GENETIC ANALYSIS OF CHUM SALMON HARVESTED IN THE SOUTH PENINSULA POST JUNE FISHERY, 1996-1997

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by

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EXECUTIVE SUMMARY

- The origin of chum salmon *Oncorhynchus keta* harvested in South Peninsula Post June test and commercial catches in 1996 and 1997 was estimated using genetic stock identification.
- Approximately 1,400 chum salmon were sampled from test fisheries in the Shumagin Islands in 1996 and 1997. The stock composition for the 1996 test fishery was estimated using 510 samples collected between July 12 and July 18. For the 1997 test fishery, the stock composition was estimated using 400 chum salmon randomly selected from the 840 samples collected from July 12 to July 19.
- We estimated stock composition of commercial catches for two areas: 1) the "Mainland Area", comprising Unimak District, Southwestern District, South Central District, the Southeastern District Mainland and 2) the Shumagin Islands Section of the Southeastern District. The commercial fishery was stratified into three periods: July 20 to July 26, July 27 to August 2, and August 3 to August 10.
- For the Mainland Area, 400 fish were randomly subsampled from the total number of fish collected in each period, proportional to the daily catch in each district. For the Shumagin Islands, 400 fish were randomly subsampled from the total number of fish collected in each period, proportional to the daily catch.
- The fishery subsamples were assayed for genetic variation at 20 allozyme loci. Stock composition was estimated via maximum likelihood using these data and the allozyme baseline compiled by Seeb et al. (1997). Mixture proportions were estimated for 10 stock groups (reporting regions): 1) JAPAN, 2) CHINA/SOUTHERN RUSSIA, 3) NORTHERN RUSSIA, 4) NORTHWEST ALASKA SUMMER, 5) FALL YUKON, 6) ALASKA PENINSULA/KODIAK, 7) SUSITNA RIVER, 8) PRINCE WILLIAM SOUND, 9)

SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and 10) SOUTHERN BRITISH COLUMBIA/WASHINGTON.

- For the Mainland Area, the largest contributor to the commercial catch was ALASKA PENINSULA/KODIAK, approximately 0.80 in both years. Catch composition varied little across the three time periods.
- ALASKA PENINSULA/KODIAK was the largest contributor to test fish catches in the Shumagin Islands, 0.54 in 1996 and 0.32 in 1997. ALASKA PENINSULA/KODIAK was the largest contributor to the commercial catches as well; the annual contribution for this reporting region was 0.60 in 1996 and 0.68 in 1997. Little variation was seen in catch composition over time.
- Stock composition differed between the Mainland Area and Shumagin Islands and also within the Mainland Area. More local fish were harvested in the Mainland Area than the Shumagin Islands. More chum salmon from Asia were observed in the most western portion of the Mainland Area (Unimak District and Ikatan Bay Section of the Southwestern District) than over the entire Mainland Area.
- Examination of the stock composition estimates of test and commercial fishery catches from the South Peninsula June fishery and Post June fishery revealed changes in the origin of chum salmon migrating through South Peninsula waters from June through mid August 1996. Mixtures were composed mainly of NORTHWEST ALASKA SUMMER and JAPAN in June. By mid July, mixtures were composed mainly of ALASKA PENINSULA/KODIAK. FALL YUKON was only observed in the 1996 test fish catches sampled off Unimak Island prior to the June commercial fishery.

INTRODUCTION

Chum salmon *Oncorhynchus keta* are harvested in commercial fisheries in the South Alaska Peninsula during June, July, and August (Eggers et al. 1991; McCullough 1995). Tagging studies conducted in June and early July (e. g., Gilbert and Rich 1926; Thorsteinson and Merrell 1964; Eggers et al. 1991) have shown that significant numbers of chum salmon harvested in this area are not of local origin. Tag recoveries have been reported not only from areas throughout Alaska, but also from Japan, Russia, British Columbia, and Puget Sound.

Results from the tagging studies were confirmed by genetic stock identification (GSI) (Seeb et al. 1997; Seeb and Crane 1999a). Seeb et al. (1995, 1997) compiled a genetic baseline for chum salmon around the Pacific Rim from studies using protein variation detected by allozyme electrophoresis and used it to estimate the stock composition of chum salmon harvested in June South Peninsula fisheries, 1993-1996. Summer run chum salmon from northwestern Alaska (Kotzebue Sound to Meshik River on the north Alaska Peninsula) were the largest component of these fisheries, with contributions ranging from 0.38 to 0.60, followed by chum salmon from Asia and the Alaska Peninsula and Kodiak Island. These studies were conducted to quantify the proportion of non-local stocks of chum salmon harvested and provide an understanding of the potential impacts of this fishery on conservation and allocation issues in other areas in western Alaska.

Genetic stock identification has also been applied to study migration patterns in the high seas and coastal waters (Winans et al. 1998; Urawa et al. 1999) and the origin of chum salmon incidentally harvested in walleye pollock *Theragra chalcogramma* fisheries (Wilmot et al. 1998). These studies show some changes in migration patterns compared to those suggested by earlier physical tagging studies. These changes may be attributed to climate changes in the North Pacific Ocean and the Bering Sea (Ignell et al. 1997; Patton et al. 1998).

Few studies, tagging or genetics, have estimated the origins of chum salmon harvested in South Peninsula fisheries in July or August or potential impacts of these fisheries on later run chum salmon populations. This study has two goals: 1) to estimate the contribution of chum salmon stocks harvested in test and commercial fisheries conducted in the South Alaska Peninsula in July and August in 1996 and 1997, and 2) to describe the dynamics of chum salmon stocks in South Peninsula waters from June through August in 1996.

MATERIALS AND METHODS

Stock Composition of Post June Test Fish and Commercial Catches

Sample Collection

The South Peninsula Post June fishery occurs in the Unimak District, Southwestern District, South Central District, and the Southeastern District Mainland (termed the "Mainland Area", shaded on Figure 1) and the Shumagin Islands Section of the Southeastern District (termed the "Shumagin Islands", Figure 1). The Post June fishery occurs from July 1 to October 31. During this study, the fishery was managed to allow fishing in terminal areas only from July 1 to July 19. After July 19, traditional cape harvest areas were opened to commercial fishing. Alaska Department of Fish and Game (ADF&G) conducted a test fish program from Sand Point in mid July to monitor the abundance of immature salmon in the Shumagin Islands; this information was used to delay the opening of commercial fishing in non-terminal areas (McCullough 1995). Currently, commercial fishing is allowed in non-terminal areas from July 6 to July 21, and fishing time from July 22 to July31 may be limited to reduce the harvest of migrating coho and sockeye salmon. The test fish program in Sand Point is now operated prior to July 6 (Campbell et al. 1999).

Catches from the South Peninsula are delivered by tender to the King Cove and Sand Point processing plants. Deliveries are also made to floating processors. The King Cove plant receives catches from the entire South Peninsula area while the Sand Point plant receives catches mostly from the Southeastern and South Central Districts.

We sampled test fish and commercial catches during the South Peninsula Post June fishery in 1996 and 1997. Test fish catches from traditional areas used by the commercial fleet in the Shumagin Islands were sampled at Sand Point from approximately July 12 to July 19. The sampling goal was 800 fish for the period or up to 100 fish per day. Immature (<400 mm) and adult (>400 mm) chum salmon were sampled proportional to their abundance in the test fish catches.

We sampled the commercial catch from July 20 to August 10. Commercial catch samples were collected from tender deliveries to Peter Pan Seafoods, King Cove, and Trident Seafoods, Sand Point. During each commercial fishing period tender deliveries from commercial catches from the Unimak, Southwestern, and South Central Districts were sampled at King Cove, and tender deliveries from commercial catches in the South Central and Southeastern Districts were sampled at Sand Point. Tender operators were interviewed to determine the origin of the catch. The sampling goal for catches from the Mainland Area was 150 fish per day at King Cove and 50 per day at Sand Point. The sampling goal for catches from the Shumagin Islands was 150 per day at Sand Point. Muscle, liver, and heart tissues were subsampled from each fish, placed in labeled cryovials, and frozen at -20^{o}C. Tissue samples were shipped on dry ice to the ADF&G Gene Conservation Laboratory within one week of collection and stored at -80^{o}C.

Stock composition estimates were based on 400 fish. For the test fishery analysis, if more than 400 fish were sampled, 400 samples were randomly selected from the total. The commercial fishery analysis was stratified into three weekly time periods (July 20 to 26, July 27 toAugust 2, August 3 to10). Separate stock composition estimates were provided for fish harvested in the Mainland Area and the Shumagin Islands for each period. Time periods will be referenced by the year and the number assigned the time period (e.g. 1996-1 represents the first time period in 1996).

The 400 fish for the Shumagin Islands estimates were randomly subsampled proportional to the daily catch in the Shumagin Islands Section in each period. Fish were subsampled proportional to the number of fish harvested each day in the individual districts for the analysis of Mainland Area catches. If too few samples were collected for a given district on a given day, the missing samples were made up from additional samples for that district for that period (i.e., not by samples from other districts on the same day). If too few samples were collected for a given district within a period, missing samples were made up from the adjacent district. Fish were sometimes sampled from tender deliveries containing chum salmon from two districts. These chum salmon were only included in the random subsampling if they were needed to complete the subsample for a district.

Laboratory Analysis

Fishery samples were assayed for genetic variation at the following loci: *sAAT-1,2*; mAAT-1*; mAH-3*; ALAT*; ESTD*; G3PDH-2*; GPI-A*; GPI-B1,2*; mIDHP-1*; sIDHP-2*; LDH-A1*; LDH-B2*; sMDH-A1*; sMDH-B1,2*; mMEP-2*; sMEP-1*; MPI*; PEPA*; PEPB-1**; and *PGDH** using the laboratory protocols of Seeb et al. (1999a).

Statistical Analysis

Stock contributions for each period of the Shumagin Islands test fishery and Mainland Area and Shumagin Islands commercial fishery, 1996 and 1997, were estimated via maximum likelihood (Pella and Milner 1987; Masuda et al. 1991) using SPAM version 3.2 (ADF&G 1997).

The baseline used in the estimation procedure was described in Seeb et al. (1997). Allele frequency data from over 240 collections of chum salmon from around the Pacific Rim were included in the baseline; data sources were Kondzela et al. (1994), Phelps et al. (1994), Wilmot et al. (1994), Winans et al. (1994), Sarafin (1995), Seeb et al. (1997), Seeb and Crane (1999b), and W. Spearman (U.S. Fish and Wildlife Service, Anchorage, AK, unpublished). Analysis of simulated mixtures showed that 10 regional stock groupings or reporting regions could be accurately identified in mixtures. These are 1) JAPAN, 2) NORTHERN RUSSIA (Anadyr River, Kamchatka Peninsula, Sea of Okhotsk), 3) CHINA/SOUTHERN RUSSIA (Amur River, Sakhalin Island, Premorye), 4) NORTHWEST ALASKA SUMMER SUMMER (Kotzebue Sound to Meshik River, including Bristol Bay and excluding fall-run chum salmon in the Yukon River), 5) FALL YUKON, 6) ALASKA PENINSULA/KODIAK, 7) SUSITNA RIVER, 8) PRINCE WILLIAM SOUND, 9) SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and 10) SOUTHERN BRITISH COLUMBIA/WASHINGTON [capitalized to distinguish reporting region from geographic area].

SPAM employed a conjugate gradient searching algorithm using a square root transformation (Pella et al. 1996). This algorithm provides good performance with large baselines and small stock differences (Pella et al. 1996). The estimation procedure used the twenty loci assayed in the fishery samples with one exception: *ALAT** was deleted due to poor resolution from the Shumagin Island samples. The estimation procedure removed genotypes from the mixture if their probability of occurring was $P < 1 \times 10^{-6}$. For these cases, the mixture estimates have an “unknown” group containing the percent of the mixture that was removed. Further, we deleted individuals missing data at four or more loci. Individual population or stock estimates were calculated first, then summed into the 10 reporting regions (allocate-sum procedure, Wood et al. 1987. The ten reporting groups were further pooled into five regions to improve the readability of the figures as follows: ASIA (JAPAN, CHINA/SOUTHERN RUSSIA, NORTHERN RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST

ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON).

Ninety percent confidence intervals for each regional contribution estimate were computed using 1,000 bootstrap resamples of the baseline and mixture genotypes. For each resample, contribution estimates were generated for all populations and summed to the regional level. The 1,000 estimates for a region were then sorted from lowest to highest with the 51st and 950th values in the sequence taken respectively as the lower and upper bounds of the 90% confidence interval for that region.

Annual contribution estimates were calculated as a weighted average of the individual period estimates weighted by the total catch for that period. Confidence intervals for the annual contribution estimates were calculated as described above from weights applied to each of the 1000 bootstrap estimates.

Time Series in 1996

We used stock composition estimates of chum salmon harvested in South Peninsula June and Post June test and commercial fisheries to describe the migration dynamics of chum salmon in South Peninsula waters in June, July, and early August in 1996.

Chum salmon were collected in 1996 from test fisheries conducted prior to the June fishery off South Unimak Island on June 13 and June 14 and the Shumagin Islands from June 5 to June 16 (Seeb et al. 1997). One stock composition estimate was made for the South Unimak test fishery (N=230), and two stock composition estimates were made for the Shumagin Islands test fishery (N=800). For the Shumagin Islands test fishery, the 800 samples were randomly subsampled from the total number collected. Laboratory and statistical analyses were as described above.

Stock composition estimates for the South Unimak June fishery occurring in the Unimak and Southwestern Districts and for the Shumagin Islands June fishery occurring in the Shumagin Islands Section of the Southeastern District are from Seeb et al. (1997). These fisheries were stratified into three time periods: the opening of the commercial fishery to June 20, June 21 to June 25, and June 26 to June 30.

RESULTS

Sampling and Analysis

Approximately 1,400 chum salmon were sampled from test fisheries off the South Alaska Peninsula in 1996 and 1997 (Table 1). For the 1996 test fishery in the Shumagin Islands, 510 samples were collected between July 12 and July 18. Genotypes were collected on all samples and used to estimate stock composition. For the 1997 test fishery, 840 samples were collected from July 12 to July 19 in the Shumagin Islands. We randomly selected 400 fish from the total number collected and used them to estimate stock composition. Chum salmon were collected in a test fishery in 1997 in the Mainland Area. These were not analyzed because the test fishery was conducted after July 20 when commercial fishing generally occurs and the number of samples collected was too small to be representative.

Approximately 7,500 individuals were sampled from commercial catches during July and August of 1996 and 1997. For each commercial fishery, samples for analysis were randomly selected from the total number collected within each time strata, weighted proportional to the daily catch within each district (Tables 2 and 3). This goal was largely met except for the Mainland Area in 1997 Period 3 (1997-3; Table 2). Fisher strikes in 1997 made sampling of the fishery problematic. Commercial fisheries only occurred during the first period of 1997 in the Shumagin Islands (Table 3), and very few fish were harvested during the second period of 1997 in the Mainland Area (Table 2).

Fishery Estimates

1996 Post June Test and Commercial Fisheries

The annual contribution estimates for the 1996 Mainland Area fishery indicated that the majority (0.83) of fish harvested are from the ALASKA PENINSULA/KODIAK region (Table

4a, Figure 2). The second largest contributors were SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA (0.05) and SOUTHERN BRITISH COLUMBIA/WASHINGTON (0.05).

The sampling design allowed comparisons through time among the three sampling periods. Very little change in the regional contributions was observed over time (Table 4a, Figure 3); contributions of ALASKA PENINSULA/KODIAK increased slightly.

Estimates were made for the mid-July test fishery and Post June commercial fishery in the Shumagin Islands. ALASKA PENINSULA/KODIAK (0.54) made the largest contribution to test fisheries conducted in the Shumagin Islands between July 12 and July 18 (Table 4b). A substantial contribution was also made by SOUTHERN BRITISH COLUMBIA/WASHINGTON (0.15), followed by SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA (0.09).

Analyses of the Post June commercial fisheries in the Shumagin Islands were made in a manner similar to those for the Mainland Area. The annual contribution estimates for the 1996 Shumagin Islands fishery were also dominated by ALASKA PENINSULA/KODIAK (0.60; Table 4b, Figure 2). The second largest contributor was SOUTHERN BRITISH COLUMBIA/WASHINGTON (0.15) and SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA (0.09). Temporal analyses through the three periods were also conducted. Similar to the Mainland Area fishery in 1996, the contribution of all reporting regions to the Shumagin Islands Post June fishery remained fairly stable over the three time periods with only a slight increase in the contribution of ALASKA PENINSULA/KODIAK (Table 4b, Figure 4).

1997 Post June Test and Commercial Fisheries

The stock composition estimates for 1997 from the Mainland Area were very similar to those for 1996. The annual contribution estimates for ALASKA PENINSULA/KODIAK (0.85) was the largest followed by SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA (0.06) (Table 4c, Figure 2). Estimates were also made through time for each of the three periods. Similar to 1996, very little change was observed over time (Table 4c, Figure 3); contributions of ALASKA PENINSULA/KODIAK increased very slightly.

Similar to 1996, test fishery samples were taken in the Shumagin Islands in 1997. The stock composition estimates for the test fishery, July 12 to July 19, were dramatically different from the 1996 estimates (Table 4d). The largest contribution in both years was ALASKA PENINSULA/KODIAK, however the estimate was 0.32 in 1997, compared with 0.54 for the previous year. JAPAN (0.25) and NORTHERN RUSSIA (0.14) were the next largest contributors in 1997, while in 1996 the estimate for all the Asian reporting groups combined was only 0.09.

Commercial fishing only occurred in the Shumagin Islands during the first time period in 1997. The contribution estimates from all the regions were similar to those observed in 1996, with ALASKA PENINSULA/KODIAK (0.68) making the largest contribution (Table 4d, Figures 2 and 4). Slightly more chum salmon from the Asian reporting regions were present in the first period of 1997 compared to 1996 while fewer fish from SOUTHERN BRITISH COLUMBIA/WASHINGTON and SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA were estimated.

Comparison of Catch Composition between Mainland Area and Shumagin Islands

Fish of local origin from the ALASKA PENINSULA/KODIAK reporting region predominated in both the 1996 and 1997 Mainland Area and the Shumagin Islands fisheries. However, the magnitude of the contribution of local-origin fish was greater in the Mainland Area than the Shumagin Islands fishery in both years. Conversely, more chum salmon originating from SOUTHERN BRITISH COLUMBIA/WASHINGTON were seen in the Shumagin Islands fishery in 1996, while in 1997 more chum salmon from Asian reporting regions occurred in the Shumagin Islands than the Mainland Area (Figure 2).

Comparison of Catch Composition Within the Mainland Area

We also examined possible differences in stock composition between the most western portion of the Mainland Area and the entire Mainland Area (composed of Unimak, Southwestern, and South Central Districts plus the Southeastern District Mainland). Sufficient samples were collected in the first and second periods in 1996 to compare estimates from a western portion consisting of the Unimak District and the Ikatan Bay Section of the Southwestern District to that derived from the entire Mainland Area (Figure 1). For each time period, 200 fish were randomly selected from the total for each of these areas. These fish were not considered representative of the catch since too few samples were collected to weight by daily catch. However, they were representative of chum salmon in the area. During the first period, a larger contribution of the local ALASKA PENINSULA/KODIAK region was estimated to contribute to the Mainland Area than to the western portion. In contrast, greater contributions of non-local stocks including ASIA and EASTERN GULF OF ALASKA/PACIFIC NORTHWEST were made to the western portion than to the entire Mainland Area (Figure 5). However, the estimates for the second period in 1996 were very similar with the vast majority of the fish originating from the local ALASKA PENINSULA/KODIAK region in both the western portion and the entire Mainland Area (Figure 5).

Time Series in 1996

The stock composition estimates for the July Shumagin Islands test fishery and Post June Mainland Area and Shumagin Islands commercial fisheries can be combined with data from previous investigations of the June South Peninsula fishery to examine trends in stock composition through time from June to August, 1996. The fisheries in June occur in the Unimak and Southwestern Districts (South Unimak June fishery) and in the Shumagin Islands Section of the Southeastern District (Shumagin Islands June fishery; Figure 1). Seeb et al. (1997) estimated the stock composition of chum salmon harvested off South Unimak Island and the Shumagin Islands in 1996. In this report we also provide new estimates for the test fisheries conducted prior to the June fisheries off South Unimak Island on June 13 and 14, 1996, and the Shumagin Islands test fishery from June 5 to June 16, 1996 (Table 5). Fishery estimates were graphed to visualize the dynamics of chum salmon stocks moving through the area in summer 1996.

Stock composition of test and commercial fisheries for seven time periods from June 13 to August 10 for the South Peninsula excluding Shumagin Islands are shown in Figure 6. Asian reporting regions were at their highest contributions during June (0.19 to 0.26; Table 5), decreasing to 0.07 or less after July 20 (Table 4a). Similarly, NORTHWEST ALASKA SUMMER contributed between 0.45 and 0.33 during June (Table 5) and was essentially absent in July and early August (Table 4a). FALL YUKON made a contribution of 0.10 during the June test fishery (Table 5); estimates for the remaining time periods ranged from 0.00 to 0.06 but were not significantly different from zero (Figure 6). The decrease in ASIA and NORTHWEST ALASKA SUMMER was made up by a corresponding increase in ALASKA PENINSULA/KODIAK. The contribution of this reporting region increased from 0.09 to 0.31 in June (Table 5), with a marked increase in July to greater than 0.80 (Table 4a). The contribution of EASTERN GULF OF ALASKA/PACIFIC NORTHWEST was relatively consistent from June through mid August.

Stock composition of test and commercial fisheries for nine time periods from June 5 to August 10 for Shumagin Islands are shown in Figure 7. The Asian contribution was low in early June, less than 0.20, and increased to a high of 0.41 during the second time period of the June commercial fishery (Table 5, Figure 7). ASIA declined rapidly from 0.32 to 0.09 between the end of June and mid July. NORTHWEST ALASKA SUMMER was the largest contributor in the early June test fishery, declining through the June commercial fishery. A large decrease was observed for this reporting region between the end of June and mid July, from 0.29 to 0.04. There was no significant contribution from FALL YUKON to fishery samples from the Shumagin Islands; zero was included in the 90% confidence interval for each estimate.

ALASKA PENINSULA/KODIAK and reporting regions from the EASTERN GULF OF ALASKA/PACIFIC NORTHWEST increased from June to early August. The contribution of ALASKA PENINSULA/KODIAK increased from 0.10 to 0.23 in June and to 0.65 in August. Similarly, reporting regions from the GULF OF ALASKA/PACIFIC NORTHWEST made a contribution ranging from 0.06 to 0.14 in June to 0.34 during the Post June fishery in the Shumagin Islands.

DISCUSSION

Seeb et al. (1997) estimated the contribution of chum salmon to the South Peninsula June fisheries. In that study, summer chum salmon from northwestern Alaska were the largest contributors to the fisheries followed by contributions from Asian and local stocks. In this report, we estimated the stock contribution of chum salmon in commercial and test fish catches in the South Peninsula Post June fishery. Unlike the South Peninsula June fishery, northwestern Alaskan and Asian chum salmon were not a major component of test and commercial catches in the Post June fishery; instead the majority of fish harvested were bound for Alaska Peninsula and Kodiak Island spawning areas. We also used contribution estimates to gain an understanding of chum salmon migration through South Peninsula waters in June, July, and early August 1996. The results of this analysis showed a dramatic change in stock composition in this region through time from non-local to local stocks.

Local chum salmon were the major component of the commercial catches in the 1996 and 1997 Post June South Peninsula fishery. ALASKA PENINSULA/KODIAK ISLAND contributed over 80% to the Mainland fishery and approximately 60% to the Shumagin Islands fishery. The majority of the other chum salmon originated from Southeast Alaska and the Pacific Northwest.

Little variation in the catch composition of the Post June harvests was observed through the three time periods in either sampling years. However, catch composition was different between the two geographic areas sampled, Mainland Area and Shumagin Islands. More non-local chum salmon were harvested in the Shumagin Islands. Interestingly, there may be some variation in catch composition within the Mainland Area as well. In 1996, we estimated stock composition of chum salmon sampled from the most western portion of the Mainland Area

(Unimak District and Ikatan Bay Section of the Southwestern District) for the first two time periods in 1996. Fewer local chum salmon were observed in the samples from the western portion than the entire Mainland Area, with 25% of the samples originating from Southeast Alaska and the Pacific Northwest and 15% from Asia. No differences were observed between the stock composition estimates between the westerly area and the entire Mainland Area in the second period.

Stock composition estimates for the 1996 Shumagin Islands test fishery were very similar to the commercial fishery estimates. However, in 1997, Asian stocks made a large contribution to the test fish catches, approximately 29%. Although previous tagging studies indicate that mixtures of immature and maturing salmon sampled in the same area may have different compositions (for example, Wilmot et al. 1998; Urawa et al. 1999; Farley et al. 1999), differential proportions of immature fish in the test fish catches are not likely to be driving stock compositions between 1996 and 1997. Few immature chum salmon (<400mm) were observed in the test fish catches in either year (D. Gray, ADF&G, Anchorage; J. McCullough, ADF&G, Kodiak; personal communication). Differences in composition are more likely due to a change in abundance or a change in migration timing for Asian chum salmon.

Fall-run chum salmon in the Yukon River are one of the two groups of late spawning chum salmon that are genetically distinct from all other chum salmon in northwest Alaska (Wilmot et al. 1994; Seeb et al. 1997; Seeb and Crane 1999b). Estimates for fall-run chum salmon from the Yukon River were not significantly different from zero in the South Peninsula Post June test and commercial catches in 1996 and 1997. Rogers (1987), examining previous tagging studies, found that in June, fall Yukon chum salmon are more commonly found farther west and south in the Aleutian Islands. Based on rate of travel, Rogers (1987) suggested that fall

Yukon fish are more likely to be observed in the South Peninsula area later; however, data in this report do not support this hypothesis for the Post June fishery in 1996 and 1997.

We did observe a significant contribution of fall Yukon chum salmon in the South Unimak test fishery, June 13 and 14, 1996. Neave et al. (1976) reported a tag recovery of Yukon River chum salmon in July close to the Kamchatka coast. It may be that fall Yukon chum salmon may have slightly earlier migration timing than other western Alaskan stocks and migrate further west in the Bering Sea.

The 1996 time series study is interesting for two reasons. First, a dramatic change in stock composition was observed through time. Second, it is one of few studies that have examined changes in stock composition over time in a single geographic area. Chum salmon migrating through South Peninsula waters in June 1996 were mainly of western Alaskan origin, followed by chum salmon from Japan and Russia. A fairly abrupt change occurred in July, when most chum salmon originated from the Alaska Peninsula, Kodiak Island, or the eastern Gulf of Alaska and the Pacific Northwest.

These findings are concordant with previous tagging studies conducted off the South Alaska Peninsula. Recoveries of salmon tagged in June were made in western Alaska and Asia, while chum salmon tagged in July were more often recovered in local areas (Gilbert and Rich 1926; Thorsteinson and Merrell 1964; Eggers et al. 1991).

These data are similar to the model of chum salmon migration derived from high seas tagging studies (Neave et al. 1976) for Asian and western Alaskan stocks but contrasts for chum salmon from central Alaska, Southeast Alaska, British Columbia, and Washington. Historic tagging information demonstrated that chum salmon from western Alaska move rapidly from Gulf of Alaska to the Bering Sea in June. Asian stocks move from the Northern Pacific Ocean and Gulf of Alaska during this time as well and are also common in the eastern Aleutian Islands in summer. We found that chum salmon from western Alaska and Asia were abundant off the South Alaska Peninsula in June but not in July.

Neave et al. (1976) and Fredin et al. (1977) found that maturing chum salmon bound for central Alaska, Southeast Alaska, British Columbia, and Washington tend to move to the northern Gulf of Alaska after the majority of western Alaska chum salmon have migrated through. Further, they were not commonly found west of 155^{o}W, well east of the South Peninsula fishery. However, our stock composition estimates showed that chum salmon from these areas contributed up to 15% to the Mainland Area Post June fishery and 30% to the Shumagin Islands Post June fishery. Historic data suggest that chum salmon from North America spend most of their ocean life history in the Gulf of Alaska and are seldom found west of 180^{o}W (Neave et al. 1976). This again contrasts with more recent studies. Wilmot et al. (1998) found a substantial portion of immature chum salmon from western Alaska from chum salmon bycaught in the 1994 and 1995 Bering Sea “B” fishery for walleye pollock occurring from late August to early October. Further, large proportions of chum salmon originating from the Pacific Northwest were also found in this fishery through genetic analysis (Wilmot et al. 1998) and scale pattern analysis (Patton et al. 1998). Thermally marked chum salmon from Southeast Alaska and British Columbia were also recovered (Ignell et al. 1997). Ignell et al. (1997) suggested that the differences between these studies and the older tagging studies for chum salmon from the Pacific Northwest may be due either to decadal changes in the marine environment or changes in abundance. In either case, chum salmon migration patterns are dynamic.

CONCLUSION

We used genetic stock identification 1) to estimate the composition of chum salmon sampled from Post June South Peninsula fishery test and commercial catches in 1996 and 1997 and 2) to examine the migration pattern of chum salmon stocks through South Peninsula waters in 1996. The major component of chum salmon caught in the South Alaska Peninsula in July and August were ALASKA PENINSULA/KODIAK followed by chum salmon from the eastern Gulf of Alaska and the Pacific Northwest. This is a major shift in composition from chum salmon mixtures observed in June, where the predominant components are NORTHWEST ALASKA SUMMER and chum salmon from Asia.

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Table 1. Genetic sampling for chum salmon from South Peninsula Post June fisheries 1996 and 1997. Sampling was conducted from commercial catches delivered to processing facilities and from test fishing. "Mainland Area" refers to the Unimak District, Southwestern District, South Central District, and Southeastern District Mainland waters.

Year	Geographic Area	Catch Sample	Catch Subsample	Test fish Sample	Test fish Subsample
1996	Mainland Area	3,240	1200	0	0
	Shumagin Islands	2,260	1200	510	510
1997	Mainland Area	1,127	920	76	0
	Shumagin Islands	900	400	840	400

Table 2. Daily catch and number of samples analyzed for genetic analysis of chum salmon harvested in the Mainland Area (Unimak District, Southwestern District, and South Central District, and the Southeastern District Mainland) during the 1996 and 1997 South Peninsula Post June fishery. Number of fish analyzed is proportional to the daily catch in each district.

			Unimak District				Southwestern District				South Central District				Southeastern District-Mainland			
			Daily Catch		Fish Analyzed		Daily Catch		Fish Analyzed		Daily Catch		Fish Analyzed		Daily Catch		Fish Analyzed	
Year	Period	Date	N	Proportion	N	Proportion	N	Proportion	N	Proportion	N	Proportion	N	Proportion	N	Proportion	N	Proportion
1996	1	20-Jul	155	0.002	0	0.000	1,911	0.021	11	0.028	7,849	0.085	35	0.088	0	0.000	0	0.000
		21-Jul	191	0.002	0	0.000	3,275	0.036	19	0.048	21,420	0.233	97	0.243	1,022	0.011	0	0.000
		22-Jul	0	0.000	0	0.000	2,467	0.027	0	0.000	13,554	0.148	62	0.155	1,039	0.011	5	0.013
		23-Jul	0	0.000	0	0.000	21	0.000	0	0.000	1,369	0.015	6	0.015	2,007	0.022	9	0.023
		24-Jul	155	0.002	0	0.000	6,509	0.071	39	0.098	1,539	0.017	7	0.018	4,744	0.052	22	0.055
		25-Jul	634	0.007	6	0.015	2,965	0.032	0	0.000	2,902	0.032	14	0.035	1,897	0.021	8	0.020
		26-Jul	0	0.000	0	0.000	3,186	0.035	19	0.048	2,130	0.023	0	0.000	8,911	0.097	41	0.103
		Total	1,135		6		20,334		88		50,763		221		19,620		85	
	2	27-Jul	0	0.000	0	0.000	0	0.000	0	0.000	2,135	0.026	17	0.043	0	0.000	0	0.000
		28-Jul	0	0.000	0	0.000	5,719	0.069	27	0.068	3,395	0.041	26	0.065	7,750	0.093	37	0.093
		29-Jul	0	0.000	0	0.000	2,965	0.036	14	0.035	2,069	0.025	17	0.043	11,744	0.141	56	0.140
		30-Jul	0	0.000	0	0.000	5,167	0.062	25	0.063	43	0.001	0	0.000	3,625	0.043	17	0.043
		31-Jul	0	0.000	0	0.000	0	0.000	0	0.000	50	0.001	0	0.000	0	0.000	0	0.000
		01-Aug	0	0.000	0	0.000	12,054	0.144	58	0.145	5,133	0.062	0	0.000	0	0.000	0	0.000
		02-Aug	0	0.000	0	0.000	16,565	0.199	79	0.198	700	0.008	5	0.013	4,319	0.052	21	0.053
		Total	0		0		42,470		203		13,525		65		27,438		131	
	3	03-Aug	0	0.000	0	0.000	2,996	0.096	41	0.103	4,532	0.145	40	0.100	4,239	0.135	0	0.000
		04-Aug	0	0.000	0	0.000	1,453	0.046	20	0.050	327	0.010	12	0.030	0	0.000	0	0.000
		05-Aug	0	0.000	0	0.000	3,214	0.102	45	0.113	73	0.002	3	0.008	0	0.000	0	0.000
		06-Aug	0	0.000	0	0.000	4,434	0.141	61	0.153	0	0.000	0	0.000	984	0.031	0	0.000
		07-Aug	0	0.000	0	0.000	1,546	0.049	22	0.055	0	0.000	0	0.000	2,110	0.067	94	0.235
		08-Aug	0	0.000	0	0.000	293	0.009	4	0.010	120	0.004	6	0.015	0	0.000	0	0.000
		09-Aug	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
		10-Aug	0	0.000	0	0.000	4,921	0.157	47	0.118	120	0.004	5	0.013	0	0.000	0	0.000
		Total	0		0		18,857		240		5,172		66		7,333		94	

Table 2. Continued.

			Unimak District				Southwestern District				South Central District				Southeastern District Mainland			
			Daily Catch		Fish Analyzed		Daily Catch		Fish Analyzed		Daily Catch		Fish Analyzed		Daily Catch		Fish Analyzed	
Year	Period	Date	N	Proportion	N	Proportion	N	Proportion	N	Proportion	N	Proportion	N	Proportion	N	Proportion	N	Proportion
1997	1	20-Jul	0	0.000	0	0.000	845	0.044	18	0.045	565	0.030	12	0.030	238	0.012	20	0.050
		21-Jul	0	0.000	0	0.000	1,201	0.063	25	0.063	2,544	0.133	53	0.133	706	0.037	0	0.000
		22-Jul	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	433	0.023	35	0.088
		23-Jul	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	526	0.027	44	0.110
		24-Jul	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	995	0.052	53	0.133
		25-Jul	180	0.009	0	0.000	826	0.043	17	0.043	761	0.040	16	0.040	807	0.042	0	0.000
		26-Jul	277	0.014	0	0.000	1,136	0.059	24	0.060	1,121	0.059	23	0.058	5,973	0.312	50	0.125
		Total	457		0		4,008		84		4,991		104		9,678		202	
	2	27-Jul	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
		28-Jul	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
		29-Jul	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
		30-Jul	0	0.000	0	0.000	35	0.058	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
		31-Jul	0	0.000	0	0.000	104	0.171	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
		01-Aug	0	0.000	0	0.000	160	0.264	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
		02-Aug	0	0.000	0	0.000	308	0.507	120	1.000	0	0.000	0	0.000	0	0.000	0	0.000
		Total	0		0		607		120		0		0		0		0	
	3	03-Aug	0	0.000	0	0.000	178	0.019	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
		04-Aug	0	0.000	0	0.000	658	0.070	135*	0.338	680	0.072	0*	0.000	0	0.000	0	0.000
		05-Aug	0	0.000	0	0.000	1,096	0.117	0	0.000	97	0.010	0	0.000	0	0.000	0	0.000
		06-Aug	0	0.000	0	0.000	1,100	0.117	109*	0.273	251	0.027	0*	0.000	0	0.000	0	0.000
		07-Aug	0	0.000	0	0.000	1,221	0.130	0	0.000	263	0.028	0	0.000	0	0.000	0	0.000
		08-Aug	0	0.000	0	0.000	825	0.088	110	0.275	36	0.004	46	0.115	0	0.000	0	0.000
		09-Aug	0	0.000	0	0.000	1,510	0.161	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
		10-Aug	0	0.000	0	0.000	846	0.090	0	0.000	622	0.066	0	0.000	0	0.000	0	0.000
		Total	0		0		7,434		354		1,949		46		0		0	

*Fish were sampled from tender deliveries containing chum salmon harvested in both the Southwestern and South Central Districts.

Table 3. Daily catch and number of samples analyzed for genetic analysis of chum salmon harvested in the Shumagin Islands section during the 1996 and 1997 South Peninsula Post June fishery. Number of fish analyzed is proportional to the daily catch in each district. No chum salmon were harvested in 1997 Period 2 and 3 due to fisher strikes.

			Shumagin Islands			
			Daily Catch		Fish Analyzed	
Year	Period	Date	N	Proportion	N	Proportion
1996	1	20-Jul	14,295	0.180	72	0.180
		21-Jul	16,359	0.206	83	0.208
		22-Jul	13,240	0.167	67	0.170
		23-Jul	0	0.000	0	0.000
		24-Jul	0	0.000	0	0.000
		25-Jul	16,155	0.204	81	0.203
		26-Jul	19,259	0.243	97	0.243
		Total	79,308		400	
	2	27-Jul	0	0.000	0	0.000
		28-Jul	9,602	0.266	142	0.355
		29-Jul	11,079	0.307	150	0.375
		30-Jul	7,939	0.220	0	0.000
		31-Jul	0	0.000	0	0.000
		01-Aug	0	0.000	0	0.000
		02-Aug	7,497	0.208	108	0.270
		Total	36,117		400	
	3	03-Aug	11,345	0.630	100	0.250
		04-Aug	0	0.000	0	0.000
		05-Aug	0	0.000	0	0.000
		06-Aug	2,930	0.163	120	0.300
		07-Aug	3,734	0.207	180	0.450
		08-Aug	0	0.000	0	0.000
		09-Aug	0	0.000	0	0.000
		10-Aug	0	0.000	0	0.000
		Total	18,009		400	
1997	1	20-Jul	4,910	0.199	109	0.273
		21-Jul	12,107	0.492	150	0.375
		22-Jul	0	0.000	0	0.000
		23-Jul	0	0.000	0	0.000
		24-Jul	0	0.000	0	0.000
		25-Jul	1,856	0.075	41	0.103
		26-Jul	5,747	0.233	100	0.250
		Total	24,620		400	

Table 4. Estimated contributions of Pacific Rim chum salmon to test and commercial catches of chum salmon during the Post June fishery 1996 and 1997. Two sets of contribution estimates were made: one for fish harvested in the Mainland Area (Unimak District, Southwestern District, South Central District, and Southeastern District Mainland) in a.) 1996 and b.) 1997, and the Shumagin Islands in c.) 1996 and d.) 1997. The commercial fishery was divided into three time strata: (1) July 20-26, (2) July 27-August 2, and (3) August 3-10. The 1996 test fishery samples were collected between July 12 and July 18, and in 1997 between July 12 and July 19.

a.

	Mainland, 1996-1			Mainland, 1996-2			Mainland, 1996-3			Mainland, 1996-Annual		
		90% C.I.			90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
ASIA	0.07	0.03	0.12	0.01	0.00	0.06	0.01	0.00	0.06	0.04	0.02	0.07
JAPAN	0.02	0.00	0.05	0.01	0.00	0.03	0.00	0.00	0.02	0.01	0.00	0.03
CHINA/S RUSSIA	0.02	0.00	0.04	0.00	0.00	0.03	0.01	0.00	0.02	0.01	0.00	0.02
N RUSSIA	0.03	0.00	0.08	0.00	0.00	0.04	0.01	0.00	0.05	0.01	0.01	0.04
NW AK SUMMER	0.00	0.00	0.03	0.00	0.00	0.03	0.01	0.00	0.02	0.00	0.00	0.02
FALL YUKON	0.02	0.00	0.03	0.00	0.00	0.02	0.00	0.00	0.01	0.01	0.00	0.02
AK PEN/KODIAK	0.80	0.70	0.85	0.83	0.73	0.89	0.89	0.80	0.93	0.83	0.76	0.85
GULF OF AK/PAC NW	0.11	0.07	0.19	0.15	0.08	0.23	0.09	0.04	0.17	0.12	0.09	0.18
SUSITNA RIVER	0.00	0.00	0.02	0.00	0.00	0.02	0.01	0.00	0.02	0.00	0.00	0.01
PWS	0.01	0.00	0.04	0.02	0.00	0.06	0.06	0.00	0.09	0.02	0.01	0.04
SE AK/N BC	0.03	0.00	0.10	0.08	0.01	0.14	0.03	0.00	0.11	0.05	0.02	0.09
S BC/WASH	0.06	0.03	0.11	0.05	0.02	0.09	0.00	0.00	0.03	0.05	0.03	0.07

b.

	Shumagin, 1996-test fishery			Shumagin, 1996-1			Shumagin, 1996-2			Shumagin, 1996-3			Shumagin, 1996-Annual		
		90% C.I.			90% C.I.			90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
ASIA	0.09	0.06	0.17	0.06	0.04	0.12	0.06	0.03	0.12	0.04	0.01	0.08	0.06	0.04	0.10
JAPAN	0.05	0.02	0.08	0.03	0.01	0.05	0.03	0.01	0.06	0.01	0.00	0.04	0.03	0.01	0.04
CHINA/S RUSSIA	0.00	0.00	0.02	0.02	0.00	0.05	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.03
N RUSSIA	0.04	0.01	0.11	0.01	0.00	0.06	0.03	0.00	0.09	0.03	0.00	0.06	0.01	0.01	0.05
NW AK SUMMER	0.04	0.02	0.08	0.07	0.03	0.10	0.02	0.00	0.04	0.03	0.00	0.05	0.05	0.02	0.06
FALL YUKON	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.02	0.01	0.00	0.02	0.00	0.00	0.01
AK PEN/KODIAK	0.54	0.44	0.61	0.60	0.48	0.66	0.57	0.49	0.68	0.65	0.55	0.73	0.60	0.53	0.65
GULF OF AK/PAC NW	0.31	0.24	0.39	0.27	0.21	0.37	0.34	0.23	0.42	0.28	0.21	0.37	0.29	0.24	0.35
SUSITNA RIVER	0.02	0.00	0.04	0.00	0.00	0.02	0.02	0.00	0.04	0.01	0.00	0.04	0.01	0.00	0.02
PWS	0.06	0.01	0.10	0.03	0.00	0.10	0.06	0.00	0.12	0.04	0.01	0.11	0.04	0.01	0.08
SE AK/N BC	0.09	0.04	0.17	0.09	0.02	0.18	0.11	0.03	0.20	0.06	0.00	0.14	0.09	0.04	0.15
S BC/WASH	0.15	0.10	0.20	0.15	0.09	0.22	0.14	0.08	0.21	0.16	0.10	0.22	0.15	0.11	0.20

Table 4. Continued.

c.

	Mainland, 1997-1			Mainland, 1997-2			Mainland, 1997-3			Mainland, 1997-Annual		
		90% C.I.			90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
ASIA	0.03	0.00	0.10	0.00	0.00	0.04	0.03	0.01	0.09	0.07	0.05	0.12
JAPAN	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.04	0.00	0.00	0.01
CHINA/S RUSSIA	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.01
N RUSSIA	0.03	0.00	0.10	0.00	0.00	0.02	0.01	0.00	0.06	0.02	0.00	0.07
NW AK SUMMER	0.00	0.00	0.03	0.00	0.00	0.04	0.02	0.00	0.04	0.01	0.00	0.03
FALL YUKON	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AK PEN/KODIAK	0.82	0.68	0.88	0.89	0.77	0.97	0.92	0.81	0.95	0.85	0.75	0.88
GULF OF AK/PAC NW	0.15	0.09	0.25	0.11	0.02	0.21	0.04	0.00	0.12	0.15	0.12	0.21
SUSITNA RIVER	0.02	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.03
PWS	0.00	0.00	0.05	0.07	0.00	0.14	0.00	0.00	0.03	0.00	0.00	0.04
SE AK/N BC	0.08	0.02	0.17	0.00	0.00	0.06	0.04	0.00	0.11	0.06	0.02	0.13
S BC/WASH	0.05	0.01	0.09	0.03	0.00	0.09	0.00	0.00	0.02	0.03	0.01	0.06

d.

	Shumagin, 1997-test fishery			Shumagin, 1997-1			Shumagin, 1997-Annual		
		90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
ASIA	0.40	0.31	0.46	0.13	0.06	0.19	0.13	0.06	0.19
JAPAN	0.25	0.18	0.29	0.06	0.02	0.09	0.06	0.02	0.09
CHINA/S RUSSIA	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.01
N RUSSIA	0.14	0.07	0.21	0.07	0.01	0.12	0.07	0.01	0.12
NW AK SUMMER	0.08	0.05	0.17	0.00	0.00	0.04	0.00	0.00	0.04
FALL YUKON	0.02	0.00	0.04	0.00	0.00	0.01	0.00	0.00	0.01
AK PEN/KODIAK	0.32	0.24	0.42	0.68	0.58	0.75	0.68	0.58	0.75
GULF OF AK/PAC NW	0.19	0.09	0.23	0.19	0.13	0.28	0.19	0.13	0.28
SUSITNA RIVER	0.04	0.00	0.06	0.05	0.02	0.08	0.05	0.02	0.08
PWS	0.05	0.00	0.08	0.06	0.03	0.11	0.06	0.03	0.11
SE AK/N BC	0.09	0.03	0.14	0.03	0.00	0.10	0.03	0.00	0.10
S BC/WASH	0.01	0.00	0.04	0.05	0.01	0.09	0.05	0.01	0.09

Table 5. Estimated contributions of Pacific Rim chum salmon to fishery catches of chum salmon in June 1996. Two sets of contribution estimates were made, one for fish harvested off a.) South Unimak Island and b.) the Shumagin Islands. Commercial catch estimates are from Seeb et al. (1997).

a.

	S Unimak, June 12-13 test fishery			S Unimak, June 15-20 commercial fishery			S Unimak, June 21-25 commercial fishery			S Unimak, June 26-30 commercial fishery		
		90% C.I.			90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
ASIA	0.26	0.17	0.33	0.26	0.20	0.34	0.24	0.18	0.34	0.19	0.12	0.27
JAPAN	0.12	0.06	0.19	0.16	0.11	0.22	0.18	0.12	0.22	0.11	0.07	0.16
CHINA/S RUSSIA	0.07	0.01	0.11	0.02	0.00	0.05	0.01	0.00	0.03	0.01	0.00	0.04
N RUSSIA	0.07	0.01	0.13	0.08	0.02	0.14	0.05	0.02	0.14	0.07	0.02	0.14
NW AK SUMMER	0.45	0.34	0.55	0.42	0.34	0.50	0.44	0.33	0.52	0.33	0.22	0.38
FALL YUKON	0.10	0.03	0.18	0.06	0.00	0.10	0.05	0.00	0.10	0.03	0.00	0.09
AK PEN/KODIAK	0.09	0.04	0.17	0.12	0.08	0.20	0.14	0.09	0.21	0.31	0.23	0.38
GULF OF AK/PAC NW	0.10	0.05	0.16	0.14	0.07	0.17	0.13	0.07	0.17	0.14	0.10	0.23
SUSITNA RIVER	0.00	0.00	0.05	0.00	0.00	0.01	0.02	0.00	0.04	0.01	0.00	0.05
PWS	0.01	0.00	0.04	0.00	0.00	0.02	0.01	0.00	0.03	0.02	0.00	0.06
SE AK/N BC	0.05	0.00	0.09	0.12	0.04	0.14	0.07	0.01	0.10	0.06	0.02	0.12
S BC/WASH	0.03	0.00	0.07	0.02	0.00	0.05	0.03	0.01	0.07	0.06	0.02	0.10

b.

	Shumagin, 6/5-10 test fishery			Shumagin, June 11-16 test fishery			Shumagin, June 18-20 commercial fishery			Shumagin, June 21-25 commercial fishery			Shumagin, June 26-30 commercial fishery		
		90% C.I.			90% C.I.			90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
ASIA	0.15	0.09	0.20	0.12	0.08	0.19	0.21	0.15	0.28	0.41	0.32	0.47	0.32	0.23	0.40
JAPAN	0.08	0.03	0.11	0.10	0.06	0.14	0.19	0.11	0.24	0.28	0.21	0.33	0.19	0.12	0.24
CHINA/S RUSSIA	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.04	0.01	0.00	0.04	0.00	0.00	0.02
N RUSSIA	0.06	0.02	0.13	0.02	0.00	0.06	0.02	0.00	0.07	0.11	0.05	0.16	0.13	0.07	0.20
NW AK SUMMER	0.70	0.62	0.75	0.67	0.58	0.72	0.51	0.41	0.56	0.30	0.24	0.38	0.29	0.21	0.37
FALL YUKON	0.00	0.00	0.03	0.01	0.00	0.06	0.00	0.00	0.05	0.03	0.00	0.07	0.02	0.00	0.06
AK PEN/KODIAK	0.10	0.06	0.16	0.11	0.07	0.17	0.19	0.13	0.26	0.17	0.10	0.22	0.23	0.16	0.30
GULF OF AK/PAC NW	0.06	0.02	0.09	0.08	0.04	0.13	0.10	0.06	0.14	0.09	0.05	0.16	0.14	0.09	0.19
SUSITNA RIVER	0.01	0.00	0.03	0.01	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.03
PWS	0.01	0.00	0.03	0.02	0.00	0.05	0.01	0.00	0.03	0.02	0.00	0.05	0.01	0.00	0.02
SE AK/N BC	0.04	0.00	0.05	0.02	0.00	0.05	0.04	0.00	0.08	0.06	0.02	0.10	0.05	0.01	0.09
S BC/WASH	0.00	0.00	0.02	0.02	0.00	0.06	0.05	0.01	0.08	0.02	0.00	0.05	0.07	0.04	0.12

OFFICE OF EQUAL OPPORTUNITY (OEO) STATEMENT

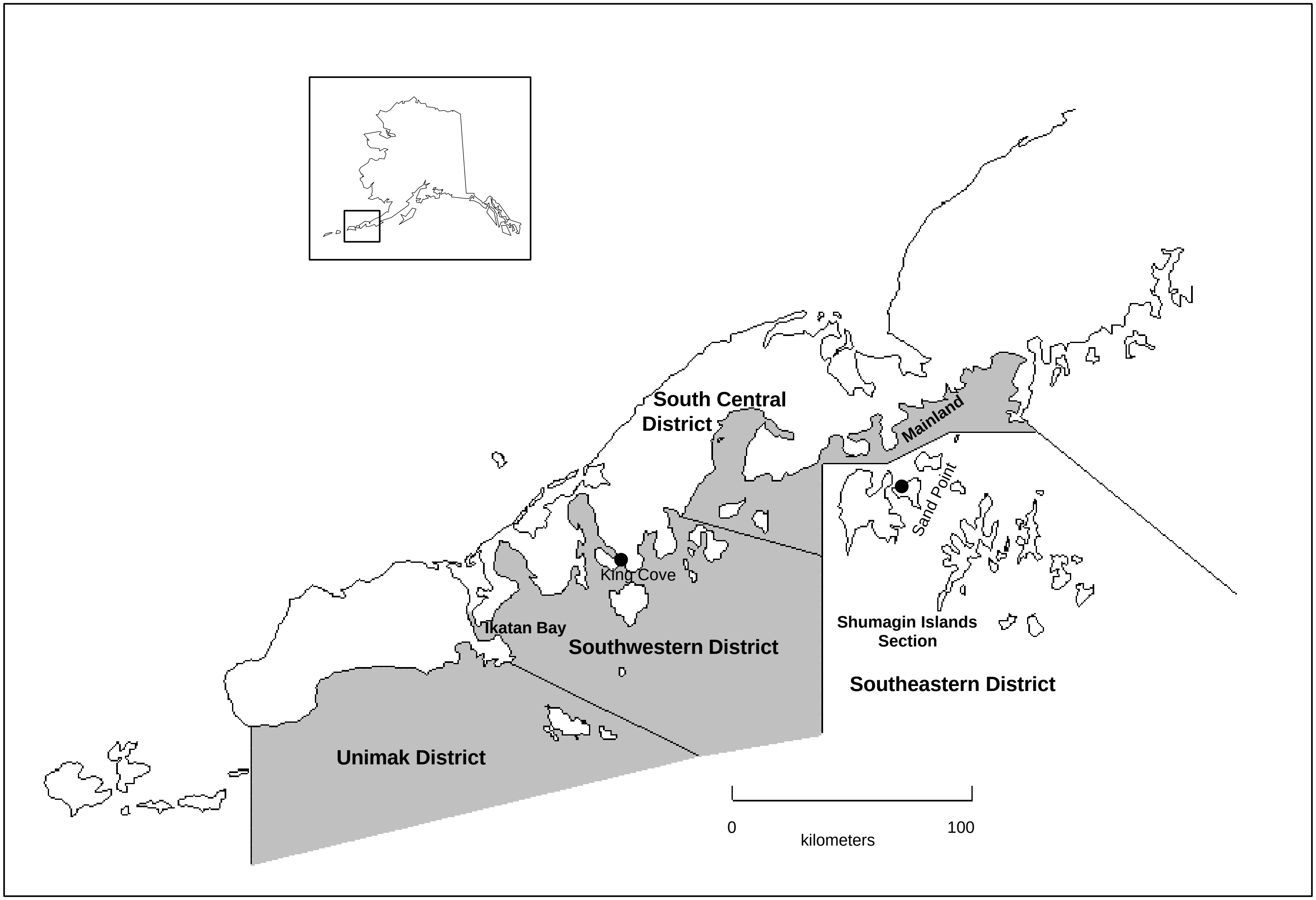

Figure 1. Map of South Alaska Peninsula fishery management districts. Stock composition of chum salmon harvested during the Post June Fishery in the Shumagin Islands section of the Southeastern District and the Mainland Area (management areas shaded in gray) are provided in this report.

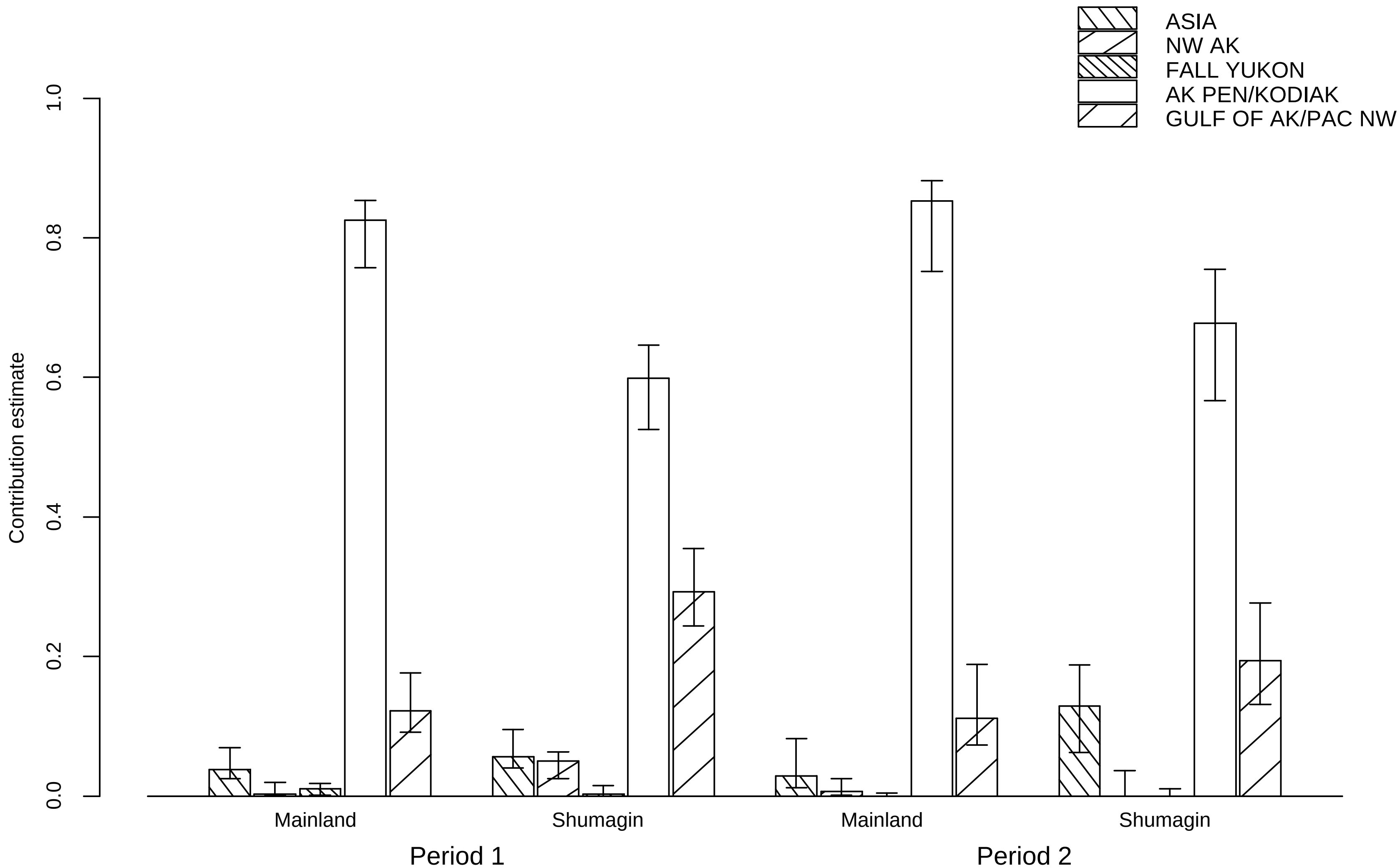

Figure 2. Annual contribution estimates and 90% confidence intervals for the Mainland and Shumagin Islands areas of the South Peninsula Post June fishery, 1996 and 1997. Averages were computed from individual period estimates weighted by catch size for that period. Reporting groups were pooled for readability: ASIA (JAPAN, CHINA/SOUTHERN RUSSIA, NORTHERN RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON).

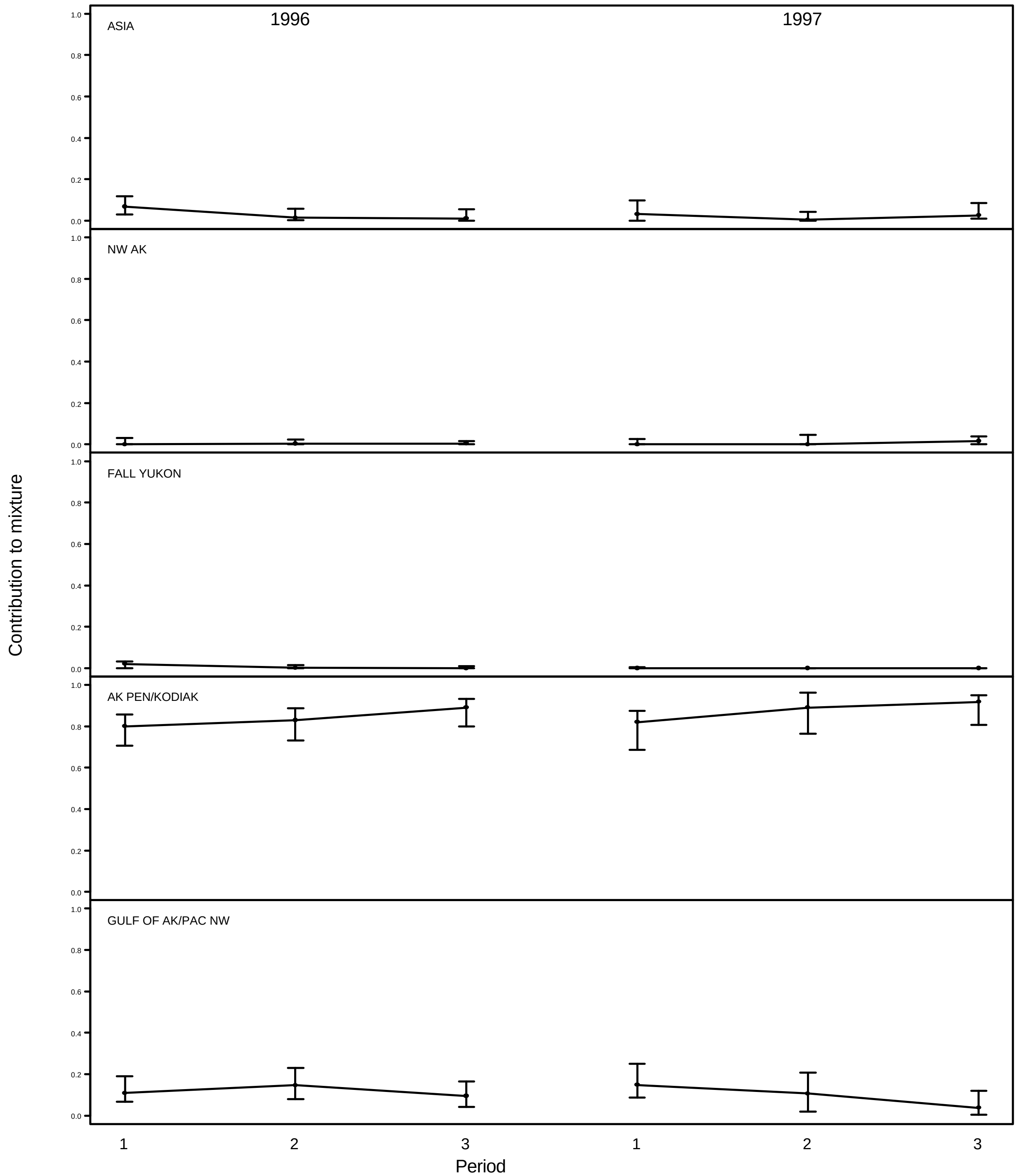

Figure 3. Contribution estimates by period and 90 % confidence intervals for the Mainland Area Post June fishery, 1996 and 1997. Reporting groups were pooled for readability: ASIA (JAPAN, CHINA/SOUTHERN RUSSIA, NORTHERN RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/ PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/ WASHINGTON).

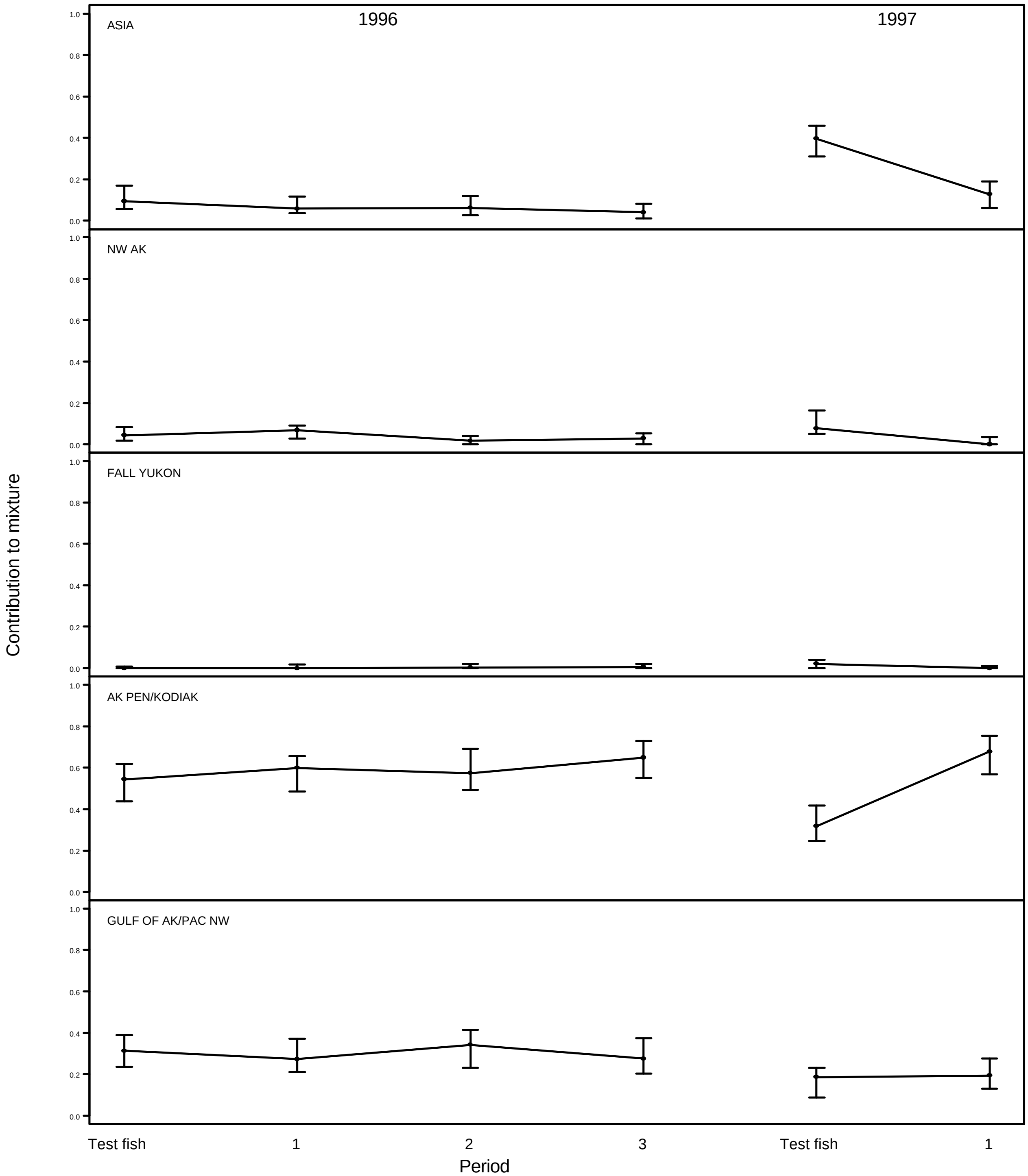

Figure 4. Contribution estimates by period and 90% confidence intervals for the Shumagin Islands Post June fishery, 1996 and 1997. Reporting groups were pooled for readability: ASIA (JAPAN, CHINA/SOUTHERN RUSSIA, NORTHERN RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON).

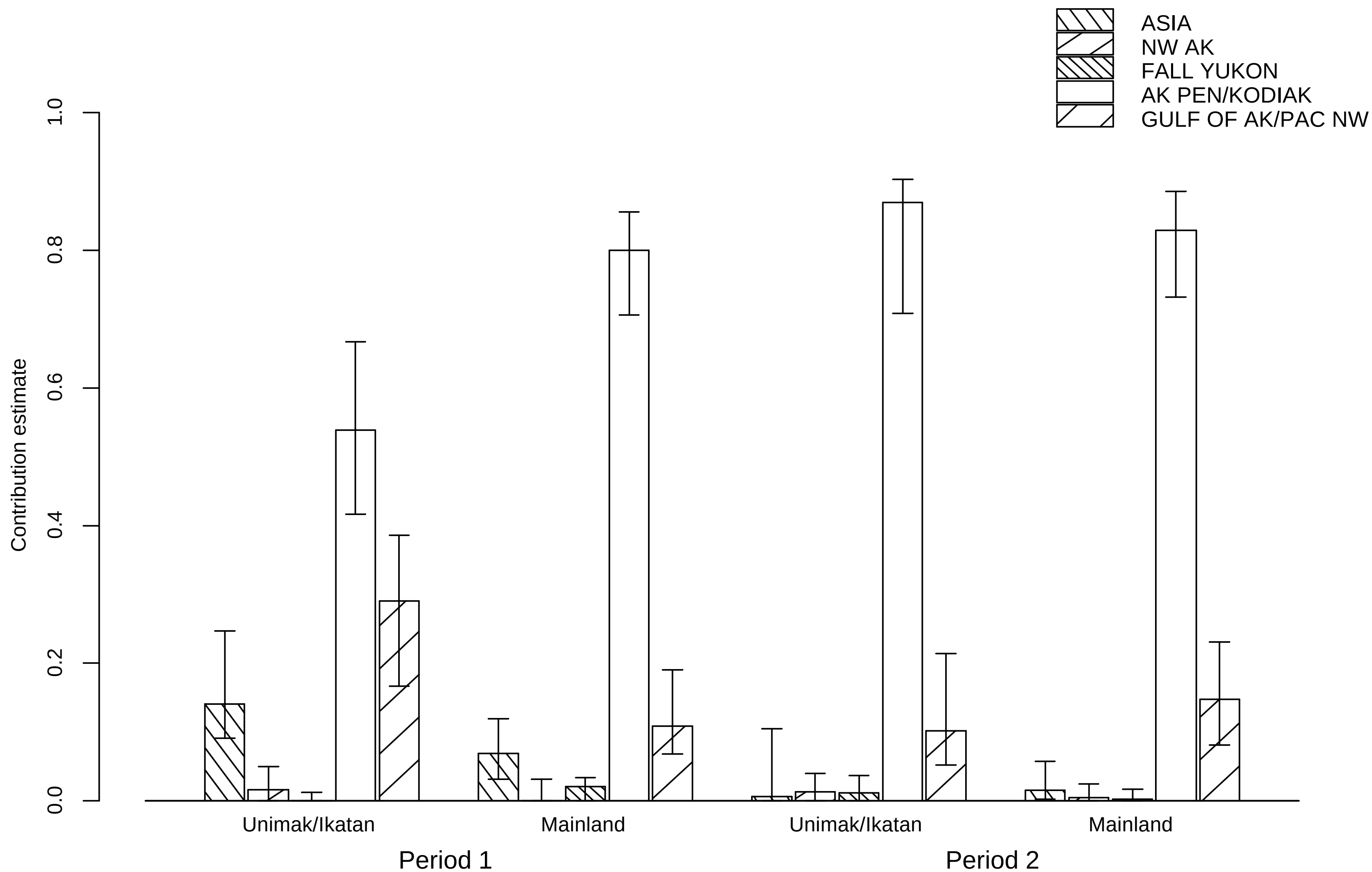

Figure 5. Contribution estimates and 90% confidence intervals for Unimak District/Southwestern District-Ikatan Bay section and the entire Mainland Area for 1996, Period 1 and 2, to determine if differences exist in overall stock composition for these areas. Reporting groups were pooled for readability: ASIA (JAPAN, CHINA/SOUTHERN RUSSIA, NORTHERN RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/ PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON).

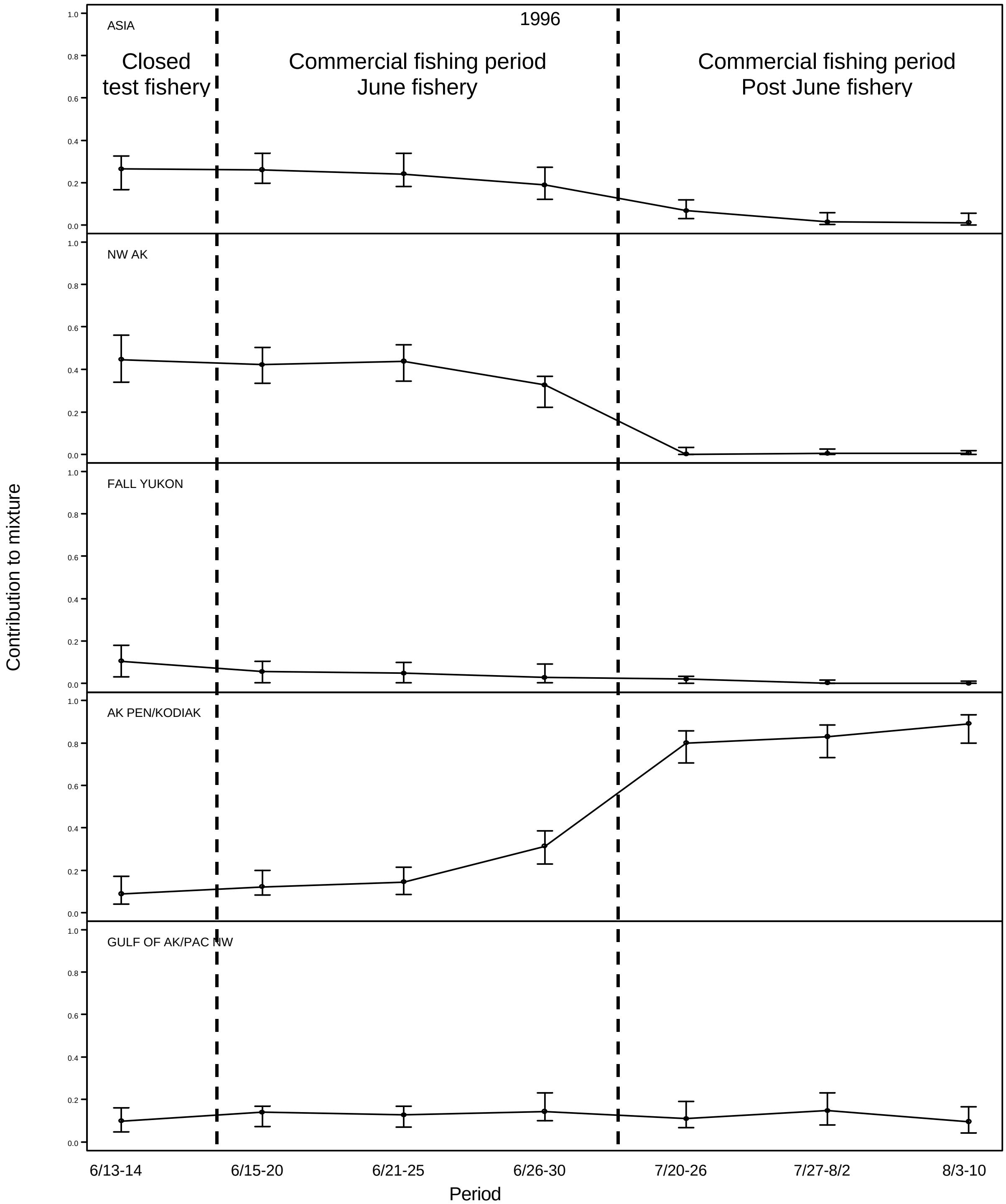

Figure 6. Contribution estimates and 90% confidence intervals for test and commercial catches made in South Alaska Peninsula, excluding the Shumagin Islands, for seven time periods from June to early August 1996. Reporting groups were pooled for readability: ASIA (JAPAN, CHINA/ SOUTHERN RUSSIA, NORTHERN RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/ PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/ WASHINGTON).

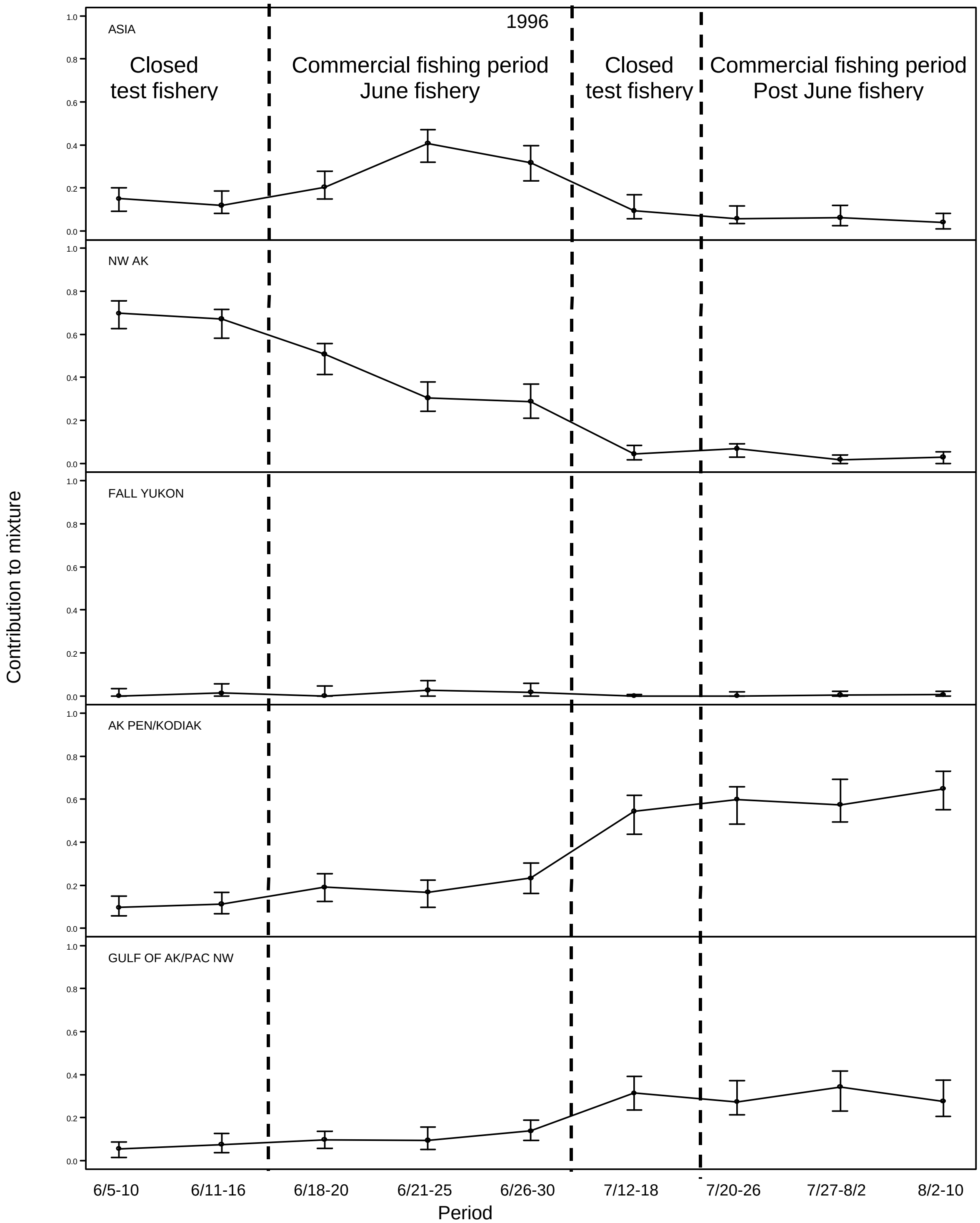

Figure 7. Contribution estimates and 90% confidence intervals for test and commercial catches made in the Shumagin Islands for nine time periods from June to early August 1996. Reporting groups were pooled for readability: ASIA (JAPAN, CHINA/SOUTHERN RUSSIA, NORTHERN RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON).