CONTRIBUTION OF ALASKAN, CANADIAN, AND TRANSBOUNDARY SOCKEYE STOCKS TO CATCHES IN SOUTHEAST ALASKA PURSE SEINE AND GILL NET FISHERIES, DISTRICTS 101-108, 1988, BASED ON ANALYSIS OF SCALE PATTERNS

By

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ABSTRACT

Sockeye salmon (*Oncorhynchus nerka*) harvested in southern Southeast Alaska's 1988 gill net and purse seine fisheries were classified to nation and/or stock of origin using linear discriminant function analysis of scale patterns and age composition data. We estimated that 225 thousand (26%) of the classified catch was of Alaskan origin, 624 thousand (73%) were bound for the Canadian Nass and Skeena Rivers, and 3 thousand (0.3%) were of transboundary Stikine River (including Tahltan Lake stock) origin. Separate Nass and Skeena River contribution estimates are presented for some districts. Stock contribution estimates are presented by age class and week for all major fisheries.

KEY WORDS: sockeye salmon,(*Oncorhynchus nerka*), stock composition, linear discriminant function analysis, scale pattern analysis, Southeast Alaska, northern British Columbia, Canada, Boundary Area.

INTRODUCTION

Commercial net fisheries in southern Southeast Alaska harvest mixed stocks of sockeye salmon (*Oncorhynchus nerka*) that originate from lakes, rivers and streams in Southeast Alaska and northern British Columbia (Rich and Morton 1930; Verhoeven 1952; Norenberg 1959; Logan 1967; Simpson 1968; Hoffman et al. 1983, 1984). The Alaska sockeye originate primarily from numerous relatively low or moderately productive Alaskan systems in the immediate vicinity (Figure 1). The Canadian sockeye originate principally from the Nass and Skeena Rivers. The Nass and Skeena Rivers lie entirely within British Columbia and flow into Chatham Sound just south of the Alaska border (Figure 2). Transboundary Stikine River sockeye, including Tahltan Lake stocks, are typically found in identifiable numbers only in Districts 106 and 108 and contribute relatively minor numbers of fish to area catches. In some years south-migrating stocks of sockeye salmon, thought to be predominately bound for the Fraser River in southern British Columbia, may be caught in some Southeast Alaskan fisheries. Contributions of these south-migrating stocks are estimated separately in years when they are present in identifiable numbers. Rarely, a few sockeye salmon returning to northern Southeast Alaska and to systems as distant as Prince William Sound, Alaska, or Washington State may also be taken but they are so uncommon that separate contribution estimates of these stocks are not feasible.

The purpose of this study is to determine the national origin of major sockeye stocks contributing to the Alaskan commercial purse seine and gill net fishery catches in Districts 101 through 108 (Figure 3). Reliable estimates of the relative Alaskan and Canadian stock compositions of sockeye salmon harvested in Southeast Alaska waters are valuable for implementation of the U.S.-Canada Pacific Salmon Treaty. This information is useful for evaluating interceptions, calculating productivity, as well as determining migratory timing and entry patterns. National equity, or benefits equal to production, requires that accurate rates of interceptions of one nations stocks by the other nations fisheries be determined. Linear discriminant function analysis of scale patterns is used to distinguish the stock groups. Significant and persistent differences between sockeye salmon stock groups originating in Alaska and Canada continue to be documented in the patterns of growth during freshwater and early marine life history (Marshall et al. 1984; Oliver et al. 1983, 1984; Oliver and Walls 1985; Oliver and Jensen 1986; Oliver and McGregor 1986; Oliver et al. 1987; Oliver et al 1987; Oliver 1988). Most sockeye salmon from Alaskan stocks grow slower during their lacustrine residence which results in scales with smaller freshwater growth zones and fewer circuli than scales from Canadian stocks. Persistent differences in the number and spacing of circuli in the spring "plus growth" and first marine zones also exist between Alaskan and Canadian stock groups. These differences in growth allow easy and accurate separation of Canadian and Alaskan stocks (Oliver et al. 1983, Marshall et al. 1984, 1986). While the differences in scale patterns between Alaskan and Canadian stock groups is much greater than the differences within these groups, further separation of Canadian component stocks is possible. Differences in age composition as well as scale patterns allow Nass and Skeena River contributions to be estimated separately except for Districts 106 and 108, in which accurate estimation of Tahltan Lake sockeye is compromised when Nass and Skeena stocks are estimated separately.

The reader is referred to McPherson et al. (1989) for detailed information on the abundance, age, sex, and length composition of 1988 Southeast Alaska sockeye salmon catches and escapements. For detailed analyses of transboundary Stikine sockeye catches in Districts 106, 108, and the Canadian Stikine River fisheries see Jensen and Frank (1989). For analyses of transboundary Taku sockeye catches in District 111 and Canadian Taku River fisheries see McGregor et al. (1989).

METHODS

Numbers of Fish Caught

We obtained estimates of the hours open, number of boats fishing, and number of fish harvested by gear type, district, and week from the ADF&G, Division of Commercial Fisheries, fish-ticket data base RUNTIME program. Catches were summarized by "statistical week". Statistical weeks, hereafter referred to as "weeks", began on Sunday at 12:01 A.M. and end the following Saturday at midnight. These statistical weeks were numbered sequentially beginning with the first Sunday of the calendar year.

Scale Collection and Processing

Commercial gill net and purse seine landings of sockeye salmon in southern Southeast Alaska were sampled for scales by ADF&G, Commercial Fisheries Division employees at fish processing facilities in Petersburg, Ketchikan, Craig, Steamboat Bay, Hydaburg, and Wrangell. Some sampling was also conducted at several smaller buying stations and aboard tenders or individual fishing vessels. Gender was determined and recorded for each fish sampled. Mid-eye to fork-of-tail length was recorded for 25% of the fish sampled.

Efforts were made to sample landings as representatively as possible. Fish were sampled at random from deliveries at all major ports of landing and from multiple vessels and tenders. Deliveries with fish of mixed gear types, districts, or weeks were not sampled.

One scale from each fish was sampled from up to 600 sockeye salmon caught in each district for each weekly opening of gill net and purse seine fisheries. When finer spatial stratification was desired up to 600 samples were collected weekly from each sub-district of the fishery. The sampling goal was intended to yield 510 ageable samples for each gear type/district/week strata which would allow accurate estimation of relative numbers of each major age class to within plus or minus 5 percentage points 90% of the time based on standard binomial formula (Cochran 1977). We assume that 20% of the scales will be unageable due to regeneration or other causes. Recent work by Thompson (1987) in simultaneously estimating parameters of a multinomial population indicates that 510 ageable scales of four major age classes yields an age proportion estimate with a precision of plus or minus 5% and a probability of 95%. Detailed age, gender, and length data for Southeast Alaskan catches and escapements are not presented in this report, but can be found in McPherson et al. (1989).

Escapements to lake systems in southern Southeast Alaska (Figure 1) were sampled by ADF&G Commercial Fisheries Division personnel. Approximately 1000 to 1500 scales were collected each from test fisheries operating in the lower reaches of the Nass and Skeena Rivers by Canadian Department of Fisheries and Oceans Canada personnel (CDFO)(Figure 2). CDFO personnel also sampled sockeye salmon from the Tahltan Lake weir and from non-Tahltan Stikine escapements.

Scales were sampled from the preferred area above the lateral line on the left side of the fish on a diagonal downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963).

Scales were mounted on gum cards and impressions made in cellulose acetate (Clutter and Whitesel 1956). Age determinations were based on examinations of scales under moderate (40 to 60 power) magnification. Criteria used to assign ages were similar to those of Mosher (1968). Ages are reported in European notation. Scale circuli were counted and incremental distances measured or "digitized" according to zones that represent the life history stages of the fish (Figure 4). Scale impressions were projected onto a digitizing tablet at 100 power magnification using equipment similar to that described by Bilton (1970) and modified by Ryan and Christie (1976). Counts and measurements were made along a line starting at the scale focus (center) at an angle approximately 20 degrees from the long axis and perpendicular to the sculptured field.

Discriminant Analysis

The ability to differentiate salmon stocks based on scale patterns depends upon the degree of difference in the scale characters between stocks (Marshall et al. 1987). Linear discriminant function analysis (LDF) (Fisher 1936) of scale patterns has been used to estimate stock contributions to southern Southeast Alaska mixed stock sockeye salmon fisheries since 1982 (Oliver 1988; Oliver et al. 1987; Oliver and Jensen 1986; Oliver and Walls 1985; Oliver et al. 1984).

The major assumptions underlying LDF analysis are: 1) the groupings investigated are discrete and identifiable; 2) the parent distributions of the measured variables are multivariate normal; and 3) the variance-covariance matrices for all groups are equal. Gilbert (1969) found LDF satisfactory if the variance-covariance matrices were not too different. In addition, large sample sizes appear to make LDF robust to the assumption of common variance-covariance matrices (Issacson 1954; Anas and Murai 1969). The method also appears to be robust to violations of the normality assumption for discrete distributions.

Scale variables to be used in the LDF are selected with a stepwise regression. In this process, variables are added until the partial F-statistic of all variables available for entry into the model is less than 4.00 (Enslein et al. 1977) or until asymptotic accuracy is reached. An almost unbiased estimate of classification accuracy for each LDF was determined using a leaving-one-out procedure (Lachenbruch 1967). One sample is 'left-out', the discriminant rule is estimated, and the 'left-out' sample is classified using the discriminant rule and checked to see if it was classified correctly. This procedure is repeated for all samples. Thus, when an LDF is run using the leaving-one-out procedure, a classification matrix is developed which gives the proportion of correctly identified fish and the proportion of misclassification of each stock to each of the other stocks.

When more than two stock groups are being analyzed the stepwise regression procedure does not always result in maximum classification accuracies or the most balanced classification matrix. Frequently, well-separated groups are separated even further while poorly separated groups remain poorly separated (Habbema and Hermans 1977). Scale variables that provided the best discrimination between the groups that most often misclassified as each other were occasionally added to or substituted for other variables used in the LDF to provide either a better balance to the classification matrix or to increase the mean classification accuracy.

The proportional estimates of stock composition in the mixed stock harvests, referred to as first order estimates, were adjusted with a classification matrix correction procedure (Cook and Lord 1978). The fish in the mixed stock composition sample are classified with the LDF. The vector of proportional estimates for each stock or stock group is multiplied by the classification matrix to give new estimates, referred to as adjusted estimates, for

the true proportions of stocks and stock groups in the mixed stock fishery. In cases where adjusted estimated proportions for a stock group were less than zero, the entire catch sample was reclassified with a model excluding that stock group. This process was repeated until all adjusted estimated proportions were positive.

The variance and 90% confidence intervals of the adjusted estimates of stock proportions were computed according to Pella and Robertson (1979). The variance-covariance matrices for the misclassification matrix and for the mixed stock proportion vector are determined from the multinomial probability distribution. These two variance-covariance matrices are combined to give variances and covariances for the second order estimates of stock proportions. The variances for the proportions of each stock are the diagonal elements of this combined matrix, i.e. they are an additive combination of: 1) the sampling variation in estimation of the probability of assignment of the known stock group and 2) the sampling variation in estimation of the assignment composition of the mixed stock group.

Classification of Catches

The commercial catches are classified by stock composition based on standards assembled from the 1988 escapements. Four major age groups, 1.2, 1.3, 2.2, and 2.3 (European notation), generally contribute more than 98% of the commercial catches. Whenever possible, standards were built for each age class. Standards are not built for age classes which contributed only a minor fraction of the escapement for a given stock or stock group because sample size would be insufficient. In 1988 no age 2.2 or 2.3 Skeena standards could be built. Age specific models are used in the analysis to: 1) account for differences in age composition between stocks, 2) remove potential bias due to differences in migratory timing of different age fish, and 3) eliminate the effect of different environmental conditions on the scale patterns of different age fish. Stock contributions are estimated for each week to track temporal patterns; however, some weeks catches are small and sample size of the less common age groups insufficient to classify unless pooled with the adjacent week's sample.

The stock apportionment of the minor age groups not classified with LDF assumes that the proportion of the minor ages belonging to any given stock is equal to the combined proportion of all LDF classified age classes.

The variance of the weekly and seasonal stock composition estimates are approximated with the delta method (Seber 1982). Variance estimates are functions of the variances associated with the weekly: 1) estimated age composition of the catch, 2) age specific stock composition estimates, and 3) sample size of the age composition, and 4) catch size. However, it is a minimum estimate of variance since it does not include any variance associated with the age classes not classified with LDF nor any variance for stocks contributing no fish during a given week.

Development of Standards

Stock identification analyses from 1982 through 1985 only distinguished between Alaskan and Canadian sockeye stocks in most districts. Additional stock groups, Tahltan and other Stikine River stocks, were added in districts where Stikine River fish were relatively numerous, e.g. Districts 106 and 108. In 1986 stock groups were further refined in order to obtain more specific stock origin data. The Canadian group was split into Nass and Skeena

River stocks. Nass and Skeena River standards remain combined for a single contribution estimate in the Districts 106 and 108 gill net fisheries due to potential misclassification with Tahltan Lake stocks (accurate estimation of which is a primary objective of the District 106 and 108 analyses) or Nass and Skeena River stocks when estimated separately.

The effect of modifying the discriminant models from 2-way Alaska vs. Nass/Skeena to 3-way Alaska vs. Nass vs. Skeena was investigated and was shown to change national contribution estimates by only a few hundred fish.

RESULTS AND DISCUSSION

Fishery Dynamics

Gill net fishing in southern Southeast Alaska Districts 101 and 106 opens by regulation the third Sunday in June. Opening of the District 108 gill net fishery is sometimes delayed until annual abundance of Stikine River stocks is known. Some purse seine fisheries (generally Districts 104 and 101) open the first Sunday in July while others, more terminal in nature and directed on local stocks, open as concentrations of fish, particularly pink salmon, become available. Primary management objectives include meeting spawning escapement goals and compliance with provisions of the U.S.-Canada Pacific Salmon Treaty. Achievement of management objectives is accomplished through manipulation of fishing time and harvest areas. This manipulation of time and area openings affects stock composition of catches. The amount of fishing time allowed early in the season depends to some extent on the abundance of sockeye and to a lesser extent chum salmon. Later in the season length of openings depends on the abundance of pink salmon. Fishing time is also affected by the U.S.-Canada Pacific Salmon Treaty which limited purse seine sockeye harvest in District 104 through statistical week 30 (about mid-July) to a 4 year total (1985 - 1988) of 480 thousand fish, or an average of 120 thousand sockeye a year. In the District 101-11 gill net fishery the Treaty limits sockeye catch to a yearly average of 130 thousand. Purse seine fisheries in Districts 103, 105, 106 and 107 are open only at times of localized pink salmon abundance generally occurring in late July and August targets on concentrations of pinks moving toward their spawning streams. Gear may move freely within Southeast Alaska fisheries and can concentrate rapidly where and when fish are abundant. In years of high pink salmon abundance, concentration of gear in conjunction with long openings can result in high incidental catches of sockeye salmon in late July and early August even though sockeye abundance is declining. Hours open, boats fishing, sockeye catch, and sockeye catch per boat-day (CPUE) by week for gill net and purse seine fisheries are detailed in Tables 1 and 2.

Fishery Performance

The 1988 southern Southeast Alaska net catch of 852 thousand sockeye salmon is above the average catch recorded since stock composition analyses were begun in 1982. Since 1982 sockeye salmon catch has ranged from a high of 1 million 50 thousand in 1985 to a low of 577 thousand in 1984 (Table 3).

National Origin of Southern Southeast Sockeye Catches

The proportion of Alaskan, Nass, Skeena, Tahltan and Stikine sockeye salmon harvested in the catch varied between gear types, districts, and time. Tahltan Lake and Stikine River sockeye salmon stocks were present in detectable levels in only Districts 106 and 108.

Approximately 851 thousand of the 852 thousand sockeye salmon harvested in 1988 net fisheries in southern Southeast Alaska (Districts 101-108) have been allocated to nation and/or stock group of origin. About 5 hundred sockeye salmon caught in the District 105 purse seine and District 102 gill net fisheries cannot be allocated due to a lack of samples. Of the 851 thousand sockeye salmon analyzed, an estimated 225 thousand (26.4%) were bound for systems in Alaska, 624 thousand (73.3%) were bound for the Canadian Nass and Skeena Rivers and 2.8 thousand (0.3%) were from the Transboundary Stikine (Table 4).

The estimated catch of 225 thousand Alaskan origin sockeye or 26% of the analyzed catch of 851 thousand is both numerically and proportionally the lowest Alaska contribution since stock contribution analyses were begun in 1982. Alaska stocks contributed 254 thousand (53%) of the area catch in 1987, 284 thousand (34%) in 1986, 381 thousand (36%) in 1985, 241 thousand (42%) in 1984, 273 thousand (30%) in 1983, and 333 thousand (43%) in 1982 (Table 1). Conversely, estimated Canadian Nass and Skeena River contributions of 624 thousand were nearly the highest on record. In analyses since 1982 Stikine River sockeye stocks have never contributed more than a small fraction of area catches.

The increased catch of Canadian origin sockeye and the decline in catch of Alaskan stocks may have been due to a combination of factors including better than average sockeye returns to Canada's Skeena River and below average or poor returns to Alaskan systems. Catches in Canadian fisheries targeting on Skeena River sockeye stocks were above average and the escapement of Skeena River sockeye, estimated at 1.4 million, was about 400 thousand over the goal. A poor return of Canadian Nass River sockeye occurred with both below average catches in directed Canadian fisheries and escapements below goal. Escapement to McDonald Lake (by far the most productive Alaskan system contributing to southern Southeast fisheries) was estimated at 70 thousand sockeye, a decline from the prior five year average of 110 thousand, this despite local reductions in fishing effort which should have reduced exploitation rates. Another factor influencing stock composition of catches may have been changes in relative purse seine effort between districts. Sockeye catch in District 104 accounted for 69% of the District 101-108 sockeye catch, an increase over the 1982-1987 average of 49%. Increased fishing time and boats fishing early in the season in District 104 resulted in increased harvest of Alaska stocks which are most common at this time.

The shift of gear to District 104 also increased the catch of Skeena River sockeye salmon in District 104. Increased fishing time in District 104 early in the season and a lack of fishing opportunities elsewhere attracted much of the Southeast purse seine fleet. Many of these boats remained in the area anticipating the predicted large return of pink salmon to the area. Fishing time was reduced when the poor return of pink salmon became apparent fishing but much of the gear continued to fish District 104 harvesting large numbers of Skeena River sockeye salmon, which were common in the later portion of the season.

Stock Composition of the District 101-11 Gill Net Catch

The District 101-11 gill net fishery occurs in the southeastern portion of District 101 along the mainland coast just north of the Alaska-Canada border (Figure 3). After mid-July fishing time was reduced from the prior 10 year average due to the poor return of pink salmon. During statistical weeks 30 and 31 (July 17-30) the northernmost portion of the fishery was closed to minimize harvest of severely depressed Hugh Smith sockeye stocks. Chum catches were excellent throughout the area and sockeye catch may have been reduced as gill netters switched to larger mesh gear to target chum salmon.

The District 101-11 gill net harvest of 116 thousand sockeye salmon is slightly below the district average in which catches since 1982 have ranged from a low of 88 thousand to a high of 191 thousand (Table 3). Sockeye salmon catches were highest early in the season; peak sockeye catch of 32 thousand occurred in the second week of the season (week 27, June 26-July 2). Over 50% of the cumulative sockeye catch was taken by the end of the third week of the season (week 28, July 3-9) and 70% by the end of week 29 (July 10-16). Sockeye catch per boat-day (CPUE) was 27 in the opening week, rising to a maximum of 74 in week in week 28 (July 3-9). CPUE remained relatively strong through week 33 (Aug 7-13)(Table 1).

An estimated 15 thousand sockeye or 13% of the catch of 116 thousand were of Alaskan origin while 101 thousand or 87% were of Canadian origin including 73 thousand (63%) from the Nass River and 28 thousand (24%) from the Skeena River (Table 5, Figure 5).

Peak catches of Alaskan sockeye stocks at about 3 thousand per week occurred from weeks 27 through week 29 (June 26-July 16) and accounted for 68% of the Alaska catch for the season (Table 5, Figure 5). Peak CPUE of Alaskan stocks of 10 sockeye per boat-day occurred in week 28 (July 3-9)(Table 6, Figure 6).

Historically, the proximity and productivity of Hugh Smith Lake sockeye stocks may have affected the magnitude of Alaska contributions to the District 101-11 fishery. Hugh Smith Lake is located just north of the District 101-11 fishery and has been the second most productive sockeye system in southern Southeast Alaska in recent years (Figure 1). The level of catch of Alaskan sockeye in the District 101-11 gill net fishery has been associated with the level of sockeye escapement to Hugh Smith Lake. In 1982 both the catch of Alaskan sockeye stocks in District 101-11, estimated at 69 thousand or 36% of the catch, and the Hugh Smith escapement of 57 thousand, were the highest in recent years. In 1986, when Hugh Smith escapement was only 7 thousand fish the estimated Alaska stock contribution was only 13 thousand or 9% of the District 101-11 catch. The 1988 Hugh Smith escapement of 5 thousand sockeye was the poorest on record while estimated contributions of Alaskan sockeye stocks to the District 101-11 fishery of 15 thousand fish or 13% of the catch were the second lowest since 1982.

Nass River sockeye salmon were the most common stock in the District 101-11 catch contributing an estimated 73 thousand (63%) of the season's catch (Table 5, Figure 5). Over 50% of the cumulative catch of Nass sockeye occurred by the end of week 28 (July 3-9) and 80% was taken through week 30 (July 17-23). Maximum weekly catches of Nass River fish occurred during weeks 27 and 28 (June 26-July 7) when they contributed 20 thousand and 17 thousand (65% and 76%) respectively of catches of 32 thousand and 23 thousand. CPUE of Nass sockeye was relatively strong from the beginning of the season through week 30 (July 17-23) peaking in week 28 at 56 fish per boat day (Table 6, Figure 6). Since 1982 the majority of sockeye taken in the District 101-11 fishery have been of Canadian Nass and Skeena River origin (Table 3). In 1986, when separate estimates for Nass River

stocks became available, the District 101-11 catch of Nass River stocks was estimated at 108 thousand or 74% of the season's total. In 1987 Nass River stocks contributed an estimated 67 thousand or 62% of the district catch. The magnitude of the Nass River contribution is not surprising given size of the run (escapement goal is 200,000) and the close proximity of the river to the fishery (Figure 3).

Skeena River sockeye were the second most common stock group in District 101-11 contributing 28 thousand fish or 24% of the catch (Table 5, Figure 5). Most of the Skeena River sockeye catch in the district occurred in two widely separated weeks. In week 27 (June 26-July 2) 7 thousand fish, mostly age 1.3 were taken. Then in week 32 (July 31-Aug. 6) 10 thousand mostly age 1.2 fish were taken. Peak CPUE of Skeena stocks was in week 32 at 19 fish per boat-day (Table 6, Figure 6). Estimated catch of Skeena River sockeye in District 101-11 was the highest since 1986 when Skeena contributions were first estimated separately. In 1986 Skeena sockeye contributed an estimated 24 thousand (17%) of a catch of 146 thousand, and in 1987 an estimated 16 thousand (14%) of 108 thousand. While 50% of the cumulative catch of both Alaska and Nass sockeye salmon was taken by the end of week 28 (July 3-9), 50% of the estimated Skeena catch was not taken until week 30 (July 17-23). In all three years for which estimated Skeena River sockeye contributions to the fishery are available their peak contribution occurred later in the season than Alaska or Nass stock groups.

Stock Composition of the District 101 Purse Seine Catch

The amount of District 101 open to the purse seine fishery varies weekly during the season depending primarily on the abundance and distribution of pink salmon in the district. Areas and duration of openings also vary for the same week from year to year. In 1988 only the southern portions of the district in lower Clarence Strait were open due to poor pink salmon returns. Differences in the portions of the district that are open makes comparison of catches and stock composition estimates difficult both within and between seasons. In 1988 the District 101 purse seine fishery was open portions of week 28 through week 34 (July 3-Aug. 20). The catch of sockeye salmon of 33 thousand was the lowest since 1982; poor returns of Alaska stocks which have been an important component of prior years catches may have been part of the reason for the reduced catch.

Only about a thousand sockeye were caught in the initial opening in week 28 (July 3-9)(Table 2). For the next 3 weeks (July 10-30) catches ranged from 3 to 6 thousand a week and reached a peak weekly catch of 12 thousand or 30% of the season total in week 32 (Aug. 7-13). Catches dropped from a few thousand to a few hundred a week in the last two weeks the district was open, weeks 33 and 34 (Aug. 7-20). Peak CPUE of 82 fish per boat-day occurred in week 31 (July 24-30)(Table 2).

Alaska sockeye contributed an estimated 13 thousand (41%) of the seasons catch while 19 thousand (59%) were of Canadian origin of which an estimated 12 thousand (37%) were from the Nass River and 7 thousand (22%) were from the Skeena (Table 7). While Alaska stocks remained the most common of the three stock groups their contribution was the lowest, both in numbers and proportion of catch, since analyses were begun in 1982 (Table 1). As in 1986 and 1987 the proportion of Nass River sockeye in the catch was highest early in the season but declined in importance relative to other stock groups as the season progressed even though the numbers of Nass stocks caught increased. Skeena River sockeye contributed only a few hundred fish a week until late in the season when, in week 32 (July 31-Aug. 6), 4.6 thousand fish or 64% of the seasonal Skeena catch for the district was taken. Peak catch of all three stock groups occurred in week 32 (July 31-Aug. 6) when an estimated 3.5 thousand (28%) were Alaskan, 4 thousand (35%) were from the Nass River, and 4.6 thousand (37%) were

from the Skeena. Peak CPUE of both Alaska and Nass stocks occurred in week 31 (July 24-30) at 40 and 32 fish per boat-day respectively. Peak CPUE of Skeena River sockeye was one week later in week 32 (July 31-Aug. 6) at 20 per boat-day (Table 6, Figure 8).

Stock Composition of the District 102 Purse Seine Catch

The District 102 purse seine fishery was open portions of weeks 29 and 30 (July 10-23), then closed for a week, reopening from week 33 through week 41 (Aug. 7-Sept. 24). In the later portion of the season, from late August through September, the fishery targeted local runs of Fall chum salmon and few sockeye were taken. Catches of sockeye salmon in the District 102 fishery were relatively low due to reduced effort in late July and early August due to poor returns of pink salmon as well as local Alaskan sockeye stocks. As with the District 101 purse seine fishery, low returns of pink salmon resulted in openings only in the southern portions of District 102. Fisheries in District 102 were particularly affected by poor weather in 1988.

Of 14.8 thousand sockeye taken in District 102 an estimated 10.3 thousand (70%) were of Alaskan origin and 4.5 thousand (30%) were Canadian, of which 1.4 thousand (9%) were from the Nass and 3 thousand (21%) were from the Skeena Rivers (Table 8, Figure 9). Contributions of Alaskan and Canadian stocks in the district were similar, both numerically and proportionally, to prior years. Peak CPUE for Alaska and Nass stocks occurred in the first week of the season while peak CPUE for Skeena stocks occurred later (Table 6, Figure 10).

Stock Composition of the District 103 Purse Seine Catch

Due to a lack of pink salmon only the southern portion of the District 103 purse seine fishery was open from week 34 through week 38 (Aug 7-Sept. 24)(Table). A total of only about 2.4 thousand sockeye salmon were caught in the District 103 purse seine fishery. This catch resulted in small sample sizes necessitating pooling of the weekly samples for a single season's stock composition estimate. For the first time since analyses were begun in 1982 Alaskan stocks contributed less than half the catch. Of the catch of 2.4 thousand an estimated 8 hundred fish (33%) were of Alaskan origin and 1.5 thousand (67%) were Canadian, including 3 hundred (15%) from the Nass River and 1.2 thousand (52%) from the Skeena (Table 9).

Historically sockeye catches in District 103 are typically not high. The fishery is primarily targeted on late run pink salmon stocks returning to the west coast of Prince of Wales Island. The fishery does not open until sufficient pink salmon move into the area from outer coastal waters, by which time most sockeye salmon are in protected terminal areas or on the spawning grounds. In years of local low pink salmon abundance the fishery may not open at all. There are several systems in the district with small to moderate runs of sockeye as well as numerous systems which added together may produce large runs of pink and chum salmon.

Stock Composition of the District 104 Purse Seine Catch

Unlike other southern Southeast purse seine fisheries all portions of the District 104 fishery are usually open throughout the season. Purse seine effort in District 104 is concentrated near capes and headlands along the outer coast from Noyes to Dall Islands. There are no sockeye producing systems of any note in the district itself, however, there are several moderately productive systems located just to the east along the western coast of Prince of Wales Island. Peak abundance of Alaskan and Canadian Nass River stocks occurs early in the season while peak abundance of Canadian Skeena stocks occurs somewhat later. Substantial numbers of Canadian sockeye stocks, particularly from the Skeena and the Nass Rivers but also in some years the Fraser are harvested in the fishery. Fraser sockeye stocks, when present, apparently peak in abundance later in the season. While sockeye abundance is usually greatest early in the season, increases in hours open and boats fishing later in the season often results in large sockeye salmon catches. Enormous numbers of pink salmon, primarily bound for streams and rivers along the Alaska mainland early in the season and local Alaska island streams later in the season, are often taken in this district (Hoffman 1983, 1984). In 1986, a record 8 million pink salmon were taken in one week by the District 104 purse seine fleet at the peak of the season. In general the direction of sockeye migration through the district seems to be from north to south (Hoffman 1983, 1984). Weather along this unprotected coast can significantly affect catches regardless of fishing effort or the abundance of fish. Fishing time since 1985 has been restricted from the beginning of the season through week 30 (mid-July) to maintain sockeye catches within a 4 year (1985-1988) ceiling of 480 thousand, or an average annual catch of 120 thousand, as agreed under terms of an annex to the U.S.-Canada Pacific Salmon Treaty. At the start of the season in 1988, an above average 215 thousand sockeye remained to be taken in the final year of this agreement. Higher than average sockeye abundance, increased numbers of boats fishing, and extra hours open to fishing, combined to produce an excellent catch of 249 thousand sockeye salmon through week 30, exceeding Treaty obligations by approximately 34 thousand fish (Table 2).

In some years large numbers of Fraser River sockeye stocks may be caught in the District 104 purse seine fishery. Pacific Salmon Commission (PSC) biologists have examined sockeye scales sampled from District 104 purse seine catches since 1982. In 1983 the PSC estimated that Fraser River sockeye contributed significant numbers to the district catch of 651 thousand. In other years no Fraser sockeye are taken in the fishery. Since District 104 apparently represents the northern limit of Fraser sockeye landfall there may be a gradient of Fraser sockeye within the district. PSC biologists were concerned that ADF&G's samples might not be representative of the district catch. Catches, particularly from the southern portions of the district, are often sold to tenders stationed on the grounds and mixed with fish from other portions of the district prior to delivery. The location where these fish were caught cannot be determined by the time they reach port (they are identified as general district samples on the sampling form). Seine boats fishing in the northern portion of the district are much closer to ports and more often deliver their catch directly to processors so being able to determine the specific catch site is more likely. This lack of identifiable samples from southern portions of the district gives the illusion that higher than representative numbers of samples are coming from the northern portions of the district. If a higher proportion of northern catches were sampled, and if Fraser stocks were more common in southern catches, the result would be the underestimation of Fraser catches. ADF&G's position was that the chance of non-representative sampling was minimized since: we routinely were collecting over twice as many samples as are typically collected by other agencies; no more than 50 fish were sampled from any one fishing boat or tender; and samples were collected in at least 3 different ports. However, ADF&G agreed to increase sample sizes and attempt to collect sufficient sub-district specific samples such as to allow separate stock composition analysis of catches both in the northern and southern portions of the district. We were successful in obtaining sufficient

samples for these analyses in 1988. Unfortunately (for this study), analysis of the samples by the PSC indicated no interceptions of Fraser stocks so testing the theory of a gradient in Fraser proportions will have to wait. However, we did use a Z statistic to test for significant differences in proportions of Alaska, Nass and Skeena stock groups in samples collected from northern against those collected from the southern portions of the district. Although there were often significant differences in stock proportions (Appendix A), it is possible that these differences were due to random sampling differences rather than a gradient of stocks across the district. In this report stock composition estimates are presented separately for weekly catches in northern and southern portions of District 104.

District 104 was open to purse seining portions of weeks 28 through 36 (July 3-Sept. 3). Alaska stocks contributed an estimated 18% or 104 thousand of the catch of 591 thousand sockeye salmon taken throughout the 1988 District 104 purse seine fishery. Canadian stocks contributed 487 thousand or 82% of the catch of which an estimated 36 thousand (6%) were from the Nass River and 452 thousand (76%) were from the Skeena (Table 3). As with other southern Southeast Alaska purse seine fisheries the proportional Alaska contribution was the lowest since analyses were begun in 1982. However, numerically the estimated Alaska contribution in the district was higher than average. Good catches of Alaskan sockeye may have been partly due to extra hours open and increased effort early in the season when Alaska stocks are more abundant. The high proportion and catch of Skeena River sockeye salmon was probably due to the excellent return of this stock group. The 1988 sockeye catch of 591 thousand was second only to the record catch in 1983 of 651 thousand of which a substantial proportion were bound for the Fraser River. The peak weekly catch of 211 thousand sockeye or 36% of the season's total in week 32 (July 31-Aug. 6) was the largest weekly sockeye catch ever recorded in the district and is greater than the total seasonal catch in many years (Table 2). Second highest weekly sockeye catch of 131 thousand occurred in week 29 (July 10-16). Maximum CPUE occurred in week 30 (July 17-23) at a record 825 fish per boat-day when 197 boats fishing 15 hours caught 102 thousand sockeye salmon. Sockeye CPUE was 532 fish per boat-day when the peak catch of 211 thousand sockeye occurred in week 32. High catches might also have occurred in week 31 (July 24-30) when a relatively low 30 thousand were caught if not for a severe storm which made fishing in exposed locations difficult.

Catch and boats fishing in the southern portion of District 104 includes sub-districts 104-10, 104-20 and half of 104-30. Northern District 104 includes half of sub-district 104-30, and sub-districts 104-35, 104-40, and 104-50. The 1988 catch of 213 thousand sockeye in the southern portion of District 104 included an estimated 48 thousand (22%) from Alaska and 165 thousand (78%) from Canada, of which 15 thousand (7%) were from the Nass River and 150 thousand (71%) were from the Skeena (Table 10, Figure 11). The catch of 379 thousand sockeye salmon in northern portion of the district included an estimated 56 thousand (15%) from Alaska and 322 thousand (85%) from Canada, of which 21 thousand (5%) were from the Nass River and 301 thousand (80%) were of Skeena River origin (Table 11, Figure 12).

Catch trends of Alaskan sockeye stocks were similar in northern and southern portions of the District 104 purse seine fishery. Peak weekly catches of Alaskan sockeye stocks in District 104 occurred in week 29 (July 10-16) when 21 thousand were taken in the south and 20 thousand in the north (Tables 10 and 11). Of the cumulative catch of Alaskan sockeye, 65% in the southern and 53% in the northern portion of the district occurred through the end of week 30 (July 17-23). Catches of all stocks were low in week 31 due to poor weather. Alaskan sockeye contributions rose in week 32 (July 31-Aug. 6) when 8 thousand were caught in the south and 14 thousand in the north. Catches remained relatively strong through week 33 (Aug. 7-13), then dropped to a few hundred fish a week. Peak CPUE of Alaska stocks occurred in week 30 (July 17-23) at 114 fish per boat-day in the south and 147 in the north (Table 6, Figure 13 and 14).

The catch of Nass River sockeye salmon in District 104 was estimated at 15 thousand (7%) of 213 thousand in the south and 21 thousand (5%) of 378 thousand in the north (Tables 10 and 11). Approximately 73% of the 1988 catch of Nass River stocks in the south, 11 thousand of 15 thousand, occurred in the first three weeks of the season (weeks 28-30, July 3-23), after which only a few hundred a week were caught for the remainder of the season. In the northern portion of the district catch of Nass stocks was spread over more weeks and continued later into the season with 80% of the catch occurring between weeks 29 and 32 (July 10-Aug. 6). Peak catch of Nass fish in the south occurred in week 29 (July 10-16) while peak catch in the north was in week 32 (July 31-Aug. 6). CPUE of Nass River stocks was relatively consistent in the south early in the season ranging from 24 to 32 fish-per-boat-day from week 28 through 31 (July 3-30), then dropped to a few fish a day for the remainder of the season (Table 6, Figure 13). In the north Nass CPUE peaked at 76 in week 30 (July 17-23) and remained above 30 through week 32 (July 31-Aug. 6)(Table 6, Figure 14).

Skeena River stocks contributed the majority of the catch throughout the season ranging from 53% to 87% of the weekly catch in both southern and northern portions of the district. Skeena sockeye contributed a total of 150 thousand (71%) of 213 thousand caught in the south and 301 thousand (80%) of 379 thousand caught in the north (Tables 10 and 11). Peak weekly Skeena catch in the south was in week 30 (July 17-23) at 47 thousand or 82% of 56 thousand caught. In the north the peak weekly Skeena catch of 153 thousand (88%) of 174 thousand in the north occurred in week 32 (July 31-Aug 6). Catch per boat-day of Skeena River was much higher and occurred later in the season than other stock groups (Table 6, Figures 13 and 14). Peak CPUE of Skeena stocks in the south was 657 fish per boat-day in week 30 (July 17-23). In the north peak Skeena CPUE of 648 occurred in week 32 (July 31-Aug. 6). In the first two weeks of the season age 1.2 and 1.3 Skeena River sockeye were taken in about equal numbers but after week 29 age 1.2 Skeena River sockeye were about 5 to 7 times more common than age 1.3.

Stock Composition of the District 106 and 108 Gill Net Catch

The District 106 gill net fishery was open for portions of weeks 26 through 36 (July 3-Sept. 3) in 1988. Of 93 thousand sockeye salmon taken an estimated 81 thousand (87%) were of Alaskan origin, 10 thousand (11%) were from both the Canadian Nass and Skeena Rivers, 2 thousand (2%) were from Tahltan Lake, and less than a hundred were of Stikine River stocks other than Tahltan. Only about 1.2 thousand sockeye were taken in District 108 of which less than 3 hundred (21%) were Alaskan, less than 1 hundred (4%) were from both the Nass and Skeena Rivers, 2 hundred (18%) were from Tahltan Lake and 7 hundred (57%) were from the Stikine River.

The primary objective of the District 106 and 108 scale pattern research is to estimate abundance of transboundary Stikine River (including Tahltan Lake) stocks of sockeye salmon. Contributions of Nass and Skeena stocks of sockeye salmon are not estimated separately due to misclassification problems with Tahltan Lake stocks. For a detailed examination of the fisheries in these districts, as well as Canadian fisheries in the Stikine River, the reader is referred to Jensen and Frank (1989).

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Table 1. Weekly hours open, boats fishing, sockeye catch, and sockeye catch per boat-day (CPUE) in southern Southeast Alaska gill net fisheries, 1988.

	District 101-11					District 106-30					District 106-41					District 108				
Week	Hours	Boats	Boat Days	Catch	CPUE	Hours	Boats	Boat Days	Catch	CPUE	Hours	Boats	Boat Days	Catch	CPUE	Hours	Boats	Boat Days	Catch	CPUE
26	96	112	448	12,187	27	48	9	18	560	31	48	37	74	1,693	23	48	7	14	151	11
27	96	142	568	31,542	56	48	30	60	2,760	46	48	49	98	5,756	59	48	8	16	397	25
28	54	141	317	23,364	74	48	31	62	2,909	47	48	44	88	5,879	67	48	11	22	313	14
29	96	158	632	15,183	24	72	31	93	9,796	105	72	48	144	14,922	104	48	4	8	385	48
30	48	127	254	9,014	35	48	55	110	7,875	72	48	59	118	10,340	88					
31	48	113	226	5,123	23	48	41	82	3,152	38	48	75	150	8,890	59					
32	96	133	532	13,988	26	48	40	80	5,404	68	48	38	76	7,004	92					
33	48	129	258	4,806	19	24	19	19	270	14	24	34	34	2,300	68					
34	48	127	254	803	3	24	59	59	1,955	33	24	20	20	410	21					
35						24	75	75	408	5	24	13	13	143	11					
36	39	97	158	145	1	24	24	24	103	4										
37	30	96	120	55	0															
38	6	78	20	18	1															
39	30	76	95	10	0															

Table 2. Weekly hours open, boats fishing, sockeye catch, and sockeye catch per boat-day (CPUE) in southern Southeast Alaska purse seine fisheries, 1988.

	District 101[a]					District 102					District 103[b]					District 104				
Week	Hours	Boats	Boat Days	Catch	CPUE	Hours	Boats	Boat Days	Catch	CPUE	Hours	Boats	Boat Days	Catch	CPUE	Hours	Boats	Boat Days	Catch	CPUE
28	15	74	46	965	21											39	86	140	16,280	116
29	30	128	160	5,142	32	30	8	10	2,025	203						54	209	470	130,926	278
30	15	68	43	2,847	67	15	5	3	592	189						15	197	123	101,583	825
31	15	112	70	5,729	82	25	0	0	0	0						15	118	74	30,244	410
32	39	141	229	12,478	54	39	32	52	5,941	114						39	244	397	211,083	532
33	54	156	351	4,807	14	54	68	153	3,556	23						54	287	646	68,003	105
34	15	64	40	690	17	15	48	30	673	22	15	24	15	395	26	15	228	143	14,662	103
35						54	111	250	1,376	6	54	218	491	1,474	3	54	277	623	15,060	24
36						30	59	74	176	2	30	203	254	482	2	30	134	168	3,444	21
37						36	147	221	320	1	36	44	66	26	0					
38						24	114	114	87	1	12	49	25	6	0					
39						77	97	311	47	0	77	17	55	0	0					
40						168	31	217	4	0	43	4	7	0	0					
41						168	10	70	1	0										

[a] Catch figures include a total of 1,475 fish from Nakat Bay (101-10) and Neets Bay (101-95) special harvest areas.
[b] Catch figures include 57 fish from Klawock special harvest area (103-60) in statistical weeks 35-36.

Table 3. Estimated sockeye contributions by nation of origin to southern Southeast Alaska's Districts 101-108 gill net and purse seine fisheries, 1982-1988.

		1982		1983		1984		1985		1986		1987		1988	
Fishery	Group	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
101-11	Alaska	69,510	36.4	48,942	36.0	34,762	39.4	30,904	17.9	12,732	8.7	25,091	23.3	14,813	12.7
Gill Net	Canada	121,373	63.6	87,064	64.0	53,464	60.6	141,959	82.1	132,899	91.3	82,489	76.7	101,432	87.3
	Total	190,883		136,006		88,226		172,863		145,631		107,580		116,245	
101	Alaska	41,401	56.1	20,493	42.8	49,209	60.3	82,376	68.9	50,261	67.2	30,088	69.4	13,430	41.1
P. Seine	Canada	32,416	43.9	27,419	57.2	32,445	39.7	37,189	31.1	24,484	32.8	13,241	30.6	19,245	58.9
	Total	73,817		47,912		81,654		119,565		74,745		43,329		32,675	
102	Alaska	18,296	80.4	6,620	59.0	17,653	82.4	27,197	78.3	8,698	73.5	16,397	93.8	10,344	69.9
P. Seine	Canada	4,451	19.6	4,593	41.0	3,764	17.6	7,549	21.7	3,142	26.5	1,076	6.2	4,454	30.1
	Total	22,747		11,213		21,417		34,746		11,840		17,473		14,798	
103	Alaska			7,053	67.9			19,829	74.5	9,798	72.2	1,544	97.7	792	33.2
P. Seine	Canada			3,336	32.1			6,795	25.5	3,773	27.8	37	2.3	1,591	66.8
	Total			10,389				26,624		13,571		1,581		2,383	
104	Alaska	107,492	37.7	157,795	24.2	78,821	26.8	93,988	21.8	100,966	22.7	68,741	40.1	104,042	17.6
P. Seine	Canada	177,739	62.3	493,012	75.8	214,847	73.2	337,587	78.2	343,024	77.3	102,473	59.9	487,243	82.4
	Total	285,231		650,807		293,668		431,575		443,990		171,214		591,285	
106	Alaska	94,187	48.7	32,670	66.7	60,367	65.8	126,952	47.9	100,334	68.8	112,893	82.7	80,868	87.4
Gill Net	Canada	61,976	32.0	10,610	21.7	24,661	26.9	111,051	41.9	42,784	29.3	21,190	15.5	9,784	10.6
	Stikine	37,365	19.3	5,693	11.6	6,761	7.4	27,064	10.2	2,687	1.8	2,344	1.7	1,877	2.0
	Total	193,528		48,973		91,789		265,067		145,805		136,427		92,529	
108	Alaska	1,632	25.0							930	22.2			265	21.3
Gill Net	Canada	3,787	58.0							73	1.7			48	3.9
	Stikine	1,110	17.0							3,184	76.0			933	74.9
	Total	6,529								4,187				1,246	
	Alaska	332,518	43.0	273,573	30.2	240,812	41.8	381,246	36.3	283,719	33.8	254,754	53.3	224,554	26.4
Total	Canada	401,742	52.0	626,034	69.2	329,181	57.1	642,130	61.1	550,179	65.5	220,506	46.2	623,797	73.3
	Stikine	38,475	5.0	5,693	0.6	6,761	1.2	27,064	2.6	5,871	0.7	2,344	0.5	2,810	0.3
	Total	772,735		905,300		576,754		1,050,440		839,769		477,604		851,161	

Table 4. Estimated contribution by stock group of origin of sockeye salmon harvested in net fisheries in Alaska Districts 101-108, 1988.

District	Type	Group	Estimated number	Percent	Standard[a] Error	90% C.I. Lower	90% C.I. Upper
101	Gill net	Alaska	14,813	12.7	1424.0	12,311	16,995
		Nass	73,101	62.9	2509.6	67,501	75,758
		Skeena	28,331	24.4	2023.7	24,640	31,298
		Total	116,245				
101	Purse seine	Alaska	13,430	41.1	659.9	12,345	14,515
		Nass	11,987	36.7	1150.8	10,094	13,880
		Skeena	7,258	22.2	972.3	5,659	8,857
		Total	32,675				
102	Purse seine	Alaska	10,344	69.9	380.2	9,590	10,841
		Nass	1,370	9.3	407.9	694	2,035
		Skeena	3,084	20.8	398.6	2,374	3,686
		Total	14,798				
103	Purse seine	Alaska	792	33.2	100.5	615	946
		Nass	346	14.5	165.8	73	619
		Skeena	1,245	52.2	156.3	961	1,475
		Total	2,383				
104 S	Purse seine	Alaska	47,580	22.4	3581.9	41,001	52,786
		Nass	14,718	6.9	3369.1	8,679	20,063
		Skeena	150,357	70.7	4431.5	141,553	156,132
		Total	212,655				
104 N	Purse seine	Alaska	56,462	14.9	6492.4	44,834	66,194
		Nass	20,899	5.5	2326.6	16,751	24,406
		Skeena	301,269	79.6	6662.5	285,456	307,376
		Total	378,630				
106	Gill net	Alaska	80,868	87.4	[b]		
		Nass/Skeena	9,784	10.6			
		Tahltan	1,813	1.9			
		Stikine	64	0.1			
		Total	92,529				
108	Gill net	Alaska	265	21.3			
		Nass/Skeena	48	3.8			
		Tahltan	222	17.8			
		Stikine	711	57.1			
		Total	1,246				
All Districts		Alaska	224,554	26.4			
		Nass/Skeena	623,797	73.3			
		Tahltan	2,035	0.2			
		Stikine	775	0.1			
		Total	851,161				

[a] The standard errors are minimum estimates since estimates of the variance for stocks contributing zero fish during a given week or for the 'other' age class are unavailable. This also applies to 90% confidence intervals.

[b] Standard errors and confidence intervals are presently unavailable for 106 gill net, 108 gill net, and the districts total.

Table 5. Estimated contribution of sockeye salmon stocks originating in Alaska and Canada to Alaska's District 101-11 drift gillnet fishery, 1988.

Dates	Group	Catch By Age Class					Total	Percent	Standard[a] Error	90% C.I.	
		1.2	1.3	2.2	2.3	Other				Lower	Upper
6/19-6/25	Alaska	192	0	277	62	49	580	4.8	280.5	69	991
Week 26	Nass	791	4,219	3,225	1,515	900	10,650	87.4	788.4	8,454	11,048
	Skeena	0	781	0	0	176	957	7.9	727.0	0	1,976
	Total	983	5,000	3,502	1,577	1,125	12,187				
6/26-7/02	Alaska	952	1,173	1,027	413	62	3,627	11.5	1031.3	1,868	5,261
Week 27	Nass	3,516	3,453	11,195	1,897	347	20,408	64.7	1723.6	17,224	22,895
	Skeena	1,034	6,336	0	0	137	7,507	23.8	1413.2	5,045	9,694
	Total	5,502	10,962	12,222	2,310	546	31,542				
7/03-7/09	Alaska	1,064	1,391	0	561	25	3,041	13.0	525.7	2,152	3,882
Week 28	Nass	2,793	3,124	10,921	733	142	17,713	75.8	1198.0	15,600	19,541
	Skeena	633	1,954	0	0	23	2,610	11.2	858.4	1,175	3,999
	Total	4,490	6,469	10,921	1,294	190	23,364				
7/10-7/16	Alaska	682	1,299	603	416	14	3,014	19.9	546.8	2,101	3,900
Week 29	Nass	2,970	492	5,545	648	46	9,701	63.9	794.9	8,349	10,964
	Skeena	1,054	1,402	0	0	12	2,468	16.3	575.5	1,509	3,403
	Total	4,706	3,193	6,148	1,064	72	15,183				
7/17-7/23	Alaska	315	394	398	295	7	1,409	15.6	320.0	875	1,928
Week 30	Nass	2,568	689	2,763	417	30	6,467	71.7	539.3	5,550	7,324
	Skeena	734	398	0	0	6	1,138	12.6	410.1	458	1,807
	Total	3,617	1,481	3,161	712	43	9,014				
7/24-7/30	Alaska	186	524	111	111	3	935	18.3	167.2	657	1,207
Week 31	Nass	1,171	170	757	221	8	2,327	45.4	353.0	1,739	2,900
	Skeena	1,298	557	0	0	6	1,861	36.3	309.3	1,346	2,364
	Total	2,655	1,251	868	332	17	5,123				
7/31-8/06	Alaska	169	410	485	206	0	1,270	9.1	362.9	673	1,867
Week 32	Nass	0	0	2,167	522	0	2,689	19.2	283.1	2,223	3,155
	Skeena	7,552	2,477	0	0	0	10,029	71.7	377.0	9,409	10,649
	Total	7,721	2,887	2,652	728	0	13,988				
8/07-9/24	Alaska	61	487	278	111	0	937	16.1	229.3	560	1,314
Weeks	Nass	728	429	1,707	282	0	3,146	53.8	384.1	2,515	3,778
33 - 39	Skeena	1,647	114	0	0	0	1,761	30.1	309.4	1,252	2,270
	Total	2,436	1,030	1,985	393	0	5,844				
	Alaska	3,621	5,678	3,179	2,175	160	14,813	12.7	1424.0	12,311	16,995
Total	Nass	14,537	12,576	38,280	6,235	1,473	73,101	62.9	2509.6	67,501	75,758
	Skeena	13,952	14,019	0	0	360	28,331	24.4	2023.7	24,640	31,298
	Total	32,110	32,273	41,459	8,410	1,993	116,245				

[a] The standard errors are minimum estimates since no estimates of the variance for stocks contributing zero fish during a given week or for the 'other' age class are available. The 90% confidence intervals are affected in a like manner.

[b] Statistical week 35 was closed to fishing.

Table 6. Estimated weekly catch per boat day (CPUE) of sockeye salmon stock groups in major southern Southeast Alaska purse seine and gill net fisheries, Districts 101-104, 1988.

	Dist. 101-11 gill net			Dist. 101 purse seine			Dist. 102 purse seine			Dist. 104 South purse seine			Dist. 104 North purse seine		
Week	Alaska	Nass	Skeena	Alaska	Nass	Skeena	Alaska	Nass	Skeena	Alaska	Nass	Skeena	Alaska	Nass	Skeena
26	1	24	2												
27	6	36	13												
28	10	56	8	10	10	1				33	25	90	29	5	52
29	5	15	4	18	13	1	180	18	5	92	30	138	81	19	196
30	6	25	4	29	25	14	168	17	4	114	32	657	147	76	632
31	4	10	8	40	32	10				83	24	487	30	21	230
32	2	5	19	15	19	20	80	4	30	51	9	169	61	30	648
33[a]	1	4	2	7	5	3	3	1	1	12	3	52	22	7	101
34										18	7	66	17	11	89
35										4	1	16	4	2	27
36										3	1	23			

[a] Statistical weeks 33 through 39 are combined for District 101-11 gill net, weeks 33 through 35 are combined for District 101 purse seine, and weeks 33 through 41 are combined for District 102 purse seine.

Table 7. Estimated contribution of sockeye salmon stocks originating in Alaska and Canada to Alaska's District 101 purse seine fishery in 1988.

Dates	Group	Catch 1.2	1.3	2.2	2.3	Other	Total	Percent	Standard[a] Error	90% C.I. Lower	Upper
7/03-7/09	Alaska	169	173	81	29	8	460	47.7	42.5	390	530
Week 28	Nass	121	82	241	9	10	463	48.0	49.1	382	544
	Skeena	0	41	0	0	1	42	4.4	27.1	0	86
	Total	290	296	322	38	19	965				
7/10-7/16	Alaska	1,083	991	434	257	67	2,832	55.1	204.1	2,496	3,168
Week 29	Nass	896	644	451	84	50	2,125	41.3	292.5	1,644	2,606
	Skeena	76	102	0	0	7	185	3.6	204.3	0	521
	Total	2,055	1,737	885	341	124	5,142				
7/17-7/23	Alaska	484	506	167	49	13	1,219	42.8	118.7	1,024	1,414
Week 30	Nass	292	393	320	36	12	1,053	37.0	163.0	785	1,321
	Skeena	568	0	0	0	7	575	20.2	129.9	361	789
	Total	1,344	899	487	85	32	2,847				
7/24-7/30	Alaska	1,176	721	654	230	31	2,812	49.1	251.1	2,399	3,225
Week 31	Nass	1,193	374	489	167	25	2,248	39.2	356.4	1,662	2,834
	Skeena	661	0	0	0	8	669	11.7	265.7	232	1,106
	Total	3,030	1,095	1,143	397	64	5,729				
7/31-8/06	Alaska	1,054	961	1,023	419	58	3,515	28.2	487.8	2,713	4,317
Week 32	Nass	3,013	159	987	101	72	4,332	34.7	950.8	2,768	5,896
	Skeena	3,680	873	0	0	78	4,631	37.1	833.9	3,259	6,003
	Total	7,747	1,993	2,010	520	208	12,478				
8/07-8/27	Alaska	972	628	764	185	43	2,592	47.0	282.5	2,127	3,057
Wk. 33-35	Nass	1,568	0	124	45	29	1,766	32.0	426.4	1,065	2,467
	Skeena	883	253	0	0	20	1,156	21.0	346.6	586	1,726
	Total	3,423	881	888	230	92	5,514				
	Alaska	4,938	3,980	3,123	1,169	220	13,430	41.1	659.9	12,345	14,515
Total	Nass	7,083	1,652	2,612	442	198	11,987	36.7	1150.8	10,094	13,880
	Skeena	5,868	1,269	0	0	121	7,258	22.2	972.3	5,659	8,857
	Total	17,889	6,901	5,735	1,611	539	32,675				

[a] The standard errors are minumum estimates since no estimates of the variance for stocks contributing zero fish during a given week or for the 'other' age class are available. The 90% confidence intervals are affected in a like manner.

Table 8. Estimated contribution of sockeye salmon stocks originating in Alaska and Canada to Alaska's District 102 purse seine fishery, 1988.

Dates	Group	Catch By Age Class					Total	Standard[a] Percent Error		90% C.I. Lower	90% C.I. Upper
		1.2	1.3	2.2	2.3	Other					
7/10-7/16	Alaska	636	692	366	75	29	1,798	88.8	93.9	1,615	1,924
Week 29	Nass	117	0	52	9	3	181	9.0	79.6	47	309
	Skeena	0	44	0	0	1	45	2.2	48.1	0	123
	Total	753	736	418	84	33	2,024				
7/17-7/23	Alaska	186	202	107	22	9	526	88.8	119.0	322	713
Week 30	Nass	34	0	15	3	1	53	9.0	101.6	0	219
	Skeena	0	13	0	0	0	13	2.2	61.8	0	115
	Total	220	215	122	25	10	592				
7/31-8/06	Alaska	1610	1663	611	237	23	4,144	69.7	258.0	3,696	4,545
Week 32	Nass	0	116	86	29	1	232	3.9	205.9	0	569
	Skeena	1344	213	0	0	9	1,566	26.4	271.6	1,110	2,004
	Total	2954	1992	697	266	33	5,942				
8/07-9/24	Alaska	2033	741	710	324	68	3,876	62.1	257.2	3,386	4,232
Weeks	Nass	613	152	100	39	0	904	14.5	340.8	344	1,465
33-41	Skeena	1234	182	0	0	44	1,460	23.4	285.1	947	1,885
	Total	3880	1075	810	363	112	6,240				
Total	Alaska	4,465	3,298	1,794	658	129	10,344	69.9	380.2	9,590	10,841
	Nass	764	268	253	80	5	1,370	9.3	407.9	694	2,036
	Skeena	2,578	452	0	0	54	3,084	20.8	398.6	2,374	3,686
	Total	7,807	4,018	2,047	738	188	14,798				

[a] The standard errors are minimum estimates since no estimates of the variance for stocks contributing zero fish during a given week or for the 'other' age class are available. The 90% confidence intervals are affected in a like manner.

Table 9. Estimated contribution of sockeye salmon stocks originating in Alaska and Canada to Alaska's District 103 purse seine fishery, 1988.

Dates	Group	Catch By Age Class					Total	Percent	Standard[a] Error	90% C.I. Lower	90% C.I. Upper
		1.2	1.3	2.2	2.3	Other					
8/07-9/24	Alaska	408	178	152	42	12	792	33.2	20.6	747	815
Weeks	Nass	255	0	58	33	0	346	14.5	12.2	326	366
34-38	Skeena	991	228	0	0	26	1,245	52.3	27.1	1,174	1,263
	Total	1,654	406	210	75	38	2,383				
	Alaska	408	178	152	42	12	792	33.2	100.5	615	946
Total	Nass	255	0	58	33	0	346	14.5	165.8	73	619
	Skeena	991	228	0	0	26	1,245	52.3	156.3	961	1,475
	Total	1,654	406	210	75	38	2,383				

[a] The standard errors are minimum estimates since no estimates of the variance for stocks contributing zero fish during a given week or for the 'other' age class are available. The 90% confidence intervals are affected in a like manner.

Table 10. Estimated contribution of sockeye salmon stocks originating in Alaska and Canada to Alaska's District 104 South seine fishery, 1988.

Dates	Group	Catch By Age Class					Total	Percent	Standard[a] Error	90% C.I.	
		1.2	1.3	2.2	2.3	Other				Lower	Upper
7/03-7/09	Alaska	1,290	418	411	122	10	2,251	22.1	324.3	1,708	2,775
Week 28	Nass	0	0	1,425	265	7	1,697	16.6	172.6	1,405	1,973
	Skeena	2,768	3,452	0	0	27	6,247	61.3	313.8	5,703	6,735
	Total	4,058	3,870	1,836	387	44	10,195				
7/10-7/16	Alaska	7,624	8,765	2,483	1,255	488	20,615	35.4	2385.8	16,204	24,053
Week 29	Nass	0	2,137	3,305	1,145	160	6,747	11.6	3170.9	1,371	11,803
	Skeena	16,655	13,378	0	0	763	30,796	53.0	3518.4	24,248	35,823
	Total	24,279	24,280	5,788	2,400	1,411	58,158				
7/17-7/23	Alaska	4,065	1,993	1,108	874	21	8,061	14.2	2098.7	4,586	11,491
Week 30	Nass	0	0	1,474	796	6	2,276	4.0	1034.9	567	3,972
	Skeena	36,188	10,311	0	0	125	46,624	81.9	1977.2	43,274	49,752
	Total	40,253	12,304	2,582	1,670	152	56,961				
7/24-7/30	Alaska	1,196	579	465	275	8	2,523	14.0	717.3	1,335	3,695
Week 31	Nass	0	0	484	252	2	738	4.1	418.7	46	1,424
	Skeena	12,092	2,637	0	0	43	14,772	81.9	635.8	13,683	15,775
	Total	13,288	3,216	949	527	53	18,033				
7/31-8/06	Alaska	4,303	2,367	1,130	330	83	8,213	22.3	1465.2	5,720	10,541
Week 32	Nass	0	0	1,176	300	15	1,491	4.0	566.1	546	2,409
	Skeena	23,460	3,420	0	0	280	27,160	73.7	1387.6	24,597	29,162
	Total	27,763	5,787	2,306	630	378	36,864				
8/07-8/13	Alaska	2,444	255	351	121	0	3,171	18.3	821.4	1,819	4,522
Week 33	Nass	0	107	575	110	0	792	4.5	621.0	0	1,813
	Skeena	11,211	2,184	0	0	0	13,395	77.2	798.7	12,082	14,710
	Total	13,655	2,546	926	231	0	17,358				
8/14-8/20	Alaska	933	122	283	0	9	1,347	19.5	353.6	757	1,920
Week 34	Nass	0	51	464	0	3	518	7.5	549.4	0	1,419
	Skeena	3,953	1,049	0	0	33	5,035	73.0	584.8	4,039	5,963
	Total	4,886	1,222	747	0	45	6,900				
8/21-9/03	Alaska	697	208	181	95	4	1,185	18.7	307.8	675	1,687
Week 35	Nass	0	0	296	87	1	384	6.1	215.6	29	738
	Skeena	4,079	679	0	0	18	4,776	75.3	248.3	4,350	5,166
	Total	4,776	887	477	182	23	6,345				
8/31-9/27	Alaska	95	64	33	20	2	214	11.6	220.6	0	512
Week 36	Nass	0	0	55	19	1	75	4.1	214.1	0	426
	Skeena	1,325	210	0	0	17	1,552	84.3	76.1	1,200	1,450
	Total	1,420	274	88	39	20	1,841				
Total	Alaska	22,647	14,771	6,445	3,092	625	47,580	22.4	3581.9	41,001	52,786
	Nass	0	2,295	9,254	2,974	195	14,718	6.9	3369.1	8,679	20,063
	Skeena	111,731	37,320	0	0	1,306	150,357	70.7	4431.5	141,553	156,132
	Total	134,378	54,386	15,699	6,066	2,126	212,655				

[a] The standard errors are minimum estimates since no estimates of the variance for stocks contributing zero fish during a given week or for the 'other' age class are available. The 90% confidence intervals are affected in a like manner.

Table 11. Estimated contribution of sockeye salmon stocks originating in Alaska and Canada to Alaska's District 104 North purse seine fishery, 1988.

Dates	Group	Catch 1.2	1.3	2.2	2.3	Other	Total	Percent	Standard[a] Error	90% C.I. Lower	Upper
7/03-7/09	Alaska	1,103	511	328	78	34	2,054	33.7	347.9	1,446	2,591
Week 28	Nass	0	0	250	128	6	384	6.3	84.2	239	516
	Skeena	1,838	1,749	0	0	62	3,649	60.0	347.0	3,016	4,157
	Total	2,941	2,260	578	206	102	6,087				
7/10-7/16	Alaska	8,683	6,106	3,917	931	331	19,968	27.4	2597.0	15,365	23,909
Week 29	Nass	0	0	2,991	1,525	76	4,592	6.3	1066.0	2,764	6,271
	Skeena	26,473	20,913	0	0	820	48,206	66.2	2577.3	43,143	51,623
	Total	35,156	27,019	6,908	2,456	1,227	72,766				
7/17-7/23	Alaska	4,277	1,804	1,038	519	53	7,691	17.2	1512.2	5,149	10,124
Week 30	Nass	0	1,614	1,480	851	27	3,972	8.9	1353.7	1,718	6,172
	Skeena	25,015	7,716	0	0	229	32,960	73.9	1897.5	29,608	35,851
	Total	29,292	11,134	2,518	1,370	309	44,623				
7/24-7/30	Alaska	621	490	65	116	9	1,301	10.7	525.9	427	2,157
Week 31	Nass	0	124	612	190	6	932	7.6	430.9	218	1,635
	Skeena	8,641	1,271	0	0	66	9,978	81.7	561.4	8,990	10,837
	Total	9,262	1,885	677	306	81	12,211				
7/31-8/06	Alaska	7,672	3,217	2,279	979	174	14,321	8.2	5396.3	5,272	23,026
Week 32	Nass	0	0	6,101	970	87	7,158	4.1	1437.4	4,708	9,437
	Skeena	129,324	21,532	0	0	1,883	152,739	87.7	5482.3	141,853	159,889
	Total	136,996	24,749	8,380	1,949	2,144	174,218				
8/07-8/13	Alaska	5,306	2,022	832	277	249	8,686	17.2	1869.4	5,364	11,514
Week 33	Nass	0	0	2,240	274	74	2,588	5.1	575.5	1,569	3,463
	Skeena	33,998	4,200	0	0	1,174	39,372	77.7	1965.6	34,964	41,430
	Total	39,304	6,222	3,072	551	1,497	50,646				
8/14-8/20	Alaska	492	334	179	110	34	1,149	14.8	365.6	513	1,716
Week 34	Nass	0	219	361	110	21	711	9.2	316.5	169	1,210
	Skeena	4,971	745	0	0	185	5,901	76.0	651.5	4,646	6,789
	Total	5,463	1,298	540	220	240	7,761				
8/21-9/03	Alaska	672	250	224	82	64	1,292	12.5	621.5	206	2,251
Week 35	Nass	0	0	453	81	28	562	5.4	320.3	7	1,061
	Skeena	6,798	1,221	0	0	445	8,464	82.0	822.0	6,666	9,370
	Total	7,470	1,471	677	163	537	10,318				
Total	Alaska	28,826	14,734	8,862	3,092	948	56,462	14.9	6492.4	44,834	66,194
	Nass	0	1,957	14,488	4,129	325	20,899	5.5	2326.6	16,751	24,406
	Skeena	237,058	59,347	0	0	4,864	301,269	79.6	6662.5	285,456	307,376
	Total	265,884	76,038	23,350	7,221	6,137	378,630				

[a] The standard errors are minumum estimates since no estimates of the variance for stocks contributing zero fish during a given week or for the 'other' age class are available. The 90% confidence intervals are affected in a like manner.

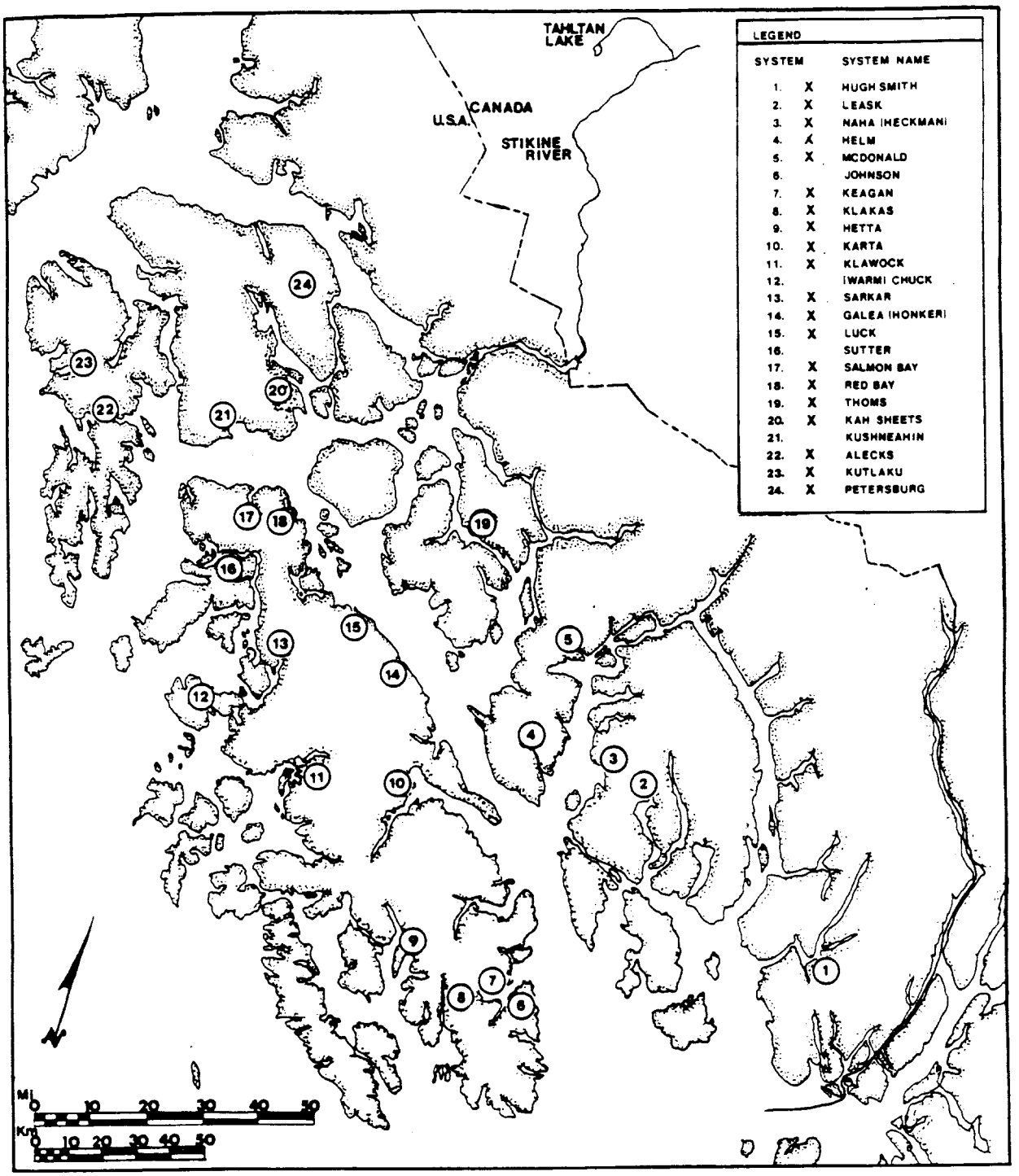

Figure 1. Major sockeye salmon systems of Southeast Alaska and the Transboundary Stikine; numbers identify Alaskan systems where scales are commonly collected while 'x' in the legend identifies stocks sampled in 1988.

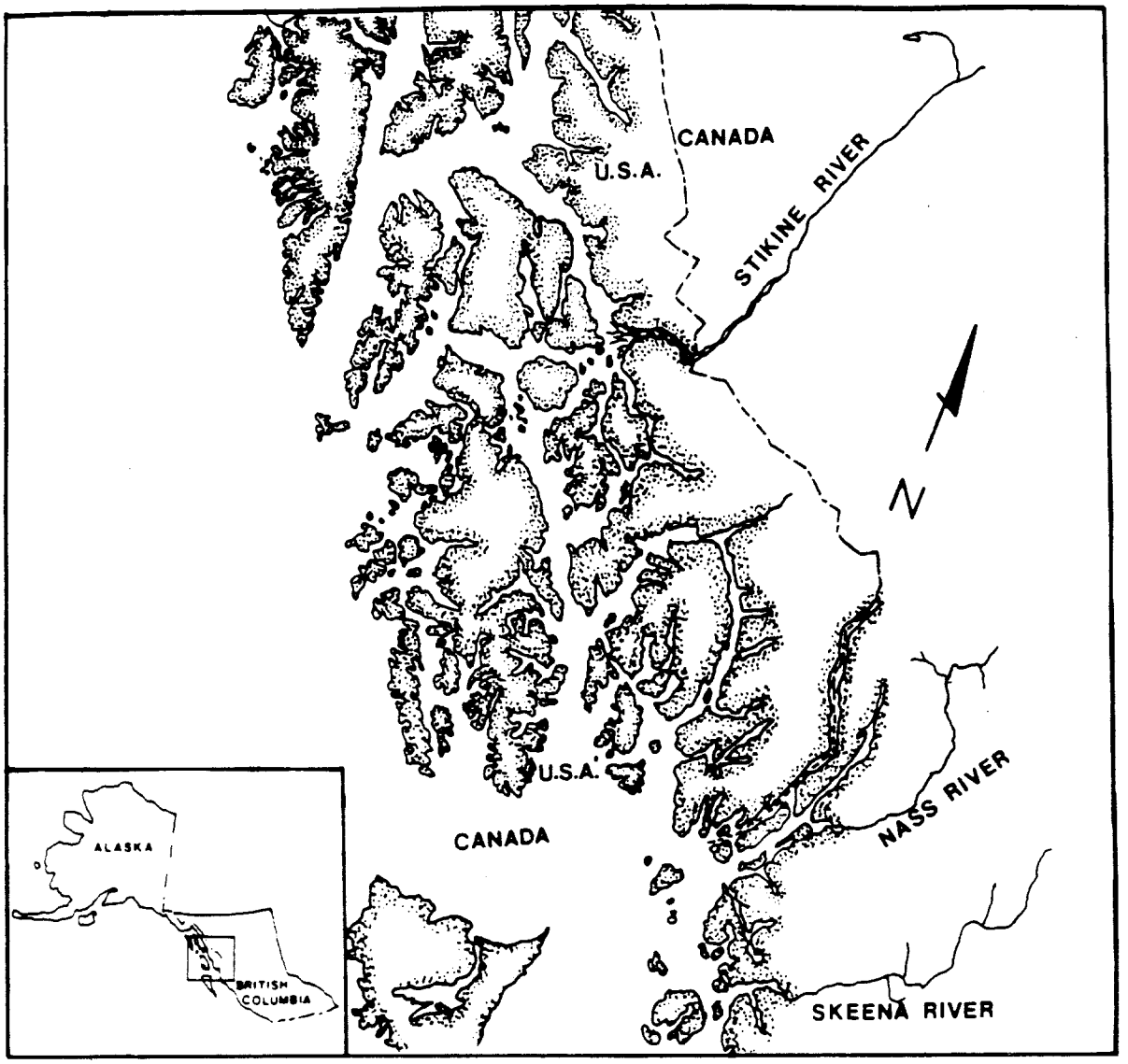

Figure 2. The Canadian Nass and Skeena Rivers and the Transboundary Stikine River.

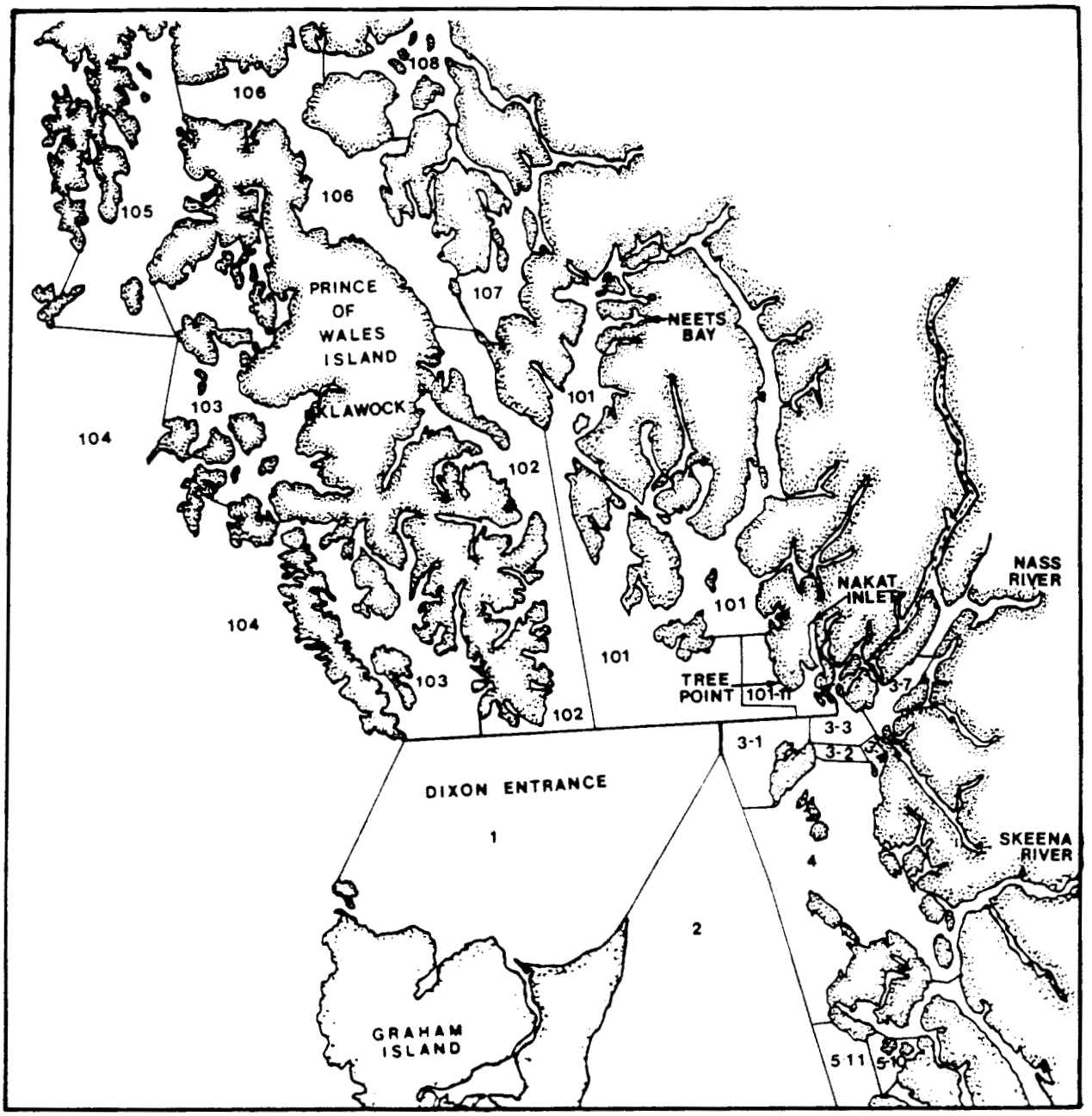

Figure 3. Fishery management districts in southern Southeast Alaska and northern British Columbia waters.

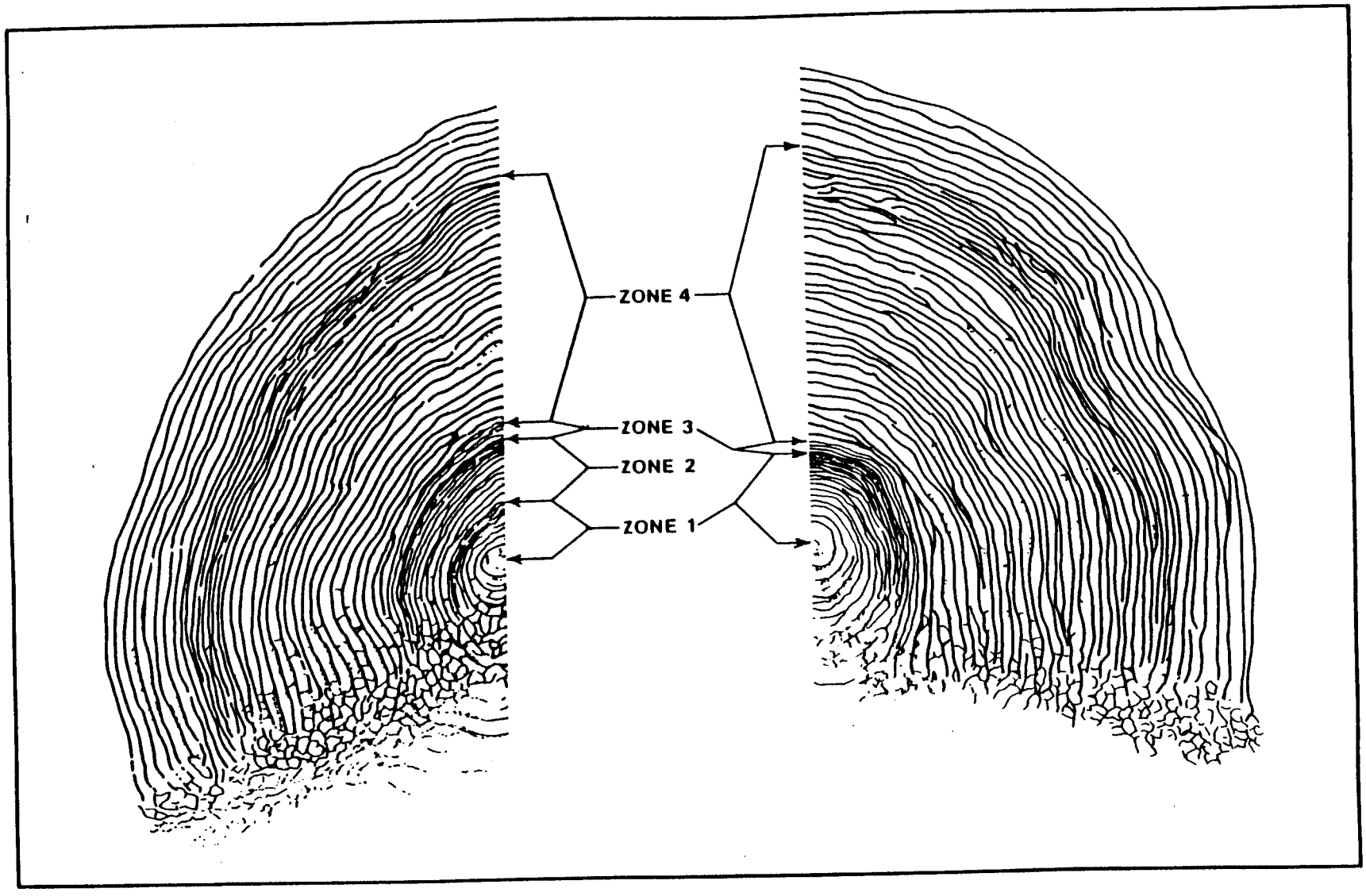

Figure 4. Typical scales with one and two freshwater growth zones showing the zones used for scale pattern analysis.

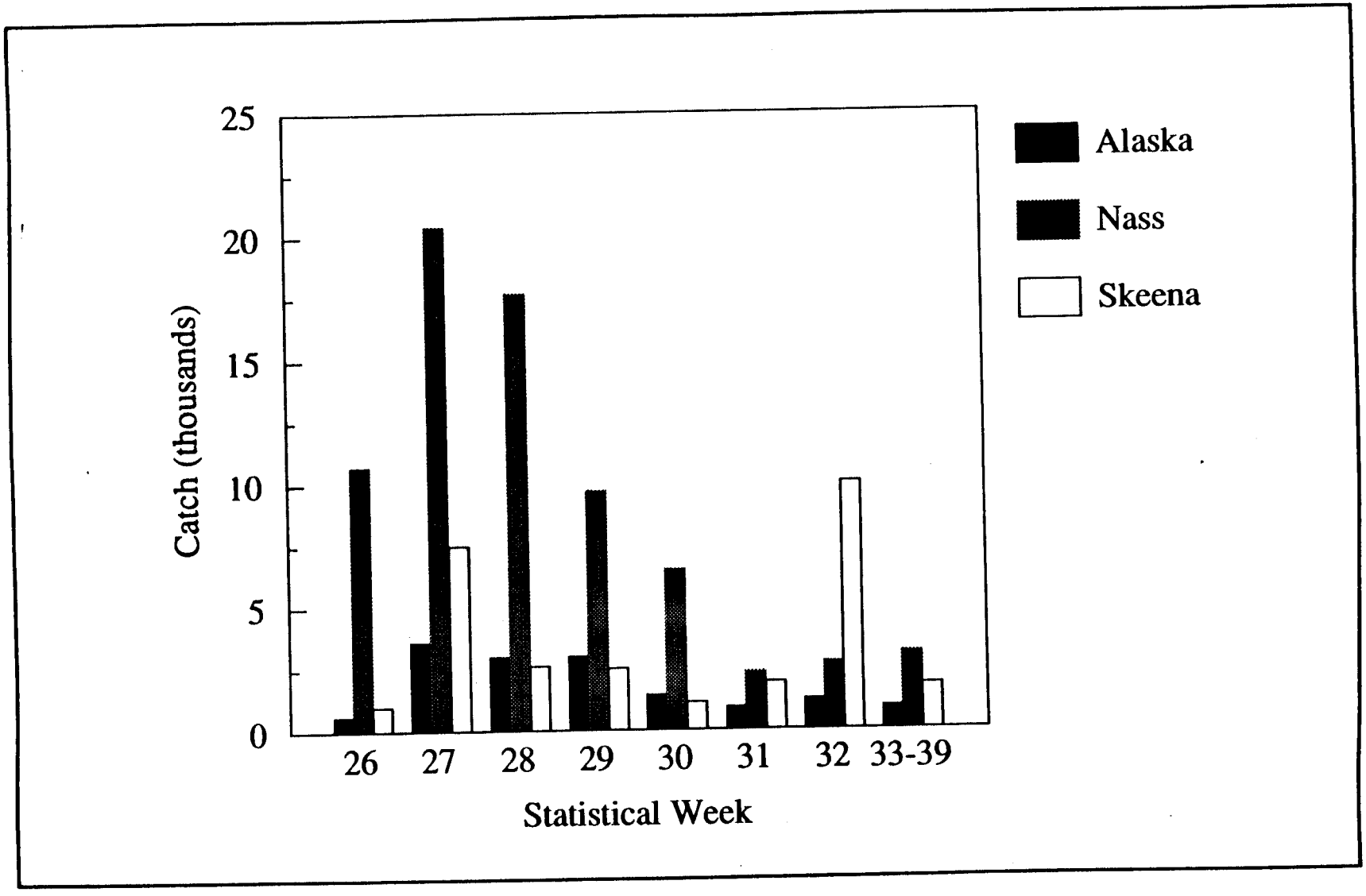

Figure 5. Weekly catch by stock group in Alaska's District 101-11 gill net fishery, 1988.

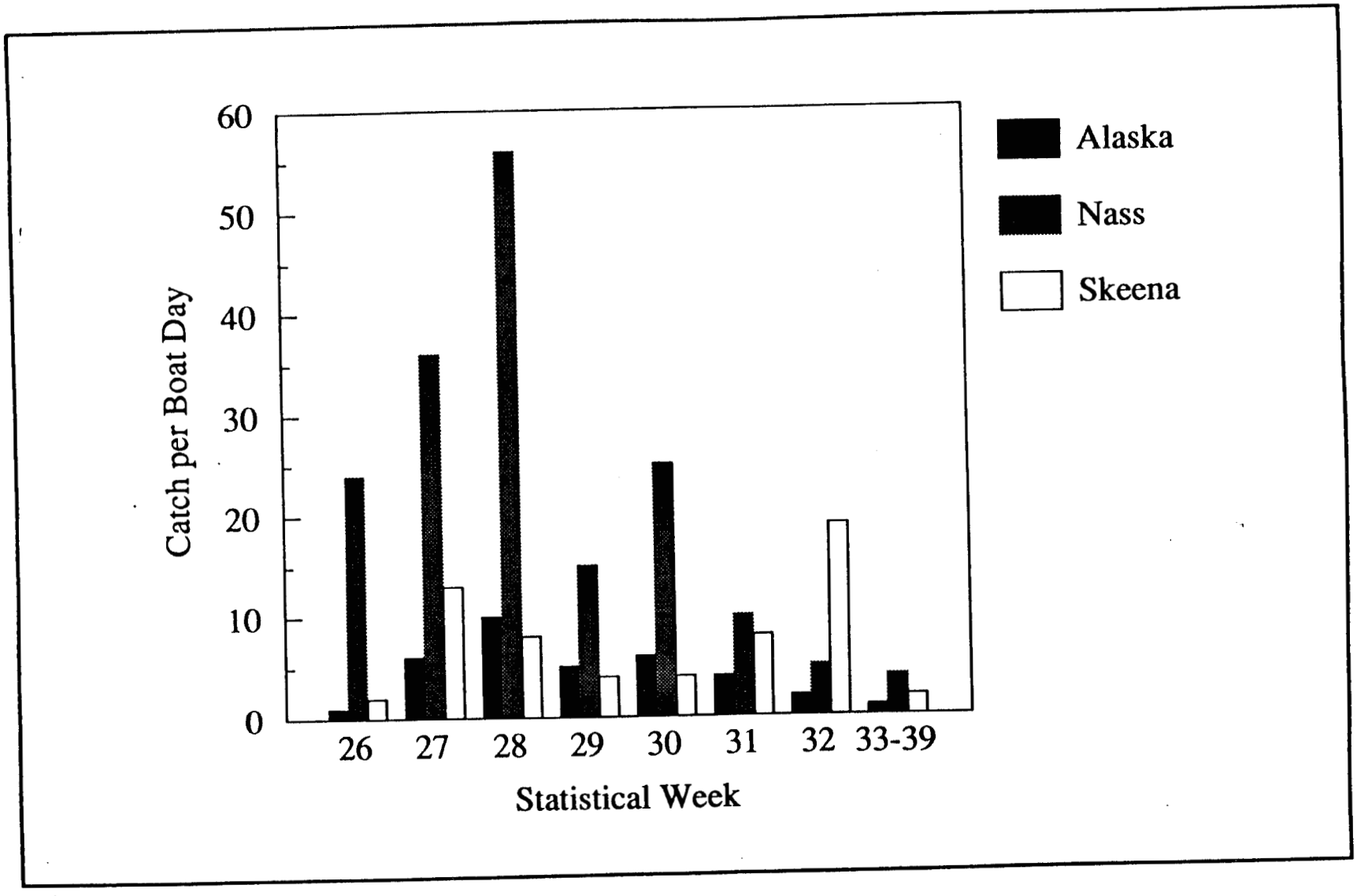

Figure 6. Weekly CPUE by stock group in Alaska's District 101-11 gill net fishery, 1988.

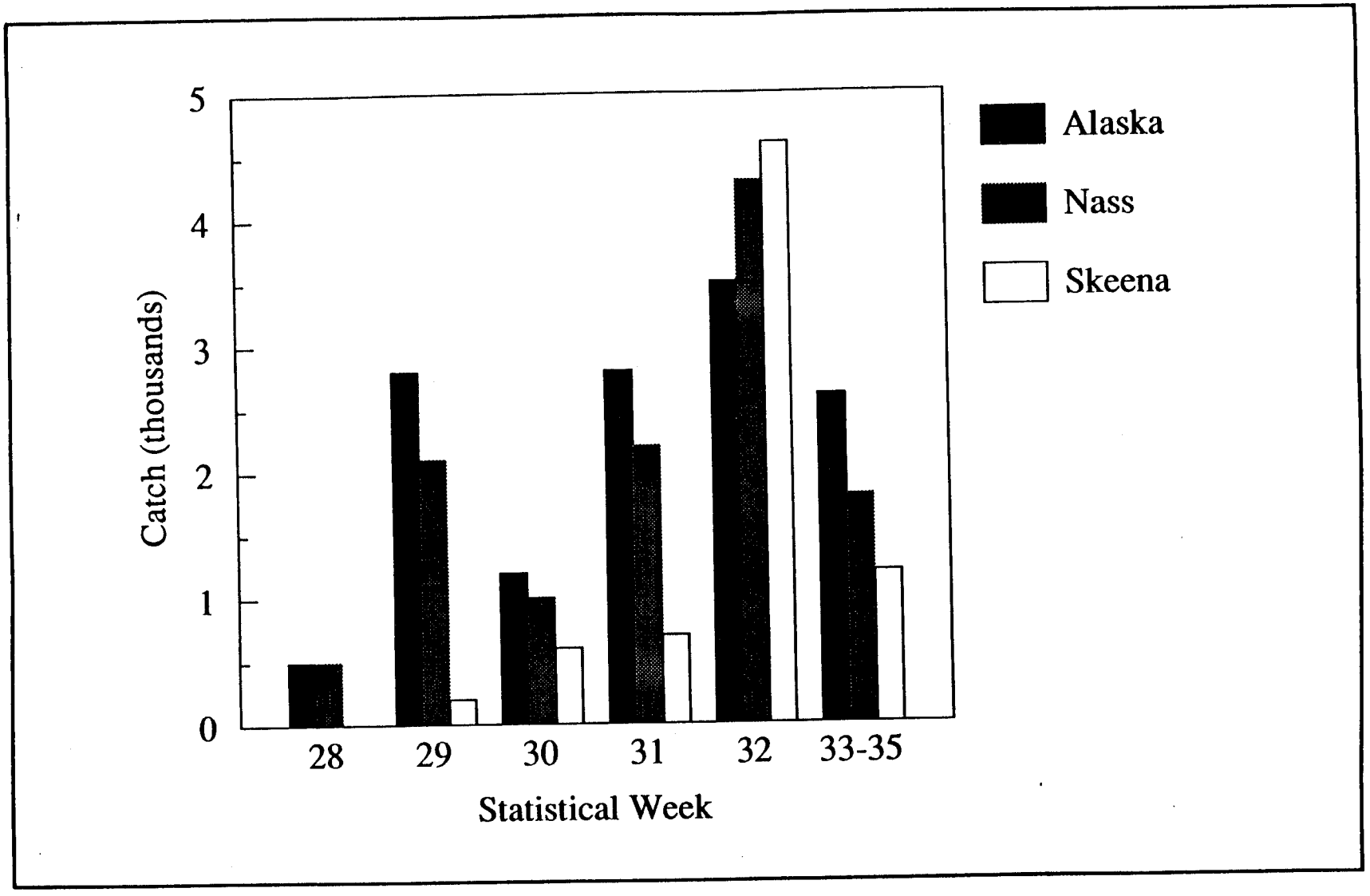

Figure 7. Weekly catch by stock group in Alaska's District 101 purse seine fishery, 1988.

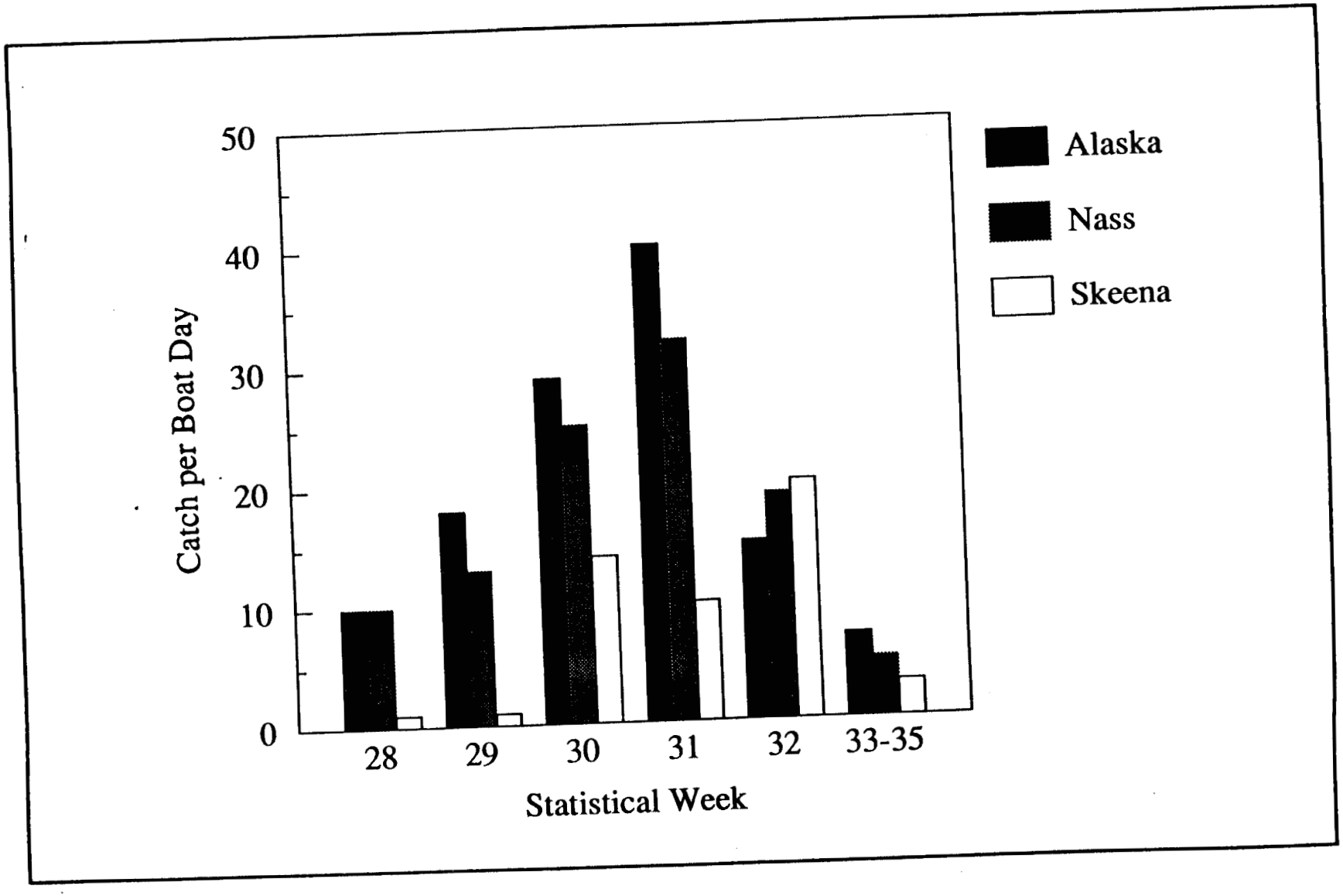

Figure 8. Weekly CPUE by stock group in Alaska's District 101 purse seine fishery, 1988.

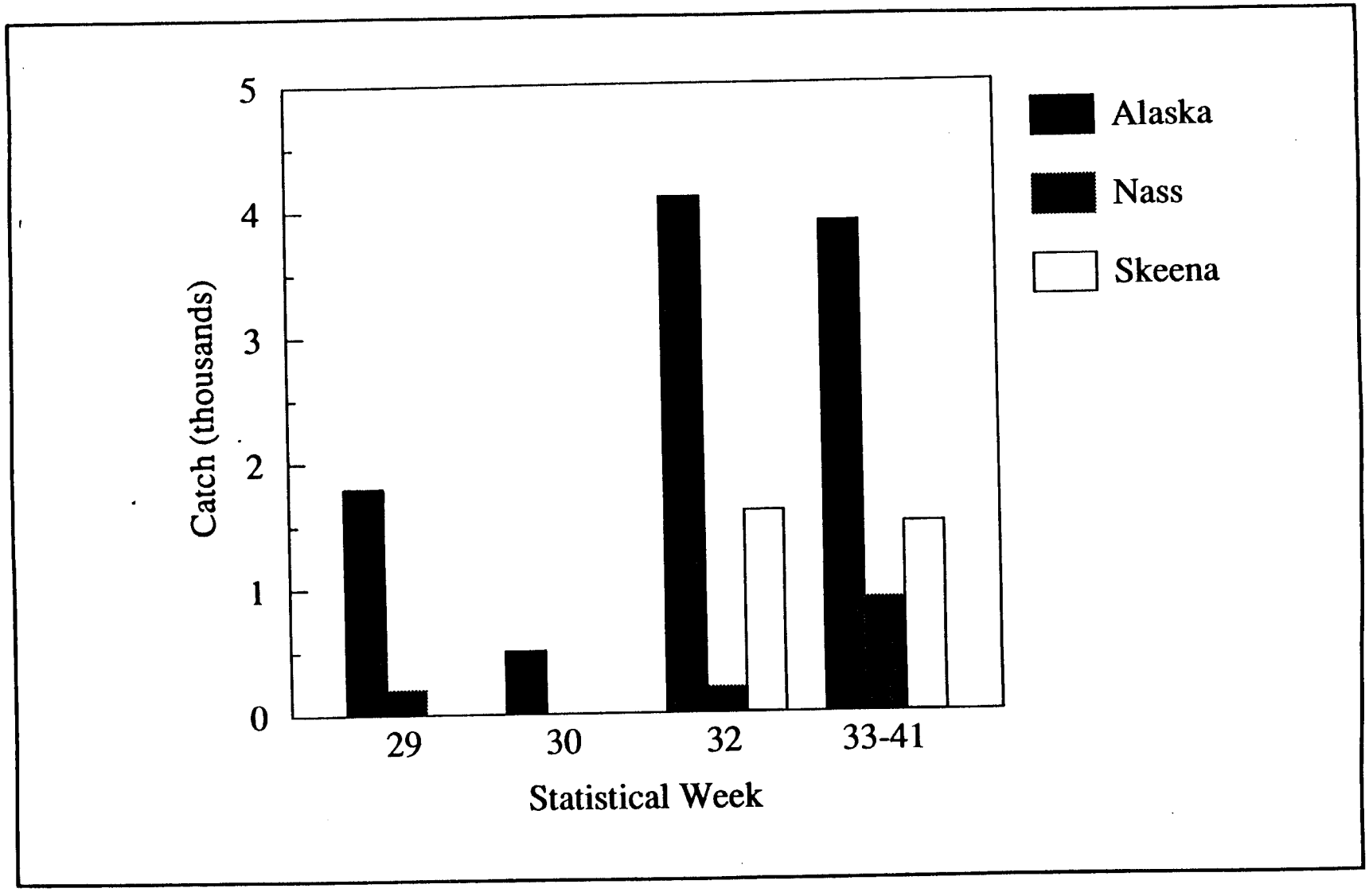

Figure 9. Weekly catch by stock group in Alaska's District 102 purse seine fishery, 1988.

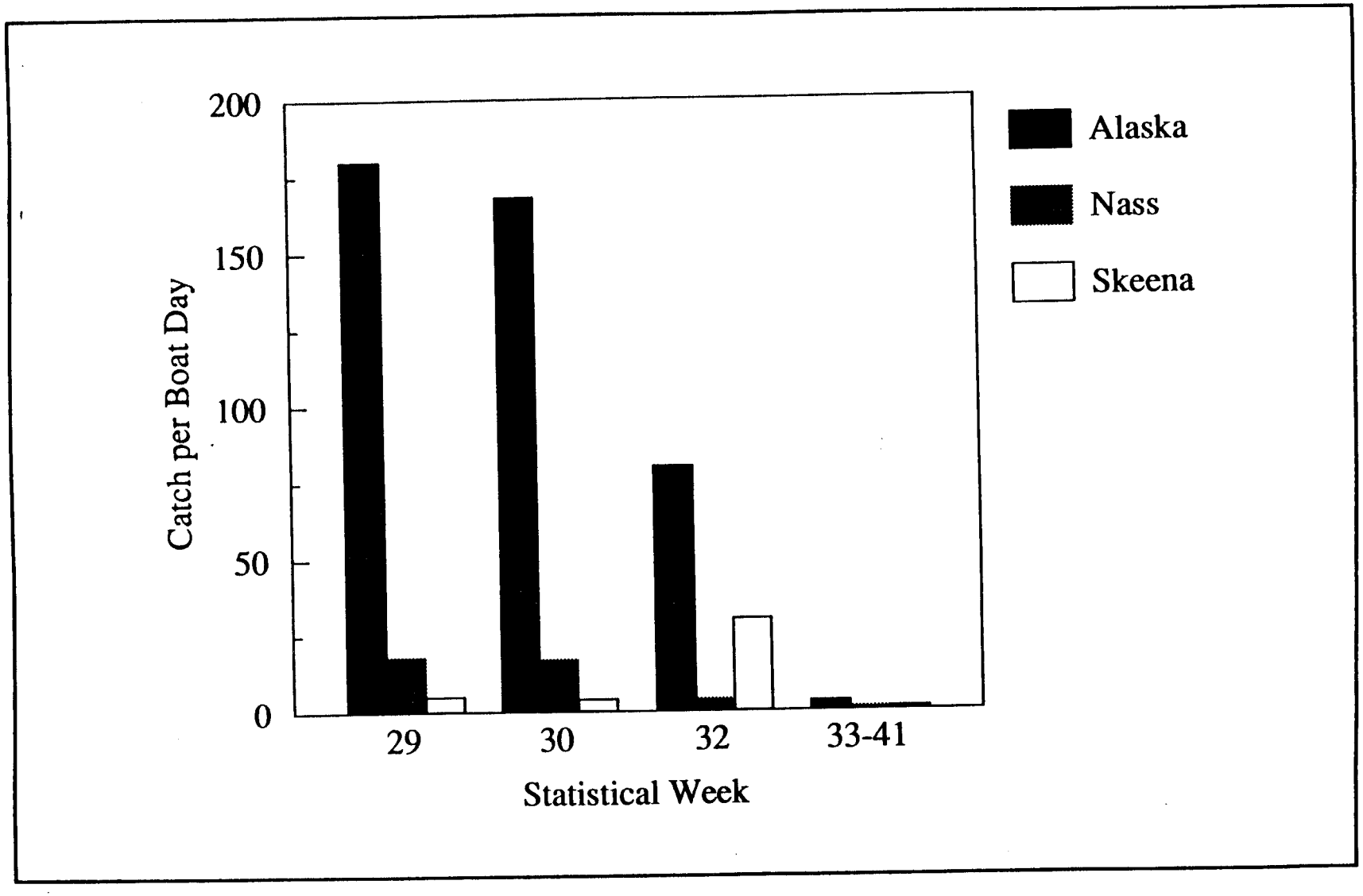

Figure 10. Weekly CPUE by stock group in Alaska's District 102 purse seine fishery, 1988.

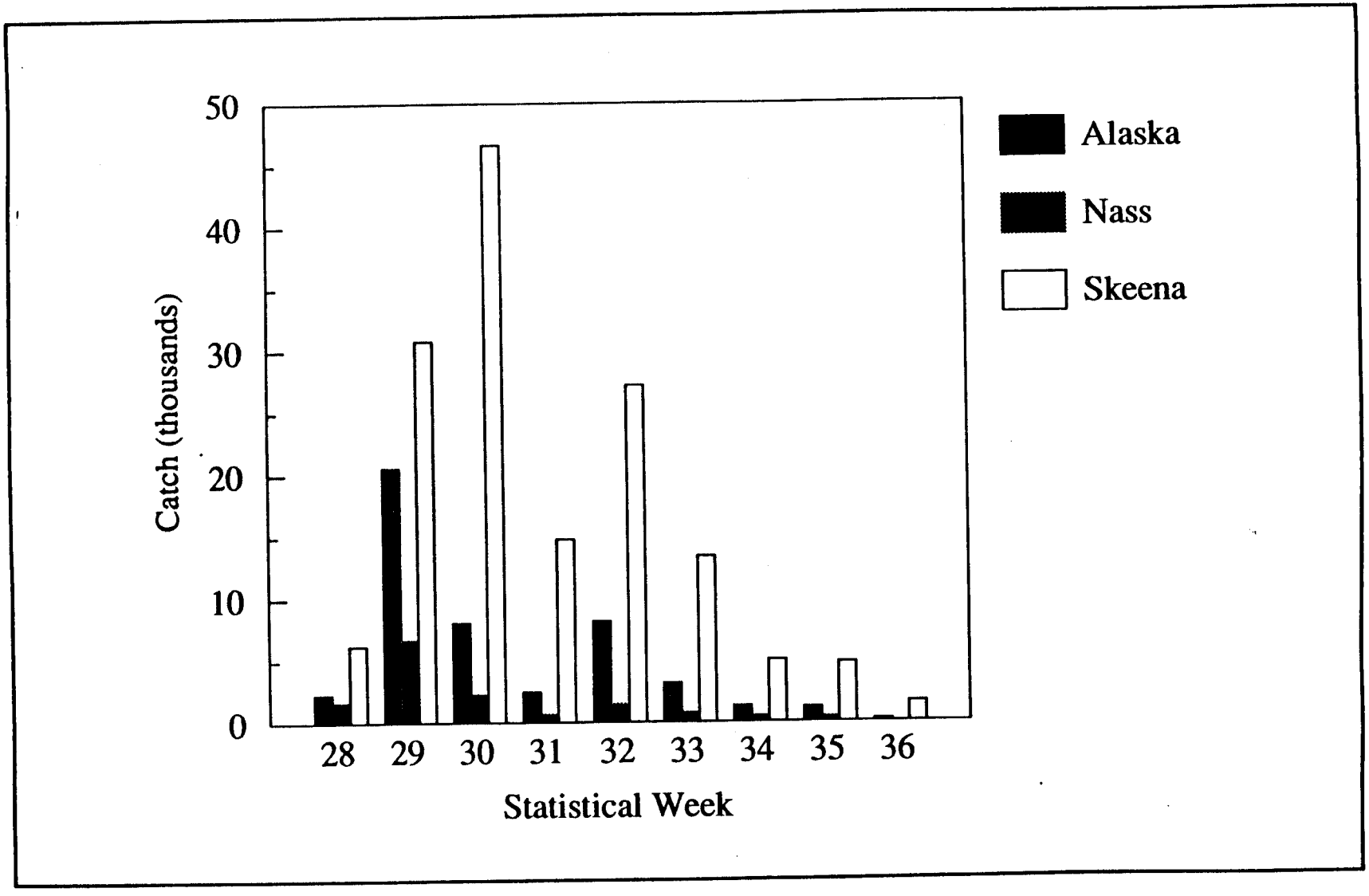

Figure 11. Weekly catch by stock group in Alaska's District 104 South purse seine fishery, 1988.

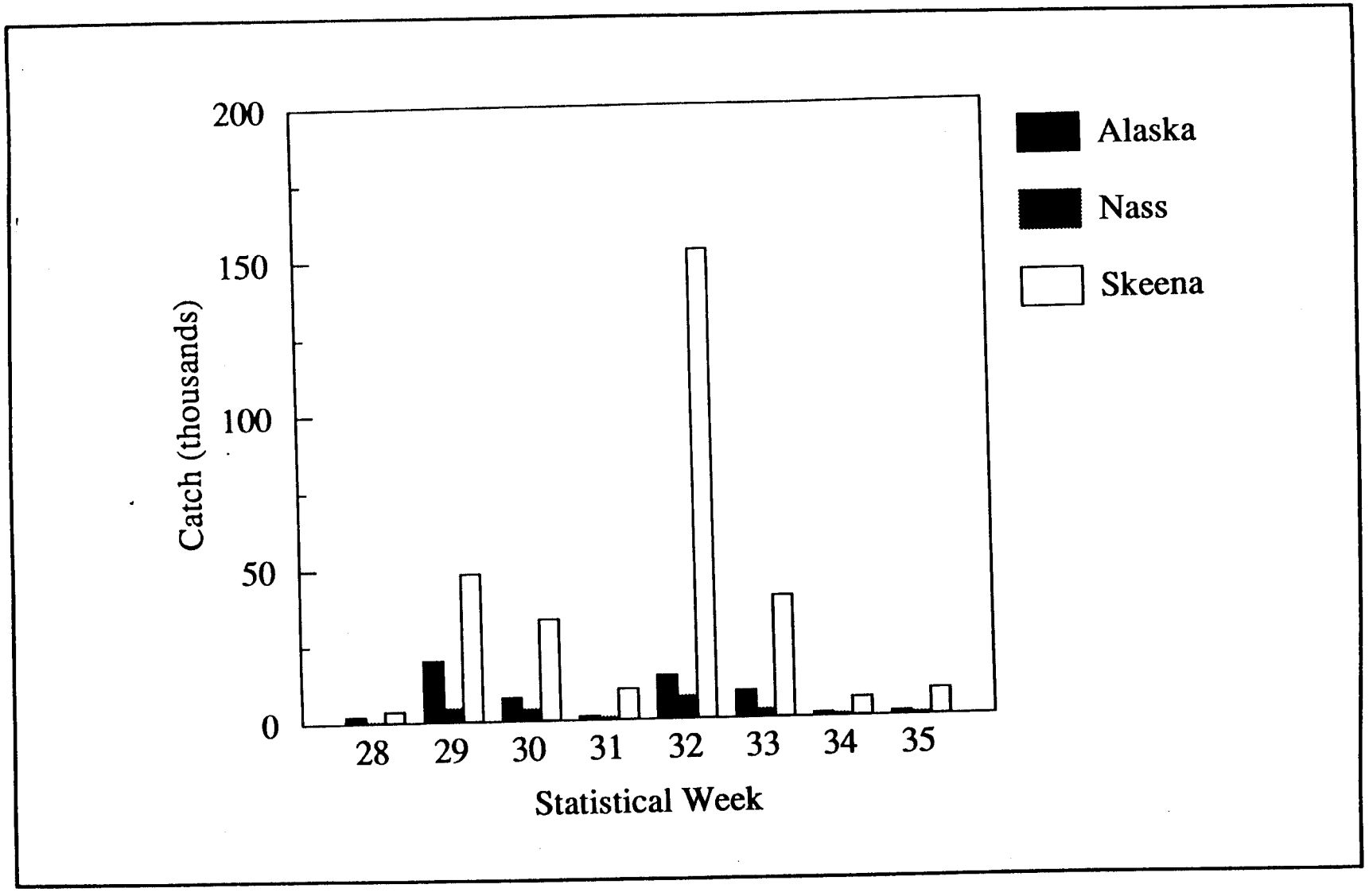

Figure 12. Weekly catch by stock group in Alaska's District 104 North purse seine fishery, 1988.

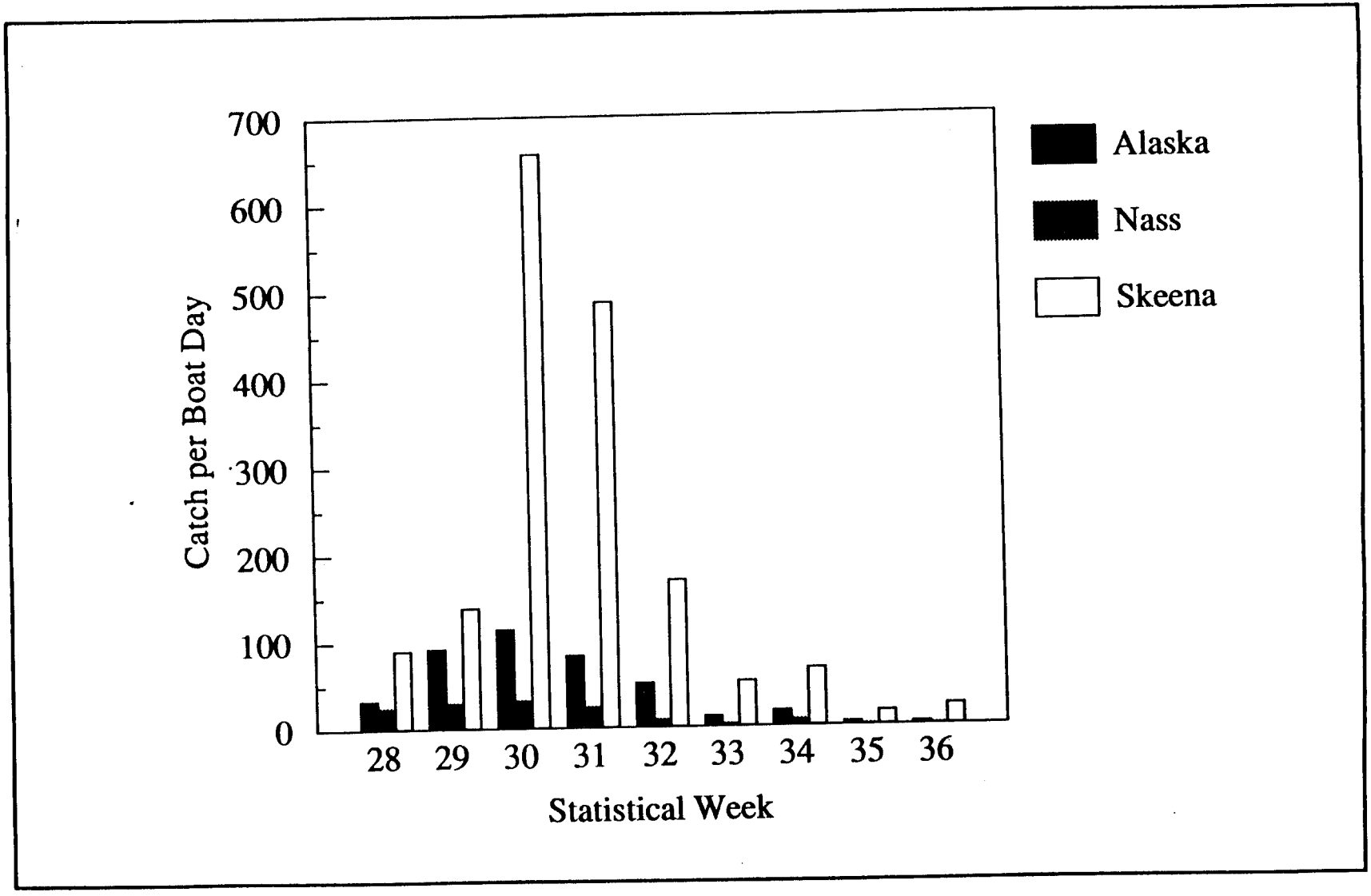

Figure 13. Weekly CPUE by stock group in Alaska's District 104 South purse seine fishery, 1988.

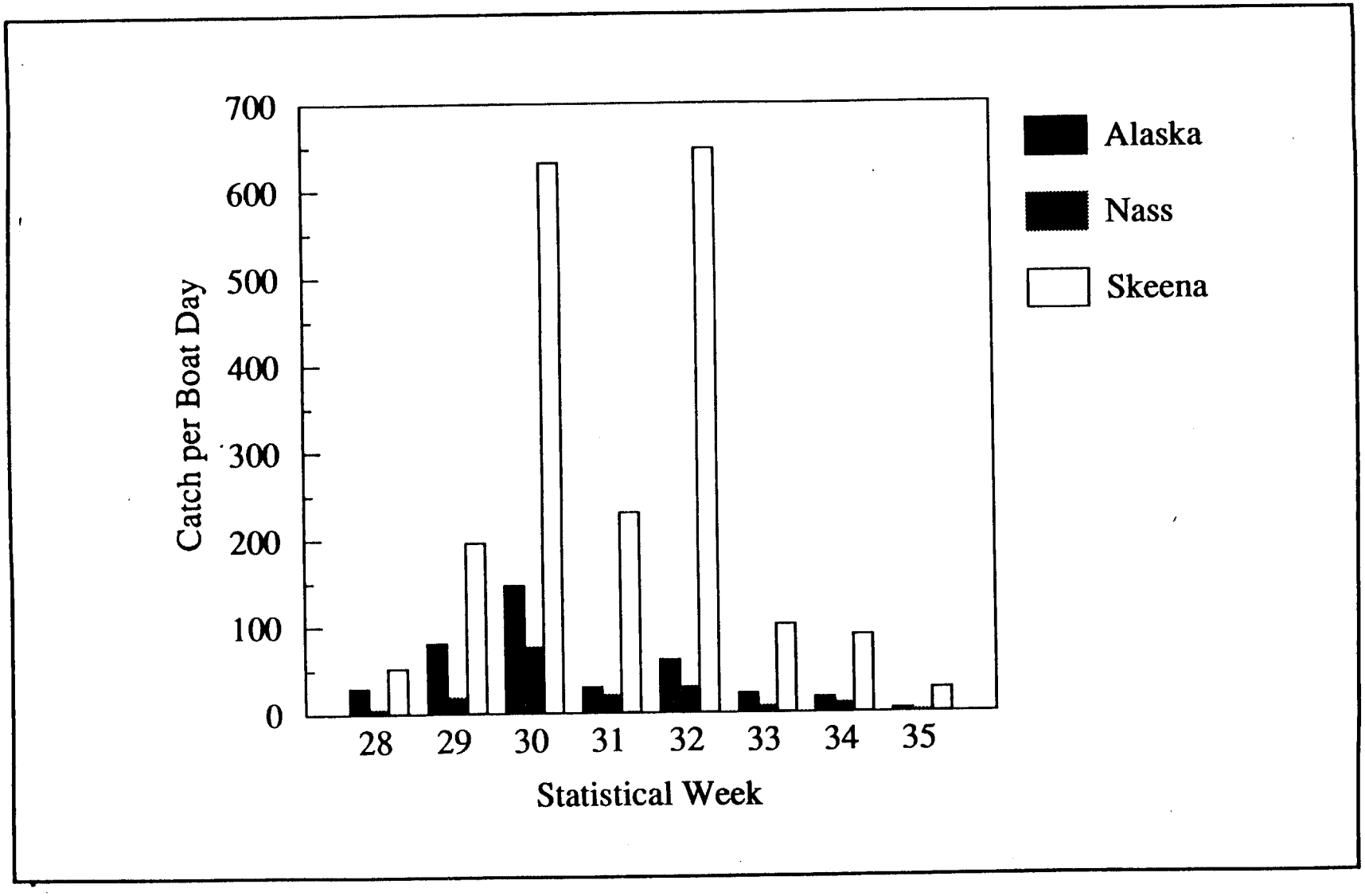

Figure 14. Weekly CPUE by stock group in Alaska's District 104 North purse seine fishery, 1988.

APPENDICES

Table A1. Comparison of sockeye stock proportions from catches from the seine fishery north and south of Cape Felix in Alaska's District 104, 1988.

Week	Proportion differences	Z values	Combined samples
Alaska-bound fish.			
28	0.161	2.64*	972
29	-0.080 [a]	-2.57*	886
30	0.031	1.38	1385
31	-0.033	-1.60	1100
32	-0.141	-8.25*	1773
33	-0.011	-0.32	793
34	-0.047	-1.90	1082
35	-0.062	-2.26*	721
36	-0.117	- [b]	188
Nass-bound fish.			
28	-0.067	-1.26	972
29	-0.053	-2.78*	886
30	0.049	3.07*	1385
31	0.035	2.20*	1100
32	0.001	0.07	1773
33	0.005	0.28	793
34	0.016	0.87	1082
35	-0.006	-0.35	721
36	-0.040	-	188
Skeena-bound fish.			
28	-0.094	-1.32	972
29	0.133	4.04*	886
30	-0.080	-3.09*	1385
31	-0.002	-0.08	1100
32	0.140	7.47*	1773
33	0.006	0.15	793
34	0.031	1.05	1082
35	0.068	2.19*	721
36	-0.843	-	188

* Significant at α=0.05.

a Negative values indicate southern proportions are the greater.

b Zero fish were caught in the north-end in week 36.