Second Revision of
Harvest Rates by the South Unimak and Shumagin Islands June Fishery on Northwest Alaska Summer Chum Salmon, 1979–1994, and Bristol Bay Sockeye Salmon, 1970–1994

by

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ABSTRACT

Indices of relative vulnerability to the South Unimak and Shumagin Islands June fishery were estimated for major stock groupings of chum and sockeye salmon, by area and time period, based on available stock identification studies. Relative vulnerability indices of regional stock groupings of chum salmon indicate tendencies to occur in the South Unimak and Shumagin Islands June fishery catches and were consistent between years, areas, and time periods. These relative vulnerability indices together with annual estimates of total run magnitude were used to estimate stock-specific June fishery catches by area and time period. Annual harvest rates by the South Unimak and Shumagin Islands June fishery on Bristol Bay sockeye salmon were estimated for the years 1970 - 1994 and on NW Alaska summer chum salmon were estimated for years 1979 - 1994. There was no significant trend in harvest rates by the South Unimak and Shumagin Islands June fishery on NW Alaska summer chum salmon during the period 1979 - 1994; however harvest rates by the June fishery on NW Alaska summer chum salmon have been increasing since 1984 when measures were first implemented by the Board of Fisheries to limit incidental catches of chum salmon in the June fishery.

INTRODUCTION[1]

The South Unimak and Shumagin Islands June fishery intercepts migrating salmon bound for river systems outside the area of the fishery. The fishery targets Bristol Bay sockeye salmon and is managed for a sockeye salmon quota based on a percentage of the forecasted inshore Bristol Bay sockeye salmon catch. The runs of Bristol Bay sockeye salmon have been increasing since the late 1970's and catches of sockeye allocated to the South Unimak and Shumagin Islands June fishery have increased consistent with the increasing Bristol Bay sockeye salmon runs.

The June fishery also harvests migrating chum salmon incidental to the targeted sockeye salmon. The chum salmon are primarily bound for river systems in western Alaska (north of Unimak Island) (Eggers et al. 1991, 1992; Seeb et al. 1995). Runs of chum salmon in western Alaska have been declining over the last 3-4 years, and the 1993 run was very weak. The weak 1993 chum salmon run prompted widespread restrictions in commercial fishing in the Kuskokwim, Yukon, Norton Sound, and Kotzebue Sound areas and closures of commercial, subsistence, and personal use fisheries has occurred for some rivers in these areas. The overall 1994 run of chum salmon in the AYK region was near average and substantially improved from the 1993 level, though run strength varied widely among stocks within the AYK region.

The Alaska Board of Fisheries has adopted a variety of measures to reduce interceptions of western Alaska chum salmon in the June fishery. These included: chum salmon caps, limited duration openings (i.e., windows), delayed openings, and period quotas. These management actions to conserve western Alaska chum salmon have, at times, impacted the ability of the fishery to achieve the sockeye salmon allocation. Because the timing and distribution of migrating Bristol Bay sockeye salmon and western Alaska chum salmon are coincidental in the traditional fishing areas of the June fishery, it is generally not possible to increase the harvest rate on migrating sockeye salmon without increasing the harvest rate on migrating chum salmon.

The following report analyzes the historical harvest or interception rates by the June fishery on Bristol Bay sockeye and western Alaska chum salmon. This information is provided, to assist the Board of Fisheries

[1]This report has been revised from version submitted to the February 1995 Alaska Peninsula and Aleutians Finfish Board of Fisheries meeting. Numerous typographical errors were corrected an harvest rate estimates were revised to reflect corrected subsistence catch estimates for Norton Sound and Kotzebue Areas.

in evaluating alternative proposals to allocate fish and the burden of conservation among Area M, inshore and inriver fishermen.

Harvest rates (i.e., catch as a percent of the inshore run + June fishery catch) by the June fishery on major sockeye salmon stock groupings, including Bristol Bay, were estimated for the years, 1970 to 1994. Harvest rates by the June fishery on major chum salmon stock groupings, including northwest Alaska summer chum salmon (i.e., aggregate grouping of Norton Sound, Yukon summer, Kuskokwim, and Bristol Bay chum salmon) were estimated for the years, 1979 - 1994. The method for estimating stock-specific catches was based on vulnerability coefficients (Eggers et al. 1991) estimated for the years where stock identification studies were conducted. The method assumed that sockeye and chum salmon exhibited consistent and stock-specific patterns of migratory timing and ocean distribution, which can be explained as stock-specific relative vulnerability indices that were constant from year to year. This assumption was tested by examining inter-annual differences in relative vulnerability indices estimated for years and areas where a stock identification study was conducted for the June fishery. Stock identification studies were conducted for chum salmon in 1987 (Eggers 1992), and 1993-1994 (Seeb et al. 1995). The relative vulnerability indices estimated for chum salmon stock groupings with similar genetic characters were similar for the Unimak area for 1993 and 1994. These also were similar to the CASE 2 Unimak area tagging estimates (Eggers 1992).

Because chum salmon stock vulnerability to the Unimak area of the June fishery was consistent between years; stock contribution to the June fishery catches by year, area, and early and late time periods, can be estimated as the relative magnitude, among stocks, of the product of vulnerability index and respective year run size (Eggers et al. 1991). The historical June fishery catches by year, area, and time period were then apportioned to stock of origin based on the respective year, area, and time period stock contribution.

Harvest rates on Bristol Bay sockeye salmon by the June fishery have ranged from 1.5 % to 7.9 % and averaged 3.5 % during the period 1979-1994. Harvest rates on NW Alaska summer chum salmon by the June fishery have ranged from 1.4% to 12.5 % and averaged 5.6 % during the period 1979 - 1994. Harvest rates by the June fishery on NW Alaska summer chum have been increasing since 1984.

METHODS AND RESULTS

Stock-specific vulnerability indices were estimated for sockeye, based on the stock contribution estimates from the 1987 tagging study and for chum salmon, based on the 1987 tagging study and 1993/1994 genetic stock identification study. These vulnerability indices were used to extrapolate the results of stock identification studies to years for which studies were not available. Estimated vulnerability indices were used to weight the relative run magnitudes for each stock grouping to estimate its contribution to the June fishery catches for the respective year. These extrapolations assumed that the stocks have consistent patterns of run timing and ocean distribution from year to year. If these patterns were consistent from year to year, then there would exist a stock-specific tendency to contribute to the South Peninsula June fisheries. This tendency would be expressed quantitatively as, V_i = Vulnerability index for the i th stock to the fishery.

It is well known that considerable inter-annual variability in run strength occurs among Pacific rim chum and western and central Alaska sockeye salmon stocks. Among stocks with similar vulnerability, more abundant stocks would contribute more to the June Fishery catches. Run strength may not be highly correlated among stocks, particular over the great geographic area encompassed by the mix of chum salmon stock which contribute to the South Peninsula June fishery. To account for effects of abundance on contribution to the June fishery, the following model was developed to estimate stock contribution to the South Peninsula June fishery catches. The model incorporates stock-specific tendencies to contribute to the fishery estimated from more limited stock identification studies as well as stock-specific abundance (terminal catch + escapement) of sockeye and chum salmon which is available on an annual basis.

For sockeye salmon, the June Fishery catches were stratified into Unimak and Shumagin areas, and for chum salmon the catches were stratified into Unimak and Shumagin areas as well as by early (June 20 and earlier) and late (June 21 and later) time periods. There are species, time, and area subscripts implicit in the following equations; however, they were left out to simplify the presentation.

For a time period, species, and area the achieved rate of exploitation by the June fishery was the total catch divided by the total collective abundance of all stocks that are vulnerable to the fishery.

$$q = \frac{\sum C_i}{\sum N_i} \qquad (1)$$

where, q = collective rate of exploitation or catchability coefficient for the fishery; C_i = total catch of the i th stock, and N_i is the total run magnitude for the i th stock. Note that these quantities were specific to year, time period, and area of the fishery.

If the North Pacific chum or sockeye salmon stocks are equally vulnerable to the South Peninsula fisheries then:

$$C_i = qN_i \qquad (2)$$

However, based on available stock identification studies, there were large differences in the vulnerability to the fishery among stocks. Generally stocks that are geographically closest to and with run timing most coincidental with the fishery are most vulnerable to the fishery (Eggers et al. 1991). To account for this stock-specific difference in vulnerability, an index of vulnerability (V_i) was defined so that the following equation holds:

$$C_i = V_i qN_i \qquad (3)$$

The estimate of the vulnerability index was derived by substituting equation 1 into equation 3 and solving for V_i:

$$V_i = \frac{\frac{C_i}{\sum C_i}}{\frac{N_i}{\sum N_i}} \tag{4}$$

Equations 4 was used to estimate the vulnerability indices for years, time periods, and areas where the stock contribution estimates were available.

The estimate of stock contribution (i.e., P_i's, where P_i = proportion of stock i in the June Fishery catch) based on stock-specific vulnerability index and abundance was derived from equation 3 as follows:

$$P_i = \frac{C_i}{\sum C_i} = \frac{V_i \times N_i}{\sum V_i \times N_i} \tag{5}$$

To facilitate inter-annual comparisons of stock vulnerability, the vulnerability indices were scaled so that the magnitude of index for the stock with the highest vulnerability was equal 1. The scaling factors cancel out in equation 5, and would not effect the stock contribution estimates. The model was used in a retrospective manner to apportion historical June fishery catches by species, area and time period into stock of origin. Inter-annual differences in the aggregate stocks catchability to the fishery (i.e., due to effort levels, fishing time, and weather, etc.) were implicit in the observed catch levels.

June Fishery catches and harvest rates were estimated for sockeye salmon 1970 - 1994, for Kuskokwim, Bristol Bay, North Alaska Peninsula, and Central Alaska (i.e., South Alaska Peninsula, Chignik, Kodiak, Cook Inlet, and Copper/Bering River) stock groupings. June Fishery chum salmon catches and harvest rates were estimated for years 1979 - 1994, for Kotzebue/Yukon Fall chum, NW Alaska summer chum (i.e., Norton Sound, Yukon summer, Kuskokwim, and Bristol Bay), Alaska Peninsula to Kodiak (North Alaska Peninsula, South Alaska Peninsula, Chignik, and Kodiak), Cook Inlet to Washington (i.e., includes river systems in the Cook Inlet, Prince William Sound, Southeast Alaska, British Columbia, and Washington), Russia, and Japan stock groupings. It was necessary to group river systems by broad geographical areas because genetic characters were observed to cluster by these areas (Seeb et al. 1995). Genetic stock identification methods were able to discriminate among these regional areas but not within these areas.

Abundance of North Pacific Chum and Sockeye Salmon

Chum Salmon

Total runs of chum salmon were tabulated for 1979 to 1994 (Tables 1 - 4). Total runs (i.e., catch + escapement) for AYK (i.e., Kotzebue, Norton Sound, Yukon River and Kuskokwim area) were based on expansion of commercial and subsistence fishery catches by an assumed exploitation rate (Table 1), except were escapement estimates were available. The latter included the upper Yukon River fall chum and recent year sonar counts for the Yukon River (1994) and Kuskokwim River (1993-1994). Bristol Bay chum salmon runs were based on expansion of chum salmon catches by fishing district based on the respective exploitation rate observed for sockeye salmon (Table 2). Total runs of Alaska Peninsula, Chignik, Kodiak chum salmon (Table 2) were the sum of commercial catch and expansion of aerial survey counts based on area under the curve methods (Barrett et al. 1990). Total runs of Cook Inlet, Prince William Sound, Southeast Alaska, British Columbia, and Washington chum salmon (Table 3) were taken from Rogers (1995). Chum salmon runs were pooled by stock groupings for which stock contribution estimates were made (Table 4).

Sockeye Salmon

Total runs (i.e., catch + escapement) of sockeye salmon were tabulated for 1970 to 1994 (Table 5). Total runs for Kuskokwim sockeye salmon were based on expansion of commercial and subsistence fishery catches by assumed exploitation rate of 0.6. Total runs of Bristol Bay sockeye were the sum of commercial catch and enumerated escapements from tower counts, sonar counts and aerial survey counts. Total runs of North Peninsula were the sum of commercial catch and enumerated escapements from tower and weir counts and expanded aerial survey counts. Central Alaska runs included runs to South Alaska Peninsula, Chignik, Kodiak, and Cook Inlet and Copper/Bering River, and were taken from the tabulation of Alaska Department of Fish and Game data provided by Rogers (1995).

Stock Contribution to the South Unimak and Shumagin Islands June Fishery Catches

Available quantitative information on the origin of sockeye and chum salmon catches in the South Unimak and Shumagin Islands June fishery include the 1987 tagging study (Eggers et al. 1991, Eggers 1992) and the 1993/1994 genetic stock identification study (Seeb et al. 1995).

1987 Tagging Study

Tagging was used to identify the stock contribution to the 1987 South Peninsula June fishery catches. The objective of the study was to determine the origin of chum and sockeye salmon caught in the South Peninsula June fisheries by recovering fish tagged near Unimak Island and the Shumagin Islands when they returned to their system of origin.

A population of tagged fish was released in the area and time of the June fishery. The tagged population represented the June fishery catches to the extent that the timing of the tag releases matched the timing of the catches in the respective fishing areas (Unimak, Shumagins, etc.).

Terminal area fisheries (i.e., commercial, subsistence, and sport fisheries) were used to recover tagged salmon that were released in the South Peninsula June fishery. Recovery of a fish that was tagged, in the South Peninsula June fishery, in a stock's terminal harvest area determined the origin of that fish. The recoveries of tagged salmon in the various terminal fishing areas were the origin of the released populations and, relative numbers of a stocks tag recoveries the basis of its contribution to the entire June fishery catches.

Because catches in terminal fisheries were constrained to provide for escapement, the catch did not contain all of the fish in the particular stock that were tagged at False Pass. Assuming that the tagged to untagged ratio is the same in the catch and in escapement, the estimated number of tagged fish in the catch was expanded to the estimated number in the total run by dividing the number of tags in the catch by the exploitation rate (i.e., the catch as a percent of the total run).

Independent fishery sampling programs were conducted in the Kuskokwim, Bristol Bay, North Peninsula, and South Peninsula fishing areas. The process involved interviewing fishermen, collecting tags and examining their catch to verify that all tags were recovered. The tags recovered in the fishery sampling program were then expanded to the entire catch based on the fraction of the total catch that was sampled. The reported fraction was estimated as the ratio of the reported tags to the estimated total recoveries, based on the fishery sampling program.

Because the tagging operations were stressful to the fish (i.e., fish were caught in purse seines, then they were dipped out of the bunt of the seine, then placed on tagging boards where the fish was restrained and the tag inserted, and then the tagged fish was returned to the water), substantial mortality was assumed to be associated with tagging. Tagged fish that died as a result of the tagging operations were not available to be recovered in terminal harvest areas and must be accounted for in the derivation of estimates of stock contribution.

It was anticipated that the expanded recoveries (tagged fish that were estimated to occur in the catch and escapement) for all of the stocks would account for most of the tag releases. Unfortunately, for chum salmon, only a relatively low fraction of the tagged fish that were released could be accounted for. For sockeye salmon, a much higher number of fish was accounted for in the expanded recoveries. The chum salmon releases that could not be accounted for were either attributed to tagging mortality, fish bound for Russian fisheries where tags could not be recovered, or fish from un-reported catch in AYK fisheries where independent fishery sampling programs were not conducted.

Sockeye salmon in the South Peninsula June fishery were entirely of Alaskan origin, based on earlier tagging studies. Good estimates of catches, escapements, and reported fraction were available for almost all of the sockeye stocks that occurred in the June fishery; therefore, the sockeye salmon tags that cannot be accounted for were due to tagging mortality. A single stage survival model, where tagging mortality and tag loss was considered a constant rate and was the same for all stocks, was used to expand recoveries.

The estimates of stock contribution were simply the number of tags that could be assigned to a particular stock (i.e., either in the reported catch, un-reported catch, escapement, or mortality) divided by the total number of tag releases. A model was used to expand the reported recoveries to totals to account for tags in the catch, escapement and mortality.

The stock contribution estimates for the South Unimak and Shumagin Islands June fisheries have undergone substantial evolution since the tagging study was conducted. Initial stock contribution estimates were published by Eggers et al. (1991). Estimates for sockeye salmon were taken from Eggers et al. (1991). The 1991 estimates for chum salmon were revised following an extensive review of the 1987 tagging study results. The review was in response to many questions by the public regarding the rationale, assumptions, and results of the 1987 tagging study that surfaced after the 1991 Board of Fisheries increased the chum salmon cap on the South Unimak and Shumagin Islands June fisheries. The revised chum salmon stock contribution estimates (Eggers 1992) corrected mistakes in the original analysis, and were stratified to account for differences in the timing of the catches and tag releases.

There were many implicit assumptions in the tagging method of estimating stock contribution. For chum salmon, there was little or no information on which to objectively base or test some of these assumptions (i.e., reported fractions for stocks without fishery sampling programs, and exploitation rates for Russian fisheries). Because of the subjective nature of the resulting estimates, it was more appropriate to present a range of estimates rather than a single, or point, estimate for chum salmon. One end of the range (i.e., Case 1) was based on assumptions that were thought to represent maximum estimates for the Arctic-Yukon-Kuskokwim (AYK) stock contribution and minimum estimates for the Asian stock contribution. The other end of the range (i.e., Case 3) was based on assumptions that were thought to represent minimum estimates for the AYK stock contribution and maximum estimates for the Asian stock contribution. Case 2 represents the two stage survival model and reported fractions that were used in the original analysis (Eggers et al. 1991).

Details of the different model parameters used to expand recoveries are as follows:

Sockeye Salmon. Reported fractions were those observed in the Kuskokwim, Bristol Bay, North Peninsula, and South Peninsula fishery sampling programs. Reported fraction for Central Alaska stocks was taken to be the average of those observed in the fishery sampling program.

A single stage survival model was used where the mortality rate was specific to the Unimak and Shumagin sockeye salmon releases. The mortality rates were estimated as recoveries that could not be accounted for by expanding for under-reporting and for tags in the escapement.

Chum Salmon - Case 1. Reported fractions were those observed in the Kuskokwim, Bristol Bay, North Peninsula, and South Peninsula fishery sampling programs. Reported fractions for Kotzebue Sound, Norton Sound, Yukon River, and coastal Russia equal to 0.25 (i.e., roughly one half of reported fraction observed for Kuskokwim chum salmon, which was the minimum observed in any of the fishery sampling programs), for central Alaska equal to 0.53, and for coastal Japan equal to 1.0. The Case 1 reported fractions were thought to be minimum estimates for AYK fisheries, which subsequently provided maximum estimates of expanded recoveries.

A single stage survival model was used where the mortality rate was specific to the Unimak and Shumagin chum salmon releases. The mortality rates were estimated as recoveries that could not be accounted for by expanding for under-reporting and for tags in the escapement.

Under the single stage survival model, stock contribution estimates for western Alaska stocks were very sensitive to subjective assumptions of model parameter values for Asian and AYK stocks. Case 1 did not resolve the different recovery rate for the chum salmon releases (i.e., 844 tags recovered out of 6,323 tags released or 13.3%) and sockeye salmon releases (i.e., 1,923 tags recovered out of 6,987 tags released or 27.5%).

Case 1 was thought to represent maximum estimates for AYK chum salmon contributions to the released populations and minimum estimates for the Asian stocks.

Chum Salmon - Case 2. Case 2 will use the two stage survival model used in the estimates of stock composition reported in Eggers et al. (1991) and presented to the Board of Fisheries at the November, 1991, meeting. Case 2 explained the differential tag recovery rates between chum salmon and sockeye salmon. Case 2 also explains the differential recovery rate for chum salmon releases in the Unimak (527 tags recovered out of 3495 tags releases or 15.1%) and Shumagin (317 tags recovered out of 2828 tags released or 11.2%) Areas.

Under the two stage survival model, estimates of AYK chum stock composition are less sensitive to errors in Asian stock expansion factors. A sensitivity analysis showed that stock composition estimates for western Alaska chums were not sensitive to errors in expansion factors for Asian stocks (Eggers et al. 1991).

Chum Salmon - Case 3. Case 3 used the single stage mortality rate specific to the Unimak and Shumagin areas. Case 3 differs from Case 1 in that mortality rates were estimated based on the mortality estimated for the sockeye salmon releases in the Unimak and Shumagin areas. The recoveries in excess of the expanded recoveries were assigned to the Asian stocks. In addition, Case 3 assumed that the reported fraction of Alaskan stocks for which no fishery sampling program occurred was 0.53, which was equal to that estimated for the Kuskokwim fishery. The 0.53 reported fraction was the lowest observed in any of the chum salmon fishery sampling programs that were conducted.

Case 3 was thought to represent minimum estimates for AYK chum salmon contributions to the released populations and maximum estimates for the Asian stocks.

The estimates of stock contribution of the 1987 June fishery sockeye catches in Table 6 were taken directly from Eggers et al. (1991). The estimated catch of central Alaska sockeye salmon (Table 6) were pooled estimated catches of South Alaska Peninsula, Chignik, Kodiak, and Cook Inlet from Eggers et. al. 1992. Bristol Bay origin sockeye salmon dominated the catches in both Unimak and Shumagin areas. Bristol Bay sockeye had highest vulnerability to the Unimak area, and North Alaska Peninsula sockeye had the highest vulnerability to the Shumagin area fishery.

There were significant differences in timing of western Alaska chum salmon stocks through the Unimak and Shumagin areas (Eggers et al. 1992). The releases were stratified by an early period (June 7 - 20) and a late period (June 21 - July 7) to correct the bias due to the different timing of the tag releases and the actual June fishery catches and stratified estimates of stock contribution (i.e., independent estimates for the early and late periods) were developed.

The estimated stock contribution of the 1987 June fishery chum salmon catches for the early period (Table 7) and late time period (Table 8) were by slightly different stock groupings than those presented in Eggers (1992). Kotzebue Sound stocks were grouped; Norton Sound, Yukon River (i.e., summer and fall runs), Kuskokwim area, and Bristol Bay stocks were grouped into a Northwest Alaska summer chum group; North Alaska Peninsula, South Alaska Peninsula, Chignik, and Kodiak stocks were grouped; and Cook Inlet, Prince William Sound, Southeast Alaska, British Columbia, and Washington were grouped. These groupings were consistent with the stock groupings in the 1993 and 1994 genetic stock identification study.

For the Unimak area, the northwest Alaska summer chum salmon group generally dominated the catches for both the early period (Table 7) and late period (Table 8), for all scenarios of model parameters. For the early period Shumagin area, the northwest Alaska summer chum salmon group generally dominated the catches (Table 7) for all scenarios of model parameters. For the late period Shumagin areas, with the NW Alaska summer chum group dominated in Case 1 and the Asian stocks dominated in Case 3 (Table 8).

The 1993-1994 Genetic Stock Identification Study

Procedures that examine direct products of individual genes or the actual genetic material (i.e., DNA) have been the basis of a new era in understanding genetic differences both within and among populations of all organisms including fishes. Genetic stock identification (commonly abbreviated GSI) using proteins detected by allozyme electrophoresis has been applied to fisheries problems since the early 1970 and has been a part of many management programs (Seeb 1994). It was recognized that these underlying genetic differences could be used to differentiate stocks in mixtures of Pacific Salmon (Grant et al. 1980; Miller et al. 1981; Winans et al. 1995; Wilmot et al. 1992; Seeb et al. 1986; Seeb, et al. 1990), and statistical methods based on maximum likelihood estimates evolved to identify individual stocks within mixtures (Miller et al., 1981; Fournier et al., 1984; Millar, 1987, 1990; Pella and Milner, 1987).

There has been considerable progress in the development of a comprehensive GSI baseline for chum salmon (Seeb 1994). These baseline collections include allozyme data for approximately 20 loci from over 144 collections ranging across the Pacific rim from Washington State to Japan. These data have been collected by a large number of agencies and university laboratories throughout the Pacific Rim. The Alaska Department of Fish and Game initiated intensive baseline collections in 1992; sampling stocks in western and central Alaska which were under-represented in the Pacific Rim database.

Analysis of the chum salmon baseline GSI database demonstrates considerable differentiation among major regional groups, (Seeb et al. 1995). Pacific Rim chum salmon subdivide into the following regions: Japan, Russia, Yukon fall, NW Alaska summer (i.e., Kotzebue, Norton Sound, Yukon summer, Kuskokwim, Bristol Bay), Alaska Peninsula to Kodiak (i.e., includes North Alaska Peninsula, South Alaska Peninsula, Chignik, and Kodiak), Prince William Sound to Washington (i.e., includes Prince William Sound, Southeast Alaska, British Columbia, and Washington).

Baseline collections were very limited in the Cook Inlet area, and available data from the Canadian portions of the Yukon River were not analyzed because of incomplete suite of genetic characters. Because of the well defined clustering of genetic characters of chum salmon stocks by geographic areas, it was assumed that the Canadian Yukon chum stocks would have genetic characters similar to the Yukon fall chum stocks in the U.S. portions of the Yukon River, and that Cook Inlet stocks would have genetic characters similar to Prince William Sound.

Baseline collections from Cook Inlet were limited to Chunilna creek. This creek is located on the northern edge of the Cook Inlet area and probably does not represent the chum salmon stocks of the Cook Inlet area. Unfortunately the genetic characteristics of the Chunilna creek were very similar to the NW Alaska summer chum salmon group. Similarly, the Meshik River is located on the northern edge of the North Alaska Peninsula management area, and has genetic characteristics very similar to Bristol Bay chum salmon. Meshik River or Chunilna Creek origin chum salmon in the mixture samples would be assigned to the NW Alaska summer chum salmon group. The misclassification could potentially bias the estimates of NW Alaska summer chum contribution to the June fishery. Because the run of chum salmon to these systems is very small relative to the aggregate NW Alaska summer, Alaska Peninsula to Kodiak, and to Cook Inlet chum salmon stock groups, this potential bias was believed to be negligible.

Mixture samples were collected from the South Alaska June Fishery during 1993 and 1994. Collections were taken from each opening in the Unimak area in 1993, and from each opening in the Unimak and Shumagin areas in 1994. Because of laboratory constraints only a subset of the Unimak area mixture samples were analyzed. The results of these analyses and estimates of stock contribution of the 1993 and 1994 catches (Table 9) were reported in Seeb et al. (1995).

For the Unimak area, the northwest Alaska summer chum salmon group dominated the June fishery catches for 1993 and 1994 (Table 9). The stock contribution of the June fishery catches was very similar between years and time period for the Unimak area. There were some slight differences in the contribution of more minor stock groupings between years. These minor stock differences were not consistent between time periods although the Russian stock contribution was higher for both time periods in 1994.

DNA markers (Parks et al. 1993) have been identified which clearly identify Japanese origin chum salmon. Mixture samples from the 1994 June fishery were analyzed for the DNA marks and contribution of Japanese origin salmon were almost identical to the estimates based on allozyme markers (Seeb et al. 1995). This result lends much credence to the results based on allozyme data.

Chum Salmon Stock Vulnerability to the South Unimak and Shumagin Islands June Fishery

With the completion of the 1993/1994 GSI study, independent estimates of stock contribution for the Unimak area catch were available for several years. Between year consistency of the stock contributions to the June fishery can be examined based on the relative vulnerability indices, which corrects for the effect of inter-annual differences in relative run strength among stocks. These were estimated for 1987 (Table 7, 8), 1993 (Table 9), and 1994 (Table 9).

A fall chum stock grouping, which included Yukon fall chums and Kotzebue chums, was used for comparison of relative vulnerability indices among years for the Unimak area (Table 10). In the 1987 tagging study it was not possible to separate Yukon fall chum recoveries from Yukon summer chum recoveries, so estimates of Yukon Fall chum catches were pooled in the NW Alaska summer chum group. Estimates of relative vulnerability for the fall chum group from the tagging study applied only to Kotzebue chums. In the GSI study, Kotzebue chum salmon were not separable from the NW Alaska summer chum group; thus, relative vulnerability indices for the fall chum group applied only to Yukon fall chums. Since the estimated timing of these stocks in the South Unimak and Shumagin Islands June fishery was almost identical (Eggers et al. 1992), the relative vulnerability estimated for individual river systems was likely indicative of the combined fall chum stocks vulnerability.

The relative vulnerability for the NW Alaska summer chum group in the Unimak Arer was the highest for all years and time periods (Table 10). The fall chum group were present in the Unimak area only during the late time period (Table 10). The general magnitude of relative vulnerability among stocks was consistent among years and areas. The stocks whose run timing through the South Alaska Peninsula area is most coincidental with the timing of the June fishery and whose natal streams are located geographically closest to the Alaska Peninsula area had the highest relative vulnerability.

There were some differences in relative vulnerability indices for the minor chum salmon stock groupings between the 1993/1994 GSI estimates and the 1987 tagging estimates. The relative vulnerability of the Alaska Peninsula to Kodiak group was much lower in 1993/1994 GSI estimates than in the 1987 tagging estimates. The relative vulnerability of the Cook Inlet to Washington group was much higher in the 1993/1994 GSI estimates than in the 1987 tagging estimates.

There was much uncertainty in the relative vulnerability of the Asian stocks based on the 1987 tagging study. The relative vulnerability of the Asian stocks based on Case 1 parameters were thought to be minimum estimates and those based on Case 3 parameters were thought to be maximum estimates. The 1993/1994 GSI estimates provide a much better estimate, particularly of the Japanese component. The relative vulnerability of the Japanese stocks, in the early period, based on GSI estimates were two to three times lower than relative vulnerability based on the CASE 3 tagging estimates. In the late period the GSI based relative vulnerabilities were six to seven times lower than the CASE 3 tagging based vulnerabilities (Table 10). The relative vulnerabilities for the Russian stocks based on GSI were more consistent with those based on CASE 3 tagging.

It is difficult to directly compare relative vulnerabilities estimated for the NW Alaska summer chum group for different years. Since NW Alaska summer chum salmon were the major stock group exploited by the fishery, relative vulnerability indices by definition were set equal to one. To check the consistency of the GSI based vulnerabilities with those based on tagging, estimates of the 1987 stock-specific catches, by time period, were made based on the average of the 1993 and 1994 GSI based vulnerabilities (Table 11). The estimates of NW Alaska summer chum salmon catches based on GSI based vulnerabilities were very similar to the estimated catches based on the tagging study under CASE 2 parameters (Table 11).

Stock-specific Catches in and Harvest Rates by the South Unimak and Shumagin Islands June Fishery

Chum Salmon

Because of several problems associated with the tagging study (Eggers et al. 1992, Eggers 1992), chum salmon stock contribution estimates based on genetic stock identification methods were believed to be more accurate. Relative vulnerability indices used to estimate historical stock-specific catches in the Unimak area June fishery were taken to be the average of the 1993 and 1994 GSI based estimates (Table 10). The 1993 and 1994 Unimak area stock-specific catches were based on the GSI estimates of stock contribution for the respective year. Samples from the 1994 Shumagin area fishery have not been analyzed; therefore, estimates of relative vulnerability indices for the Shumagin area were not available. Estimates of historical stock-specific catches for the Shumagin area were based on the CASE 2 tagging relative vulnerability indices estimated for the Shumagin areas. This assumption was based on the similarity in the 1987 Unimak area stock-specific catches estimated from GSI based relative vulnerability indices to those estimated with the tagging study under CASE 2 parameters (Table 11).

A worksheet was developed to calculate stock contribution of the June fishery chum salmon catches, by time period, fishing area, and year (Table 12). Here stock contribution was taken to be the relative magnitude of the product of assumed vulnerability index and the respective year/stock abundance. These stock contribution estimates were applied to the respective June fishery chum salmon catch by area, time period, and year to estimate stock-specific catches (Table 13).

Harvest rates by the South Unimak and Shumagin Islands June fishery on NW Alaska summer chum salmon (i.e., estimated catch of NW Alaska summer chum salmon by the June fishery divided by total run plus June fishery catch) were estimated for the years 1979 - 1994 (Table 13, Figure 1). The trend in harvest rate of NW Alaska summer chum by the June fishery (Figure 1) was examined for the period since 1979 and since 1984 when measures to limit incidental catches of chum salmon in the June fishery were implemented by the Board of Fisheries. There no increasing trend in harvest rate for the period 1979 - 1994 [Cox and Stuart test for trend (Conover 1971), $p = 0.50$]; however, for the period, 1984 - 1994, the increasing trend in harvest rate was significant ($p = 0.03$). The mean harvest rate of NW Alaska summer chum salmon by the June fishery was 3.8 % for the period 1984 - 1988 and 6.3 % for the period 1989 - 1994 (Figure 1).

Since 1989, there has occurred a decrease in the run size of Northwest Alaska summer chum salmon (Figure 1). During this period of decreasing inshore runs of Northwest Alaska summer chum salmon there has occurred a reduction of the harvest rate (Figure 2) and catches (Figure 3) in inshore fisheries. The overall inshore harvest rate on NW Alaska summer chum salmon in 1993-1994 averaged 34.3 % and lower than the 45.8 % average for the period 1984 - 1988. There existed differences in harvest rate by various inshore fisheries on NW Alaska summer chum salmon. For example, in northern Norton Sound commercial and subsistence fisheries for chum salmon have been closed recent years and catches of these runs have occurred only in the South Unimak and Shumagin Islands June fishery. This reduction in harvest rate by inshore fishers was the department's management strategy to maintain escapements at desired levels.

Sockeye Salmon

Relative vulnerability indices used to estimate historical stock-specific catches of sockeye salmon in the June fishery were estimated based on the 1987 tagging study (Eggers et al. 1991). These estimates were thought to be accurate, because of the large contribution of Bristol Bay sockeye salmon to the June fishery catches, the relatively small number of potential stocks in the fishery, and the large fraction of the deployed tags that were recovered in the inshore harvest areas.

A worksheet was developed to calculate stock contribution of the June fishery sockeye salmon catches, by fishing area and year (Table 14). Here stock contribution was taken to be the relative magnitude of the product of assumed vulnerability index and the respective year/stock abundance. These stock contribution estimates were applied to the respective June fishery sockeye salmon catch by area and year to estimate stock-specific catches (Table 15).

Harvest rates by the South Unimak and Shumagin Islands June fishery on Bristol Bay sockeye salmon (i.e., estimated catch of Bristol Bay sockeye salmon by the June fishery divided by total run plus June fishery catch) were estimated for the years 1970 - 1994 (Table 15, Figure 4). The trend in harvest rate of Bristol Bay sockeye salmon the June fishery (Figure 4) was examined for the period since 1979 and since 1984 when measures to limit incidental catches of chum salmon in the June fishery were implemented by the Board of Fisheries. There no increasing trend in harvest rate for the period 1979 - 1994 [Cox and Stuart test for trend (Conover 1971), $p = 0.50$]; or, for the period,1984 - 1994, the increasing trend in harvest rate was significant ($p = 0.50$).

There has occurred an large increase in the harvest rate of Bristol Bay sockeye salmon by inshore fishers (Figure 5) since the early to mid 1970's. This increase in harvest rate by the June fishery and by the inshore fishery on Bristol Bay sockeye has occurred because of the increasing size of the Bristol Bay sockeye salmon runs (Figure 4). This increase in harvest rate by inshore fishermen was the Department's management strategy to maintain escapements at desired levels. The 1975 management plan which sets the June fishery sockeye quota as a fixed percentage of the forecasted Bristol Bay inshore catch. This plan in conjunction with preseason forecasts that generally track the Bristol Bay sockeye salmon run, has been effective in enabling both inshore and area M fishers to share in the increasing surplus production of Bristol Bay sockeye salmon.

The harvest rate of Northwest Alaska chum salmon and Bristol Bay sockeye salmon in the South Unimak and Shumagin Islands June fishery was closely related (Figure 6). This was because Bristol Bay sockeye salmon and Northwest Alaska summer chum salmon occur together in the South Unimak and Shumagin Islands area during June. Increases in fishing effort in the June fishery since the mid- 1980's to harvest an increasing proportion (i.e., harvest rate) of the Bristol Bay run has necessarily resulted in an increasing rate of harvest of Northwest Alaska summer chum salmon runs by the June Fishery during this period. This increasing rate of harvest by the June fishery on Northwest Alaska summer chum salmon has occurred on declining runs of the stocks making up that group.

DISCUSSION

The harvest, escapement, and total run size approximations for AYK chum salmon should be viewed, and used, with a large measure of caution. While commercial harvests of these stocks are probably known with a high degree of accuracy, other components of the runs are more difficult to assess. Subsistence harvests of Yukon and Kuskokwim area chum salmon are estimated based on interviews of subsistence fishermen. However, less is known of subsistence harvests in the Norton Sound and Kotzebue areas, and subsistence harvests in these areas have been approximated using subjective assumptions. Escapements, in particular, are difficult to assess. In many cases, the only available escapement information consists of aerial survey counts from selected portions of selected streams. The degree to which these data provide information about total escapement for the given management area is difficult to assess. For that reason, most total escapement estimates have been approximated by applying an assumed exploitation rate to the harvest. Because of the unavoidable difficulties in the estimation of subsistence harvests and total escapements, both of which are significant components of most AYK chum salmon runs, these data should be viewed as reflecting, at most, broad trends in abundance over time.

The estimation of historical harvest rates on Northwest Alaska summer chums and Bristol Bay sockeye salmon by the South Unimak and Shumagin Islands June fishery was based on the assumption that vulnerability by these stocks to the June fishery was consistent from year to year. The assumption of consistent vulnerability from year to year was supported by the observation that relative vulnerability indices for the stock groupings based on the GSI studies were very similar between years and time periods. In addition, the relative vulnerability indices from the GSI studies were within the range of values based on the 1987 tagging study. The estimated 1987 catch of NW Alaska summer chum salmon based on GSI vulnerabilities were very similar to the those estimated by the 1987 tagging study with CASE 2 parameters; thus, relative vulnerability indices estimated based on the 1987 tagging study CASE 2 parameters were used to estimate historical stock-specific catches for the Shumagin Area.

There was variability in the GSI based vulnerability indices for minor stock groupings between years and time periods. Except for Yukon fall and Russian chum salmon, there were no consistent patterns between years and time periods. Yukon fall chum salmon occurred only in the late time period, and the vulnerability was very similar between years. Russian stocks had much higher vulnerability in 1994. These differences for the Russian stocks may reflect uncertainty in the estimated run sizes.

Harvest rate trends were analyzed only for the major stock groupings; however, these trends might be sensitive to inter-annual variations in minor stock vulnerabilities. To examine the effect of inter-annual variability in Russian stock vulnerability of the magnitude observed in the two year GSI study, historical NW Alaska summer chum harvest rates were recalculated based on the low Russian stock vulnerability observed in 1993 and the high Russian stock vulnerability observed in 1994. The difference in the mean (i.e., 1979 - 1992) harvest rates for these two series was 0.6 percent. If the Russian stock vulnerabilities observed in 1993 and 1994 are extremes, then the harvest rate estimates for NW Alaska chum salmon might vary by + or - 0.3 percent due to due to inter-annual variability in Russian stock vulnerability to the June fishery.

It was necessary to combine the Norton Sound, Yukon summer, Kuskokwim area, and Bristol Bay chum salmon into a single stock grouping, because of high similarity in genetic characters among these stocks. Although the trends in harvest rate for the aggregated stocks apply to individual river systems, there are likely differences in the relative magnitude of harvest rate among the individual river systems in the NW Alaska summer chum salmon grouping. Yukon summer chum salmon have much earlier run timing through the South Peninsula area (Eggers et al. 1992), than the Norton Sound, Kuskokwim area, and Bristol Bay stocks. Because of the earlier run timing, the vulnerability of Yukon summer chum salmon to the June fishery would presumably be lower than that estimated for the aggregate NW Alaska chum salmon group. Thus, the harvest rates estimated for the aggregate NW Alaska chum salmon group were likely too high for Yukon summer chum salmon and too low for the other stocks in this group (i.e., Norton Sound, Kuskokwim, and Bristol Bay).

To examine the potential magnitude of this bias, the historical stock-specific catches of NW Alaska summer chum catches were apportioned into Yukon summer chum and Norton Sound/Kuskokwim/Bristol Bay stock group assuming the relative vulnerability index for Yukon summer chum was one half of that based on GSI estimated for the aggregate NW Alaska summer chum stock grouping for the early period. For the late period, the relative vulnerability index for Yukon summer chum was one fourth of that based on GSI estimated for the aggregate NW Alaska summer chum stock grouping. The lower vulnerability indices assumed for Yukon summer chum salmon was consistent with that estimated in the 1987 tagging study (Eggers 1992). An increasing trend in harvest rate by the June fishery occurred for both Yukon summer chum and the Norton Sound/Kuskokwim/Bristol Bay stock group (Figure 7); however the harvest rates on Yukon summer chum averaged 3.0 % and on the Norton Sound/Kuskokwim/Bristol Bay group averaged 7.0 %. The estimated harvest rate for Yukon summer chum was lower and the Norton Sound/Kuskokwim/Bristol Bay stock group higher than the harvest rate of 5.6 % estimated for aggregate NW Alaska summer chum group.

June fishery harvest rates estimated for the aggregate Norton Sound, Kuskokwim and Bristol Bay chum salmon apply to individual river systems if relative vulnerabilities are equal among these stocks. It is possible that variabilities in relative vulnerability exists among the Norton Sound, Bristol Bay, and Kuskokwim chum salmon stocks. The magnitude of this variability cannot be assessed with the methods used to identify origin of the June fishery chum salmon catches. However, it is believed that the relative vulnerability is similar for the Norton Sound, Kuskokwim, and Bristol Bay salmon stocks due to their similar run timing in the June fishery area.

Harvest rates by the June fishery on NW Alaska summer chum salmon were greater than those on Bristol Bay sockeye salmon (Figure 6). The mean harvest rate by the June fishery during the period, 1984 - 1994, on NW Alaska summer chum salmon was 5.6 % and on Bristol Bay sockeye salmon was 3.5 %. This difference rests on the assumption that estimated run magnitudes for NW Alaska summer chum salmon were unbiased. Estimates of certain components of the NW Alaska summer chum stock grouping were based on assumed exploitation rates and could be biased; however, the estimates of Bristol Bay chum salmon runs are based on well documented inshore harvest rates and catches. Estimates of Yukon and Kuskokwim chum escapements in 1993 and 1994 were estimated based on sonar counts and thought to be accurate. Harvest rates on NW Alaska chum salmon by the June fishery for these years (i.e., 8.2% and 5.0% for 1993 and 1994, respectively) were substantially greater than those for Bristol Bay sockeye salmon (i.e., 4.8 % and 2.5 % for 1993 and 1994, respectively).

The difference in harvest rates indicated that the June fishery was more efficient on NW Alaska summer chum salmon than on Bristol Bay sockeye salmon. This suggests that NW Alaska summer chum salmon were more vulnerable to the June fishery than Bristol Bay sockeye salmon. This was consistent with the ocean distribution of western Alaska chum salmon and Bristol Bay sockeye salmon based on the INPFC tagging studies. Western Alaska chum salmon and Bristol Bay sockeye salmon occurred over a broad area in the North Pacific Ocean; however western Alaska chum salmon occurred further east in the Gulf of Alaska than Bristol Bay sockeye salmon, and Bristol Bay sockeye occurred further west in the North Pacific Ocean than western Alaska chum salmon (Harris 1988). Because western Alaska chum salmon occurred further to the east in the Gulf of Alaska, a greater portion of maturing western Alaska chum salmon migrated through the South Peninsula June fishery fishing areas during their migration to their natal streams.

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Table 1. Approximate run sizes of chum salmon in the AYK Region by management area, 1979-1994, based upon best estimates of catch (commercial and subsistence combined) and in most cases some very subjective approximations of total spawning escapement. The estimates of total spawning escapement for Yukon River fall chum salmon are considered the most reliable, and are part of a long established database used to study population trends for that run. All other total spawning escapement estimates by management area are more subjective. These were developed only for the purpose of describing general trends across a broad portion of the Bering Sea across a number of years. This summary should not be used outside of this context, as reliable estimates of total spawning escapement by management area have not historically been available, thereby requiring the use of trend information from selected indicator stocks. Reference footnotes for methods of estimation by management area. All numbers are in thousands of fish.

	Kotzebue \a			Norton Sound \b			Yukon Summer \c			Yukon Fall \d			Kusko River \e			Kusko Bay \f			Total AYK	
	Cat.	Esc.	Run	Cat.	Esc.	Run	Cat.	Esc.	Run	Cat.	Esc.	Run	Cat.	Esc.	Run	Cat.	Esc.	Run	Cat.	Esc.
1979	202	134	336	166	166	332	1011	674	1685	615	799	1414	368	368	735	37	86	123	2398	2227
1980	427	285	712	206	206	412	1236	1053	2289	488	231	720	589	1375	1964	79	185	264	3026	3335
1981	737	491	1229	195	195	389	1398	2380	3778	677	343	1020	525	1224	1748	69	181	250	3600	4814
1982	478	319	796	208	208	417	835	905	1740	373	110	484	384	897	1281	49	98	146	2327	2536
1983	236	157	393	344	344	689	1146	763	1909	525	210	735	374	374	747	32	95	127	2656	1944
1984	380	253	634	171	171	343	1033	1837	2870	412	142	555	530	530	1059	66	238	304	2593	3172
1985	581	388	969	160	160	320	1093	2030	3123	516	498	1013	292	292	584	26	75	101	2668	3442
1986	321	214	536	172	172	344	1372	2146	3518	318	281	599	444	444	889	41	123	164	2669	3381
1987	170	113	283	128	128	255	798	799	1597	406	465	871	637	637	1273	31	61	92	2169	2202
1988	413	275	688	133	133	266	1824	1976	3800	354	192	546	1499	1499	2997	63	110	173	4286	4184
1989	315	210	524	68	101	169	1634	960	2594	534	390	924	871	871	1743	55	111	166	3477	2643
1990	223	149	372	90	135	225	632	658	1290	355	311	665	558	558	1116	64	134	197	1922	1944
1991	300	200	500	112	168	280	771	1496	2267	439	341	780	514	514	1027	72	198	270	2207	2916
1992	349	233	582	108	163	271	672	1305	1977	149	247	396	430	430	860	94	213	307	1803	2590
1993	131	200	331	79	118	196	246	871	1116	90	240	330	89	401	490	53	123	176	687	1952
1994	213	275	488	43	200	243	498	2020	2518	161	634	795	359	684	1043	92	193	285	1366	4006
1979-84 Average	342	244	586	149	173	322	1012	1367	2379	401	339	740	529	693	1222	58	139	197	2491	2956

\a Kotzebue Sound: Total catch is the sum of documented commercial catch each year and an assumed annual subsistence catch of 60,000. Escapement is approximated by assuming that total catch (commercial plus subsistence) represents a 60% exploitation rate, except for 1993, for which escapement was approximated at 200,000 fish, and 1994, for which escapement was approximated at 275,000 fish.

\b Norton Sound: Total catch is the sum of documented commercial catch each year and an assumed annual subsistence catch of 25,000. Escapement is approximated by assuming that total catch (commercial plus subsistence) represents a 50% exploitation rate for 1979-1988, a 40% exploitation rate for 1989-1993, except for 1994 for which escapement was approximated at 200,000 fish.

\c Yukon Summer: Total catch is the sum of documented commercial and estimated subsistence catch each year. Escapement is approximated based on an estimated exploitation rate derived for each year based upon total catch for that year and an analysis of escapement data, except for 1994 in which Pilot Station sonar data was used to assess the run above Pilot Station.

\d Yukon Fall: Total catch is the sum of documented commercial and estimated subsistence catch each year, including Canadian catches. Escapement is estimated as the doubled sum of the escapement to the Sheenjek, Delta, Toklat, and Fishing Branch Rivers.

\e Kuskokwim River: Total catch is the sum of documented commercial and estimated subsistence catch each year. The subsistence catch of "small salmon" was not identified by species prior to 1985, therefore the average chum salmon percentage for 1985-1989 was applied to the annual "small salmon" catch estimate for the years 1979-1984. Escapement is approximated by assuming that total catch (commercial plus subsistence) represents a 50% exploitation rate, except for 1993 and 1994, for which data from the Kuskokwim River sonar project was used.

\f Kuskokwim Bay: Total catch is the sum of documented commercial and estimated subsistence catch each year for Districts W-4 and W-5 combined. Escapement for Districts W-4 and W-5 is approximated based upon exploitation rate estimates from Goodnews River tower/weir escapement data and aerial survey escapement distribution information in the Goodnews River, except for 1994 is which an exploitation rate of 50% in District W-4 was assumed.

Table 2. Estimated catch, escapement, and run sizes (thousands of fish) for Bristol Bay, North Alaska Peninsula, South Alaska Peninsula , Chignik, and Kodiak chum salmon.

	Bristol Bay\a			North Ak. Peninsula \b			South Ak. Peninsula \b			Chignik\c			Kodiak\c		
	Cat.	Esc.	Run	Cat.	Esc.	Run	Cat.	Esc.	Run	Cat.	Esc.	Run	Cat.	Esc.	Run
1979	907	759	1,666	66	454	520	378	489	867	180	180	360	360	800	1,160
1980	1,301	2,039	3,340	700	1,147	1,847	823	467	1,290	310	230	540	1,080	1,100	2,180
1981	1,505	595	2,100	707	797	1,504	1,195	456	1,651	580	240	820	1,350	980	2,330
1982	921	409	1,330	331	682	1,013	1,177	466	1,643	390	260	650	1,260	1,360	2,620
1983	1,632	528	2,160	349	586	935	923	536	1,459	160	100	260	1,090	1,090	2,180
1984	2,023	1,497	3,520	798	1,295	2,093	1,319	831	2,150	60	370	430	650	900	1,550
1985	1,069	972	2,040	667	517	1,184	915	612	1,527	30	60	90	430	960	1,390
1986	1,227	983	2,210	271	364	635	1,399	653	2,052	180	50	230	1,130	1,170	2,300
1987	1,529	1,351	2,880	369	494	863	933	729	1,662	130	80	210	680	850	1,530
1988	1,469	1,071	2,540	393	859	1,252	1,379	588	1,967	270	360	630	1,430	950	2,380
1989	1,259	981	2,240	157	239	396	538	343	881	0	140	140	20	1,530	1,550
1990	1,059	622	1,680	126	398	524	719	446	1,165	270	250	520	580	600	1,180
1991	1,290	740	2,030	191	411	602	816	913	1,729	260	470	730	1,030	1,070	2,100
1992	885	495	1,380	342	524	866	891	408	1,299	220	570	790	660	530	1,190
1993	724	296	1,020	135	721	856	516	392	908	120	260	380	640	670	1,310
1994	833	468	1,301	84	711	795	1,596	701	2,297	210	370	580	700	550	1,250
1979-94 Average	1,227	863	2,090	355	637	993	970	564	1,534	211	249	460	818	944	1,763

a\ Total runs estimated by expanding district catches of chum salmon by respective district harvest rate on sockeye salmon.
b\ Escapements by expanding peak aerial survey counts by area under the curve method (Barrett et al. 1990)
c\ Data taken from summaries of ADF&G data in Rogers (1995)

Table 3. Estimated catch, escapement, and run sizes (thousands of fish) for Cook Inlet, Prince William Sound, and estimated run sizes for Southeast Alaska, British Columbia, and Washington chum salmon.

	Cook Inlet\a			Prince William Sound \b			SE Alaska, BC, Washington \c
	Cat.	Esc.	Run	Cat.	Esc.	Run	Run
1979	870	373	1,243	330	100	430	4,000
1980	460	197	657	410	90	500	11,000
1981	1,170	501	1,671	1,750	150	1,900	6,000
1982	1,630	699	2,329	1,340	370	1,710	9,000
1983	1,270	544	1,814	1,030	390	1,420	6,000
1984	760	326	1,086	1,200	230	1,430	13,000
1985	780	334	1,114	1,310	190	1,500	17,000
1986	1,190	510	1,700	1,680	230	1,910	17,000
1987	480	206	686	1,910	340	2,250	12,000
1988	940	403	1,343	1,840	590	2,430	20,000
1989	140	60	200	990	320	1,310	9,000
1990	360	154	514	960	410	1,370	13,000
1991	330	141	471	330	250	580	11,000
1992	380	163	543	330	270	600	16,000
1993	120	51	171	1,190	270	1,460	21,000
1994	300	129	429	1,060	290	1,350	21,000
1979-94 Average	699	299	998	1,104	281	1,384	12,875

a\ Total runs estimated by expanding catches of chum salmon by mean sockeye harvest rate (0.7) Rogers (1995).
b\ Data from Annual Management Report.
c\ Data taken from Rogers (1995)

Table 4. Chum salmon runs, 1979 to 1994, for various stock groupings.

	Kotzebue/ Yukon Fall	NW Alaska Summer	Ak. Penisula/ Chignik/Kodiak	Cook Inlet/Prince William Sound/SE Alaska British Columbia/Washington	Russia/a	Japan/a
1979	1,750	4,541	2,907	5,673	13,800	32,200
1980	1,432	8,269	5,857	12,157	8,273	30,727
1981	2,248	8,266	6,305	9,571	10,256	38,744
1982	1,280	4,914	5,926	13,039	8,324	35,676
1983	1,128	5,632	4,834	9,234	13,469	41,531
1984	1,188	8,096	6,223	15,516	7,933	43,067
1985	1,982	6,169	4,191	19,614	12,762	54,238
1986	1,135	7,125	5,217	20,610	14,700	48,300
1987	1,153	6,097	4,265	14,936	13,696	45,304
1988	1,234	9,777	6,229	23,773	13,433	48,567
1989	1,448	6,912	2,967	10,510	13,206	50,794
1990	1,038	4,508	3,389	14,884	13,173	62,827
1991	1,280	5,874	5,161	12,051	10,164	51,836
1992	978	4,795	4,145	17,143	17,270	46,730
1993	661	2,998	3,454	22,631	21,000	59,000
1994	1,283	5,390	4,922	22,779	14,000	62,000
1979-94 Average	1,326	6,210	4,750	15,258	12,841	46,971

a/ High seas salmon fishery catches allocated to Russia and Japan based on relative coastal runs, data from Rogers (1995)

Table 5. Sockeye salmon runs (thousands of fish), 1970 to 1994, for various stock groupings. Data taken from Rogers (1995).

	Kuskokwim	Bristol Bay	North Alaska Peninsula	Central Alaska	Total
1970	30	39,400	660	7,000	47,090
1971	20	15,820	790	6,000	22,630
1972	10	5,410	2,440	5,000	12,860
1973	10	2,440	350	4,000	6,800
1974	70	10,970	580	4,000	15,620
1975	50	24,230	750	3,000	28,030
1976	40	11,540	1,170	7,000	19,750
1977	50	9,710	1,010	10,000	20,770
1978	40	19,920	2,110	9,000	31,070
1979	390	39,110	3,550	7,000	50,050
1980	110	62,490	2,780	8,000	73,380
1981	270	34,480	3,190	10,000	47,940
1982	240	22,210	2,150	14,000	38,600
1983	220	45,910	2,670	15,000	63,800
1984	200	41,120	2,560	14,000	57,880
1985	300	36,860	3,500	15,000	55,660
1986	360	23,740	3,040	17,000	44,140
1987	504	27,500	1,844	22,000	51,848
1988	440	23,599	1,912	17,000	42,951
1989	243	44,184	2,580	17,000	64,007
1990	601	47,922	2,920	18,000	69,443
1991	595	42,323	3,800	19,000	65,718
1992	390	45,030	4,440	23,000	72,860
1993	330	52,110	4,800	19,000	76,240
1994	330	50,548	3,950	15,000	69,828
1979-94 Average	345	39,946	3,105	15,625	59,022

Table 6. Estimates of sockeye salmon catch, and relative vulnerability index by stock grouping, in the South Unimak and Shumagin Islands June fishery, for the Unimak and Shumagin areas. Estimates of stock contributions based on the 1987 tagging study.

Fishery/Stock	Total Run (1000's)		Unimak Area			Shumagins Area		
	Number	Percent	June Fishery Catch (thousands)	Stock Contribution (percent)	Relative Vulnerability Index	June Fishery Catch (thousands)	Stock Contribution (percent)	Relative Vulnerability Index
Kuskokwim	504	1.0%	5	0.7%	0.443	0	0.0%	0.000
Bristol Bay	27,500	53.0%	585	89.4%	1.000	85	60.6%	0.775
North Peninsula	1,844	3.6%	27	4.1%	0.681	7	5.2%	1.000
C. Alaska	22,000	42.4%	38	5.8%	0.081	48	34.1%	0.545
Total	51,848	100%	654	100%		141	100%	

Table 7. Estimates of chum salmon catch, and relative vulnerability index, by stock grouping, in the South Unimak and Shumagin Islands June fishery based on the 1987 tagging study. Estimates of stock contributions based on the EARLY (June 7-20) tag releases and recoveries. Estimates presented for model parameter scenarios of CASE 1, CASE 2, and CASE 3 and by Unimak and Shumagin areas. For CASE 3 estimates are for pooled Japan and Russia.

	Total Run (1000's)		Case 1			Case 2			Case 3		
Fishery/Stock	Number	Percent	Stock Contribution (percent)	June Fishery Catch (thousands)	Relative Vulnerability Index	Stock Contribution (percent)	June Fishery Catch (thousands)	Relative Vulnerability Index	Stock Contribution (percent)	June Fishery Catch (thousands)	Relative Vulnerability Index
Unimak Area											
Kotzebue	283	0.3%	0.0%	0.0	0.000	0.0%	0.0	0.000	0.0%	0.0	0.000
N.S./Yukon/Kusko/BBay	6,968	8.2%	78.0%	182.8	1.000	75.8%	177.7	1.000	41.8%	98.1	1.000
Alaska Peninsula to Kodiak	4,265	5.0%	13.7%	32.1	0.287	17.2%	40.3	0.371	9.5%	22.3	0.287
Cook Inlet to Washington	14,936	17.5%	0.0%	0.0	0.000	0.0%	0.0	0.000	0.0%	0.0	0.000
Russia	13,696	16.0%	7.1%	16.7	0.046	4.2%	9.9	0.028	48.7%	114.2	0.046
Japan	45,304	53.0%	1.2%	2.8	0.002	2.8%	6.6	0.006	---	---	---
Total	85,451	100.0%		234.5			234.5			234.5	
Shumagins Area											
Kotzebue	283	0.3%	0.0%	0.0	0.000	0.0%	0.0	0.000	0.0%	0.0	0.000
N.S./Yukon/Kusko/BBay	6,968	8.2%	83.2%	24.0	1.000	77.1%	22.2	1.000	50.9%	14.7	1.000
Alaska Peninsula to Kodiak	4,265	5.0%	11.4%	3.3	0.224	12.5%	3.6	0.264	8.2%	2.4	0.264
Cook Inlet to Washington	14,936	17.5%	0.6%	0.2	0.003	0.7%	0.2	0.004	0.4%	0.1	0.004
Russia	13,696	16.0%	0.0%	0.0	0.000	0.0%	0.0	0.000	40.5%	11.7	0.094
Japan	45,304	53.0%	4.8%	1.4	0.009	9.8%	2.8	0.020	---	---	---
Total	85,451	100.0%		28.8			28.8			28.8	

Table 8. Estimates of chum salmon catch, and relative vulnerability index, by stock grouping, in the South Unimak and Shumagin Islands June fishery based on the 1987 tagging study. Estimates of stock contributions based on the LATE (June 21-July 2) tag releases and recoveries. Estimates presented for model parameter scenarios of CASE 1, CASE 2, and CASE 3 and by Unimak and Shumagin areas. For CASE 3 estimates are for pooled Japan and Russia.

Fishery/Stock	Total Run (1000's)		Case 1			Case 2			Case 3		
	Number	Percent	Stock Contribution (percent)	June Fishery Catch (thousands)	Relative Vulnerability Index	Stock Contribution (percent)	June Fishery Catch (thousands)	Relative Vulnerability Index	Stock Contribution (percent)	June Fishery Catch (thousands)	Relative Vulnerability Index
Unimak Area											
Kotzebue	283	0.3%	1.2%	2.0	0.360	0.6%	1.0	0.207	0.3%	0.6	0.179
N.S./Yukon/Kusko/BBay	6,968	8.2%	79.4%	136.2	1.000	68.1%	116.7	1.000	47.6%	81.6	1.000
Alaska Peninsula to Kodiak	4,265	5.0%	15.5%	26.6	0.319	15.8%	27.1	0.379	9.8%	16.8	0.336
Cook Inlet to Washington	14,936	17.5%	0.5%	0.9	0.003	0.6%	1.1	0.004	0.3%	0.6	0.003
Russia	13,696	16.0%	3.1%	5.3	0.020	9.4%	16.1	0.070	41.9%	71.9	0.104
Japan	45,304	53.0%	0.3%	0.5	0.001	5.6%	9.6	0.013	---	---	---
Total	85,451	100.0%		171.5			171.5			171.5	
Shumagins Area											
Kotzebue	283	0.3%	1.7%	0.1	0.806	0.6%	0	0.513	0.4%	0.0	0.380
N.S./Yukon/Kusko/BBay	6,968	8.2%	45.9%	3.8	0.898	27.3%	2.2	0.905	19.2%	1.6	0.778
Alaska Peninsula to Kodiak	4,265	5.0%	31.3%	2.6	1.000	18.4%	1.5	1.000	15.1%	1.2	1.000
Cook Inlet to Washington	14,936	17.5%	8.0%	0.7	0.073	5.3%	0.4	0.082	3.9%	0.3	0.073
Russia	13,696	16.0%	0.0%	0.0	0.000	15.2%	1.3	0.257	61.3%	5.0	0.293
Japan	45,304	53.0%	13.1%	1.1	0.040	33.2%	2.7	0.169	---	---	---
Total	85,451	100.0%		8.2			8.2			8.2	

Table 9. Estimates of chum salmon catch, and relative vulnerability index, by stock grouping, in the South Unimak and Shumagin Islands June fishery based on the 1993/1994 genetic stock identification study. Estimates presented for the Early (June 17-20) and the LATE (June 21-29) periods for 1993 and 1994, and for the Unimak area.

Fishery/Stock	Total Run (1000's)		Unimak Area Early (June 13-20)			Unimak Area Late (June 21-29)		
	Number	Percent	June Fishery Catch (thousands)	Stock Contribution (percent)	Relative Vulnerability Index	June Fishery Catch (thousands)	Stock Contribution (percent)	Relative Vulnerability Index
1993								
Yukon Fall	330	0.3%	0	0.0%	0.000	1	0.9%	0.141
Northwest Alaska Summer	2,998	2.7%	176	62.1%	1.000	56	56.9%	1.000
Alaska Peninsula to Kodiak	3,454	3.2%	12	4.2%	0.059	13	13.3%	0.202
Cook Inlet to Wash.	22,631	20.7%	31	10.8%	0.023	7	7.6%	0.018
Russia	21,000	19.2%	16	5.7%	0.013	6	6.6%	0.017
Japan	59,000	53.9%	48	16.9%	0.014	14	14.7%	0.013
Total	109,414	100.0%	284	99.7%		98	100.0%	
1994								
Yukon Fall	795	0.7%	0	0.0%	0.000	3	1.1%	0.125
Northwest Alaska Summer	5,390	4.9%	71	51.5%	1.000	146	61.4%	1.000
Alaska Peninsula to Kodiak	4,922	4.5%	10	7.5%	0.159	19	7.9%	0.142
Cook Inlet to Wash.	22,779	20.8%	12	8.7%	0.040	12	5.2%	0.020
Russia	14,000	12.8%	26	18.9%	0.142	28	11.8%	0.074
Japan	62,000	56.7%	18	13.1%	0.022	29	12.3%	0.017
Total	109,886	100.4%	137	99.7%		237	99.8%	

Table 10. Summary of relative vulnerability indices for various stock groupings of chum salmon based on available stock identification studies. Estimates are presented by time period, area.

	Early Time Period (June 7 - 20)						Late Time Period (June 21 - 30)					
	1987 Tagging Study			Genetic Stock Identification			1987 Tagging Study			Genetic Stock Identification		
	Case 1	Case 2	Case 3	1993	1994	Average	Case 1	Case 2	Case 3	1993	1994	Average
Unimak Area												
Kotzebue/Yukon Fall	0.000	0.000	0.000	0.000	0.000	0.000	0.360	0.207	0.179	0.141	0.125	0.133
NW Alaska Summer	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Alaska Peninsula to Kodiak	0.287	0.371	0.287	0.059	0.159	0.109	0.319	0.379	0.336	0.202	0.142	0.172
Cook Inlet to Washington	0.000	0.000	0.000	0.023	0.040	0.032	0.003	0.004	0.003	0.018	0.020	0.019
Russia	0.046	0.028	0.046	0.013	0.142	0.077	0.020	0.070	0.104	0.017	0.074	0.045
Japan	0.002	0.006	0.046	0.014	0.022	0.018	0.001	0.013	0.104	0.013	0.017	0.015
Shumagins Area												
Kotzebue/Yukon Fall	0.000	0.000	0.000	----	----		0.806	0.513	0.380	----	----	
NW Alaska Summer	1.000	1.000	1.000	----	----		0.898	0.905	0.778	----	----	
Alaska Peninsula to Kodiak	0.224	0.264	0.264	----	----		1.000	1.000	1.000	----	----	
Cook Inlet to Washington	0.003	0.004	0.004	----	----		0.073	0.082	0.073	----	----	
Russia	0.000	0.000	0.094	----	----		0.000	0.257	0.293	----	----	
Japan	0.009	0.020	0.094	----	----		0.040	0.169	0.293	----	----	

Table 11. Estimates of chum salmon catch, by stock grouping, in the 1987 Unimak Area based on the 1987 tagging study, and based on vulnerability indices estimated from the 1993/1994 genetic stock identification study.

	Total Run (1000's)		1987 Unimak Area Early				1987 Unimak Area Late			
			Tagging \1, \2			GSI Based	Tagging \1, \2			GSI Based
Fishery/Stock	Number	Percent	Case 1	Case 2	Case 3	Vulnerabilities	Case 1	Case 2	Case 3	Vulnerabilities
Kotzebue/Yukon Fall	1,153	1.3%	0.0	0.0	0.0	0.0	2.0	1.0	0.6	3.1
NW Alaska Summer	6,097	7.1%	182.8	177.7	98.1	160.5	136.2	116.7	81.6	121.9
Alaska Peninsula to Kodiak	4,265	5.0%	32.1	40.3	22.3	12.3	26.6	27.1	16.8	14.7
Cook Inlet to Washington	14,936	17.5%	0.0	0.0	0.0	12.4	0.9	1.1	0.6	5.7
Russia	13,696	16.0%	16.7	9.9	26.5	27.9	5.3	16.1	16.7	12.4
Japan	45,304	53.0%	2.8	6.6	87.7	21.4	0.5	9.6	55.2	13.9
Total	85,451	100.0%	234.5	234.5	234.5	234.5	171.5	171.5	171.5	171.5

\1 Tagging estimates of Kotzebue/Yukon Fall chum group include only Kotzebue
\2 Tagging estimates of NW Alaska Summer chums include Yukon Fall chums.

Table 12. Worksheet for calculating stock contribution to the South Unimak and Shumagin Islands June fishery chum salmon catches, 1979-1994, based on relative vulnerability indices by area and abundance. Vulnerability indices for Unimak Area estimated from an average of 1993 -1994 vulnerabilities from the genetic stock identification study; the vulnerabilities for Shumagin Islands based on 1987 tagging study, CASE 2.

Management Area	Index of Vulnerability			
	Unimak Area		Shumagin Islands	
	E	L	E	L
Kotzebue/Yukon Fall	0.000	0.133	0.000	0.513
NW Alaska Summer	1.000	1.000	1.000	0.905
Alaska Peninsula to Kodiak	0.109	0.172	0.264	1.000
Cook Inlet to Washington	0.032	0.019	0.004	0.082
Russia	0.077	0.045	0.000	0.257
Japan	0.018	0.015	0.020	0.169

	Total N. Pac.	Estimated Inshore Run (thousands)	Stock Contribution				Vulnerability X Estimated Run			
			Unimak Area		Shumagin Islands		Unimak Area		Shumagin Islands	
			E	L	E	L	E	L	E	L
1979	Kotzebue/Yukon Fall	1,750	0.0%	3.6%	0.0%	5.2%	0	233	0	898
	NW Alaska Summer	4,541	67.9%	69.9%	76.2%	23.6%	4541	4541	4541	4110
	Alaska Peninsula to Kodiak	2,907	4.8%	7.7%	12.9%	16.7%	318	500	768	2907
	Cook Inlet to Washington	5,673	2.7%	1.7%	0.4%	2.7%	179	107	22	465
	Russia	13,800	16.0%	9.6%	0.0%	20.4%	1069	625	0	3551
	Japan	32,200	8.7%	7.6%	10.6%	31.4%	579	493	629	5451
	Total N. Pac.	60,871	100.0%	100.0%	100.0%	100.0%	6686	6498	5960	17381
1980	Kotzebue/Yukon Fall	1,432	0.0%	1.8%	0.0%	3.3%	0	190	0	734
	NW Alaska Summer	8,269	78.9%	78.4%	79.0%	33.4%	8269	8269	8269	7483
	Alaska Peninsula to Kodiak	5,857	6.1%	9.6%	14.8%	26.1%	640	1007	1547	5857
	Cook Inlet to Washington	12,157	3.7%	2.2%	0.5%	4.4%	384	230	48	996
	Russia	8,273	6.1%	3.6%	0.0%	9.5%	641	374	0	2129
	Japan	30,727	5.3%	4.5%	5.7%	23.2%	552	470	600	5202
	Total N. Pac.	66,715	100.0%	100.0%	100.0%	100.0%	10486	10541	10464	22401
1981	Kotzebue/Yukon Fall	2,248	0.0%	2.7%	0.0%	4.6%	0	299	0	1153
	NW Alaska Summer	8,266	76.9%	75.9%	77.1%	30.0%	8266	8266	8266	7480
	Alaska Peninsula to Kodiak	6,305	6.4%	10.0%	15.5%	25.3%	689	1084	1665	6305
	Cook Inlet to Washington	9,571	2.8%	1.7%	0.4%	3.1%	302	181	38	784
	Russia	10,256	7.4%	4.3%	0.0%	10.6%	794	464	0	2639
	Japan	38,744	6.5%	5.4%	7.1%	26.3%	697	593	757	6559
	Total N. Pac.	75,390	100.0%	100.0%	100.0%	100.0%	10748	10887	10725	24920
1982	Kotzebue/Yukon Fall	1,280	0.0%	2.3%	0.0%	3.2%	0	170	0	656
	NW Alaska Summer	4,914	67.7%	67.6%	68.0%	21.9%	4914	4914	4914	4447
	Alaska Peninsula to Kodiak	5,926	8.9%	14.0%	21.7%	29.2%	648	1019	1565	5926
	Cook Inlet to Washington	13,039	5.7%	3.4%	0.7%	5.3%	412	247	51	1068
	Russia	8,324	8.9%	5.2%	0.0%	10.6%	645	377	0	2142
	Japan	35,676	8.8%	7.5%	9.6%	29.8%	641	546	697	6039
	Total N. Pac.	69,158	100.0%	100.0%	100.0%	100.0%	7260	7272	7227	20279

Table 12. (Continued) Worksheet for calculating stock contribution to the South Unimak and Shumagin Islands June fishery chum salmon catches, 1979-1994, based on relative vulnerability indices by area and abundance. Vulnerability indices for Unimak Area estimated from an average of 1993 -1994 vulnerabilities from the genetic stock identification study; the vulnerabilities for Shumagin Islands based on 1987 tagging study, CASE 2.

Management Area	Index of Vulnerability			
	Unimak Area		Shumagin Islands	
	E	L	E	L
Kotzebue/Yukon Fall	0.000	0.133	0.000	0.513
NW Alaska Summer	1.000	1.000	1.000	0.905
Alaska Peninsula to Kodiak	0.109	0.172	0.264	1.000
Cook Inlet to Washington	0.032	0.019	0.004	0.082
Russia	0.077	0.045	0.000	0.257
Japan	0.018	0.015	0.020	0.169

	Total N. Pac.	Estimated Inshore Run (thousands)	Stock Contribution				Vulnerability X Estimated Run			
			Unimak Area		Shumagin Islands		Unimak Area		Shumagin Islands	
			E	L	E	L	E	L	E	L
1983	Kotzebue/Yukon Fall	1,128	0.0%	1.9%	0.0%	2.7%	0	150	0	579
	NW Alaska Summer	5,632	68.3%	70.1%	72.6%	23.4%	5632	5632	5632	5097
	Alaska Peninsula to Kodiak	4,834	6.4%	10.3%	16.5%	22.2%	529	831	1277	4834
	Cook Inlet to Washington	9,234	3.5%	2.2%	0.5%	3.5%	292	175	36	756
	Russia	13,469	12.7%	7.6%	0.0%	15.9%	1043	610	0	3466
	Japan	41,531	9.1%	7.9%	10.5%	32.3%	747	635	811	7031
	Total N. Pac.	75,828	100.0%	100.0%	100.0%	100.0%	8242	8033	7756	21762
1984	Kotzebue/Yukon Fall	1,188	0.0%	1.5%	0.0%	2.5%	0	158	0	610
	NW Alaska Summer	8,096	76.0%	76.1%	76.1%	29.6%	8096	8096	8096	7327
	Alaska Peninsula to Kodiak	6,223	6.4%	10.1%	15.4%	25.1%	680	1070	1644	6223
	Cook Inlet to Washington	15,516	4.6%	2.8%	0.6%	5.1%	490	294	61	1271
	Russia	7,933	5.8%	3.4%	0.0%	8.2%	615	359	0	2041
	Japan	43,067	7.3%	6.2%	7.9%	29.4%	774	659	841	7291
	Total N. Pac.	82,023	100.0%	100.0%	100.0%	100.0%	10656	10636	10642	24762
1985	Kotzebue/Yukon Fall	1,982	0.0%	2.9%	0.0%	4.1%	0	263	0	1017
	NW Alaska Summer	6,169	67.0%	69.1%	73.3%	22.5%	6169	6169	6169	5582
	Alaska Peninsula to Kodiak	4,191	5.0%	8.1%	13.2%	16.9%	458	720	1107	4191
	Cook Inlet to Washington	19,614	6.7%	4.2%	0.9%	6.5%	620	372	77	1607
	Russia	12,762	10.7%	6.5%	0.0%	13.2%	989	578	0	3284
	Japan	54,238	10.6%	9.3%	12.6%	36.9%	975	830	1059	9182
	Total N. Pac.	98,956	100.0%	100.0%	100.0%	100.0%	9210	8931	8412	24862
1986	Kotzebue/Yukon Fall	1,135	0.0%	1.5%	0.0%	2.2%	0	151	0	582
	NW Alaska Summer	7,125	68.8%	71.5%	74.8%	24.9%	7125	7125	7125	6448
	Alaska Peninsula to Kodiak	5,217	5.5%	9.0%	14.5%	20.1%	570	897	1378	5217
	Cook Inlet to Washington	20,610	6.3%	3.9%	0.9%	6.5%	651	390	81	1688
	Russia	14,700	11.0%	6.7%	0.0%	14.6%	1139	665	0	3783
	Japan	48,300	8.4%	7.4%	9.9%	31.6%	868	739	943	8177
	Total N. Pac.	97,087	100.0%	100.0%	100.0%	100.0%	10353	9967	9527	25894

Table 12. (Continued) Worksheet for calculating stock contribution to the South Unimak and Shumagin Islands June fishery chum salmon catches, 1979-1994, based on relative vulnerability indices by area and abundance. Vulnerability indices for Unimak Area estimated from an average of 1993 -1994 vulnerabilities from the genetic stock identification study; the vulnerabilities for Shumagin Islands based on 1987 tagging study, CASE 2.

Management Area	Index of Vulnerability			
	Unimak Area		Shumagin Islands	
	E	L	E	L
Kotzebue/Yukon Fall	0.000	0.133	0.000	0.513
NW Alaska Summer	1.000	1.000	1.000	0.905
Alaska Peninsula to Kodiak	0.109	0.172	0.264	1.000
Cook Inlet to Washington	0.032	0.019	0.004	0.082
Russia	0.077	0.045	0.000	0.257
Japan	0.018	0.015	0.020	0.169

	Total N. Pac.	Estimated Inshore Run (thousands)	Stock Contribution				Vulnerability X Estimated Run			
			Unimak Area		Shumagin Islands		Unimak Area		Shumagin Islands	
			E	L	E	L	E	L	E	L
1987	Kotzebue/Yukon Fall	1,153	0.0%	1.8%	0.0%	2.6%	0	153	0	592
	NW Alaska Summer	6,097	68.4%	71.1%	74.7%	24.2%	6097	6097	6097	5517
	Alaska Peninsula to Kodiak	4,265	5.2%	8.5%	13.8%	18.7%	466	733	1126	4265
	Cook Inlet to Washington	14,936	5.3%	3.3%	0.7%	5.4%	472	283	59	1223
	Russia	13,696	11.9%	7.2%	0.0%	15.5%	1061	620	0	3524
	Japan	45,304	9.1%	8.1%	10.8%	33.7%	814	693	885	7669
	Total N. Pac.	85,451	100.0%	100.0%	100.0%	100.0%	8910	8579	8167	22791
1988	Kotzebue/Yukon Fall	1,234	0.0%	1.3%	0.0%	2.2%	0	164	0	633
	NW Alaska Summer	9,777	74.5%	76.3%	78.4%	30.2%	9777	9777	9777	8847
	Alaska Peninsula to Kodiak	6,229	5.2%	8.4%	13.2%	21.2%	681	1071	1645	6229
	Cook Inlet to Washington	23,773	5.7%	3.5%	0.8%	6.6%	751	450	94	1947
	Russia	13,433	7.9%	4.7%	0.0%	11.8%	1041	608	0	3457
	Japan	48,567	6.7%	5.8%	7.6%	28.0%	873	743	949	8222
	Total N. Pac.	103,013	100.0%	100.0%	100.0%	100.0%	13122	12813	12464	29335
1989	Kotzebue/Yukon Fall	1,448	0.0%	2.1%	0.0%	3.3%	0	192	0	743
	NW Alaska Summer	6,912	72.7%	75.2%	79.2%	27.4%	6912	6912	6912	6255
	Alaska Peninsula to Kodiak	2,967	3.4%	5.6%	9.0%	13.0%	324	510	784	2967
	Cook Inlet to Washington	10,510	3.5%	2.2%	0.5%	3.8%	332	199	41	861
	Russia	13,206	10.8%	6.5%	0.0%	14.9%	1023	598	0	3398
	Japan	50,794	9.6%	8.5%	11.4%	37.7%	913	777	992	8599
	Total N. Pac.	85,837	100.0%	100.0%	100.0%	100.0%	9505	9188	8729	22823
1990	Kotzebue/Yukon Fall	1,038	0.0%	2.0%	0.0%	2.3%	0	138	0	532
	NW Alaska Summer	4,508	60.1%	63.8%	67.4%	17.6%	4508	4508	4508	4080
	Alaska Peninsula to Kodiak	3,389	4.9%	8.2%	13.4%	14.6%	371	583	895	3389
	Cook Inlet to Washington	14,884	6.3%	4.0%	0.9%	5.2%	470	282	59	1219
	Russia	13,173	13.6%	8.4%	0.0%	14.6%	1020	596	0	3390
	Japan	62,827	15.1%	13.6%	18.3%	45.8%	1129	961	1227	10636
	Total N. Pac.	99,819	100.0%	100.0%	100.0%	100.0%	7499	7068	6689	23246

Table 12. (Continued) Worksheet for calculating stock contribution to the South Unimak and Shumagin Islands June fishery chum salmon catches, 1979-1994, based on relative vulnerability indices by area and abundance. Vulnerability indices for Unimak Area estimated from an average of 1993 -1994 vulnerabilities from the genetic stock identification study; the vulnerabilities for Shumagin Islands based on 1987 tagging study, CASE 2.

Management Area	Index of Vulnerability			
	Unimak Area		Shumagin Islands	
	E	L	E	L
Kotzebue/Yukon Fall	0.000	0.133	0.000	0.513
NW Alaska Summer	1.000	1.000	1.000	0.905
Alaska Peninsula to Kodiak	0.109	0.172	0.264	1.000
Cook Inlet to Washington	0.032	0.019	0.004	0.082
Russia	0.077	0.045	0.000	0.257
Japan	0.018	0.015	0.020	0.169

	Total N. Pac.	Estimated Inshore Run (thousands)	Stock Contribution				Vulnerability X Estimated Run			
			Unimak Area		Shumagin Islands		Unimak Area		Shumagin Islands	
			E	L	E	L	E	L	E	L
1991	Kotzebue/Yukon Fall	1,280	0.0%	2.0%	0.0%	2.8%	0	170	0	656
	NW Alaska Summer	5,874	68.8%	69.8%	70.8%	22.6%	5874	5874	5874	5315
	Alaska Peninsula to Kodiak	5,161	6.6%	10.5%	16.4%	22.0%	564	887	1363	5161
	Cook Inlet to Washington	12,051	4.5%	2.7%	0.6%	4.2%	381	228	48	987
	Russia	10,164	9.2%	5.5%	0.0%	11.1%	787	460	0	2615
	Japan	51,836	10.9%	9.4%	12.2%	37.3%	932	793	1012	8775
	Total N. Pac.	86,366	100.0%	100.0%	100.0%	100.0%	8538	8412	8297	23510
1992	Kotzebue/Yukon Fall	978	0.0%	1.7%	0.0%	2.2%	0	130	0	502
	NW Alaska Summer	4,795	60.2%	64.3%	69.8%	19.1%	4795	4795	4795	4339
	Alaska Peninsula to Kodiak	4,145	5.7%	9.6%	15.9%	18.2%	453	713	1095	4145
	Cook Inlet to Washington	17,143	6.8%	4.4%	1.0%	6.2%	541	325	68	1404
	Russia	17,270	16.8%	10.5%	0.0%	19.5%	1338	782	0	4444
	Japan	46,730	10.5%	9.6%	13.3%	34.8%	840	715	913	7911
	Total N. Pac.	91,060	100.0%	100.0%	100.0%	100.0%	7967	7459	6870	22745
1993	Kotzebue/Yukon Fall	661	0.0%	1.8%	0.0%	1.4%	0	93	0	339
	NW Alaska Summer	2,998	62.2%	56.4%	58.2%	11.4%	2998	2998	2998	2713
	Alaska Peninsula to Kodiak	3,454	4.3%	13.1%	17.7%	14.5%	205	698	912	3454
	Cook Inlet to Washington	22,631	10.8%	7.5%	1.7%	7.8%	523	401	89	1854
	Russia	21,000	5.8%	6.5%	0.0%	22.8%	277	348	0	5404
	Japan	59,000	16.9%	14.6%	22.4%	42.1%	815	775	1152	9988
	Total N. Pac.	109,745	100.0%	100.0%	100.0%	100.0%	4819	5314	5152	23752
1994	Kotzebue/Yukon Fall	1,283	0.0%	1.8%	0.0%	2.5%	0	160	0	658
	NW Alaska Summer	5,390	51.6%	61.1%	67.5%	18.5%	5390	5390	5390	4878
	Alaska Peninsula to Kodiak	4,922	7.5%	7.9%	16.3%	18.6%	784	697	1300	4922
	Cook Inlet to Washington	22,779	8.7%	5.2%	1.1%	7.1%	913	460	90	1866
	Russia	14,000	19.0%	11.7%	0.0%	13.6%	1984	1036	0	3603
	Japan	62,000	13.1%	12.3%	15.2%	39.7%	1372	1083	1211	10496
	Total N. Pac.	110,374	100.0%	100.0%	100.0%	100.0%	10444	8825	7991	26422

Table 13. Worksheet for calculating chum salmon catches by stock of origin in South Unimak and Shumagin Islands June fishery, 1979 to 1994, based on vulnerability indices by area and abundance. Catches are in thousands of fish, as percent of total June fishery chum salmon catch, and as percent of individual stock total run.

			Unimak Area					Shumagin Area					South Peninsula Total		
		Total Run	Catch (thousands)			Catch	Harvest Rate	Catch (thousands)			Catch	Harvest Rate	Catch		Harvest Rate
Year	Stock	(thousands)	E	L	Total	(percent)	(percent)	E	L	Total	(percent)	(percent)	(thousands)	(percent)	(percent)
1979	Kotzebue/Yukon Fall	1,750	0	1	1	1.4%	0.0%	0	1	1	2.4%	0.1%	2	1.8%	0.1%
	NW Alaska Summer	4,541	27	17	43	68.7%	1.0%	16	5	21	51.3%	0.5%	64	61.8%	1.4%
	Alaska Peninsula to Kodiak	2,907	2	2	4	5.9%	0.1%	3	3	6	14.7%	0.2%	10	9.3%	0.3%
	Cook Inlet to Washington	5,673	1	0	1	2.3%	0.0%	0	1	1	1.5%	0.0%	2	2.0%	0.0%
	Russia	13,800	6	2	9	13.6%	0.1%	0	4	4	9.7%	0.0%	13	12.0%	0.1%
	Japan	32,200	3	2	5	8.2%	0.0%	2	6	8	20.4%	0.0%	14	13.0%	0.0%
	Total	60,871	39	24	63	100.0%		22	19	41	100.0%		104	100.0%	
1980	Kotzebue/Yukon Fall	1,432	0	4	4	1.0%	0.3%	0	1	1	1.9%	0.1%	5	1.1%	0.4%
	NW Alaska Summer	8,269	165	195	361	78.6%	4.4%	16	10	26	52.2%	0.3%	387	76.0%	4.5%
	Alaska Peninsula to Kodiak	5,857	13	24	37	8.0%	0.6%	3	8	11	21.5%	0.2%	47	9.3%	0.8%
	Cook Inlet to Washington	12,157	8	5	13	2.9%	0.1%	0	1	1	2.8%	0.0%	15	2.9%	0.1%
	Russia	8,273	13	9	22	4.7%	0.3%	0	3	3	5.6%	0.0%	24	4.8%	0.3%
	Japan	30,727	11	11	22	4.8%	0.1%	1	7	8	16.0%	0.0%	30	5.9%	0.1%
	Total	66,715	210	249	459	100.0%		21	30	50	100.0%		509	100.0%	
1981	Kotzebue/Yukon Fall	2,248	0	7	7	1.4%	0.3%	0	1	1	1.1%	0.0%	8	1.4%	0.3%
	NW Alaska Summer	8,266	193	196	390	76.4%	4.7%	32	4	36	66.3%	0.4%	425	75.4%	4.9%
	Alaska Peninsula to Kodiak	6,305	16	26	42	8.2%	0.7%	6	3	10	17.8%	0.2%	51	9.1%	0.8%
	Cook Inlet to Washington	9,571	7	4	11	2.2%	0.1%	0	0	1	1.0%	0.0%	12	2.1%	0.1%
	Russia	10,256	19	11	30	5.8%	0.3%	0	1	1	2.4%	0.0%	31	5.5%	0.3%
	Japan	38,744	16	14	30	6.0%	0.1%	3	3	6	11.5%	0.0%	37	6.5%	0.1%
	Total	75,390	252	258	510	100.0%		42	12	54	100.0%		564	100.0%	
1982	Kotzebue/Yukon Fall	1,280	0	9	9	0.9%	0.7%	0	3	3	1.6%	0.2%	11	1.0%	0.9%
	NW Alaska Summer	4,914	379	253	632	67.6%	12.9%	54	18	72	44.6%	1.5%	704	64.3%	12.5%
	Alaska Peninsula to Kodiak	5,926	50	52	102	11.0%	1.7%	17	24	41	25.5%	0.7%	143	13.1%	2.4%
	Cook Inlet to Washington	13,039	32	13	44	4.8%	0.3%	1	4	5	3.0%	0.0%	49	4.5%	0.4%
	Russia	8,324	50	19	69	7.4%	0.8%	0	9	9	5.4%	0.1%	78	7.1%	0.9%
	Japan	35,676	49	28	78	8.3%	0.2%	8	24	32	19.8%	0.1%	110	10.0%	0.3%
	Total	69,158	560	374	934	100.0%		80	82	161	100.0%		1095	100.0%	

Table 13. (Continued). Worksheet for calculating chum salmon catches by stock of origin in South Unimak and Shumagin Islands June fishery, 1979 to 1994, based on vulnerability indices by area and abundance. Catches are in thousands of fish, as percent of total June fishery chum salmon catch, and as percent of individual stock total run.

			Unimak Area					Shumagin Area					South Peninsula Total		
		Total Run	Catch (thousands)			Catch	Harvest Rate	Catch (thousands)			Catch	Harvest Rate	Catch		Harvest Rate
Year	Stock	(thousands)	E	L	Total	(percent)	(percent)	E	L	Total	(percent)	(percent)	(thousands)	(percent)	(percent)
1983	Kotzebue/Yukon Fall	1,128	0	1	1	0.2%	0.1%	0	0	0	0.0%	0.0%	1	0.2%	0.1%
	NW Alaska Summer	5,632	371	51	422	68.5%	7.5%	123	0	123	72.6%	2.2%	545	69.4%	8.8%
	Alaska Peninsula to Kodiak	4,834	35	8	42	6.9%	0.9%	28	0	28	16.5%	0.6%	70	8.9%	1.4%
	Cook Inlet to Washington	9,234	19	2	21	3.4%	0.2%	1	0	1	0.5%	0.0%	22	2.8%	0.2%
	Russia	13,469	69	6	74	12.1%	0.6%	0	0	0	0.0%	0.0%	74	9.5%	0.5%
	Japan	41,531	49	6	55	8.9%	0.1%	18	0	18	10.5%	0.0%	73	9.3%	0.2%
	Total	75,828	543	73	616	100.0%		169	0	169	100.0%		786	100.0%	
1984	Kotzebue/Yukon Fall	1,188	0	0	0	0.0%	0.0%	0	1	1	0.9%	0.1%	1	0.3%	0.1%
	NW Alaska Summer	8,096	173	0	173	76.0%	2.1%	54	11	65	59.6%	0.8%	238	70.7%	2.9%
	Alaska Peninsula to Kodiak	6,223	15	0	15	6.4%	0.2%	11	10	21	18.9%	0.3%	35	10.4%	0.6%
	Cook Inlet to Washington	15,516	10	0	10	4.6%	0.1%	0	2	2	2.2%	0.0%	13	3.8%	0.1%
	Russia	7,933	13	0	13	5.8%	0.2%	0	3	3	2.9%	0.0%	16	4.8%	0.2%
	Japan	43,067	17	0	17	7.3%	0.0%	6	11	17	15.5%	0.0%	34	9.9%	0.1%
	Total	82,023	228	0	228	100.0%		71	39	109	100.0%		337	100.0%	
1985	Kotzebue/Yukon Fall	1,982	0	2	2	0.6%	0.1%	0	1	1	1.2%	0.1%	3	0.7%	0.2%
	NW Alaska Summer	6,169	176	43	220	67.4%	3.6%	56	7	63	58.0%	1.0%	283	65.0%	4.4%
	Alaska Peninsula to Kodiak	4,191	13	5	18	5.6%	0.4%	10	6	16	14.3%	0.4%	34	7.8%	0.8%
	Cook Inlet to Washington	19,614	18	3	20	6.2%	0.1%	1	2	3	2.6%	0.0%	23	5.3%	0.1%
	Russia	12,762	28	4	32	9.9%	0.3%	0	4	4	4.0%	0.0%	37	8.4%	0.3%
	Japan	54,238	28	6	34	10.3%	0.1%	10	12	22	19.9%	0.0%	55	12.7%	0.1%
	Total	98,956	263	63	326	100.0%		76	33	109	100.0%		435	100.0%	
1986	Kotzebue/Yukon Fall	1,135	0	1	1	0.3%	0.1%	0	1	1	1.0%	0.1%	2	0.5%	0.2%
	NW Alaska Summer	7,125	138	37	175	69.4%	2.5%	40	11	51	51.7%	0.7%	227	64.4%	3.1%
	Alaska Peninsula to Kodiak	5,217	11	5	16	6.2%	0.3%	8	9	17	17.1%	0.3%	33	9.3%	0.6%
	Cook Inlet to Washington	20,610	13	2	15	5.8%	0.1%	0	3	3	3.5%	0.0%	18	5.1%	0.1%
	Russia	14,700	22	3	26	10.1%	0.2%	0	7	7	6.8%	0.0%	32	9.2%	0.2%
	Japan	48,300	17	4	21	8.2%	0.0%	5	14	20	19.9%	0.0%	40	11.5%	0.1%
	Total	97,087	201	52	253	100.0%		53	46	99	100.0%		352	100.0%	

Table 13. (Continued). Worksheet for calculating chum salmon catches by stock of origin in South Unimak and Shumagin Islands June fishery, 1979 to 1994, based on vulnerability indices by area and abundance. Catches are in thousands of fish, as percent of total June fishery chum salmon catch, and as percent of individual stock total run.

			Unimak Area					Shumagin Area					South Peninsula Total		
		Total Run	Catch (thousands)			Catch	Harvest Rate	Catch (thousands)			Catch	Harvest Rate	Catch		Harvest Rate
Year	Stock	(thousands)	E	L	Total	(percent)	(percent)	E	L	Total	(percent)	(percent)	(thousands)	(percent)	(percent)
1987	Kotzebue/Yukon Fall	1,153	0	3	3	0.8%	0.3%	0	0	0	0.6%	0.0%	3	0.7%	0.3%
	NW Alaska Summer	6,097	160	122	282	69.5%	4.6%	22	2	24	63.5%	0.4%	306	69.0%	4.8%
	Alaska Peninsula to Kodiak	4,265	12	15	27	6.6%	0.6%	4	2	6	14.9%	0.1%	32	7.3%	0.8%
	Cook Inlet to Washington	14,936	12	6	18	4.5%	0.1%	0	0	1	1.7%	0.0%	19	4.2%	0.1%
	Russia	13,696	28	12	40	9.9%	0.3%	0	1	1	3.4%	0.0%	42	9.4%	0.3%
	Japan	45,304	21	14	35	8.7%	0.1%	3	3	6	15.9%	0.0%	41	9.3%	0.1%
	Total	85,451	234	172	406	100.0%		29	8	37	100.0%		443	100.0%	
1988	Kotzebue/Yukon Fall	1,234	0	4	4	0.8%	0.3%	0	1	1	1.4%	0.1%	5	0.9%	0.4%
	NW Alaska Summer	9,777	130	222	351	75.6%	3.6%	16	12	29	46.4%	0.3%	380	72.2%	3.7%
	Alaska Peninsula to Kodiak	6,229	9	24	33	7.2%	0.5%	3	9	11	18.5%	0.2%	45	8.5%	0.7%
	Cook Inlet to Washington	23,773	10	10	20	4.3%	0.1%	0	3	3	4.7%	0.0%	23	4.4%	0.1%
	Russia	13,433	14	14	28	5.9%	0.2%	0	5	5	7.8%	0.0%	32	6.2%	0.2%
	Japan	48,567	12	17	28	6.1%	0.1%	2	12	13	21.2%	0.0%	42	7.9%	0.1%
	Total	103,013	174	291	465	100.0%		21	41	62	100.0%		527	100.0%	
1989	Kotzebue/Yukon Fall	1,448	0	0	0	0.1%	0.0%	0	0	0	0.0%	0.0%	0	0.1%	0.0%
	NW Alaska Summer	6,912	282	15	297	72.8%	4.3%	38	0	38	79.2%	0.5%	335	73.5%	4.6%
	Alaska Peninsula to Kodiak	2,967	13	1	14	3.5%	0.5%	4	0	4	9.0%	0.1%	19	4.1%	0.6%
	Cook Inlet to Washington	10,510	14	0	14	3.4%	0.1%	0	0	0	0.5%	0.0%	14	3.1%	0.1%
	Russia	13,206	42	1	43	10.5%	0.3%	0	0	0	0.0%	0.0%	43	9.4%	0.3%
	Japan	50,794	37	2	39	9.5%	0.1%	5	0	5	11.4%	0.0%	44	9.7%	0.1%
	Total	85,837	387	21	408	100.0%		48	0	48	100.0%		455	100.0%	
1990	Kotzebue/Yukon Fall	1,038	0	6	6	1.3%	0.6%	0	0	0	0.8%	0.0%	7	1.3%	0.6%
	NW Alaska Summer	4,508	85	200	285	62.7%	6.3%	28	4	32	50.6%	0.7%	317	61.2%	6.6%
	Alaska Peninsula to Kodiak	3,389	7	26	33	7.2%	1.0%	6	3	9	13.8%	0.3%	42	8.0%	1.2%
	Cook Inlet to Washington	14,884	9	13	21	4.7%	0.1%	0	1	1	2.3%	0.0%	23	4.4%	0.2%
	Russia	13,173	19	27	46	10.0%	0.3%	0	3	3	4.9%	0.0%	49	9.4%	0.4%
	Japan	62,827	21	43	64	14.1%	0.1%	8	10	18	27.6%	0.0%	81	15.7%	0.1%
	Total	99,819	141	314	455	100.0%		42	21	64	100.0%		518	100.0%	

Table 13. (Continued). Worksheet for calculating chum salmon catches by stock of origin in South Unimak and Shumagin Islands June fishery, 1979 to 1994, based on vulnerability indices by area and abundance. Catches are in thousands of fish, as percent of total June fishery chum salmon catch, and as percent of individual stock total run.

			Unimak Area					Shumagin Area					South Peninsula Total		
		Total Run	Catch (thousands)			Catch	Harvest Rate	Catch (thousands)			Catch	Harvest Rate	Catch		Harvest Rate
Year	Stock	(thousands)	E	L	Total	(percent)	(percent)	E	L	Total	(percent)	(percent)	(thousands)	(percent)	(percent)
1991	Kotzebue/Yukon Fall	1,280	0	8	8	1.1%	0.6%	0	1	1	1.2%	0.1%	9	1.1%	0.7%
	NW Alaska Summer	5,874	204	261	465	69.4%	7.9%	43	10	53	50.4%	0.9%	518	66.8%	8.1%
	Alaska Peninsula to Kodiak	5,161	20	39	59	8.8%	1.1%	10	10	20	18.8%	0.4%	79	10.2%	1.5%
	Cook Inlet to Washington	12,051	13	10	23	3.5%	0.2%	0	2	2	2.1%	0.0%	26	3.3%	0.2%
	Russia	10,164	27	20	48	7.1%	0.5%	0	5	5	4.7%	0.0%	53	6.8%	0.5%
	Japan	51,836	32	35	68	10.1%	0.1%	7	17	24	22.8%	0.0%	92	11.8%	0.2%
	Total	86,366	296	374	670	100.0%		61	45	106	100.0%		776	100.0%	
1992	Kotzebue/Yukon Fall	978	0	2	2	0.7%	0.2%	0	0	0	0.2%	0.0%	3	0.6%	0.3%
	NW Alaska Summer	4,795	113	87	201	61.9%	4.2%	66	2	68	65.4%	1.4%	269	62.7%	5.3%
	Alaska Peninsula to Kodiak	4,145	11	13	24	7.3%	0.6%	15	2	17	16.1%	0.4%	41	9.5%	1.0%
	Cook Inlet to Washington	17,143	13	6	19	5.8%	0.1%	1	1	1	1.4%	0.0%	20	4.7%	0.1%
	Russia	17,270	32	14	46	14.1%	0.3%	0	2	2	1.7%	0.0%	48	11.1%	0.3%
	Japan	46,730	20	13	33	10.1%	0.1%	13	3	16	15.2%	0.0%	49	11.4%	0.1%
	Total	91,060	188	136	324	100.0%		95	9	104	100.0%		428	100.0%	
1993	Kotzebue/Yukon Fall	661	0	2	2	0.5%	0.3%	0	2	2	1.0%	0.2%	3	0.6%	0.5%
	NW Alaska Summer	2,998	177	55	232	60.7%	7.7%	25	12	37	24.7%	1.2%	269	50.5%	8.2%
	Alaska Peninsula to Kodiak	3,454	12	13	25	6.5%	0.7%	8	16	23	15.4%	0.7%	48	9.1%	1.4%
	Cook Inlet to Washington	22,631	31	7	38	10.0%	0.2%	1	8	9	6.1%	0.0%	47	8.9%	0.2%
	Russia	21,000	16	6	23	6.0%	0.1%	0	25	25	16.3%	0.1%	47	8.9%	0.2%
	Japan	59,000	48	14	62	16.3%	0.1%	10	46	55	36.5%	0.1%	118	22.0%	0.2%
	Total	109,745	284	98	382	100.0%		43	108	151	100.0%		533	100.0%	
1994	Kotzebue/Yukon Fall	1,283	0	4	4	1.1%	0.3%	0	4	4	1.9%	0.3%	8	1.4%	0.6%
	NW Alaska Summer	5,390	71	145	216	57.6%	4.0%	38	30	68	31.0%	1.3%	284	47.8%	5.0%
	Alaska Peninsula to Kodiak	4,922	10	19	29	7.8%	0.6%	9	30	40	18.0%	0.8%	69	11.6%	1.4%
	Cook Inlet to Washington	22,779	12	12	24	6.5%	0.1%	1	12	12	5.5%	0.1%	36	6.1%	0.2%
	Russia	14,000	26	28	54	14.4%	0.4%	0	22	22	10.1%	0.2%	76	12.8%	0.5%
	Japan	62,000	18	29	47	12.6%	0.1%	9	65	73	33.4%	0.1%	120	20.3%	0.2%
	Total	110,374	137	237	374	100.0%		56	163	219	100.0%		594	100.0%	

Table 14. Worksheet for calculating stock contribution to the South Unimak and Shumagin Islands June fishery sockeye catches, 1970-1994, based on relative vulnerability indices by area and abundance. Vulnerability indices estimated from 1987 sockeye abundance and stock contribution based on 1987 tagging study.

Fishery/Stock	Index of Vulnerability: Unimak Area	Index of Vulnerability: Shumagin Islands
Kuskokwim	0.44	0.00
Bristol Bay	1.00	0.77
North Peninsula	0.68	1.00
C. Alaska	0.08	0.56

Year	Fishery/Stock	Estimated Inshore Run (thousands)	Stock Contribution: Unimak Area	Stock Contribution: Shumagin Islands	Vulnerability X Estimated Run: Unimak Area	Vulnerability X Estimated Run: Shumagin Islands
1970	Kuskokwim	30	0.0%	0.0%	13	0
	Bristol Bay	39,400	97.4%	86.9%	39400	30521
	North Peninsula	660	1.1%	1.9%	450	660
	C. Alaska	7,000	1.4%	11.2%	581	3921
	Total	47,090	100%	100%	40444	35103
1971	Kuskokwim	20	0.1%	0.0%	9	0
	Bristol Bay	15,820	93.8%	74.7%	15820	12255
	North Peninsula	790	3.2%	4.8%	538	790
	C. Alaska	6,000	3.0%	20.5%	498	3361
	Total	22,630	100%	100%	16865	16406
1972	Kuskokwim	10	0.1%	0.0%	4	0
	Bristol Bay	5,410	72.2%	44.4%	5410	4191
	North Peninsula	2,440	22.2%	25.9%	1662	2440
	C. Alaska	5,000	5.5%	29.7%	415	2801
	Total	12,860	100%	100%	7492	9432
1973	Kuskokwim	10	0.1%	0.0%	4	0
	Bristol Bay	2,440	80.9%	42.2%	2440	1890
	North Peninsula	350	7.9%	7.8%	238	350
	C. Alaska	4,000	11.0%	50.0%	332	2241
	Total	6,800	100%	100%	3015	4481
1974	Kuskokwim	70	0.3%	0.0%	31	0
	Bristol Bay	10,970	93.5%	75.1%	10970	8498
	North Peninsula	580	3.4%	5.1%	395	580
	C. Alaska	4,000	2.8%	19.8%	332	2241
	Total	15,620	100%	100%	11728	11319
1975	Kuskokwim	50	0.1%	0.0%	22	0
	Bristol Bay	24,230	96.9%	88.5%	24230	18770
	North Peninsula	750	2.0%	3.5%	511	750
	C. Alaska	3,000	1.0%	7.9%	249	1681
	Total	28,030	100%	100%	25012	21201

Table 14. (Continued) Worksheet for calculating stock contribution to the South Unimak and Shumagin Islands June fishery sockeye catches, 1970-1994, based on relative vulnerability indices by area and abundance. Vulnerability indices estimated from 1987 sockeye abundance and stock contribution based on 1987 tagging study.

Fishery/Stock	Index of Vulnerability Unimak Area	Index of Vulnerability Shumagin Islands
Kuskokwim	0.44	0.00
Bristol Bay	1.00	0.77
North Peninsula	0.68	1.00
C. Alaska	0.08	0.56

Year	Fishery/Stock	Estimated Inshore Run (thousands)	Stock Contribution Unimak Area	Stock Contribution Shumagin Islands	Vulnerability X Estimated Run Unimak Area	Vulnerability X Estimated Run Shumagin Islands
1976	Kuskokwim	40	0.1%	0.0%	18	0
	Bristol Bay	11,540	89.2%	63.7%	11540	8940
	North Peninsula	1,170	6.2%	8.3%	797	1170
	C. Alaska	7,000	4.5%	27.9%	581	3921
	Total	19,750	100%	100%	12936	14031
1977	Kuskokwim	50	0.2%	0.0%	22	0
	Bristol Bay	9,710	86.3%	53.2%	9710	7522
	North Peninsula	1,010	6.1%	7.1%	688	1010
	C. Alaska	10,000	7.4%	39.6%	831	5602
	Total	20,770	100%	100%	11251	14134
1978	Kuskokwim	40	0.1%	0.0%	18	0
	Bristol Bay	19,920	90.0%	68.3%	19920	15431
	North Peninsula	2,110	6.5%	9.3%	1438	2110
	C. Alaska	9,000	3.4%	22.3%	748	5042
	Total	31,070	100%	100%	22123	22583
1979	Kuskokwim	390	0.4%	0.0%	173	0
	Bristol Bay	39,110	92.5%	80.2%	39110	30297
	North Peninsula	3,550	5.7%	9.4%	2419	3550
	C. Alaska	7,000	1.4%	10.4%	581	3921
	Total	50,050	100%	100%	42283	37768
1980	Kuskokwim	110	0.1%	0.0%	49	0
	Bristol Bay	62,490	96.0%	87.0%	62490	48408
	North Peninsula	2,780	2.9%	5.0%	1894	2780
	C. Alaska	8,000	1.0%	8.1%	664	4482
	Total	73,380	100%	100%	65097	55670
1981	Kuskokwim	270	0.3%	0.0%	120	0
	Bristol Bay	34,480	91.7%	75.2%	34480	26710
	North Peninsula	3,190	5.8%	9.0%	2173	3190
	C. Alaska	10,000	2.2%	15.8%	831	5602
	Total	47,940	100%	100%	37604	35502

Table 14. (Continued) Worksheet for calculating stock contribution to the South Unimak and Shumagin Islands June fishery sockeye catches, 1970-1994, based on relative vulnerability indices by area and abundance. Vulnerability indices estimated from 1987 sockeye abundance and stock contribution based on 1987 tagging study.

	Index of Vulnerability	
Fishery/Stock	Unimak Area	Shumagin Islands
Kuskokwim	0.44	0.00
Bristol Bay	1.00	0.77
North Peninsula	0.68	1.00
C. Alaska	0.08	0.56

	Fishery/Stock	Estimated Inshore Run (thousands)	Stock Contribution		Vulnerability X Estimated Run	
			Unimak Area	Shumagin Islands	Unimak Area	Shumagin Islands
1982	Kuskokwim	240	0.4%	0.0%	106	0
	Bristol Bay	22,210	89.0%	63.3%	22210	17205
	North Peninsula	2,150	5.9%	7.9%	1465	2150
	C. Alaska	14,000	4.7%	28.8%	1163	7843
	Total	38,600	100%	100%	24944	27198
1983	Kuskokwim	220	0.2%	0.0%	97	0
	Bristol Bay	45,910	93.6%	76.3%	45910	35564
	North Peninsula	2,670	3.7%	5.7%	1819	2670
	C. Alaska	15,000	2.5%	18.0%	1246	8403
	Total	63,800	100%	100%	49072	46637
1984	Kuskokwim	200	0.2%	0.0%	89	0
	Bristol Bay	41,120	93.2%	75.4%	41120	31854
	North Peninsula	2,560	4.0%	6.1%	1744	2560
	C. Alaska	14,000	2.6%	18.6%	1163	7843
	Total	57,880	100%	100%	44116	42257
1985	Kuskokwim	300	0.3%	0.0%	133	0
	Bristol Bay	36,860	90.7%	70.6%	36860	28554
	North Peninsula	3,500	5.9%	8.7%	2385	3500
	C. Alaska	15,000	3.1%	20.8%	1246	8403
	Total	55,660	100%	100%	40623	40457
1986	Kuskokwim	360	0.6%	0.0%	159	0
	Bristol Bay	23,740	86.7%	59.4%	23740	18390
	North Peninsula	3,040	7.6%	9.8%	2071	3040
	C. Alaska	17,000	5.2%	30.8%	1412	9523
	Total	44,140	100%	100%	27383	30954
1987	Kuskokwim	504	0.7%	0.0%	223	0
	Bristol Bay	27,500	89.3%	60.1%	27500	21303
	North Peninsula	1,844	4.1%	5.2%	1256	1844
	C. Alaska	22,000	5.9%	34.7%	1827	12324
	Total	51,848	100%	100%	30807	35471

Table 14. (Continued) Worksheet for calculating stock contribution to the South Unimak and Shumagin Islands June fishery sockeye catches, 1970-1994, based on relative vulnerability indices by area and abundance. Vulnerability indices estimated from 1987 sockeye abundance and stock contribution based on 1987 tagging study.

Fishery/Stock	Index of Vulnerability: Unimak Area	Index of Vulnerability: Shumagin Islands
Kuskokwim	0.44	0.00
Bristol Bay	1.00	0.77
North Peninsula	0.68	1.00
C. Alaska	0.08	0.56

Year	Fishery/Stock	Estimated Inshore Run (thousands)	Stock Contribution: Unimak Area	Stock Contribution: Shumagin Islands	Vulnerability X Estimated Run: Unimak Area	Vulnerability X Estimated Run: Shumagin Islands
1988	Kuskokwim	440	0.7%	0.0%	195	0
	Bristol Bay	23,599	89.0%	61.5%	23599	18281
	North Peninsula	1,912	4.9%	6.4%	1303	1912
	C. Alaska	17,000	5.3%	32.0%	1412	9523
	Total	42,951	100%	100%	26509	29716
1989	Kuskokwim	243	0.2%	0.0%	108	0
	Bristol Bay	44,184	93.1%	73.9%	44184	34227
	North Peninsula	2,580	3.7%	5.6%	1758	2580
	C. Alaska	17,000	3.0%	20.6%	1412	9523
	Total	64,007	100%	100%	47461	46331
1990	Kuskokwim	601	0.5%	0.0%	266	0
	Bristol Bay	47,922	92.7%	74.1%	47922	37123
	North Peninsula	2,920	3.9%	5.8%	1990	2920
	C. Alaska	18,000	2.9%	20.1%	1495	10084
	Total	69,443	100%	100%	51673	50127
1991	Kuskokwim	595	0.6%	0.0%	263	0
	Bristol Bay	42,323	90.5%	69.4%	42323	32786
	North Peninsula	3,800	5.5%	8.0%	2589	3800
	C. Alaska	19,000	3.4%	22.5%	1578	10644
	Total	65,718	100%	100%	46754	47230
1992	Kuskokwim	390	0.3%	0.0%	173	0
	Bristol Bay	45,030	89.8%	66.8%	45030	34883
	North Peninsula	4,440	6.0%	8.5%	3025	4440
	C. Alaska	23,000	3.8%	24.7%	1910	12885
	Total	72,860	100%	100%	50138	52207
1993	Kuskokwim	330	0.3%	0.0%	146	0
	Bristol Bay	52,110	91.3%	72.3%	52110	40367
	North Peninsula	4,800	5.7%	8.6%	3270	4800
	C. Alaska	19,000	2.8%	19.1%	1578	10644
	Total	76,240	100%	100%	57105	55811

Table 14. (Continued) Worksheet for calculating stock contribution to the South Unimak and Shumagin Islands June fishery sockeye catches, 1970-1994, based on relative vulnerability indices by area and abundance. Vulnerability indices estimated from 1987 sockeye abundance and stock contribution based on 1987 tagging study.

Fishery/Stock	Index of Vulnerability: Unimak Area	Index of Vulnerability: Shumagin Islands
Kuskokwim	0.44	0.00
Bristol Bay	1.00	0.77
North Peninsula	0.68	1.00
C. Alaska	0.08	0.56

	Fishery/Stock	Estimated Inshore Run (thousands)	Stock Contribution		Vulnerability X Estimated Run	
			Unimak Area	Shumagin Islands	Unimak Area	Shumagin Islands
1994	Kuskokwim	330	0.3%	0.0%	146	0
	Bristol Bay	50,548	92.5%	76.0%	50548	39157
	North Peninsula	3,950	4.9%	7.7%	2691	3950
	C. Alaska	15,000	2.3%	16.3%	1246	8403
	Total	69,828	100%	100%	54631	51510

Table 15. Worksheet for calculating sockeye salmon catches by stock of origin in South Unimak and Shumagin Islands June fishery, 1970-1994, based on vulnerability indices by area and abundance. Catches are in thousands of fish, as percent of total June fishery sockeye catch, and as percent of individual stock total run.

			Unimak Area			Shumagin Area			South Peninsula Total		
		Total Run	Catch		Harvest Rate	Catch		Harvest Rate	Catch		Harvest Rate
Year	Stock	(thousands)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)
1970	Kuskokwim	30	0	0.0%	1.7%	0	0.0%	0.0%	0	0.0%	1.6%
	Bristol Bay	39,400	1,471	97.4%	3.7%	122	86.9%	0.3%	1,593	96.5%	3.9%
	North Peninsula	660	17	1.1%	2.5%	3	1.9%	0.4%	19	1.2%	2.9%
	C. Alaska	7,000	22	1.4%	0.3%	16	11.2%	0.2%	37	2.3%	0.5%
	Total	47,090	1,510	100%		140	100%		1,650	100%	
1971	Kuskokwim	20	0	0.1%	1.1%	0	0.0%	0.0%	0	0.0%	1.1%
	Bristol Bay	15,820	397	93.8%	2.5%	29	74.7%	0.3%	426	92.2%	2.6%
	North Peninsula	790	13	3.2%	1.7%	2	4.8%	0.4%	15	3.3%	1.9%
	C. Alaska	6,000	12	3.0%	0.2%	8	20.5%	0.2%	20	4.4%	0.3%
	Total	22,630	423	100%		39	100%		462	100%	
1972	Kuskokwim	10	0	0.1%	2.5%	0	0.0%	0.0%	0	0.1%	2.5%
	Bristol Bay	5,410	308	72.2%	5.7%	33	44.4%	0.3%	341	68.1%	5.9%
	North Peninsula	2,440	95	22.2%	3.9%	19	25.9%	0.4%	114	22.7%	4.5%
	C. Alaska	5,000	24	5.5%	0.5%	22	29.7%	0.2%	46	9.1%	0.9%
	Total	12,860	427	100%		74	100%		501	100%	
1973	Kuskokwim	10	0	0.1%	3.3%	0	0.0%	0.0%	0	0.1%	3.2%
	Bristol Bay	2,440	180	80.9%	7.4%	10	42.2%	0.3%	190	77.3%	7.2%
	North Peninsula	350	18	7.9%	5.0%	2	7.8%	0.4%	19	7.9%	5.3%
	C. Alaska	4,000	25	11.0%	0.6%	12	50.0%	0.2%	36	14.7%	0.9%
	Total	6,800	223	100%		23	100%		246	100%	
1974	Kuskokwim	70	0	0.0%		0	0.0%		0	0.0%	0.0%
	Bristol Bay	10,970	0	0.0%		0	0.0%		0	0.0%	0.0%
	North Peninsula	580	0	0.0%		0	0.0%		0	0.0%	0.0%
	C. Alaska	4,000	0	0.0%		0	0.0%		0	0.0%	0.0%
	Total	15,620	0			0			0		

Table 15. (Continued) Worksheet for calculating sockeye salmon catches by stock of origin in South Unimak and Shumagin Islands June fishery, 1970-1994, based on vulnerability indices by area and abundance. Catches are in thousands of fish, as percent of total June fishery sockeye catch, and as percent of individual stock total run.

			Unimak Area			Shumagin Area			South Peninsula Total		
		Total Run	Catch		Harvest Rate	Catch		Harvest Rate	Catch		Harvest Rate
Year	Stock	(thousands)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)
1975	Kuskokwim	50	0	0.1%	0.3%	0	0.0%	0.0%	0	0.1%	0.3%
	Bristol Bay	24,230	185	96.9%	0.8%	43	88.5%	0.3%	228	95.2%	0.9%
	North Peninsula	750	4	2.0%	0.5%	2	3.5%	0.4%	6	2.3%	0.7%
	C. Alaska	3,000	2	1.0%	0.1%	4	7.9%	0.2%	6	2.4%	0.2%
	Total	28,030	191	100%		49	100%		240	100%	
1976	Kuskokwim	40	0	0.1%	0.8%	0	0.0%	0.0%	0	0.1%	0.8%
	Bristol Bay	11,540	208	89.2%	1.8%	46	63.7%	0.3%	254	83.2%	2.2%
	North Peninsula	1,170	14	6.2%	1.2%	6	8.3%	0.4%	20	6.7%	1.7%
	C. Alaska	7,000	10	4.5%	0.1%	20	27.9%	0.2%	31	10.0%	0.4%
	Total	19,750	233	100%		72	100%		305	100%	
1977	Kuskokwim	50	0	0.2%	0.8%	0	0.0%	0.0%	0	0.2%	0.8%
	Bristol Bay	9,710	169	86.3%	1.7%	24	53.2%	0.3%	194	80.0%	2.0%
	North Peninsula	1,010	12	6.1%	1.2%	3	7.1%	0.4%	15	6.3%	1.5%
	C. Alaska	10,000	14	7.4%	0.1%	18	39.6%	0.2%	33	13.5%	0.3%
	Total	20,770	196	100%		46	100%		242	100%	
1978	Kuskokwim	40	0	0.1%	0.8%	0	0.0%	0.0%	0	0.1%	0.8%
	Bristol Bay	19,920	377	90.0%	1.9%	46	68.3%	0.3%	424	87.0%	2.1%
	North Peninsula	2,110	27	6.5%	1.3%	6	9.3%	0.4%	34	6.9%	1.6%
	C. Alaska	9,000	14	3.4%	0.2%	15	22.3%	0.2%	29	6.0%	0.3%
	Total	31,070	419	100%		68	100%		487	100%	
1979	Kuskokwim	390	3	0.4%	0.7%	0	0.0%	0.0%	3	0.3%	0.7%
	Bristol Bay	39,110	622	92.5%	1.6%	144	80.2%	0.3%	765	89.9%	1.9%
	North Peninsula	3,550	38	5.7%	1.1%	17	9.4%	0.4%	55	6.5%	1.5%
	C. Alaska	7,000	9	1.4%	0.1%	19	10.4%	0.2%	28	3.3%	0.4%
	Total	50,050	672	100%		179	100%		851	100%	

Table 15. (Continued) Worksheet for calculating sockeye salmon catches by stock of origin in South Unimak and Shumagin Islands June fishery, 1970-1994, based on vulnerability indices by area and abundance. Catches are in thousands of fish, as percent of total June fishery sockeye catch, and as percent of individual stock total run.

			Unimak Area			Shumagin Area			South Peninsula Total		
		Total Run	Catch		Harvest Rate	Catch		Harvest Rate	Catch		Harvest Rate
Year	Stock	(thousands)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)
1980	Kuskokwim	110	2	0.1%	1.9%	0	0.0%	0.0%	2	0.1%	1.8%
	Bristol Bay	62,490	2,622	96.0%	4.2%	413	87.0%	0.3%	3,035	94.7%	4.6%
	North Peninsula	2,780	79	2.9%	2.9%	24	5.0%	0.4%	103	3.2%	3.6%
	C. Alaska	8,000	28	1.0%	0.3%	38	8.1%	0.2%	66	2.1%	0.8%
	Total	73,380	2,731	100%		475	100%		3,206	100%	
1981	Kuskokwim	270	5	0.3%	1.7%	0	0.0%	0.0%	5	0.3%	1.7%
	Bristol Bay	34,480	1,349	91.7%	3.9%	264	75.2%	0.3%	1,613	88.5%	4.5%
	North Peninsula	3,190	85	5.8%	2.7%	32	9.0%	0.4%	117	6.4%	3.5%
	C. Alaska	10,000	32	2.2%	0.3%	55	15.8%	0.2%	88	4.8%	0.9%
	Total	47,940	1,471	100%		351	100%		1,822	100%	
1982	Kuskokwim	240	7	0.4%	3.0%	0	0.0%	0.0%	7	0.3%	2.9%
	Bristol Bay	22,210	1,485	89.0%	6.7%	285	63.3%	0.3%	1,770	83.6%	7.4%
	North Peninsula	2,150	98	5.9%	4.6%	36	7.9%	0.4%	134	6.3%	5.9%
	C. Alaska	14,000	78	4.7%	0.6%	130	28.8%	0.2%	208	9.8%	1.5%
	Total	38,600	1,668	100%		451	100%		2,119	100%	
1983	Kuskokwim	220	3	0.2%	1.4%	0	0.0%	0.0%	3	0.2%	1.4%
	Bristol Bay	45,910	1,447	93.6%	3.2%	317	76.3%	0.3%	1,765	89.9%	3.7%
	North Peninsula	2,670	57	3.7%	2.1%	24	5.7%	0.4%	81	4.1%	3.0%
	C. Alaska	15,000	39	2.5%	0.3%	75	18.0%	0.2%	114	5.8%	0.8%
	Total	63,800	1,547	100%		416	100%		1,963	100%	
1984	Kuskokwim	200	2	0.2%	1.1%	0	0.0%	0.0%	2	0.2%	1.1%
	Bristol Bay	41,120	1,054	93.2%	2.6%	194	75.4%	0.3%	1,248	89.9%	2.9%
	North Peninsula	2,560	45	4.0%	1.7%	16	6.1%	0.4%	60	4.3%	2.3%
	C. Alaska	14,000	30	2.6%	0.2%	48	18.6%	0.2%	78	5.6%	0.6%
	Total	57,880	1,131	100%		257	100%		1,388	100%	

Table 15. (Continued) Worksheet for calculating sockeye salmon catches by stock of origin in South Unimak and Shumagin Islands June fishery, 1970-1994, based on vulnerability indices by area and abundance. Catches are in thousands of fish, as percent of total June fishery sockeye catch, and as percent of individual stock total run.

			Unimak Area			Shumagin Area			South Peninsula Total		
		Total Run	Catch		Harvest Rate	Catch		Harvest Rate	Catch		Harvest Rate
Year	Stock	(thousands)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)
1985	Kuskokwim	300	5	0.3%	1.6%	0	0.0%	0.0%	5	0.3%	1.6%
	Bristol Bay	36,860	1,320	90.7%	3.6%	237	70.6%	0.3%	1,557	87.0%	4.1%
	North Peninsula	3,500	85	5.9%	2.4%	29	8.7%	0.4%	114	6.4%	3.2%
	C. Alaska	15,000	45	3.1%	0.3%	70	20.8%	0.2%	114	6.4%	0.8%
	Total	55,660	1,455	100%		336	100%		1,791	100%	
1986	Kuskokwim	360	2	0.6%	0.5%	0	0.0%	0.0%	2	0.4%	0.5%
	Bristol Bay	23,740	273	86.7%	1.2%	93	59.4%	0.3%	366	77.7%	1.5%
	North Peninsula	3,040	24	7.6%	0.8%	15	9.8%	0.4%	39	8.3%	1.3%
	C. Alaska	17,000	16	5.2%	0.1%	48	30.8%	0.2%	64	13.6%	0.4%
	Total	44,140	315	100%		156	100%		471	100%	
1987	Kuskokwim	504	5	0.7%	0.9%	0	0.0%	0.0%	5	0.6%	0.9%
	Bristol Bay	27,500	584	89.3%	2.1%	85	60.1%	0.3%	668	84.1%	2.4%
	North Peninsula	1,844	27	4.1%	1.4%	7	5.2%	0.4%	34	4.3%	1.8%
	C. Alaska	22,000	39	5.9%	0.2%	49	34.7%	0.2%	88	11.0%	0.4%
	Total	51,848	654	100%		141	100%		795	100%	
1988	Kuskokwim	440	3	0.7%	0.8%	0	0.0%	0.0%	3	0.5%	0.8%
	Bristol Bay	23,599	422	89.0%	1.8%	173	61.5%	0.3%	595	78.8%	2.5%
	North Peninsula	1,912	23	4.9%	1.2%	18	6.4%	0.4%	41	5.5%	2.1%
	C. Alaska	17,000	25	5.3%	0.1%	90	32.0%	0.2%	116	15.3%	0.7%
	Total	42,951	474	100%		282	100%		756	100%	
1989	Kuskokwim	243	3	0.2%	1.3%	0	0.0%	0.0%	3	0.2%	1.2%
	Bristol Bay	44,184	1,255	93.1%	2.8%	293	73.9%	0.3%	1,548	88.7%	3.4%
	North Peninsula	2,580	50	3.7%	1.9%	22	5.6%	0.4%	72	4.1%	2.7%
	C. Alaska	17,000	40	3.0%	0.2%	82	20.6%	0.2%	122	7.0%	0.7%
	Total	64,007	1,348	100%		397	100%		1,745	100%	

Table 15. (Continued) Worksheet for calculating sockeye salmon catches by stock of origin in South Unimak and Shumagin Islands June fishery, 1970-1994, based on vulnerability indices by area and abundance. Catches are in thousands of fish, as percent of total June fishery sockeye catch, and as percent of individual stock total run.

			Unimak Area			Shumagin Area			South Peninsula Total		
		Total Run	Catch		Harvest Rate	Catch		Harvest Rate	Catch		Harvest Rate
Year	Stock	(thousands)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)	(thousands)	(percent)	(percent)
1990	Kuskokwim	601	6	0.5%	0.9%	0	0.0%	0.0%	6	0.4%	0.9%
	Bristol Bay	47,922	1,012	92.7%	2.1%	190	74.1%	0.3%	1,201	89.2%	2.4%
	North Peninsula	2,920	42	3.9%	1.4%	15	5.8%	0.4%	57	4.2%	1.9%
	C. Alaska	18,000	32	2.9%	0.2%	51	20.1%	0.2%	83	6.2%	0.5%
	Total	69,443	1,091	100%		256	100%		1,347	100%	
1991	Kuskokwim	595	7	0.6%	1.2%	0	0.0%	0.0%	7	0.4%	1.1%
	Bristol Bay	42,323	1,101	90.5%	2.6%	234	69.4%	0.3%	1,335	85.9%	3.1%
	North Peninsula	3,800	67	5.5%	1.8%	27	8.0%	0.4%	94	6.1%	2.4%
	C. Alaska	19,000	41	3.4%	0.2%	76	22.5%	0.2%	117	7.5%	0.6%
	Total	65,718	1,216	100%		337	100%		1,553	100%	
1992	Kuskokwim	390	7	0.3%	1.8%	0	0.0%	0.0%	7	0.3%	1.8%
	Bristol Bay	45,030	1,838	89.8%	4.1%	279	66.8%	0.3%	2,116	85.9%	4.5%
	North Peninsula	4,440	123	6.0%	2.8%	35	8.5%	0.4%	159	6.5%	3.5%
	C. Alaska	23,000	78	3.8%	0.3%	103	24.7%	0.2%	181	7.3%	0.8%
	Total	72,860	2,046	100%		417	100%		2,463	100%	
1993	Kuskokwim	330	6	0.3%	1.8%	0	0.0%	0.0%	6	0.2%	1.8%
	Bristol Bay	52,110	2,160	91.3%	4.1%	443	72.3%	0.3%	2,603	87.4%	4.8%
	North Peninsula	4,800	136	5.7%	2.8%	53	8.6%	0.4%	188	6.3%	3.8%
	C. Alaska	19,000	65	2.8%	0.3%	117	19.1%	0.2%	182	6.1%	0.9%
	Total	76,240	2,367	100%		612	100%		2,979	100%	
1994	Kuskokwim	330	3	0.3%	0.8%	0	0.0%	0.0%	3	0.2%	0.8%
	Bristol Bay	50,548	926	92.5%	1.8%	361	76.0%	0.3%	1,288	87.2%	2.5%
	North Peninsula	3,950	49	4.9%	1.2%	36	7.7%	0.4%	86	5.8%	2.1%
	C. Alaska	15,000	23	2.3%	0.2%	77	16.3%	0.2%	100	6.8%	0.7%
	Total	69,828	1,001	100%		475	100%		1,476	100%	

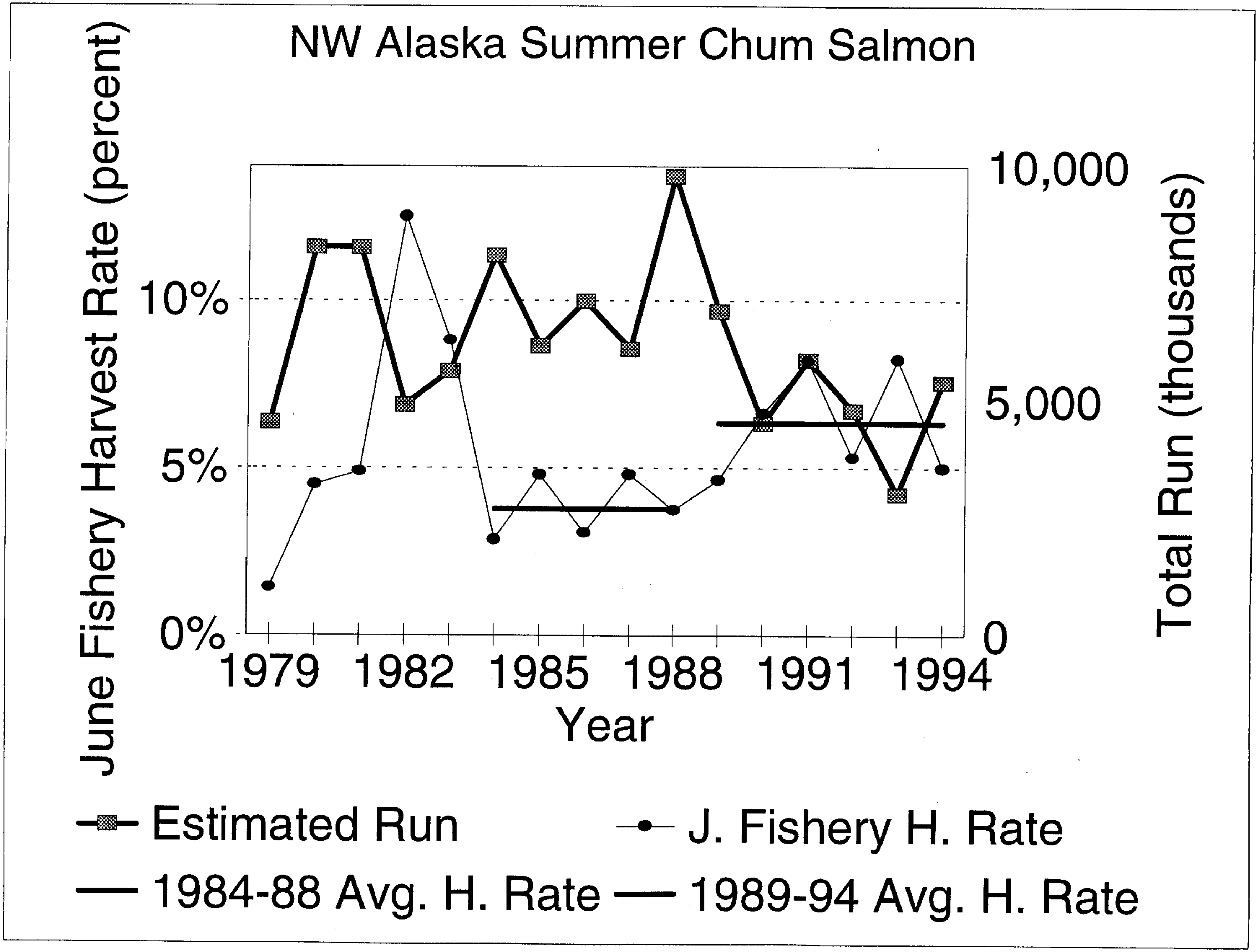


Figure 1. Northwest Alaska summer chum salmon estimated inshore run (thick solid line) and harvest rate (thin solid line) by the South Unimak and Shumagin Islands June fishery, 1979–1994.

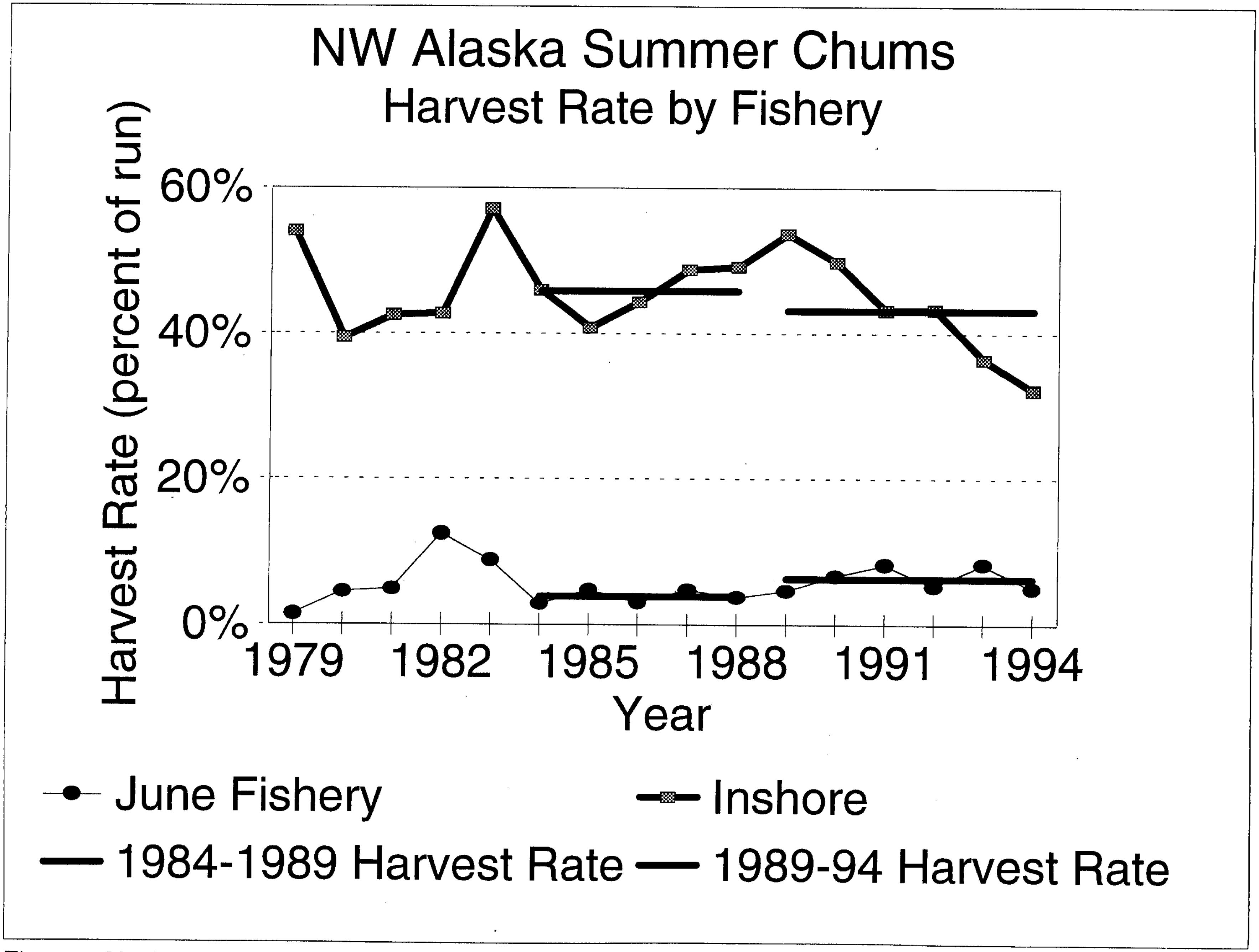


Figure 2. Northwest Alaska summer chum salmon harvest rate by inshore fishermen (thick solid line) and by South Unimak and Shumagin Islands June fishermen (thin solid line), 1979–1994.

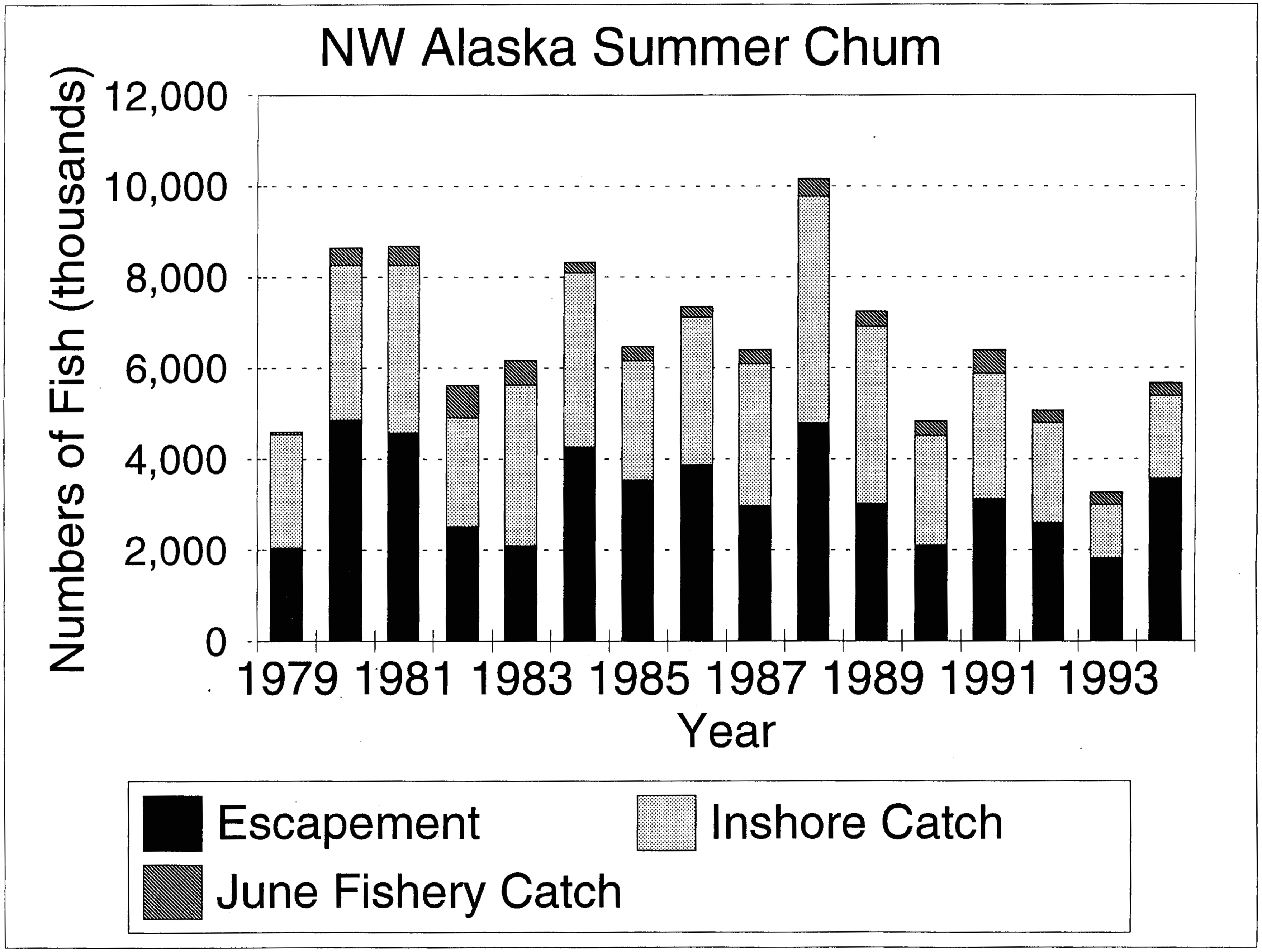


Figure 3. Number Northwest Alaska summer chum salmon in escapement, inshore catch, and South Alaska June fishery catch, 1979–1994.

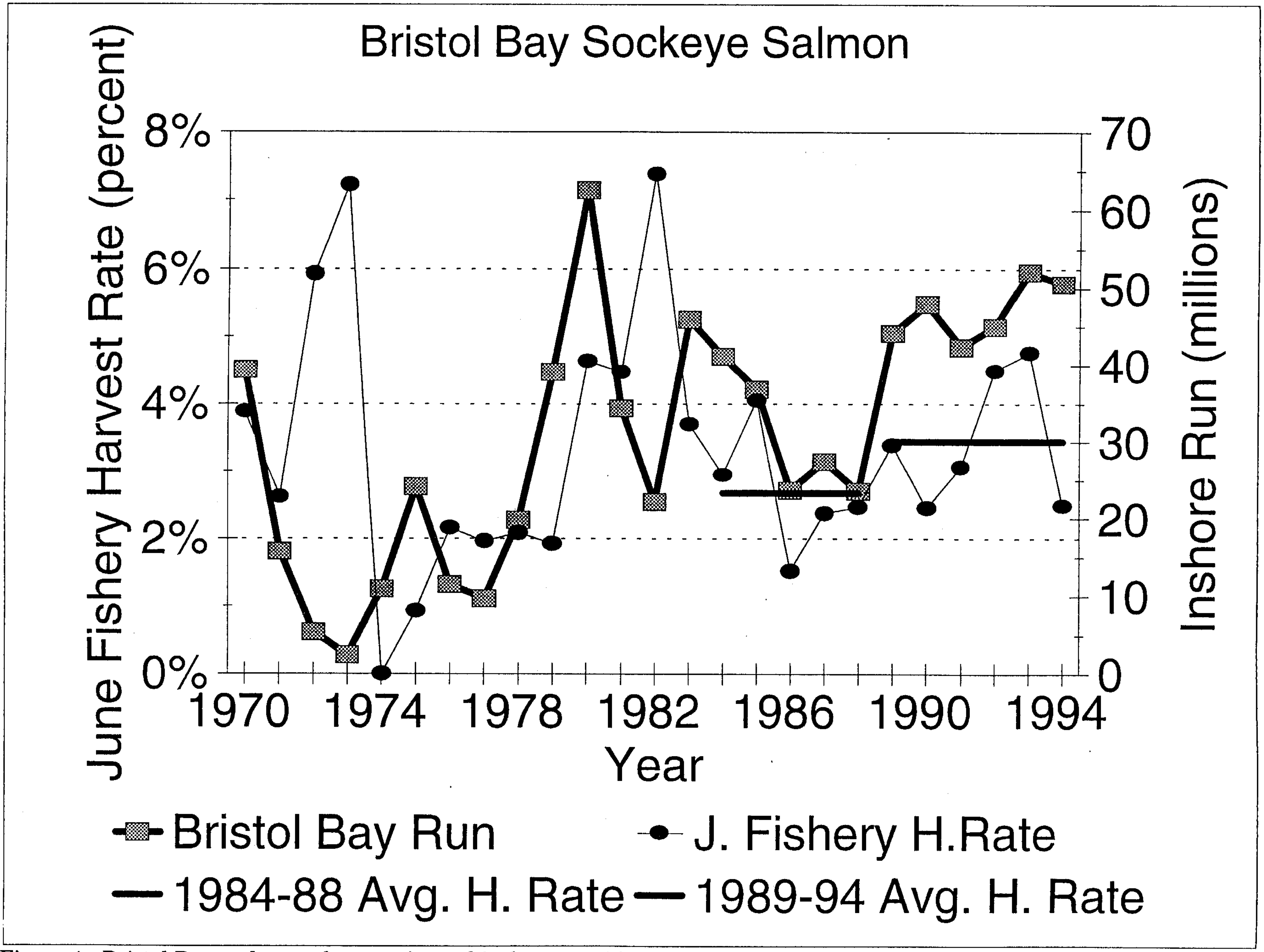


Figure 4. Bristol Bay sockeye salmon estimated inshore run (thick solid line) and harvest rate (thin solid line) by the South Unimak and Shumagin Islands June fishery, 1970–1994.

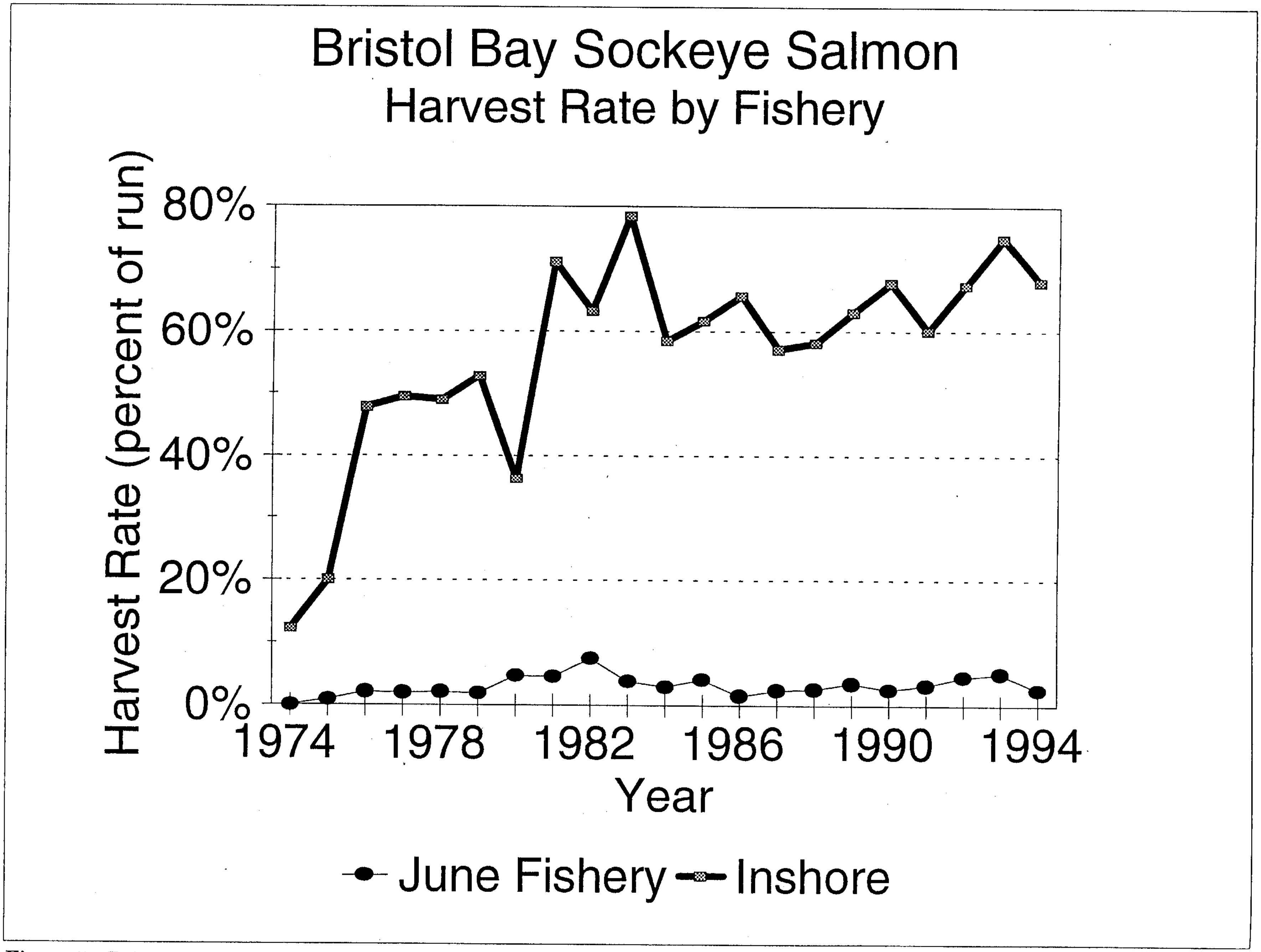


Figure 5. Bristol Bay sockeye salmon harvest rate by inshore fishermen (thick solid line) and by South Unimak and Shumagin Islands June fishermen (thin solid line), 1970–1994.

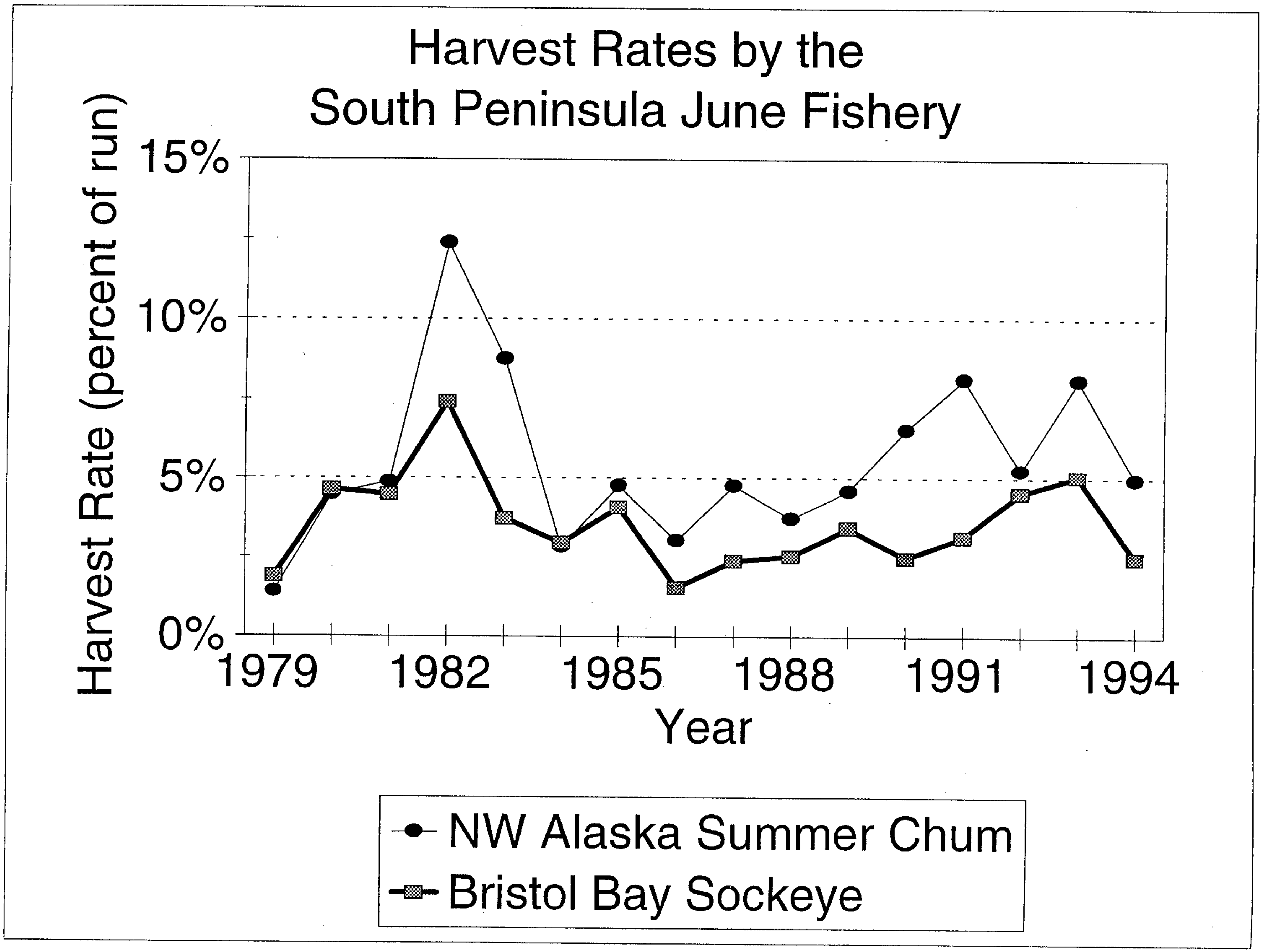


Figure 6. Harvest rate by South Unimak and Shumagin Islands June fishermen on Bristol Bay sockeye salmon (thick solid line) and on Northwest Alaska summer chum salmon (thin solid line), 1979–1994.

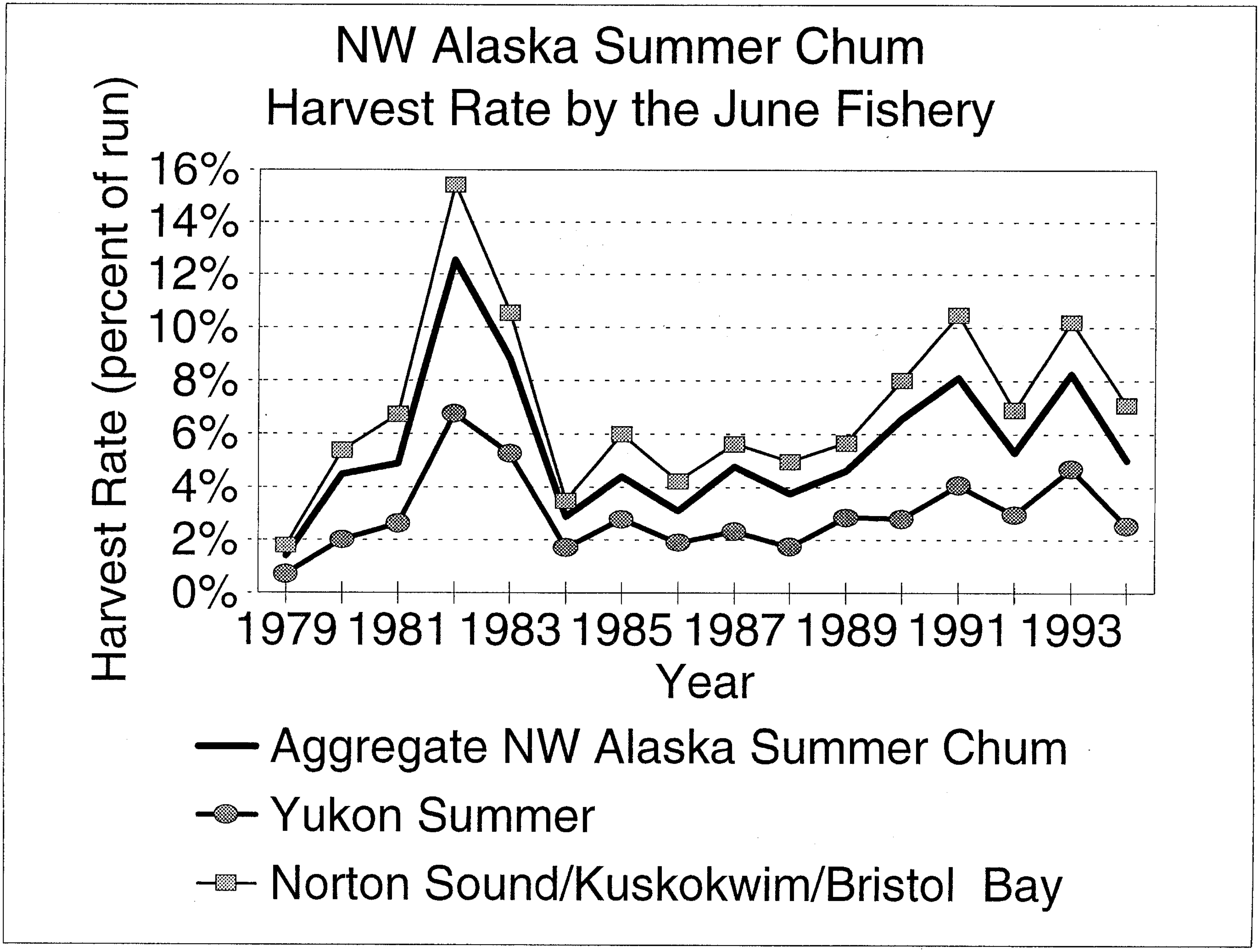


Figure 7. Harvest rate by South Unimak and Shumagin Islands June fishery, 1979–1994, on aggregated NW Alaska summer, Yukon summer, and Norton Sound/Kuskokwim/Bristol Bay chum salmon. The latter two groups estimated assuming the relative vulnerability of Yukon summer chums was one-half for the early period and one-fourth for the late period of the GSI based vulnerabilities estimated for aggregate NW Alaska summer chum salmon group.

APPENDIX

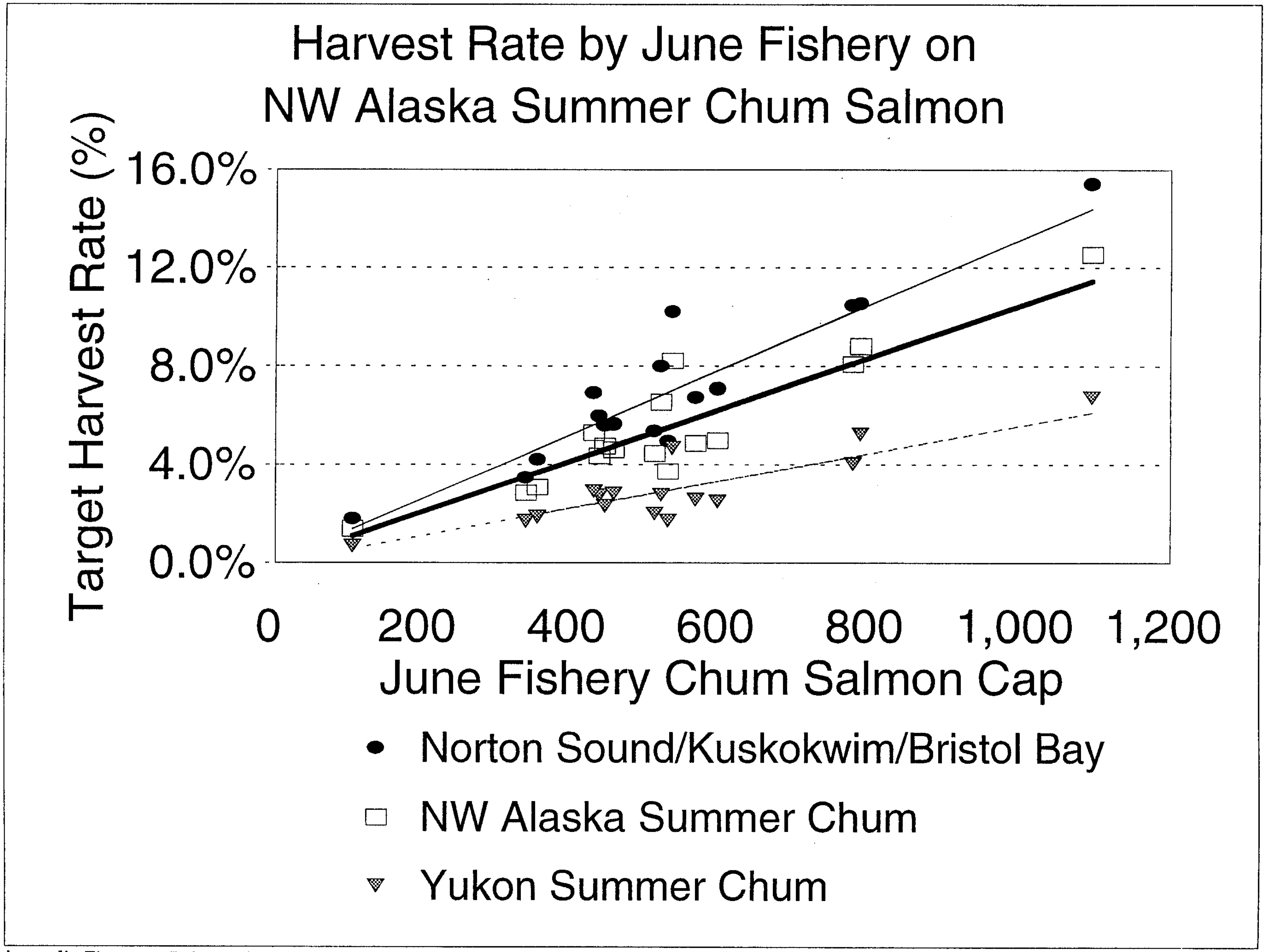
APPENDIX

RELATIONSHIPS BETWEEN JUNE FISHERY HARVEST RATE ON NORTHWEST ALASKA SUMMER CHUM SALMON AND POTENTIAL JUNE FISHERY CHUM SALMON CAPS

The harvest rate on NW Alaska summer chum salmon is closely related to the total catch of chum salmon in the South Unimak and Shumagin Islands June fishery (Appendix Table 1). Historical June fishery harvest rates on NW Alaska summer chum salmon was highly correlated with the total catch of chum salmon in the June fishery. Harvest rates can be capped at target levels by limiting the catch of chum salmon in the June fishery. To assist the Board of Fisheries in evaluating alternative proposals to limit the June fishery harvest rates on NW Alaska summer chum salmon, quantitative relationships between target harvest rate and potential chum caps were estimated by simple linear regression. These relationships were estimated for the aggregated NW Alaska summer chum salmon, Yukon summer chum salmon, and for Norton Sound/Kuskokwim/Bristol Bay chum salmon (Appendix Figure 1).

Appendix Table 1. Relationship between harvest rate by the South Unimak and Shumagin Islands June fishery on various stock groupings and total catch of chum salmon in the June fishery.

Year	June Fishery Total Chum Salmon Catch	Northwest Alaska Summer Chum			Yukon Summer Chum			Norton Sound/Kuskokwim/Bristol Bay		
		Observed Catch	Observed Harvest Rate	Predicted Harvest Rate	Observed Catch	Observed Harvest Rate	Predicted Harvest Rate	Observed Catch	Observed Harvest Rate	Predicted Harvest Rate
1979	104	64	1.4%	1.1%	12	0.7%	0.6%	52	1.8%	1.4%
1980	509	387	4.5%	5.3%	47	2.0%	2.8%	340	5.4%	6.7%
1981	564	425	4.9%	5.9%	101	2.6%	3.2%	324	6.7%	7.4%
1982	1,095	704	12.5%	11.4%	126	6.8%	6.1%	578	15.4%	14.4%
1983	786	545	8.8%	8.2%	106	5.3%	4.4%	439	10.5%	10.3%
1984	337	238	2.9%	3.5%	50	1.7%	1.9%	188	3.5%	4.4%
1985	435	283	4.4%	4.5%	89	2.8%	2.4%	194	6.0%	5.7%
1986	352	227	3.1%	3.7%	68	1.9%	2.0%	159	4.2%	4.6%
1987	443	306	4.8%	4.6%	38	2.3%	2.5%	268	5.6%	5.8%
1988	527	380	3.7%	5.5%	67	1.7%	2.9%	313	5.0%	6.9%
1989	455	335	4.6%	4.8%	76	2.8%	2.5%	259	5.7%	6.0%
1990	518	317	6.6%	5.4%	37	2.8%	2.9%	280	8.0%	6.8%
1991	776	518	8.1%	8.1%	96	4.1%	4.3%	422	10.5%	10.2%
1992	428	269	5.3%	4.5%	60	2.9%	2.4%	209	6.9%	5.6%
1993	533	269	8.2%	5.6%	55	4.7%	3.0%	214	10.2%	7.0%
1994	594	284	5.0%	6.2%	65	2.5%	3.3%	219	7.1%	7.8%
Average	529	347	5.6%		68	3.0%		279	7.0%	



Appendix Figure 1. Relationship between target harvest rate and June fishery chum salmon cap, based on regression of estimated stock-specific harvest rate by the June fishery and total chum salmon in the June fishery for the years 1979–1994. Relationships estimated for aggregate northwest Alaska summer chum salmon, Yukon River summer chum, and Norton Sound/Kuskokwim/Bristol Bay chum salmon.