INFORMATION ON COHO SALMON STOCKS AND FISHERIES OF SOUTHEAST ALASKA

By

Southeast Region
Coho Technical Workgroup

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ISSUE SUMMARY

Extensive coho conservation measures were implemented in troll, drift gillnet and recreational fisheries in 1988 in response to extremely poor coho salmon returns to large portions of the region. Normal fishing patterns were disrupted for many fisheries, and in some cases, fishing opportunities and distribution of coho harvest between gear types was also affected. In response to numerous public concerns, some of which are expressed in proposals to the Board of Fisheries, the Alaska Department of Fish and Game prepared this informational report on management of Southeast Alaska coho salmon. The report provides information on basic coho salmon biology, migratory patterns, harvest rates, catch histories, and a general description of the management approach currently used in Southeast Alaska. It also identifies some critical information needs necessary for improvement of the management program.

Management of Southeast Alaska coho salmon stocks is extremely complex and difficult due to the large number of stocks involved and the mixed stock nature of the fisheries. Over 2,500 rivers and streams which produce coho have been identified in the region. With the exception of inriver gillnet fisheries in the Yakutat area and some inriver sport fisheries, virtually all Southeast Alaska fisheries operate to varying degree on mixed stocks of coho salmon. The majority of the coho harvest is currently taken in outer coastal areas and straits by mixed stock fisheries before reliable data is available to determine the strength of individual stock units. While it is recognized that utilization of Southeast Alaska coho salmon returns requires that significant levels of mixed stock fishing be maintained in most areas, the degree to which coho are currently harvested in mixed stock fisheries reduces management's ability to selectively increase harvest of stronger stock units while protecting weaker ones. Successive or guantlet fisheries which harvest certain coho stocks often produce high cumulative exploitation rates on those stocks. Given the high degree of mixed stock harvest, inseason stock assessment and associated management programs are not adequate to ensure a uniform distribution of escapements to all areas and more uneven distributions are beginning to occur. Furthermore, adequate information for determining optimum spawning levels of coho salmon is not available.

Concerns:

- During 1979-88 an average of 65% of the troll harvest occurred in outside districts compared with an average of 38% during 1960-78.

- The trend toward harvesting the majority of the troll caught coho from outside waters has also been accompanied by a larger proportion of the troll catch occurring early in the season during some recent years; this has probably been accentuated by the shortened summer troll chinook seasons, after which most troll effort is directed toward coho salmon.

- Harvesting a large portion of the catch by mixed stock fisheries early in the season complicates in-season management because a major portion of the return is harvested before the department has reliable indicators of the run strength of specific stock groups.

- Due to a combination of high harvest rates on some stocks, variable survival rates, and a large proportion of the coho catch being harvested in mixed stock fisheries, escapement distribution appears to have become more variable in recent years. Low coho escapements to some geographical areas and to certain habitat types (such as small streams) has raised general concern that losses in production may occur. Lack of adequate information on optimum spawning levels precludes a quantitative assessment of potential losses.

- Some stocks which pass through successive fisheries often incur harvest rates in excess of 75%. These harvest rates are probably too high for certain stock types in years of average or below average returns, and over the long term may cause reduced harvest yield. High harvest rates occur on stocks returning to Lynn Canal, Taku River, Stikine River, and the Ketchikan area.

- Efficiency of most gear types continues to increase affecting both potential overall coho harvest rates, and use of fishery performance data such as catch per unit effort for inseason management.

Most of these problems are not new and have been discussed by the Board at previous regulatory meetings. In 1979, the Board responded to the Department's concern over growth of the outer coastal mixed stock fishery by establishing an objective of returning inside troll coho catch proportions to pre-1978 levels by 1984 (5AAC 33.365(7)). Beginning in 1980 the Board authorized the Department to implement a 10-day troll closure if necessary for stock conservation or to aid in maintaining historical distribution of coho catches between outside and inside fisheries. (Such closures have been implemented each year since 1980.) On the strength of increased coho harvests in the early 1980's, the Board in 1983 rescinded the objective of returning inside troll catches to pre-1978 levels. The Department was directed to manage coho based on the in-season determination of run strength and the remaining provisions of the Southeast Alaska-Yakutat chinook and coho salmon troll fisheries management plan (5 AAC 33.365).

Recommendations

Given the coho management concerns identified above, most of which were illustrated during the 1988 season, the Department recommends:

1.) The Board instruct the Department to develop, for the 1991 Board meeting, a framework management plan for Southeastern Alaska coho salmon. Board guidance on the plan's objectives, scope, and the desired public participation and review process would be necessary before the Department would begin work. The framework plan should identify options to address conservation and allocation issues, and describe impacts associated with various options.

2.) During the interim period, the Department should continue the general in-season management approach currently used, but with further Board guidance or clarification on (i) specific catch allocation issues, and (ii) any interim modifications to the general management approach.

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INTRODUCTION

Southeast Alaska coho salmon stocks represent a dynamic resource that is of major importance to several fishery user groups. In recent years, management of this resource has been a topic of continual controversy from both conservation and allocation standpoints. Numerous proposals have been presented at meetings of the Board of Fisheries that would, in some cases, dramatically change recent allocation trends and restructure the way the fisheries are managed. The controversy about management has been increased by the relative scarcity of reliable information on the majority of stocks and the wide range of potential interpretations of what information does exist.

This report brings together what available stock status information, provides interpretations within the bounds of that information, and outlines management considerations that take into account both facts and uncertainties. Critical information needs for improvement of coho management programs are also identified.

STOCK INFORMATION

Life Cycle, Population Dynamics and Production

In Southeast Alaska, the majority of maturing coho salmon enter streams during September and October. Peak spawning activity occurs in late October and November, although spawning occurs until at least the end of February in some systems. Fry emerge from the gravel during the following spring and remain in freshwater for 1 to 6 years before emigrating to saltwater as smolts. While the majority of Southeast Alaska coho salmon spend 2 years rearing in freshwater, significant overall contributions are made by smolts that are ages 1, 3 and in some systems 4. This age structure contrasts sharply with Oregon, Washington and most southern British Columbia stocks which are comprised almost entirely of age 1 smolts. Most coho salmon spend only one year in the ocean prior to returning to spawn.

Juvenile coho salmon feed primarily on insects (aquatic, winged and terrestrial forms) while fish and zooplankton sometimes form important parts of their diet. In most systems, coho salmon populations are thought to be limited by rearing habitat rather than spawning area. Typically, far more fry emerge in the spring than the food and habitat resources of a stream can support to rear them to smolt size. Research on populations in Oregon and Washington has indicated that juvenile coho salmon are highly territorial and that fish that fail to establish territories move downstream and eventually outmigrate prematurely. It has long been assumed that these early outmigrants were not prepared to enter saltwater and, therefore, perished. However, more recent evidence from British Columbia and Southeast Alaska indicates that, in at least some systems, some of these fish feed and grow rapidly in the intertidal zone and/or saltwater and return to the system in the fall to overwinter before migrating as smolts the following spring. There is also relatively limited but increasing evidence indicating that some juveniles may actually move along the coast and enter other streams to rear. This, along with adult straying, may help to explain the presence of juvenile coho salmon in many streams with too little rearing habitat to sustain a permanent spawning population, especially under continual high fishery exploitation rates. Recent genetic research in southern B.C. indicates that small populations from fewer that 100 spawners to possibly as many as 1,000 receive immigration from other populations to the extent that they cannot adapt to the specific conditions in a single system, but are more generally adapted to a wide variety of habitats.

Southeast Alaska coho salmon rear in a number of habitat types that are found in small streams, lakes and large river systems. Important habitat features include pools, undercut banks, logs and other woody debris, aquatic weedbeds and large rocks. These features are found in lakes, beaver ponds, side channels and sloughs off large rivers, and in small streams. Three general types of coho salmon producing systems are recognized in Southeast Alaska including small-medium streams, lake systems and large mainland rivers.

Small-Medium Streams

The vast majority of coho salmon producing systems in the region are small to medium size streams without lakes. These generally produce small returns from several to about 1,000 spawners. While individually producing small numbers of fish, their collective contribution is large because of their large number (approximately 2,000 streams). Most rearing coho salmon are found around undercut banks and debris in instream pools and side channels. In some cases, beaver and muskeg ponds provide additional, important habitat. Small to medium size streams provide a relatively dynamic environment and their populations of rearing coho salmon are heavily affected by freshets, droughts and freezing. They support fewer age classes of fish compared with lake systems which tend to have more older, larger juveniles. Therefore, because of their dynamic environment and more limited age structure, small stream stocks are expected to vary more widely in production from year to year compared with stocks in more stable environments.

Lake Systems

Lake systems are believed to contribute an average of somewhere between 10-25% of the region's wild coho salmon. Most lake systems are medium to large producers with average total returns ranging from about 1,000-8,000 adults. Lake systems are characterized by a relatively stable environment and, consequently, somewhat stable production. Important rearing habitat is found around windfalls, rocks and other structural features near the shoreline and in offshore aquatic weedbeds. Lakes provide refuge habitat during dry and freezing periods, and buffer fluctuations in temperature and streamflow. They typically produce smolts that are larger, on the average, and older with more age classes (up to six). These larger smolts experience higher average marine survival that is probably accompanied by less variability. While individual year class strength has been observed to fluctuate substantially, overall smolt production from lake systems tends to be relatively stable from year to year because a multiple age class structure tends to buffer the effect of random interannual variations in escapement.

Therefore, lake systems are relatively stable producers that are protected from brood year failures caused by unfavorable environmental conditions in freshwater. Because of their stability, returns to lake systems are governed primarily by conditions that affect survival in the marine environment.

Currently, the majority of research on Southeast Alaska coho salmon stocks is being conducted on lake systems because of their relatively high individual production potential, less variable streamflow, ease of access, and the reduced cost of combining coho and sockeye projects on the same systems.

Large Mainland Rivers

Large mainland rivers provide a very important contribution to the region's coho salmon production. Included in this category are the Taku, Chilkat, Berners, Stikine, Unuk, and Chickamin Rivers as well as several other systems in Southeast, and most Yakutat rivers. These systems are particularly important because most are located in inside areas and contribute to several fisheries which, in combination, harvest a relatively high percentage of returns.

Most of the large mainland rivers are glacially influenced. They typically have relatively broad river bottoms that hold numerous clearwater sloughs, streams, ponds and lakes. These clearwater lowland habitats provide most of the basis for coho salmon production. Most spawning occurs in clear headwaters streams and in small tributaries and along the perimeter of the valley bottom.

Large river systems incorporate a complex and dynamic blend of habitat types. Their potential for production is under constant change related to beaver activity, changing stream channels, and the activity of glaciers. Populations in these systems are very difficult to assess because of their complex and dynamic environment. Currently, the Berners River is the only system of this type that has a research program to assess and monitor escapement and total production. While a major escapement estimation program is also under development on the Taku River, most escapement assessment on large mainland rivers is limited to aerial and foot surveys and an occasional weir operated on tributary streams.

Hatchery Production

Hatchery production of coho salmon in Southeast Alaska was relatively minor prior to 1980, but has increased significantly since then. Hatchery contributions to Southeast Alaska fisheries increased each year through 1986, reaching a high of about 420 thousand cohos that year (Figure 1). However, contributions declined in 1987 and 1988 to approximately 124 and 54 thousand coho salmon respectively. Long term projections for hatchery production are still in the range of 600 to 700 thousand coho salmon, annually.

The decline in hatchery coho production in 1987 and 1988 appears to be due primarily to reduced marine survival as total hatchery releases have remained relatively constant. For example, at the Neets Bay hatchery near Ketchikan, one of the region's largest producers of hatchery coho, survival rates averaged 10.4 percent (range 7.7-13.2%) during 1981-86, but declined to 3.7% and 0.5%, respectively, in 1987 and 1988 (Figure 2, pers. comm., Gary Freitag, Southern S.E. Alaska Regional Aquaculture Assoc.). It is not known to what extent recent declines in survival rates have been due to poor natural survival, or to potential impacts of high seas fisheries.

Contributions of Alaska hatchery coho salmon to the total coho salmon harvest by Southeast Alaska fisheries have averaged about 8% annually since 1985 (Figure 3). The percentage has ranged from a high of 12% in 1986 to a low of 5% in 1988.

The proportional harvest of hatchery coho by gear type tends to be similar to that of the total coho harvest in Southeast Alaska (Fig. xx). For example, harvest percentages by gear type in 1987 are shown below:

	Troll	Seine	Gillnet	Sport
Total catch	68%	9%	20%	3%
Hatchery catch	64%	14%	19%	4%

In the case of the gillnet fisheries, virtually all of the harvest of hatchery coho occurs in drift gillnet fisheries, with few if any hatchery coho being harvested in Yakutat set gillnet fisheries.

The majority of hatchery produced coho salmon in Southeast Alaska are represented by coded wire tagged releases. Combined with extensive catch sampling programs, this provides estimates of hatchery contributions to the region's fisheries. Additional capabilities need to be developed to provide more timely inseason estimates of hatchery contributions which can be taken into account when interpreting fishery statistics for inseason management.

Migration Patterns

Southeast Alaska coho salmon smolts migrate from their natal streams into saltwater during mid-April through mid-June with the peak migration occurring in May. Sampling and tagging studies indicate that most leave local marine waters during mid-summer to fall and migrate northwestward along the coast during late summer and fall. Jacks (0-ocean age fish) return to the streams during the first fall after only 4 months in saltwater, while larger 1-ocean age fish remain at sea for another year and return to the streams approximately 16 months after smolting. Most fish that remain at sea for a full year migrate southward out of the Gulf of Alaska and into the North Pacific Ocean during the fall and winter months, reaching their most southern distribution (as far south as 40°N) during late winter and early spring (Figure 5). They then migrate northward during spring and early summer, as the sea surface warms, and arrive along the outer coast of Southeast Alaska in large numbers during early to mid-July.

Maximum coho salmon abundance in troll fishing districts in Southeast occurs during July and August (Figure 6). Most fish remain for a period of weeks in outer coastal areas where they feed and undergo rapid growth before migrating to inside waters. Based on the 1969-1985 data, the average dressed weight of troll caught fish increases from an average 5.0 lbs. in late June to about 8.2 lbs. in mid-September for an overall gain of approximately 60% (Figure 7). The peak migration in drift gillnet fisheries in inside waters near stream mouths typically occurs in early to mid-September while peak weir counts on spawning streams usually occur near the end of September. Most spawning takes place during October and November but occurs through February in some systems.

Most coho salmon returning to Southeast Alaska streams approach the coast from the northwest of their systems of origin and migrate southeastward. Therefore, most of the harvest of individual stocks occurs in the outside waters to the northwest and in local waters, while a relatively small percentage is taken southward (Figures 8-10). For example, the troll harvest of Lynn Canal stocks is restricted largely to more northern areas of the outside coast and the most northern straits leading to inside waters (Figure 8) while the troll catch of southern inside stocks such as Hugh Smith Lake is more evenly distributed throughout the region, particularly in outside areas (Figure 9). The harvest of outside area stocks occurs primarily in outside waters near and northward of their systems of origin (Figure 10).

Although most coho salmon stocks are available to the troll fishery to some extent throughout the season, there are significant differences in the timing of peak abundance among stocks. For example, the Berners River stock shows a timing pattern that is distinctively late and is typical of the major stocks in Lynn Canal (Figure 11). Stocks in the Berners, Chilkoot and Chilkat Rivers are consistently most abundant in troll catches during the second half of August and September. The Ford Arm Lake stock, located on the outer coast of Chichagof Island, incurs a more consistent harvest throughout most of the troll season from early July through early September. The Warm Chuck Lake stock on the southern outside coast typically peaks in the troll catch in late July.

Assessment Program

Escapement assessment programs are conducted on only a small percentage of the 2,500 or so coho salmon producing streams in Southeast Alaska. The very small proportion of the escapement that is enumerated is due, in large part, to the extremely scattered distribution of stocks, difficult conditions for observation of spawners during the fall months relatively high operational costs.

At present, weirs are operated throughout the coho salmon migration on eleven systems in the region of which only six have 5 or more years of complete escapement counts. Mark-recapture estimation is under development in the Taku and Berners River systems. Surveys are conducted on approximately 75 additional streams located throughout the region. Beginning in 1987, additional funds were allocated to improve escapement survey coverage for southern Southeast stocks. Current objectives are to develop a set of escapement indicator streams for which a comparable series of data is available in each management area.

Studies of total escapement and production are being conducted on five systems with the objective of determining population dynamics and optimum escapement for these stocks. Over a number of years, the studies should lead to development of escapement goals for these five systems and a better overall understanding of coho salmon population dynamics and optimum management strategies.

Weirs, while providing the best quality information on the escapement to a particular stream, are expensive and can only be effectively used on certain types of systems during the wet, fall months. Weirs are most effective on lake systems which are more buffered from extremes in water flow caused by periods of heavy rainfall. Mark-recapture estimation is feasible on some larger river systems such the Taku River, but is also relatively expensive and limited in application. Sonar has been tested on a limited basis, but also appears to have very limited applicability for coho escapement assessment in Southeast because of various operational problems related to large fluctuations in stream flow, the irregular nature of coho salmon migrations in freshwater, and difficulty in estimating the fraction of sonar counts that are coho salmon.

Foot, dive, helicopter and fixed-wing surveys currently account for the major portion of the Department's escapement assessment program. Surveys are most cost-effective but suffer from several potential sources of bias, with comparable results possible on only a limited number of streams. Surveys are considered to be only an index of escapement to a stream compared with total estimates that are obtained by weirs or tagging. A technique has been developed that can provide more complete estimates of salmon escapements using multiple surveys, if average stream life is known, but these have shown relatively little promise for coho salmon in Southeast Alaska because of the difficulty of making the number of surveys needed for individual systems and because of the irregular nature of coho salmon spawning migrations. Therefore, the index used is typically the highest or "peak" survey count. Survey counts are generally biased substantially downward compared with actual total escapement because: (1) not all fish are present in survey areas when counts are made. Typically, some have yet to enter the survey area while others may have already been removed by predators and scavengers; and (2) not all fish in the survey area are seen by an observer. Glare, poor light, fish hiding under banks and debris, and a natural tendency for most observers to underestimate large groups of fish all contribute to undercounting escapement. Surveys are useful as an indicator of escapement to the extent that: (1) Peak survey counts represent a constant fraction of the annual escapement; and (2) escapement in index streams accurately represents escapement trends in systems that are not surveyed.

The first (common fraction) assumption is very difficult to meet for most systems in Southeast Alaska because of the physical characteristics of many streams and the behavior of returning adult coho salmon. After entering freshwater, fish typically hold and ripen for a period of weeks or months in deeper, less swift areas including pools, sloughs and lakes, where they are relatively safe from predators. When conditions are right, groups of fish move quickly into shallow areas and small tributaries where they spawn. Once on the spawning beds, they are susceptible to predators and carcasses may be quickly removed by scavengers. Peak migrations into shallow spawning areas typically occur during high-water periods when fish are less vulnerable to predators compared with low-water conditions. Surveys conducted only in spawning areas are, by nature, highly unreliable as indicators of actual escapement. The necessary characteristics of a reliable survey indicator stream require that most spawners be visible regardless of where they are in the system. This rules out lakes and many tributaries of large river systems where fish may hold in glacially colored water or other places where visibility is poor. Surveys are typically more useful for small to medium clearwater systems where fish gather in clear pools. Overall, a large percentage of the streams throughout Southeast Alaska, including most major producers, are not conducive to obtaining representative survey counts.

The assumption that surveyed systems are representative of other streams is largely untested. Stocks in the same geographical area and of the same habitat type are affected by similar environmental conditions and, therefore, might be expected to fluctuate in a similar trend even if the fluctuations are of a different magnitude. However, there are also undoubtedly somewhat localized conditions that are different for stocks in nearby systems and, as noted earlier, stocks in different habitat types are likely to be affected differently by the same environmental factors. There have been substantial differences in escapement trends for small stream indices and lake stocks in the same management district. In addition, dramatic differences are typically seen in run strength to different parts of the region (i.e. north vs. south and inside vs. outside). This points to the need to select escapement indicators to represent all of the major habitat types and geographical areas of the region.

Several combined factors, including the small number of systems assessed, the effect of environmental factors on coho salmon populations, and conditions other than escapement that affect survey counts, make interpretation of escapement data very difficult when trying to assess the overall status of stocks in any management area. Even with a much improved escapement assessment program, including better estimates for more systems over a longer period of time, there would still remain the fundamental question of what escapements should be. What number of spawners in each system will result in optimum harvestable production? Answering that question requires either extensive information on survival rates and the capacities of different rearing habits to produce smolts, or estimates of smolt and adult production from a wide range of escapements over a number of years. Currently, five projects are underway in the region that are designed to address the question of optimum escapement by measuring escapement and estimating production through coded-wire tagging studies.

The utility of currently available escapement data is limited primarily to after-the-fact evaluation of compliance with interim management objectives which include: (1) maintaining overall escapements at near average historical levels, and (2) regulating the fisheries to provide a relatively even distribution of escapement to all stock groups while harvesting surpluses.

Recent Escapement Trends

There are relatively few coho salmon stocks in the region for which a sufficient time series of data is available to determine escapement trends. Because available escapement data is generally insufficient to determine long-term trends, catch data for some of the inside drift gillnet fisheries are presented to show trends in production in certain near-terminal areas as indication of escapement to those areas (Figures 12 and 13). These fishery indicators are, of course, affected by factors other than fish abundance including effort, gear efficiency, management actions, weather, fish migration patterns, etc. In addition, the two more southern indicators (Tree Point and Prince of Wales) have been significantly affected by recent increases in hatchery production. Coded-wire tag information is available to identify hatchery contributions in all of the fisheries.

In 1988, escapement to southeast Alaska streams was highly variable across the region (Table 1) as it has been in most years. Very low escapements were observed for the second consecutive year in southern Southeast. In both years, these poor returns were related in large part to widespread poor marine survival rates for the southern portion of the region. Escapement in other parts of the region was mixed, ranging from far below average to far above.

Ketchikan Area. Escapement of coho salmon to Hugh Smith Lake in 1988 was an estimated 513 spawners (preliminary) which was the lowest recorded estimate for that system and 65% below the 1982-1987 average. Peak survey counts in three other index streams show a similar trend with an aggregate count that was 63% below the 5-year average (Figure 14). Low escapement counts in the Ketchikan area for 1987 and 1988 apparently reflected poor overall returns to southern inside districts. In spite of large hatchery smolt releases, catches in inside fisheries of southern Southeast indicated poor overall returns (Figure 12). The drift gillnet fisheries in Districts 101 and 106 showed dramatically increasing catch trends during the early to mid-1980's resulting from large increases in hatchery smolt releases and high survival rates for both hatchery and wild smolts. However, a dramatic decrease in catches in 1987 and 1988 resulted from overall poor returns combined with management restrictions to increase escapements.

Petersburg Area. No reliable time series of escapement counts or indices is available for the Petersburg-Wrangell area. Historically, escapement surveys have been conducted inconsistently from year to year or not at all. An annual program to select, survey, and evaluate coho salmon index streams was initiated in 1987.

Sitka Area. In the Sitka area, Salmon Lake and Ford Arm Lake weirs have provided accurate escapement data since 1982-1983. The 1988 escapement to Salmon Lake in Sitka Sound was 28% below the 1983-87 average and escapement indices for other systems in Sitka and Salisbury Sounds were 83% below the 1981-1987 average. Escapements to Salmon Lake and the surveyed small and medium sized index streams near Sitka have shown up and down fluctuations characterized by a similar trend but a somewhat different magnitude since 1983 (Figure 15). Ford Arm Lake, located on the outer coast of Chichagof Island north of Sitka, has not followed the other indicator stocks as closely and posted a record escapement in 1988 resulting from a combination of a near-record total return and a moderate harvest rate.

Juneau Area. The 1988 escapement index for indicator streams along the Juneau roadside was 43% below the 1981-1987 average (Figure 16). This was the third consecutive year of below average counts for these streams. In contrast, the total escapement past the Auke Creek weir was 12% above the 1981-1987 average. The escapement to Auke Lake has fluctuated within a narrower range compared with the index for the surveyed non-lake systems.

Taku River. Coho salmon escapement past Canyon Island on the Taku River was relatively strong in 1988, but lack of a historical time series for the entire migration period makes interpretation difficult. Helicopter and foot survey counts on lower river tributaries also indicated above average escapements in 1988 for most streams (Figure 17). However, fewer fish were counted at Yehring Creek Weir in the lower Taku River valley compared with 1986 and 1987. Three early migrating and spawning stocks in the upper Taku River system have been assessed since 1985-1986 (Figure 18). Escapement counts have shown relatively little correlation among these indicators except that the combined counts for the two surveyed systems and the weir count for the Hackett River both peaked in 1986.

While Escapement data is inconclusive, the harvest by the District 111 drift gillnet fishery is comprised to a large extent of Taku River stocks and, therefore, provides some indication of overall abundance trends in the near terminal area since the early 1960's (Figure 13). This is only a gross indicator because harvest rates have undoubtedly varied substantially from year to year because of changes in effort, gear efficiency and management. For example, in 1975, the season was completely closed during the fall season. Overall, coho salmon production in the District 111 fishery has shown a very stable trend since the early 1960's.

Lynn Canal. The Berners River in Lower Lynn Canal is one of the best coho escapement index streams in Southeast Alaska. It is possible to survey escapements relatively thoroughly and consistently from year to year, and a relatively long time series of index counts is available starting in 1974 (Figure 19). The 1988 escapement survey count of 2,724 was 34% below the 14-year average. Survey counts fluctuated between 1,800 and 4,400 from 1974 to 1981 and then increased dramatically to a peak of nearly 10,000 in 1983 before decreasing again to 1,800-3,300 during 1986-1988. In addition to escapement survey counts, estimates of total return (survey count plus total fishery contribution) are available for most recent years. Estimated total returns showed a similar trend to survey counts except that the 1986 total return was relatively strong but was harvested very heavily by both the troll and drift gillnet fisheries (Figure 34) which resulted in a record low escapement count (1,752). Total return estimates for 1974, 1978 and 1979 ranged from 8-18 thousand fish and increased to 31-34 thousand in 1982-1983 before decreasing to 24-25 thousand in 1985-1986 and 14-15 thousand in 1987-1988. This overall trend was also reflected by regionwide catches which peaked in the early to mid 1980's before declining substantially in the two most recent years to a level similar to the 1970's.

In the Haines area, coho salmon escapements to Chilkoot and Chilkat Lake weirs have remained relatively stable from 1981 to present with the exception of low escapement to Chilkoot Lake in 1987 (Figure 20). While surveys have been conducted on some systems in past years, a consistent annual program to obtain survey counts was not begun until 1987 and no sound interpretations can yet be made from this data.

The coho salmon harvest by the Lynn Canal drift gillnet fishery has shown a generally upward trend since the early 1960's. High catches in recent years are undoubtedly partly a reflection of high stock abundance in near terminal areas in the early to mid-1980's, but probably also reflects increases in effort, fishing time and, to some extent, gear efficiency.

Yakutat. Escapement data for the Yakutat area (Figure 21) is based on aerial, float and foot surveys on larger river systems and, therefore, is subjected to several potential sources of bias. For example, extreme precipitation (98 inches) during September-October 1987 resulted in continuously high, murky water conditions and made it impossible to conduct reliable surveys during the optimum survey period on most systems. This is reflected in the extremely low peak counts for Situk and Tsiu Rivers which probably are largely unrelated to actual escapement. Very strong inriver returns were observed in 1988 based on set gillnet catches but, again, survey conditions were very difficult and resulted in low peak counts for the Tsiu River and Tawah Creek which were made about 3 weeks before the optimum period. However, some broad patterns are apparent. Escapement to the Situk River - Tawah Creek area appear contradictory, probably a result of poor survey conditions. However, it is likely that escapement to the area has increased relative to the previous three years based on high counts in the Situk River. Escapement to the Tsiu-Tsivat system was below average, marking the third year below its 15 year average. Overall, the Tsiu River shows no significant trend in escapements while the Situk River and Tawah Creek have shown an increase in average peak counts compared with the mid to late 1970's.

FISHERY INFORMATION

Coho salmon are an important resource to the salmon fisheries of Southeast Alaska. In 1987, commercial fisheries harvested 1.5 million coho worth approximately ($17) million which represented 23% of the total value of all salmon harvested by the region's commercial fisheries. This was the largest single species contribution. The recreational harvest of 50.3 thousand coho salmon in 1987 contributed about 34 percent of the total number of salmon taken in recreational fisheries.

A brief review of historical and current coho catch and effort trends in Southeast Alaska fisheries is provided in the following section. Current management approaches are described, and harvest rate information for a number of indicator stocks is presented.

Long-term Catch History

Commercial coho salmon catch statistics for Southeast Alaska fisheries are available dating back to the late 1800's. Regionwide recreational coho catch data are not available until 1977, and data on subsistence catches are limited to recent years. However, since commercial fisheries account for a high percentage (currently more than 95%) of the region's coho harvest, commercial catch statistics provide a relatively complete time series of coho catches for historical comparisons.

Southeast Alaska commercial coho salmon catches since 1890 are shown graphically in Figure 22. Catches increased rapidly during the early 1900's as commercial fisheries developed. Decade averages approximately doubled from 238 thousand during the 1890's to 434 thousand during 1900-1909, and then more than doubled again to about 1.2 million during 1910-1919. Catches continued to increase, although more slowly, reaching a peak decade average of 2.0 million during the 1940's. The largest annual catch occurred in 1951 when 3.3 million coho were harvested.

Following the peak decade of the 1940's, commercial coho salmon catches began to decline in the early 1950's. Decade averages were 1.5 and 1.1 million during the 1950's and 1960's, respectively. The decline continued until 1975 when a record low catch of 427 thousand coho salmon was recorded.

Coho salmon catches began to increase in Southeast Alaska after 1975 and continued an increasing trend through 1986. During 1980-86, catches averaged 2.1 million, or about 1.9 million excluding Alaska hatchery contributions. (As noted in a previous section, hatchery production of coho salmon, which began in Southeast Alaska during the early 1980's, currently contributes about 5-10% of the region's coho harvest.) Thus, the average coho catch during 1980-86, excluding hatchery production, was similar to the peak decade average of 2.0 million during the 1940s.

Commercial coho catches have declined to about 1.4 million and 973 thousand in 1987 and 1988 respectively (excluding hatchery contributions).

Trends and fluctuations in historical coho salmon catches in Southeast Alaska have been due to a number of factors. Probably the most important factors were changes in fishing effort, and changes in stock sizes due to environmental conditions and fishing impacts. The increasing trend in catches during the first half of the century was primarily due to increasing fishing effort during early development of the fisheries. A similar trend is reflected in the historical statewide commercial catches of all salmon species (Fig. 23).

Statewide, all species salmon catches peaked about a decade earlier, during the late 1930's and early 1940's, than Southeast Alaska coho catches. This was probably due to earlier overfishing in the large sockeye and pink salmon fisheries of the State where intense commercialization first occurred. It is interesting to note that the subsequent declines ended in the late 1950's in both instances. A short term recovery then occurred during the early to mid-1960s, followed by another decline during the late 1960's and early 1970's. The latter decline appeared to be primarily the result of the more severe winter conditions occurring during that period. Since the late 1970s, commercial salmon catches have increased substantially. The primary factor appears to be improved natural stock abundance, however, new enhancement programs have contributed significantly in some areas, and foreign high seas harvest of certain western Alaska stocks have been reduced.

Catches by Gear Type (1960 - Present)

The average distribution of the commercial coho harvest among the major gear types during 1960-1988 was as follows: troll 56%; purse seine 22%; drift gillnet 13%; and set gillnet 9%. The percent harvested by the troll fishery increased from an average of 52% in the 1960's to 56% in the 1970's and 61% in the 1980's through 1988. The troll share dropped sharply in 1988 to 48% from an average of 63% in 1980-1987 (Figure 24). The purse seine share decreased from an average of 28% through 1972 to 16% during 1973-1988. A major contributing factor in the decline in the purse seine share was closure of major coho salmon migration corridors in northern Southeast to purse seining in 1973. Purse seine fisheries accounted for an average of 17% of the catch during 1980-1988. The average percent of the catch taken by drift gillnet fisheries increased from a 1960's average of 10% to a decade peak of 17% in the 1970's, and subsequently declined again to an average of 10% in the 1980's. The drift gillnet share has generally increased since the beginning of the decade and was up in 1988 to 12% from a 1980-1987 average of 9%. The percent of the harvest taken by set gillnet fisheries in the Yakutat area has fluctuated from 3-17% between peaks in 1960 and 1988 and low points in 1972 and 1986. Decade average shares were 10% in the 1960's, 6% in the 1970's and 9% during 1980-1988.

During the period of available recreational catch records (1977-1988), the percent of the total commercial and sport coho salmon catch taken by the sport fishery has averaged 2.6% and ranged from a peak of 3.4% in 1977 to a low of 1.7% in 1986 (Figure 25). The total estimated sport harvest during this period averaged 44,891 fish and increased from 33,748 fish during 1977-1981 to a higher, relatively stable harvest averaging 56,195 (range 50,284-59,910) during 1982-1987 before declining to 32,800 (preliminary) in 1988. A similar pattern was evident for commercial catches (Figure 22). The Juneau and Sitka marine sport fisheries have shown a relatively stable trend, accounting for an average catch of 15,209 fish (33%) and 2,909 fish (6%), respectively, of the region total during 1977-1987. However, a dramatic increase in both the total harvest and share by the Ketchikan marine fishery occurred during this period from an average of 4,556 fish (12%) during 1977-1979 to 8,755 fish (20%) in 1980-1983 and 17,689 fish (41%) in 1984-1987. This increase is attributed to increased interest in sport fishing for coho salmon in the Ketchikan area accompanied by a rapid expansion of charterboat operations and increased availability of hatchery fish. Overall, the Ketchikan marine fishery accounted for an average of 10,859 fish or 24% of the region total sport harvest during 1977-1987.

Harvest Patterns in the Troll Fishery

Major changes in the distribution of the troll catch have occurred in recent years that have had significant effects on management and the stock composition of the catch. While the north-south distribution of the catch has shown no significant trend since 1960 (Figure 26), substantially more of the catch has occurred in outside districts in more recent years compared with harvest distribution during the period from 1960 through the mid to late 1970's (Figure 27). The trend toward harvesting a larger percentage of the catch in outside waters became most pronounced beginning in 1979 when major restrictions were placed on trolling in migration corridors and inside waters in northern Southeast. During 1979-1988, an average of 65% of the troll catch occurred in outside districts compared with a 1960-1978 average of 38%. The percent of the catch taken in outside districts peaked at 76% in 1986, which coincided with a record annual harvest and peak estimated troll harvest rates for four indicator stocks in northern Southeast (Figures 31 and 32). In 1987 and 1988, the harvest in outside districts accounted for 68% and 62%, respectively, of the total troll harvest. In addition, there has been a trend toward fishing farther offshore along the outer coast in some recent years to harvest schools of feeding fish. The shift in fishing effort to outside and offshore areas has probably resulted in a more even distribution of the harvest over all stocks in the region because stocks on the outer coast are only available to a significant extent in outside fishing districts. However, it has also made it more difficult to manage the fishery on the basis of specific stock groups because it is all stocks in the region intermingle to some extent in outer coastal and offshore districts, and run strength among stocks groups is usually highly variable.

The trend toward harvesting a larger proportion of the total catch in outside waters has also been accompanied in some years by very large catches early in the season during the month of July. Strong early catches occurred during most years in the early 1980's, however, early season catches were poor in 1988, while fishing improved during later open periods (Figure 28). Harvesting the majority of the catch early in the season complicates inseason management because a substantial percentage of the total return to the region is taken a month or more before performance by inside fisheries becomes a reliable indicator of the run strength of specific stock groups. In addition, there is some loss in landed weight from harvesting coho salmon in mid-July compared with mid-August because fish grow by an average of about 1.3 lbs. or 21% during that period (Figure 7). The extent to which this represents a loss in yield is dependent upon the availability of alternative management strategies that result in harvest of the same stocks after they have completed more growth. When averaged over the entire season, the change in the average timing of the troll harvest in 1980-1987 compared to 1960-1979 has resulted in a reduction in average weight of individual fish landed of only about 2%.

Effort Changes

Most major commercial gear types that harvest Southeast Alaska coho salmon have shown a relatively stable trend in the number of permits fished (Figure 29). The major exception is the hand troll fishery which showed a dramatic increase in participation during the late 1970's in anticipation of limited entry which was instituted in 1980; participation has subsequently declined to earlier levels.

Sport fishing effort in Southeast Alaska has increased since records are available beginning in the mid-1970's. Overall angler effort in all recreational fisheries increased by 56% since the mid to late 1970's from an annual average of 232,584 angler-days in 1977-1979 to 362,494 angler-days in 1985-1987.

Since comparable records of charter boats were kept beginning in 1982, the number of registered charter boats increased from 139 in 1982 to 317 in 1984 and has varied within a range from 225 to 272 boats during 1985-1988.

In spite of relatively stable participation, some fisheries have probably undergone a significant increase in their ability to harvest coho salmon in recent years. For example, new types of nets that have come into use by the drift gillnet fishery since the early 1980's are substantially more effective in catching coho salmon under some conditions compared with previously used nets. Also, the increasing use of more advanced electronics combined with reduced opportunities to fish for chinook salmon have undoubtedly increased the effectiveness of the troll fishery in harvesting coho salmon. Increased sport charter boat activity has probably also increased efficiency in the recreational fishery.

Harvest Rate Information

Harvest rate information based on coded-wire tagging studies is available for coho salmon stocks in most major producing areas in Southeast Alaska. Recent harvest rates for tagged stocks have averaged approximately 60%. However, some stocks are consistently fished more intensively than others so that average harvest rates for individual systems range from as low as about 40% to as high as 85-90%.

Troll Fishery Harvest Rates

The troll harvest is relatively evenly distributed over most stocks in the region (Figure 30). Overall, recent estimated harvest rates by the troll fishery for index systems have averaged between 40-45% with most individual estimates ranging between 30-60%. Troll harvest rates for two outside stocks located along the central outside coast near Sitka have ranged from 41-61% (average 50%) for Ford Arm Lake (1982, 1983 and 1984-1988) and 35-55% (average 44%) for Salmon Lake (1984-1988; Figure

31). Peak troll harvest rate estimates of 61% and 55%, respectively (average 58%), occurred for both stocks in 1986 when a record region total coho salmon harvest was recorded. Troll harvest rates for those stocks decreased from 1986 to average estimates of 48% (45-51%) in 1987 and 46% (45-48%) in 1988.

Troll fishery harvest rate estimates for three inside stocks including Auke Creek and the Berners River near Juneau and Hugh Smith Lake near Ketchikan are shown in Figure 32. Harvest rate estimates for the Berners River are biased somewhat high because of less thorough survey accounting of the escapement compared with weir counts for other stocks, however, interannual estimates are comparable. The troll fishery was relatively unrestricted by time-area closures through 1978. However, several major restrictions were implemented beginning in 1979 and 1980 that had a strong initial impact on troll harvest rates on northern inside area stocks. The restrictions included: closure of most of Stephens Passage to commercial trolling; time restrictions in Icy Strait, northern Chatham Strait and Cross Sound; implementation of a 10-day regionwide troll closure; and limited entry restrictions on hand troll gear. The impact of these restrictions on troll harvest rates on northern inside stocks is reflected in estimates for the Berners River in 1979 and Auke Lake in 1980 and 1981 (Figure 32). After an initial decrease in 1979-1981, harvest rates on northern inside stocks increased to 1986 peak estimates of 55% for the Berners River and 43% for Auke Lake before decreasing to 40% and 25%, respectively in 1988. Reduced troll harvest rates in 1988 probably resulted from a combination of additional inseason restrictions and reduced fishing effort because of low abundance. While available data indicates that recent average troll harvest rates for northern inside stocks have returned to levels comparable to the period immediately preceding major restrictions, the distribution of the troll catch of these stocks has changed significantly with a higher percentage of more recent catches taken in outside districts.

Estimated harvest rates by the Alaska troll fishery for the Hugh Smith Lake stock near Ketchikan have averaged 35% during 1982-1987, ranging from a high of 45% in 1982 to a low of 28% in 1987. When the harvest by the troll fishery in British Columbia is included, the average overall troll harvest rate for that stock was estimated at 41%.

Total Harvest Rates

Estimated total harvest rates by all gear types (Figures 33 and 34) show the combined effect of the harvest by all fisheries. Some inside coho stocks are subjected to substantial additional harvest by net and sport fisheries which, in combination with the troll catch, results in harvest rates that are very high.

Based on available data, the upper Lynn Canal stocks including the Chilkat and Chilkoot Rivers are, on the average, subjected to the highest harvest rates of any coho salmon stocks in the region. In addition to the troll fishery, upper Lynn Canal stocks are harvested by an intensive fall drift gillnet fishery in Lynn Canal and to a lesser extent by purse seine fisheries and marine and freshwater sport fisheries. Estimates for 1983 indicated that returns to both systems incurred total harvest rates between 85-90% (Figure 8). Given the conduct of current fisheries, it is likely that high harvest rates in this range continue to occur in some years. The annual drift gillnet harvest in Lynn Canal has remained relatively stable for over 25 years (Figure 13) and actually increased since 1982 indicating that overall production from Lynn Canal coho salmon stocks has been maintained at high harvest rates. Harvest rates have probably peaked during the most recent 5 years as more efficient nets have been developed and increased fishing time has been allowed to harvest large chum returns. Therefore, it is not known if average past production can be maintained under the extreme fishing pressure of more recent years.

The Berners River stock in lower Lynn Canal also incurs substantial pressure in the drift gillnet fishery with total estimated fishery removals by all gear types since 1982 averaging 79% (range 71-93%; Figure 34). As mentioned before, these estimates are somewhat high because of the method currently used to account for escapement to that system.

Most other stocks in the region are subjected to substantially lower average harvest pressure compared to the Lynn Canal stocks.

The Auke Creek stock near Juneau is harvested at a substantially lower rate by the drift gillnet fishery compared with Lynn Canal stocks and, therefore, has been subjected to more moderate overall harvest rates with estimates since 1982 ranging from 36-52% (average 44%). Outer coastal indicator stocks in District 113 incur only minor harvest by other gear types in addition to the troll catch with average total harvest rate estimates of 54% (range 44-69%) for Ford Arm Lake and 45% (range 35-56%) for Salmon Lake (Figure 33). Most stocks in southern Southeast are harvested at relatively consistent, moderate to high rates (55-70%), with the catch distributed across a broad range of fisheries from Yakutat to northern B.C. Total harvest rate estimates for the Hugh Smith Lake stock during 1982-1987 averaged 61% (range 52-65%; Figure 34).

Comparison with Southern Pacific Coastal Stocks

Escapement, harvest rate and production data from Oregon, Washington and southern B.C. stocks provides some indication of how coho salmon stocks have performed under sustained high harvest rates. Oregon and Columbia River stocks were subjected to a period of dramatically increasing ocean fishing pressure coincidental with development of major hatchery production in the 1960's. Ocean harvest rates (troll and sport) for stocks in the Oregon Production Index (OPI) averaged 80% during 1961-1970 and increased to an average of 87% in 1971-1977 before being reduced by restrictions. Stocks that originated in the Columbia River were subjected to additional inriver fisheries and total harvest rates of over 90%. Natural stock escapements declined sharply following a relatively stable trend from 1950-1964. Escapements to coastal streams and Columbia River tributaries declined at annual rates of about 9% and 22%, respectively, during 1965-1983, leaving wild stocks at only remnant levels in Columbia River tributaries. Management objectives for Oregon coho salmon include maintaining an average ocean harvest rate of 69% which, it is hoped, will allow the coastal stocks to rebuild.

During 1979-1981, estimated average ocean harvest rates for seven indicator stocks in Puget Sound and five stocks on the Washington coast were approximately 59% (range 49-66%) and 64% (range 54-

69%), respectively. Estimated total harvest rates by all fisheries for Puget Sound, north coast and south coast indicator stocks that were managed for natural production averaged 81%, 77% and 84%, respectively. The response of Washington stocks to continual high harvest rates around 80% has been mixed. A few such as the Snohomish River stock continue to provide stable production and meet escapement goals while others such as those in the Skagit and Stillaguamish Rivers and some coastal stocks have somewhat consistently fallen below established escapement objectives.

Total harvest rate estimates for southern B.C. indicator stocks including four in Georgia Strait and one on the west coast of Vancouver Island averaged 76% (range 70-81%) and 64%, respectively. Very little information exists about the status of southern B.C. stocks. However, Fraser River escapements have shown a declining trend averaging about 1% per year since 1951 and 4% per year since 1970. There is also concern about the status of other Georgia Strait coho stocks. In addition to concern about overall escapement levels, there is some evidence of a loss in spatial diversity in coho salmon stocks in southern B.C. with an increasing proportion of the total documented escapement concentrated in fewer systems in recent years.

Although most stocks in southern B.C. and Washington have not deteriorated under heavy exploitation to the extent of Oregon stocks, managers are concerned about a slow, cyclic decline in abundance of coho salmon between the Columbia River and the northern end of Vancouver Island since the mid-1970's, particularly considering that hatchery contributions in that area have increased. This leads to the conclusion that overall natural stock abundance has declined.

Direct inferences should not be drawn between Southeast Alaska coho stock productivity and that of more southern stocks. Average productivity, expressed in terms of optimum harvest rates, may be lower for Southeast Alaska stocks due to harsher climatological conditions, particularly during freshwater life phases. However, given the above information on productivity of more southern coho stocks, and general productivity information on salmon in Alaska, it seems unlikely that optimum harvest rates for Southeast Alaska coho salmon would be higher than say 75-80% (equivalent to a range of 4:1 to 5:1 returns per spawner). Thus, while higher harvest rates may be sustainable, they may not generate maximum sustainable yield, particularly if they occur in years of low coho abundance.

Review of Management

General Management Approach

Coho salmon in Southeast Alaska are managed on the basis of perceived relative annual abundance. Catch and catch per unit effort information from various fisheries are used to assess run strength for inseason management. Regulations are implemented by emergency or field order for stock conservation, or to achieve allocation objectives established by the Board. Catch ceilings or quotas are not used for coho management as they currently are for chinook salmon in Southeast Alaska. Postseason assessment of management actions relative to conservation of coho salmon is made on the basis of observed spawning escapements and harvest rates for selected indicator stocks.

Contemporary salmon management is based on the fundamental principle that a relationship exists between the number of parent spawners and the surplus harvest which can be produced on a sustained basis. A salmon population can theoretically be sustained at a wide range of stock sizes, depending on the spawning escapement level and harvest rate. However, for each stock there is an "optimum" escapement level, and associated harvest rate, which maximizes the sustainable yield or harvest. The primary objective of management is usually to obtain the maximum yield by maintaining optimum escapement levels.

It should be noted that the "optimum" harvest rate is that rate which occurs when the stock is at optimum level, and the return surplus to the optimum escapement is harvested. If the stock size or return is smaller, the harvest rate must be reduced below the "optimum" harvest rate if the optimum escapement is to be achieved. If, for example, the total return is equal the optimum escapement, then no catch can be allowed, and the harvest rate would be zero if optimum escapement is desired. The basic management strategy used for Southeast Alaska coho salmon is intended to approximate escapement goal management, however, harvest rates are also used as management guidelines. Under strict harvest rate management, where a fixed optimum harvest rate is the management goal, annual escapements will vary from optimum escapements depending on annual run size fluctuations, but escapements are expected to trend toward an average optimum level over time. Strict harvest rate management will, by nature, usually result in more stable catches between years, but lower total yield over time.

Optimum escapements and harvest rates are directly determined from a time series of data relating parent escapements to subsequent production. This is generally referred to as a spawner/recruit or spawner/return relationship. Such relationships may be developed either for an individual stock, or for a management unit consisting of a number of stocks. Due to the high degree of variability generally characteristic of salmon spawner/recruit data, a relatively long time series of data, covering a wide range of escapements, is required.

Information necessary for describing spawner/recruit relationships are only now be acquired for a limited number of indicator coho stocks in Southeast Alaska. Studies initially begun in the early 1970's were directed primarily toward determining basic migratory information and harvest rate data for selected coho indicator stocks throughout the region. It is difficult and costly to obtain information required to determine optimum escapements for coho salmon in Southeast Alaska due to (1) the large number of coho salmon stocks (2) the difficulty of enumerating coho escapements which occur in the fall during extreme streamflow conditions, and (3) the difficulty of measuring coho production from known escapements. For management purposes, determination of optimum escapements or harvest rates must be made for a relatively large number of stocks representative of coho production in the region.

In the absence of information needed to determine stock specific optimum spawning goals, or optimum harvest rates, management of

Southeast Alaska coho stocks is currently based on the following general objectives:

(1) maintain coho escapements at near average levels for indicator stocks that have an adequate time series of data: in particular, ensure that declining escapement trends below average levels do not develop;

(2) maintain harvest rates for coded wire tagged indicator stocks within a range considered to produce maximum production and prevent overfishing based on general salmon stock productivity information;

(3) manage terminal or near-terminal coho directed fisheries to maintain average catch per unit effort levels as indirect indicators of subsequent coho escapements (that is, fishing effort is reduced if CPUE falls below average levels); this applies primarily to some drift gillnet fisheries, and to Yakutat set net fisheries.

Management of coho salmon in Southeast Alaska is difficult due to the highly mixed stock nature of most fisheries, lack of general stock identification techniques, and the existence of guantlet or serial fisheries operating on many stocks. Management is also complicated by the harvest of significant numbers of coho in net fisheries targeting on, and managed primarily for, other species. Because of the extensive delay between the time when fisheries are conducted and when coho move into rivers or streams where some direct assessment of spawning escapement can be made (Figure 6), inseason management is currently based primarily on relative catch per unit effort in the various fisheries. The relationship between fishery performance data and actual stock abundance can often be quite variable due to various factors affecting fleet efficiency and stock availability.

Review of 1988 Inseason Management

A review of the 1988 season provides a good illustration of how inseason management is implemented for coho salmon stocks in Southeast Alaska. The 1988 coho run was characterized by: (1)

extreme early season weakness in all fisheries; (2) continued weakness in most areas through the middle of the season or approximately mid-August; (3) improvement during late August and September in coho run strength to northern inside areas of Icy Straits, Stephens Passage and Lynn Canal; (4) continued weakness in coho returns to the central and southern portions of the region through the remainder of the season; and (4) development of near-record coho returns to the Yakutat area. The 1988 regionwide coho harvest of approximately 1,060,000 was the lowest since 1975 (Figure 22). (Alaska hatchery contributions declined from over 400,000 in 1986 to about 53,000 in 1988.)

Troll Fishery. The troll fishery is the primary coho directed fishery in Southeast Alaska, accounting for 60-65% of the region's coho harvest in most recent years. (In 1988, this percentage declined to about 48%.) Because the majority of troll effort occurs in outer coastal areas, the troll fishery provides the first inseason indication of overall coho run strength.

Opening of the 1988 summer troll season was delayed until July 1, compared with June 20 in 1986-87, because of chinook management considerations. Coho salmon catches by the troll fishery during the first three weeks of July were substantially below recent averages in most areas (Figure 35). Troll catch per unit effort rates obtained from the port sampling program indicated a similar pattern of weak coho abundance. Although the troll fleet had targeted primarily on chinook salmon through July 12 when the chinook season ended, coho catch rates were still much weaker than normally expected. These first indications of weak coho salmon returns were substantiated by poor early abundance in inside fisheries (Figures 36-45). In response, the Department implemented a 10-day troll closure July 25 through August 4. This closure, tentatively scheduled for the middle of August, was implemented earlier to provide more flexibility for stock assessment and to allow for implementation of additional conservation measures if required later in the season.

Since 1981, the Board has authorized the Department to implement a 10-day troll closure during the season, if required for conservation, or to better maintain the historical distribution of coho salmon catches between outside and inside fisheries. Criteria established by the Board to be used by the Department inseason to determine whether such a closure should be implemented are as follows:

(A) the Department determines that the number of coho reaching inside areas may be inadequate to provide for spawning requirements given normal or even restricted inside fisheries on coho and other species; the primary abundance indicators for this assessment consist of relative harvest levels by all fisheries and, in particular, catch per unit effort in inside drift gillnet and sport fisheries compared to 1971-80 averages; or

(B) the Department determines that the proportional share of the coho harvest by the troll fishery is larger than that of inside gillnet and recreational fisheries compared to average 1971-80 levels; primary inside fisheries for this assessment are overall coho harvests and catch per unit effort in the Tree Point, Prince of Wales, Taku/Snettisham, and Lynn Canal drift gillnet fisheries and the Juneau marine sport fishery.

Following reopening of the troll fishery on August 5, coho catch rates in the troll fishery and inside indicator fisheries did not improve substantially (Figs. 35-45). Subsequently, a second 10-day troll closure was implemented during August 15-24.

After mid-August, coho abundance indicators for some inside fisheries, and troll test fishing in Icy Straits, began to show improvement. Consequently, a 7-day troll opening was announced for August 25-31. This opening was intended to provide additional information for a regionwide assessment of coho run strength development.

Assessment of coho salmon run development through the end of August indicated a continued weakness of coho returns to central and southern areas of the region, while returns to the northern area and Yakutat continued to improve. As a result, central and southern areas of the region were closed for the rest of the season. Trolling was reopened September 4 in northern Districts

112, 114, 116, and in the Yakutat area for the remainder of the season which closed mid-night September 20.

Troll restrictions implemented in 1988 for coho conservation were the most extensive of any season to date. The 1988 troll harvest of approximately 500 thousand coho salmon was the smallest catch since 1975.

Net Fisheries. Approximately 30-40% of the region's coho salmon harvest is usually taken in commercial net fisheries. Most of the net coho harvest occurs during late August and September as coho move inshore en route to spawning areas (Figure 6). Coho salmon are harvested both in coho directed net fisheries, and as incidental harvest by net fisheries targeting on other species. The primary incidental harvest occurs in the purse seine fishery which targets on pink, chum and sockeye salmon, but still accounts for about 15-20 percent of the region's coho harvest. The drift gillnet fisheries in District 106 (Prince of Wales) and District 108 (Stikine) are managed primarily for coho salmon during the fall season, while District 111 (Taku/Snettisham) is managed for both coho and fall chum salmon stocks depending on relative run sizes, while District 101 (Tree Point) and District 115 (Lynn Canal) are managed primarily for fall chum salmon. In the drift gillnet fisheries that are managed primarily for other species, it is still possible to implement some time/area closures for coho salmon conservation. The fall Yakutat set gillnet fisheries, which are conducted mostly inriver, are managed primarily for coho salmon.

Substantial time/area closures were implemented for coho salmon conservation in drift gillnet fisheries during 1988. The most extensive actions were taken in District 108 (Stikine) where the traditional fall coho salmon fishery was closed entirely, and in District 106 (Prince of Wales) which was closed during September when most of the directed coho harvest occurs. Nighttime closures and shortened fishing weeks were implemented for coho salmon conservation in District 101 (Tree Point) beginning in late August. Some time/area adjustments for coho conservation were also made in the District 115 (Lynn Canal) drift gillnet fishery, although this fishery was managed primarily for fall chum salmon. The 1988 drift gillnet harvest of 165 thousand coho salmon was the lowest since 1981.

Set gillnet fisheries in Yakutat were managed in response to exceptionally strong 1988 coho returns to that area. The set gillnet harvest of 206 thousand coho salmon was the largest since 1954 when 267 thousand coho were harvested.

Recreational Fisheries. Approximately 3 percent of the region's coho salmon harvest is taken in recreational fisheries in both marine and freshwater areas. The marine fishery and catches in most freshwater systems are regulated primarily by gear limitations and a general regionwide daily bag limit of six fish (12 in possession). The bag limit is restricted to two fish in certain more accessible freshwater systems.

On August 26, 1988, the regionwide bag limit was reduced by emergency regulation (effective September 1) to 2 fish per day in response to indications of weak coho salmon returns throughout the region. Exceptions to this restriction were made for the immediate areas around several enhancement sites in southern Southeast. At that time, the cumulative catch by the Juneau and Ketchikan marine fisheries was 40 percent and 25 percent of average, respectively (Figures 44 and 45). Subsequent information collected through August 31 indicated that abundance had increased substantially in northern inside areas. Therefore, the daily bag limit in Stephens Passage, northern sections of Frederick Sound, Lynn Canal, Icy Strait, and northern sections of Chatham Strait was returned to six fish effective September 2, while the emergency restriction remained in effect for the rest of the region throughout the remainder of the season.

The Chilkoot River drainage upstream of the weir was closed to sport fishing for coho salmon by emergency order on October 7 in order to protect fish that were holding in the river above the weir, thereby increasing spawning escapement.

DISCUSSION

Overview of Management Considerations

The Southeast Alaska coho salmon resource presents an extremely complex fishery management problem. This complexity is inherent in both the resource, itself, and in the diversity of resource users and harvesting methods. Progress toward achieving improved management and higher sustained yields is hindered by a lack of information on the resource combined with delicate allocation balances that can be affected by changes in management.

Information on the status and productivity of the stocks is, at this point, surrounded by a large amount of uncertainty and, therefore, so is the proper course of action to achieve improved benefit from the resource. It is important that managers, including the Board and management staff, fully consider available information in making management decisions while keeping in mind its limitations and remaining uncertainties.

Available catch and harvest rate information indicates that, overall, the Southeast Alaska coho salmon resource is close to full utilization but there is currently no convincing evidence that any stocks are being chronically overfished. The lack of evidence of chronic stock conservation problems is probably attributed, to some extent, to an overall lack of stock status information. Some stocks are undoubtedly fished beyond optimum levels in some years but there is no evidence of continual overfishing or that harvest rates have been higher than optimum for the overall mixture of stocks. Harvest rates have averaged close to 60%, while ranging from about 40% for some stocks to as high as 85-90% for others. Available information for the most heavily harvested populations in Lynn Canal has not yet provided any indication of overall stock depletion or loss of production due to overfishing. However, indirect evidence indicates that recent harvest rates on Lynn Canal stocks are probably somewhat higher than pre-1980's levels while conditions for survival have apparently been favorable in most recent years. Therefore, it is still unknown if recent harvest rates would result in substantial overfishing and depletion of these stocks under less favorable survival conditions. Near-terminal fishery catches for some other systems such as the Taku River have shown a relatively stable overall production trend, not withstanding interannual fluctuations related to environmental variables. Available information from Oregon, Washington and Southern B.C. indicates that, at higher harvest rates averaging close to 80%, conservation problems are evident for a number of wild coho salmon stocks while others have remained productive and have shown no signs of depletion. Serious conservation problems have developed for Oregon wild stocks that were managed for many years under relatively unrestricted ocean fishing. In addition, the total abundance of wild stocks in Washington and southern B.C. has been slowly declining under harvest rates averaging near 80%.

It is risky to use what little objective information currently exists on stock productivity to manage the overall mixture of stocks in the region at the very high harvest rates that have apparently been sustained by some coho stocks. The nature of mixed stock fisheries indicates that similar levels of sustained yield can be maintained over a range of harvest rates. Many stocks in Southeast could undoubtedly sustain substantially larger average harvests than they have incurred in recent years. However, allowing increased harvest rates on some stocks would likely result in depletion of others that are currently harvested at very high rates, are generally less productive, or are at low production levels because of sequential years of unfavorable environmental conditions. While it may be possible to maintain higher average catches under a somewhat higher average harvest rate, total resource abundance would likely decline as production from overfished stocks declines and the harvest becomes more concentrated on fewer stocks. This would result in decreased harvest shares for those user groups that depend on the more heavily fished stocks that are subjected to gauntlet fisheries and would necessitate expending increased fishing effort to extract a marginally increased harvest from a smaller total resource. Fishing on mixed stocks at sustained high harvest rates without an adequate ability to evaluate the impacts involves substantial risks of resource depletion and unsustainable expectations by resource users.

The fishery structure that most closely optimizes use of the resource is a topic of continued debate among resource users and managers. A theoretical optimum yield can be obtained by harvesting each stock at a variable rate that optimizes escapement each year and maximizes future harvest. The management strategy that achieves this theoretical optimum yield would preclude fishing in mixed-stock fisheries so that the harvest rate for each stock can be individually set at any level down to zero, as appropriate, based on total return strength. Achieving optimum potential yield from all stocks requires that managers have "perfect" information on abundance and optimum escapement levels for individual stocks and that the fisheries can be regulated to precisely achieve optimum escapement. However, the reality facing managers of the Southeast Alaska coho salmon resource is that optimum escapement is currently unknown for any stocks, while obtaining reliable inseason information on total run strength of individual stocks would require eliminating most marine fisheries and confining fishing to specific terminal areas at stream mouths or instream. The closest example of such a fishery structure exists for Yakutat set gillnet fisheries, several of which can be effectively managed for individual stocks using fishery performance data and inseason stream surveys. This type of true terminal fishery could theoretically be established on a few other medium to large producing systems in Southeast Alaska. However, terminal fisheries for the thousands of smaller producing streams would be very costly and difficult to manage. Furthermore, the drastic social and economic impacts of such a management approach on existing fisheries and resource users would preclude its use. Given a limited ability to assess stock strength inseason and very little information on stock productivity, an appropriate management strategy is to distribute fishing pressure relatively evenly over all stock groups while managing for fixed escapement levels for individual stocks to the extent possible, and ensure that overall harvest rates are maintained at intermediate, sustainable levels.

With the exception of some commercial setnet, freshwater sport and subsistence fisheries, virtually all fisheries that harvest coho salmon in Southeast Alaska are highly mixed-stock in nature. Included are all of the traditional troll, drift gillnet, purse seine and marine sport fisheries including some such as the Lynn

Canal and Taku-Snettisham drift gillnet fisheries that are commonly considered to be more terminal in nature. All of these fisheries harvest mixtures of dozens to thousands of intermingling stocks that are characterized by different productivities and relative return strengths. Theoretically, stocks that are located in close proximity are affected by similar conditions, show similar trends in production and, therefore, can be managed somewhat in common. However, available information indicates a high degree of variability in run strength and escapement exists within even relatively limited geographical areas such as Lynn Canal, the Juneau roadside and Taku River tributaries. In addition, fishery performance in all fisheries is highly affected by interannual variations in the migratory behavior of returning stocks. For example, fishery and coded-wire tag data from recent years indicates that fishery performance in the Lynn Canal drift gillnet fishery is heavily affected by variations in timing of entry into the fishery and milling behavior of the stocks as well as overall abundance. In some cases, high early-season catch rates may indicate high harvest rates more than high abundance. Similarly, troll harvest rate estimates for indicator stocks in 1986 indicate that exceptional early season catches not only reflected very strong overall abundance, but probably an earlier than normal arrival of most stocks in the troll fishery accompanied by a longer period of availability and, consequently, increased harvest rates. Conversely, it appears that the 1988 return was not only very weak for many stocks, but was late in arriving in the troll fishery.

This information is presented to point out the complexities, uncertainties and risks involved when managing Southeast Alaska coho stocks inseason. All fisheries naturally evolve to higher levels of efficiency to the extent permitted by law through increased experience, competition and investments in new technology. As the fisheries become more effective at harvesting a larger proportion of the total resource, the need for quickly available, accurate management information becomes much more critical. Acquisition of this information is a slow, expensive process that cannot always keep pace with changes in the fisheries. Never-the-less, proceeding to higher levels of fishing without this information puts at risk a very productive, valuable natural resource that has demonstrated an ability to consistently produce under sustained moderate-to-high exploitation rates. Because of its highly complex nature, acquiring the level of information needed to manage the Southeast Alaska coho salmon resource for optimum yield is very costly. Current research programs are expected to provide managers with an improved understanding of the resource and fisheries impacts to better meet current management objectives and, eventually, provide a better understanding of the productivity of some specific stocks under different management techniques. Improvements in managers' ability to collect and accurately interpret inseason information to better distribute escapement to all stocks in the region are expected to result in higher average yields.

The trend since the late 1970's for the troll fishery to harvest a larger proportion of the catch in outside and offshore waters has been a controversial topic among fishery managers and resource users. There are a number of factors to consider in evaluating this trend. All stocks in the region intermingle and feed in outside and offshore waters and, therefore, most are harvested at relatively similar rates by the troll fishery (averaging 40-45%). While concentrating troll effort in outside areas results in a relatively even distribution of the harvest over all stocks, it also makes it more difficult to manage individual stock groups on the basis of inside fishery performance indicators because a large proportion of the return is harvested before these indicators become useful. Catches in outside waters, particularly in more offshore areas, come from a composite of all stocks from Yakutat through northern B.C. (only minor contributions occur from stocks in southern B.C., Washington and Oregon.) Available information indicates that, even in years of very high overall coho salmon abundance in outside and offshore waters, returns to different parts of the region are usually highly variable, with at least some stocks being relatively weak. To realize the harvestable production from all systems in Southeast Alaska, a substantial amount of fishing effort must occur in outside districts where outer coastal stocks are available. However, if harvest rates are allowed to increase in outside and offshore waters without a commensurate reduction in inside and corridor areas, there is a danger of depleting important inside stock groups by allowing them to be heavily fished throughout their return migration. Available coded-wire tag data indicates that outer coastal stocks are currently being substantially utilized while average troll harvest rates for northern inside area stocks have probably increased to close to pre-restriction (before 1979) levels in years when no emergency restrictions have been implemented.

Available information also suggests that most stocks should continue to be harvested at an average overall rate similar to that of the past few years, but that harvest rates in the more mixed-stock fisheries should not be allowed to increase above peak 1986 levels, even in years of very high total abundance. In addition, stocks that are heavily fished in certain intensive fall drift gillnet fisheries need to be closely monitored to evaluate their status under the effect of recent increases in gear efficiency, and in some cases, total effort (boat-days). Fishing effort should be adjusted inseason to the extent that run strengths and weaknesses for specific stock groups can be identified, toward the objective of maintaining escapements near interim objectives based on historical levels. Available information on the migration patterns of specific stocks has, on a very limited basis, allowed the Department to selectively manage for major stock groups in the troll fishery when strengths or weaknesses could be identified early enough in the season. Some drift gillnet fisheries are more easily managed for more specific coho stock groups while others are complicated by a highly mixed-stock, mixed-species nature. It is important to recognize the limitations in our current ability to manage the resource for fixed escapement levels and to maintain an overall fishery structure that does not present substantial risks of overfishing when managers fail to identify stock weaknesses.

In order to best utilize the resource and meet the needs of the various user groups, it is essential to develop a management strategy that is based on specific stock groups and takes into consideration all fisheries that harvest those groups. Currently, the Department recognizes and attempts to manage for several major groups of coho salmon stocks in the region. Each of these groups or management units represents a number of stocks with similar geographic locations, migration patterns and environmental conditions. The stocks within each unit are harvested in common by the same fisheries at similar rates.

Developing an improved management strategy for Southeast Alaska coho salmon under this concept of management units requires that: (1) inseason and post-season stock assessment programs be conducted for each unit including collecting fishery performance, coded-wire tag, age and escapement data, (2) this information is analyzed and interpreted and (3) a management plan is developed that specifies objectives for each stock unit and regulatory actions that are to be taken to meet those objectives. The Department is currently undertaking programs to best meet the first two requirements with available funds. However, developing a management plan requires the active participation of the Board and user groups to insure that allocation issues and other questions relating to the conduct of the fisheries are fully addressed. These issues need to be addressed in order to fully explore available options and develop an improved management program. Therefore, the Department recommends that a framework management plan be developed for Southeast Alaska coho salmon.

Information Needs

Fishery Performance Indicators and Coded-wire Tag Data Analysis

Currently, coho salmon management in Southeast Alaska relies almost totally on inseason fishery performance data to determine overall abundance and assess run strength to different parts of the region. Therefore, it is important to continue to develop comparable, meaningful indicators and to use the information from these indicators in a timely fashion. Fishery performance, as an indicator of run strength, can be distorted by changes in effort levels, fleet efficiency, and the relative contribution by hatchery stocks. One of the Department's objectives is to evaluate changes in fleet efficiency to maintain comparable indices of run strength and, where possible, to determine how these indicators interrelate and how well they reflect actual abundance. This requires accounting for hatchery production in both historical and inseason data sets.

Currently, a major limitation in management of coho salmon stocks is a very limited ability to assess run strength to specific parts of the region early enough in the season to take effective action to insure an even distribution of escapement. Some aquaculture managers are using coded-wire tag data from the troll fishery in late July and early August to predict overall run strength of southern Southeast hatchery stocks. Coded-wire tag data for wild stocks and other hatchery stocks should be examined to determine its potential to supplement fishery performance data as an inseason indicator of stock strength.

Continued collection and analysis of coded-wire tag data for indicator stocks in needed to further our understanding of the migratory behavior of coho salmon stocks and the effects of the fisheries. A more thorough analysis of coded-wire tagged hatchery coho stocks can provide additional information on harvest rate patterns.

Escapement Assessment and Goal Development

The current escapement assessment program needs to be expanded and refined to accurately assess escapement trends throughout the region. In addition, intensive investigations of escapement and production for a subset of indicator stocks in different types of systems needs to be expanded to better determine stock-recruitment relationships and appropriate management strategies for Southeast Alaska coho salmon stocks.

Forecast

Development of an accurate and precise forecast of coho salmon returns would be highly useful for both management and the fishing industry. However, at present it appears to have a relatively poor chance of success because of the large number of variables that affect returns and lack of estimates of total return. Never-the-less, preliminary investigations indicate that some environment factors including precipitation\streamflow patterns and coastal upwelling are correlated to some extent with coho salmon catches. Returns of jacks (0-ocean age fish) form the basis of a relatively reliable forecast for Oregon coastal and Columbia River stocks, but available information on jack returns in Southeast Alaska is very limited. Data that is currently being collected for several indicator stocks should further our understanding of factors affecting returns. Existing information needs to be analyzed in more detail to better determine the feasibility of forecasting coho salmon returns to Southeast Alaska.

High Seas Fisheries

Recently available information indicates that large numbers of salmon, of which some are probably of Southeast Alaska origin, are being taken by high seas fisheries. More information on the effects of these fisheries is needed to accurately assess their impact on catches and escapements of coho salmon in Southeast.

Table 1. Percent change of 1988 coho salmon escapement indices in Southeast Alaska from historical averages.

Area	Period of Average	Index Ave.	Index 1988	Percent Change
Ketchikan				
Survey index	1983 - 1987	1,912	698	- 63%
Hugh Smith Lake Weir	1983 - 1987	1,468	513[1]	- 65%
Sitka				
Survey index	1981 - 1987	639	108	- 83%
Salmon Lake Weir	1983 - 1987	946	680	- 28%
Ford Arm Lake Weir	1982 - 1987	2,034	3,028	+ 48%
Juneau				
Survey index	1981 - 1987	1,030	578	- 43%
Auke Creek weir	1981 - 1987	676	756	+ 12%
Lower Lynn Canal				
Berners River survey	1974 - 1987	4,117	2,724	- 34%
Upper Lynn Canal				
Chilkat/Chilkoot weirs	1981 - 1987	1,793	2,745	+ 53%
Yakutat area surveys				
Situk River	1973 - 1986	5,930	11,000	+ 85%
Tawah Creek	1973 - 1987	3,703	1,600	- 57%
Tsiu/Tsivat Rivers	1973 - 1987	26,007	16,000	- 62%

[1] Preliminary

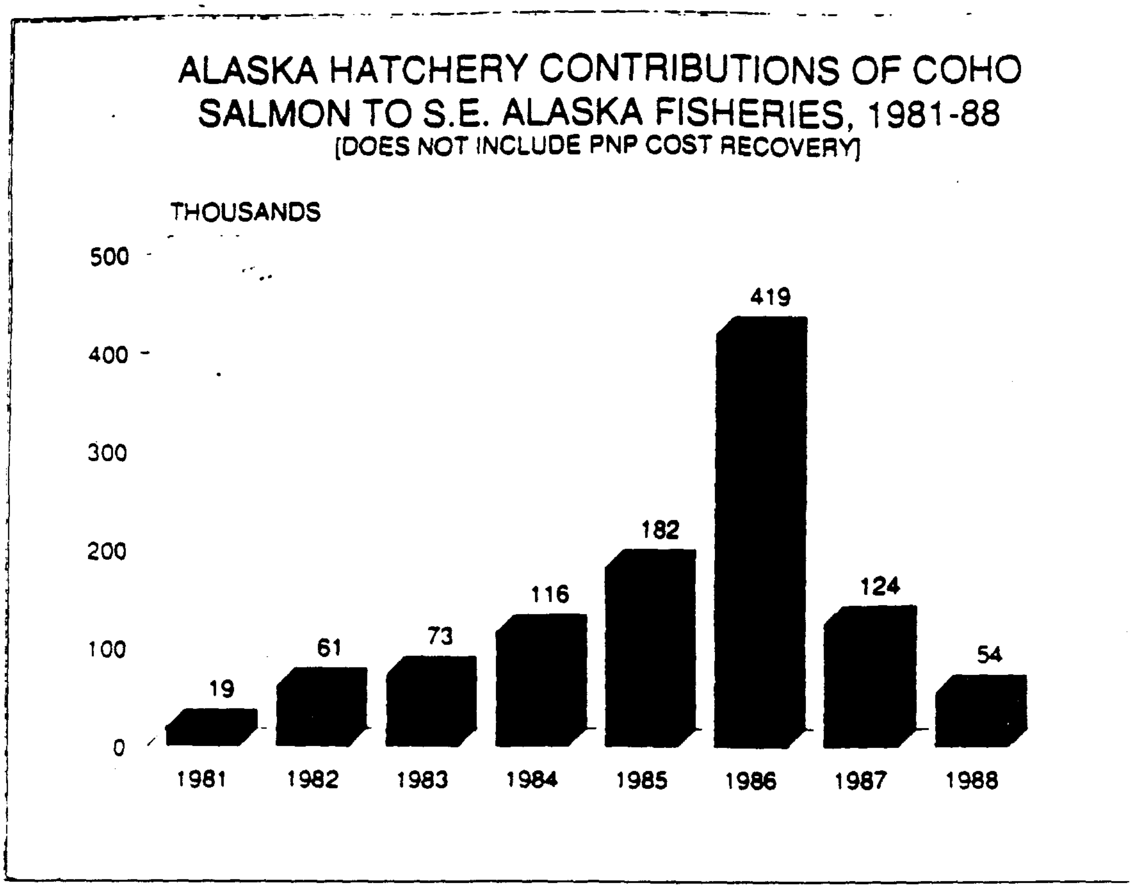


Figure 1. Alaska hatchery contributions of coho salmon to Southeast Alaska fisheries, 1981-1988.

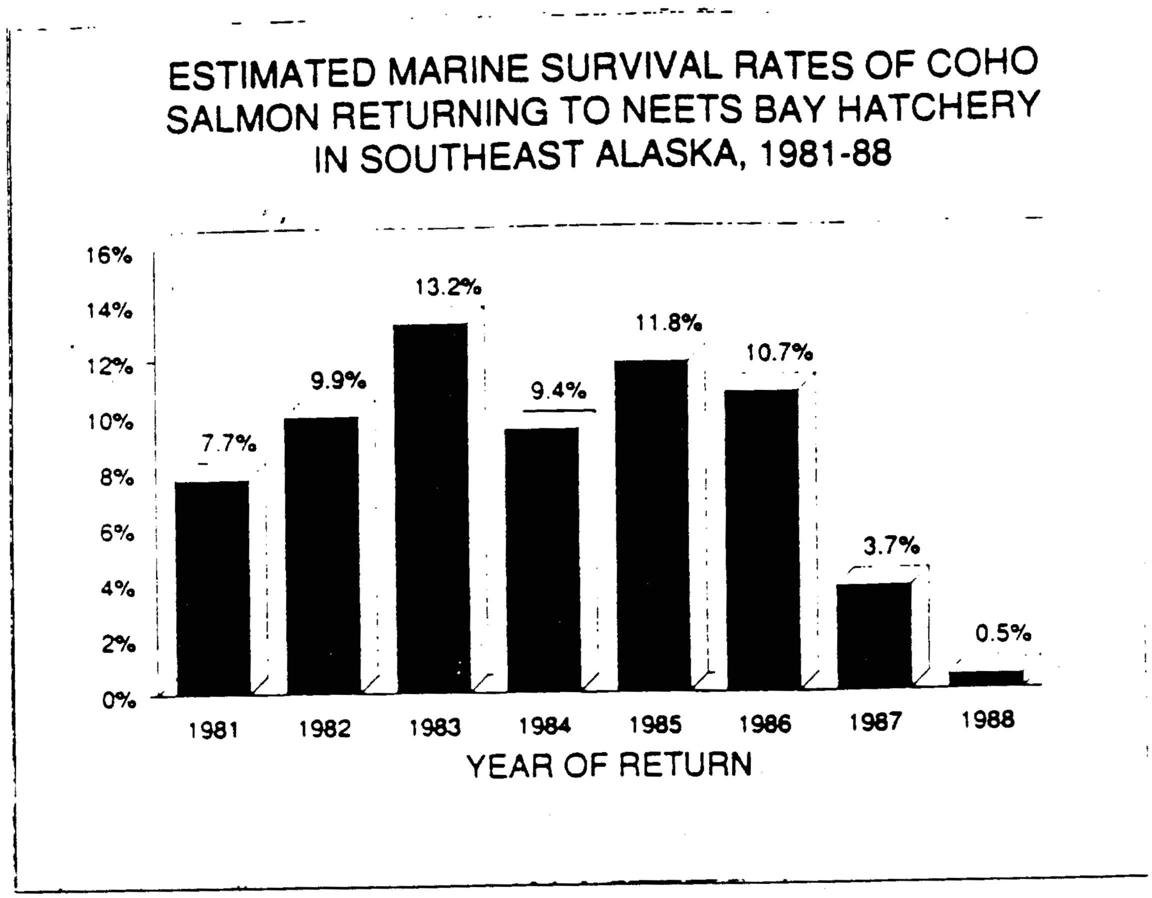


Figure 2. Estimated marine survival rates of coho salmon returning to Neets Bay Hatchery in Southeast Alaska, 1981-1988 (Gary Frietag, Southern Southeast Regional Aquaculture Association, pers. comm.).

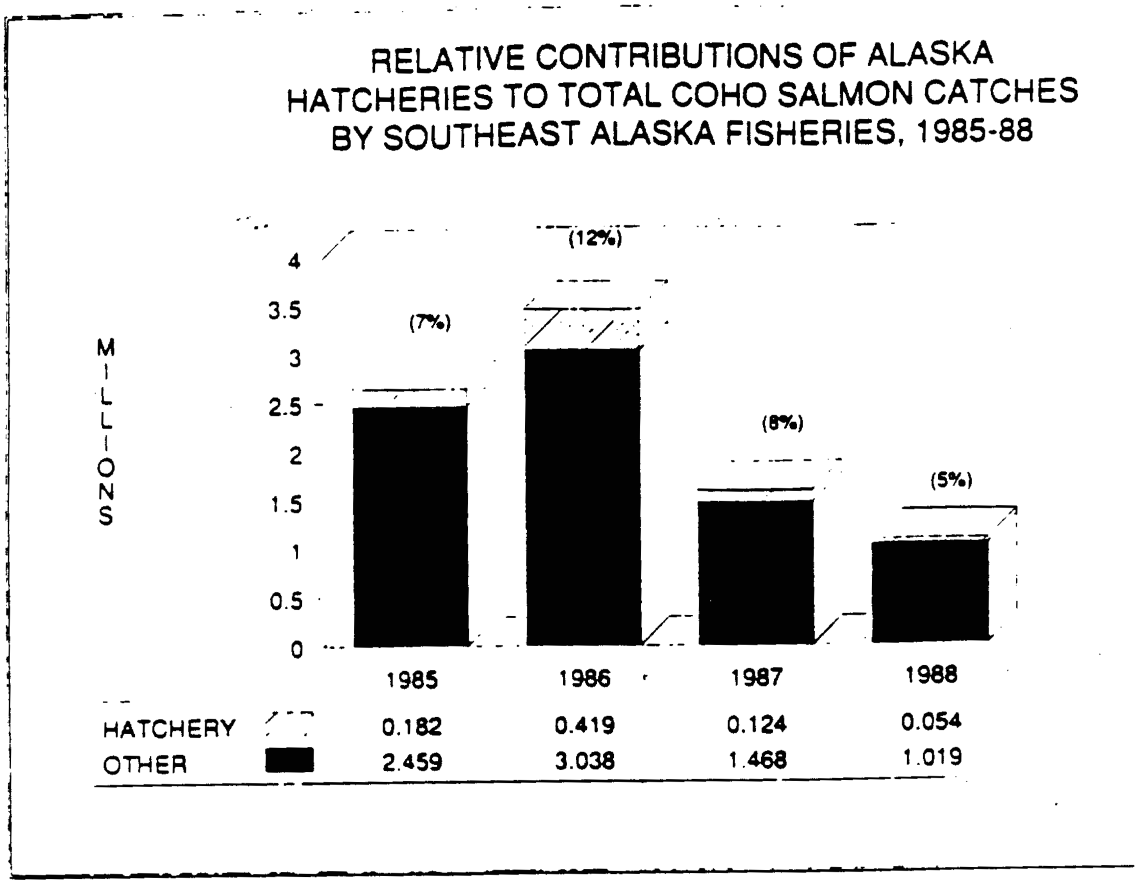


Figure 3. Relative contributions of Alaska hatcheries to total coho salmon catches by Southeast Alaska fisheries, 1985-1988.

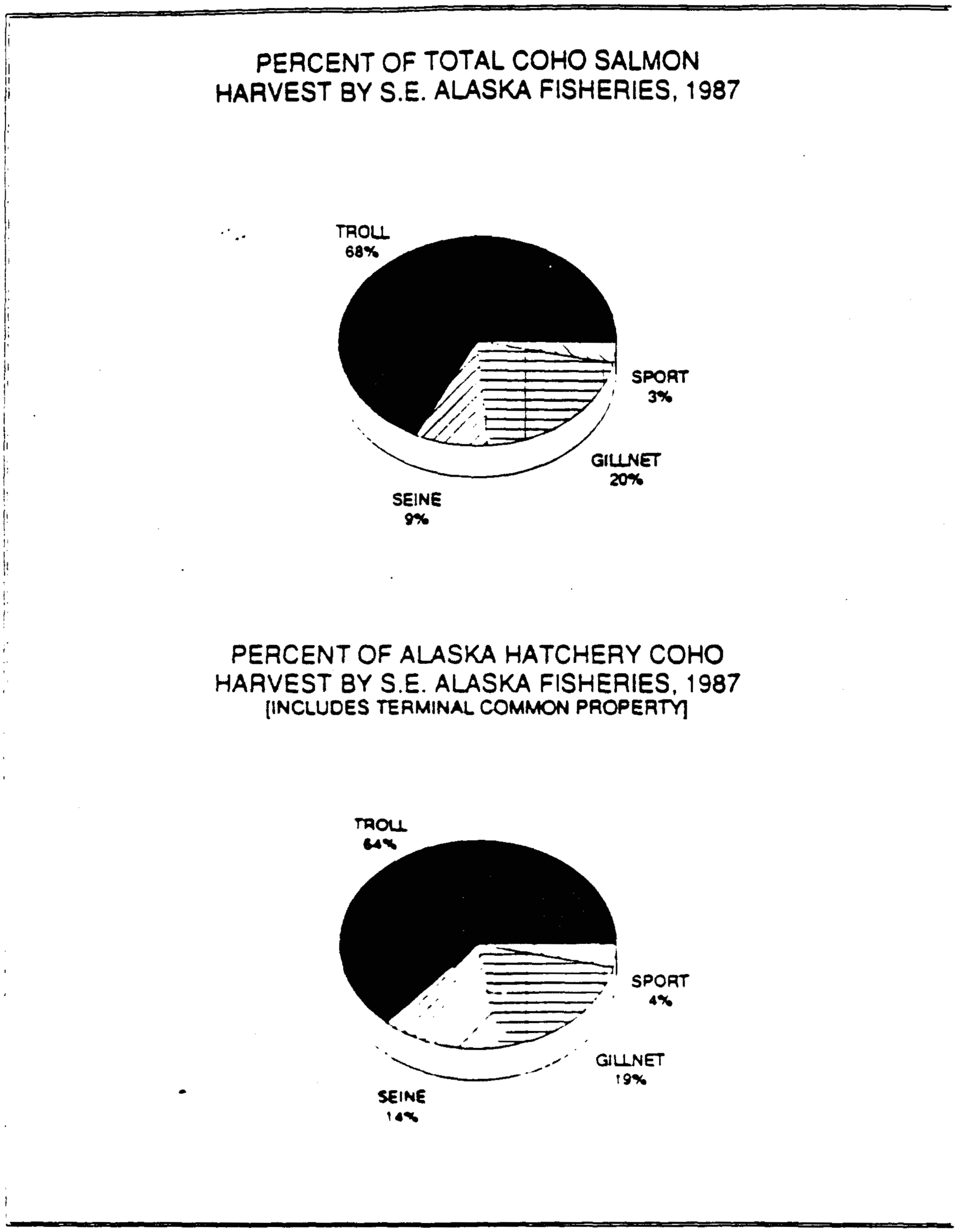


Figure 4. Distribution of the total Southeast Alaska commerical coho salmon harvest and the harvest of Alaska hatchery coho salmon by gear type, 1987.

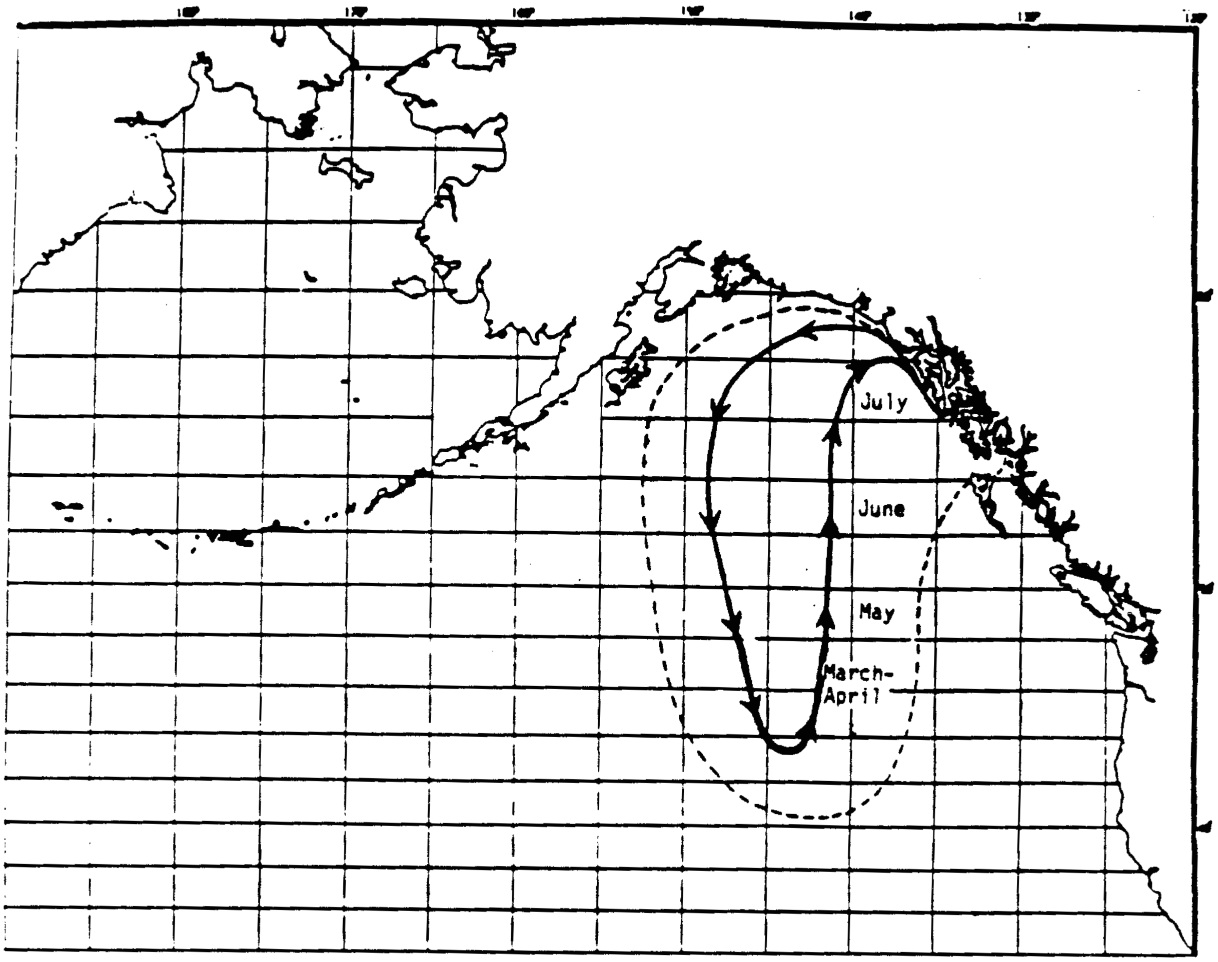


Figure 5. Ocean migration patterns of Southeast Alaska coho salmon based on coastal and high seas tagging and test-fishing studies.

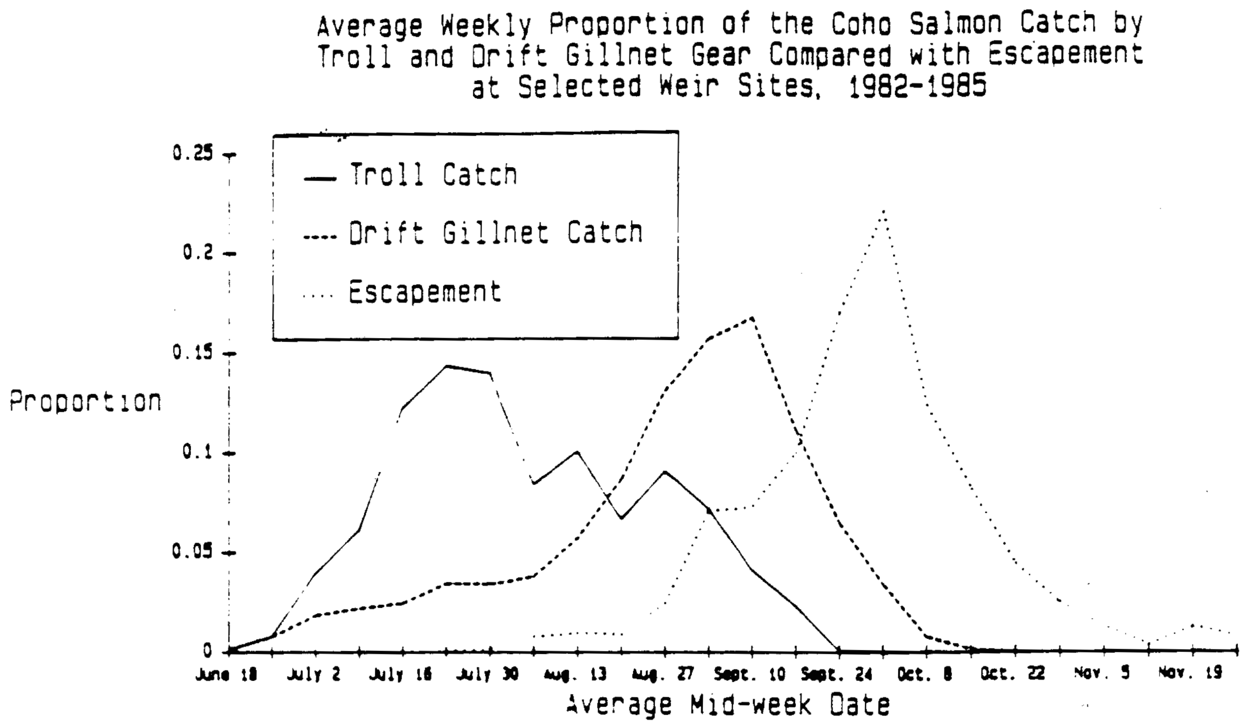


Figure 6. Average timing distribution of coho salmon in the Southeast Southeast Alaska troll and drift gillnet fisheries and at selected weir sites, 1982-1985.

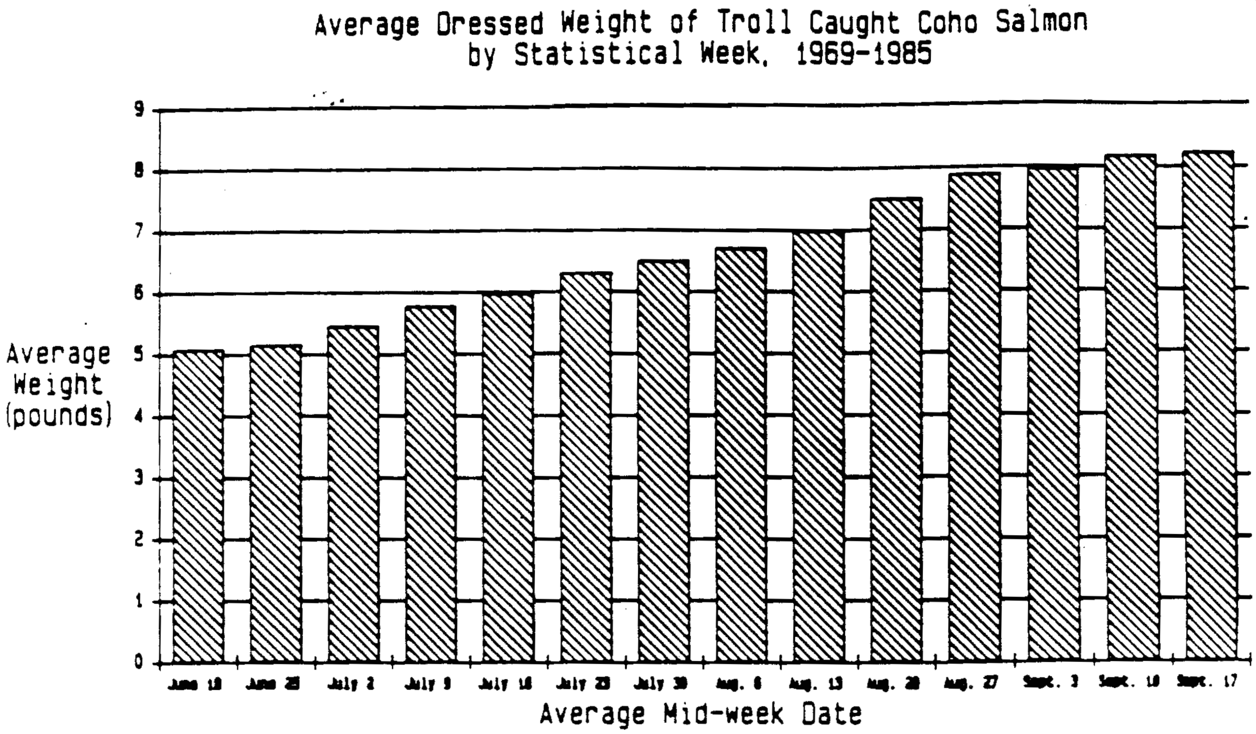


Figure 7. Average dressed weight of coho salmon harvested by the Southeast Alaska troll fishery by week, 1969-1985.

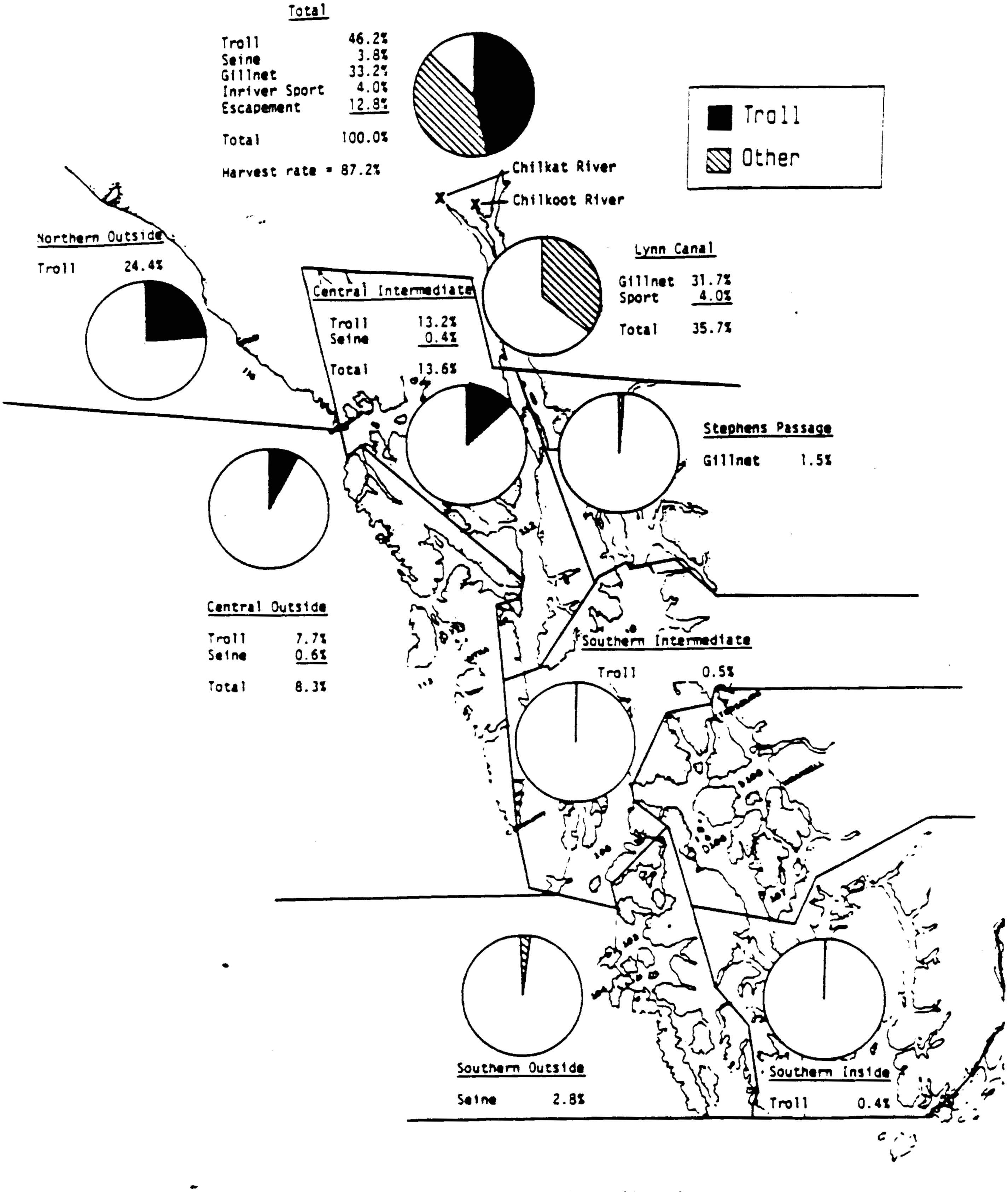


Figure 8. Estimated average harvest distribution and escapement as a percentage of the total return of coded-wire tagged coho salmon to Upper Lynn Canal systems (Chilkoot and Chilkat Rivers), 1983.

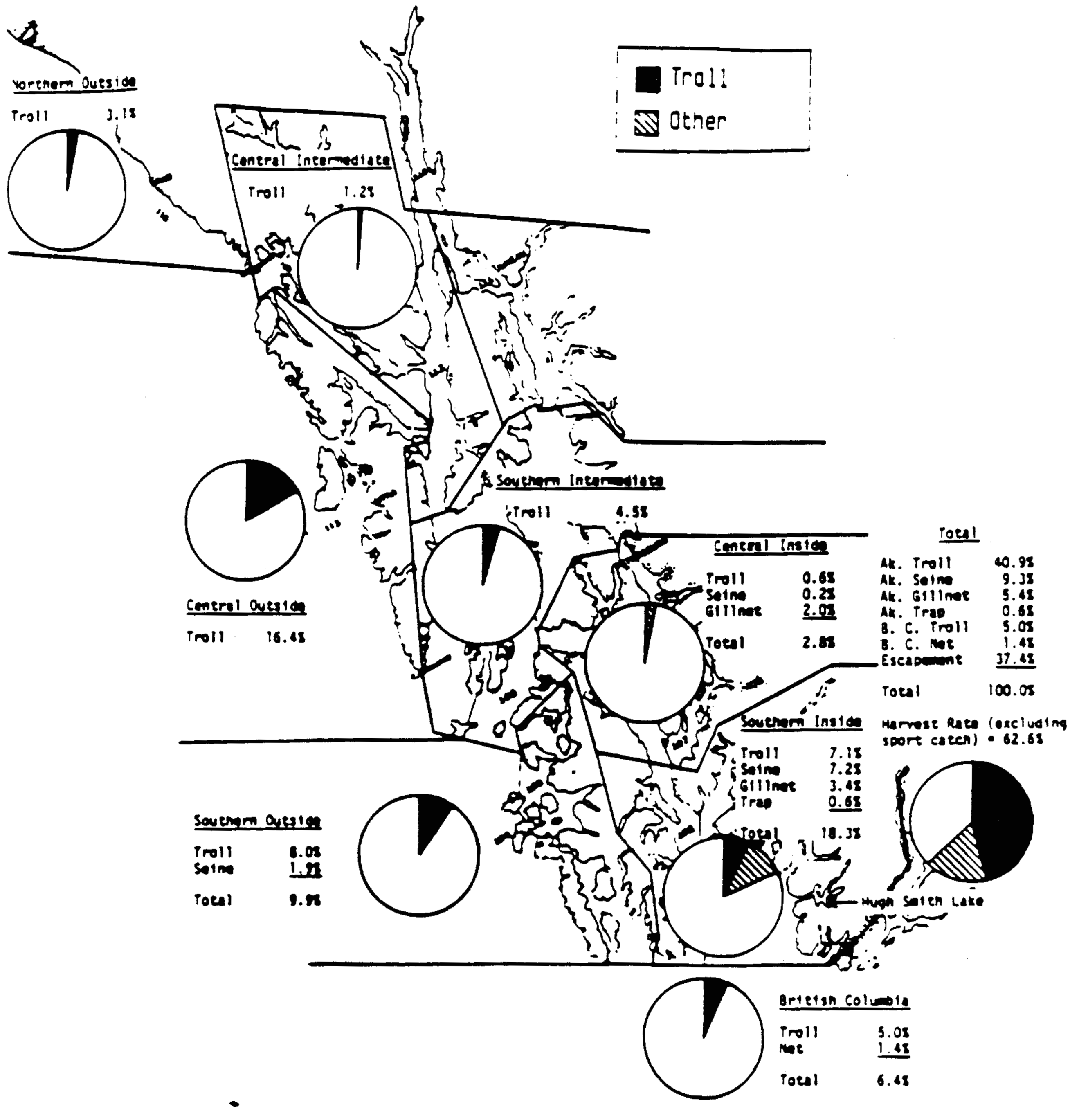


Figure 9. Estimated average harvest distribution and escapement as a percentage of the total return of coded-wire tagged coho salmon to Hugh Smith Lake in the southern inside area, 1982-1983.

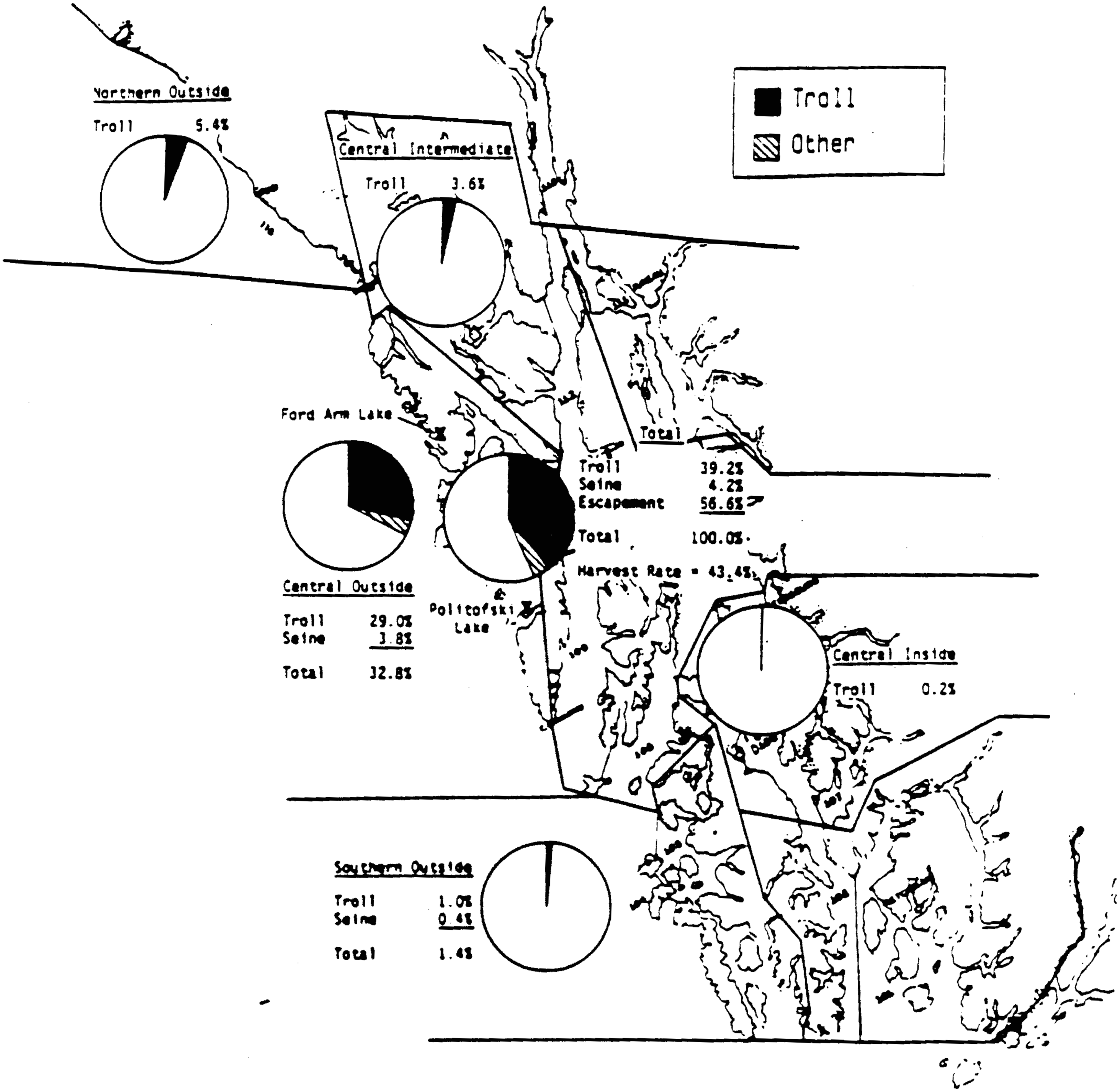


Figure 10. Estimated average harvest distribution and escapement as a percentage of the total return of coded-wire tagged coho salmon to Ford Arm Lake and Politofski Lakes on the central outside coast, 1982-1983.

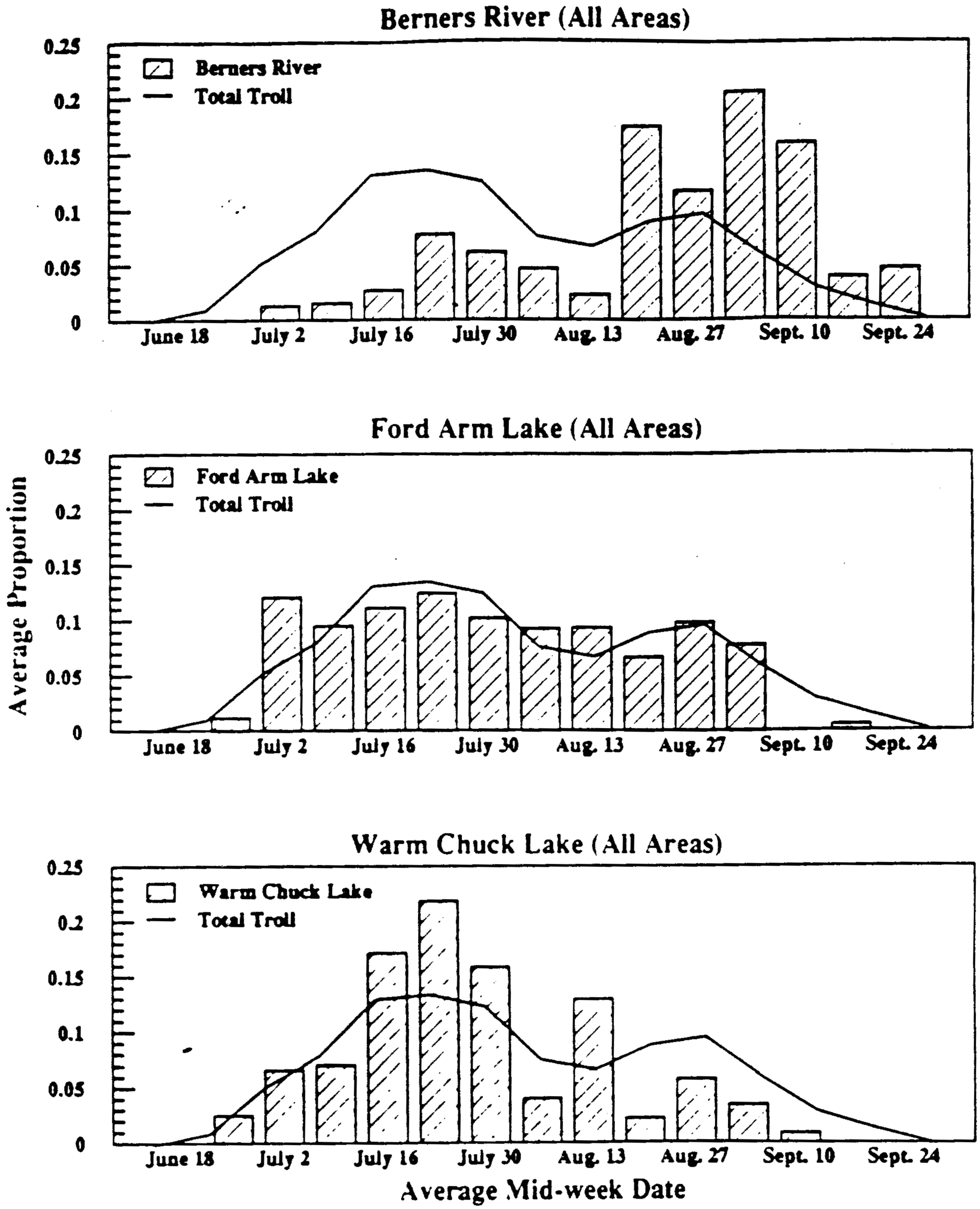
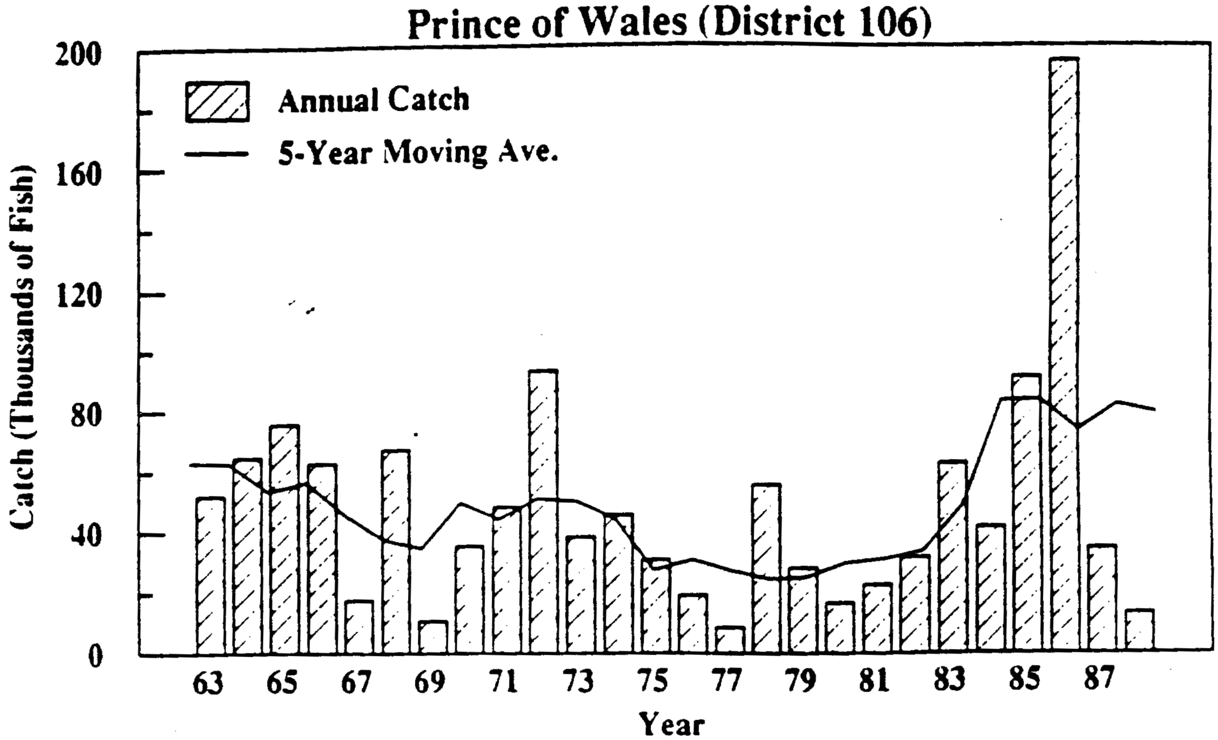


Figure 11. Average weekly proportion of the total coho salmon troll catch (line graph) and estimated troll catch of coded-wire tagged coho salmon from the Berners River, Ford Arm Lake and Warm Chuck Lake (bar graph) in Southeast Alaska, 1982, 1983 and 1985-1987.



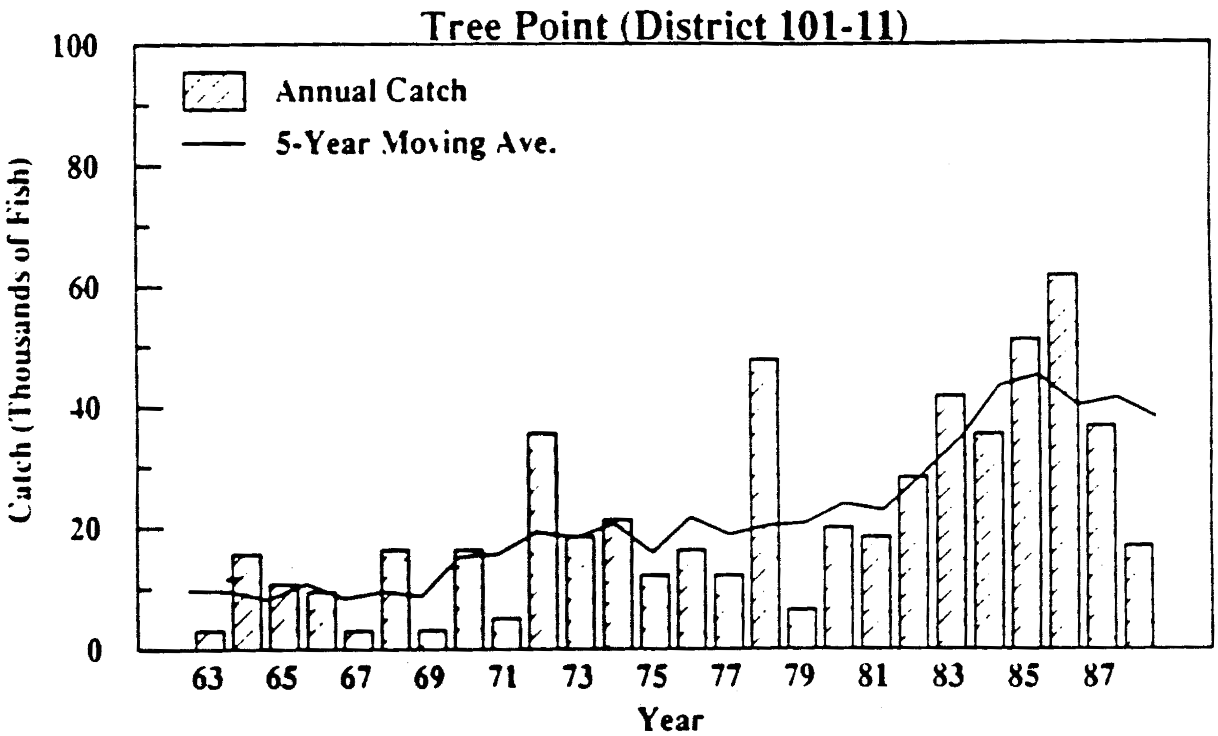


Figure 12. Total annual coho salmon harvest by the Tree Point (District 106) and Prince of Wales (District 101-11) drift gillnet fisheries and 5-year moving averages, 1963-1988.

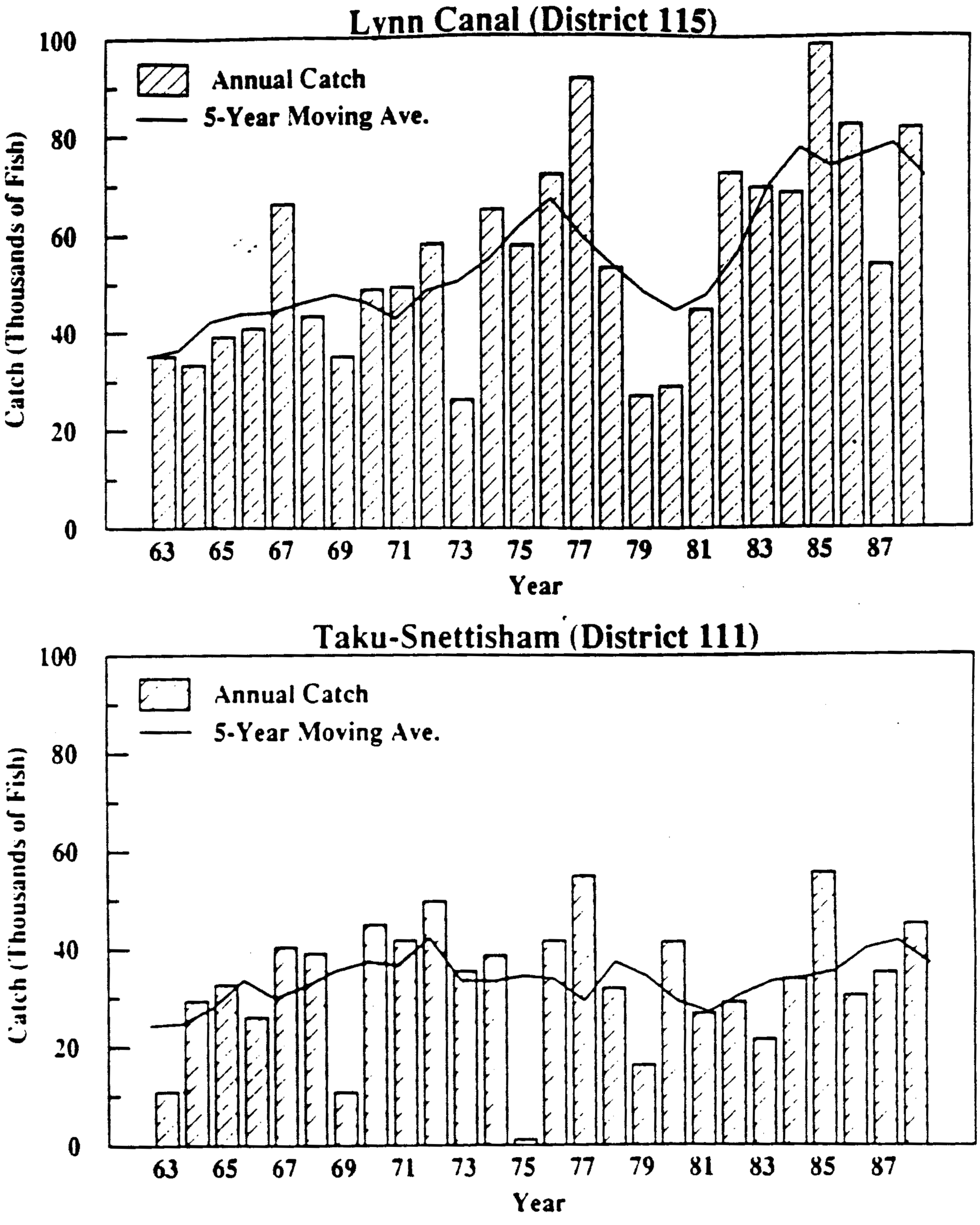


Figure 13. Total annual coho salmon harvest by the Lynn Canal (District 115) and Taku-Snettisham (District 111) drift gillnet fisheries and 5-year moving averages, 1963-1988.

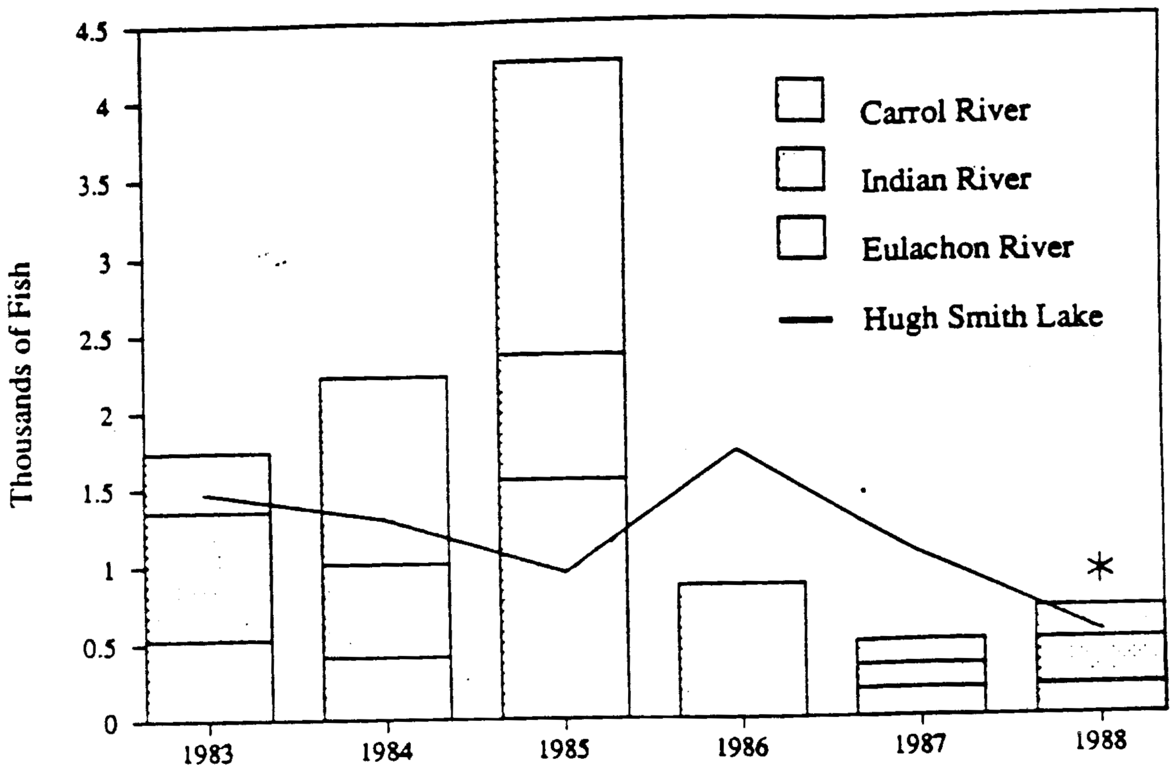


Figure 14. Peak coho salmon survey counts for three streams in the Ketchikan area, 1983-1988 compared with total estimates for Hugh Smith Lake. Carrol and Indian Rivers were not surveyed in 1986. The 1988 estimate for Hugh Smith Lake is preliminary.

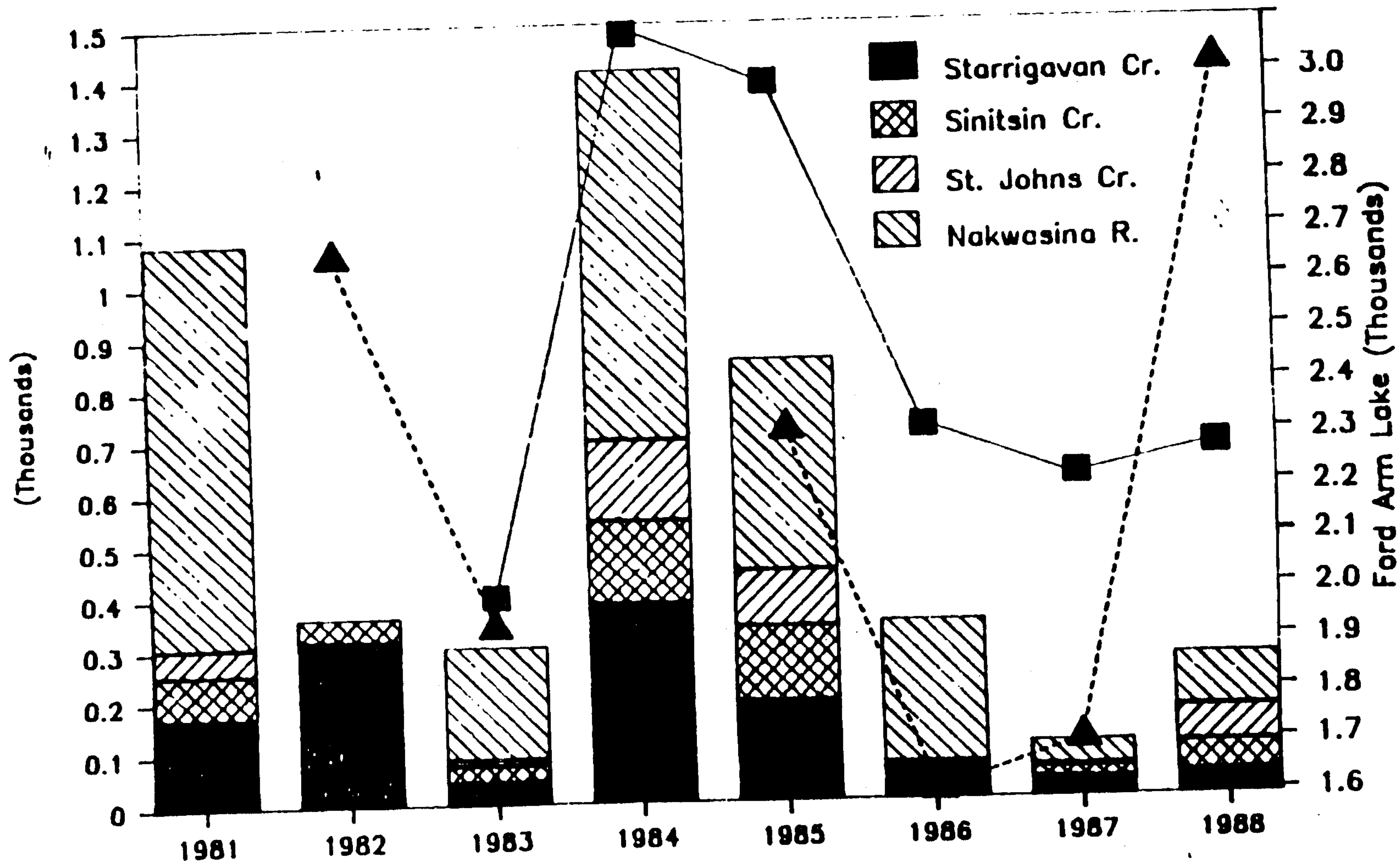


Figure 15. Peak coho salmon survey counts for three streams in the Ketchikan area, 1983-1988, compared with total estimates for Hugh Smith Lake.

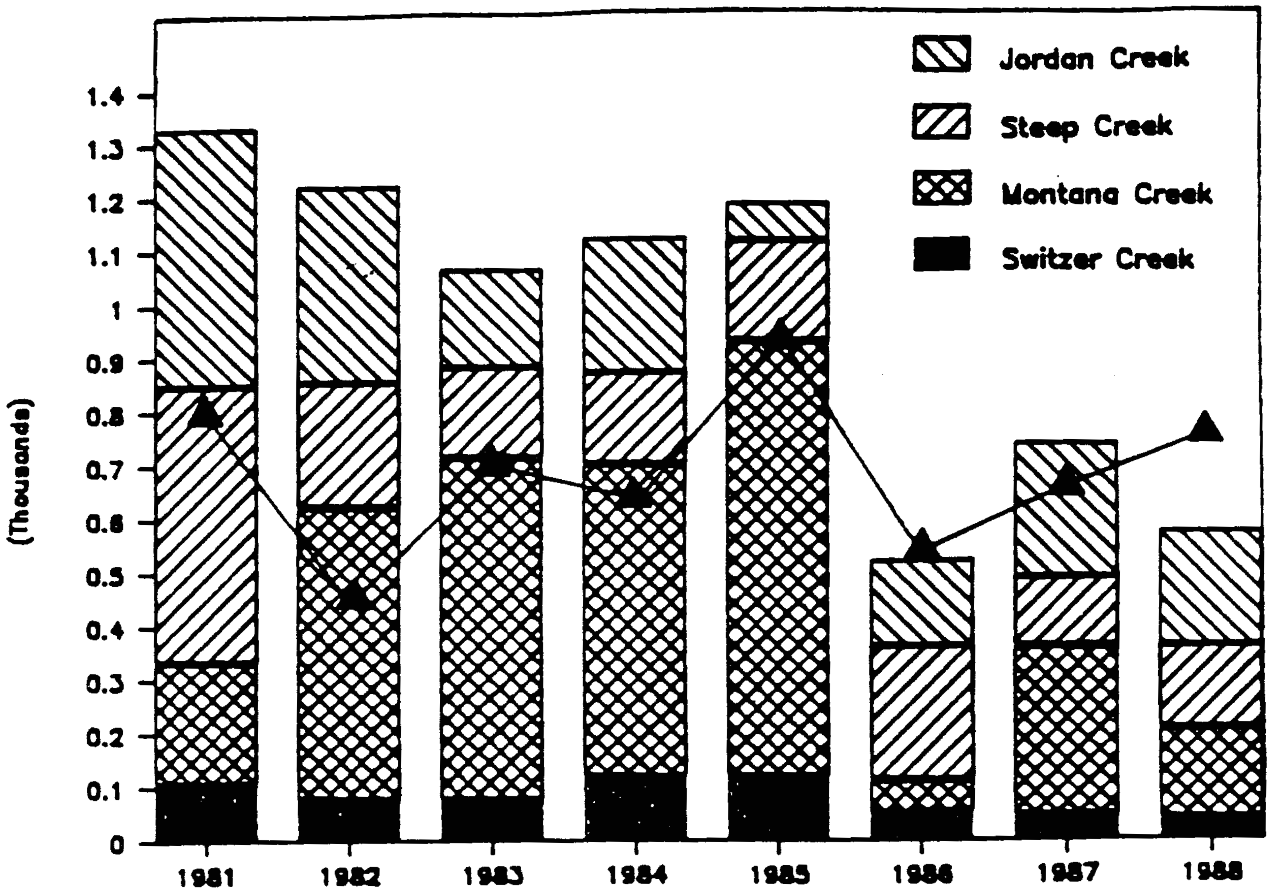


Figure 16. Peak coho salmon survey counts for four streams on the Juneau roadside compared with total weir counts for Auke Creek, 1981-1988.

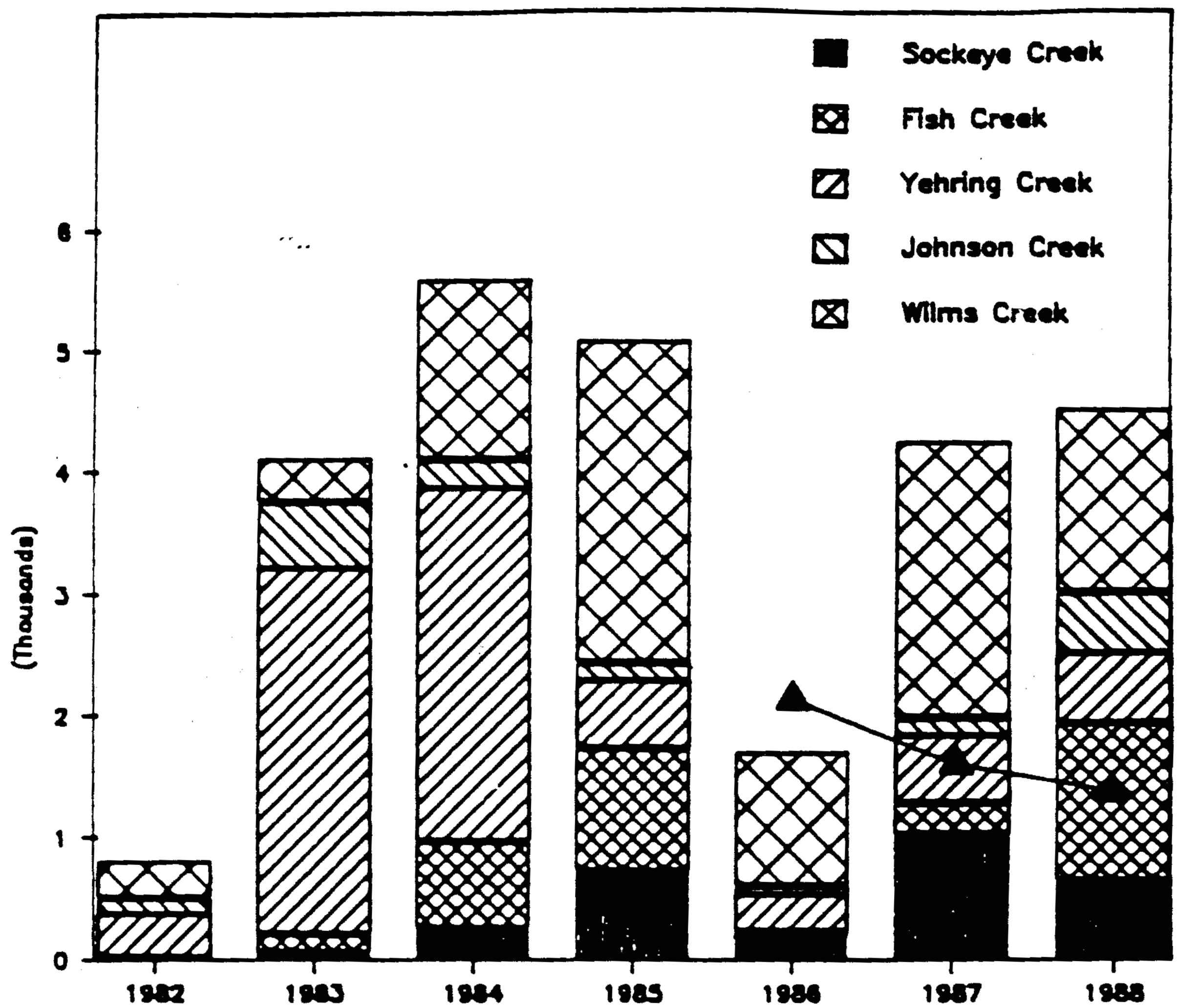


Figure 17. Peak coho salmon survey counts for five lower Taku River streams compared with Yehring Creek weir counts, 1982-1988.

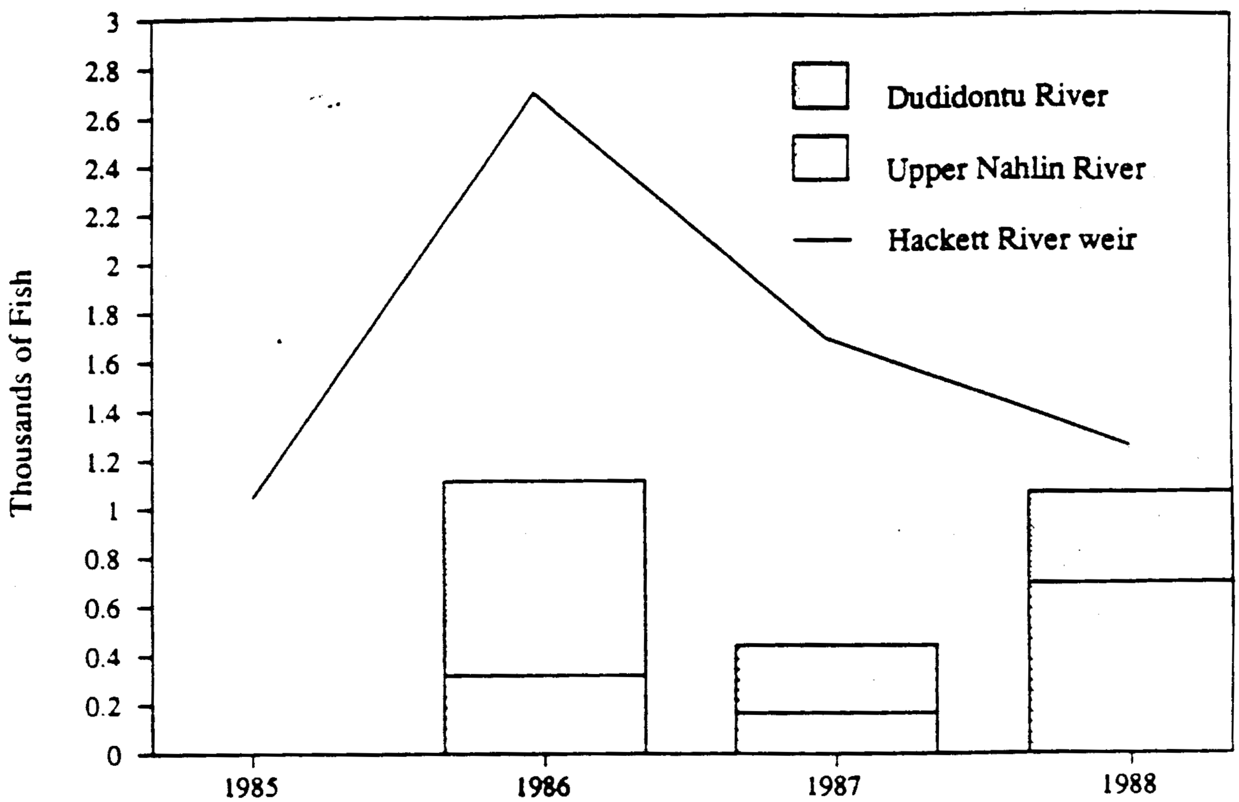


Figure 18. Peak coho salmon survey counts for two tributaries of the Upper Taku River tributaries compared total weir counts for another upper tributary, 1985-1988.

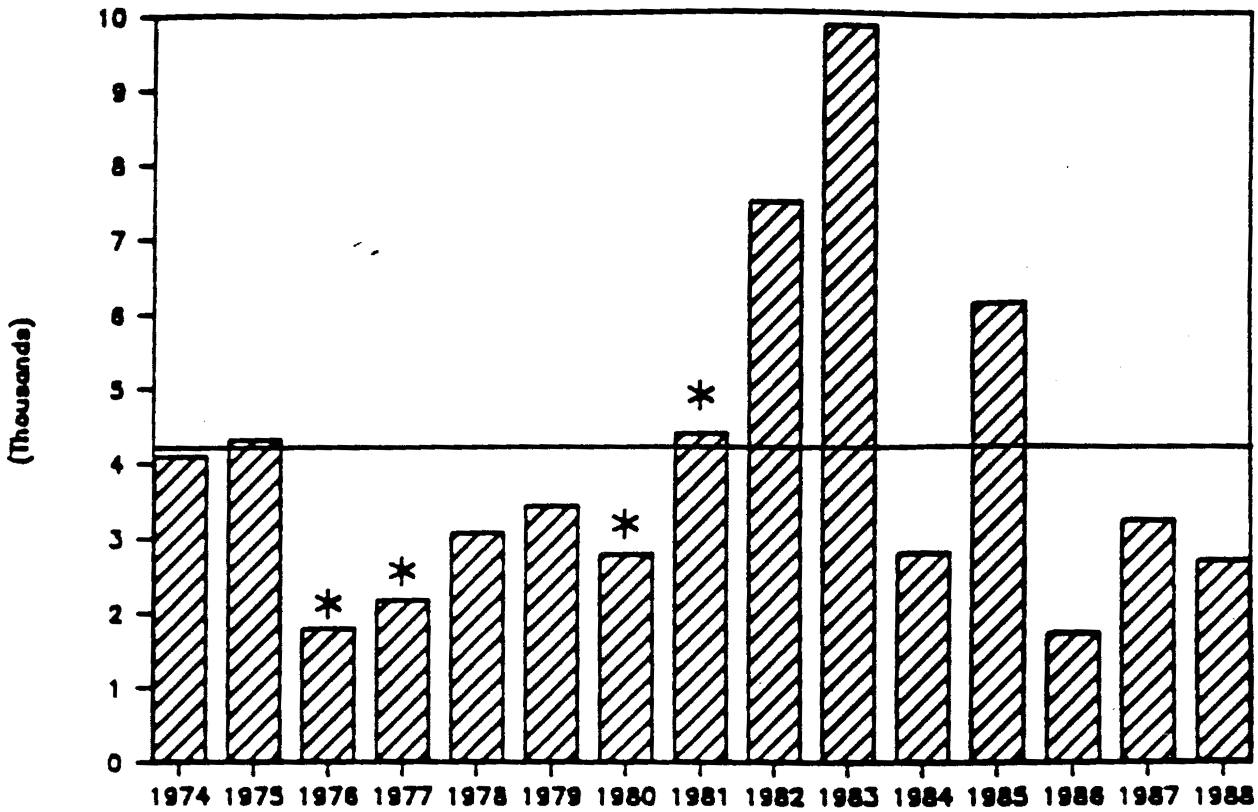


Figure 19. Foot and helicopter survey counts of the coho salmon escapement in the Berners River, 1974-1988.

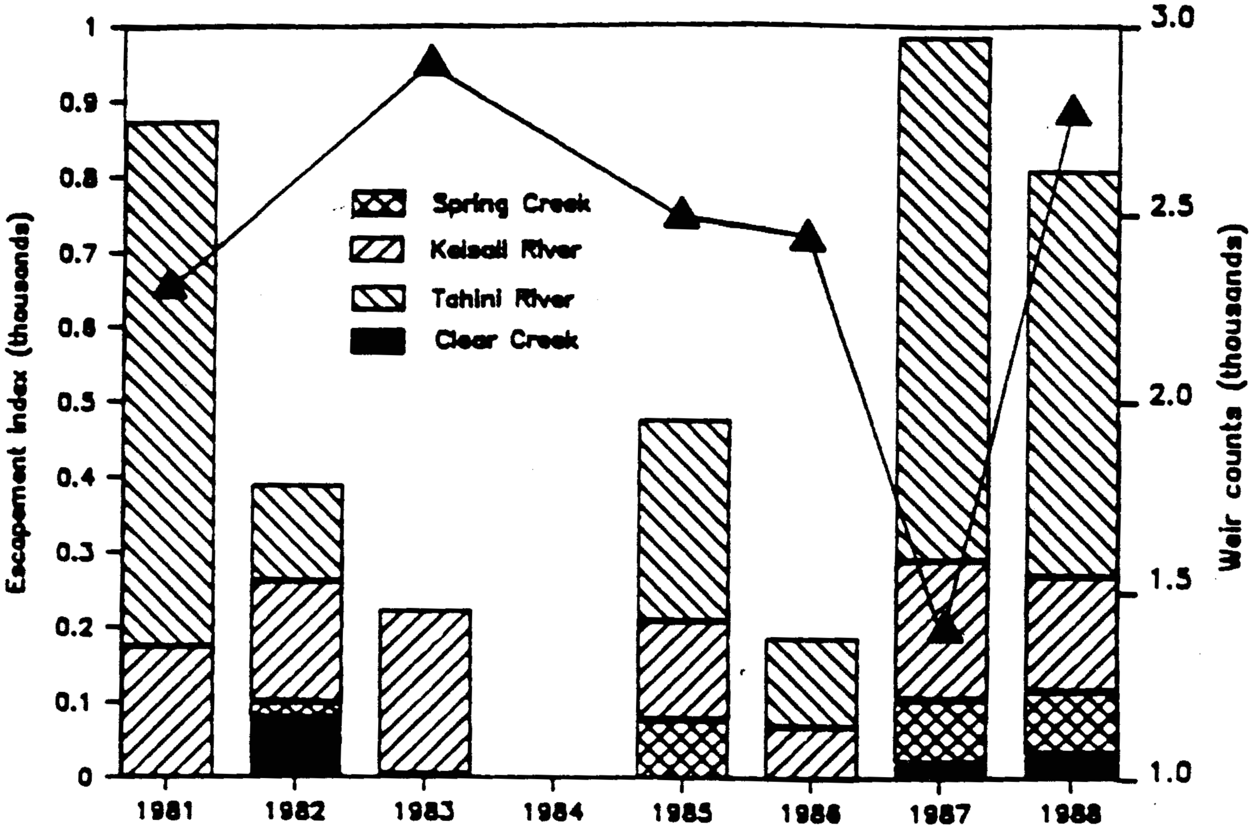


Figure 20. Peak coho salmon survey counts for four streams in the Haines area compared with aggregate counts for the Chilkat and Chilkoot Lake Weirs, 1981-1988.

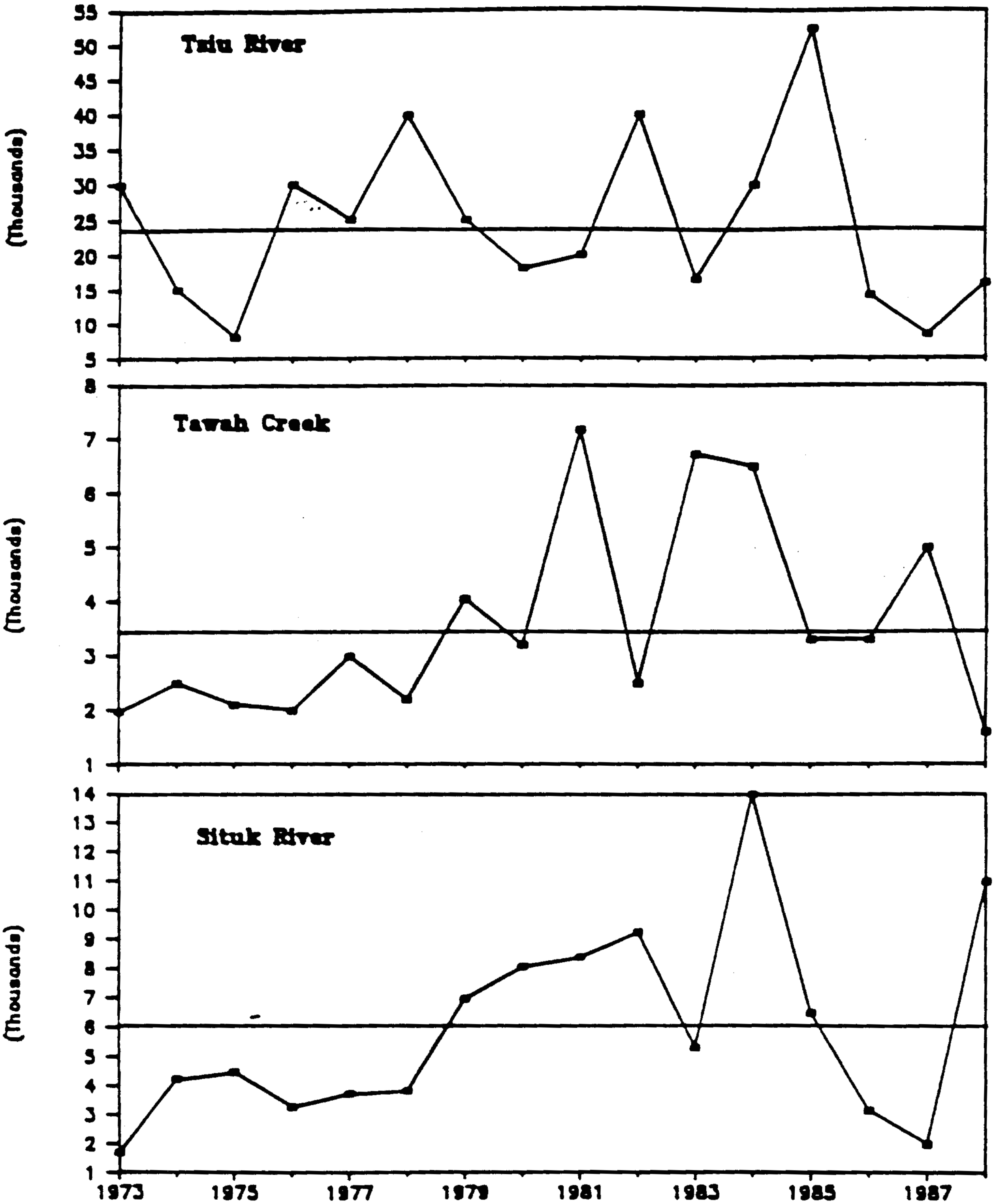


Figure 21. Peak coho salmon survey counts for three Yakutat area systems including the Tsiu-Tsivat Rivers, Tawah Creek (Lost River tributary) and the Situk River, 1974-1988.

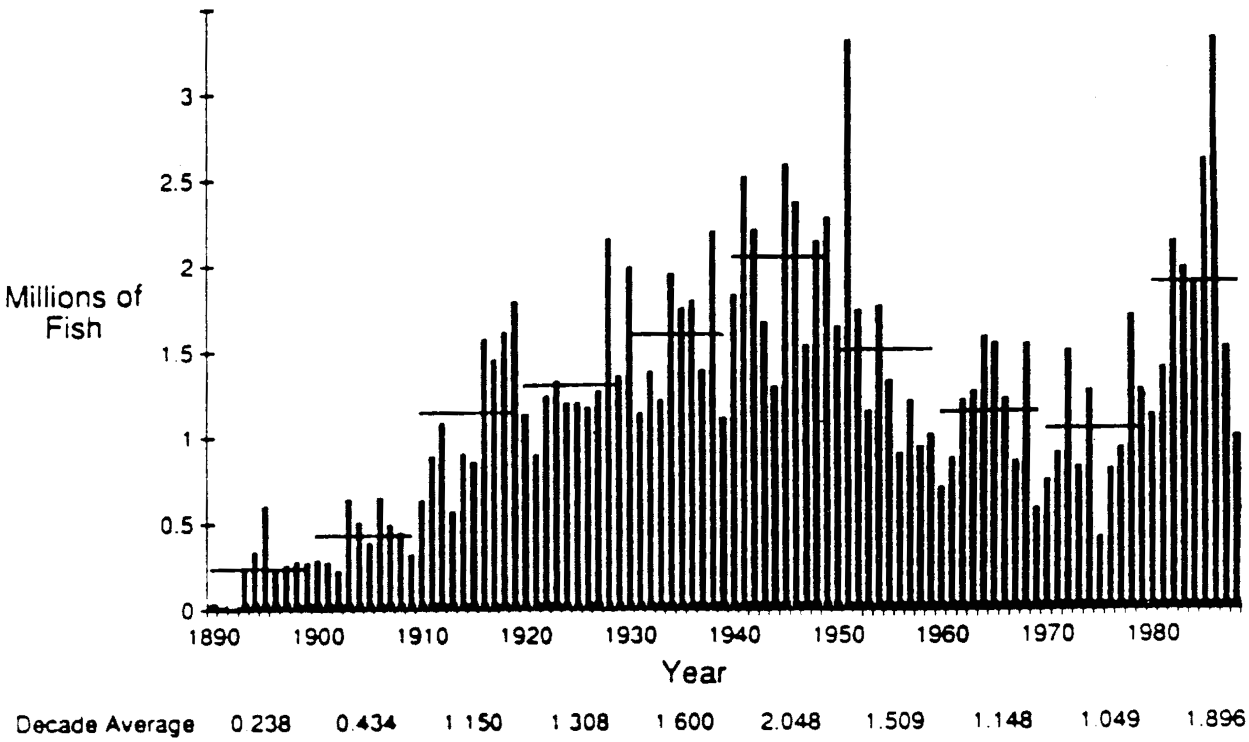


Figure 22. Annual commercial catch of coho salmon in Southeast Alaska and decade averages, in millions of fish, 1890-1988.

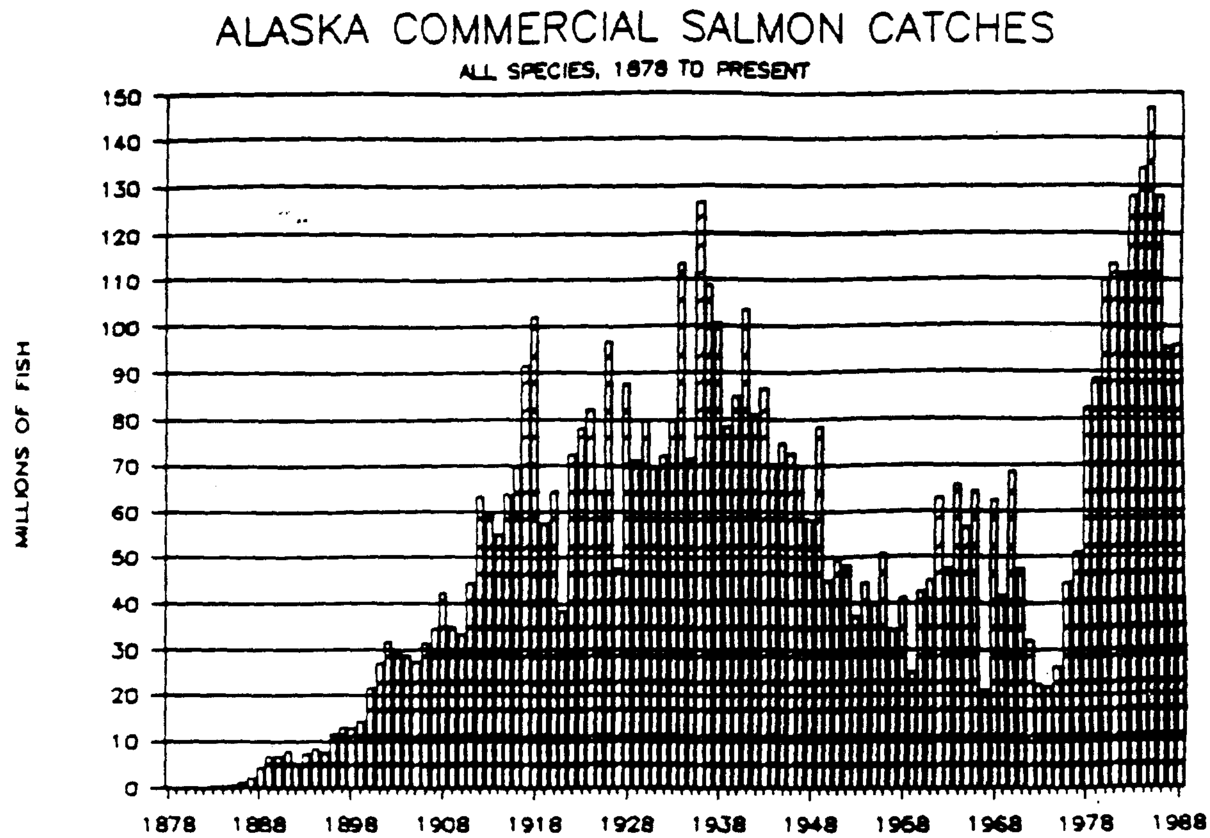


Figure 23. Alaska statewide commercial salmon harvest (all species), 1881-1988.

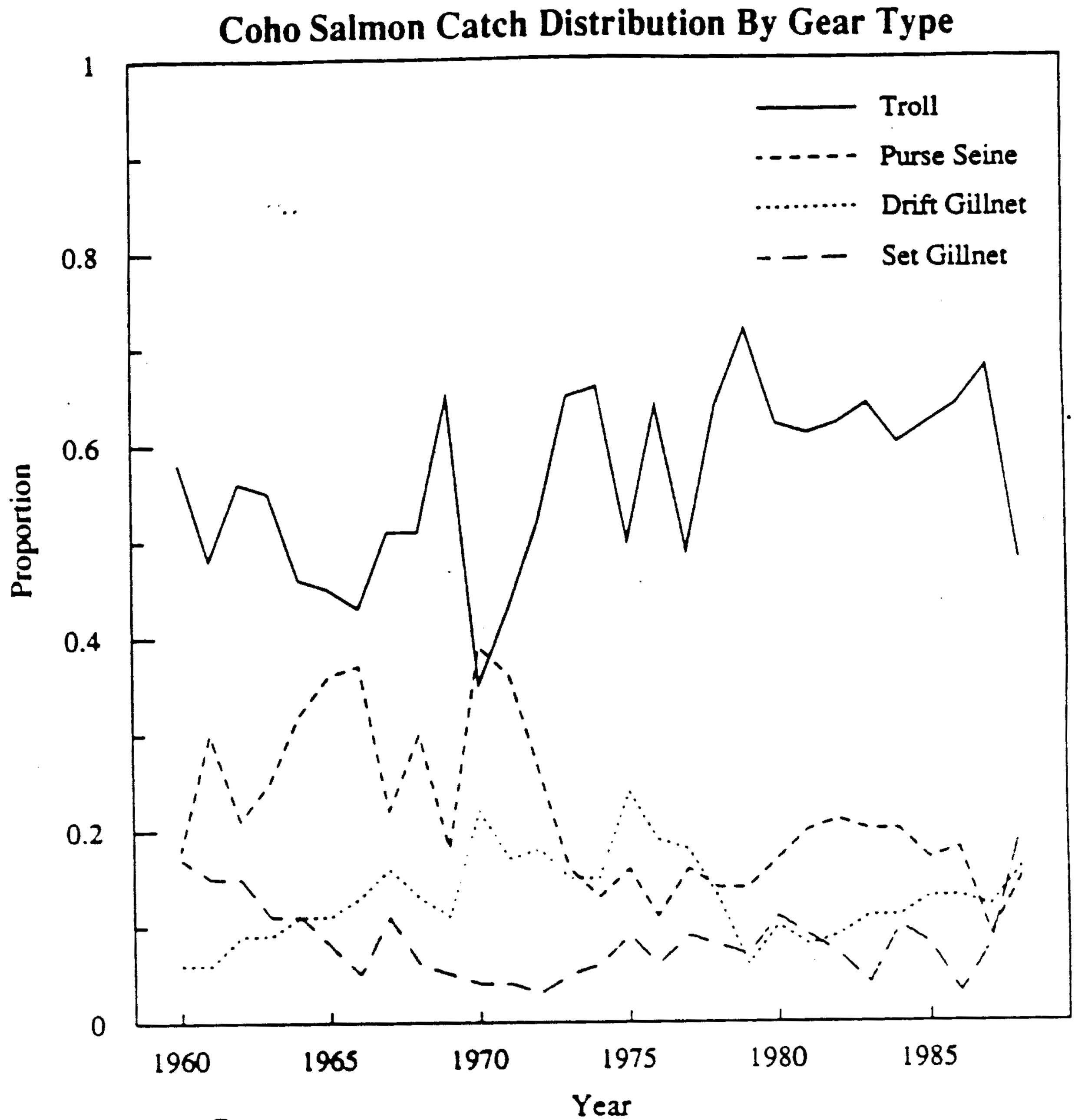


Figure 24. Distribution of the Southeast Alaska coho salmon commercial commercial by gear type, 1960-1988.

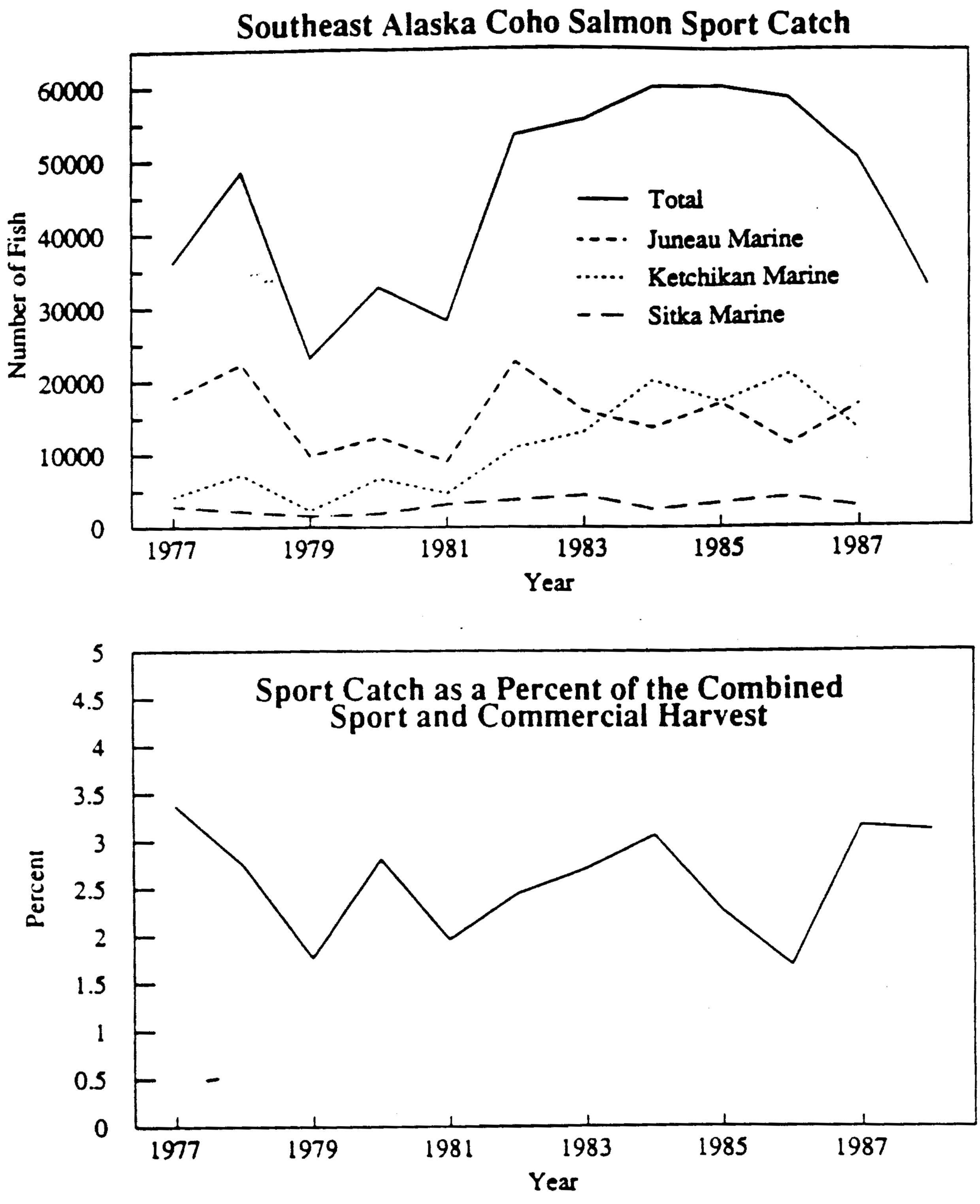


Figure 25. Southeast Alaska recreational coho salmon harvest in total numbers of fish and as a percentage of the combined commercial and sport harvest, 1977-1988. Harvest trends for three major marine recreational fisheries are also shown for the years 1977-1987.

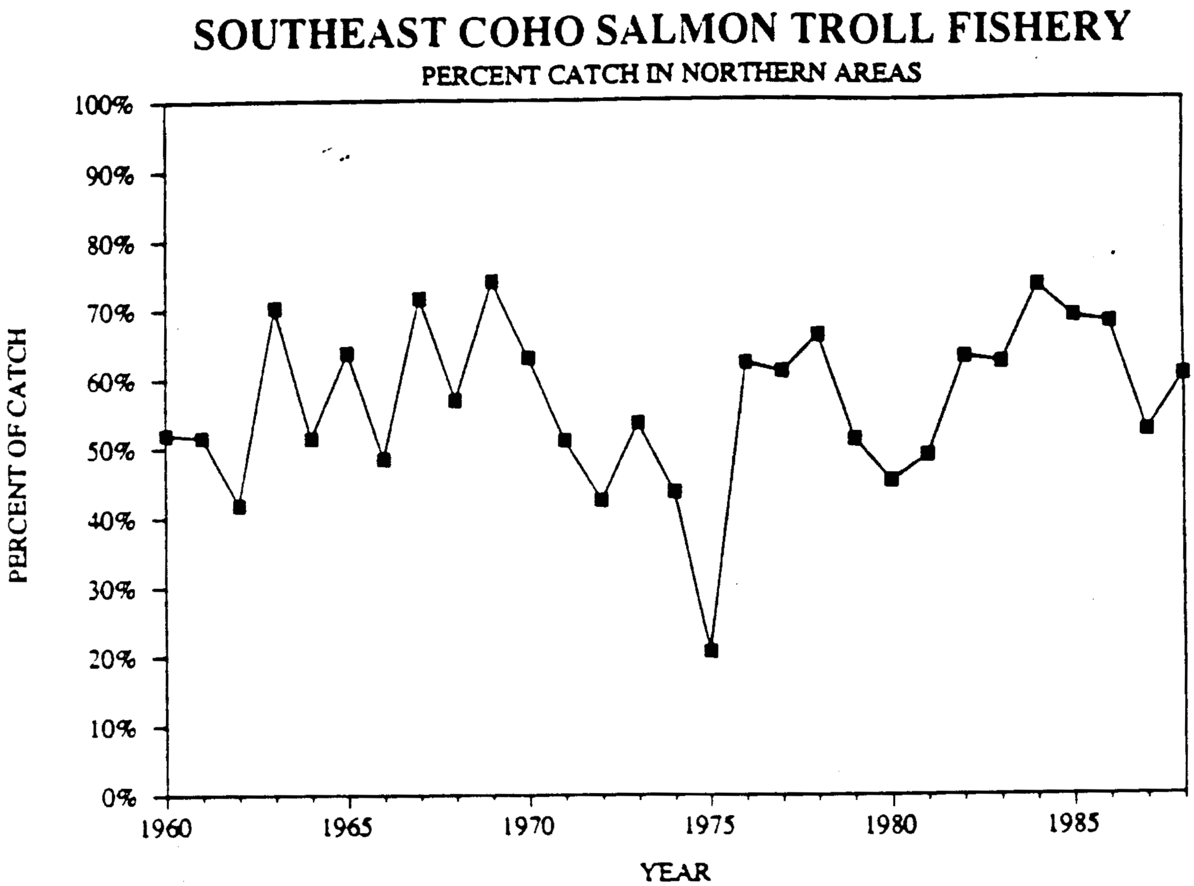


Figure 26. Percent of the total Southeast Alaska troll catch of coho salmon harvested in northern districts, 1960-1988.

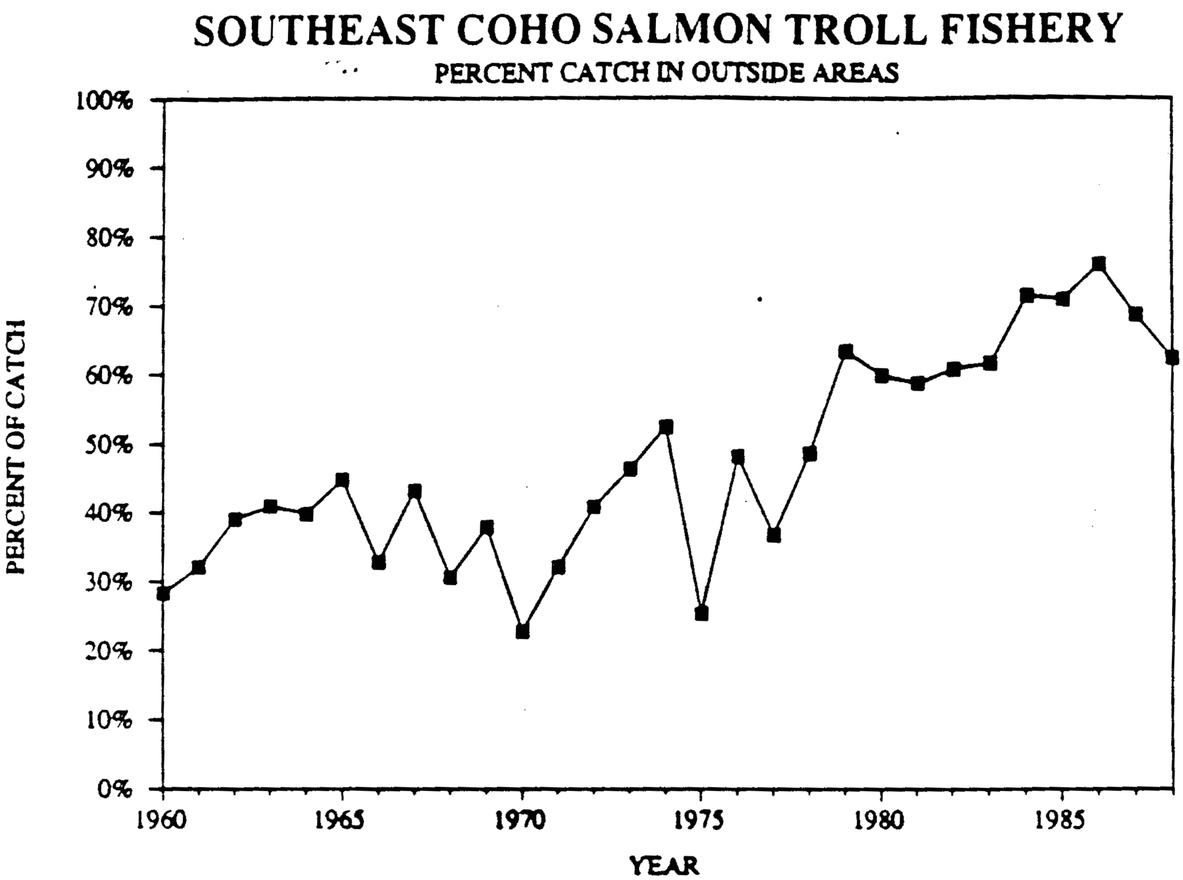


Figure 27. Percent of the total Southeast Alaska troll catch of coho salmon harvested in outside districts, 1960-1988.

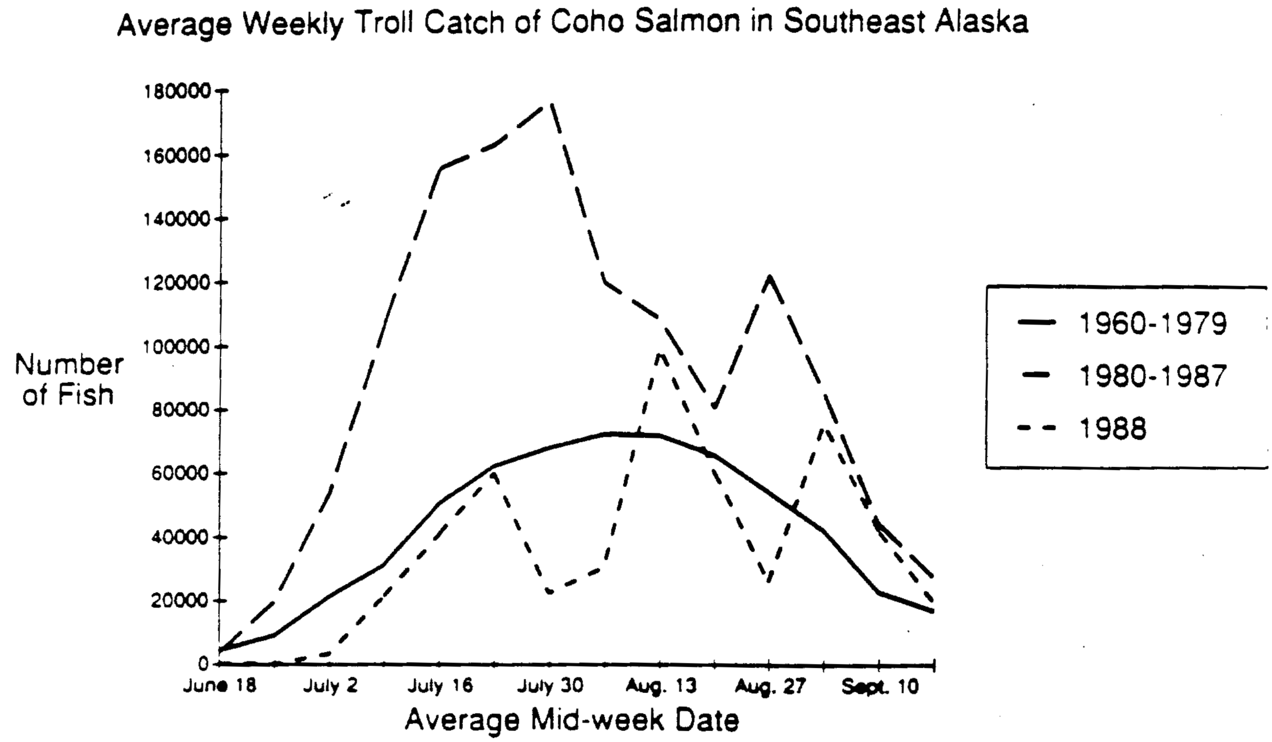


Figure 28. Average weekly catch of coho salmon by the Southeast Alaska troll fishery, 1960-1979, 1980-1987 and 1988.

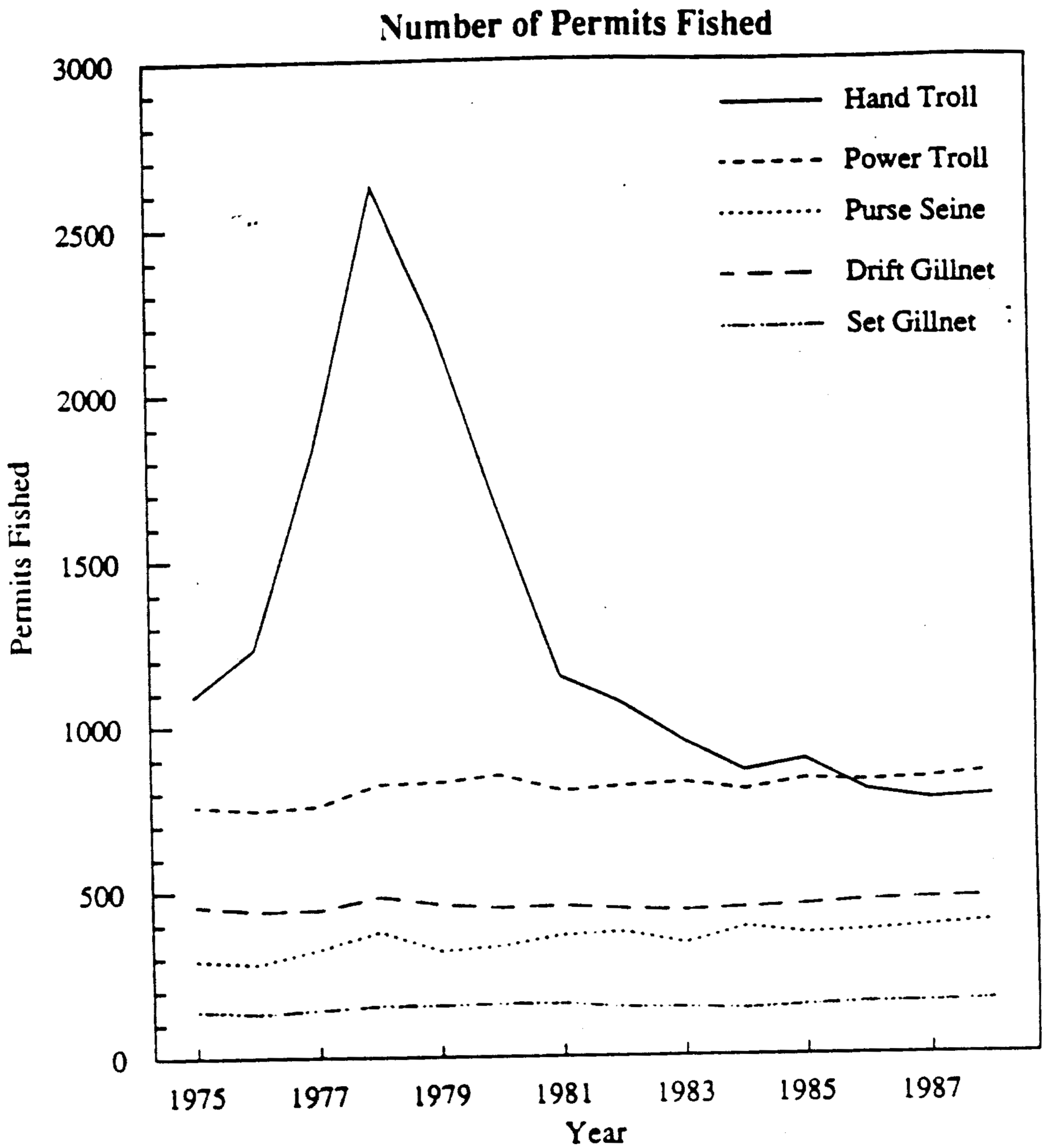


Figure 29. Number of limited entry and interum use permits actively fished in Southeast Alaska by gear type, 1975-1988.

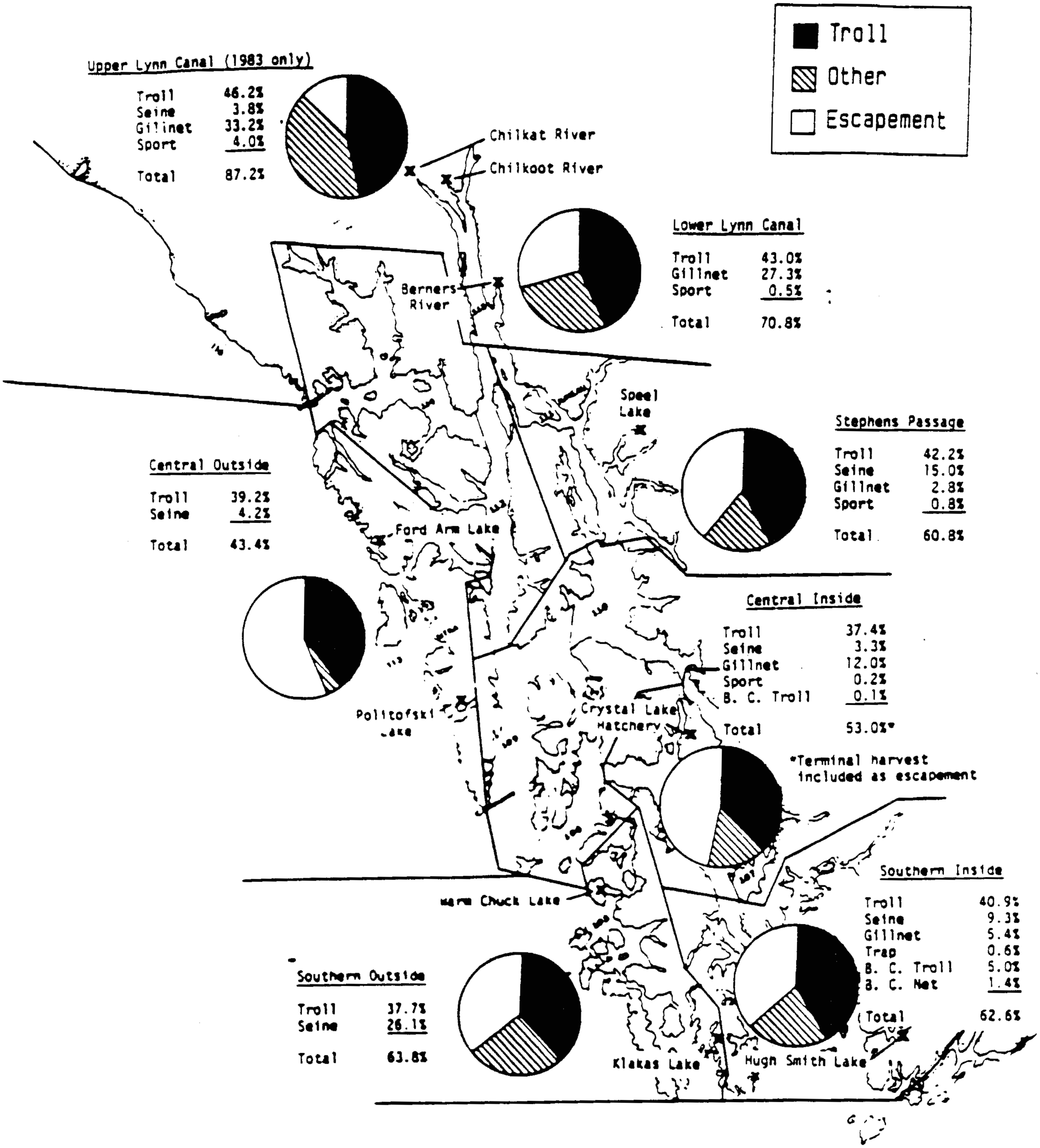


Figure 30. Average estimated harvest by gear type as a percentage of total coho salmon returns to selected systems in different management areas of Southeast Alaska, 1982-1983.

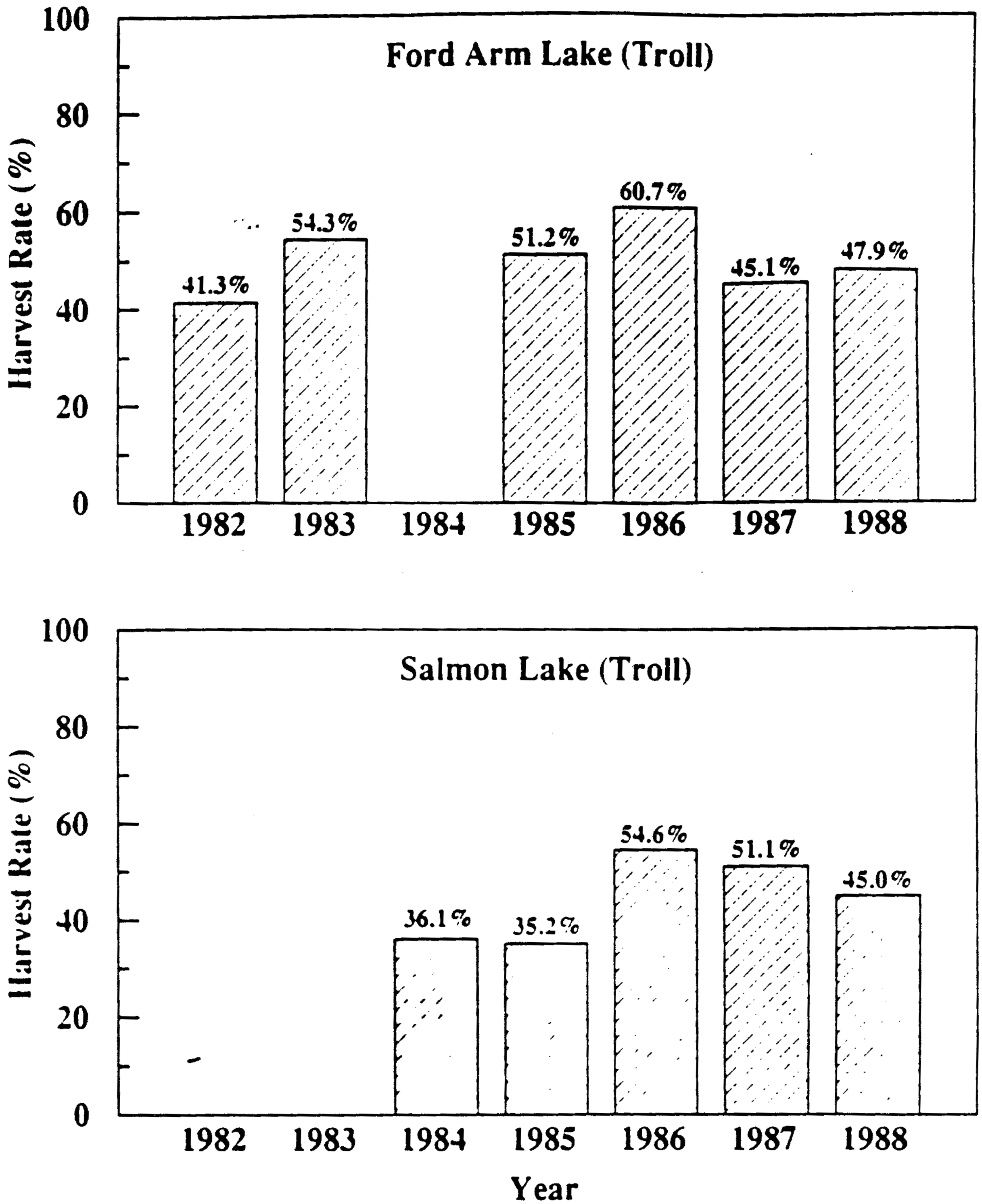


Figure 31. Estimated harvest rates by troll fisheries for two outer coastal coho salmon stocks, 1982-1988. The stocks include Salmon Lake located in Sitka Sound and Ford Arm Lake located on the outer coast of Chichagof Island north of Sitka.

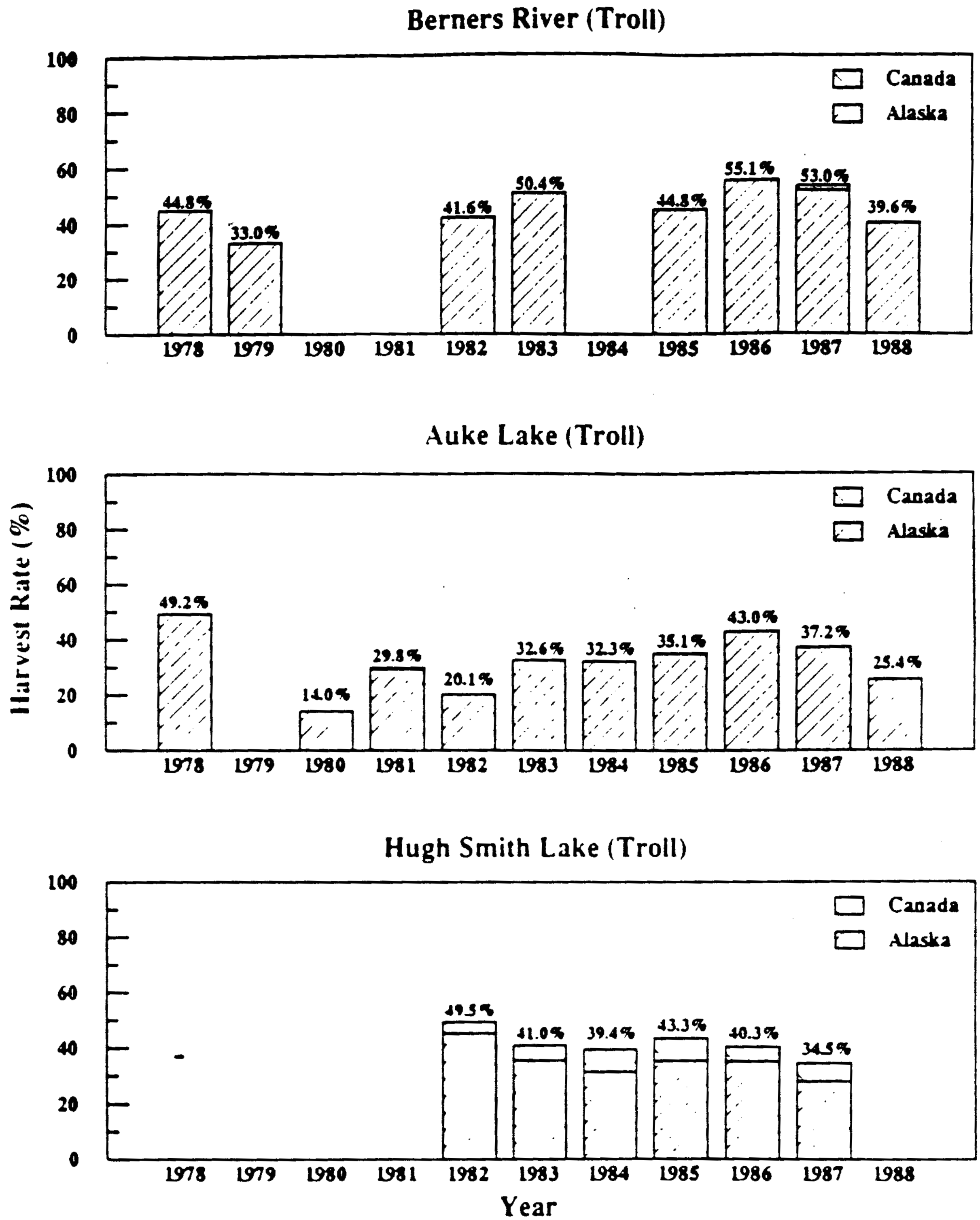


Figure 32. Estimated harvest rates by troll fisheries for three inside area coho salmon stocks, 1978-1988. The stocks include the Berners River and Auke Lake located in northern Southeast near Juneau and Hugh Smith Lake located south of Ketchikan.

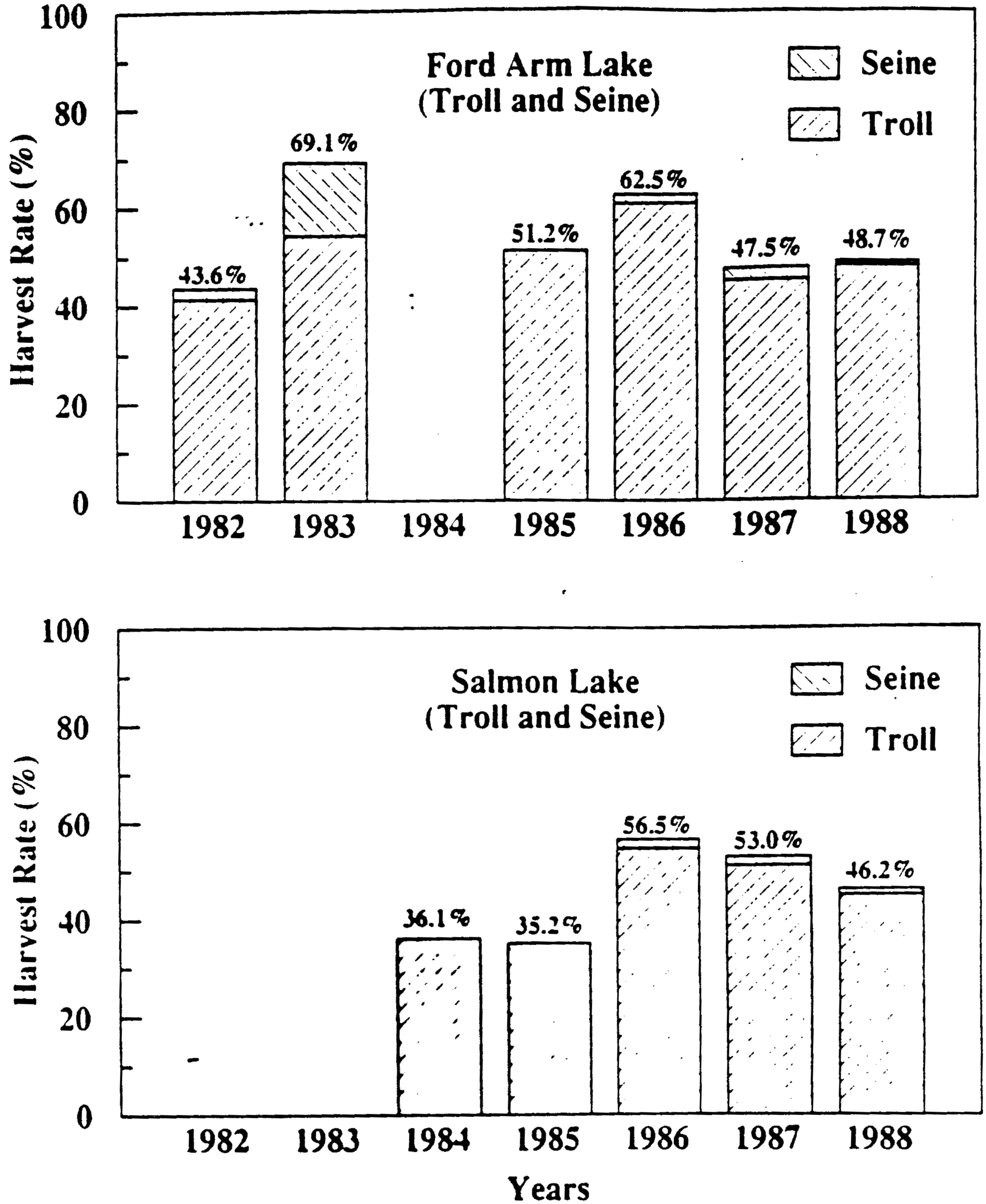


Figure 33. Estimated total harvest rates by commercial fisheries for two outer coastal coho salmon stocks, 1982-1988. The stocks include Salmon Lake located in Sitka Sound and Ford Arm Lake located on the outer coast of Chichagof Island north of Sitka.

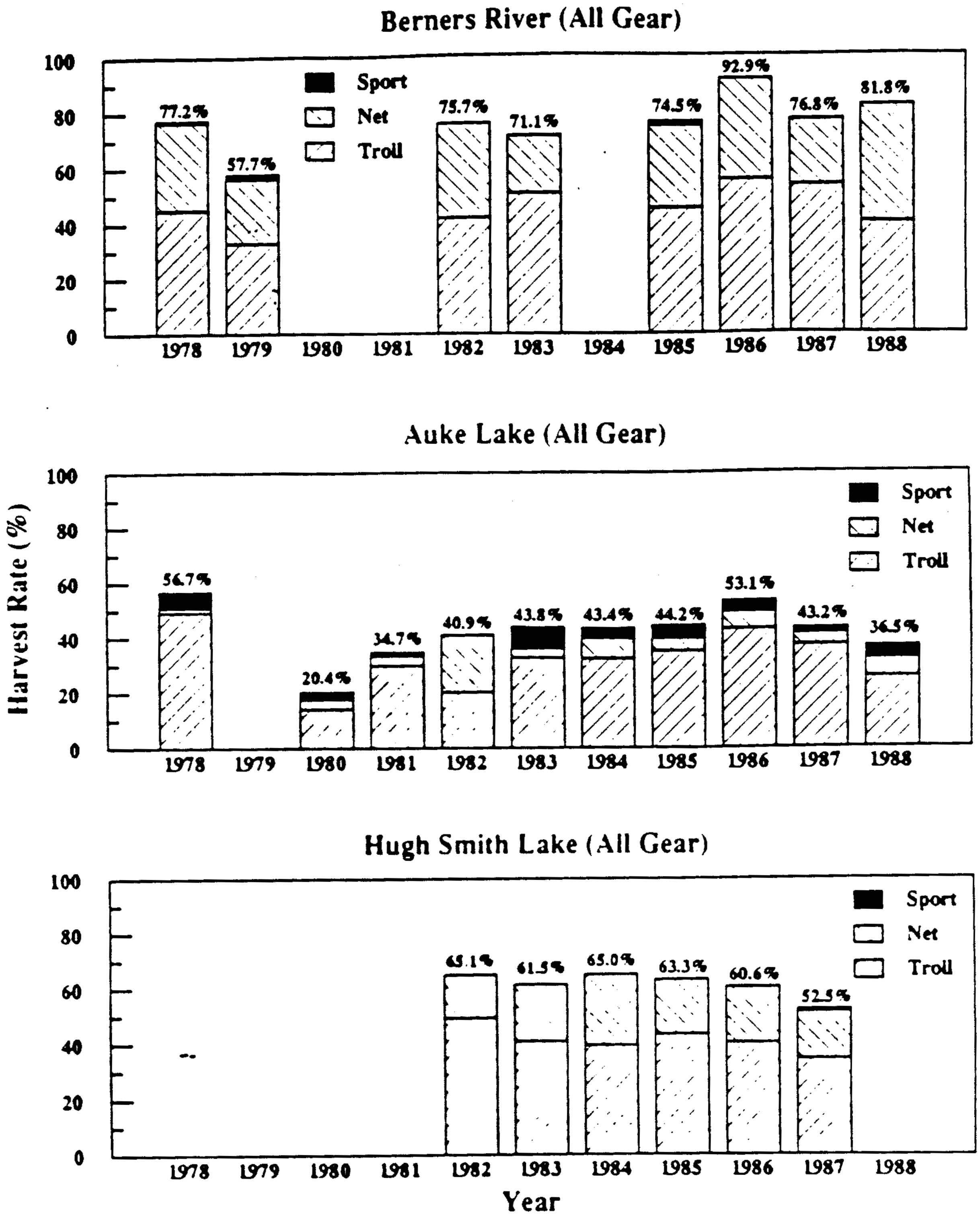


Figure 34. Estimated total harvest rates by all fisheries for three inside area coho salmon stocks, 1978-1988. The stocks include the Berners River and Auke Lake in northern Southeast near Juneau and Hugh Smith Lake located south of Ketchikan.

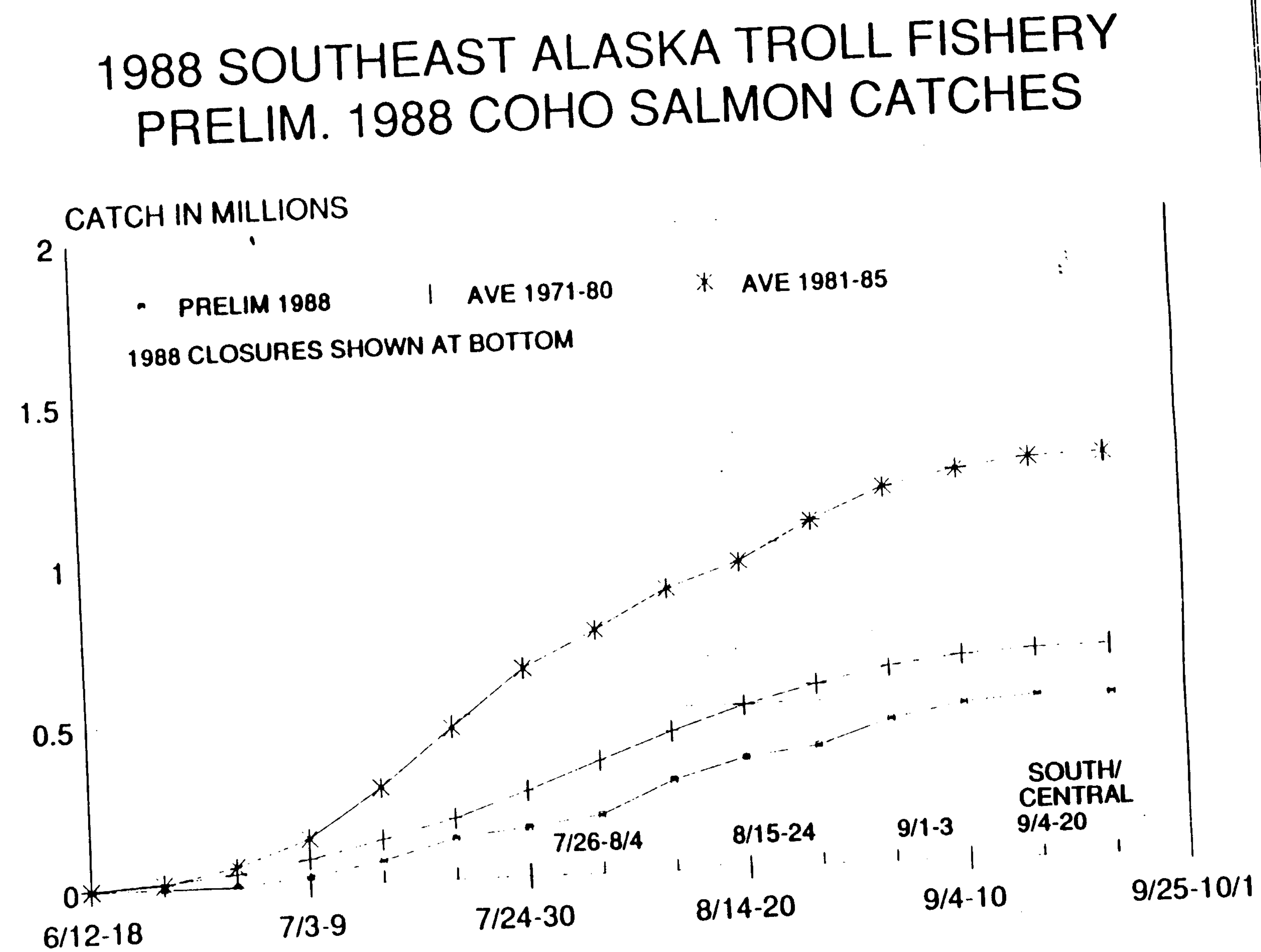

1988 SOUTHEAST ALASKA TROLL FISHERY
PRELIM. 1988 COHO SALMON CATCHES
CATCH IN MILLIONS
2
1.5
1
0.5
0
PRELIM 1988
AVE 1971-80
AVE 1981-85
1988 CLOSURES SHOWN AT BOTTOM
SOUTH/
CENTRAL
9/4-20
7/26-8/4
8/15-24
9/1-3
6/12-18
7/3-9
7/24-30
8/14-20
9/4-10
9/25-10/1

Figure 35.

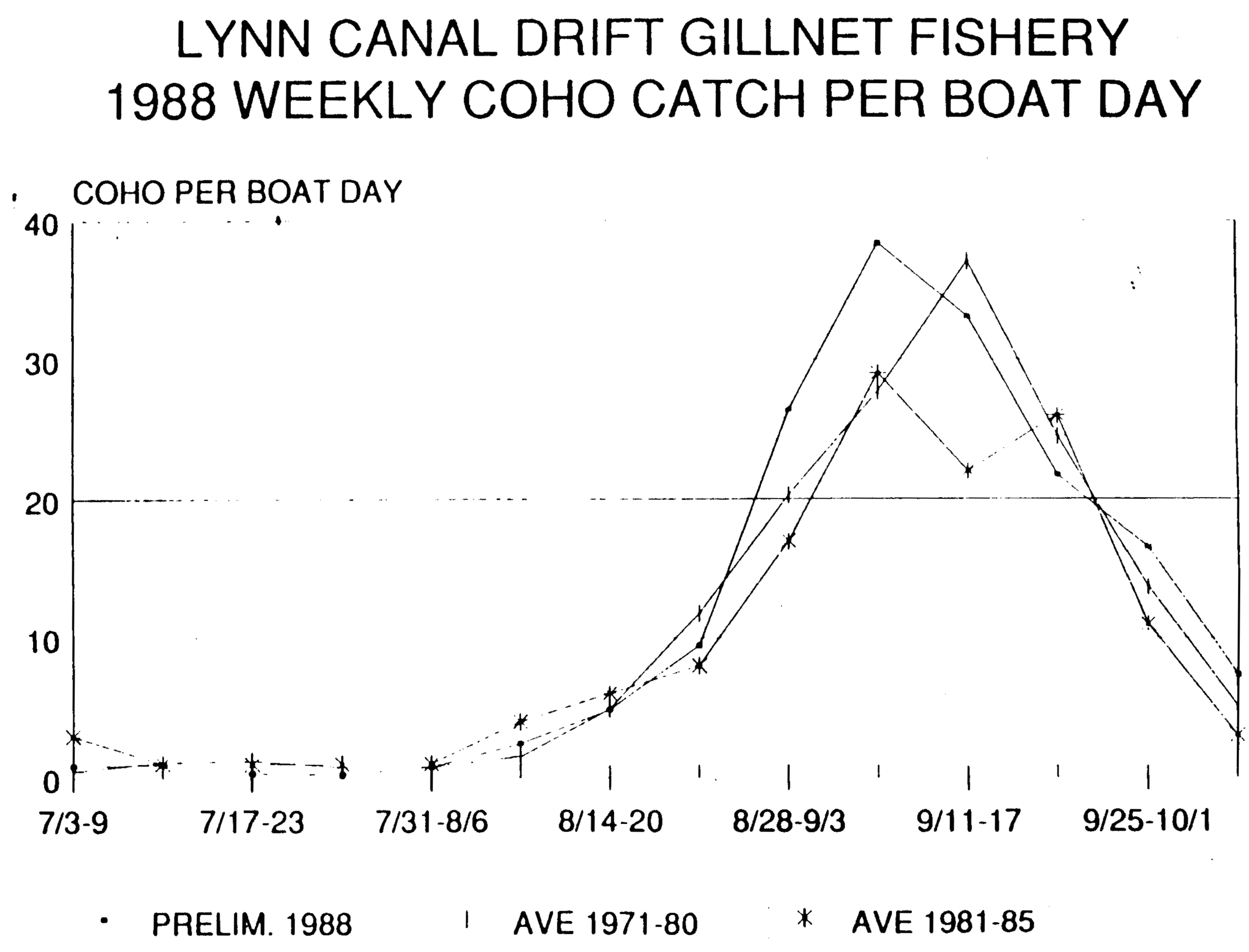
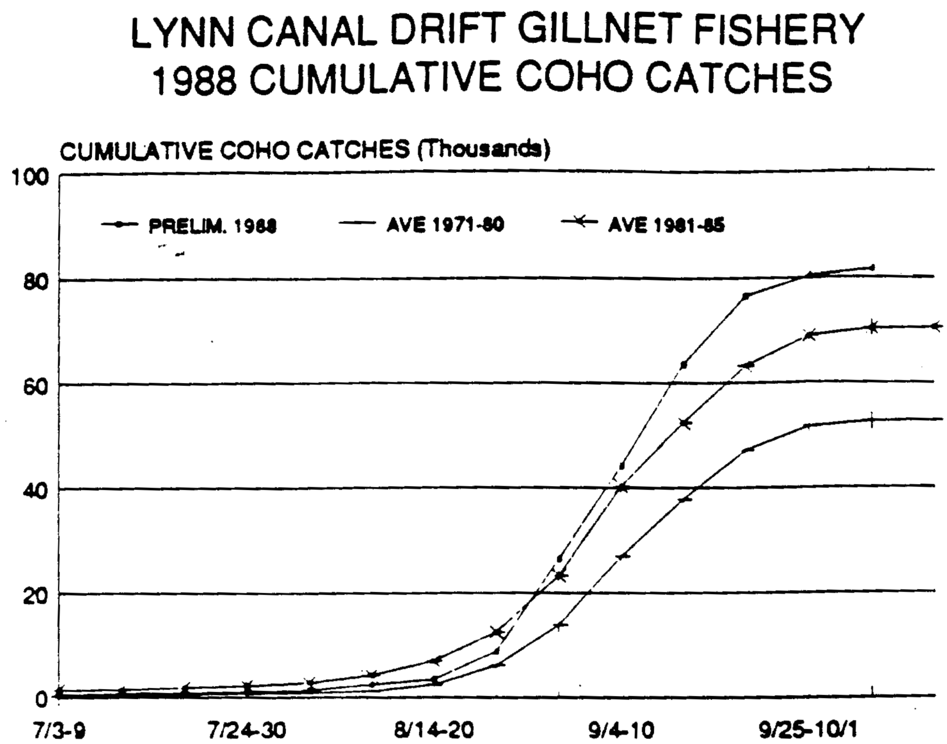

LYNN CANAL DRIFT GILLNET FISHERY
1988 WEEKLY COHO CATCH PER BOAT DAY
COHO PER BOAT DAY
40
30
20
10
0
7/3-9
7/17-23
7/31-8/6
8/14-20
8/28-9/3
9/11-17
9/25-10/1
PRELIM. 1988
AVE 1971-80
AVE 1981-85

Figure 36.


LYNN CANAL DRIFT GILLNET FISHERY
1988 CUMULATIVE COHO CATCHES
CUMULATIVE COHO CATCHES (Thousands)
100
80
60
40
20
0
PRELIM. 1988
AVE 1971-80
AVE 1981-85
7/3-9
7/24-30
8/14-20
9/4-10
9/25-10/1

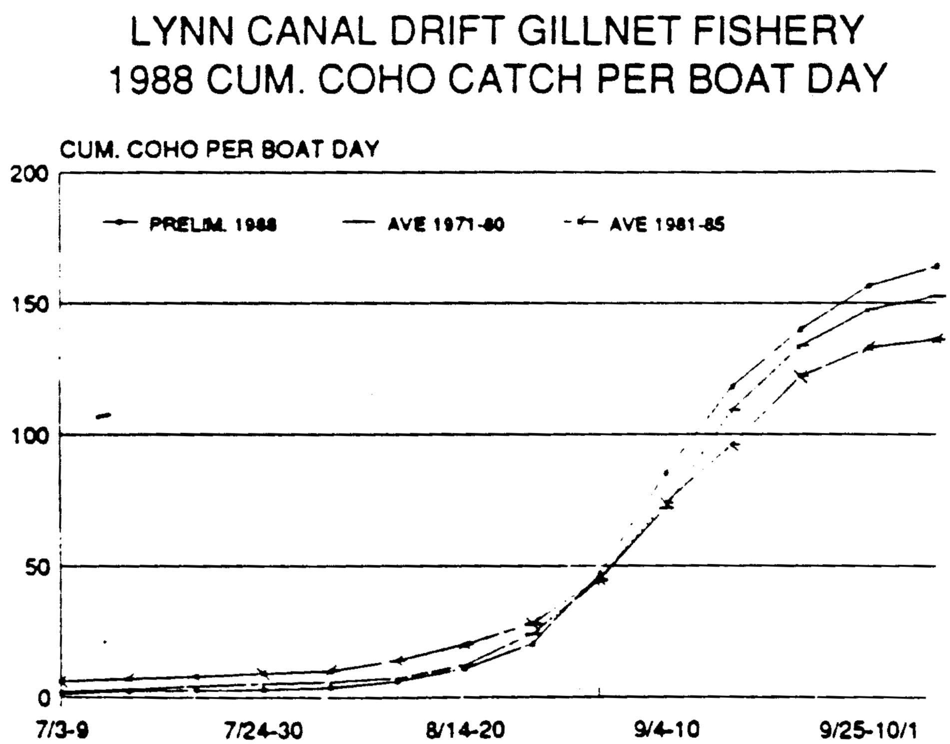

LYNN CANAL DRIFT GILLNET FISHERY
1988 CUM. COHO CATCH PER BOAT DAY
CUM. COHO PER BOAT DAY
200
150
100
50
0
PRELIM. 1988
AVE 1971-80
AVE 1981-85
7/3-9
7/24-30
8/14-20
9/4-10
9/25-10/1

Figure 37.

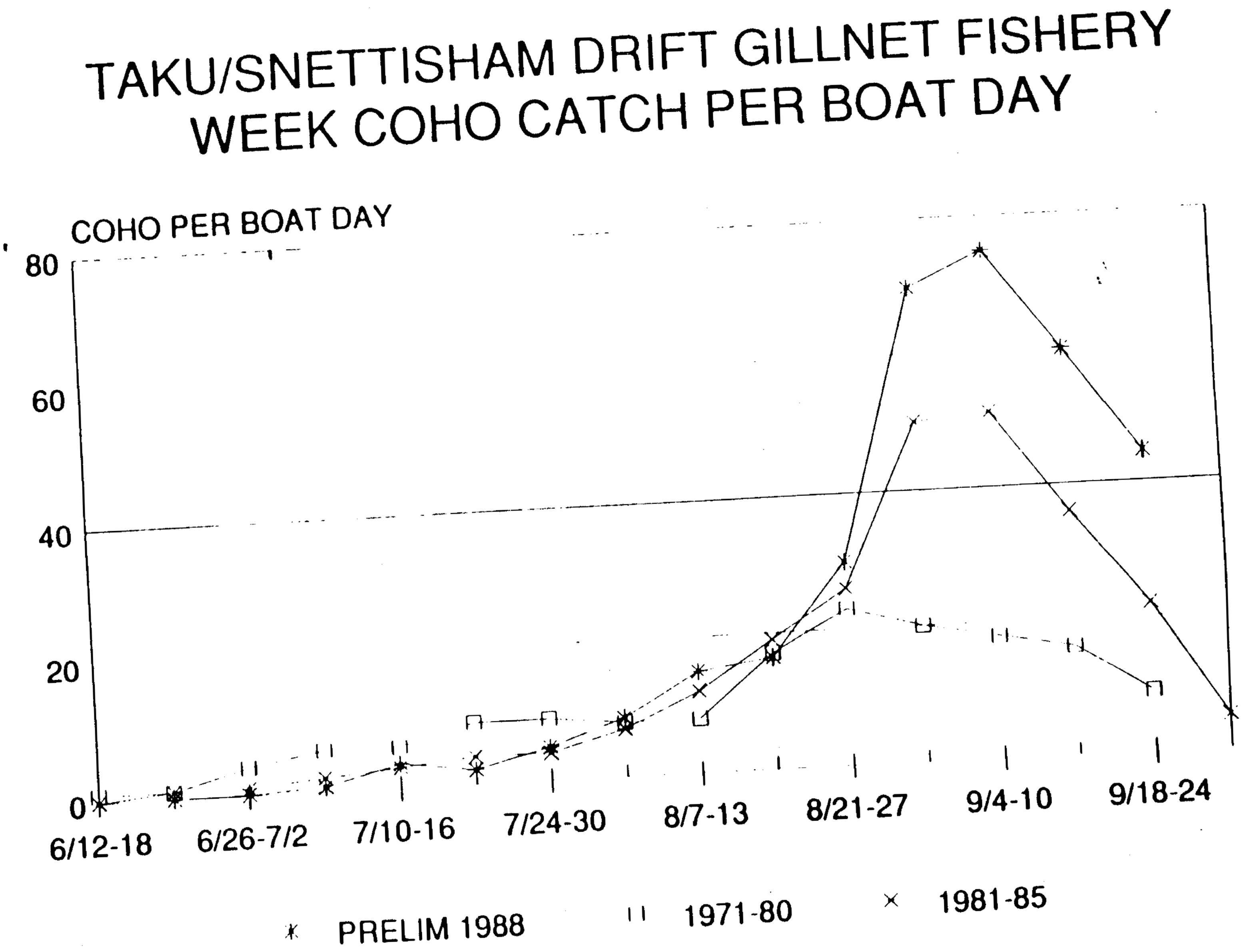
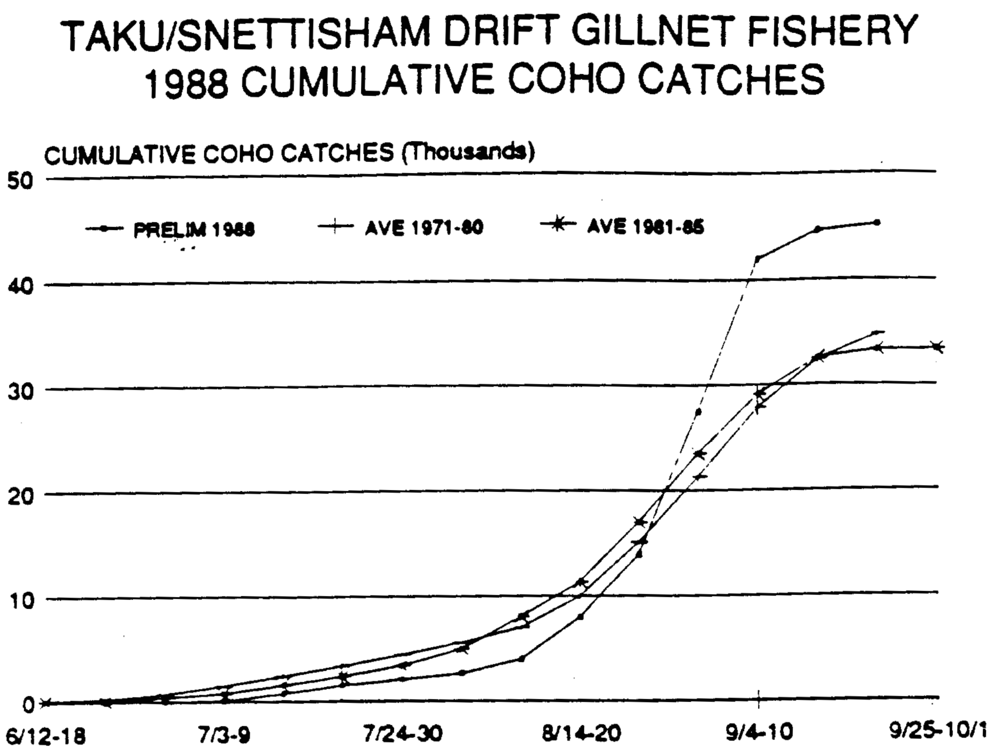

TAKU/SNETTISHAM DRIFT GILLNET FISHERY
WEEK COHO CATCH PER BOAT DAY
COHO PER BOAT DAY
80
60
40
20
0
6/12-18
6/26-7/2
7/10-16
7/24-30
8/7-13
8/21-27
9/4-10
9/18-24
PRELIM 1988
1971-80
1981-85

Figure 38.


TAKU/SNETTISHAM DRIFT GILLNET FISHERY
1988 CUMULATIVE COHO CATCHES
CUMULATIVE COHO CATCHES (Thousands)
PRELIM 1988
AVE 1971-80
AVE 1981-85
50
40
30
20
10
0
6/12-18
7/3-9
7/24-30
8/14-20
9/4-10
9/25-10/1

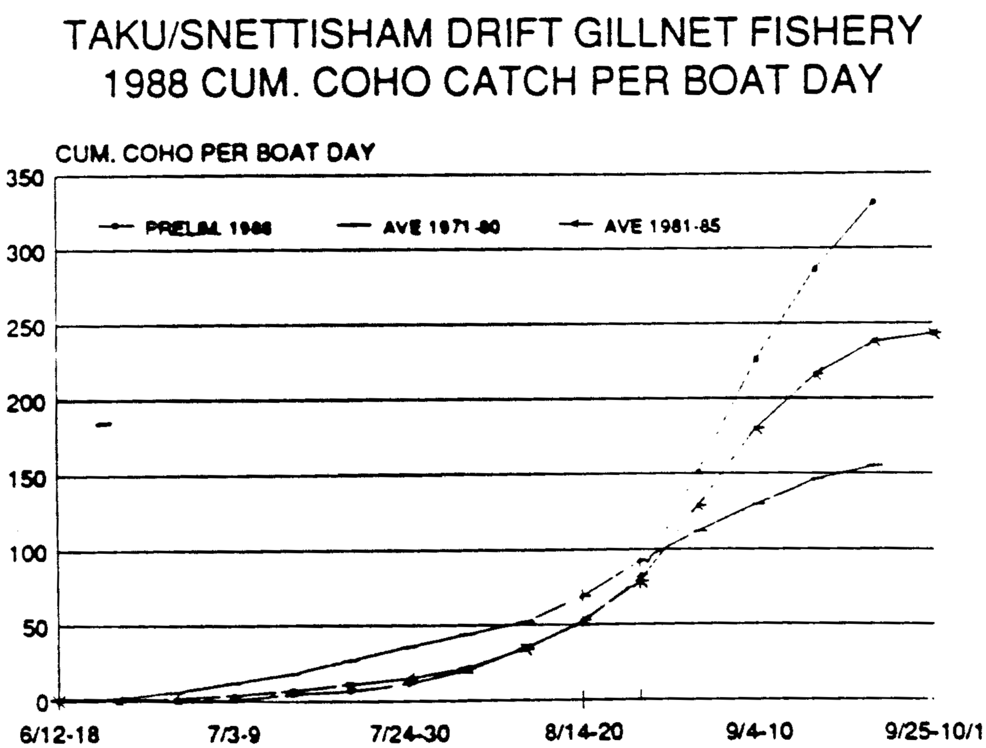

TAKU/SNETTISHAM DRIFT GILLNET FISHERY
1988 CUM. COHO CATCH PER BOAT DAY
CUM. COHO PER BOAT DAY
PRELIM. 1988
AVE 1971-80
AVE 1981-85
350
300
250
200
150
100
50
0
6/12-18
7/3-9
7/24-30
8/14-20
9/4-10
9/25-10/1

Figure 39.

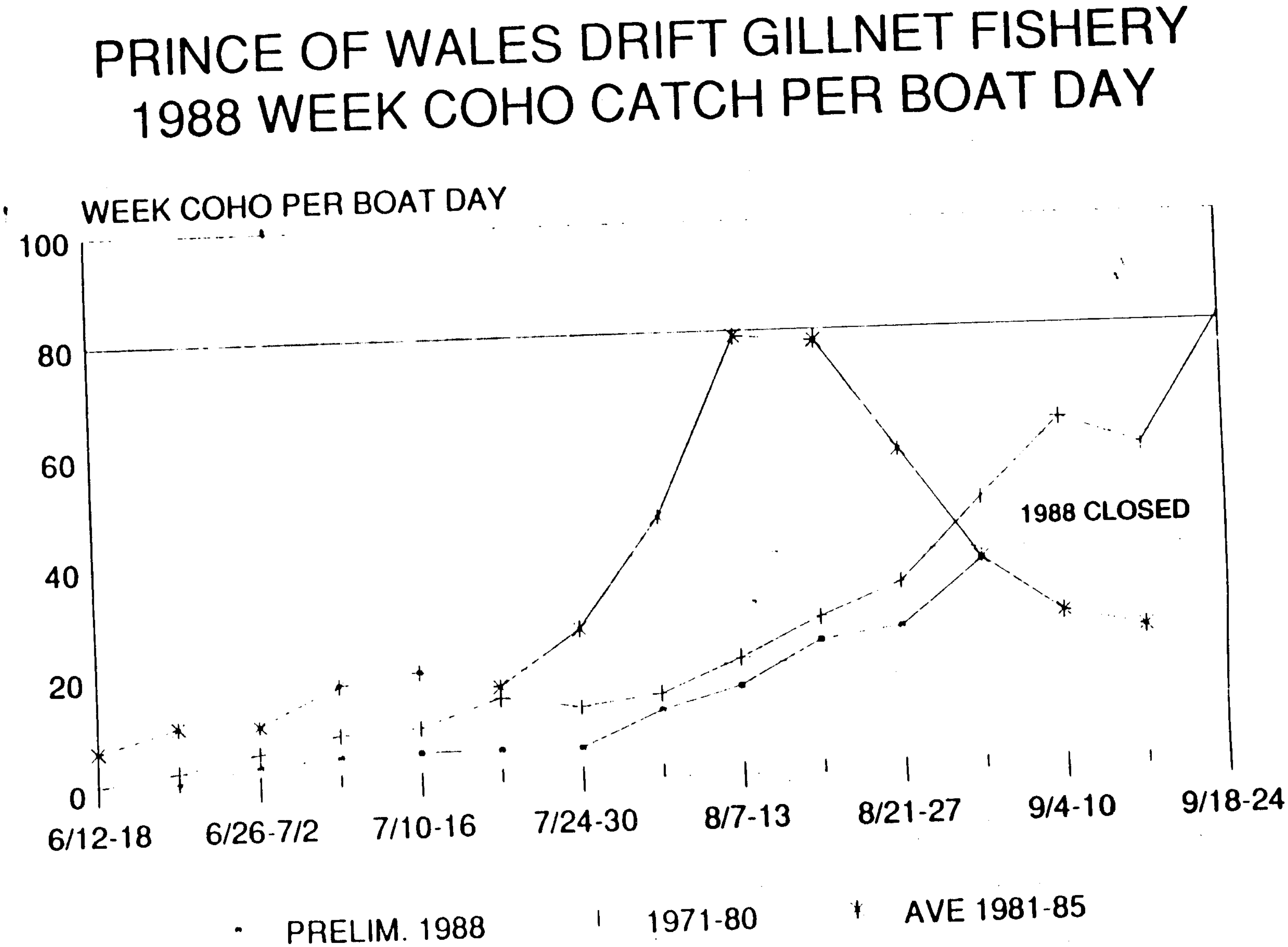
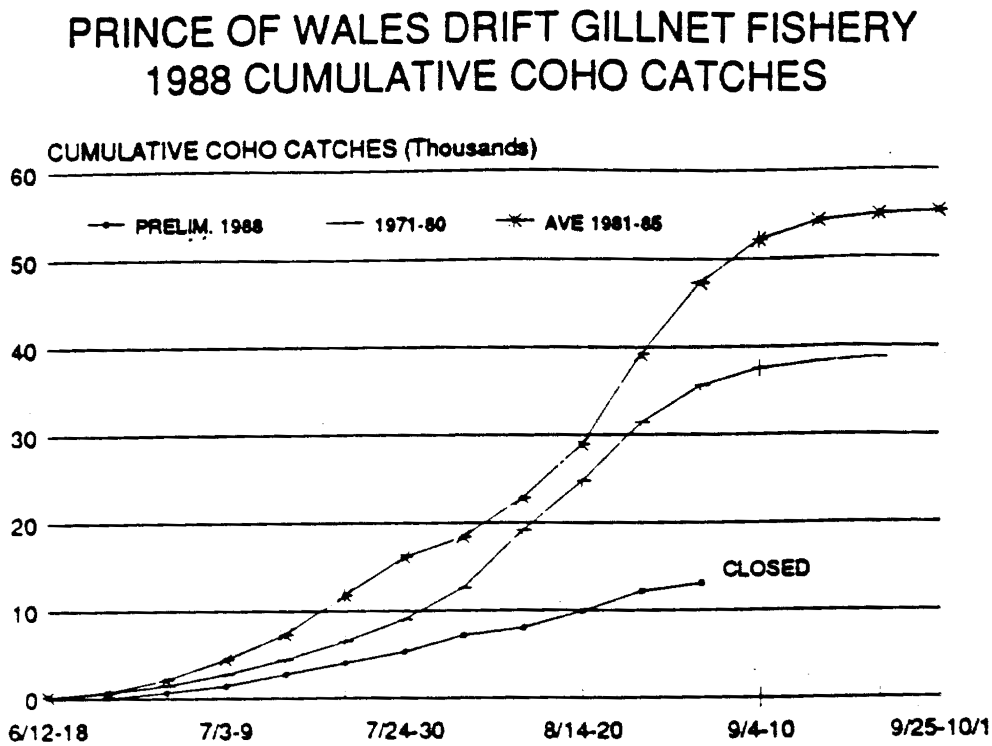

PRINCE OF WALES DRIFT GILLNET FISHERY
1988 WEEK COHO CATCH PER BOAT DAY
WEEK COHO PER BOAT DAY
100
80
60
40
20
0
6/12-18
6/26-7/2
7/10-16
7/24-30
8/7-13
8/21-27
9/4-10
9/18-24
1988 CLOSED
PRELIM. 1988
1971-80
AVE 1981-85

Figure 40.


PRINCE OF WALES DRIFT GILLNET FISHERY
1988 CUMULATIVE COHO CATCHES
CUMULATIVE COHO CATCHES (Thousands)
PRELIM. 1988
1971-80
AVE 1981-85
CLOSED
0
10
20
30
40
50
60
6/12-18
7/3-9
7/24-30
8/14-20
9/4-10
9/25-10/1

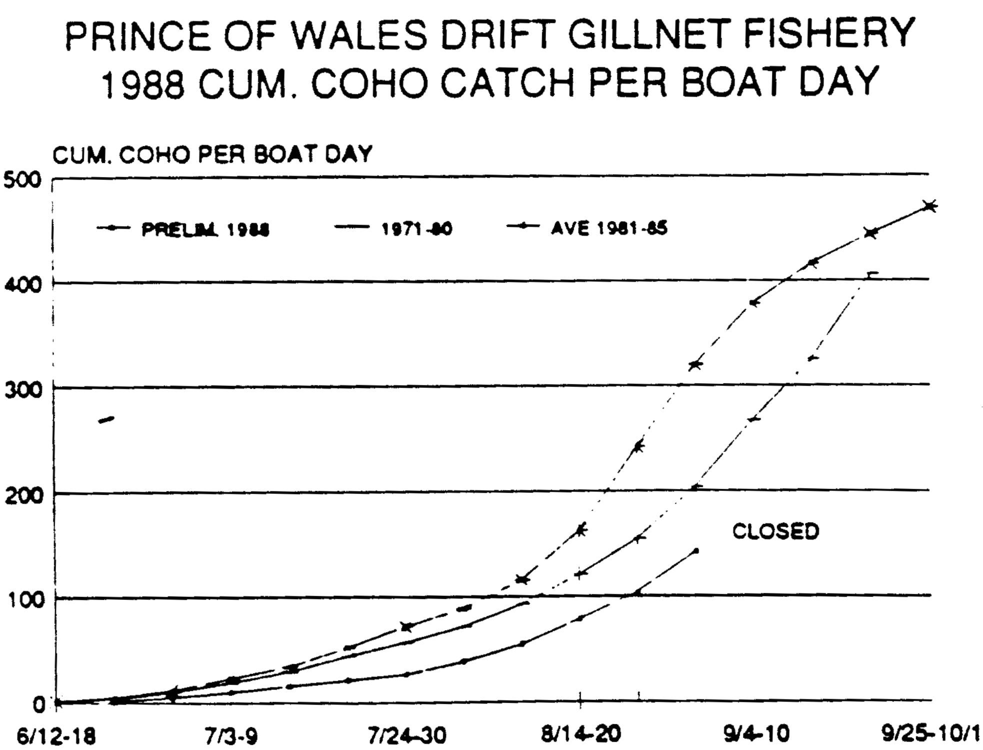
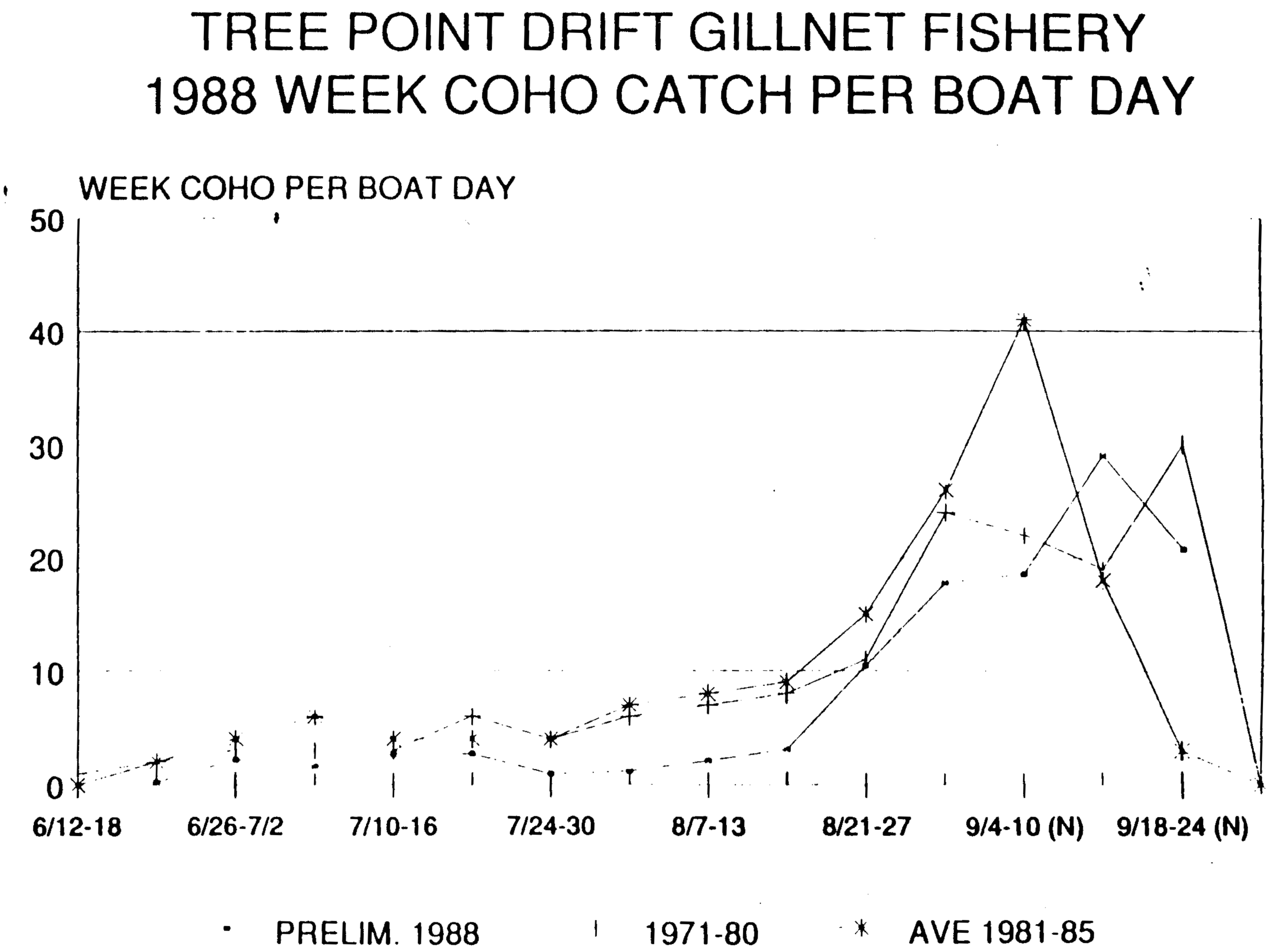
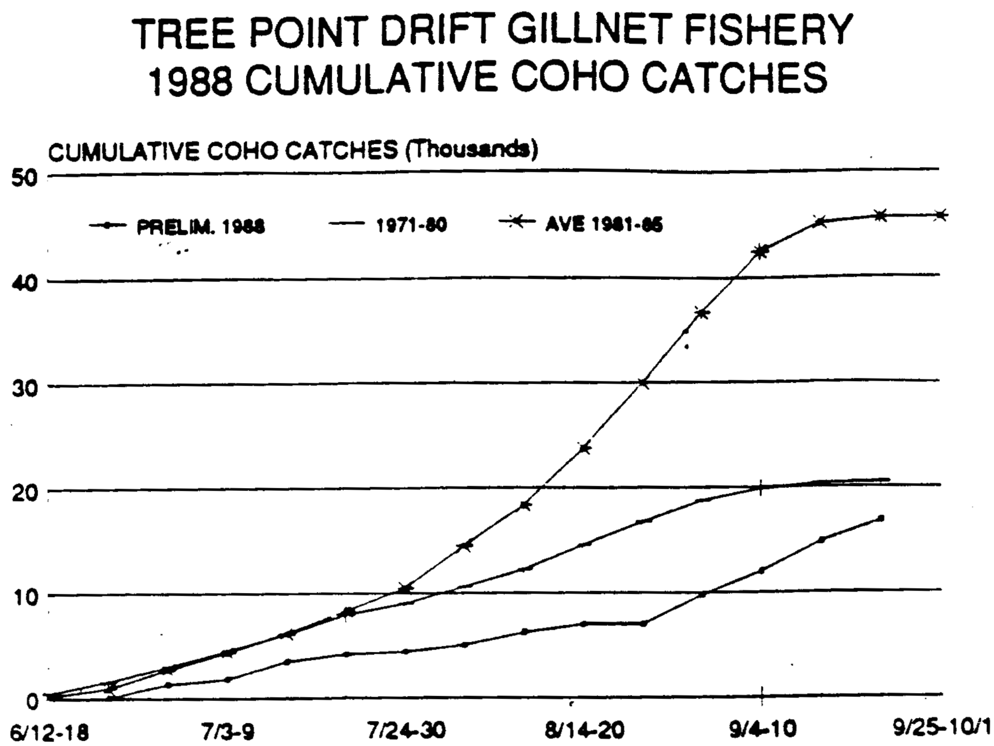

PRINCE OF WALES DRIFT GILLNET FISHERY
1988 CUM. COHO CATCH PER BOAT DAY
CUM. COHO PER BOAT DAY
PRELIM. 1988
1971-80
AVE 1981-85
CLOSED
0
100
200
300
400
500
6/12-18
7/3-9
7/24-30
8/14-20
9/4-10
9/25-10/1

Figure 41.



TREE POINT DRIFT GILLNET FISHERY
1988 WEEK COHO CATCH PER BOAT DAY
WEEK COHO PER BOAT DAY
50
40
30
20
10
0
6/12-18
6/26-7/2
7/10-16
7/24-30
8/7-13
8/21-27
9/4-10 (N)
9/18-24 (N)
PRELIM. 1988
1971-80
AVE 1981-85

Figure 42.


TREE POINT DRIFT GILLNET FISHERY
1988 CUMULATIVE COHO CATCHES
CUMULATIVE COHO CATCHES (Thousands)
PRELIM. 1988
1971-80
AVE 1981-85
50
40
30
20
10
0
6/12-18
7/3-9
7/24-30
8/14-20
9/4-10
9/25-10/1

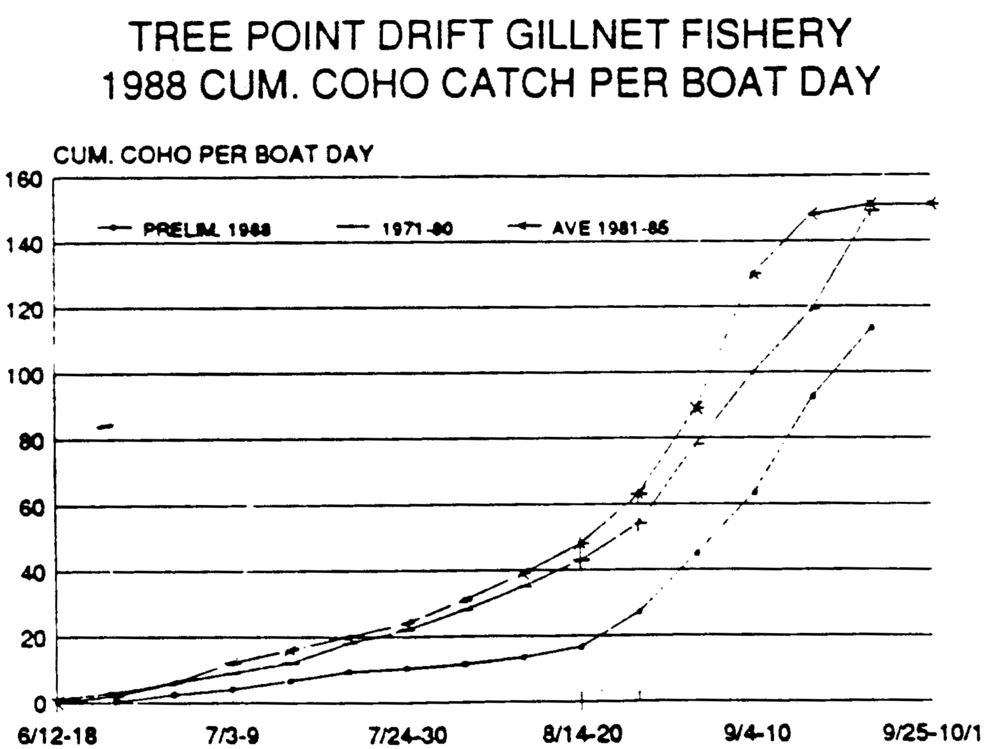
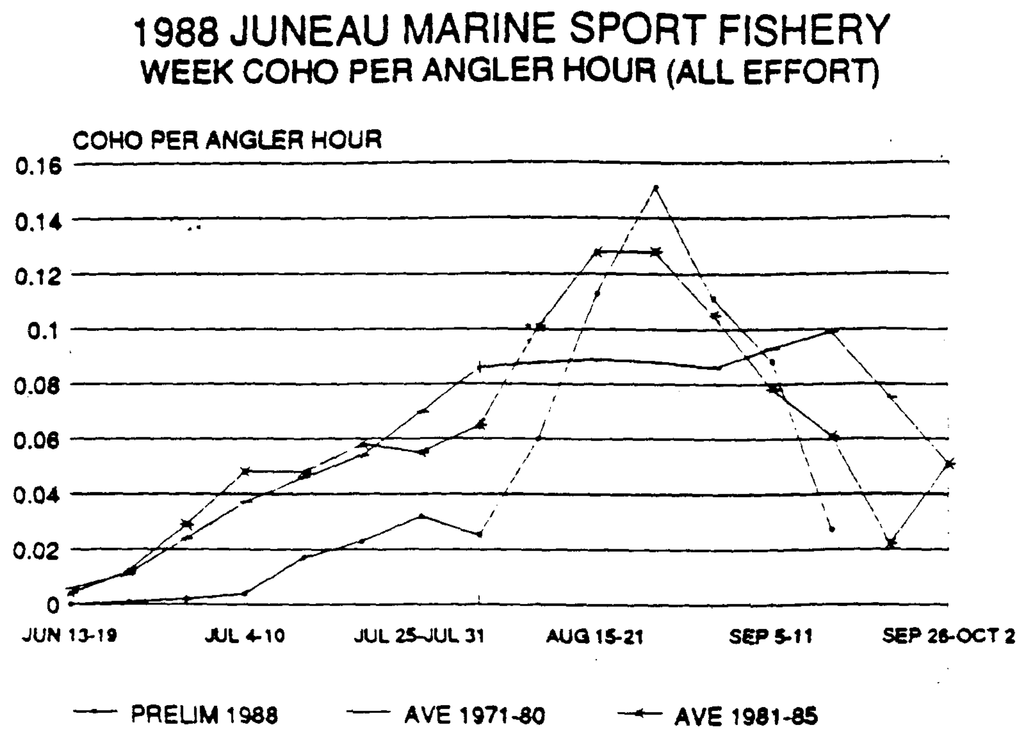

TREE POINT DRIFT GILLNET FISHERY
1988 CUM. COHO CATCH PER BOAT DAY
CUM. COHO PER BOAT DAY
PRELIM. 1988
1971-80
AVE 1981-85
160
140
120
100
80
60
40
20
0
6/12-18
7/3-9
7/24-30
8/14-20
9/4-10
9/25-10/1

Figure 43.


1988 JUNEAU MARINE SPORT FISHERY
WEEK COHO PER ANGLER HOUR (ALL EFFORT)
COHO PER ANGLER HOUR
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
JUN 13-19
JUL 4-10
JUL 25-JUL 31
AUG 15-21
SEP 5-11
SEP 26-OCT 2
PRELIM 1988
AVE 1971-80
AVE 1981-85

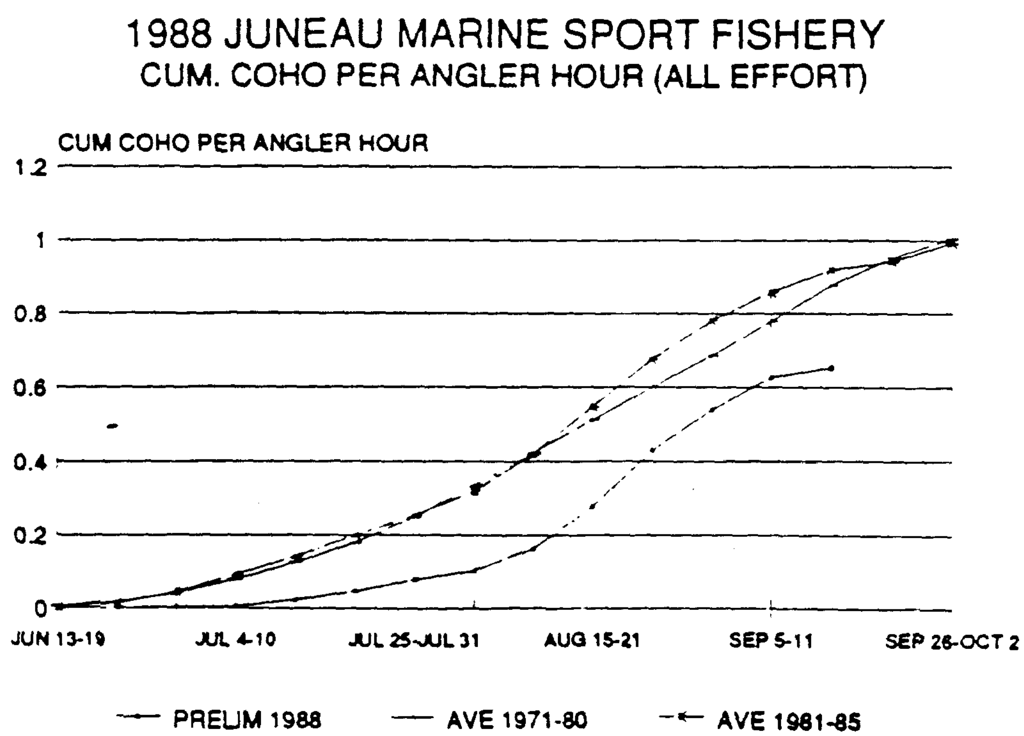
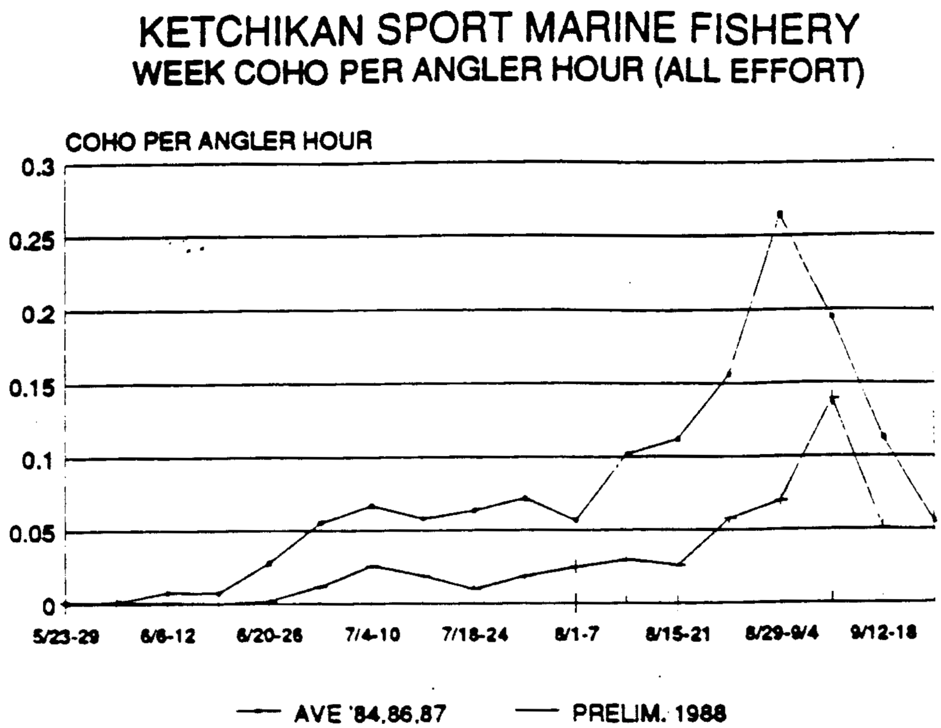

1988 JUNEAU MARINE SPORT FISHERY
CUM. COHO PER ANGLER HOUR (ALL EFFORT)
CUM COHO PER ANGLER HOUR
1.2
1
0.8
0.6
0.4
0.2
0
JUN 13-19
JUL 4-10
JUL 25-JUL 31
AUG 15-21
SEP 5-11
SEP 26-OCT 2
PRELIM 1988
AVE 1971-80
AVE 1981-85

Figure 44.


KETCHIKAN SPORT MARINE FISHERY
WEEK COHO PER ANGLER HOUR (ALL EFFORT)
COHO PER ANGLER HOUR
0.3
0.25
0.2
0.15
0.1
0.05
0
5/23-29
6/6-12
6/20-26
7/4-10
7/18-24
8/1-7
8/15-21
8/29-9/4
9/12-18
AVE '84,86,87
PRELIM. 1988

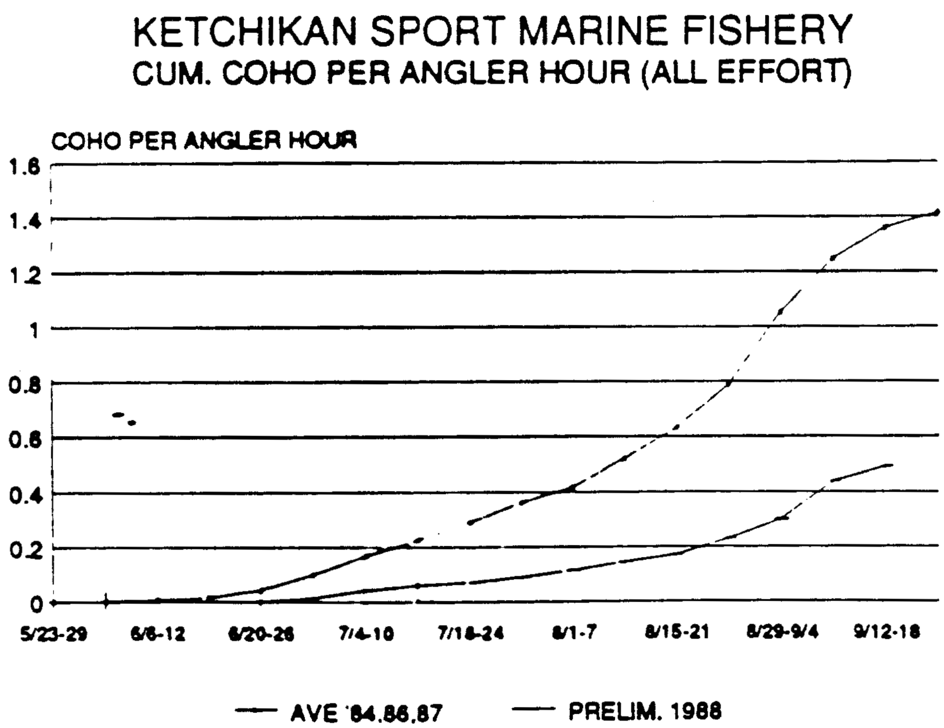

KETCHIKAN SPORT MARINE FISHERY
CUM. COHO PER ANGLER HOUR (ALL EFFORT)
COHO PER ANGLER HOUR
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5/23-29
6/6-12
6/20-26
7/4-10
7/18-24
8/1-7
8/15-21
8/29-9/4
9/12-18
AVE '84,86,87
PRELIM. 1988

Figure 45.