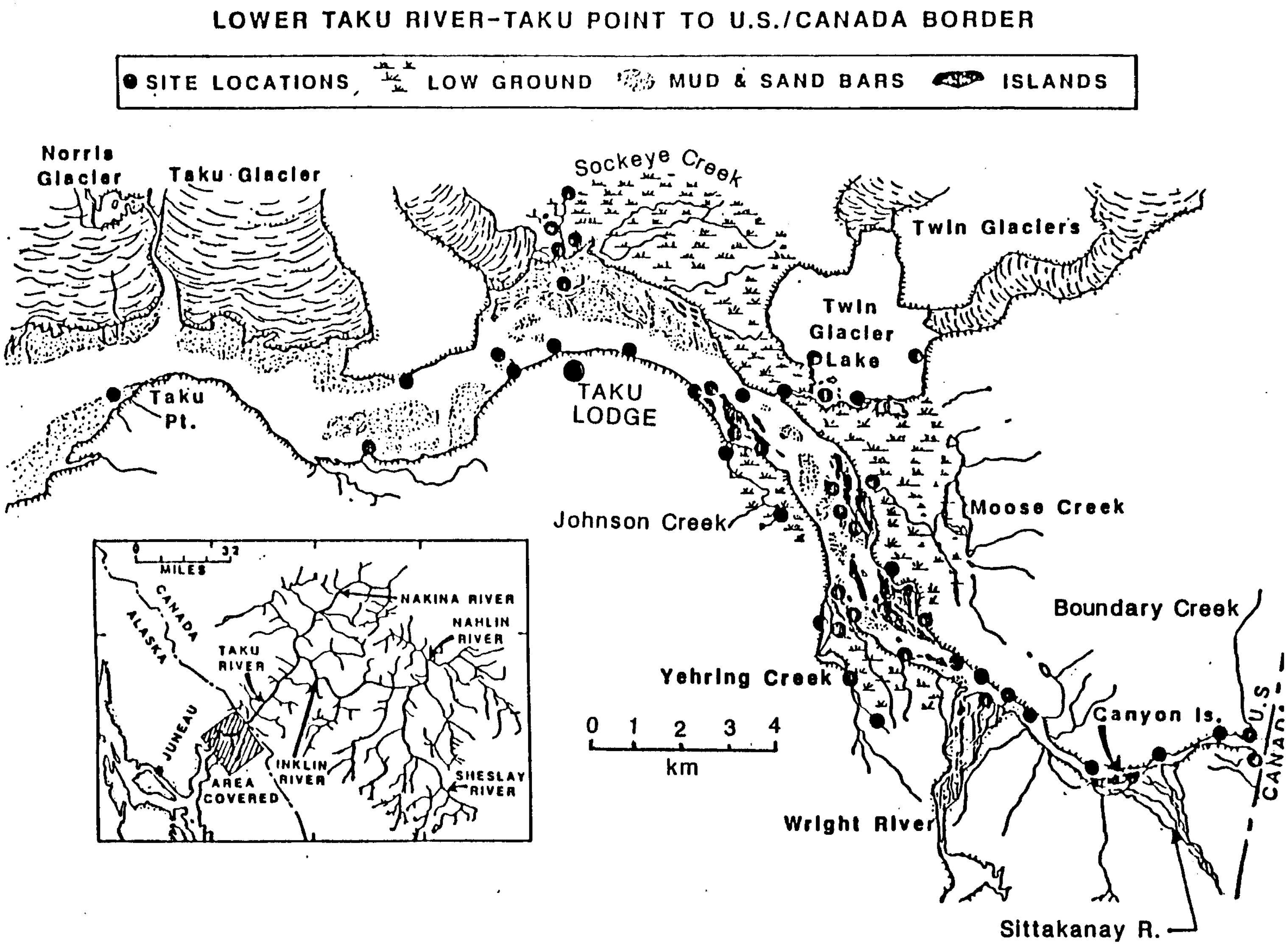


Figure 1.--Locations of sampling sites on the lower Taku River, Alaska.

Table 1.--Definitions of habitat types for classifying rearing areas of coho salmon (*Oncorhynchus kisutch*) in the lower Taku River, Alaska, in July-September 1986.

Habitat type	Definition
	RIVER-CHANNEL HABITATS
Main channel	Areas of main river flow; deep, turbulent, and rapid (>30 cm/s); clarity poor.
Side channel	Narrow branches of the main channel; fast (>30 cm/s), turbulent flow.
Channel edge	Margins of main and side channels, extending about 3 m from shore; water velocity often moderate (<30 cm/s).
Wooded	Channel edges along tree-lined banks.
Nonwooded	Channel edges along channel bars within river channel.
Braid	Shallow, secondary channels across mudflats and around channel bars; water velocity moderate (10-30 cm/s).
Side slough	Percolation-fed channels with slow (0-15 cm/s), sometimes clear water; formed when the head of a braid or side channel is blocked by sediment and organic debris.
Backwater	Slack waters formed by obstructions, such as point bars in main channel.
	OFF-CHANNEL HABITATS
Terrace tributary	Tributary streams draining valley side slopes and flowing across the river terrace to main river; usually clear but may be turbid if glacial.
Tributary mouth	Lower reach of terrace tributary at its confluence with main river; often has slack water.
Upland slough	A spring-fed slough on river terrace connected to main river; may have clear or tannic water.
Beaver pond	Ponds impounded by beaver dams on terrace tributaries and upland sloughs.

fixed with poles at each end and pulled parallel to shore for 20 m. Main river and side channels could not be seined because of their swift, turbulent flow. Based on their current velocity, we assumed they did not support rearing coho salmon.

All fish caught in each seine haul were anesthetized with MS-222, identified to species, and counted. A subsample of the fish was measured for fork length (FL) to the nearest millimeter and sampled for scales. Age-0 fish (no annuli on scale) were considered fry; fish with one or more annuli were considered parr. Number of fish per species at each transect was determined by the removal method (Zippin 1958). Density was calculated by dividing the population estimate by the area seined at each transect, and density at each site was computed as the mean of the transects.

Total populations of juvenile coho salmon downstream of the Canadian border in both river-channel and off-channel habitats were estimated from the total area and mean fish density (Cochran 1953). Total area of each habitat type was measured by digitizing outlines of each habitat drawn on aerial photographs (scale, 1:6,621). A computer with Autocad[1] software and a Science Accessories Corporation GP-8 sonic digitizer were used to digitize and compute areas. Main and side channels were omitted from the calculations of total populations.

Selected physical characteristics were measured at each site to characterize the habitat types. Water temperature was measured, usually at mid-day, and mean water velocity (measured with a current meter) was estimated from measurements at three equidistant places across the

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

middle of each seined area. The range of suitable water velocity for each salmon species was determined from probability-of-use curves (Bovee and Cochnauer 1977). These curves were derived from frequency distributions relating the number of occupied transects to the mean water velocity at the transects.

To monitor downstream movement of juvenile coho salmon, a stationary fyke net was set overnight near the Taku Lodge about once a week from 6 August to 19 September. The fyke net (3 m wide by 1.5 m deep at the mouth and 10 m long) was connected to a live box at the cod end. Placed about 4 m from shore, the fyke net was secured to a dock so that it rested on the bottom of the main channel, perpendicular to the flow. Catches were compared to the river stage data which, for July and August, were obtained from the Alaska Department of Fish and Game records of Canyon Island and, for September, were from a gauge near Taku Lodge.

RESULTS AND DISCUSSION

Juvenile coho salmon primarily used habitats with slow or standing water. Based on the probability-of-use curve, optimum water velocity for coho salmon was near 0 cm/s, and habitats with velocity >28 cm/s were unused (Fig. 2). Based on this curve, water velocity in all habitat types, except main and side channels, was suitable for juvenile coho salmon (Table 2). Water velocity in sloughs, backwaters, and beaver ponds was optimal (mean, 0-3 cm/s), whereas in channel edges, braids, and terrace tributaries, velocity generally was too great (mean, 11-19 cm/s) for coho salmon. Main river and side channels, except

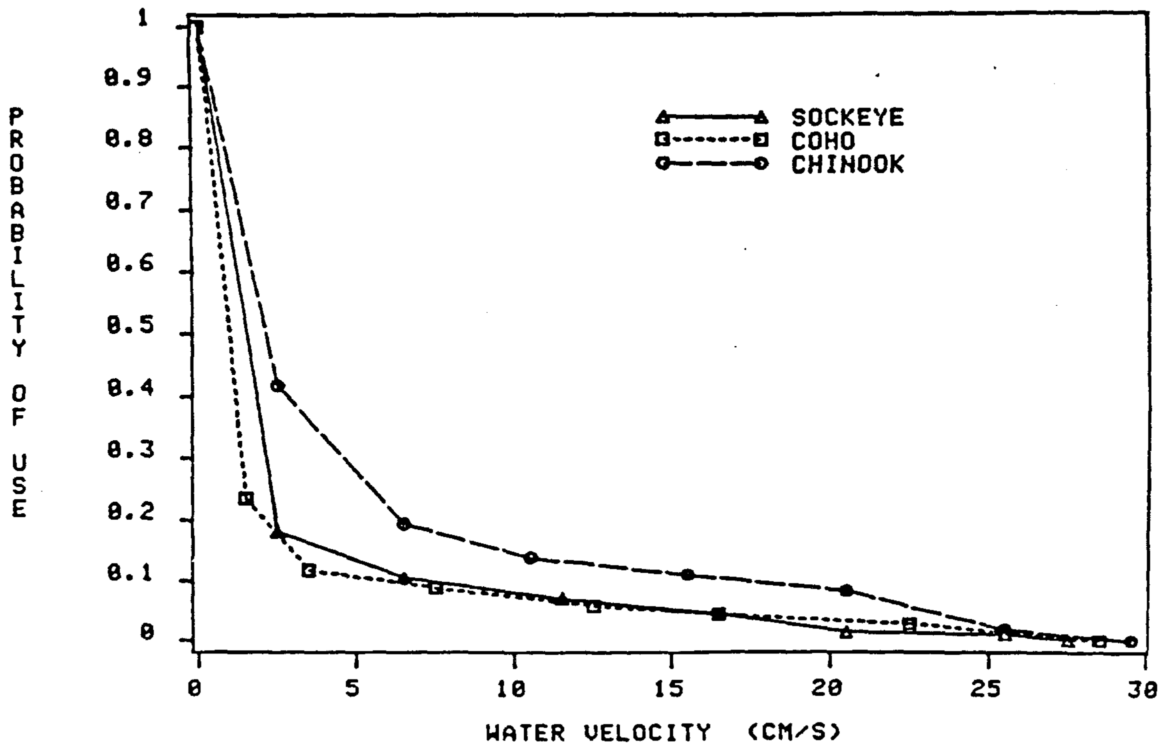


Figure 2.--Probability-of-use curve for juvenile coho salmon (Oncorhynchus kisutch) versus water velocity in the lower Taku River. Probability-of-use curves for sockeye (O. nerka) and chinook salmon (O. tshawytscha) are provided for comparison. The curves were constructed as described in Methods.

Table 2.--Comparison of mean physical characteristics of the different habitat types of the lower Taku River, Alaska, in July-September 1986.

	River-channel habitat				Off-channel habitat			
	Channel edge	Braid	Side slough	Back-water	Terrace tributary	Tributary mouth	Upland slough	Beaver pond
Mean water velocity (cm/s)	11	19	3	0	15	5	1	0
Mean water temperature (°C)	7.9	8.7	10.3	9.5	9.1	9.5	11.4	12.0

their edges, were unsuitable because their swift (30-75 cm/s) currents were well above the range used by juvenile coho salmon. Main river and side channels, except for edges, were assumed to not support any appreciable numbers of coho salmon.

Coho salmon occurred almost exclusively in off-channel areas with slow water, particularly beaver ponds, upland sloughs, and tributary mouths (Table 3, Fig. 3). Density was significantly greater in off-channel than in river-channel habitats ($\underline{P} < 0.001$, Kruskal-Wallis test (Sokal and Rohlf (1969)), averaging 2,400 fish/ha (0.24 fish/m^2) versus 100 fish/ha (0.01 fish/m^2), respectively.

Most (99%) coho salmon were either fry (33-87 mm FL) or age-1 parr (57-117 mm FL). Age-2 parr (107-132 mm FL) were <1% of the populations. Relative abundance of fry and parr differed between beaver ponds and other habitats (Fig. 4). Parr usually outnumbered fry in beaver ponds, but fry outnumbered parr in all other habitats. In three beaver ponds, parr accounted for 72, 96, and 98% of the populations, compared to only 2-6% in all other habitats.

The sole exception to the pattern of parr dominance in beaver ponds was the beaver pond on Fish Creek, where fry comprised the entire population. The Fish Creek pond had spawning habitat upstream; the other ponds had no spawning habitat in the sedge meadows upstream. Thus, fry colonizing the Fish Creek pond had emigrated from the spawning grounds, but fry colonizing the other ponds had emigrated from elsewhere. Generally, fry apparently do not colonize beaver ponds from downstream areas until fall freshets occur because access is generally impaired by beaver dams (Peterson 1982; Heifetz et al. unpubl. data).

Table 3.--Area, fish density, and total population of juvenile coho salmon (*Oncorhynchus kisutch*) by habitat type in the lower Taku River, Alaska, in July-September 1986. Standard error of fish density is in parentheses; *n* = number of habitats sampled. Data on sockeye (*O. nerka*) and chinook salmon (*O. tshawytscha*) are provided for comparison.

Habitat type	*n*	Area		Fish density (no./ha)			Total population (thousands)		
		ha	%	Sockeye	Coho	Chinook	Sockeye	Coho	Chinook
RIVER-CHANNEL HABITATS									
Main and side channels	0	1,342	69.5	0 (0)	0 (0)	0 (0)	0	0	0
Wooded channel edge	7	29	1.5	901 (502)	159 (61)	1,796 (996)	26	5	52
Nonwooded channel edge	10	7	0.4	348 (133)	51 (27)	172 (61)	2	0	1
Braid	5	408	21.1	548 (412)	100 (76)	338 (162)	224	41	138
Side slough	5	36	1.9	3,582 (1,266)	118 (38)	646 (515)	129	4	23
Backwater	3	9	0.5	2,110 (1,416)	290 (256)	513 (257)	19	3	5
OFF-CHANNEL HABITATS									
Terrace tributary	7	52	2.7	173 (150)	1,150 (420)	668 (485)	9	60	35
Tributary mouth	4	29	1.5	3,789 (2,128)	2,274 (1,988)	643 (500)	110	66	19
Upland slough	4	7	0.4	7,343 (4,556)	5,823 (2,694)	0 (0)	51	41	0
Beaver pond	4	13	0.7	4,793 (3,973)	5,850 (2,757)	93 (92)	62	76	1
Totals	49	1,932	100.0				633	295	274
					95% confidence limits		182-1,084	122-468	90-458
					d.f.		8	14	8

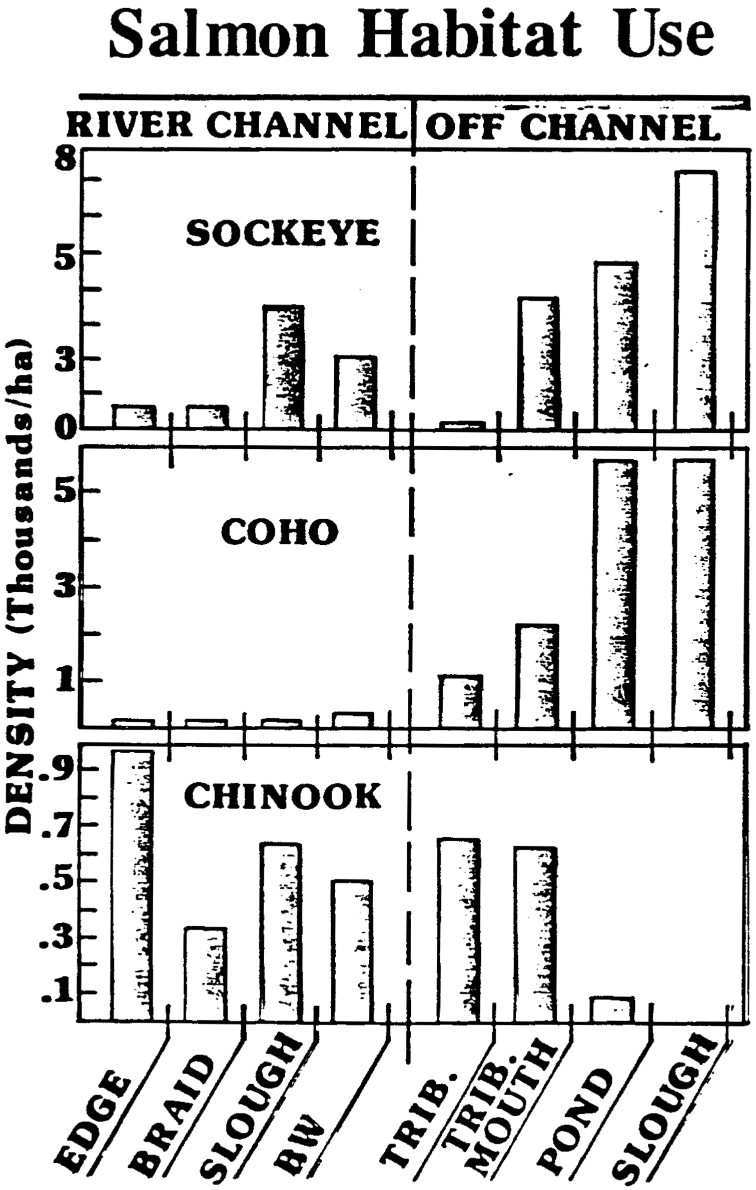


Figure 3.--Mean density of coho salmon (Oncorhynchus kisutch) by habitat type. Data on sockeye (O. nerka) and chinook salmon (O. tshawytscha) are provided for comparison.

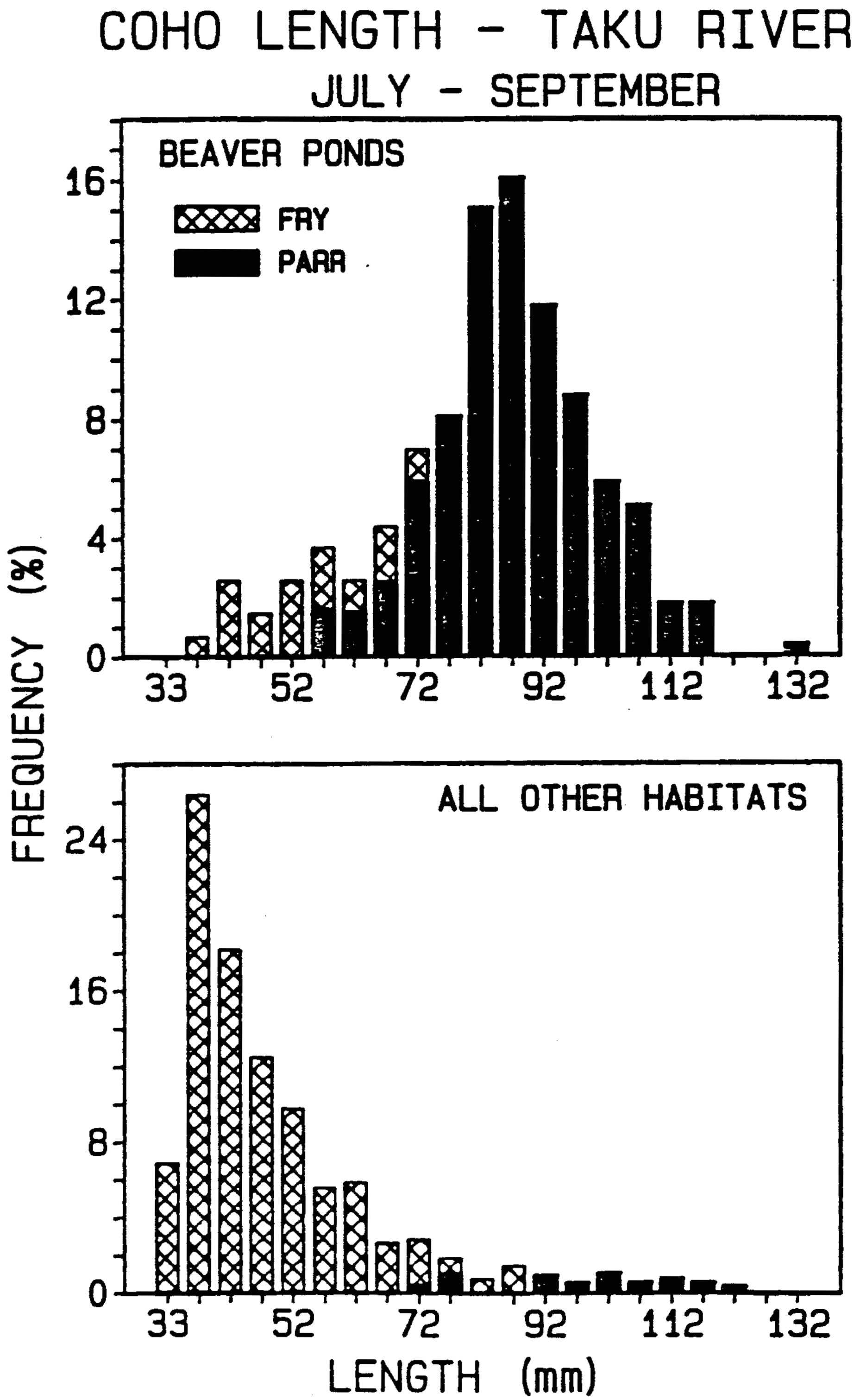


Figure 4.--Length (in millimeters fork length) frequencies of coho salmon (<u>Oncorhynchus kisutch</u>) in beaver ponds and in all other habitat types, July-September 1986.

Size of coho salmon fry increased from about 36-42 mm FL in early July to about 44-50 mm FL in September (Fig. 5). The slope of the line fitted to the observed mean FL's at sampling sites estimated fry growth at 0.14 mm FL/day. All sites with sufficient samples conformed to this growth rate, except one beaver pond in the Sockeye Creek drainage (Fig. 1) that had significantly (*t*-test, $P < 0.05$) larger fry than expected for that date. Coho salmon fry had a faster growth rate probably due to the warmer water in this pond than in the other areas.

The fyke net was set six nights and caught 592 salmon of which 426 (72%) were coho salmon. Catches were low in the first half of August, increased sharply in late August, and declined to a low level again in September (Fig. 6). Catches were not related to river stage alone (Fig. 6), but rather to a combination of river stage and precipitation. Generally, river flow declined gradually during August and September, except for two discharge events: a sharp spike during 12-16 August when the Tulsequah River ice dam burst, and a much smaller spike during 28-30 August when heavy rains in the lower watershed raised the river about 30%. The second spike, however, was still lower than the average flow in early August. Catches of coho salmon did not increase during the Tulsequah flood but increased in late August during heavy rains. Age composition and size of coho salmon caught in the fyke net (Fig. 7) were similar to fish in the off-channel habitats but not in beaver ponds; thus, the fish probably had emigrated from off-channel areas. Coloration and body form of the coho salmon were typical of the freshwater rearing stage, and they did not appear to be smolts. Instead, they probably were "nomads" (Chapman 1962; Skeesick 1970; Crone and Bond 1976; Scrivener and Andersen 1984) moving downstream.

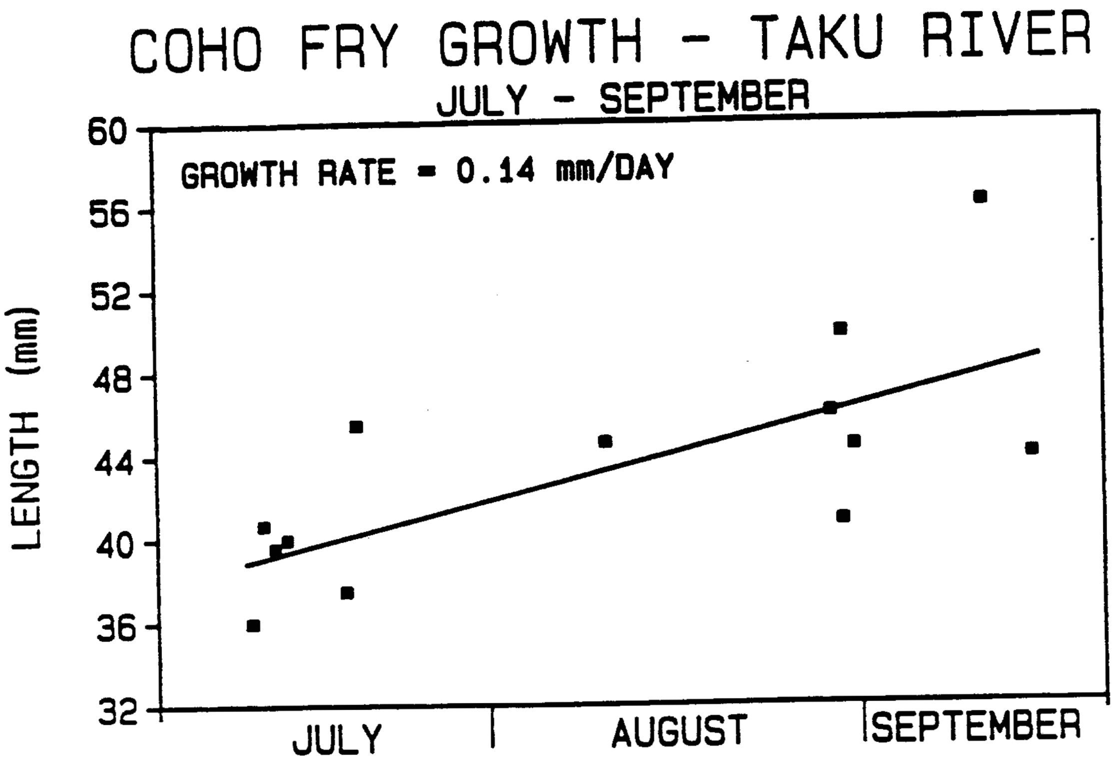


Figure 5.--Increase in mean length (in millimeters fork length) of coho salmon (*Oncorhynchus kisutch*) fry from July to September 1986. Data are means of fry length for sites with more than five fry measured and with sufficient scale samples taken to define age classes. The equation for the line was $\underline{Y} = 37.9 + 0.14\ \underline{X}$, where $\underline{Y}$ = mean length (mm) and $\underline{X}$ = number of days since 30 June; $\underline{n} = 13$; $\underline{R}^2 = 0.54$. One site (beaver pond discussed in text) was a significant outlier and was not used for fitting the equation.

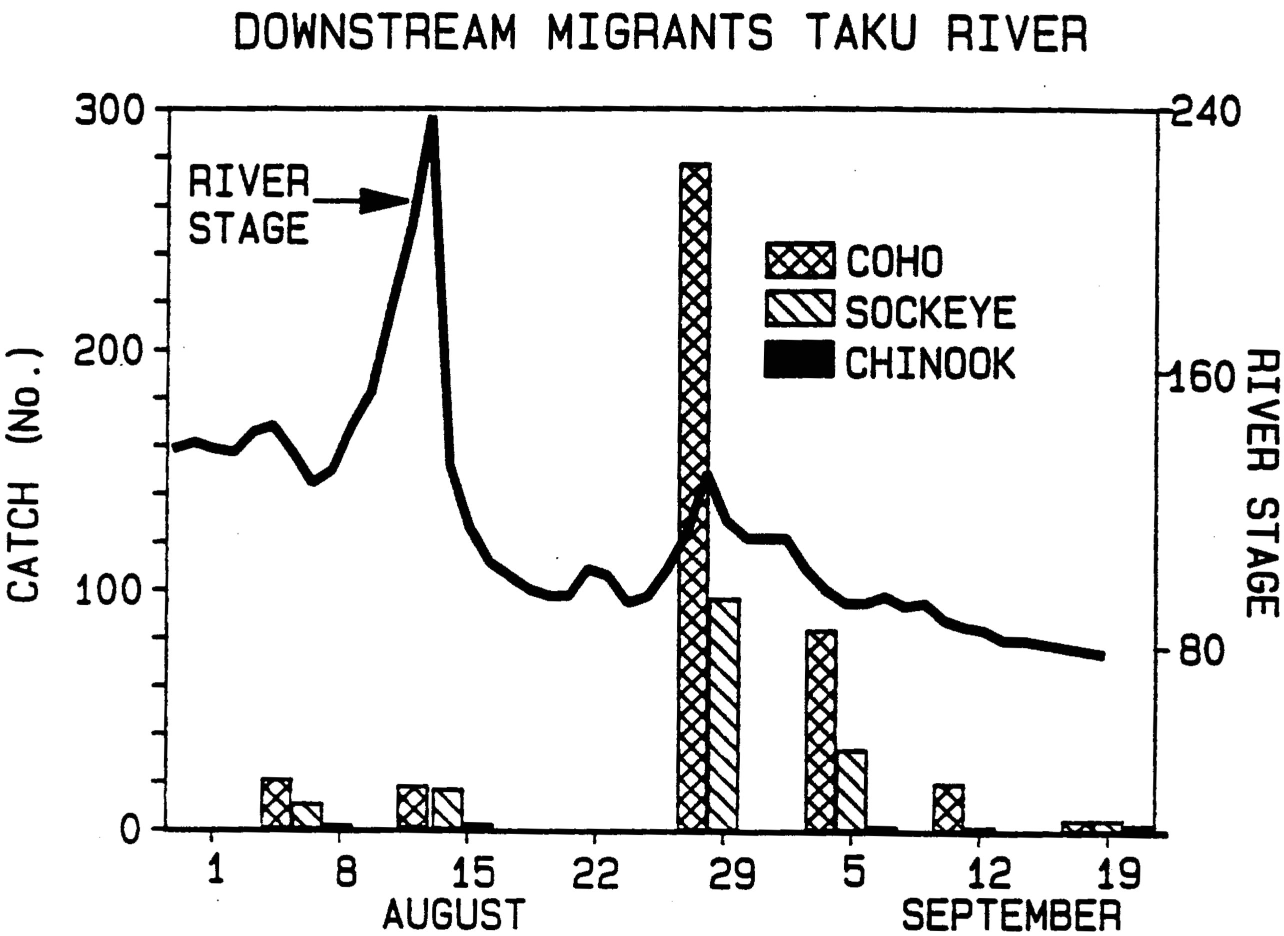


Figure 6.--Number of coho salmon (Oncorhynchus kisutch) caught in the downstream trap at the Taku Lodge site and river stage in August and September 1986. Data on sockeye (O. nerka) and chinook salmon (O. tshawytscha) are provided for comparison.

Early life history of coho in streams is often different from that of coho rearing in lakes. In the Baranof-Chichagof area the smolt age of stream-reared fish is primarily 2, while smolt age of lake-reared fish varies dramatically from year to year (Figure 21). Example: The 1985 smolt from Salmon Lake were 52% age 2, while the 1986 smolt were only 18% age 2.

Lake systems have a multiple age class structure in the smolt population which provides a buffered smolt production, i.e. a poor escapement as in 1983 will not limit smolt production from lakes as greatly as it will from streams or river systems which have primarily a single age class of smolt.

The study of lake systems only is misleading and is not representative of what happens to stream and river-reared stocks. Coho presmolt overwintering in small streams and rivers are much more subject to harsh winter conditions and freeze-out.

We have good evidence that the 1983 escapement produced low numbers of smolt in 1986 from Salmon Lake (Figure 22). Did stream systems produce any significant numbers of smolt (age 2) in 1986 from this year of reduced escapement? Did the cold weather in October and November 1985 cause mortality of rearing coho from brood year 1983? How many smolt emigrated from streams in 1986 to contribute to the 1987 adult return?

The cold temperatures of November 1985 could well have influenced smolt production from three brood years (1983-1985) in streams and rivers thereby affecting adult returns until 1989.

We need to look at smolt production from smaller streams as related to adult escapement, i.e. escapement to many smaller systems on the outer coast this year was nearly nonexistent (4, 9, 9, etc.). Will these systems produce any smolt in 1990? What is the smolt production from these streams now from the good escapements of 1984 and 1985?

The 1986 troll fishery caught unprecedented numbers of hatchery-produced coho. The troll catch of coho from District 113 (Baranof and Chichagof) was more than half of the total coho catch for Southeast and Yakutat. The troll fleet had a tremendous C.P.U.E.; but when all was over, there were no wild stock coho to spawn in the numerous small streams on the outside coast. Increasing hatchery production will further aggravate this relationship. If we hope to have wild stock coho in our rivers, we definitely need better information on adult escapement and smolt production from representative systems and a better management tool than C.P.U.E.

RECOMMENDATIONS

In order to document wild stock status we should develop a study program which will document escapement to the three system types (lakes, rivers, streams) throughout Southeast Alaska. Much of this is being done now by the various Divisions. Someone needs to be given the responsibility of coordinating this data collection, compiling the data, and analyzing for trends, etc. I assume the Division of Sport Fish person doing this in the future will be Steve Elliott, our new Coho Research Project Leader.

Sitka Area:

The stock evaluation program needs to be expanded to include detailed study of representative smaller stream systems. I feel this should be done on one or two of the index streams for which we have "escapement" data (St. John or Sinitsin near Sitka).

This program should be initiated during the summer of 1987 to allow evaluation of smolt production from a year of good escapement (1985) and continue through smolt production from years of poor adult escapement (1986 and likely 1987).

The smolt production study should be conducted for a minimum period of 3 years with continuing evaluation of adult returns.

Escapement index counts should be continued on all Sitka Area index streams now being evaluated with possible exclusion of Indian River, which is hatchery influenced.

Another "larger river" system should be officially added to the index list. Black River on west Chichagof Island is the prime candidate as we have good index counts on this system from 1980, 1984, 1985, and 1986. Survey of this system costs 2 hours worth of helicopter time per year ($900-$1,000).

Salmon Lake smolt and adult evaluation should be continued. This system is very similar to other lakes on Baranof and Chichagof islands (including Ford Arm Lake) and has a continuous 4-year database.

Ketchikan Area:

The "Escapement Index" program should be continued on the two larger river systems now being surveyed. Ward Creek is not a good index system for wild stock escapement evaluations.

Two or three smaller index streams which are not influenced by hatchery production should be added to the index lists.

Petersburg Area:

Someone needs to be given the responsibility of obtaining the escapement index data for Petersburg Creek and Bear Creek. Data should be collected in the same manner and for the same area as was done in 1983-1985. Addition of at least two more index streams in the Petersburg Area should be considered.

Juneau Area:

Index counts should be continued for streams which are not going to receive hatchery influence. The escapement counts to Auke Creek appear to be indicative of smaller lakes in this area so should be continued.

OBJECTIVES

1. To index coho escapements in streams near Juneau, Ketchikan, Sitka, and Petersburg and establish escapement goals for coho salmon in the index streams contributing to urban area recreational fisheries in Southeast Alaska.

2. To determine <u>immigration route</u>, <u>run timing</u>, <u>harvest rate</u>, and <u>areas of harvest</u> of coho salmon from selected Index Streams in Southeast Alaska (Salmon Lake system).

Figure 1.

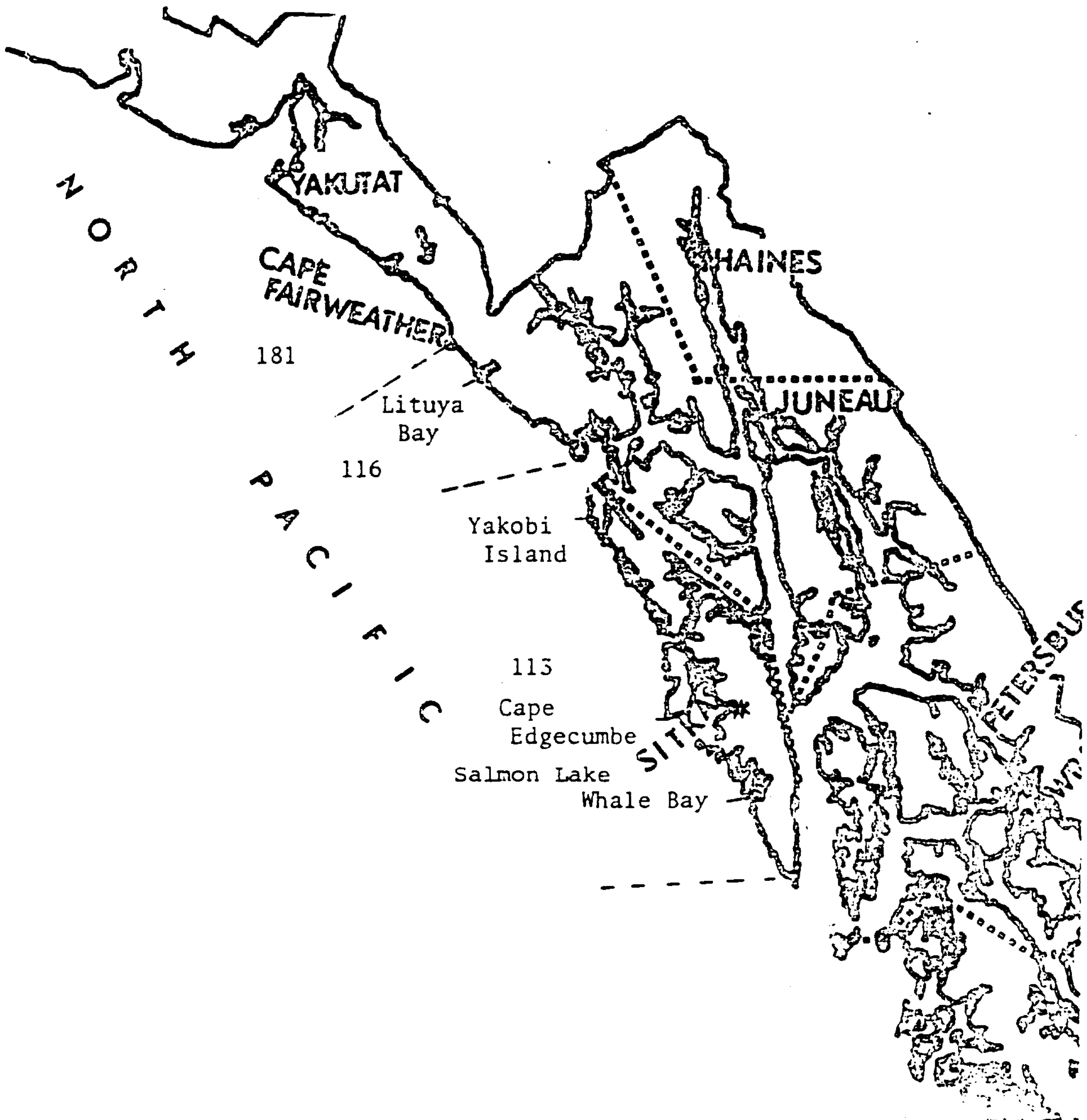

YAKUTAT
NORTH PACIFIC
CAPE FAIRWEATHER
181
Lituya Bay
116
HAINES
JUNEAU
Yakobi Island
113
Cape Edgecumbe
SITKA
Salmon Lake
Whale Bay

Figure 2.

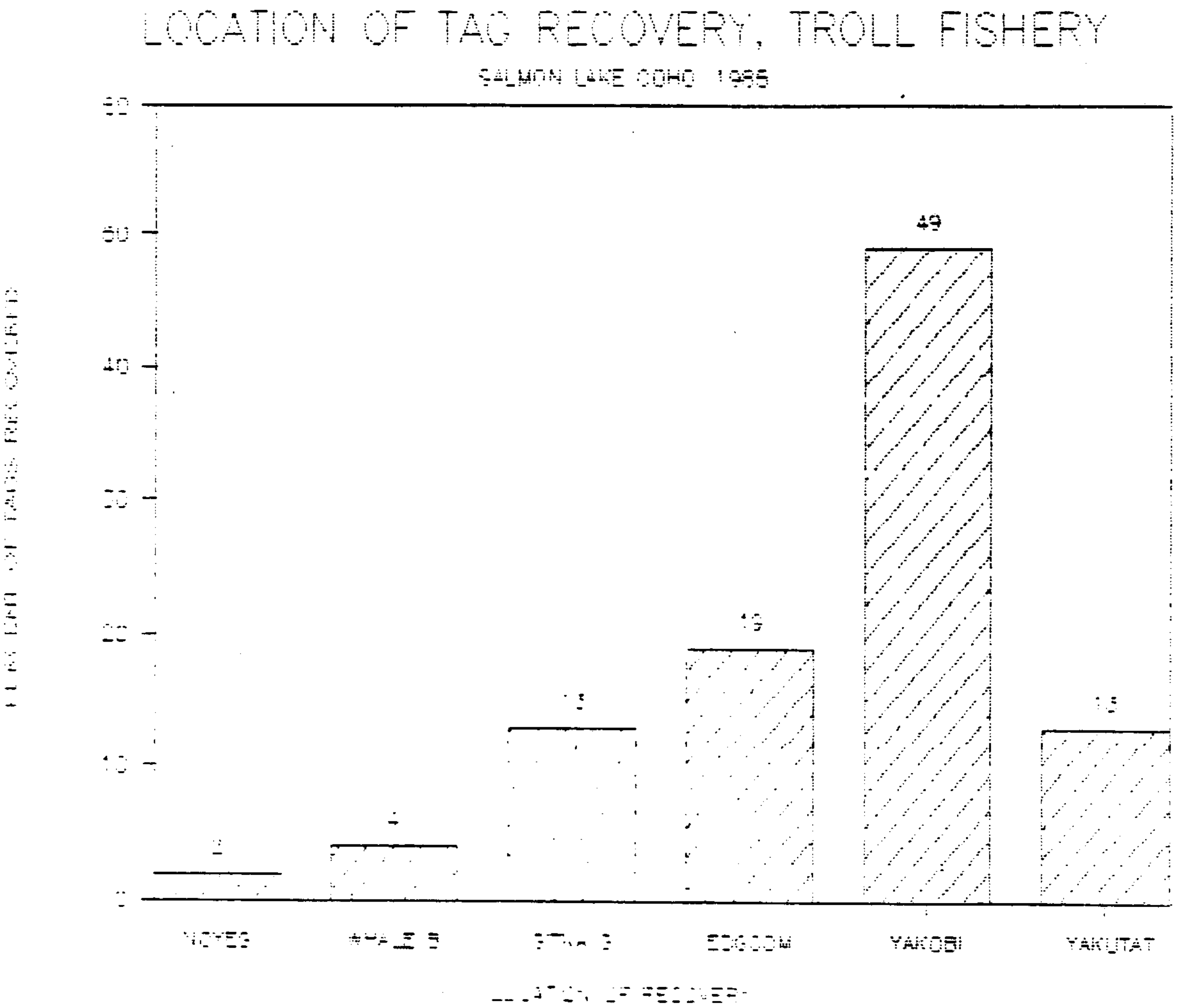
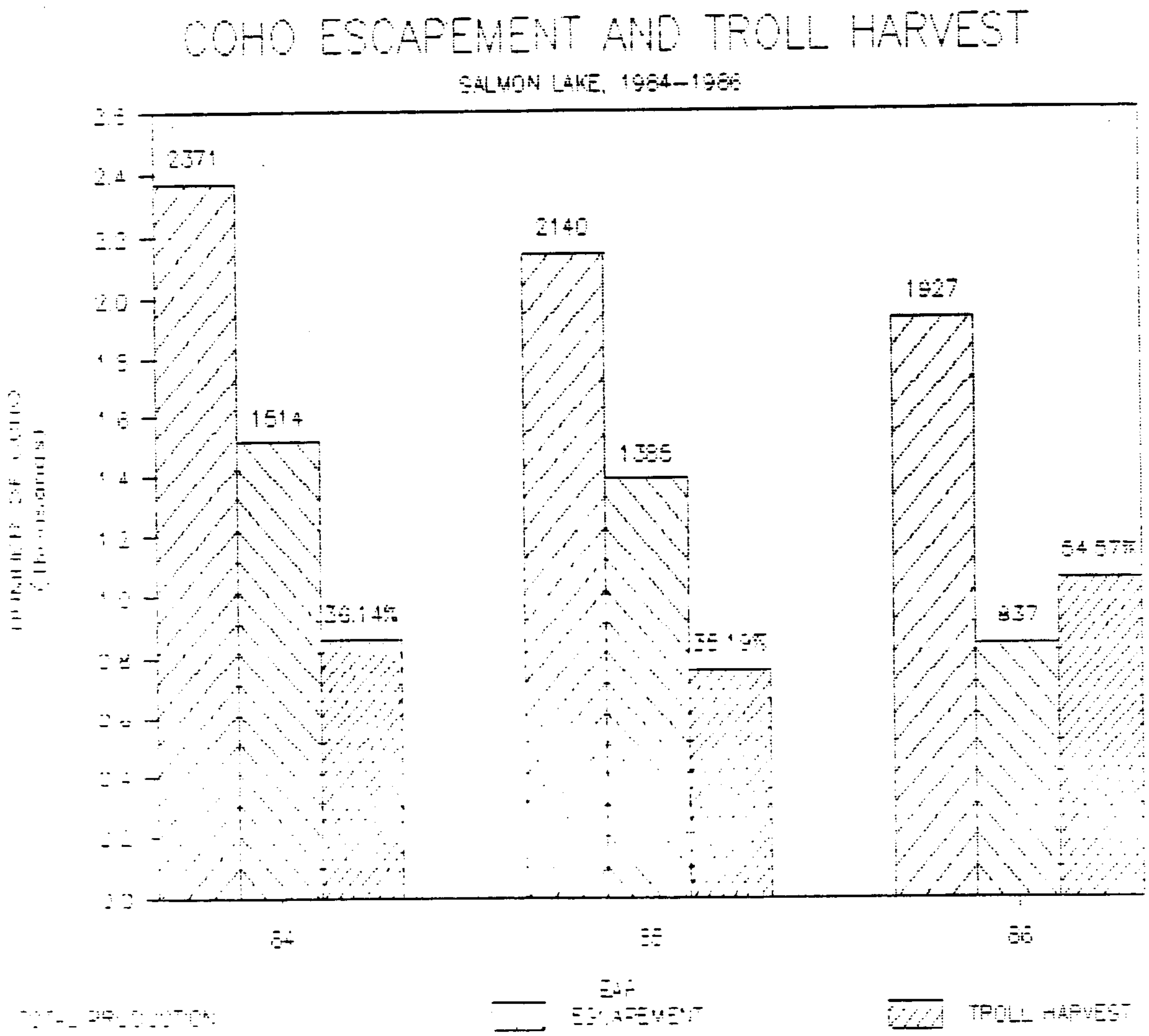

LOCATION OF TAG RECOVERY, TROLL FISHERY
SALMON LAKE COHO 1985
49
19
4
2
NOYES
YAKOBI
YAKUTAT

Figure 3.



COHO ESCAPEMENT AND TROLL HARVEST
SALMON LAKE, 1984–1986
2371
1514
36.14%
2140
1386
35.19%
1927
837
54.57%
84
85
86
TROLL HARVEST

Figure 4.

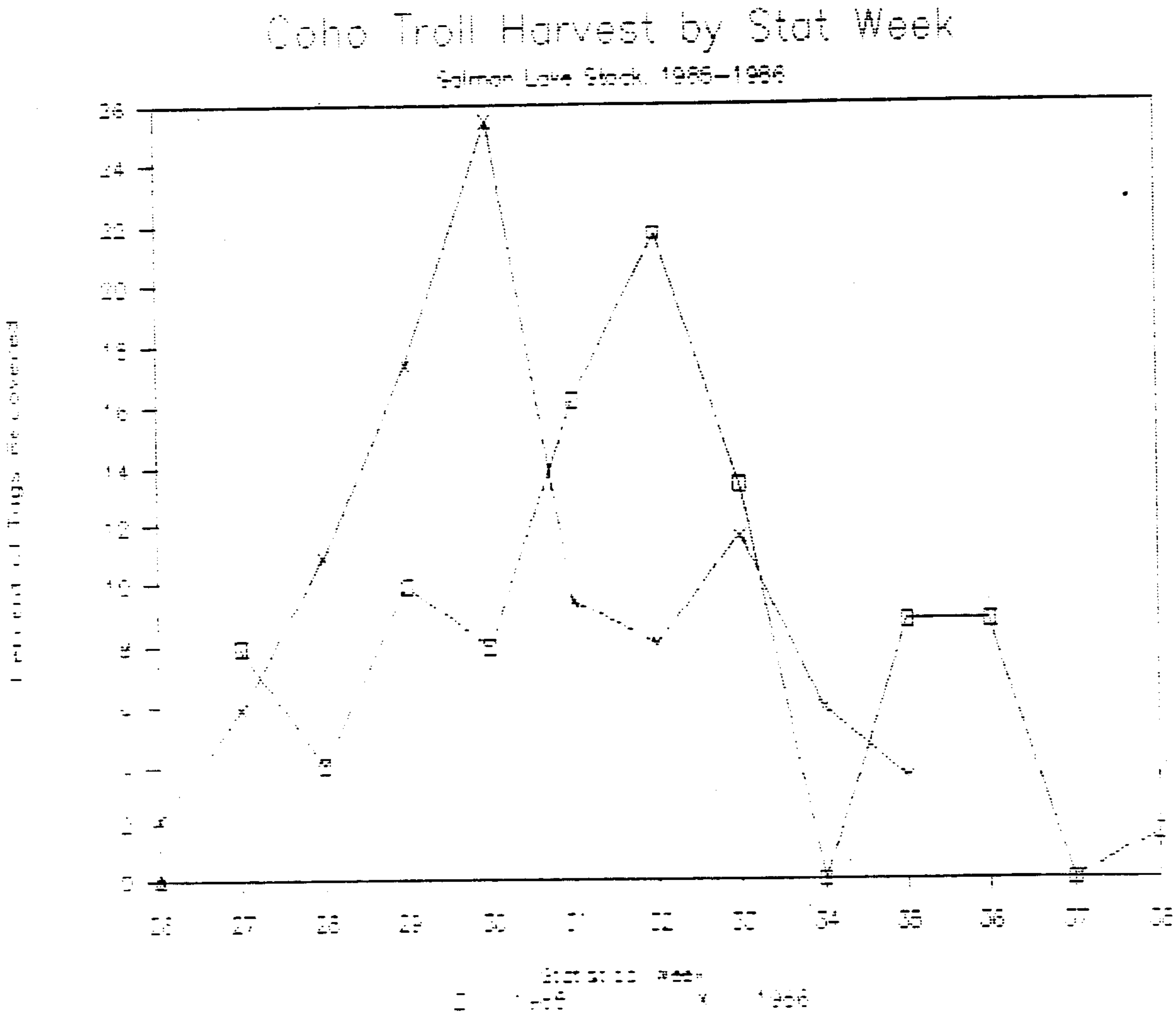
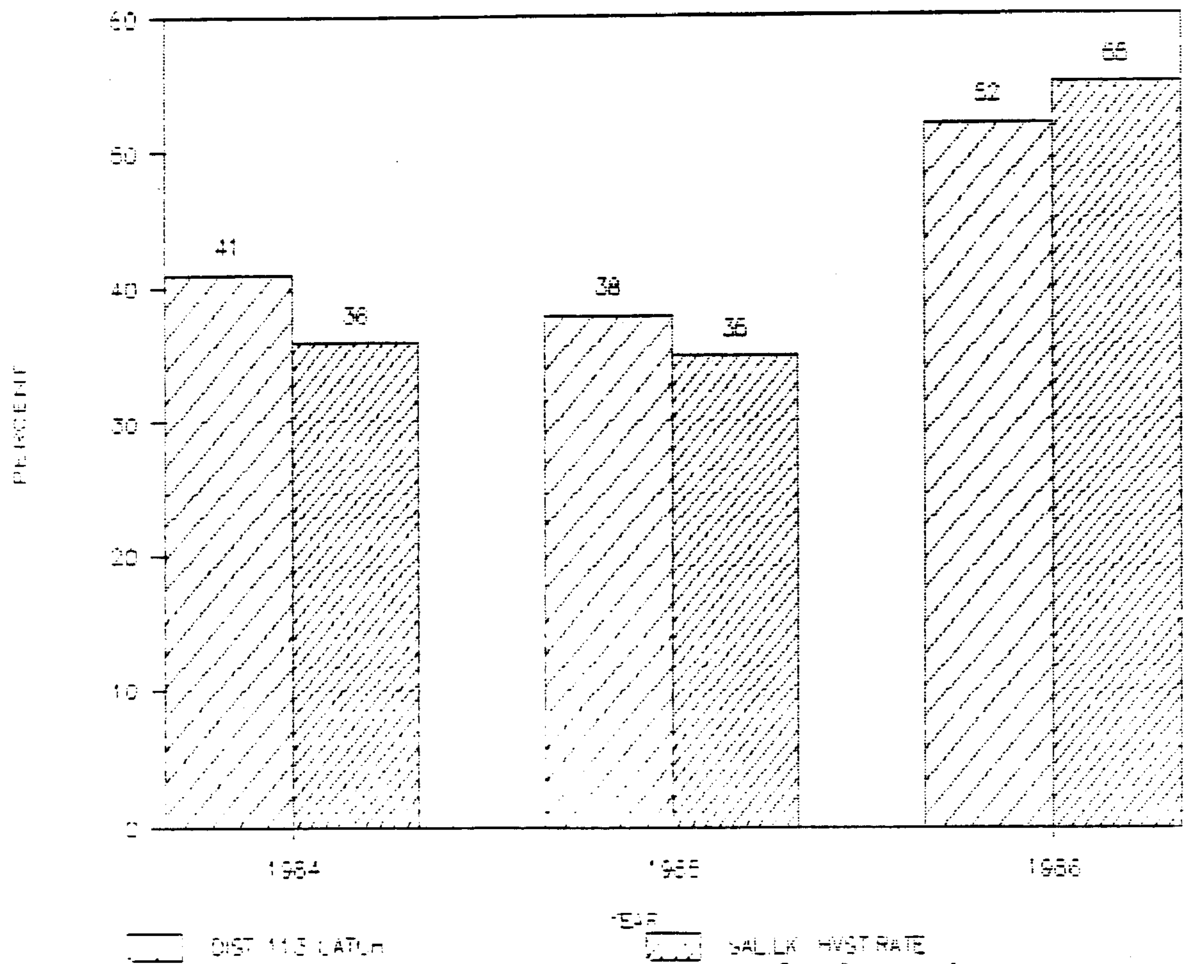

Coho Troll Harvest by Stat Week
Salmon Lake Stock, 1985–1986
26
24
22
20
14
8
0
27
34

Figure 5.



as % of total troll catch in Southeast and Yakutat

% of Salmon Lake total production harvested commercially

Figure 6.

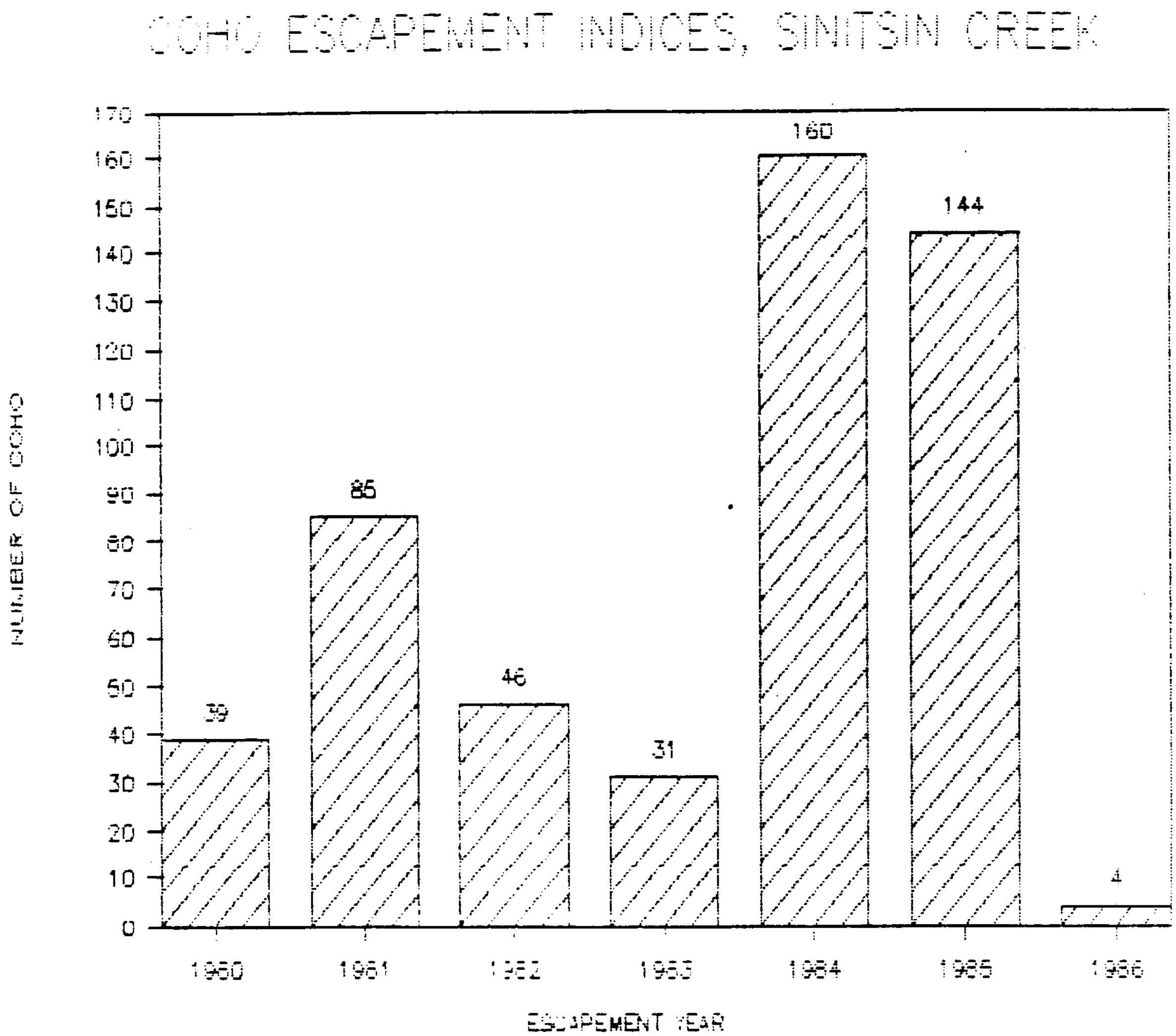

COHO ESCAPEMENT INDICES, SINITSIN CREEK
NUMBER OF COHO
ESCAPEMENT YEAR
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
39
85
46
31
160
144
4
1980
1981
1982
1983
1984
1985
1986

Figure 7.

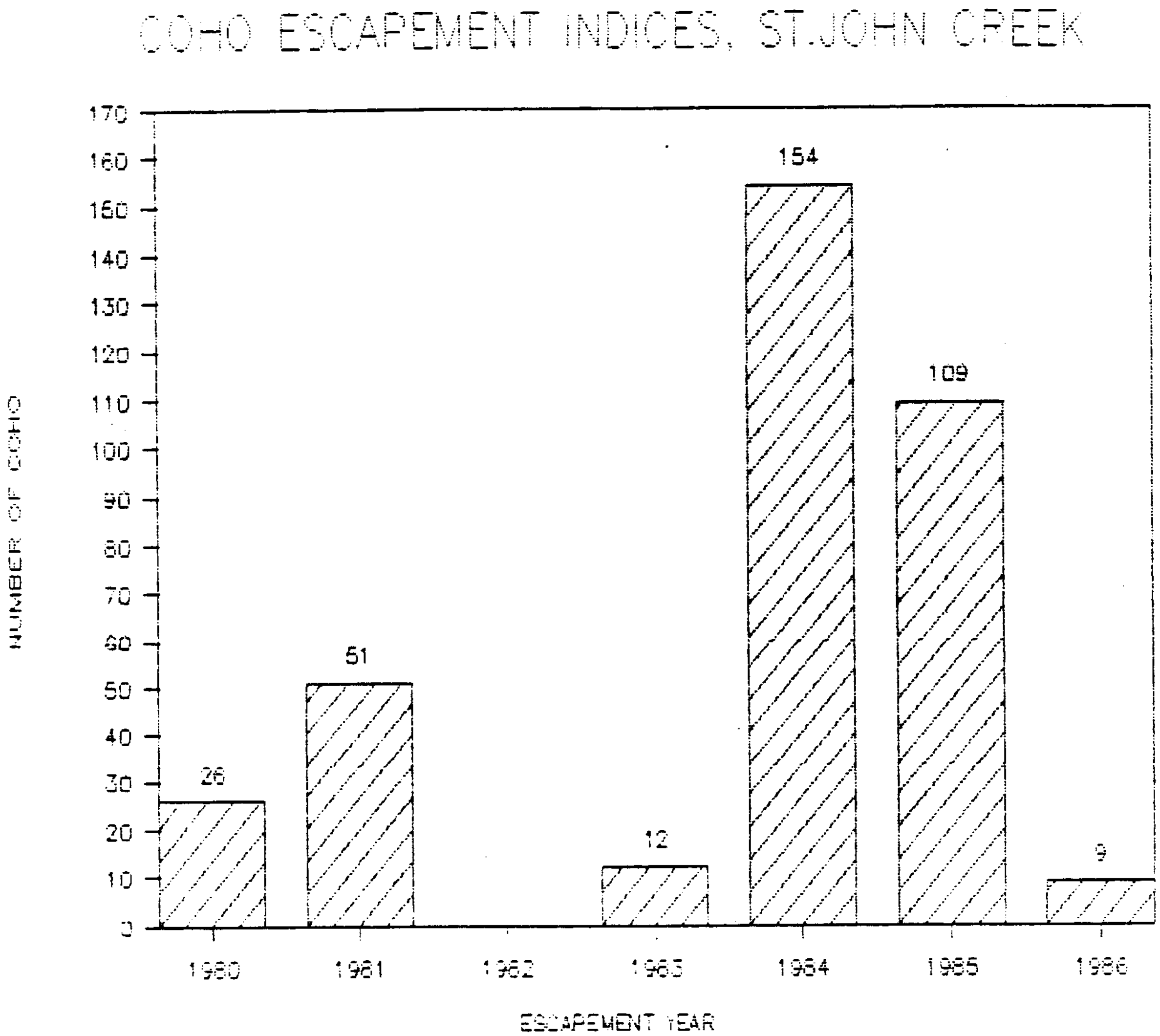

COHO ESCAPEMENT INDICES, ST.JOHN CREEK
NUMBER OF COHO
ESCAPEMENT YEAR
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
26
51
12
154
109
9
1980
1981
1982
1983
1984
1985
1986

Figure 8.

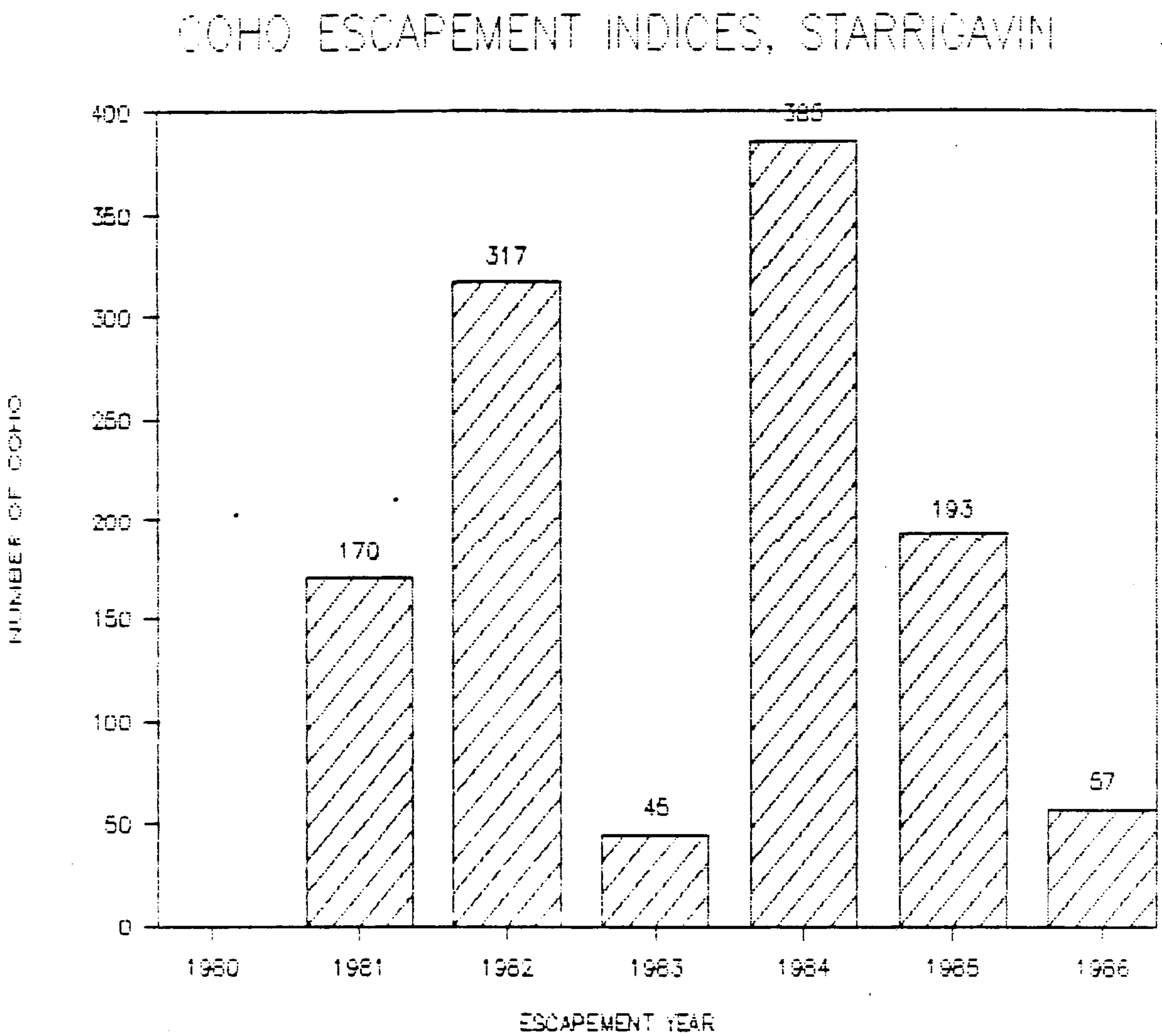

COHO ESCAPEMENT INDICES, STARRIGAVIN
NUMBER OF COHO
ESCAPEMENT YEAR
400
350
300
250
200
150
100
50
0
1980
1981
1982
1983
1984
1985
1986
170
317
45
385
193
57

Figure 9.

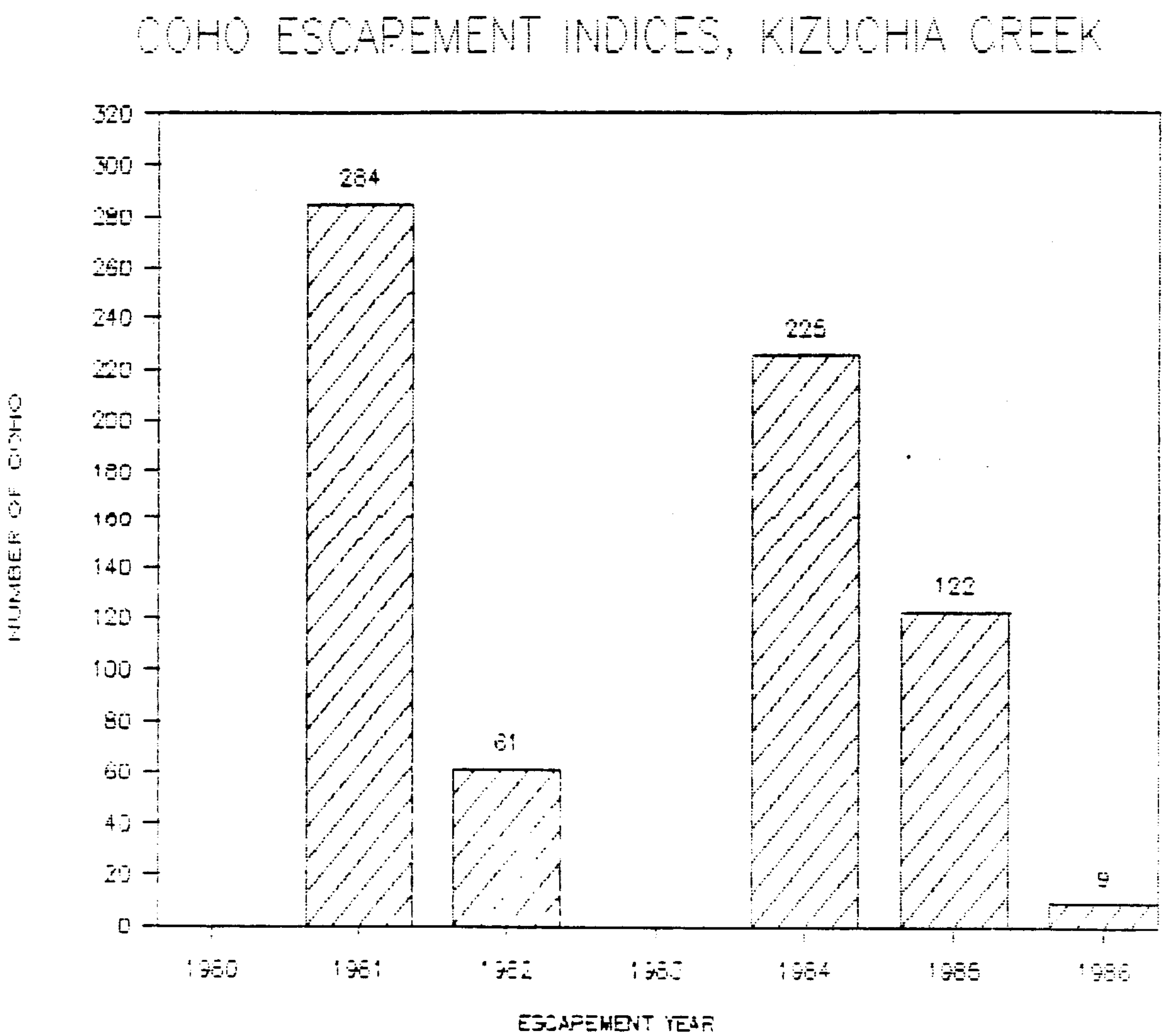

COHO ESCAPEMENT INDICES, KIZUCHIA CREEK
NUMBER OF COHO
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
284
61
225
122
9
1980
1981
1982
1983
1984
1985
1986
ESCAPEMENT YEAR

Figure 10.

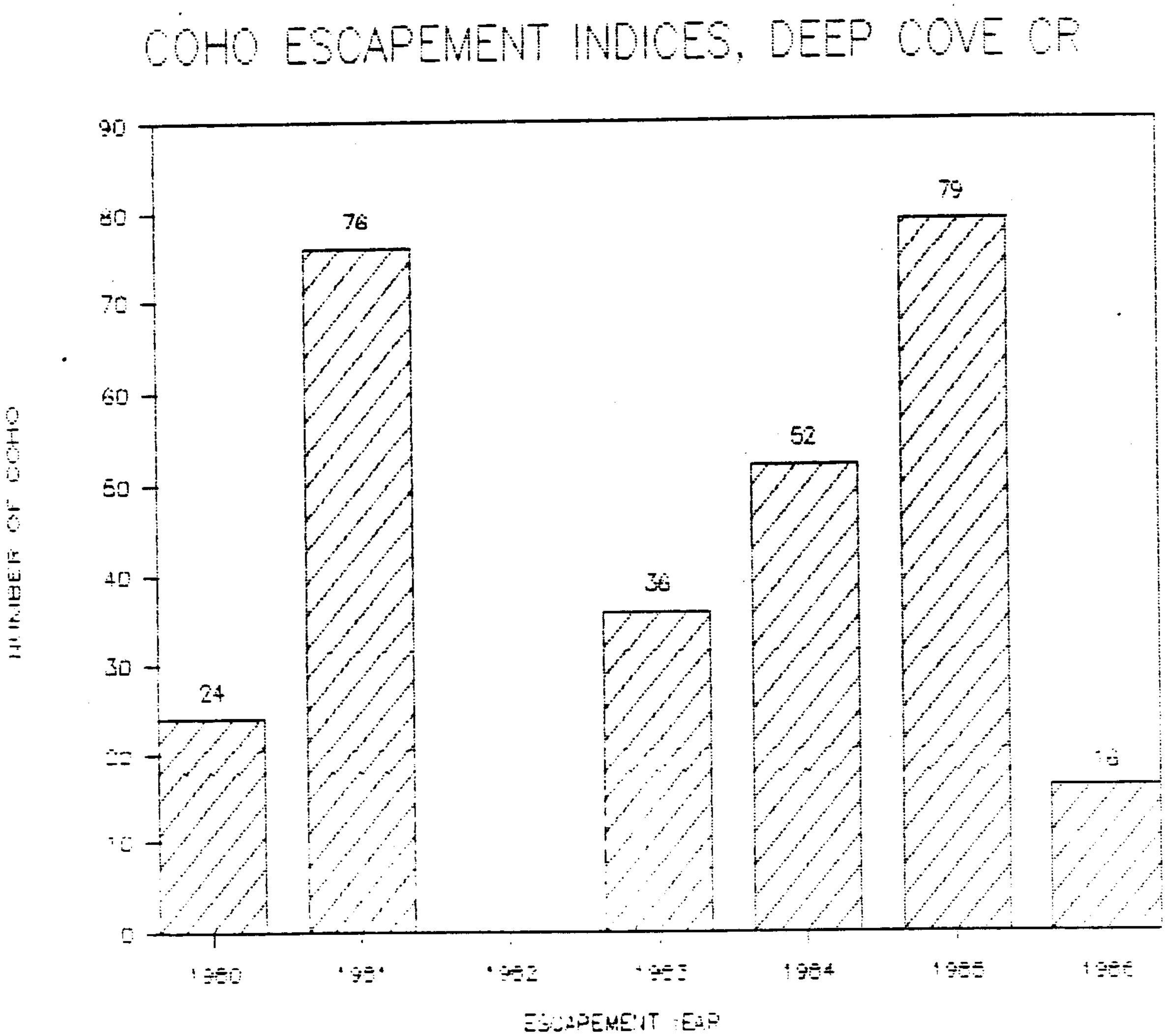

COHO ESCAPEMENT INDICES, DEEP COVE CR
90
80
70
60
50
40
30
0
24
76
36
52
79
1980
1984

Figure 11.

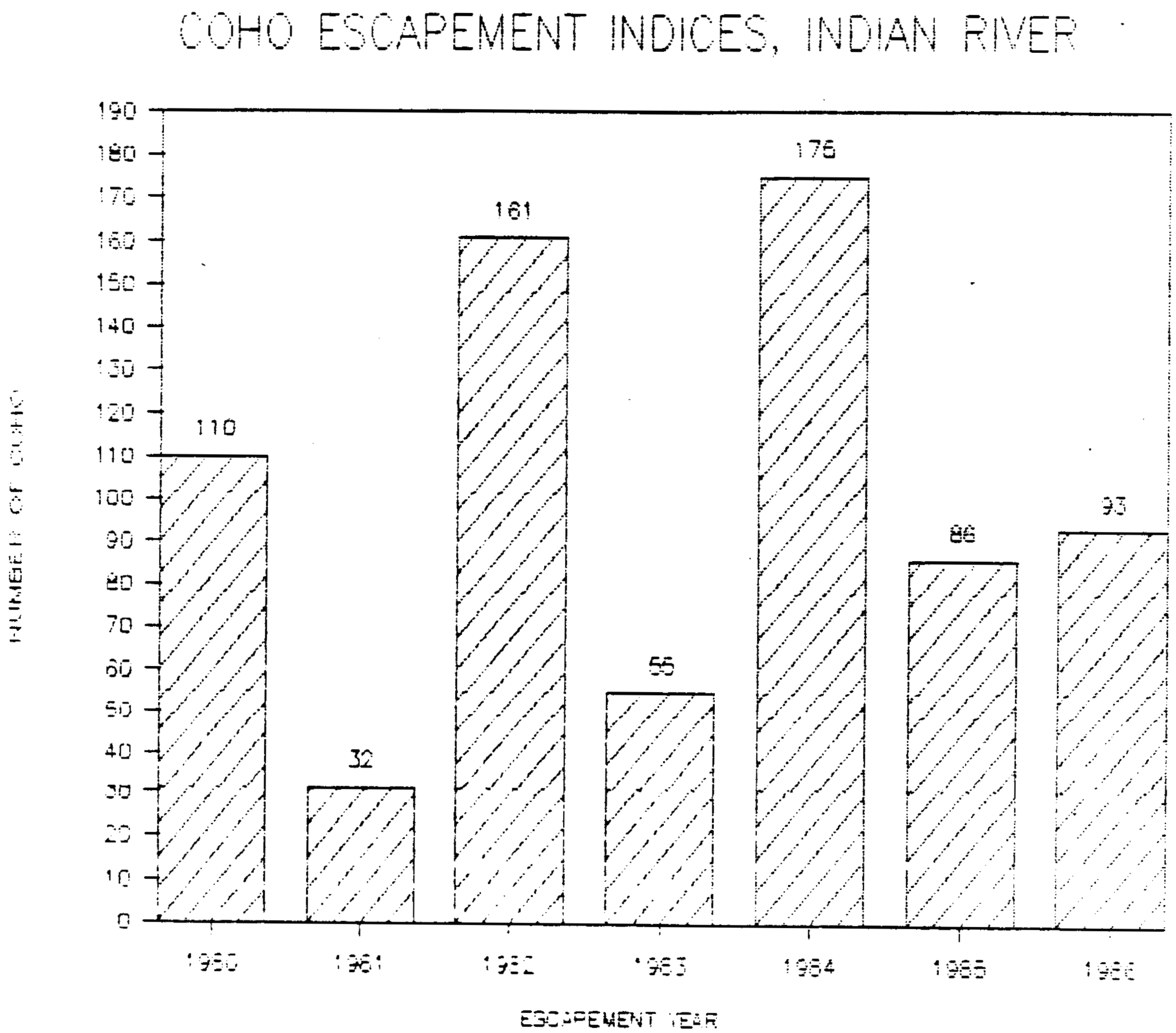
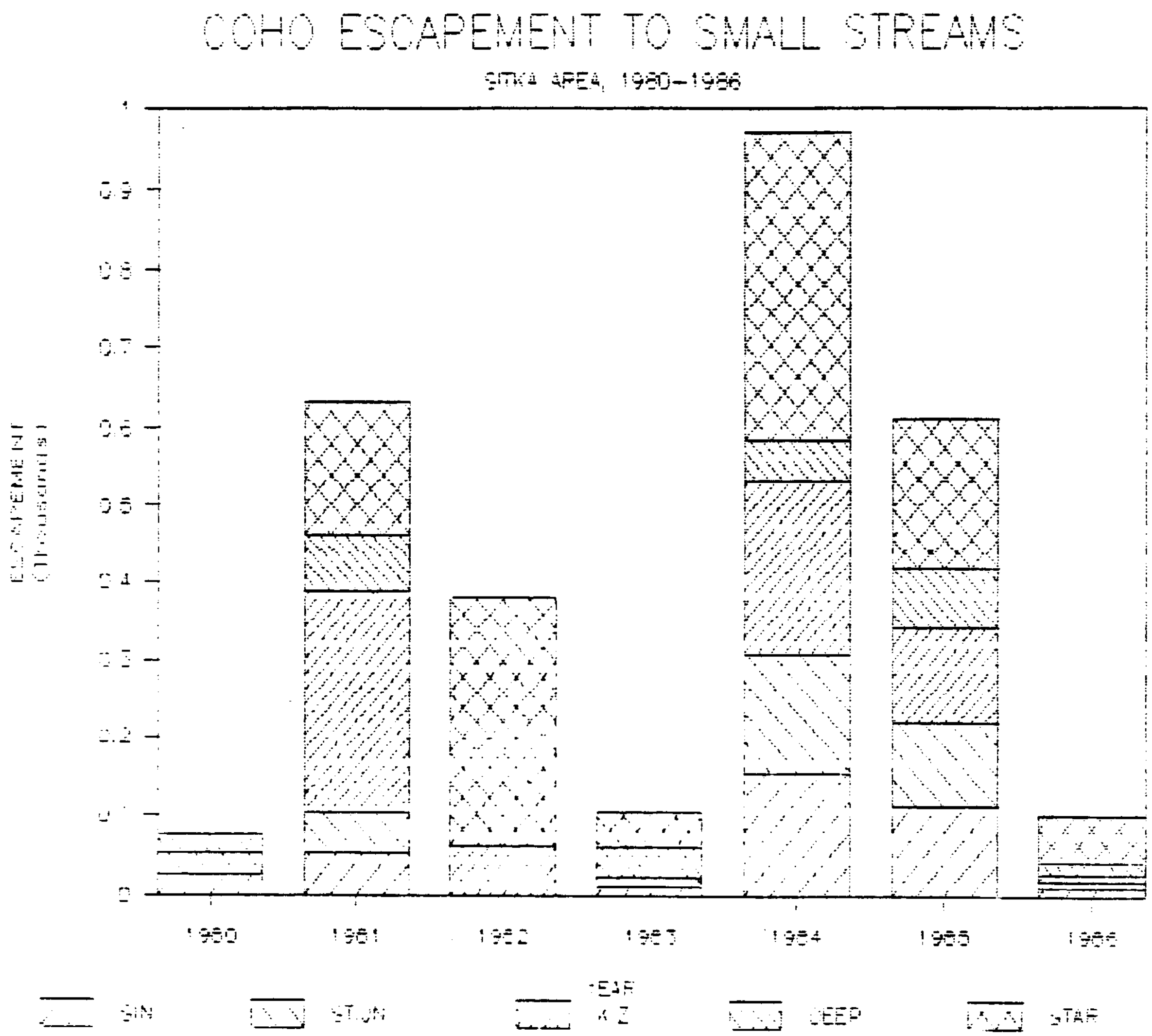

COHO ESCAPEMENT INDICES, INDIAN RIVER
NUMBER OF COHO
ESCAPEMENT YEAR
110
32
161
55
176
86
93
1980
1981
1982
1983
1984
1985
1986

Figure 12.



COHO ESCAPEMENT TO SMALL STREAMS
SITKA AREA, 1980–1986
0.9
0.8
0.7
0.6
0.5
0.3
0
1980
1981
1984
1986
DEEP

Figure 13.

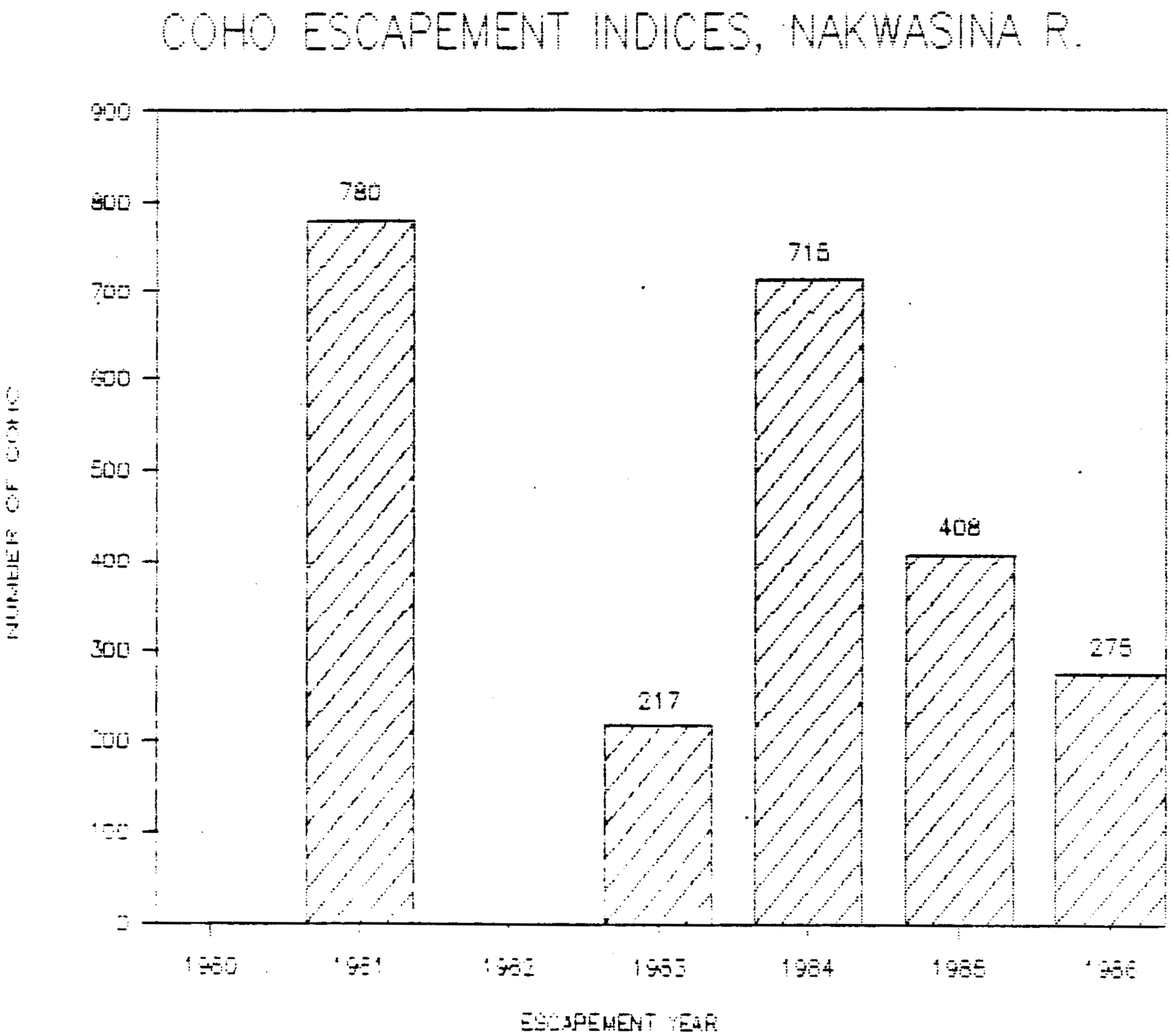

COHO ESCAPEMENT INDICES, NAKWASINA R.
NUMBER OF COHO
ESCAPEMENT YEAR
0
100
200
300
400
500
600
700
800
900
780
217
715
408
275
1980
1981
1982
1983
1984
1985
1986

Figure 14.

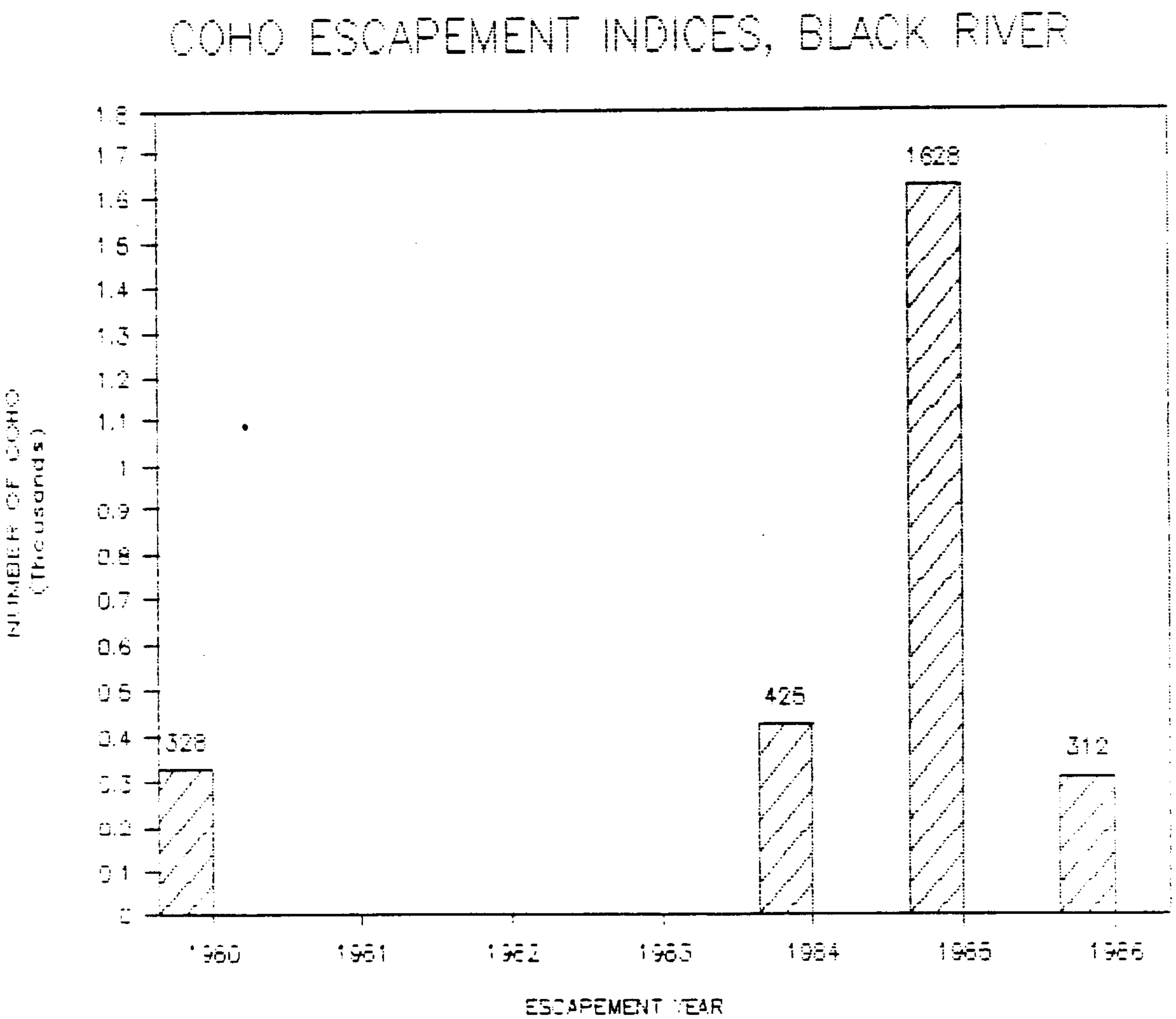

COHO ESCAPEMENT INDICES, BLACK RIVER
NUMBER OF COHO
(Thousands)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
328
425
1628
312
1960
1961
1962
1963
1964
1965
1966
ESCAPEMENT YEAR

Figure 15.

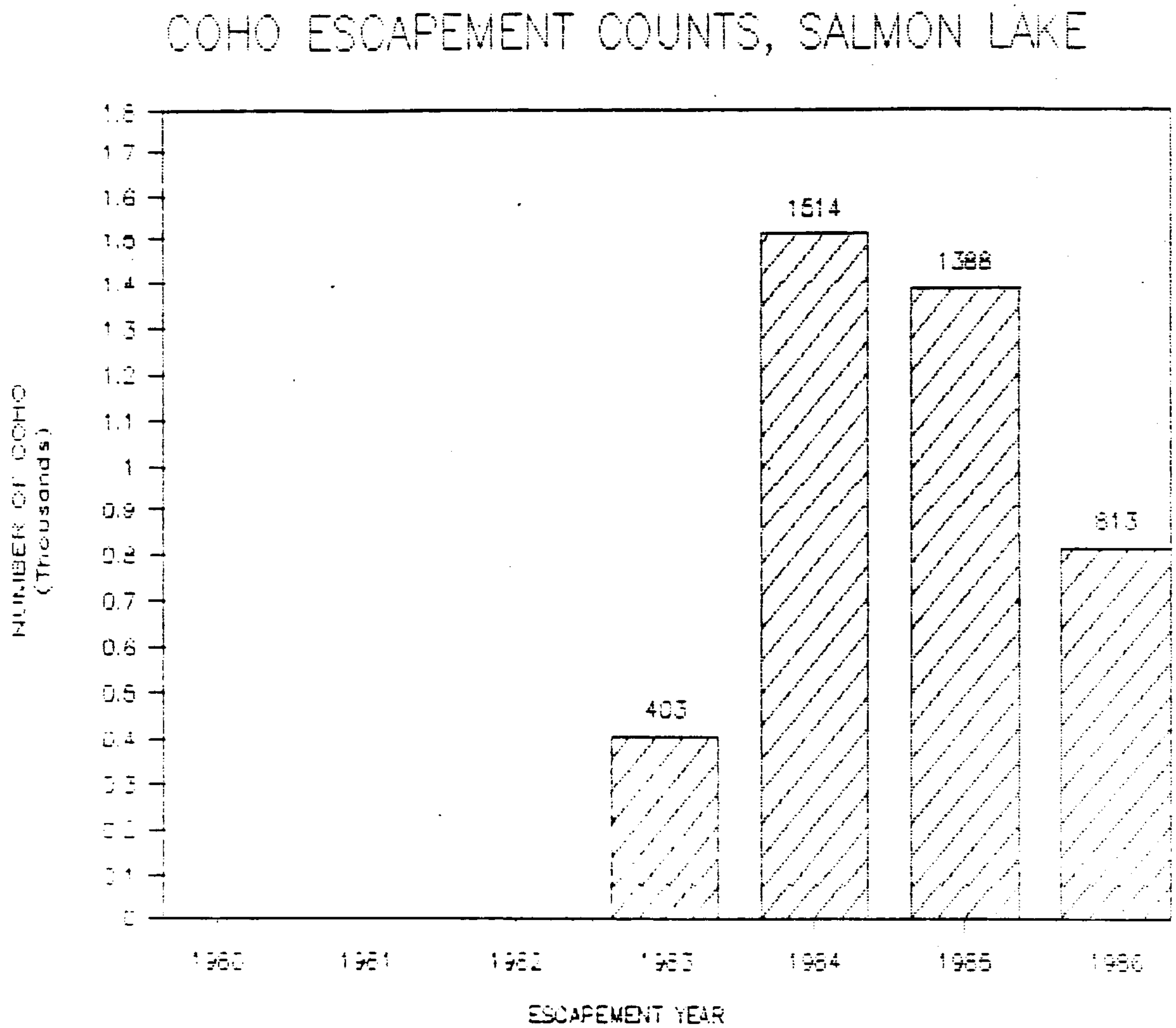

COHO ESCAPEMENT COUNTS, SALMON LAKE
NUMBER OF COHO
(Thousands)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0
403
1514
1388
813
1980
1981
1982
1983
1984
1985
1986
ESCAPEMENT YEAR

Figure 16.

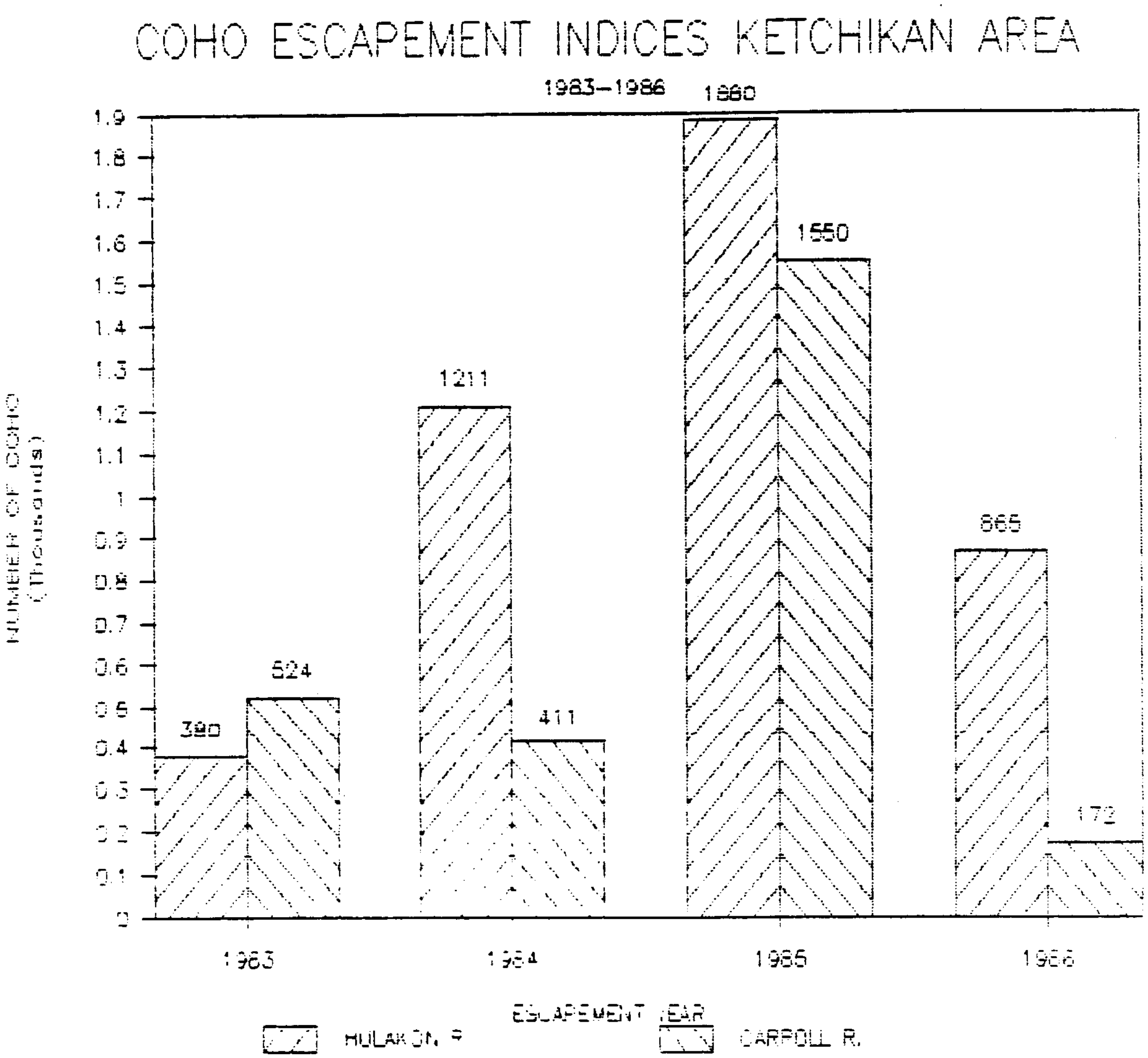

COHO ESCAPEMENT INDICES KETCHIKAN AREA
1983–1986
NUMBER OF COHO (Thousands)
ESCAPEMENT YEAR
HULAKON R.
CARROLL R.
1983
1984
1985
1986
380
524
1211
411
1860
1550
865
172

Figure 17.

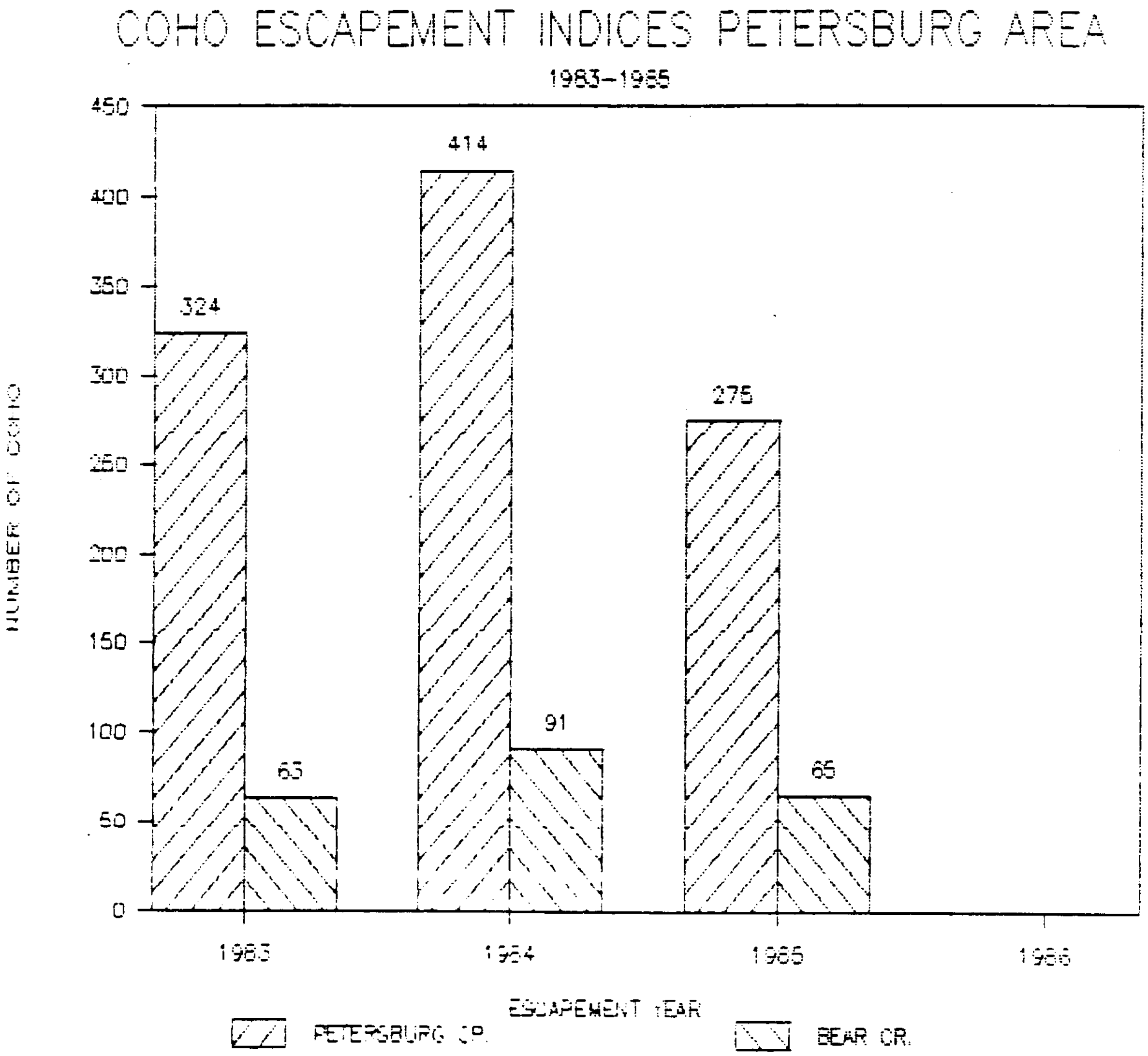

COHO ESCAPEMENT INDICES PETERSBURG AREA
1983–1985
450
400
350
300
250
200
150
100
50
0
NUMBER OF COHO
324
63
414
91
275
65
1983
1984
1985
1986
ESCAPEMENT YEAR
PETERSBURG CR.
BEAR CR.

Figure 18.

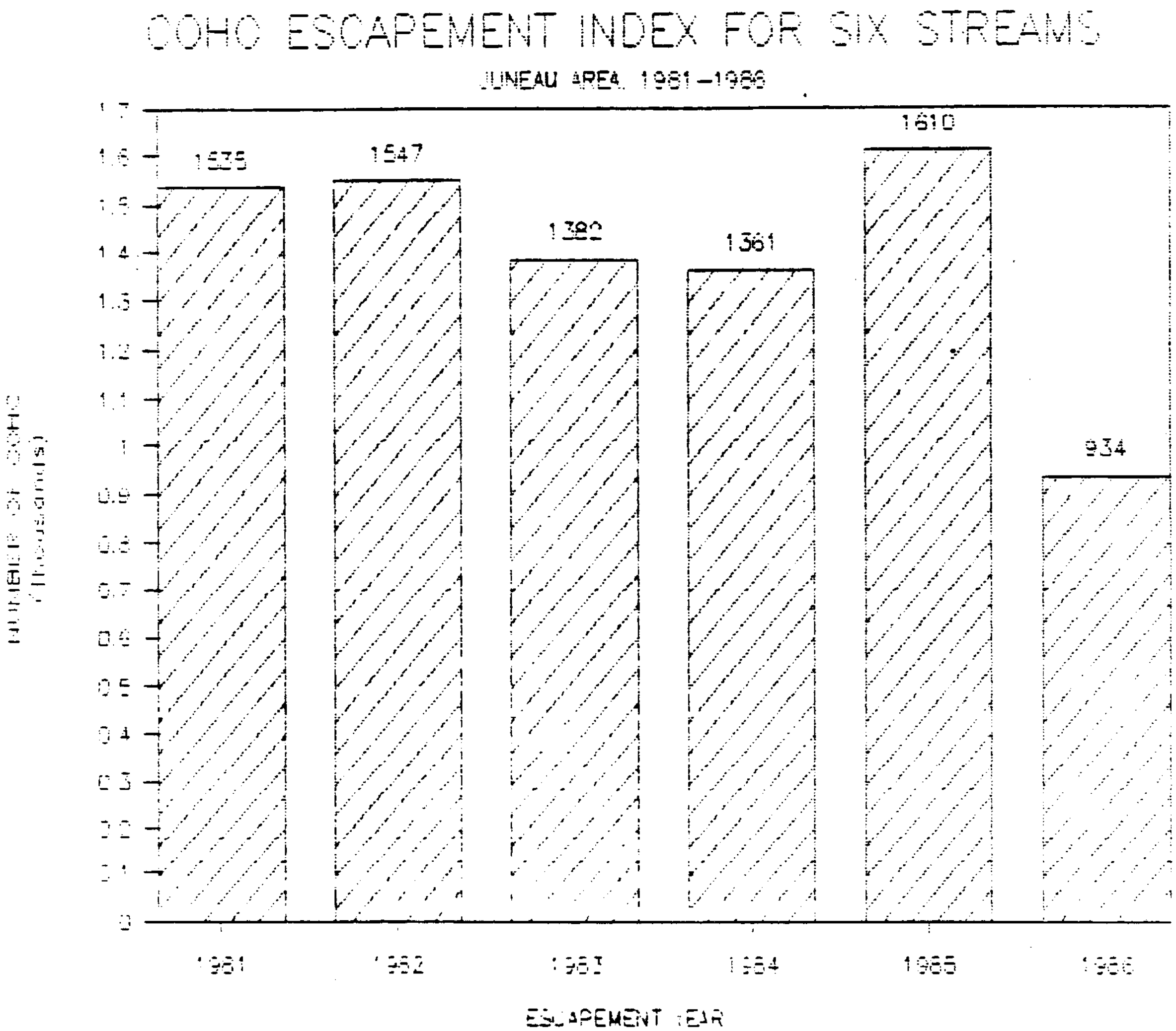

COHO ESCAPEMENT INDEX FOR SIX STREAMS
JUNEAU AREA 1981-1986
NUMBER OF COHO (Thousands)
1535
1547
1382
1361
1610
934
1981
1982
1983
1984
1985
1986
ESCAPEMENT YEAR

Figure 19.

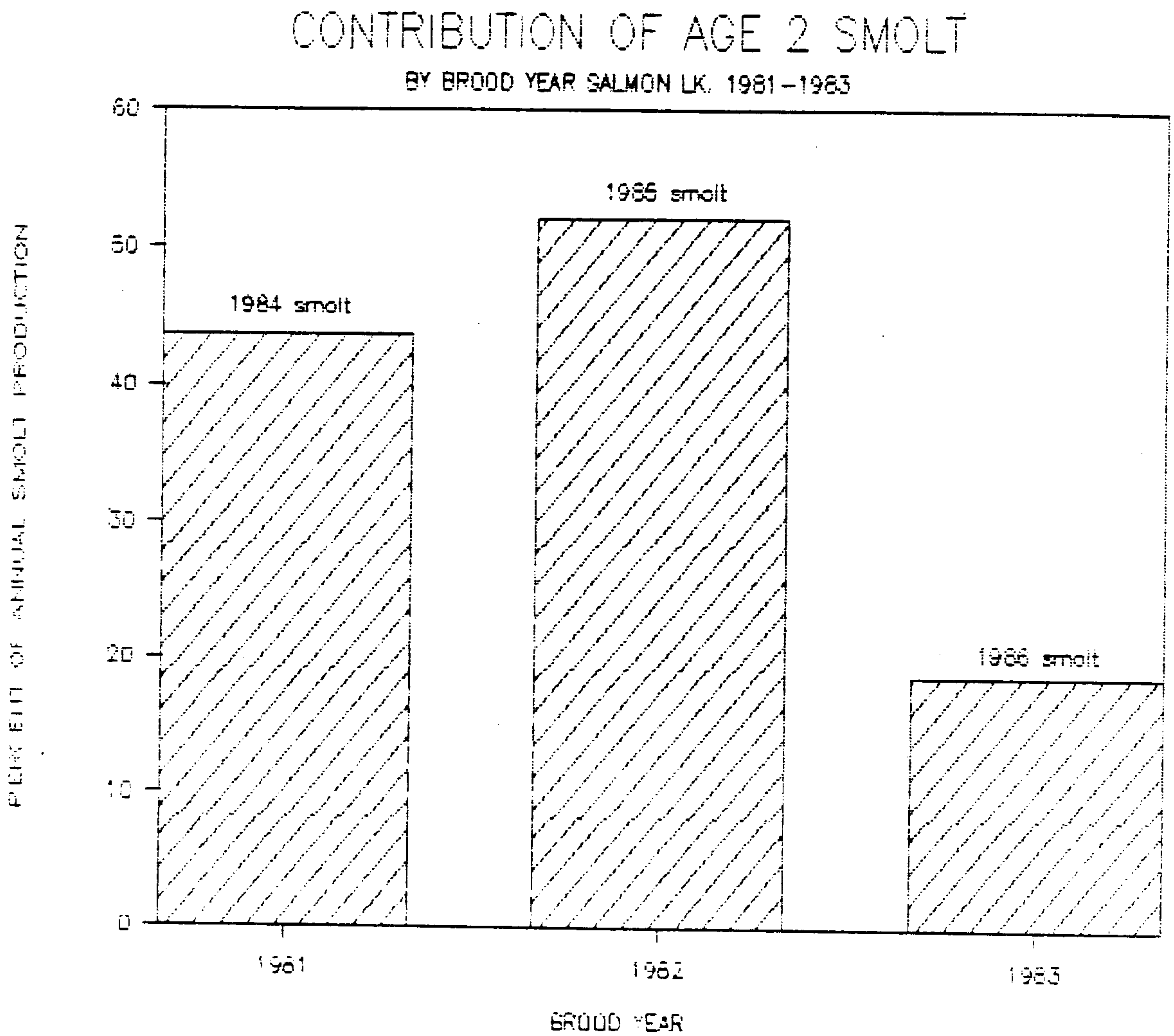

CONTRIBUTION OF AGE 2 SMOLT
BY BROOD YEAR SALMON LK. 1981-1983
PERCENT OF ANNUAL SMOLT PRODUCTION
60
50
40
30
20
10
0
1984 smolt
1985 smolt
1986 smolt
1981
1982
1983
BROOD YEAR

Figure 20.

Freshwater age (percent composition) of coho smolt at Salmon Lake, 1984-1986.

Year	1984	1985	1986
Number Aged	89	240	356
Freshwater Age		**Percent Composition**	
1.0		3.3	2.0
2.0	43.8	52.1	18.5
3.0	46.1	25.4	50.3
4.0	10.1	14.2	26.1
5.0		4.6	3.1
6.0		0.4	

Figure 21.

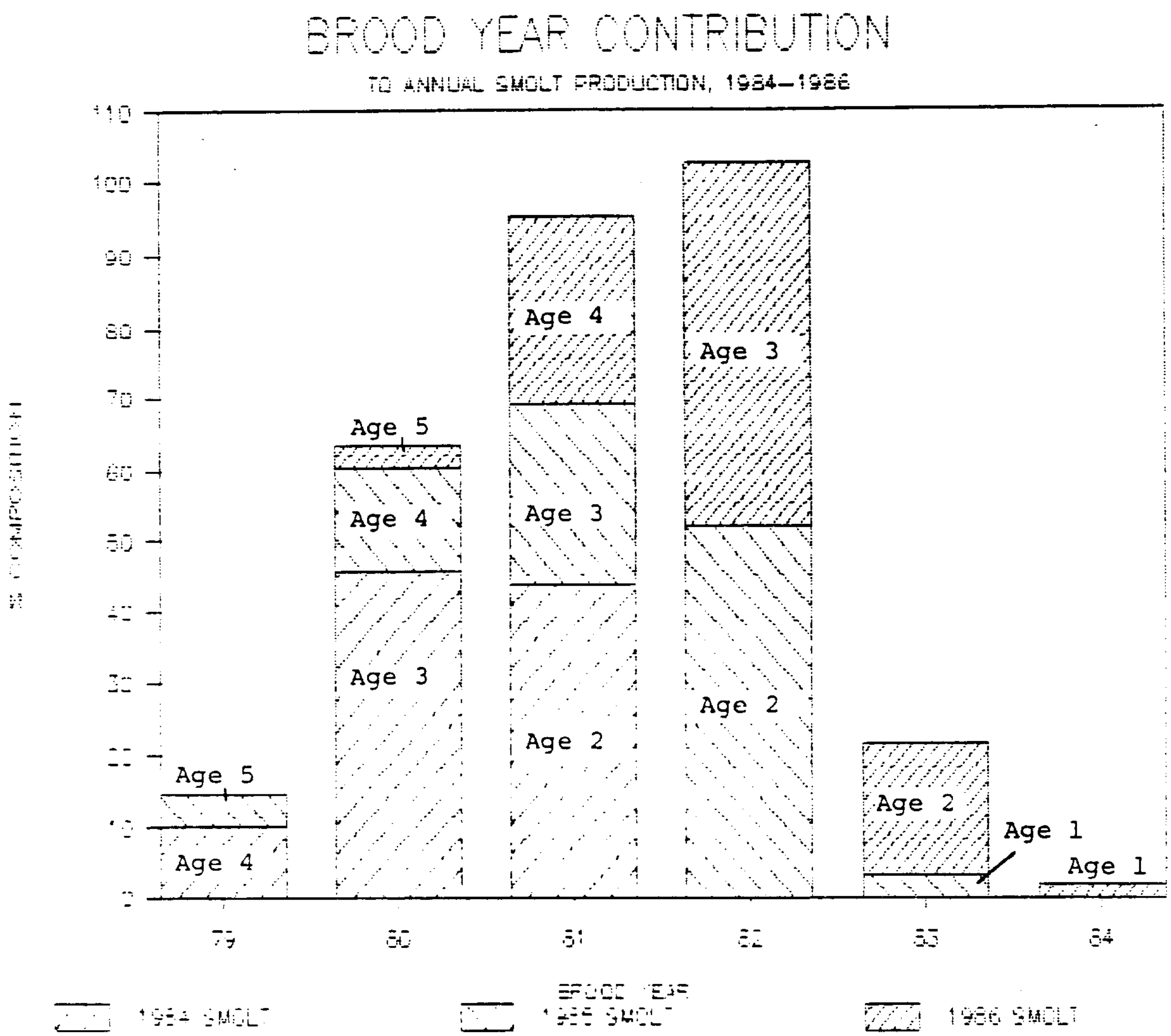

BROOD YEAR CONTRIBUTION
TO ANNUAL SMOLT PRODUCTION, 1984—1986
110
100
90
80
70
60
50
40
30
0
Age 5
Age 4
Age 5
Age 4
Age 3
Age 4
Age 3
Age 2
Age 3
Age 2
Age 2
Age 1
Age 1
79
80
81
82
83
84
1986 SMOLT

Figure 22.

Discussion Points (Schmidt's presentation)

1. Index systems should be increased to include small stream (non-lake) systems.

2. Drop any index stream which has received hatchery fish.

3. Coordinate/unify CF/SF coho research and information.

4. Expand Ketchikan area index streams.

5. We already have the personnel in the area offices to conduct local stream surveys; all we need is a coordinated program to do them.

6. We are probably over-emphasizing lake systems for escapement indices; lake systems are not representative of wild stock coho production in Southeast Alaska.

7. Escapements tend to be tied to high water periods in early October.

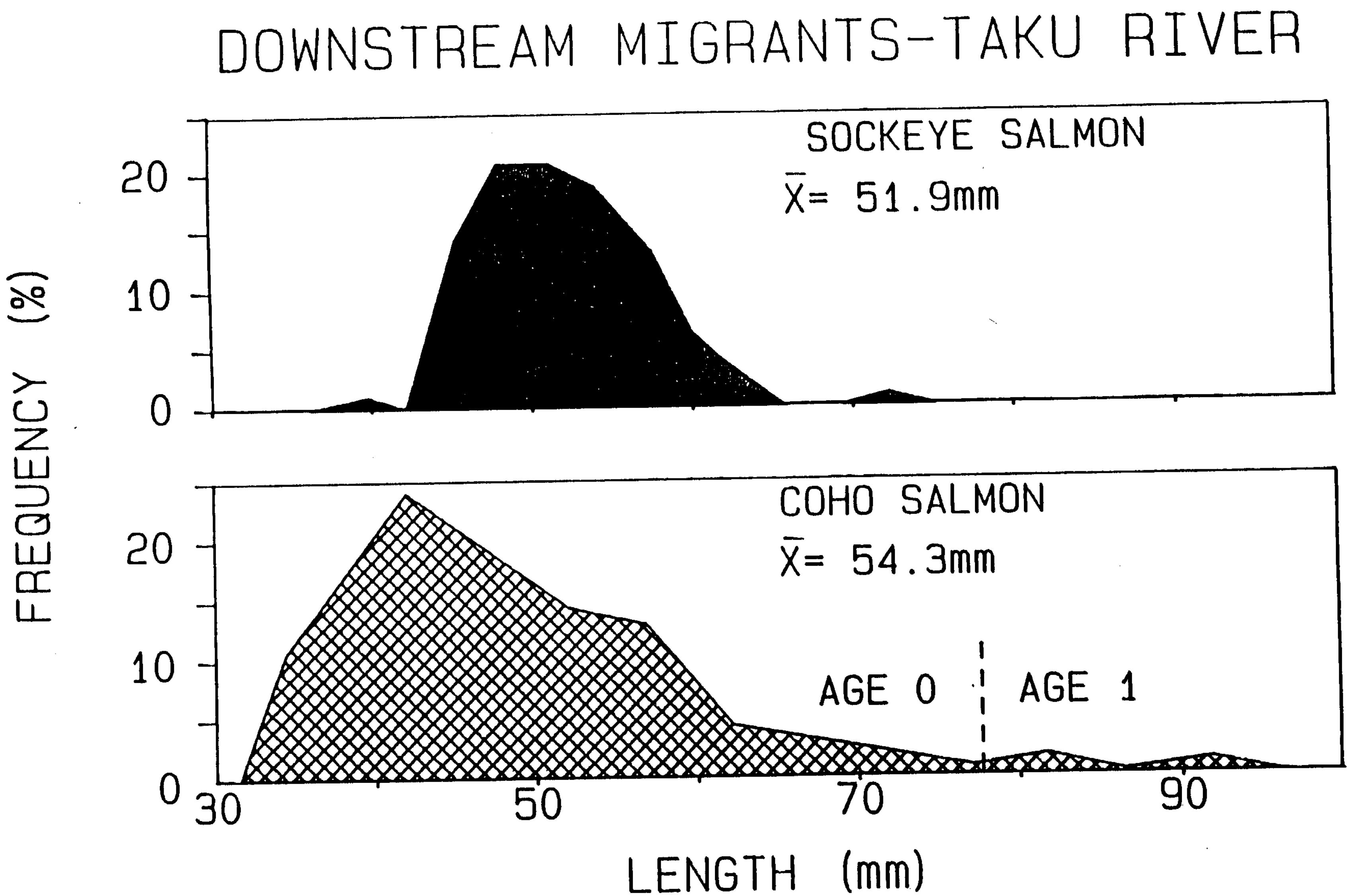


Figure 7.--Length frequencies of coho salmon (*Oncorhynchus kisutch*) caught in the downstream migrant trap at Taku Lodge, 6 August-19 September 1986. Data on sockeye salmon (*O. nerka*) are provided for comparison.

Total area of the lower Taku River and its off-channel habitats from Taku Point to the Canadian border was 1,932 ha (Table 3), as calculated from aerial photographs. Not included in this calculation were Twin Glacier Lake and Wright and Sittakanay rivers. Most (69%) of the area was composed of main and side channels, where swift current precluded salmon rearing. Channel edges, which provided the only suitable rearing area in these channels, made up only 2% of the total area. Almost a quarter of the area consisted of braids. Side sloughs and backwaters made up only 2% and off-channel habitats only 5% of the total area.

The total juvenile coho salmon population in the lower Taku River was estimated at 295,000 ± 173,000 (mean ± 95% confidence interval). This estimate probably is conservative because the analysis did not include some areas that may provide additional rearing habitat, such as Twin Glacier Lake, Moose Lake, Wright and Sittakanay rivers, the intertidal basins of upper Taku Inlet, and tributary streams on the valley slopes.

The contribution of these juveniles to the total coho salmon production of the Taku River can be estimated from a simple population model with mean life-history parameters from Crone and Bond (1976) (Table 4). Our estimate of 295,000 juvenile coho salmon rearing in the lower Taku River was composed of 95% (280,000) fry. Major (70%) losses typically occur during the first 3 months, June-August. Based on this 70% loss, about 933,000 fry were recruited to the area. With an assumed egg-to-fry survival of 21% and egg retention of 0%, the number of eggs deposited was 4,443,000. If mean fecundity was 3,200 eggs per female, the number of females in the escapement was 1,400. Therefore, a

Table 4.--Estimate of minimum number of coho salmon (*Oncorhynchus kisutch*) at different life stages (95% confidence intervals are in parentheses) in the lower Taku River, Alaska, July-September 1986.

Life stage	Number (thousands)
Summer residents--fry (assumed 70% mortality from emergence to August)[a/]	280 (116-445)
Post-emergent fry (assumed 21% egg-to-fry survival)[a/]	933 (387-1,482)
Eggs deposited (assumed 3,200 eggs per female and 0% egg retention)[a/]	4,443 (1,843-7,062)
Adult females (50% of escapement)	1.4 (0.6-2.2)
Coho salmon escapement	2.8 (1.2-4.4)

[a/] Crone and Bond (1976)

conservative estimate of the total escapement of coho salmon, assuming a 50:50 sex ratio, was about 2,800 ± 1,600 (mean ± 95% confidence interval).

IMPLICATIONS FOR ENHANCEMENT

Enhancement opportunities that utilize available habitat may be limited in the lower Taku River based upon the observed rearing densities. Over 80% of the coho salmon juveniles were in the off-channel habitats which constituted only 5% of the total available habitat. Summer densities of juvenile (fry and parr) coho salmon in off-channel habitats averaged 0.24 fish/m^2. In other areas of Southeast Alaska, summer densities of rearing coho salmon averaged 0.33 fish/m^2 in 6 forested streams (Murphy et al. 1986), 0.18 fish/m^2 in Deer Track Creek, 0.58 fish/m^2 in Kake Creek (Auke Bay Laboratory unpubl. data), and 0.15 fish/m^2 in 10 forested streams in northern Southeast Alaska (Elliott and Hubartt 1983). Based on these results, the density of juvenile coho salmon in the lower Taku River in 1986 apparently was at or close to carrying capacity in the preferred (off-channel) habitats. Because river-channel habitats had such low densities of fish, they probably represent only marginal habitats that are incapable of supporting higher densities.

Undoubtedly, there are areas in the lower Taku River that, because of escapement or access problems, are underutilized and could possibly be enhanced. More research is needed, however, to delineate the quality and quantity of spawning and rearing habitats in the lower Taku River. Because juvenile coho and sockeye salmon (_O. nerka_) use similar habitats in the lower Taku River, research on their competitive interaction should be undertaken before enhancement programs are developed.

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Discussion Points (Thedinga's presentation)

1. Estimated 295,000 rearing coho in the U.S. portion of the Taku River; back-calculates to approximately 2,800 adults (conservative estimate).

2. Habitat types with rearing coho were the off-channel areas: beaver ponds, upland sloughs, and tributaries. We didn't find any in the Taku River itself. Off-channel areas amounted to only 5% of the total river area below the U.S./Canada border.

3. Density of rearing cohos in off-channel rearing areas was about 1/4 fish per square meter which fits into the range of 1/10 - 1/2 fish per square meter found in other areas of S.E. Alaska. Looks like we may be approaching the carrying capacity for rearing cohos in the lower Taku River.

4. Only sampled about 1% of the total habitat in the lower Taku River. Used aerial photos to extrapolate to total rearing area.

5. Found downstream migration occurring throughout the summer.

6. It doesn't look like there is much opportunity for coho enhancement in the lower Taku as it appears that the rearing areas are being fully utilized.

Coho Salmon Research in Southeast Alaska

Anadromous Fish Habitat Research

Forestry Sciences Laboratory

Juneau, Alaska

March 1987

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Research Fishery Biologist

Pamela E. Porter,

Research Fishery Biologist

C. Andrew Dolloff

Research Fishery Biologist

The Forestry Sciences Laboratory (FSL) conducts research on fish and fish habitat to provide the scientific information necessary for the management of streams in the National Forest for fish production. The FSL conducts applied (management oriented) research although special emphasis is placed on the identification of basic ecological relations. Studies are designed to identify factors and interactions affecting survival and growth of juveniles in spawning and rearing habitat.

Coho salmon are of particular interest and importance because of their value in the sport, subsistence, and commercial fisheries. Juvenile coho salmon are found in a wide variety of habitats throughout southeast Alaska. Changes in land use patterns may affect populations of coho and other salmonids by altering the amount, composition, and distribution of habitat. The research summaries provided below address these relations.

I. Influence of Stormflows and Large Woody Debris on Channel Morphology and Stability of Spawning Gravel and Rearing Habitat

The quality of habitat for juvenile anadromous fish in forested streams is defined by a complex array of geomorphic, hydrologic and biological processes. In small streams (<4m wide), large woody debris is often the major factor controlling the distribution and amount of spawning and rearing habitat. Autumn storms represent the primary hydrologic events which influence channel morphology and sediment transport. This study focuses on the relationships among stormflows, large woody debris, sediment transport, and salmon spawning and rearing habitat. Channel morphology, bedload sediment transport and densities of salmonids are being measured on sections of Bambi Creek, second order stream on Chichagof Island. Data collected in during the 1985-86 storm season illustrate the dynamic nature of the streambed. Channel scour of 20-30 cm was recorded at several locations and can be most likely related to a storm event of 1.95 m^3/s approximating a 3 year return interval which transported 21,957 and 14,9000 kg of bedload sediment past two successive riffles. Aggradation of the streambed over the entire storm season of 20 cm was recorded in several sections. Scour and fill occurred in sections with and without debris. Changes in bedform of this magnitude can have a major influence on salmonid spawning success. For juvenile salmonids, rearing success over the storm season appeared to be related to the availability of refuge habitat during high flow events. Information on density and movement patterns of juvenile salmonids after storm events is currently being analyzed. This study will provide information on the contribution of various habitat features to the survival of juvenile salmonids over the storm season.

II. Large Woody Debris Accumulations and Juvenile Salmonid Habitat in Small Streams on Prince of Wales Island

Streams flowing through old-growth forest systems typically have numerous accumulations of large woody debris (LWD) in their channels. Trees fall into streams as a result of floods, bank scour, and blowdown during normal seasonal events. Logging to the streambanks in these drainages will change the amount, type, and rate of entry of material entering the streams. This study examines the chronosequence of LWD additions to streams following logging in the riparian zone, and the role of LWD as habitat for juvenile salmonids.

The objectives are:

(1) to estimate changes in number and frequency of accumulations of LWD over a 30-year period in streams with three types of riparian zones,

(2) to identify the effect of the number of log-size pieces in accumulations on stream morphology and the relationship to salmonid habitat,

(3) to relate salmonid density to habitat type and debris loading,

(4) to determine the seasonal use and survival rates of juvenile salmonids in habitat formed by LWD.

Five streams were selected in the Kassan Bay area on Prince of Wales Island. Each has been affected by different land management activities. The Old Tom Creek watershed has not been logged; the Harris River and Maybeso Creek study sections were completely logged in the 1950's. The Twelve-Mile Creek drainage was extensively logged at various times since the late 1950's but has a fringe of trees along the bank. The Indian Creek watershed was partially logged in the lower section. Each stream was mapped in 1949 before logging began. The maps were updated and redrawn annually for the logged watersheds through the late 1950's. The map for Old Tom Creek was updated through 1954. These maps and subsequent map surveys in 1983 and 1984 provide a data base from which to determine changes in debris and stream morphology over a period of more than 30 years.

The number of LWD accumulations in the two logged stream systems increased in all categories during the following logging up to 1960. From 1960 to 1984 the number of LWD accumulations decreased to numbers at or lower than those before logging in 1952. Similar changes were not observed in the other systems although there was year to year variation. In addition, differences in channel stability and type of LWD were observed between systems logged to the bank and those with unlogged riparian zones.

Although the number of accumulations decreased in the logged systems, the remaining accumulations provided important habitat for juvenile salmonids and supported the highest densities of juvenile coho salmon in these streams. LWD accumulations were also important in the streams with unlogged and partially logged riparian zones.

III. Winter Population and Habitat Characteristics of Juvenile Salmonids

Juvenile coho salmon in southeast Alaska typically spend one or more years in freshwater before migrating to the ocean. During this time, the growth and survival of these fish may be limited by harsh winter conditions and a lack of adequate winter habitat. The purpose of this study is to determine the effect of winter conditions on juvenile salmonid production and habitat selection.

The specific objectives are:

(1) to identify the areas used by juvenile salmonids (particularly coho salmon) as winter habitats,

(2) to describe the population characteristics (i.e. density growth, survival) of these fish in different habitat types, and

(3) to evaluate the distribution and movement patterns of juvenile salmonids on a seasonal basis.

Sampling began in September 1983 and has continued at quarterly intervals through 1986. The primary study area is located in the kadashan River drainage on Chichagof Island. Four distinct habitat types were identified and selected for sampling: 1) four ponds in a beaver pond complex, 2) three first order tributaries to the beaver ponds 3) a second order tributary to the main Kadashan River (including reaches with and without a forest canopy, and 4) a 1-km section of the Kadashan River. All debris jams (5) and side channels (2), areas presumed to provide winter habitat, were sampled within the 1-km section of the main Kadashan River. Four additional river sites were randomly selected to account for the bias associated with the subjective determination of winter habitat. All salmonids captured were marked with a freeze brand identifying the specific habitat type during the fall sampling period each year.

Data analyses are continuing for population density (N/m^2), growth, and movements. Juvenile salmonids have been found in all of the habitats and at all times of the year. In general, greater densities of fish are found at main river and stream sites with dense accumulations of large woody debris (LWD), and in the beaver ponds. During the summer and early fall, all areas including sites lacking LWD or other cover had large numbers of fish, but the seasonal variation in density for sites without cover or LWD was much greater.

Preliminary analysis of movement patterns indicates that coho salmon juveniles are capable of moving long distances, but most fish remain at the location where originally caught and marked. No habitat preference was apparent in the movement data; fish have been recaptured in all types of habitat.

The results from this study suggest that the amount and quality of habitat, its distribution throughout the watershed, and its accessibility are major factors influencing survival of juvenile coho salmon. Because it appears that early in the season age 0+ coho salmon are not selective for specific habitat, high quality, accessible habitat distributed throughout the stream basin will provide better survival than high quality habitat concentrated in a few locations.

IV. Seasonal Population Characteristics and Habitat Use by Juvenile Coho Salmon in a Small Southeast Alaska Stream

The density, growth, production, and movements of juvenile coho salmon from a wild population were evaluated after transplant into five types of habitat in a small southeast Alaska stream. Instantaneous growth ranged from 0.0066 in the clear cut to 0.0055 in the slough tributary. Daily increase in fork length was about 0.10 mm/d system-wide. Annual production of coho salmon in each habitat type was: meadow-3.32 g/m^2, slough tributary-2.48 g/m^2, clearcut-1.74 g/m^2, forest-1.59 g/m^2, and forest tributary-1.34 g/m^2. During all sampling periods, most fish were recaptured at the site where they were released; those fish that moved neither selected nor avoided specific habitat types. These findings suggest that habitats should be managed to meet both the summer and winter needs of juvenile coho salmon because most fish do move among habitats after the initial population adjustment in the spring. The ability of a stream to produce fish depends not only on the amount and accessibility of habitat, but also on the distribution of habitat types.

Discussion Points (Dollof's presentation)

1. Author doesn't believe that the severe freeze in November 1985 will effect future salmon returns.

2. Elliott found coho juveniles of up to 100 mm in length living in the gravel in Kake Bake Creek during the November 1985 freeze. This same phenomenon with coho has been observed previously by other investigators during pre-emergent sampling for pink salmon fry.

HATCHERY PRODUCTION/ENHANCEMENT

FRED DIVISION COHO SALMON PROGRAM REVIEW

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Coho salmon, Oncorhynchus kisutch, have been produced in hatcheries along the north Pacific coast of the United States and Canada since last century. With the king salmon, O. tshawytscha, it was one of the earliest salmon to be cultured in the Northwest (Roppel, 1982). In her book on Alaska's early hatcheries, Roppel (op. cit.) cites several 19th century Alaskan hatcheries as having produced coho salmon. It seems from a cursory examination of her book that many more early hatcheries used coho salmon as feed or destroyed runs of this species because of fear of their impact on rearing sockeye salmon populations than actually produced coho salmon.

Since the inception of the Fisheries Rehabilitation, Enhancement, and Development Division (FRED) in 1971, the production of coho salmon has been an active part of it's program. The initial hatcheries involved in the FRED program including Crystal Lake and Deer Mountain hatcheries had coho salmon programs. Some of the initial programs such as Starrigavan Hatchery and the Fish Creek Rearing Pens were primarily coho salmon production facilities. As major new hatcheries were constructed in southeast Alaska, coho salmon programs were incorporated at Klawock Hatchery and at Snettisham Hatchery. Two of the present six FRED facilities in southeast have never had coho salmon programs, Beaver Falls has, to my knowledge, never been officially considered for a coho salmon program. The goal of Hidden Falls Hatchery was originally stated to include production of king/coho salmon. King salmon became the species of choice so no coho salmon program has been implemented at this facility.

The coho salmon program of FRED Division now involves major programs at three hatcheries, Klawock, Snettisham and Crystal Lake and a reinstitution of a program at Deer Mountain Hatchery (Table 1). Both Klawock and Snettisham hatcheries have coho salmon smolt capacities in excess of a million smolts. Crystal Lake Hatchery has a large green egg capacity and a smaller smolt production capability. The coho salmon is just being reinstituted at Deer Mountain Hatchery with the introduction of summer coho salmon eggs in 1986. A short synopsis of each hatchery program follows.

Crystal Lake Hatchery is one of the earliest producers of FRED coho salmon. It supplied eggs and fry for Starrigavan and the Fish Creek Rearing Pond complex. The coho salmon stock at Crystal Lake Hatchery is the Crystal Creek (Blind Slough) stock although several stocks including one from Duncan Salt Chuck were initially taken into the hatchery. In 1979-80 its smolt production capacity was equally split between coho and king salmon. Around 1981 a decision was made to increase the production of king salmon at the expense of the coho salmon smolt production capacity of that facility. Shortly after that, a plan to utilize the large green egg capacity of Crystal Lake Hatchery to produce coho salmon fry for lake and stream stocking was put into place. Smolt releases from the hatchery are being made into Crystal Creek and several other area creeks.

Table 1. Southeast Alaska FRED Coho Salmon Program Information

HATCHERY	CAPACITY (millions)				1986		
	Green egg	Fry(emer.)	Fry(fed)	Smolt	Releases(K)	Eggtakes(K)	Return
Klawock Hatchery	1.3000	1.3720	1.2340	1.0000	1,002	1,900	55,800
Crystal Lake Hatchery	2.0000	1.4100	0.1310	0.3600	1,086	723	35,340
Deer Mountain Hatchery	0.2000	0.1500	0.1500	0.1300	0	45	0
Snettisham Hatchery	1.8000	1.3900	1.2500	1.0700	316	1,600	5,030

Klawock Hatchery is now the largest FRED producer of coho salmon in southeast Alaska. Although initial goals for this facility included chum and coho salmon production, the chum salmon goal is being lowered and because of increasing success with coho salmon, production of this species is increasing. Cultural conditions at Klawock Hatchery allow the greatest growth of this species seen in any of southeast Alaska FRED hatcheries. The release strategy for coho salmon at Klawock is unique. The majority of coho salmon produced here are released into Klawock Lake as fed fingerling during their first winter and emigrate naturally as smolt the following spring. This strategy has produced better returns than spring smolt releases from the hatchery. Klawock Hatchery is being used to plant coho salmon smolt in several lakes and streams including Funny Blue Creek and at Tunga Inlet on Prince of Wales Island.

Snettisham Hatchery has a burgeoning coho salmon production. The initial stock of this species for this facility was the Speel Lake stock. Returns of this species have proven to be disappointing so several alternate strategies are being developed. Alternate brood stocks from King Salmon River and Montana Creek are being tested in the hatchery and alternate release sites and strategies are also being tested. Release of approximately 20 thousand smolt into Dredge Lakes in 1985 resulted in a return rate approximately 4 times as great as fish released from the hatchery. Size at release of the Speel Lake stock seems to have been a problem, early releases were too small. Heating of incubation water and selection of an earlier stock will produce fish of adequate size to survive well. Work with the Speel Lake stock seems to indicate that a large portion, perhaps 40%, of that stock tends to remain in freshwater for two years. Rearing this stock in a cold water facility apparently is not a good option. Coho salmon from Snettisham Hatchery have been used in lake stocking of Indian Lake and in experimental netpen releases at various sites in the Juneau area.

Deer Mountain Hatchery is undergoing changes in its major goals. Designated a chinook salmon research facility in the recent past, it is now moving toward the production of sportfish species for southern southeast Alaska. According to local fishermen's groups, there is a need in the Ketchikan area for summer coho salmon to fill the fishing gap between the chinook salmon run and the later fall coho salmon runs. In response to this need, summer coho salmon eggs were taken into this facility in 1986 and plans for increasing the scope of this project are being made. This is the first time in four years that coho salmon eggs have been in this facility but is far from the first time. As previously stated, coho salmon production at Deer Mountain Hatchery was well underway when FRED Division came into being. The present plan is to develop a viable summer coho salmon run from this facility and probably will include remote releases of this species when eggs are available to broaden the impact on sport fishermen.

FRED Division has had and maintains a strong involvement with coho salmon production in areas outside hatchery environs. Table 2 contains coho salmon information extracted from a table of FRED Division activities that support natural runs of all species compiled by Brad Sele. Major types of activities used with coho salmon include fish passes with and without stocking; lake and stream stocking; and habitat improvement. While no attempt at an exhaustive review of all these projects will be made here, several of them are especially noteworthy.

FRED Division, most often in conjunction with U.S. Forest Service, works with fish passes, primarily with stocking areas opened by the fishway with appropriate numbers, sizes, life stages of desired species. One of the most notable recent projects involved planting coho salmon above a fishpass on Irish Creek. In 1986 FRED finished four years of planting unfed fry into Irish Creek with a cumulative total of over 3.5 million fry planted. Results in this run development project are very encouraging. Spawning adults are returning in acceptable numbers and a great deal of information has been gleaned from this and other fish pass projects. FRED and local USFS biologists in the Petersburg area, after three fish pass projects made the following observations:

A. Indigenous runs of coho salmon will not readily go through a fish pass to use newly accessible habitat. Returning adults need to be imprinted as juveniles above the barrier. Adults not imprinted to areas above the barrier will even drop back down if placed above the barrier. Adults that are imprinted readily use the fish way.

B. Unfed coho salmon fry plants, as at Irish Creek, appear successful in establishing a self sustaining run, but fry to smolt survivals are low as was anticipated. This is a viable means of establishing a run only if significant numbers of the hatchery stock are available for planting.

C. When numbers of a hatchery stock available for fish pass planting are low, it is beneficial to rear the juveniles as long as possible to increase smolt survival and concomitant increases in adult production.

D. Removal of cutthroat trout is recommended in release sites whenever it does not conflict with existing sport fisheries and is operationally feasible.

Other unique coho salmon projects have included improving access to riverine ponds along the Chilkat River near Haines. Ponds which were opened were utilized by rearing coho salmon. Tagging studies and adult returns have indicated the success of these ponds in producing adults. As with all research of this nature, we cannot answer the question as to whether or not this production beyond that of the natural system or did we just provide more rearing room for the natural production.

Table 2. FRED Division activities that support natural runs of fish, Region I.

Project	Location	Species	Type of project	Number of adults	Type of fishery	Annual cost ($)	Status
Fishpasses w/o stocking							
1. Sunny Creek	Pr. of Wales Is.	pink/coho	run enhancement	10,500	commercial	$10,000	current
2. Ketchikan Creek	Ketchikan	pink/coho/chinook	run enhancement	101,000	comm./sport		current
3. Anan Creek	Wrangell	pink/coho	run enhancement		commercial		current
4. Navy Creek	Wrangell	pink/coho	run enhancement		commercial		current
5. Pavlof Creek	Tenakee	pink/coho	run enhancement		commercial		current
6. Survey Creek	Pr. of Wales Is.	pink/coho	run enhancement		commercial		current
7. Mills Creek	Wrangell	sockeye/coho	run enhancement	52,500	commercial	undetermined	proposed
Fishpasses w/ stocking							
8. Irish Creek	Petersburg	coho/chum/pink	run development	82,000	commercial	$0	complete
9. Dean Creek	Petersburg	coho	run development	3,500	commercial	<$2,000	current
10.Tuya River	Petersburg	chinook/sockeye/coho	run development	805,000	commercial	undetermined	proposed
11.St. Johns Creek	Wrangell	coho	run development	9,200	commercial	<$2,000	current
12.Slippery Creek	Petersburg	coho	run development	11,500	commercial	undetermined	proposed
13.Old Franks Creek	Pr. of Wales Is.	sockeye or coho	run development	31,000	commercial	undetermined	proposed
Lake Fertilization/Stocking							
14.Falls Lake	Sitka	sockeye/coho	run enhancement	20,000	commercial	$0	complete
Lake/Stream Stocking							
15.Old Franks Lakes	Pr. of Wales Is.	sockeye or coho	run development	30,000	commercial	undetermined	proposed
16.Twin Lakes	Juneau	coho	run development		sport		current
17.Indian Lake	Juneau	sockeye/coho	run development	1,200	comm./sport		current
18.Dredge Lake	Juneau	coho	run development		comm./sport		current
19.Cable Creek	Pr. of Wales Is.	coho	run enhancement		comm./sport		current
20.Ward Lake	Ketchikan	coho	run enhancement	1,000	sport/comm.		current
Habitat Improvement							
21.Tsirku River Dike	Haines	sockeye/coho	rehabilitation	unknown	comm./sport	$0	complete
22.Beaver dam removal	Region-wide	all species	rehabilitation	unknown	comm./sport	<$2,000	current
23.Stream clearance	Region-wide	all species	rehabilitation	unknown	comm./sport	<$2,000	current
24.Coho pond access	Haines	coho	run ehancement	unknown	comm./sport	$0	complete
25.Woody debris insertion	Juneau	coho	run ehancement	unknown	comm./sport	undetermined	proposed

Discussion Points (Holland's presentation)

1. Coho was one of the earliest cultured species.

2. Coho are being raised in 4 of the 6 hatcheries in S.E. Alaska - Klawock (1 million smolt), Crystal Lake (.36 million smolt), Deer Mtn (0.13 million smolt), & Snettisham (1.07 million smolt). Returns were 95,000 adults in 1986 from these hatcheries (55,800 from Klawock; 35,340 from Crystal Lake; 5,030 from Snettisham).

3. FREDD tagging program was designed for hatchery production evaluation not fisheries management. Given the present budget situation we are likely to see less tagging in the immediate future.

4. There is general agreement that increased tagging is needed to provide stock strength data for fisheries management. Perhaps the NRPT should address the problem to the Commissioner.

5. Klawock and Snettisham Hatcheries should stabilize at coho production levels of 1,000,000 smolts and 100,000 adult returns.

6. There have been problems reported getting indigenous populations of coho to use habitat above a new fish pass. This has been reported for other species as well. Fish plants above a new pass will speed the enhancement process.

7. It would not be economically feasible to rear age 2.0 smolts at Snettisham to try to duplicate the donor stock (Speel Lake) for increased survival.

8. By stocking Klawock Lake late in the season just before freeze-up (late December - early January, or not at all) when water temperature is at its lowest point, it is hoped that the coho will emigrate prior to the emergence of the new sockeye year class.

9. FREDD believes that the number of coho that is being planted in Klawock Lake is in the realm of the numbers of coho that typically reared in the lake historically (60-70 years ago) when there were healthy populations of coho and sockeye utilizing the system.

10. Smolt target size varies between facilities, though 15-20 grams is considered optimum. Have released them as small as 7 grams (Snettisham) but not successfully.

A Summary of Coho Salmon Enhancement Research at Auke Creek Hatchery

by

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Coho salmon enhancement studies at Auke Creek began in 1978. In most years, the basic study plan was to compare marine survivals of groups of smolts receiving different treatments during their hatchery experience. Marking and tagging of wild coho smolts occurred concurrently with the enhancement studies and comparisons of marine survivals of hatchery and wild fish were often a secondary objective. The objectives of this report are to present a summary of two enhancement studies, compare marine survivals of hatchery and wild fish observed during all enhancement studies and outline the present studies.

The coho salmon enhancement studies summarized in this report involved a comparison of the marine survivals of hatchery-reared versus lake-stocked fish and a comparison of the performance of transplanted versus endemic stock fish. Although the study objectives changed between studies, there were some methods similar to both. These methods are presented first to eliminate repetition when describing the studies. Only methods unique to a particular treatment are discussed in the section for that study.

Coho salmon adults at Auke Creek typically migrate upstream into the Auke lake watershed from mid-September through October. Fish for enhancement studies are captured at Auke Creek weir and held in pens as long as three weeks until the females are ready to spawn. All spawning occurred in the last two weeks of October. The fertilized eggs were placed in vertical tray incubators until they reached the eyed staged of embryo development. Dead eggs were then removed from each tray, and all live eggs were pooled. Approximately 2,000 eggs were placed in each tray on a triple layer substrate of 18 mm heavy duty plastic screen. The fry were ponded in 2.5 m^3 fiberglass tanks in the hatchery when initial swim-up reached 50%, usually by mid-April. Approximately 3,000 fry were placed in each tank, and this number was usually reduced to about 2,500 by the time the smolts were released. Stocking densities for 10 to 15 gm smolts ranged from 10-14 gm/liter (.6 to .9 lbs./cu. ft.).

All hatchery smolts were tagged with a coded-microwire tag and marked with a double fin-clip (adipose and ventral fin combination). The release of smolts from the hatchery was timed to coincide with the midpoint of the Auke Creek wild smolt migration. Coho salmon adults that returned to Auke Creek were captured at the weir. Hatchery fish were identified by the missing ventral fin and killed to recover the wire tags. No hatchery fish were released to spawn in the Auke Creek watershed.

Hatchery Rearing vs. Lake Stocking - 1978 Brood

The objective of this study was to determine the return rate of coho salmon reared to smolt stage by two methods. One method, hatchery rearing, was to rear the fish from egg to age 1 smolt in a hatchery and release the smolts during the downstream migration of the wild coho salmon smolts. The other method, lake stocking, was to rear the fish from egg to age 0 pre-smolts, then stock the fish in a lake shortly before the winter ice cover developed.

Lake stocking could be advantageous to hatchery rearing for at least three reasons. First, the fish would be in the hatchery environment for 12 months instead of the usual 18 months, thus reducing feeding costs, disease concerns and crowding problems, particularly when the fry are being ponded and smolts from the previous brood have not been released. Second, lake stocking may allow an increased in hatchery production if surplus fry could be successfully stocked in a lake. Third, once released in a lake, smoltification and timing of downstream migration are determined by each fish, as compared to the usual hatchery method of releasing smolts based on the hatchery manager's perceptions of the best time.

This was the first rearing of coho salmon at Auke Creek and, based on the wild smolt data, the release size for hatchery smolts was set at 10-12 gms. Auke Creek hatchery uses subsurface lake water and, during the first three months of rearing, temperatures did not exceed 7^{o}C. Growth estimates indicated the fish would not reach the desired smolt size within a year. A pipeline was installed to bring surface water from Auke Creek into the hatchery, and, by mixing lake and creek water, temperatures could be maintained in the 10-12^{o}C range. Growth of coho juveniles increased dramatically in the warmer water.

The lake-stocked fish were marked and tagged, then released into Auke Lake on November 20, 1979. Auke Lake was ice-covered by December 13. Average size of lake stocked fish at release was 85 mm and 6.4 gm. The hatchery-reared group was fed throughout the winter and grew slowly, although water temperatures averaged 3.4^{o}C during most of the winter period.

Water temperatures began to increase in April and the ice was gone from Auke Lake by April 19, 1981. Downstream migration of wild and lake-stocked coho salmon were first observed on April 28, although fewer than 100 smolts migrated before May 10. All coho salmon smolts captured at the weir were examined for adipose fins, and fish without that fin were passed through a wire tag detector. The timing of downstream migration of the lake-stocked fish was identical to that of wild smolts; migration midpoint was May 23. The wild coho salmon smolts were also fin-clipped and wire tagged using a distinctive tag code. During the downstream migration period in 1980, a total of 998 age 1 coho salmon smolts of the lake-stocked group left Auke Lake. Average size of these smolts was 103 mm and 10 gms. Wild smolts averaged 115 mm and 14.5 gms. The hatchery-reared fish were fin-clipped and tagged with a distinctive coded-wire three weeks before release. A total of 1,169 hatchery-reared coho salmon were released downstream from the weir on May 27, 1980. The hatchery reared fish averaged 117 mm and 17.7 gms. Some lake-stocked coho salmon remained in Auke Lake and were captured at ages 2-5 during the downstream migrations in 1981 and 1984, respectively (Table 1). Mean sizes of lake-stocked fish captured during downstream migrations after 1980 were: 1981, 144 mm and 27 gm; 1982, 131 mm and 22 gm; 1983, 139 mm and 26 gm and 1984, 146 mm and 30 gm. Over a 5-year period, a total of 1,458 fish, 57% of the number stock, migrated downstream from Auke Lake. Survival of coho salmon stocked in Alaskan lakes has shown considerable variation. Coho salmon fry stocked in Princess Bay Lake, Tranquil Lake, Osprey Lake and Ludvik Lake, Southeast Alaska, produced coho smolts that amounted to <0.1, 57.2, 58.1 and 14.2%, respectively, of the number stocked (Finger 1960, Crone 1981). Coho salmon juveniles stocked in Bear Lake, southcentral Alaska, have produced survivals of 5.5 to 41.9% (Logan 1966-69, McHenry

1970) when stocked at the large age-0+ stage and 25.1 to 43.0% when stocked as fry (McHenry 1980). Most of the smolts from these stockings were age I and II at time of migration, except for the Ludvik Lake smolts which emigrated at ages I through V.

In this study, return rates of coho salmon were estimated from the number of smolts that migrated downstream and the number of jacks and adults that returned to Auke Creek. Hatchery-reared fish returned as jacks in 1980 and as adults in 1981. Lake stocked fish were recovered as jacks in 1980, and as adults in 1981 and 1982. There were no recoveries of lake-stocked fish after 1982.

Overall, the return rates of hatchery-reared fish was greater than that of the lake-stocked fish. A total of 18 coho salmon jacks were recovered from the hatchery-reared fish and 6 from lake-stocked fish; return rates were 1.5 and 0.4%, respectively. A total of 38 coho salmon adults were recovered from the hatchery-reared fish for a return rate of 3.2%. Adult salmon from the lake-stocked fish were observed in 2 years, and a total of 21 fish were recovered for a total return rate of 1.4% (Table 1).

In this study, the overall return rate of coho salmon reared in a hatchery exceeded that of fish stocked in a lake. An evaluation of the rearing techniques was complicated because of the differences observed at the smolt and returning jack and adult stages. The hatchery-reared fish were released as a single group in one year, while the lake-stocked fish migrated during a 6-week period in 5 consecutive years. The hatchery-reared fish were larger at time of migration than lake-stocked fish as age-1 smolts, but lake-stocked fish were larger at ages 2 and older, although no comparable groups of hatchery fish were released. Smolts migrating at age 3 and older were low in numbers and none were observed in weir and fishery recoveries. Of the lake-stocked fish, 57% emigrated from Auke Lake. Survival of coho salmon from stocked juveniles to smolts at Auke Creek was generally similar to other introduced populations in Alaska. At Tranquil and Osprey Lakes, survivals at the age 1 and II smolt stage combined were 57 and 58%, respectively, while at Ludvik Lake, the smolts migrated at up to age 5 and survival was 14% (Crone 1981).

Performance of Transplanted Coho Salmon - 1980, 1982-Broods

Salmon aquaculture initiatives in Alaska have focused much attention on transplanting stocks between river systems and geographic areas. Policy decisions in this area are often made without the benefit of supporting research data, and sharp controversies frequently develop over whether a particular stock transplant should occur. There are many considerations surrounding transplants in general, and an endemic stock on a stream chosen for a hatchery location or enhancement effort is often disregarded if more eggs are available from a donor stock. Many transplants were not adequately evaluated at the returning adult stage, often because few fish returned, and, even in successful efforts, evaluations seldom included recoveries in the ocean fisheries. We are not aware of any studies that compared the performance of transplanted and endemic stocks of coho salmon at the same location.

This study was initiated to determine the relative performance of transplanted and endemic stocks of coho salmon at two locations. The original study plan involved a two-way transplant of coho salmon eggs between Auke Creek and Little Port Walter, Sashin Creek, hatcheries. Specifically, we intended to transplant eyed eggs, rear transplanted and endemic stock juveniles to the smolt stage at each location; then compare return rates, run timing and fishery contributions of transplanted and endemic fish. For this report, only the Auke Creek portion of the study is presented.

Coho salmon eggs were collected Auke and Sashin Creeks in 1980 and 1982. The Sashin Creek stock of eggs was transported to Auke Creek after they reached the eyed stage of embryo development. Each stock was cultured in separate rearing units under identical conditions. The smolts were tagged with distinctive tag codes and distinguishing adipose-ventral fin excisions.

Coho salmon adults from both stocks of 1980 and 1982 brood years returned to Auke Creek weir or were caught in the fishery in 1982 and 1985, respectively. Sashin Creek adults began upstream migration before the Auke Creek fish and reached the midpoint of migration 10 days earlier. The earlier migration of Sashin Creek coho salmon was consistent with that reported for that stock (Crone and Bond 1976). A total of 254 Sashin Creek stock and 131 Auke Creek stock coho salmon returned to the weir at Auke Creek in 1983. Estimated return rates, from smolts released to adults recovered at the weir, were 0.051 and 0.025 for the Sashin and Auke Creek stocks, respectively (Table 2). A total of 386 Sashin Creek and 344 Auke Creek stock coho salmon returned in 1985; returns to the weir were 0.056 and 0.078, respectively (Table 2). None of the Auke Creek stock of coho salmon transplanted to Sashin Creek returned to Auke Creek.

The fishery catch rates on coho salmon adults returning to Auke Creek differed between years. In 1983, 53% of the returning Sashin Creek fish were caught in the commercial fisheries, compared with 57% of the Auke Creek stock. Catch rates were lower in 1985, 44 and 38% of the Sashin and Auke Creek fish, respectively. Fishery catch distribution of the Sashin Creek stock of coho salmon adults from releases at Auke Creek indicated that these fish returned along the same migration route followed by the endemic Auke Creek stock. Most of the fishery catch of coho salmon adults resulting from releases at Auke creek occurred in the northern and central outside, central intermediate, Lynn Canal and Stephens Passage districts (Table 3). The midpoint of the catch of Sashin Creek stock coho salmon preceded that of the Auke Creek stock by 2 to 4 weeks.

For releases of 1980-brood coho salmon smolts at Auke Creek, the endemic stock returned at a lower total rate than the transplanted stock, but total return rate was higher for the 1982-brood endemic stock. Total return rates for the 1980-brood coho salmon released at Auke Creek were determined to be 0.107 and 0.070 for the Sashin and Auke Creek stocks, respectively (Table 2). Total return rates for the 1982-brood coho salmon released at Auke Creek were 0.100 and 0.123 for the Sashin and Auke Creek stocks, respectively (Table 2).

The study demonstrated that coho salmon transplanted at the eyed egg stage can contribute to commercial and sport fisheries and produce meaningful returns to the release site stream. The transplanted stocks retained their distinctive run timing characteristics, but adopted the adult migration route of the endemic stock. Given a particular release site, it is conceivable that coho salmon stocks could be selected on the basis of run timing to contribute to a particular fishery.

Smolt Quality Studies

For the Auke Creek stock of coho salmon, hatchery-reared fish can be manipulated through the hatchery experience to mimic size and time of migration of wild smolts. However, the return rates of hatchery-reared smolts were less than those of wild smolts (Table 4). Because of the observed differences in marine survival between hatchery and wild coho salmon smolts, we began projects that we referred to as smolt quality studies.

In 1984, we began studies to measure differences between hatchery and wild smolts and determine if marine survival was a function of these differences. Swimming performance of subsamples of 1982-brood hatchery smolts and a group of wild smolts was measured in a stamina tunnel. The tests revealed that although the hatchery smolts were larger, their performance in the stamina tunnel was less than the wild smolts (Table 5). The return of adult coho salmon of these groups in 1985 revealed that the total marine survival (weir counts plus fishery harvest) was greater for the wild fish (Table 5).

In 1986, we began a study to determine the effects of exercise on the return rate of differentially exercised smolts reared in a hatchery. The 1984-brood coho salmon smolts at Auke Creek hatchery were split into four representative groups in early March 1986. Each group was reared in fiberglass tanks which were modified into circular raceways. Each raceway had a different water velocity that was checked daily and remained constant through the study. The velocities were set at 0.0, 0.3, 0.7 and 1.0 feet/second, and the fish were exposed to their particular velocity for 60 days before release.

Each group of hatchery smolts was tagged as a separate coded-wire tag lot before release. An equal number of wild smolts were used for a control and tagged with a distinguishing wire tag. All hatchery and wild smolts were released on the same day. Subsamples of fish from the four hatchery groups and a group of wild smolts were sampled for size, body fat and swimming stamina. There were no differences in size, body fat or swimming stamina among the hatchery groups. All groups of hatchery fish had considerably more body fat than the wild fish. In six replicate trials, there were no differences in swimming stamina of hatchery and similar-sized wild coho salmon smolts. A total of 51 wild coho salmon jacks, 4% of the number of smolts released, were captured at Auke Creek weir in 1986. No jacks returned from the four groups of hatchery fish.

The return in 1987 of adult coho salmon from this study will provide the marine survival estimates for comparisons of the effects of exercise on survival of smolts. The data from this study will be useful in planning future projects related to increasing the return rate of coho salmon from hatcheries.

Table 1. Number of lake stocked and hatchery reared coho salmon smolts, 1978 brood, counted or released, respectively, at Auke Creek weir 1980-1984, and number of jacks and adults recovered (adult recoveries include fishery harvest).

Year	Lake Stocked Smolts	Lake Stocked Jacks	Lake Stocked Adults	Hatchery Reared Smolts	Hatchery Reared Jacks	Hatchery Reared Adults
1980	998	6	0	1,169	18	0
1981	225	0	15	--	--	28
1982	124	0	9	--	--	--
1983	87	0	0	--	--	--
1984	24	0	0	--	--	--
Total	1,458	6	24	1,169	18	28
Returns, %		0.4	1.6		1.5	2.4

Table 2. Weir recovery and fishery catch of coho salmon adults produced from releases at Auke Creek, 1980 and 1982 broods. Weir recovery rates are for observed numbers of fish and fishery catch rates are expanded for numbers of fish. Total return rates are the sum of the weir recoveries and fishery catch.

		Weir	Fishery	Return Rates		
Stock	Brood	Recovery	Catch	Weir	Fishery	Total
Sashin Creek	1980	254	283	0.051	0.056	0.107
Auke Creek	1980	131	171	0.025	0.034	0.059
Sashin Creek	1982	386	300	0.056	0.044	0.100
Auke Creek	1982	344	213	0.078	0.045	0.123

Table 3. Fishery catch distribution in percent by southeast Alaska fishery district of Sashin and Auke Creek stock coho salmon from releases at Auke Creek Hatchery.

		Fishery Districts[1]			
Stock	Brood	NC	CI	LC	SP
Auke	1980	53	22	21	2
Sashin	1980	60	21	7	9
Auke	1982	49	18	42	0
Sashin	1982	35	42	10	11

[1]NC = Northern and central outside,
CI = Central intermediate
LC = Lynn Canal and
SP = Stephens Passage

Table 4. Return rate, expressed as a percent of number of smolts released, of hatchery and wild coho salmon at Auke Creek, 1978-80 and 1982-83 brood years. Return rate is for weir recoveries only.

Brood	Hatchery	Wild
1978	1.4, 3.2	8.3
1979	1.0	9.7
1980	2.5	10.0
1982	7.8	13.9
1983	1.0	7.5

Table 5. Length, weight, swimming performance and marine survival (return rate) of hatchery and wild coho salmon at Auke Creek (smolts released in 1984).

Stock	Length (mm)	Weight (gm)	Performance (index, FL/s)	Return (%)
Auke Creek Wild	114	14	3.7	20.0
Auke Creek Hatchery	120	17	3.3	13.7
Sashin Creek Hatchery	118	16	3.5	11.3

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Discussion Points (Taylor's presentation)

1. Normally have three freshwater age classes migrating out of Auke Lake; ages 2.0, 3.0 & 4.0.

2. Tried rearing "nomad fry" one year at Auke Lake Hatchery. They grew well and looked normal, but the adult return was only about 1% of the smolts released.

3. Wild stocks from Auke Lake have always had over a 10% return; 20% in 1985.

4. Wild stocks have consistently out-performed the hatchery stocks at Auke Lake.

5. Transplant studies: stocks retained their inherited run timing but learned the new migration route for the area. These were short term studies (2 years) involving swaps with Sashin Creek.

6. All the returning hatchery fish are killed at the weir, none are allowed to go into the natural system.

7. When the hatchery was releasing chum salmon (100% tagged), 2-5% of the returning adults were untagged. They were counted as "strays."

NORTHERN SOUTHEAST ALASKA REGIONAL AQUACULTURE ASSOCIATION'S COHO SALMON ENHANCEMENT

By

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NSRAA COHO ENHANCEMENT

Overview

Currently, Northern Southeast Regional Aquaculture Association (NSRAA) utilizes the "fry to smolt rearing in barriered lakes" technique for its entire coho salmon production. A few years ago, the Association also reared several broods of coho to smolts at the Twin Lakes/Salmon Creek Hatchery in Juneau. With the closure of the Juneau facility, NSRAA no longer has a "feed-lot rearing" hatchery being operated for coho production.

The Medvejie Hatchery near Sitka was built by NSRAA for chum salmon production and as a central incubation facility (CIF) to produce coho salmon fry for stocking into barriered lakes on Baranof, Chichagof, and Kruzof islands. Coho have not been reared to smolt or released at the Medvejie Hatchery. The broodstock necessary to produce the fry for lake stocking was originally obtained from wild broodstocks located close to the lakes being stocked, and is now obtained from adults that return to the outlet(s) of the lake(s) stocked.

The objective of the NSRAA Coho Lake Rearing Project is to identify and then utilize barriered lakes that contain food resources sufficient to grow significant numbers (1,000 to 2,500/ha) of coho fry to yearling smolts -- thereby saving the cost of prepared food and the rearing space and water needed to produce coho smolts at a hatchery. Coho smolts leave the lakes volitionally in the spring following stocking and survivors return as adults after some 15 months at sea to the mouth of the lake's outlet stream. Here, they are collected for broodstock purposes and/or for cost recovery harvest. The Medvejie Hatchery has the capacity to produce 1.6 million coho fry annually for lake stocking. The largest plant to date has been the $\approx$1.1 million fry stocked into six lakes and one stream section in 1985.

Discussion of the Coho Lake Rearing Concept

When the last major ice recession occurred in southeastern Alaska some 9,000 years ago (Wahrhaftig 1965), waterfalls along many of the precipitous streams, including lake outlets, served as barriers to post-glacial invasion and colonization by fish. Thus, the recent glacial history and present rugged topography of the region have combined to produce many lakes and portions of streams that are devoid of fish.

The amount of this potential salmon rearing water can be extensive. As an example, on the portion of Baranof Island south of Sitka there are about 700 barriered ponds and lakes of 1 acre (0.4 ha) or larger, which total about 25,000 acres (10,000 ha) in area. Not all of these lakes and ponds are suitable for producing coho smolts, however. Some have outlet streams that are unsafe for migrating smolts, the elevation of others is too high to provide the length of growing season needed to produce yearling smolts, other lakes lack the food necessary to support large numbers of coho fry, etc. Some barriered lakes, particularly the large ones, have been planted with trout or char during this century. Nevertheless, lakes having a resident population of fish may still contain sufficient amounts of those food groups necessary to support good coho performance (growth and survival). To date, successful plants of coho fry have been made into barriered lakes inhabited by monospecies populations of rainbow trout and of Dolly Varden, as well as into fishless lakes.

The use of fishless lakes and their natural foods as rearing areas for raising salmon fry to smolts is not a new idea; however, intensive studies were not conducted until recent years. Spraque (1921) discussed the concept and gave details of two early efforts at planting eyed salmon eggs in fishless waters of southeastern Alaska, including a winter (1919-20) planting of pink and coho salmon eggs in Baranof Lake. Juvenile salmon were observed in the lake during the following summer, but detailed assessment of the success or failure of the introductions was not attempted. Robertson (1922) and Rodd (1924) reported successful rearing of sockeye from fry to smolts in fishless lakes in British Columbia, but again, detailed studies of the introductions were not undertaken. Salmon fry (primarily sockeye and coho) were stocked with little follow-up in several salmon-free lakes in southeastern Alaska in the 1950's (Anonymous 1959, 1960; Finger 1960). More detailed studies of the introduction of sockeye to fishless or salmon-free lakes in southcentral Alaska have been conducted since about 1950 (Anonymous 1952; Meehan 1966). The Washington Department of Fisheries and the Oregon Fish Commission have used lakes and impoundments in which the original fish populations were first reduced or eliminated for the rearing of salmon fry to smolts on naturally occurring foods (Kruse 1963; Noble 1963; Laramie 1963; Kval, Phinney, and Finn 1964; Hansen and Willis 1965; Phinney 1965). Atlantic salmon were reared from unfed fry to smolts in small, fishless mountain lakes in Great Britain (Jones and Evans 1962; Sinha and Evans 1969).

A basic tenet of the barriered lake-rearing technique is that coho salmon fry will behave as zooplankton feeding, limnetic fish when they are stocked into a lake that contains abundant large-sized zooplankters (e.g., Diaptomus, Chaoborus, and Daphnia) and lacks fish that are better planktivors (e.g., sockeye salmon and stickleback). Such behavior allows barriered lake coho to utilize much more of a lake's secondary productivity, and is in contrast to the behavior of coho that rear in natural (anadromous) lake systems. There, coho are found near shore and in the inlet and outlet streams where they feed on benthic and surface insects as well as other invertebrates (but very little zooplankton). By feeding primarily on zooplankton, coho in barriered lakes can produce a much higher yield of smolts, and then adults, per unit of lake surface area than can coho in anadromous systems. Yields of sockeye from anadromous lake systems are many times greater than yields of coho (Tables 1 and 2). The species that is best equipped to utilize the plankton food resources of a lake will nearly always be the one that dominates the fish community (Svärdson, 1976). The yields of coho stocked into some barriered lakes have rivalled the yields of sockeye from the most productive anadromous lake systems. Stocking coho fry into selected barriered lakes gives them the unique opportunity to become limnetic plankton feeders and produce sockeye-like yields.

The first detailed study in southeastern Alaska of coho salmon fry plants into barriered lakes and a stream section were conducted at the Little Port Walter field research station of the National Marine Fisheries Service in the late 1960's through the late-1970's. Results of three lake plants of coho fry are given in Tables 3 to 6 for comparison with NSRAA barriered lake stocking results (Tables 7 and 8).

NSRAA's Coho Lake Rearing Project Description and History

In 1977, about the time that NSRAA was being formed, a large return of adult coho arrived at the outlet stream from Osprey Lake in Port Walter. These fish resulted from the stocking of fry in Osprey Lake by National Marine Fisheries Service personnel in 1975. A special-regulation fishery was established to harvest that return, and some 10,000 coho were taken. As a result, commercial fishermen became interested in developing a barriered lake rearing program for coho as part of the NSRAA effort to enhance salmon returns in northern Southeast Alaska.

In order to be cost effective, it was determined that 1,000 to 1,500 acres (400 to 600 ha) of lakes would have to be stocked each year with coho fry. Few barriered lakes of 1,000 acres or more exist on Baranof or Chichagof islands (none are found on Kruzof Island) and most of those are not available for coho lake stocking. That meant that it was necessary to identify groups or clusters of smaller lakes for stocking in a given year in order to bring the desired number of adults back to a terminal area.

The NSRAA Coho Lake Rearing Project was begun in the summer of 1979 with one-time visits to 30 barriered lakes. These lakes were sampled for nutrient concentration, phytoplankton and zooplankton abundance by taxa, water chemistry parameters, light penetration and temperature profiles, and the presence or absence of fish. Another 20 lakes were surveyed in the same manner in 1980. The purpose of the initial surveys was to identify lakes and groups of lakes with seemingly good potential for lake rearing of coho. Banner and "Sea Lion Cove" lakes were selected from the 30 lakes screened in 1979 to receive more frequent and detailed limnology study in 1980. These more intensive surveys were begun on another 8 lakes in 1981, and 4 to 10 lakes have been studied in the same manner every year thereafter. The project was designed such that one or more years of detailed study would occur on a given lake before coho would be planted there (termed the prestocking surveys) in order to have a basis for selecting a stocking density and to provide a data base for determining the impacts of introducing the young salmon. The lake would then be studied with the same intensity in the year that coho fry were planted (post-stocking surveys). Finally, in order to document the recovery of the lake to prestocking conditions, lake surveys following the same procedures as before would be conducted during the succeeding year (third year). The third year of study would usually be the growing season following the emigration as smolts of most of the coho biomass.

One of the goals of the Coho Lake Rearing Project is to conduct detailed limnology surveys on 8 to 10 barriered lakes for at least three years each (prestocking, poststocking, and recovery years). The information obtained from these studies will be used to construct a model that hopefully will demonstrate which of the limnological parameters that have been measured are most important in explaining coho performance in a barriered lake. With that information, future surveys could be limited to collecting data from only the most useful parameters and at the most important times of the year.

NSRAA originally planned to stock a lake or cluster of lakes once every three years (thereby fitting the life cycle of coho and creating the situation where a lake contained large numbers of coho juveniles in only one year out of three). Three lake clusters were necessary in order to have annual plants of fry and then, annual returns of adults. Two clusters were selected on southern Baranof Island and one cluster was indentified on west Chichagof Island from the 50 lakes surveyed in 1979 and 1980. In addition, two small lakes on north Kruzof Island were also picked for stocking to provide a return of adult coho reasonably close to Sitka. The first coho fry stocked by NSRAA were planted in Banner and "Sea Lion Cove" lakes in July 1982 (Table 7 and Figure 1).

Recently, NSRAA has consolidated the lake stocking program and is operating only at the two lake clusters on southern Baranof Island. The west Chichagof Island lake cluster was dropped because of high losses during freshwater rearing caused by infestations of the cestode, Diphyllobothrium. Rather than develop a third cluster on southern Baranof Island, a once-every-two-years stocking cycle instead of the original three-year rotation has been implemented at the two existing southern Baranof Island lake clusters. Coho fry are now being stocked in each lake once every two, instead of three, years.

NSRAA's Medvejie Hatchery near Sitka was constructed for chum salmon production and to serve as a CIF for the Coho Lake Rearing Project. Eggs are collected at or near each lake cluster, flown to the Medvejie CIF for hatching and initial rearing, and then returned to the lake or lake cluster for stocking in June or July.

Because a large number of coho eggs are not available from wildstocks for the Coho Lake Rearing Project, NSRAA has opted to use two generations to develop a lake cluster to capacity. One lake from a cluster is chosen to receive the fry resulting from eggs taken from a nearby broodstock donner stream. If the coho survive and grow well in that lake, and average or better marine survival follows, more than enough adult coho will return to provide the eggs necessary to stock the entire cluster with fry -- three years after that first lake was stocked.

Results from NSRAA's Coho Lake Rearing Project

To date, NSRAA has stocked 11 batches of coho fry into nine different barriered lakes (Table 7 and Figure 1). So far, results from these plants have been quite variable. Because of the variable results and because of the experimental nature of the project, it is unlikely that in the near future "coho lake rearing" will be the consistent producer that "feed-lot hatchery rearing" of coho smolts is. NSRAA is at a crossroads in deciding at what level the Coho Lake Rearing Project should be continued. Adult returns in 1987 will play an important role in the decision.

In terms of producing adult coho, results have ranged from a planting that far exceeded expectations to several plants that were below expectations (Table 8). As discussed previously, coho yields from some of the barriered lakes that have been planted by NMFS and by NSRAA have more similarity to sockeye yields than to the coho yields that come from the natural populations found in anadromous lakes.

So far, NSRAA has avoided stocking too many fry in a given lake. Consequently, growth rates in all instances have been high enough during that first summer and fall of lake life that primarily age 1 smolts are produced. Unexpectedly, survival of coho stocked in two lakes was low due to mortality caused by heavy infestations of pleroceroids of the cestode, *Diphyllobothrium* sp. The procercoid (an earlier stage of the tapeworm) is found in the calanoid copepod, *Diaptomus*. By eating infected *Diaptomus*, the rearing coho also ingest some *Diphyllobothrium* procercoids. These parasites burrow through the stomach wall of the fish into the coelom where they transform into plerocercoids, move about among the viscera, and grow for a period of time before encysting. A few plerocercoids in a coho parr do not appear to be harmful. Large numbers (>10 or 15), however, are detrimental to the fish and frequently cause death.

Apparently, survival-to-smolt has been high (>50%, and as high as ≈80%) at all of the other lakes stocked by NSRAA with coho. However, at four of these lakes, mortality to the smolts moving from the lake to tidewater has been excessive. In other words, the lakes can produce the smolt numbers and biomass desired, but there has been difficulty at some sites in getting the smolts to sea safely. Outlet streams having a series of waterfalls (six or seven falls on the outlets of three lakes stocked) have caused higher mortality than anticipated. The cumulative effect of bruising and scale loss may be significant to the mortality observed at such streams.

At several lakes where the outlet barrier falls has(have) been determined to be dangerous to smolts during emigration, NSRAA has installed a weir or collecting trap upstream from the falls, and from there passed the smolts in a 2" to 4" diameter polyethylene pipeline around the falls to netpens anchored in the bay. A lake must be reasonably large and/or productive before the expected adult return would be big enough to make the installation and operation of a bypass pipeline cost effective.

Table 1. Smolt yields reported for representative naturally-reproduced and introduced salmonid populations.

Location	Kind of fish	Wild (W) or introduced (I) population	Major age groups	Annual smolt yield: Number (No./ha)		Fry to smolt survival (%)		Biomass (kg/ha)		Reference(s) for data or data adaptation
				Mean	Range	Mean	Range	Mean	Range	
Little Kitoi L., southcentral AK	Coho salmon	W	I-III	110	50-153	...	...	...	...	Meehan (1966)
Bear Lake, southcentral AK	Coho salmon	W	I-III	30	20-40	...	...	<1	<1-<1	Logan (1963, 1964)
Bear Lake, southcentral AK	Coho salmon	I	I&II	377	75-1,209	27	6-49	12*	7-26*	Kyle (1980)†
Sashin Cr., southeastern AK	Coho salmon	W	I-III	973	546-1,685	<10	1-15	...	5-18	Olson & McNeil (1967) Crone & Bond (1976) Crone, unpubl. data
Princess Bay L., southeastern AK	Coho salmon	I	I	25	...	<1	...	...	...	Finger (1960)
Lakelse Lake, B.C., Canada	Coho salmon	W	...	70	...	...	...	...	...	Foerster (1952, 1968)
Hooknose Creek, B.C., Canada	Coho salmon	W	I	2,687	1,607-4,288	...	...	...	...	Hunter (1959)
Cultus Lake, B.C., Canada	Coho salmon	W	I	3	<1-6	...	...	...	...	Foerster and Ricker (1953)
B.C. streams, Canada	Coho salmon	W	I	≈2,400	...	...	...	...	...	Wickett, unpubl., in Chapman (1965)
Drift Creek tributaries, OR	Coho salmon	W	I	4,205	1,802-6,667	3	1-7	34	15-56	Chapman (1965)
Wahkeena Pond, Oregon	Coho salmon	I	I	3,541	1,187-6,360	27	2-51	28	5-50	Hansen and Willis (1965)

Table 1. --continued.

Location	Kind of fish	Wild (W) or introduced (I) population	Major age groups	Annual smolt yield: Number (No./ha) Mean	Number (No./ha) Range	Fry to smolt survival (%) Mean	Fry to smolt survival (%) Range	Biomass (kg/ha) Mean	Biomass (kg/ha) Range	Reference(s) for data or data adaptation
Little Kitoi L., southcentral AK	Sockeye salmon	W	I-III	1,030 972	270-1,730 515-1,559	12 ...	6-28 ...	... ...	... ...	Meehan (1966)† Meehan (1966)
Ruth Lake, southcentral AK	Sockeye salmon	I	I-III	1,371	191-2,173	24	7-47	...	...	Meehan (1966)
Bear Lake, southcentral AK	Sockeye salmon	W	I-III	285	188-381	...	...	...	...	Logan (1963, 1964)
Princess Bay L., southeastern AK	Sockeye salmon	I	I	93	...	<1	...	...	...	Finger (1960)
Cultus Lake, B.C., Canada	Sockeye salmon	W&I	I	1,502	62-4,954	...	6-15	8	<1-30	Ricker and Foerster (1948)
Lake Dal'neye, Kamchatka, USSR	Sockeye salmon	W	I-III	257	...	...	...	11	...	Kroglus (1969)
Happy Valley Res., Oregon	Chinook salmon	I	<I‡ I**	2,705 ≈100	1,639-3,770 32-≈150	14 <1	13-15 <1-<1	86 ...	74-98 2-...	Higley and Bond (1973)
Big Springs Cr., Idaho	Chinook salmon	I	0*	10,584	9,892-11,275	22	21-22	104	100-107	Bjornn (1978)‡, ††

Table 1. --concluded.

Location	Kind of fish	Wild (W) or introduced (I) population	Major age groups	Annual smolt yield: Number (No./ha) Mean	Number (No./ha) Range	Fry to smolt survival (%) Mean	Fry to smolt survival (%) Range	Biomass (kg/ha) Mean	Biomass (kg/ha) Range	Reference(s) for data or data adaptation
Big Springs Cr., Idaho	Steelhead trout	I	0*	3,757	852-6,768	5	4-6	23	5-45	Bjornn (1978)†, ††
Whistler's Bend Impoundment, OR	Steelhead trout	I	<I	3,006	...	38	...	28	...	Coche (1967)‡
			I	...	...	...	...	34	...	Coche (1967)‡‡
Bothwell's Cr., Ontario, Canada	Steelhead trout	W	<I	2,247	...	...	...	32	...	Alexander and MacCrimmon (1974)‡
Shelligan Burn, Scotland	Atlantic salmon	W	II	1,600	1,000-2,200	...	...	15	10-19	Egglishaw (1970)

*Calculated from data presented for the 1971 through 1976 brood years only. Values given for No./ha and percentage survival are for the 1962 through 1966 and 1971 through 1976 brood years combined.

†Values listed are from data grouped by year class instead of the more usual annual totals for mixed-age fish.

‡Values given are based on pre-smolts at the end of the growing season.

**Actual age-I smolt yield.

††Most migrants left the stream between September and December.

‡‡Estimated annual yield.

Table 2. Annual number of naturally-reproduced adult salmon returning to selected North American lakes in terms of catch plus escapement or, (escapement only).

Lake(s)	Location	Surface area (ha)	Kind of fish	Annual total return per hectare of lake surface			Reference for data or data adaptation
				Mean	Range	Period	
Tumakof	Southeast AK	95	Sockeye	441	222-657	1966-71	Parker (1971)
Situk and Mountain	Southeast AK	485	Sockeye	(275)	(103-447)	1971-79	*
Chignik	Southwest AK	2,270	Sockeye	249	124-520	1949-66	Dahlberg (1979)
				470	170-874	1922-39	Dahlberg (1979)
Cultus	B.C., Canada	626	Sockeye	180	...	1952-67	Narver (1969)
Karluk	Southwest AK	4,000	Sockeye	160	...	1950-67	Narver (1969)
				434	149-1,230	1921-50	Rounsefell (1958)
				(≥750)	...	pre-1880	Shuman (1950)
Owikeno	B.C., Canada	9,600	Sockeye	135	...	1948-67	Narver (1969)
Auke	Southeast AK	71	Sockeye	123	64-261	1974-80	†
				(104)	(77-155)	1963-73	†
Chilkoot	Southeast AK	≈700	Sockeye	(113)	(51-139)	1976-80	‡
Black	Southwest AK	4,110	Sockeye	84	34-191	1949-66	Dahlberg (1979)
				191	21-695	1922-39	Dahlberg (1979)
Babine	B.C., Canada						
North arm		5,600	Sockeye	81	...	1957-67	Narver (1969)
Main lake		43,000	Sockeye	17	...	1957-67	Narver (1969)

Table 2. --continued.

Lake(s)	Location	Surface area (ha)	Kind of fish	Annual total return per hectare of lake surface			Reference for data or data adaptation
				Mean	Range	Period	
Fraser	B.C., Canada	5,200	Sockeye	80	...	1952-67	Narver (1969)
Shuswap	B.C., Canada	31,000	Sockeye	74	...	1952-67	Narver (1969)
Igushik (2)	Southwestern AK	6,700	Sockeye	70	...	1956-66	Narver (1969)
Chilkat	Southeastern AK	≈960	Sockeye	(57)	(23-89)	1967-80	‡
Bowron	B.C., Canada	1,100	Sockeye	53	...	1952-67	Narver (1969)
Chilko	B.C., Canada	9,400	Sockeye	51	...	1952-67	Narver (1969)
Tahltan	B.C., Canada	≈380	Sockeye	(42)	(4-135)	1959-79	*
Bear	Southcentral AK	180	Sockeye	27	17-50	1961-65	Kyle (1980)
Little Kitoi	Southcentral AK	39	Sockeye	(26)	(7-52)	1954-58	Meehan (1959)
Auke	Southeastern AK	71	Coho	(11)	(4-19)	1971-80	**, ††
Little Kitoi	Southcentral AK	39	Coho	(8)	(7-9)	1954-58	Meehan (1959)
Bear	Southcentral AK	180	Coho	(5)	...	1961-64	McHenry (1980)
Karluk	Southcentral AK	4,000	Coho	(2)	...	1945-53	Rounsefell (1958)

Table 2. --concluded.

Lake(s)	Location	Surface area (ha)	Kind of fish	Annual total return per hectare of lake surface: Mean	Range	Period	Reference for data or data adaptation
Cultus	B.C., Canada	626	Coho	(1)	(<1-2)	1925-43	Foerster and Ricker (1953)
Chilkoot	Southeastern AK	≈700	Coho	(1)	(<1-2)	1976-80	‡
Chilkat	Southeastern AK	≈960	Coho	(<1)	(<1-1)	1971-79	‡

[*]Values in this row were calculated from unpublished data provided by D. Ingledo and A. E. Schmidt, ADF&G, Feb. 1981.

[†]Values in this row were calculated from unpublished data provided by R. D. Dewey, USFS, Sept. 1980, S. G. Taylor, NMFS, Oct. 1980, and A. E. Schmidt, ADF&G, Feb. 1981.

[‡]Values in this row were calculated from Bergander (1980) and unpublished data provided by D. Ingledo and A. E. Schmidt, ADF&G, Feb. 1981.

[**]Values in this row were calculated from unpublished data provided by S. G. Taylor, NMFS, Oct. 1980.

[††]Values in this row do not include large numbers of jacks which return to this lake. With jacks included, mean and range are increased to 16/ha and 9 to 25/ha, respectively.

Table 3. Spring emigrant yields from coho salmon populations stocked as fry into three salmon-free lakes near Port Walter by NMFS personnel.

Lake	Age group	Spring emigrant numbers: Counted or estimated total	No./ha	Percentage of the fry introduced	Spring emigrant biomass: Gross yield (kg/ha)	Yield as a net change in biomass (kg/ha)	Ratio of input biomass to gross yield
Tranquil	I	4,514	3,224	37.6	25.3	21.8	1:7.4
	II	2,356	1,683	19.6	20.4	...	1:6.0
	Sum I&II	6,870	4,907	57.3	45.7	42.3	1:13.3
	Mean I&II	3,435	2,454	28.6	22.9	21.1	1:6.7
Ludvik	I	6,607	432	6.5	1.9	-0.1	1:<1.0
	II	815	53	0.8	0.4	...	1:0.2
	III	4,689	306	4.6	2.5	...	1:1.2
	IV	2,359	154	2.3	2.6	...	1:1.3
	V	2	<1	<0.1	<0.1	...	1:<0.1
	Sum I&II	7,422	485	7.3	2.3	0.3	1:1.2
	Mean I&II	3,711	243	3.6	1.2	0.2	1:0.6
	Sum I-IV	14,470	946	14.2	7.4	5.4	1:3.7
	Mean I-IV	3,618	236	3.5	1.9	1.4	1:0.9
	Sum I-V	14,472	946	14.2	7.4	5.4	1:3.7
	Mean I-V	2,894	189	2.8	1.5	1.1	1:0.7
Osprey	I	146,150	1,532	53.0	15.0	12.1	1:5.2
	II	13,987	147	5.1	3.8	...	1:1.3
	Sum I&II	160,137	1,679	58.0	18.9	16.0	1:6.5
	Mean I&II	80,069	839	29.0	9.4	8.0	1:3.3

Source: Crone (1981).

Table 4. Emigrant and adult yields resulting from the 1969 stocking of 1.4-ha Tranquil Lake with 12,000 coho salmon fry by NMFS personnel.

Year	Emigrant yield				Number of spring emigrants released to sea	Adult yield†			
	Outlet trap count*	Percentage of the fry introduced	No./ha	kg/ha		Estimated number	Marine survival‡ (%)	No./ha**	kg/ha**
1969	414	3.5	296	0.4	...	...	...	...	...
1970	4,514	37.6	3,224	25.3	4,391	...	...	...	...
1971	2,356	19.6	1,683	20.4	2,211	555	12.6	396	1,506
1972	...	...	...	...	...	149	6.7	106	373
Total	7,284	60.7	5,203	46.1	6,602	704	10.7	503	1,879

Source: Crone (1981).

*Emigrants left as parr in July and August in 1969 and as smolts during the springs of 1970 through 1972. Emigration did not occur at other times.

†Includes only those adults which escaped the coastal commercial fisheries and returned to Port Walter area streams.

‡The estimated adult return for a given year divided by the estimated number of emigrants entering the sea during spring of the previous year, multiplied by 100.

**The estimated total number or combined weight (as appropriate) of returning adults divided by the lake area (i.e., the amount of freshwater rearing habitat).

Table 5. Emigrant and adult yields resulting from the 1972 stocking of 15.3-ha Ludvik Lake with 102,155 coho salmon fry by NMFS personnel.

Year	Emigrant yield				Number of spring emigrants released to sea	Adult yield†			
	Outlet trap count*	Percentage of the fry introduced	No./ha	kg/ha		Esti-mated number	Marine survival‡ (%)	No./ha**	kg/ha**
1972	9,924	9.7	649	1.7	...	...	...	...	...
1973	8,921	8.7	583	2.5	6,153	...	...	...	...
1974	878	0.9	59	0.4	733	460	7.5	30	102
1975	4,690	4.6	307	2.5	4,641	29	4.0	2	6
1976	2,410	2.4	158	2.8	2,104	258	5.6	17	66
1977	9	<0.1	<1	<0.1	0	177	8.4	12	54
1978	0	0.0	0	0.0	0	0	0.0	0	0
Total	26,852	26.3	1,755	10.0	13,631	924	6.8	60	229

*Emigrants left as parr from June until December in 1972 and as smolts and parr in the spring and fall periods of the other years. Few fall emigrants left after 1973 and few parr emigrated after 1974.

†Includes only those adults which escaped the usual coastal commercial fisheries and returned to the Port Walter area. Most were collected at weirs on streams in Port Walter, except in 1977 when most were taken during the special-regulation commercial fisheries in the Port Walter area.

‡, **Methodology as in correspondingly identified footnotes on Table 3.

Source: Crone (1981).

Table 6. Emigrant and adult yields resulting from the 1975 stocking of 95.4-ha Osprey Lake with 276,000 coho salmon fry by NMFS personnel.

Year	Emigrant yield				Number of spring emigrants released to sea	Adult yield†			
	Estimated number*	Percentage of fry introduced	No./ha	kg/ha		Estimated number	Marine survival‡ (%)	No./ha**	kg/ha**
1975	44,639	16.2	468	5.0	...	...	...	...	...
1976	146,150	53.0	1,532	15.0	144,593	...	...	...	...
1977	13,987	5.1	147	3.8	13,844	14,014	9.5	147	661
1978	...	...	...	...	...	1,189	8.6	12	42
Total	204,776	74.2	2,146	23.8	158,437	15,203	9.4	159	703

Source: Crone (1981).

*Emigrants left as parr during the autumn of 1975 and as smolts during the springs of 1976 and 1977. Insignificant numbers emigrated at other times.

†Includes estimates of those caught in the usual coastal commercial and sport fisheries, in the special-regulation Port Walter area commercial fisheries, and at weirs on streams in Port Walter.

‡The estimated adult return (from spring emigrants) for a given year divided by the estimated number of emigrants entering the sea during the spring of the previous year, multiplied by 100. Percentages given were calculated after reducing the 1977 adult return by 344 adults that had emigrated from the lake in the fall of 1975.

**The estimated total number or combined weight (as appropriate) of returning adults divided by the lake area (i.e., the amount of freshwater rearing habitat).

Table 7. Spring emigrant yields from coho salmon populations stocked as fry into barriered lakes in northern Southeast Alaska by NSRAA.

Lake name (area)	FRY STOCKED				SMOLT YIELD (April through June)							Comment sheet code
	Date	Number	No./ha of lake surface	Input biomass (kg/ha)	Year/age	Number	Percent of plant	No./ha of lake surface	Gross yield (kg/ha)	Net change in biomass (kg/ha)	Ratio of input biomass to gross yield	
"Sea Lion Cove" (7.5 ha)	8Jul82	15,150	2,020	2.8	83/age 1 84/age 2 Total	11,851 32 11,883	78.2% 0.2% 78.4%	1,580 4 1,584	21.2 0.4 21.6	18.4 -- 18.7	1:7.6 -- 1:7.7	A
Banner (65 ha)	17 & 18 Jul82	97,500	1,500	1.8	83/age 1 84/age 2 Total	65,920 680 66,600	67.6% 0.7% 68.3%	1,014 10 1,025	16.1 0.6 16.7	14.3 -- 14.9	1:8.9 -- 1:9.3	
Elfendahl (322 ha)	28Jun83	115,330	358	0.4	84/age 1 85/age 2	7,750 ND	6.7% --	24 --	0.3 --	-0.1 --	1:0.8 --	B C
"Lower Rostislaf" (105 ha)	20Jun84	188,600	1,796	1.8	85/age 1 86/age 2 Total	123,212 12,470 135,682	65.3% 6.6% 71.9%	1,173 119 1,292	10.5 2.5 13.0	8.8 -- 11.3	1:5.8 -- 1:7.2	
"Sea Lion Cove" (7.5 ha)	8Jul85	30,000	4,000	4.8	86/age 1 87/age 2	18,911	63.0%	2,521	26.7	21.9	1:5.6	D E
Surprise (58 ha)	26Jun85	75,160	1,296	1.3	86/age 1 87/age 2	22,587	30.1%	389	≈4.3	≈3.0	≈1:3.3	F G
Deer (396 ha)	1 & 2 Jul85	780,800	1,972	1.6	86/age 1 87/age 2	329,758	42.2%	833	10.8	9.3	1:6.8	H
"Fiddle" (16 ha)	2Jul85	29,980	1,874	1.7	86/age 1 87/age 2	4,520	15.1%	283	≈3.8	≈2.1	≈1:2.2	I J
Finger (40 ha)	2Jul85	49,960	1,249	1.2	86/age 1 87/age 2	5,660	11.3%	142	≈1.9	≈0.7	≈1:1.6	K L
Blanchard (44 ha)	2Jul85	74,960	1,704	1.5	86/age 1 87/age 2	36,000	48.0%	818	≈12.5	≈11.0	≈1:8.3	M N
Blanchard (44 ha)	2Jul86	69,970	1,590	1.9	87/age 1 88/age 2							
Deer (396 ha)	mid-Jun87	850,000 ?	2,146 ?	1.7 ?	88/age 1 89/age 2							

Table 8. Adult yield from coho salmon populations stocked as fry into barriered lakes in northern Southeast Alaska by NSRAA.

Lake name (area)	SPRING EMIGRANTS RELEASED TO SEA		ESTIMATED ADULT RETURN							Comment sheet code
	Year/age	Number	Year/age	Commercial catch (CWT expansion)	Terminal area harvest (cost recovery)	Escapement (weir counts, underwater surveys)	Total return	Marine survival	No./ha of lake surface	
"Sea Lion Cove" (7.5 ha)	83/age 1 84/age 2	5,000? 32	84/age 1.1 85/age 2.1	200 0	0 0	200 ND 1/	400 ND	8% ? --	53 --	O
Banner (65 ha)	83/age 1 84/age 2	65,000 680	84/age 1.1 85/age 2.1	7,300 20	4,200 0	1,000 35	12,500 55	19% 8%	192 1	
Elfendahl (322 ha)	84/age 1 85/age 2	7,750 ND(few)	85/age 1.1 86/age 2.1	425 50	150 0	40 ND	615 ND	8% --	2 --	P
"Lower Rostislaf" (105 ha)	85/age 1 86/age 2	103,981 10,747	86/age 1.1 87/age 2.1	895	0	885	1,780	2%	17	Q

1/ Not determined.

Comment Sheet for Tables 7 and 8.

Code	Comment
A	Low stream flows delayed the downstream migration of smolts from the lake outlet trap to the sea. Many (probably most) smolts were caught and killed by mink during the delay. The actual number of smolts reaching the sea alive is unknown.
B	The low smolt yield is due to tapeworm-caused mortality during lake life.
C	Very few age 2 smolts emigrated; only 51 were captured during 11 days of emigrant trap operation in mid-May 1985.
D	The lake was stocked following 1 year of fertilizer additions; fertilization continued for 3 months following stocking. An additional 6,971 coho left the lake as age 0+ emigrants during the first 4 months following stocking. Most left during late September and early October freshets -- a time when food abundance in the lake was declining rapidly.
E	Fewer than 100 age 2 smolts are expected.
F	The low smolt yield is due primarily to tapeworm-caused mortality. Some outlet falls-caused mortality is suspected.
G	Very few age 2 smolts are expected.
H	Between 50,000 and 100,000 age 2 smolts are expected.
I	The smolt yield from the lake was much greater than these data indicate. Based on the October 1985 mark:recapture population estimate and on funnel trapping success in the lake, survival to smolt was probably >50%. Most smolts that left the lake were apparently killed at one of the seven waterfalls between the lake and tidewater, and therefore, did not reach the emigrant trap.
J	Fewer than 100 age 2 smolts are expected.
K	The smolt yield from the lake was much greater than these data indicate. Based on funnel trapping success in the lake in October 1985, survival to smolt was probably >50%. Most smolts that left the lake were apparently killed at one of the six waterfalls between the lake and tidewater, and therefore, did not reach the emigrant trap.
L	Fewer than 500 age 2 smolts are expected.
M	The yield values given are minimums because some of the outmigration was unmonitored. A mark:recapture estimate of population size indicated 75% of the fry stocked were still alive in the lake in October 1985.
N	Fewer than 500 age 2 smolts are expected.

Comment Sheet for Tables 7 and 8 (continued).

Code	Comment
O	The actual number of smolts to reach the sea alive is unknown.
P	The low adult yield was due primarily to high mortality during freshwater life caused by tapeworm parasitism.
Q	Poor marine survival and the resulting low adult yield value may have been the result of most smolts having entered saltwater 3 to 4 weeks later than is normal for this stock. A mid-June breakup of the lake surface ice in the spring of 1985 is thought to have caused the delay in emigration.

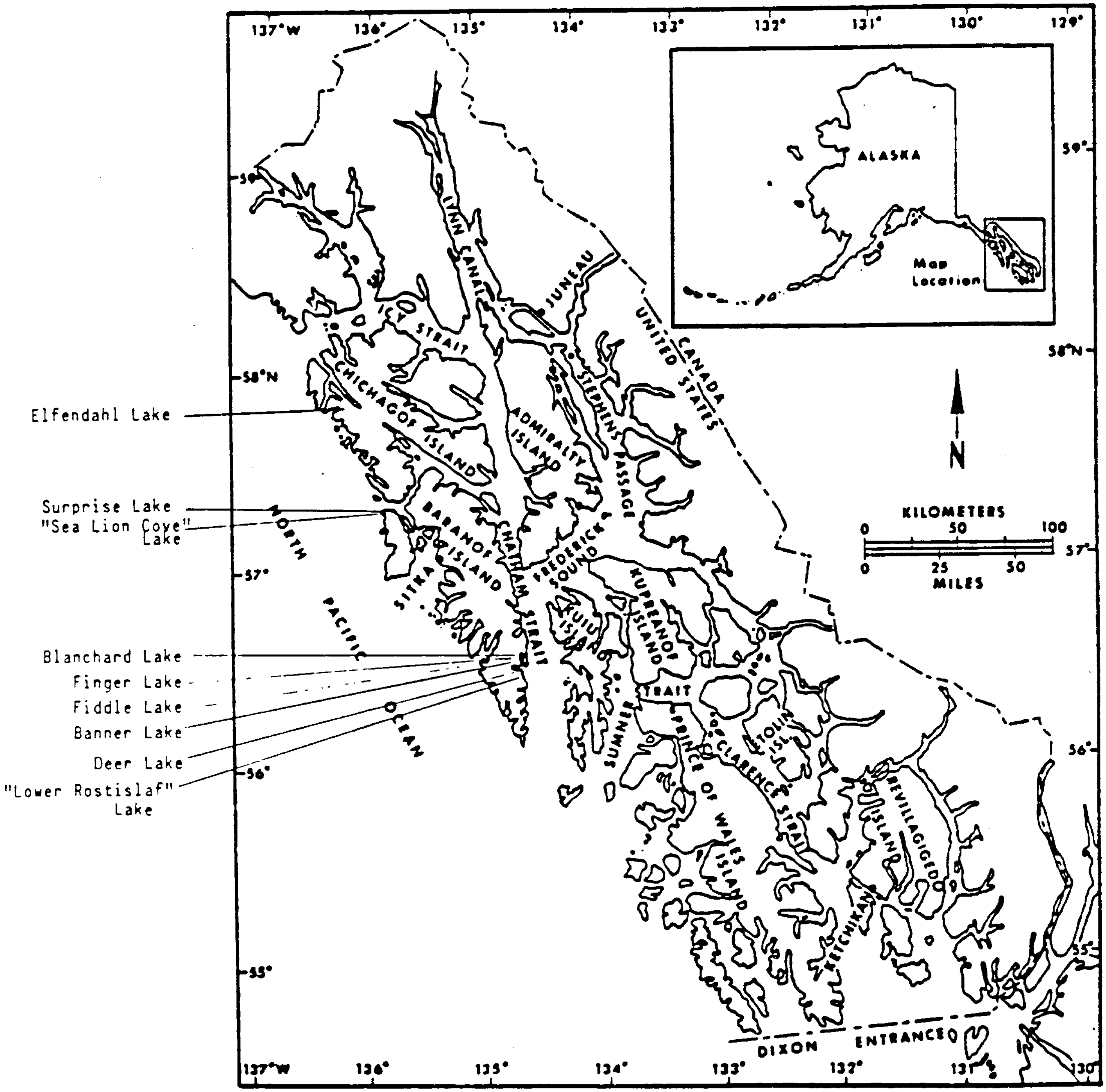

Figure 1. Location of nine barriered lakes that Northern Southeast Regional Aquaculture Association has stocked with coho salmon fry during the years 1982-86.

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Discussion Points (Crone's presentation)

1. Coho salmon rearing in barriered lakes is the major NSRAA program.
2. Medvejie Hatchery can produce 1.6 million coho fry at 1 gram each.
3. NSRAA policy has been to stock a lake or cluster of lakes of fry every 3 years to maintain diversity of zooplankters. Changed recently to once every 2 years.
4. Stock short-term reared fish in June & July.
5. Eggs are taken from nearby donor streams.
6. Have planted 9 lakes (11 plantings).
7. Goal is 1 year smolts.
8. Variable results; returns in 1987 will determine future program.
9. Cestode, Diphylobothrium, has caused problems in Elfendahl Lake.

HATCHERY PRODUCTION OF COHO SALMON

BY

THE SOUTHERN SOUTHEAST REGIONAL

AQUACULTURE ASSOCIATION (SSRAA)

BY

DONALD F. AMEND

SUMMARY

SSRAA started broodstock development of coho salmon in 1978 at the Whitman Lake Hatchery. Release of smolts occurred both at Neets Bay and Herring Cove for broodstock development. Self sustaining coho broodstock now return to both Whitman Lake and Neets Bay Hatchery.

SSRAA currently releases up to 3.0 million smolts at Neets Bay, 150,000 at Herring Cove, 100,000 at Nakat Inlet, and 200,000 at Earl West Cove. The releases at Nakat and Earl West Cove are to target specific user groups and terminal wipe-up fisheries are planned. Releases at Herring Cove are primarily for broodstock. Releases at Neets Bay are targeted for all user groups, but those fish returning to the special harvest area (SHA) are used for broodstock, cost recovery, and harvest by a rotational fishery of all user groups.

The water supply at the Whitman Lake and Neets Bay hatcheries comes from barriered lakes with no access to anadromous fish. Standard fish culture practices are used for spawning, egg incubation, and fry rearing. SSRAA uses Biodiet almost exclusively during all rearing phases. The target size at release is 25 grams at about June 1 of each year. However, the release strategy has varied between sites.

Smolts released from the Whitman Lake Hatchery typically have been released directly into Herring Cove Creek as practiced at most salmon hatcheries. However, at Neets Bay the smolts have

always been imprinted in saltwater net pens prior to release, and the majority of the fry have been held in saltwater net pens over the winter before being released the following spring. All smolts released at remote sites at Nakat and Earl West Cove were imprinted in net pens prior to release.

The fry that are reared over the winter in Neets Bay are placed in net pens in September at a target size of 10 grams. The goal is to grow the fish to a 15 gram size by November, maintain the fish until late March, and complete the growth by the June 1 release date. It has become necessary to have a freshwater lens around the net pens from January through March to avoid excess mortality. Those fish imprinted in salt water typically are placed in net pens in April at about 15 grams and released by June 1 at 25 grams.

The June 1 release date is used to avoid interaction with pink and chum fry out migrations. Future releases will evaluate later release dates to develop a more flexible release schedule. The historical releases from all SSRAA sites is shown in Figure 1.

The return of adult coho salmon is shown in Table 1 and Figure 2. Total survival at Whitman Lake has ranged from 3.0% to 17.0% with a six year average of 8.2%. Survival at Neets Bay has ranged from 8.0% to 13.0% with a six year average of 10.5%. Size at release has ranged from 16 grams to 27 grams and no significant difference in survival has been noted. There were two years when survival was compared at Whitman Lake between freshwater releases and saltwater releases, and at Neets Bay where fry held over the winter were compared to the normal net pen releases in the spring. In both cases, no significant difference was found.

The interception rates between Whitman Lake and Neets Bay have been very similar. The common property interception has ranged from 64.0% to 87.0% with a six year average of about 75.0% (Table 1). The distribution of catch has also been very similar between Neets Bay and Whitman Lake. Typically, the trollers harvest about 50.0%, the gillnetters 8.0%, seiners 15.0%, sport 4.0%, cost recovery 18.0%, and broodstock 5.0%. Based on current production, the annual harvest rate should be about 250,000 coho annually.

The troll interception occurs primarily (65%) off shore in the central outside area during the month of August and the harvest moves to inside areas in September (Figures 3-5). The gillnet and seine harvests occur mostly in inside areas during the month of September. Nearly all of the sport harvest occurs near Ketchikan.

There are special harvest areas (SHA) at Neets Bay, Herring Cove, Nakat Inlet, and Earl West Cove. The primary cost recovery site is in Neets Bay, but, if needed, the other SHA's could be used for cost recovery. Those fish not used for broodstock or cost recovery are harvested by the common property fishery. SSRAA has used a rotational system where the rotation is gillnet, troll, followed by seine using a time formula of one unit for seine, two units for gillnet, and four units for troll. As expected, the net fisheries harvest most of the fish in the SHA.

The SSRAA coho program has matured and there are no future coho projects currently being planned. Also, the number of fish released is not expected to increase beyond those currently in use. Some modifications in time and size at release may be done, depending upon the available data, and the degree of interaction with pink and chum fry. In conclusion, SSRAA believes the coho program has been very successful.

COHO RELEASES - SSRAA

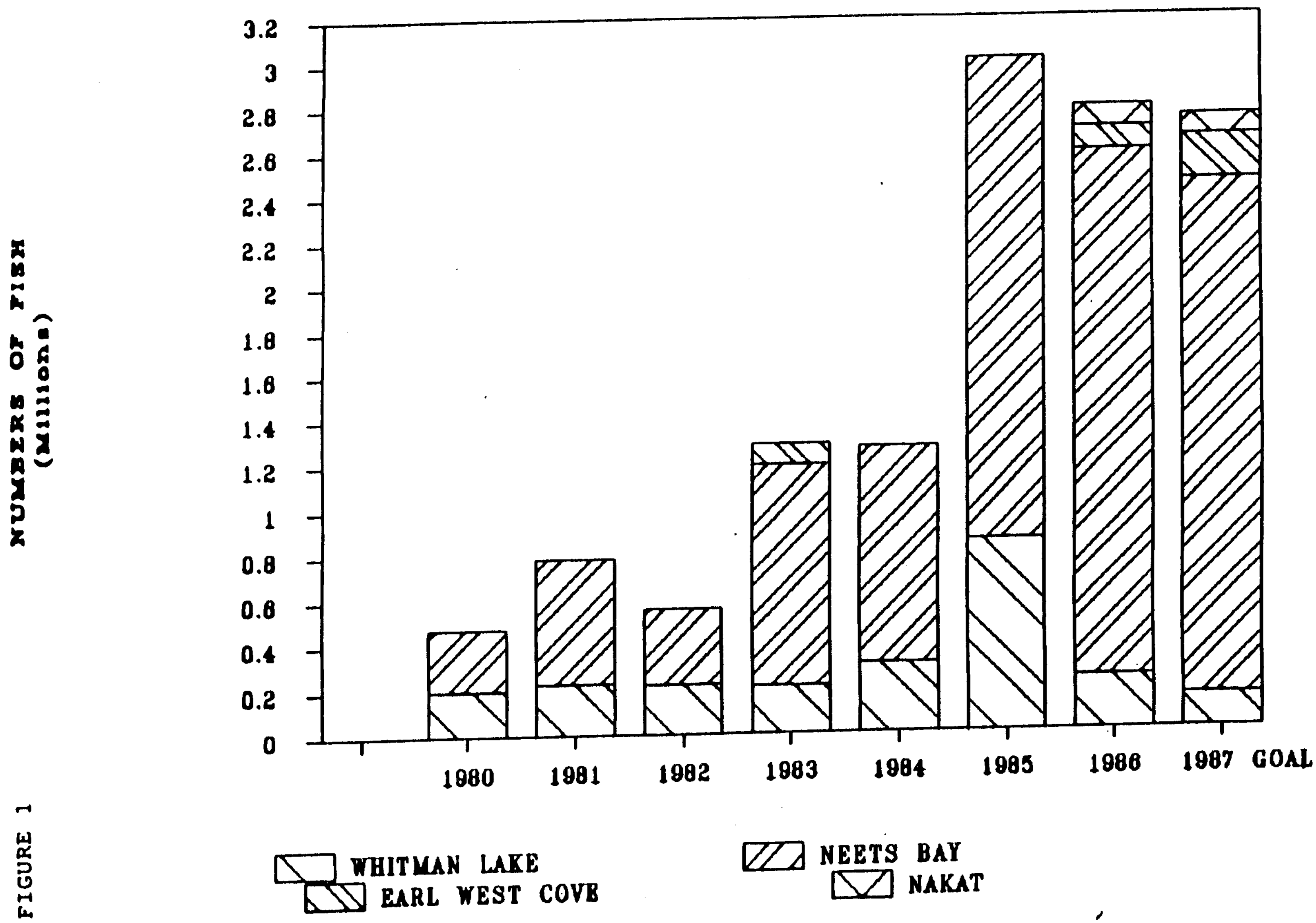


FIGURE 1

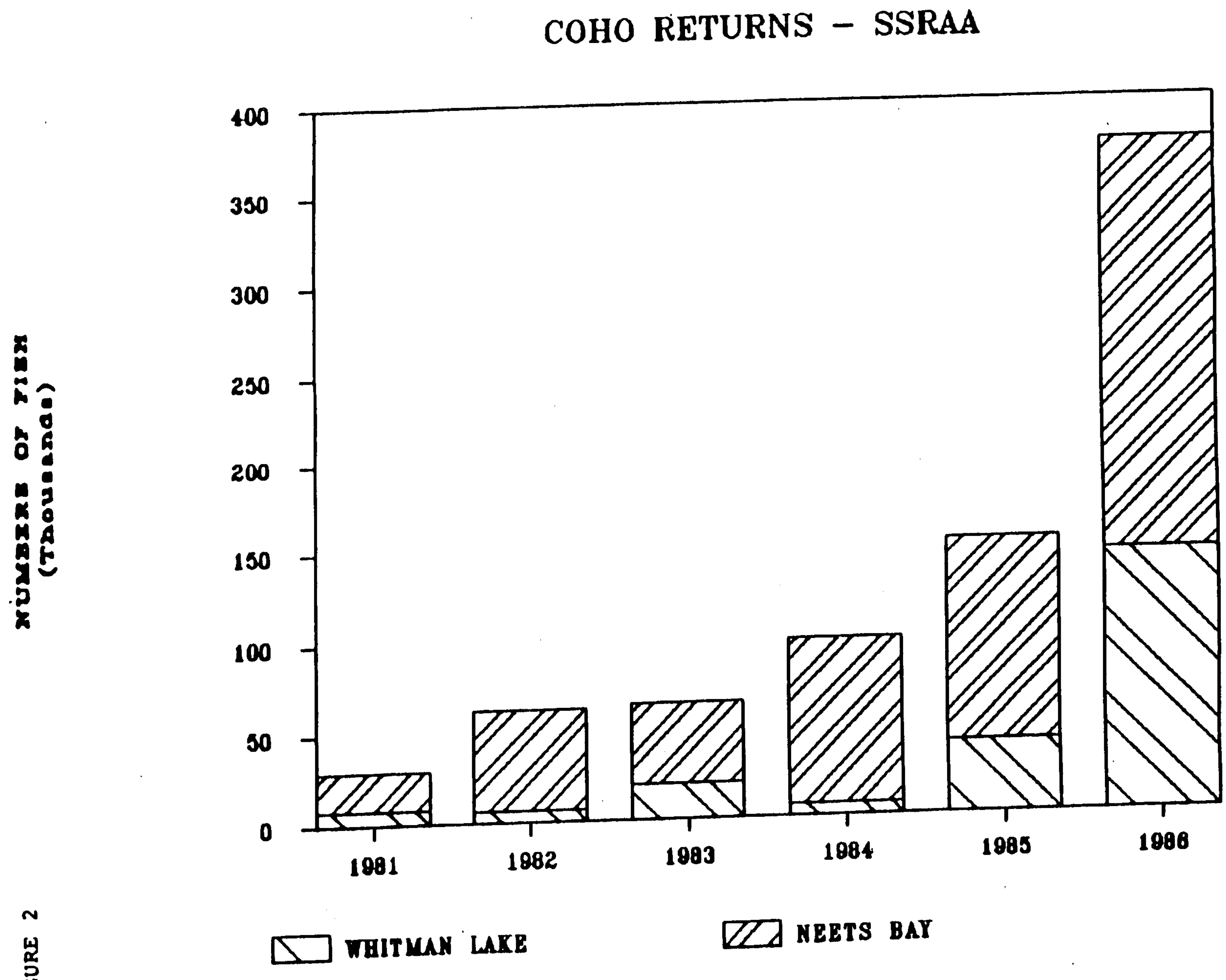

COHO RETURNS - SSRAA
NUMBERS OF FISH
(Thousands)
400
350
300
250
200
150
100
50
0
1981
1982
1983
1984
1985
1986
WHITMAN LAKE
NEETS BAY

FIGURE 2

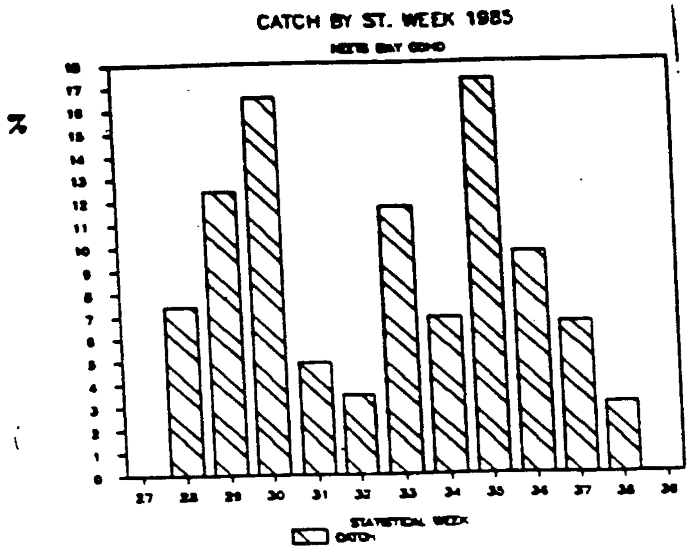
FIGURE 3

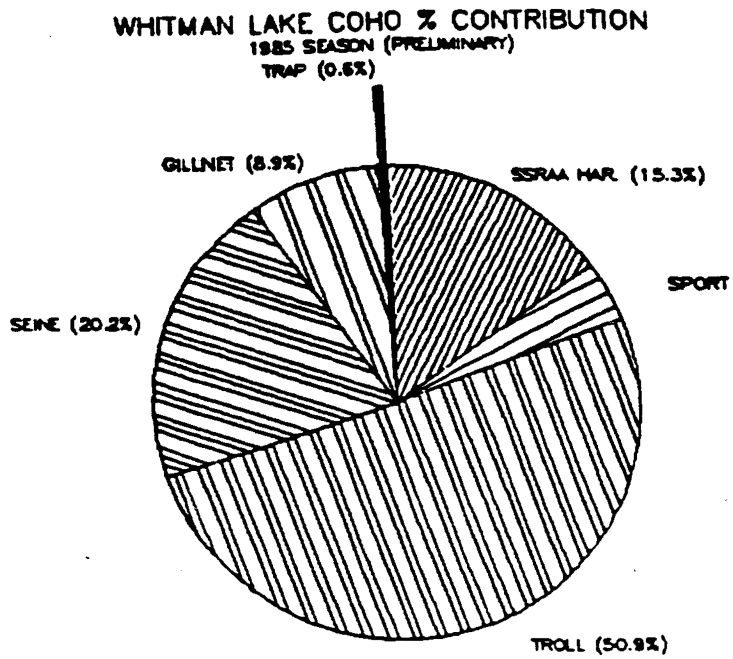
SSRAA COHO

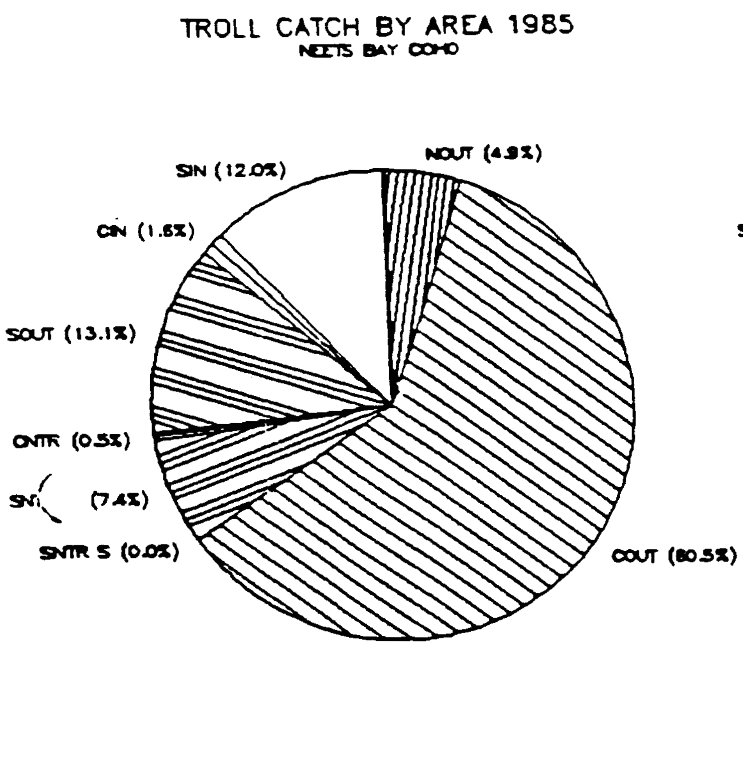
1985 SEASON COHO RETURN & RESULTS

RELEASE SITE	SSRAA HAR. & BROOD	SPORT	TROLL	SEINE	GILLNET	TRAP	TOTAL
WHITMAN LK							
#	5757	1500	19113	7585	3337	225	37517
%	15%	4%	51%	20%	9%	1%	100%
NEETS BAY							
#	29900	2000	52336	17185	5918	25	107372
%	28%	2%	49%	16%	6%	0%	100%

	%HARVEST	% ESCAPEMENT	RELEASED	% SURVIVAL
WHITMAN LK	85%	15%	308500	12%
NEETS BAY	72%	28%	957838	11%







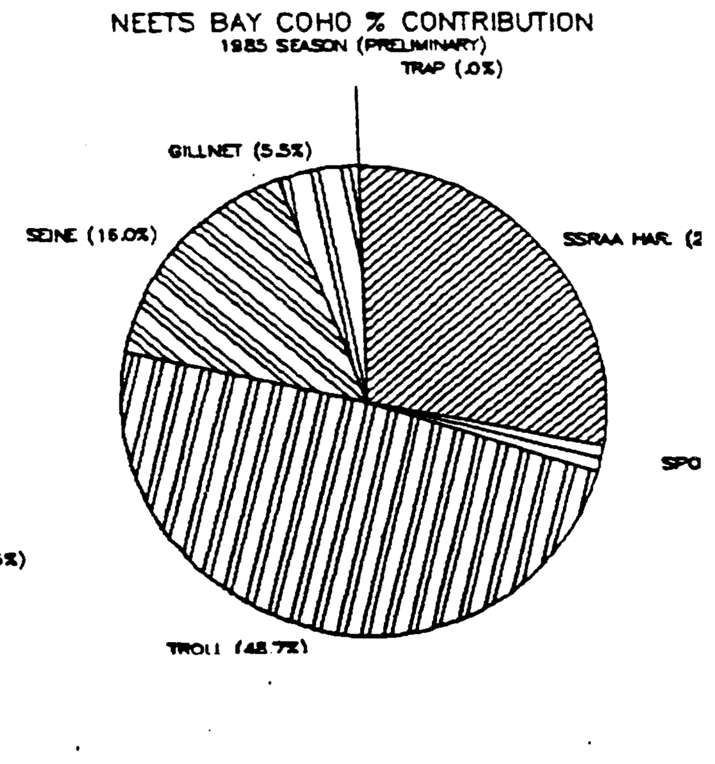
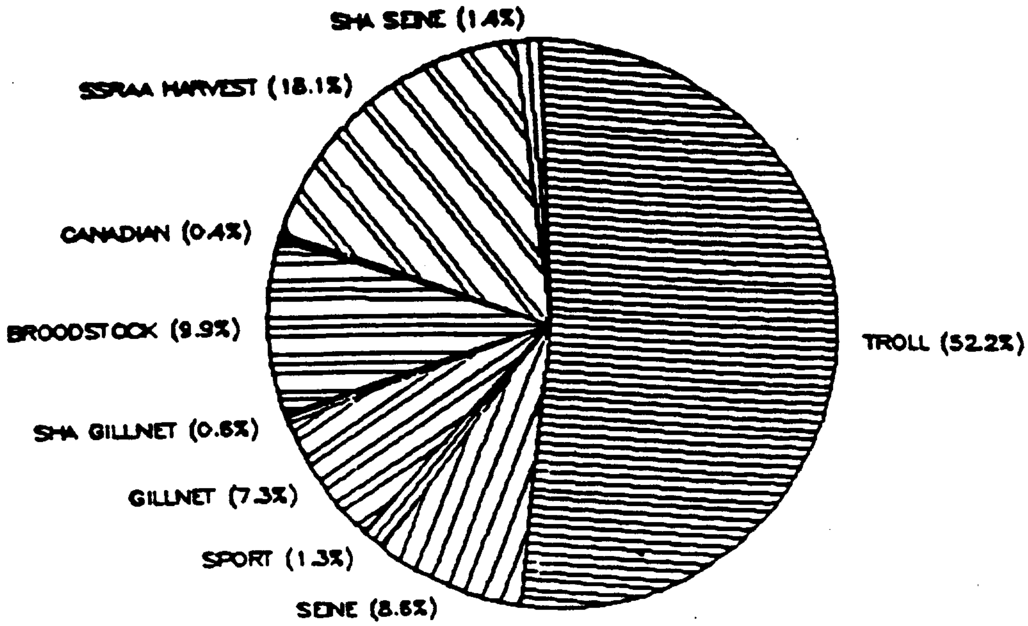


FIGURE 4

1986 TOTAL RETURN BY HARVEST TYPE

NEETS BAY COHO

239,758 FISH



AREA CONTRIBUTION TO TROLL GROUP

NEETS BAY COHO (1986 RETURN)

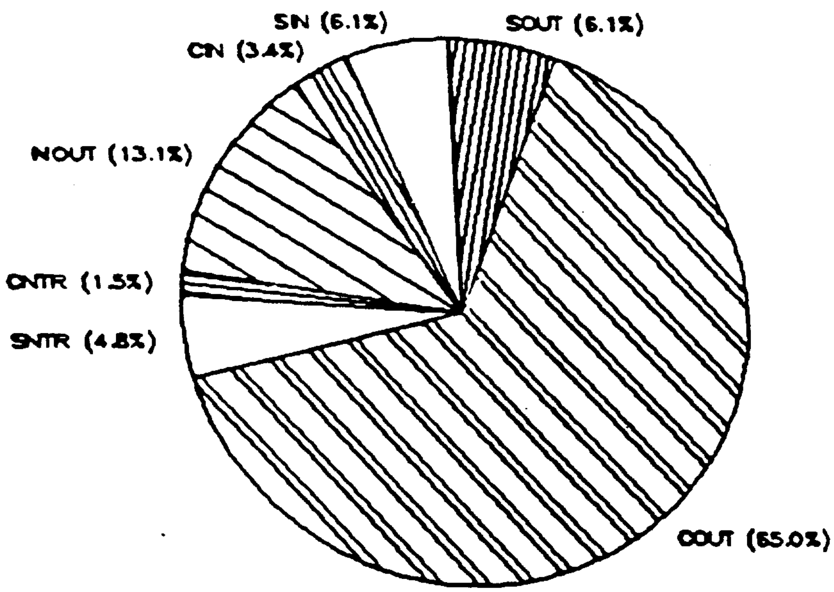
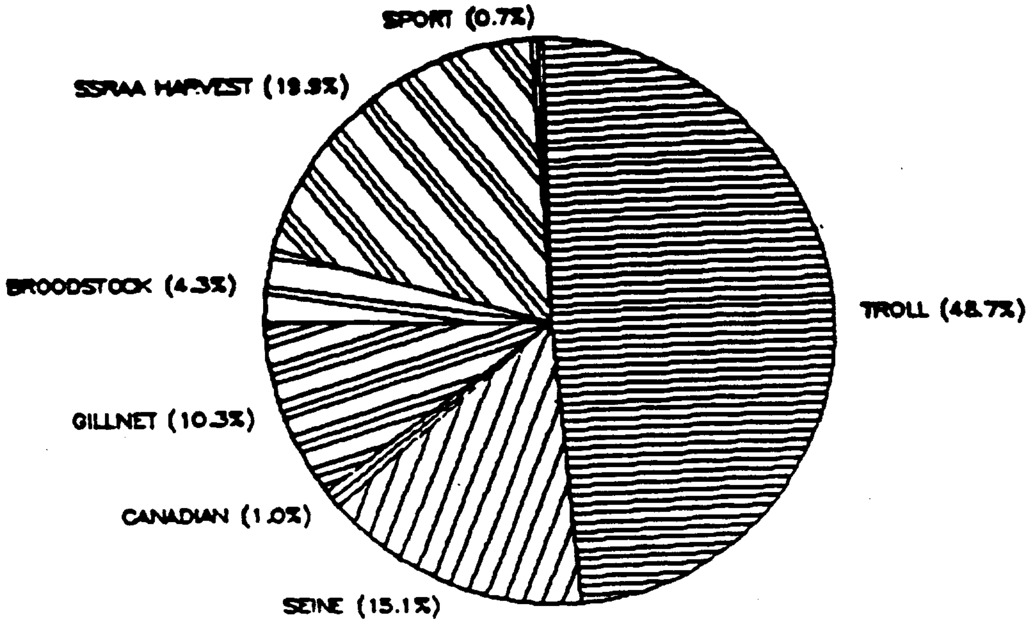


FIGURE 5

1986 TOTAL RETURN BY HARVEST TYPE
WHITMAN LAKE COHO
145,306 FISH



AREA CONTRIBUTION TO TROLL GROUP
WHITMAN LAKE COHO 1986

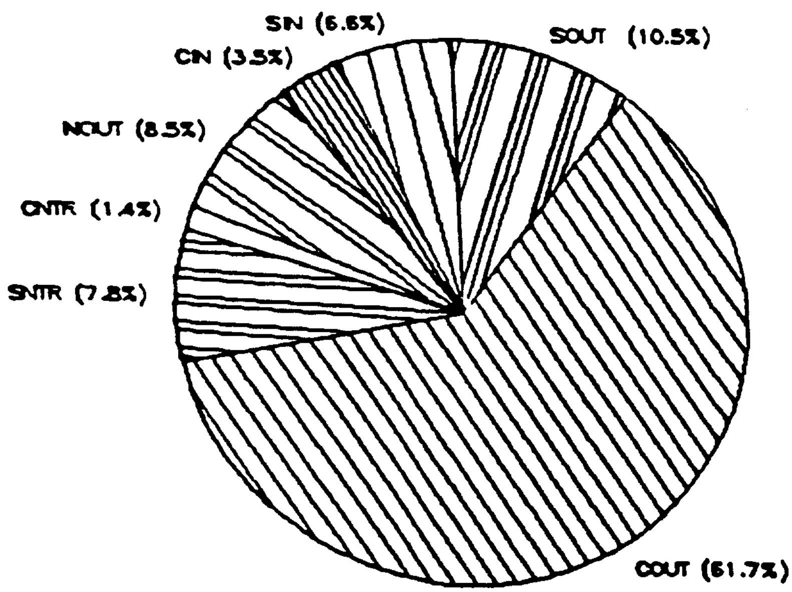


TABLE 1

COHO

12-Feb-87

LOCATION	BROOD YEAR	YEAR RELEASED	NUMBER RELEASED	YEAR OF RETURN	COMMON P HARVEST	TERMINAL RETURN	TOTAL RETURN	PERCENT SURVIVAL	percent CPH	percent TERM.
WHITMAN	1978	5/80-15.5g	196,000	1981	5,360	2,800	8,160	4.16	65.7	34.3
LAKE	1979	5/81-17.3g	224,300	1982	5,779	1,022	6,801	3.03	85.0	15.0
	1980	6/82-17.1g	219,400	1983	14,100	5,500	19,600	8.93	71.9	28.1
	1981	5/83-22.0g	208,000	1984	4,500	2,300	6,800	3.27	66.2	33.8
	1982	5/84-24.7g	308,500	1985	33,835	5,757	39,592	12.83	85.5	14.5
	1983	5/85-23.3g	856,600	1986	110,256	35,050	145,306	16.96	75.9	24.1
	1984	5/86-22.0g	234,200	1987			0	0.00		
	1985		200,000	1988			0	0.00		
	1986		200,000	1989			0	0.00		
	1987		200,000	1990			0	0.00		
	1988		200,000				0	0.00		
	1989		200,000				0	0.00		
	1990		200,000				0	0.00		
							AVE.	8.20	75.02	24.98

COHO

LOCATION	BROOD YEAR	YEAR RELEASED	NUMBER RELEASED	YEAR OF RETURN	COMMON P HARVEST	TERMINAL RETURN	TOTAL RETURN	PERCENT SURVIVAL	percent CPH	percent TERM.
NEETS	1978	5/80-24.5g	280,000	1981	13,695	7,800	21,495	7.68	63.7	36.3
BAY	1979	5/81-17.9g	560,000	1982	41,667	13,920	55,587	9.93	75.0	25.0
	1980	6/82-23.3g	340,000	1983	38,800	6,000	44,800	13.18	86.6	13.4
	1981	5/83-24.2g	980,000	1984	70,716	21,320	92,036	9.39	76.8	23.2
	1982	5/84-26.0g	958,000	1985	75,048	38,299	113,347	11.83	66.2	33.8
	1983	6/85-27.2g	2,153,000	1986	162,050	68,700	230,750	10.72	70.2	29.8
	1984	6/86-20.6g	2,356,000	1987			0	0.00		
	1985		2,000,000	1988			0	0.00		
	1986		2,000,000	1989			0	0.00		
	1987		2,000,000	1990			0	0.00		
	1988		2,000,000				0	0.00		
	1989		2,000,000				0	0.00		
	1990		2,000,000				0	0.00		
							AVE.	10.45	73.09	26.91

TABLE 2

			PERCENT BY GROUP						12-Feb-87
SPECIES	SITE	YEAR	TROLL	GILLNET	SEINE	SPORT	BROOD	COST RECOVERY	NUMBER
COHO	WHITMAN	1984	36.59	7.38	20.4	1.96	13.55	20.11	6,832
		1985	48.27	8.43	19.16	9.6	8.19	6.35	39,592
		1986	48.66	10.53	14.93	1.76	4.29	19.84	145,306
		1987							
		1988							
		1989							
		1990							
		AVE.	44.51	8.78	18.16	4.44	8.68	15.43	
	NEETS BAY	1984	50.74	8.12	16.95	1.03	7.12	16.04	92,036
		1985	46.17	5.22	15.16	7.06	4.41	21.97	113,347
		1986	52.57	7.73	10.18	1.75	9.76	18.01	230,762
		1987							
		1988							
		1989							
		1990							
		AVE.	49.83	7.02	14.10	3.28	7.10	18.67	

Discussion Points (Amend's presentation)

1. SSRAA has seen very little indication of straying by its coho stocks. Try to place fish in net pens for imprinting in April and release them by June 1. Hold them a minimum of 3 weeks for imprinting, though its not known how much this could be shortened for the same results. Net pens are located near the stream mouth; fresh water is not pumped directly from the stream into the net pens, though a freshwater lens is evident in the net pens at both Earl Wess Cove and Nakat Inlet.

2. SSRAA's target size for its coho smolts in 25 grams.

3. Have had some problems in 1985 and 1986 with missing pectoral fins on coho (25% of the smolt released in 1986 were missing pectoral fins). Thought to be the result of underfeeding or over-crowding. Trying to identify cause and correct it. Problem has been very evident in the commercial catches.

4. May 15 seems to be the optimum time for releasing coho smolts based on release results at Little Port Walter and Auke Bay.

5. It cost 15 cents to produce a 25 gram smolt.

6. Try to have fry up to 15 grams before November to provide for better survival through the winter. Fish often smolt by September and they are moved into salt water. Smaller fish tend to revert back to parr and die. Sometimes the reverted parrs can be fed up in the spring and saved and they become smolts again.

7. Fisherman are emphatic in wanting the Department to manage for wild stocks, while giving them access to the hatchery stocks.

GENERAL DISCUSSION

(Where Do We Go From Here?)

General Discussion

Items

1. An increase in targeted effort on coho by the troll fleet is evidenced by movement of the fleet offshore early in the season to intercept feeding schools of fish and by much of the fleet continuing to concentrate on coho even while the chinook season is still open.

2. The Commercial Fisheries/Sportfish cooperative research study should be evaluated in light of our perceived need to include more small (non-lake influenced) coho index streams. It was suggested that Sanders and Gunstrom and their coho staff meet following this workshop to review index streams in each area. Consideration should be given to stream type, and available sources of existing data (i.e., existing weirs). Streams with hatchery influence should not be considered.

3. We need to address the subject of increased tagging and evaluation for management purposes through the Regional Planning Teams and the Commissioner's Office. Further, we need to stress to them the concurrent need for increased financial assistance to the Tab Lab in order that it may process an increased tag load and provide the recovery data in a timely manner for management.

4. The group expressed interest in following the developing study on infared spectrophotometry as a technique for stock identification.

5. We need to increase the number of coho escapements and designated survey streams and establish a stream list by area, by divisional responsibility, that will be surveyed annually. Sportfish and Commercial Fisheries representatives are to meet immediately following this workshop to formulate a draft list.

6. Considerable discussion revolved about a suggestion that an interdivisional/interagency coho working group be formed to address coho research and management and to develop a regional coho plan document. The group, as envisaged, would function in a manner similar to that of the Alaska Working Group on Cooperative Forestry/Fisheries Research. The document, which might be modeled after the Chinook Salmon Plan that was developed 5 years ago (and has been updated annually), would identify data gaps and how to address them, and provide policy for an inter-agency approach to coho research, rehabilitation, enhancement, habitat protection, and management in the Region.

7. There was concern expressed that large hatchery releases of coho smolts may have deleterious effects on other stocks, and there was concern about our overall lack of knowledge re species interactions following large hatchery coho releases. Perhaps consideration should be given to placing limits on artificial production until the biological implications are better understood.

8. Consideration should be given to the creation and access of a common regional data base. This would be a logical topic for an inter-agency coho working group to address in its regional plan document.

9. Consistency of annual data collection should be one of our common goals.