



NOAA Technical Memorandum NMFS-AFSC-18

Adult Sockeye and Pink Salmon Tagging Experiments for Separating Stocks in Northern British Columbia and Southern Southeast Alaska, 1982-1985

by

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U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary
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August 1993

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ABSTRACT

Adult sockeye (*Oncorhynchus nerka*) and pink (*O. gorbuscha*) salmon were-captured, tagged, and released in coastal fisheries of southern Southeast Alaska and northern British Columbia between 1982 and 1985. Sockeye salmon were tagged in 1982 and 1983; pink salmon were tagged in 1982, 1984, and 1985. The tagging experiments were part of a cooperative effort by the United States and Canada to assess contributions of stocks of each country to fisheries of the region and to learn about the coastal migrations of these salmon.

Catches and escapements in Alaska and Canada were sampled for the purpose of estimating numbers of tagged fish that either were caught among or escaped to contributing stocks. Estimated numbers of tagged fish in catches and escapements were used to assess stock composition of catches of the fisheries during the tagging years.

Most sockeye salmon in Alaskan fisheries were of Canadian origin, and only a small percentage of the catch in Canada was of Alaskan origin. Alaskan sockeye salmon were relatively more numerous in 1982 than in 1983, compared to Canadian stocks of those years. Sockeye salmon from the Canadian Nass and Skeena Rivers constituted major portions of catches of most fisheries. In 1983, southward-migrating stocks, probably mainly from Canada's Fraser River, occurred in outer coastal fisheries of Alaska and Canada, and in Canadian fisheries at the southern end of the study area..

Most pink salmon in nearly all Alaskan fisheries throughout the season were of Alaskan origin. Only in two of nine Alaskan fishing areas examined did the percentage from Alaskan stocks drop below 75% at times. Percentage of Alaskan pink salmon in Canadian fisheries was also substantial but more variable among areas and years of tagging than in Alaska. In Canada, percentage of Alaskan pink salmon was generally greatest in areas adjoining Alaska.

The interpretation of the experiments for assessing stock composition in fisheries was fraught with difficulties. Among the shortcomings were large potential errors in estimates of numbers of tagged fish escaping to the spawning grounds. However, numerical studies showed that stock-composition estimates for sockeye or pink salmon would generally not be misleading because of such errors. Lack of information on stock origin of tagged fish caught in intervening fisheries and the apparent incomplete accounting for tagged fish in sampled catches and escapements were further deficiencies whose potential effects on stock-composition estimates were not examined.

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INTRODUCTION

Joint U.S.-Canada salmon research in the international boundary area off the coasts of southern Southeast Alaska and northern British Columbia has emphasized development and application of stock-separation techniques for resolving salmon-interception issues and improving management of Pacific salmon resources of the region. A major component of these studies was a sockeye (*Oncorhynchus nerka*) and pink (*O. gorbuscha*) salmon-tagging project, coupled with incidental tagging of chum salmon (*O. keta*), conducted from 1982 through 1985. Sockeye salmon were tagged in 1982 and 1983. Pink salmon were tagged in 1982, 1984, and 1985. Each year, tagging was conducted simultaneously in fisheries of southern Southeast Alaska and northern British Columbia by the Alaska Department of Fish and Game (ADF&G), contracted by the National Marine Fisheries Service, and by LGL Limited, Environmental Research Associates, Sidney, B.C., contracted by the Canada Department of Fisheries and Oceans. The immediate purpose of tagging was to provide estimates of stock composition in Alaskan and Canadian fisheries of the international boundary area, for assessing numbers of fish from each country intercepted in fisheries of the other nation. In addition, tagging provided information on the coastal migrations of salmon useful for managing fisheries of the region. This report describes each tagging experiment and the assessment of stock composition in the boundary fisheries. The Glossary at the end defines terms that may be unfamiliar.

METHODS

Purse-seine, gill-net, and troll vessels similar to those used in a commercial fishery in a given area were chartered to capture adult pink and sockeye salmon. The salmon were caught, tagged, and released throughout the season in locations within southern Southeast Alaska fisheries of Sumner Strait, Clarence Strait, Tree Point, Cordova Bay, Noyes Island, and Dall Island (Fig. 1). Similar fishing and tagging operations occurred within northern British Columbia fisheries of Dixon Entrance, Hecate Strait, and Portland Inlet. These operations in the coastal fisheries were termed *primary taggings* to distinguish them from subsequent *secondary taggings* conducted on fish which had escaped these fisheries. Methods for *secondary taggings* will be discussed later.

Petersen disk tags, used during the 1982 and 1983 field seasons, were replaced by spaghetti tags in 1984 and 1985 because fish with Petersen disk tags were probably more vulnerable to fishing gear, disk tags easily fouled in commercial nets, and ancillary studies indicated equal or higher recovery rates of spaghetti tags over disk tags (English et al. 1984). Greater numbers of tagged fish escaping the fisheries would result in better estimates of stock composition for the release fisheries. Both tag types were colored the highly-visible international orange, uniformly labeled with instructions for return, and numbered serially.

Tag-recovery efforts were directed toward both spawning grounds and commercial fisheries to determine numbers and places where tagged fish released from each fishery were caught or escaped to spawning grounds. Tags were recovered from commercial fisheries through wide-scale port-sampling programs in both Southeast Alaska and British Columbia. For each fishing area, information obtained included estimates of numbers of fish caught, numbers examined for tags, and tag identification numbers. Substantial proportions of catches of each fishery were examined for tags, and estimates of total number of tagged fish caught from any release in any fishery were obtained by simple expansion of numbers of tags observed (to account for the unexamined catch).

As with the commercial catches, the number of tagged fish in the spawning escapements of either country could not be directly counted. Instead, these numbers were estimated for both sockeye and pink salmon by examination of portions of escapements for tagged fish and appropriate expansion of the numbers of tags recovered to account for the unexamined escapements. Procedures differed between countries and species. In all cases, recovery of tagged fish in escapements was accomplished at weirs across streams, from spawning-ground foot surveys, or from fisheries in terminal areas where stock origins were evident.

In Canada, both tagged sockeye and pink salmon were recovered at weirs. However, not all Canadian weirs were operated each year of the tagging experiments.

The largest populations of sockeye salmon in the boundary area occur in Canada in the drainages of Nass and Skeena Rivers. Weirs near Babine Lake (Skeena) and Meziadin Lake (Nass) allowed enumeration of major portions of escapements to these rivers and capture of tagged fish. To recover additional tagged sockeye salmon, Canada established weirs on the following less-important lake systems in northern British Columbia: Tahltan Lake (Stikine River drainage), Devon Lake, Bonilla Lake, and Eden Lake.

Canada could not examine escapements to many sockeye salmon grounds south of the boundary area that potentially contained tagged fish; outlet rivers from these grounds occur along the central and southern Canadian coasts and Vancouver Island coastline. Monitoring some catches from southern British Columbia, however, partially covered these stocks and recovered tagged fish which otherwise would have been missed.

A weir intended primarily to recover tagged pink salmon was placed on the Yakoun River of the Queen Charlotte Islands in northern British Columbia. Escapement sampling from weirs in Canada is described later under individual experiments.

Weirs were used in Southeast Alaska to recover tagged sockeye salmon, but none were built to recover pink salmon. When the tagging program was planned, sockeye salmon stocks of northern Southeast Alaska were not thought to contribute significantly to boundary-area fisheries. The Chilkat and Chilkoot Rivers are the major sockeye salmon systems of northern Southeast Alaska, and the ADF&G routinely operates weirs on both rivers to obtain management information. During the 1982 and 1983 tagging years, combined escapements to these two rivers equaled at least 50% of that estimated for all of southern Southeast Alaska, yet only a few tagged sockeye salmon from releases in the boundary-area fisheries were observed at these weirs and only one tag was recovered. Therefore, the initial supposition that the main Alaskan stocks involved in the boundary-area fisheries were from southern Southeast Alaska appears correct.

Southern Southeast Alaska has numerous sockeye salmon systems, though none with escapements of the magnitude of Canada's Nass or Skeena Rivers. Only part (roughly one-third to one-half) of the total escapement of sockeye salmon to southern Southeast Alaska could be examined for tags at weirs. The weirs were located mainly on lake systems that were large

'S. A. McPherson, fishery biologist, ADF&G, Region 1, P.O. Box 240020, Douglas, AK 99824-0020, pers. commun.

producers of sockeye salmon, including Hugh Smith Lake, McDonald Lake, Naha River, Kegan Lake, Karta Lake, Sarkar Lake, Hetta Lake, Klakas Lake, Klawock Lake, Salmon Bay Lake, Chuck Lake, and Tamgas Lake. As in Canada, not all weirs were operated in both years of sockeye salmon tagging. Details are in Pella et al. (1988) and are summarized later under individual experiments.

Spawning-ground foot surveys were also used to recover tagged salmon in both countries. During the pink salmon taggings, regular surveys were conducted on 316-388 streams in Alaska and 20-60 streams in British Columbia, depending on tagging year. Tagged sockeye salmon were also sought during foot surveys on 13-17 lake systems in Southeast Alaska and within the Skeena, Nass, and Fraser Rivers in British Columbia. Numbers of tagged fish recovered during foot surveys were expanded to account for numbers in the portions of escapements not examined.

Recovery of primary-tagged fish entering the Nass and Skeena Rivers was expected to be incomplete. Unmonitored subsistence fishing occurred within the rivers. Shedding of tags and mortality of tagged fish seemed likely because of the great distances (240 km on the Nass River and 480 km on the Skeena River) fish migrated to the weirs. Tagged fish on spawning grounds within the river systems not covered by the weirs might be missed by foot survey crews or even migrate to unsurveyed spawning grounds.

Secondary, riverine tagging experiments (as opposed to primary-tagging in the coastal fisheries) on sockeye salmon were performed in the Nass and Skeena Rivers to develop expansions for recoveries at the weirs and from foot surveys to estimate total numbers of tagged entrants to the rivers. Proportions of primary-tagged entrants recovered in the rivers were estimated by the known proportions of secondary-tagged fish recovered at the weirs and from foot surveys. A basic assumption in this procedure was that the expected percentage of primary-tagged entrants recovered equaled that of the secondary-tagged fish. This assumption will be scrutinized and effects of alternative assumptions on analyses of the tagging experiments will be determined.

In Alaska, secondary taggings were also conducted on several sockeye salmon stocks in both 1982 and 1983 (Pella et al. 1988) to estimate total escapement to systems without weirs by expanding their estimated average escapement per system by the number of such systems. Such estimates of total escapement could then be used to expand tag recoveries at weirs for those missed in systems without weirs. The estimated average escapement per system was determined for a sample of systems without weirs from a combination of Petersen tagging experiments adjusted for mortality of tagged fish and foot-survey counts expanded to account for unobserved fish.

The estimate of total escapement of sockeye salmon to various ADF&G statistical areas of southern Southeast Alaska was the sum of the known escapements to systems with weirs and the estimated escapements to systems without weirs. Finally, numbers of tagged fish recovered at weirs were expanded to estimate total numbers of tagged fish for all systems of a statistical area. The expansion was based on the assumption that the expected recovery percentage of tagged fish from all escapements to the statistical area equaled the percentage of its total escapement covered by the weirs. Riverine tag loss in advance of the weirs was considered negligible because outlet streams were short; maximum distance to any weir was 1 km or less.

Secondary tagging of pink salmon was also conducted in a number of Alaskan streams in 1982, but the practice was abandoned when large numbers of tagged fish were observed to migrate from the intertidal tagging locations of target streams to other streams (Jones and Thomason 1983). Usefulness of secondary tagging of Alaskan pink salmon stocks was questionable in view of the observed migration patterns of these fish.

Secondary tagging of pink salmon was also conducted on a number of Canadian stocks subsequent to fish reaching their natal streams. These fish were tagged to estimate percentages of primary-tagged entrants to the streams that were unobserved for whatever reason (e.g., tag shedding, mortality, capture in unmonitored native food fisheries, or limited examination of spawning escapements), so that counts of primary-tagged fish could be expanded to estimate total numbers escaping to the spawning grounds. Canada studied major escapements of the Skeena, Kwinamass, Khutzeymateen, and Yakoun Rivers. In the Skeena and Yakoun Rivers, fish to be tagged were captured within the rivers. Tagging was conducted at the mouth of the Kwinamass and Khutzeymateen Rivers. Numbers of secondary-tagged pink salmon that strayed and which were either caught in fisheries or detected in other escapements were estimated, and corresponding numbers initially released were reduced by these estimates before the percentages recovered in the Canadian escapements were computed.

Finally, the ADF&G estimated pink salmon escapements to southern Southeast Alaska. Counts from repeated aerial surveys of escapements to most of the significant stocks in Southeast Alaska are obtained each year as part of the routine fisheries-management program. The maximum of such counts from a stream was expanded by a factor to estimate total escapement (Hoffman et al. 1984). Similarly, Canadian fishery

officers on foot surveys counted pink salmon escapements in northern British Columbia. These counts were also adjusted to estimate total escapement'.

³K. English, LGL Limited, Environmental Research Associates, 9768 Second St., Sidney, B.C. V8L-4P8, Canada, pers. commun.

ASSUMPTIONS, DATA ANALYSIS, AND LIMITATIONS

Assumptions

Two assumptions are fundamental in the use of primary tagging to determine stock composition and numbers of salmon intercepted in fisheries of the boundary area. First, representative samples of stocks comprising the mixtures in fisheries must be tagged. In this study, the number of tagging vessels necessarily was small compared to those of the commercial fisheries because of costs of employing crews and vessels. Undoubtedly, coverage of fisheries in time and space was restricted, so stock composition of fish actually tagged probably deviated from that of the catch in the fisheries. However, limited coverage would not bias -estimated stock composition in fisheries in the sense that abundances of certain stocks would be consistently overestimated or underestimated during their time of passage through the fisheries.

Second, migratory behavior must not be severely affected by tagging. If migration routes or destinations were altered by tagging, results of the experiments could not be easily extrapolated to the salmon stocks of the region. Comparison of scale features of tagged and untagged fish in escapements of these studies showed no evidence of pronounced altering of destinations due to tagging (Oliver and Walls 1985). Migration may be delayed for a period of some days to several weeks after tagging, judging from results of freshwater tagging of sockeye salmon (Greenough 1971). Bevan (1962) observed that movements of many of the sockeye salmon tagged in the coastal fishery of Kodiak Island were probably reduced for about 48 hours after tagging. If recovery of normal movement for most tagged fish occurs within a few days, the effect on stock-composition estimates would probably be unimportant. Our assumption is that choices of routes and destinations were unaffected by tagging.

Data Analysis

Primary tagging of returning adult salmon to determine stock composition in interceptive fisheries relied on
1) release of tagged fish in the fisheries of concern, and
2) enumeration of these fish, or estimation of their numbers, when their stock origins became evident. Relative numbers of tagged fish of a release belonging to each stock contributing to the interceptive fishery would then provide the estimates of stock composition in that fishery. However, although

⁴J. Eiler, Auke Bay Laboratory, National Marine Fisheries Service, NOAA, 11305 Glacier Hwy., Juneau, AK 99801-8626, pers. commun., September 1989.

recovery of tagged fish in escapements and some catches provided clear evidence of stock origins, substantial numbers were recovered in subsequent catches of other interceptive fisheries; hence, stock origins of these fish remained unknown. (Had the stock origins of the tagged fish been evident in the interceptive fisheries, stock composition in the release fishery would have simply and correctly been estimated by relative numbers from the contributing stocks occurring in combined catches and escapements.) Importantly, even though the stock origins were unknown, the recoveries could not be ignored.

Stock composition of the survivors of any group of tagged salmon released in a fishery was probably altered by intervening fisheries as the individuals migrated toward their various spawning streams. In particular, tagged fish of Canadian stocks released from an Alaskan fishery, such as Noyes Island, encountered intervening fisheries of both British Columbia and Alaska; however, Alaskan fish of the release mainly encountered Alaskan fisheries. On the other hand, tagged fish of Alaskan stocks released from a Canadian fishery, such as area 4 in Hecate Strait, encountered fisheries of both Canada and Alaska; however, Canadian fish of the release encountered mainly Canadian fisheries. The proportions caught of the various stocks comprising the initial release group would differ. As a result, the relative numbers in escapements to the stocks comprising the release group were not the same as they were at the time of release in the original fishery. To correct stock composition based on only relative numbers in escapements, the number of tagged fish subsequently caught in intervening fisheries was allocated to stocks and combined with tagged fish in escapements.

The correction for tagged fish caught in intervening fisheries omits tags shed by fish during encounters with fishing gear. Petersen disk tags were probably more likely than spaghetti tags to be shed by entanglement in nets, and such shedding would also alter stock composition of surviving tagged fish as they migrated to their spawning grounds. Substantial percentages of tagged fish of each experiment were not accounted for by catches and escapements; presumably some of the missing tagged fish had shed their tags. Information for estimating numbers of tags shed during the experiments was not obtained.

The procedure by which recovered tags in catches were allocated to stocks was described by Gazey (1983). The proportion of recoveries from primary tagging in any fishing area destined for any stock (this is the estimate of that stock's unknown actual proportion in the release fishery) was computed as that stock's proportion of the total recoveries from the primary-tagged release group; these recoveries were either found in the escapement to that stock or allocated to that

stock from tags caught in intervening fisheries. Tags recovered in intervening fisheries were allocated to stocks by the estimates of stock proportions in each interceptive fishery where they were captured. Although the allocation of recovered tags in catches involved use of the estimates of stock proportions desired (and so appears circular), this allocation and calculation of stock composition for all fishing areas was done in a single mathematical operation next described.

The procedure by which tags caught in intervening fisheries were allocated and stock composition was computed can be illustrated by considering the general situation in which S stocks occur in mixtures in F fisheries. Tagged fish must be released in each fishery. Numbers of tagged fish from these releases subsequently caught in each intervening fishing area, and numbers returning to each spawning stock are presumed known. Let the following definitions apply:

E is the number of tagged fish released in fishing area f which escaped to stock s ;

C is the number of tagged fish released in fishing area f that were subsequently caught in fishery f' ;

T , is the total number of tagged fish released in fishing area f that were recovered; and

p_f , is the proportion of tagged fish in fishing area f that we're destined for stock s ,

where $s = 1, 2, \dots, S$; $f = 1, 2, \dots, F$; and $f' = 1, 2, \dots, F$.

Simple relationships among the catch and escapement recoveries were proposed (Gazey 1983) by which to allocate tags caught in intervening fisheries and compute the estimates of stock composition for each fishery:

$$\begin{aligned}
 E_{1,s} + \sum_{f=1}^F C_{1,f} \cdot p_{f,s} &= T_1 \cdot p_{1,s} \\
 E_{2,s} + \sum_{f=1}^F C_{2,f} \cdot p_{f,s} &= T_2 \cdot p_{2,s} \\
 &\vdots \\
 E_{F,s} + \sum_{f=1}^F C_{F,f} \cdot p_{f,s} &= T_F \cdot p_{F,s}
 \end{aligned} \tag{1}$$

Each equation in the set above refers to recoveries of tagged fish of a particular stock from one release area. Each equation can be restated in words as follows: the number of tagged fish recovered in the escapement to any stock s , plus the sum across fisheries of the caught tags multiplied by corresponding proportions from stock s , equals the total number of tagged fish recovered times the proportion destined for stock s . More simply yet, the numbers of tagged fish which escaped to stock s plus caught tagged fish allocated to stock s equals the total number of recovered tagged fish from the release area which were destined for stock s . Values of all variables are known except for the p -variables. However, the F p -variables occur linearly in the F equations, so their values can be easily determined from the other known values. The p -variables are the estimates of stock composition from tagging. Solving the system above for the p -variables provides the estimates of proportions of fish in each fishing area which came from stock s . Solving S such systems for their p -variables provides the complete set of stock-composition estimates for all S stocks in all F fisheries.

Although allocation of caught tags by the equation system appears reasonable on superficial examination, closer inspection reveals an aspect of dubious validity. Tagged fish subsequently caught in any intervening fishery are assigned by the procedure in the same proportions to the stocks regardless of where (i.e., which fishery) the fish originally were tagged. (Notice in the equation system above that the same F p -variables occur in each of the F equations.) However, fish tagged at Noyes Island and caught in Canada's area 3X, for example, could be destined for different stocks, or probably could occur in different proportions to the same stocks than those caught in the same area but originally released from Canada's area 4. However, tagged fish from the two areas are allocated in the same proportions.

Numerical simulation studies indicate that the procedure provides reasonably accurate estimates of stock composition if numbers tagged in fisheries were in proportion to abundance. However, estimates of stock composition became inaccurate when numbers tagged were not in proportion to abundance (Gazey et al. 1983). The tagging program was conducted with the intent to approximate such proportional tagging. Violations of proportional tagging presumably induced errors in the stock-composition estimates. We could not evaluate the magnitude of such errors because the potential degree of deviations from proportional tagging was unknown.

Significant numbers of tagged fish could not be accounted for by catches and escapement estimates. Soon after release, many may have died from the stress of tagging. The loss of tagged fish through such mortality was simply equivalent to

releasing fewer tagged fish in the fisheries if fish of the various stocks were equally susceptible to stress. Therefore, had actual numbers of tagged fish released been proportional to abundance, tagged survivors should also have been proportional to abundance, provided the percentage surviving the tagging was uniform among release fisheries. However, even given that tagging was proportional to abundance, numbers of survivors from tagging stress might not have been proportional to abundance if survival rate varied among release fisheries; later results show considerable apparent variation among release fisheries in percentage of tagged fish accounted for by catches and escapements.

In summary, essential data for calculation of stock composition in each interceptive fishery were the numbers of tagged fish released from each fishery which subsequently escaped to each contributing stock and corresponding numbers of tagged fish caught in each intervening interceptive fishery. This information was needed for all significant interceptive fisheries before stock composition could be calculated for any of them. Next described are details of the application of Equation (1) shared by all the tagging experiments.

Releases of tagged sockeye and pink salmon were stratified into half-month periods: 15-30 June, 1-15 July, 16-31 July, and 1-15 August. Some tagged fish used in the analyses were released before 15 June or after 15 August; these were included in the nearest period. Such stratification allows a straightforward comparison of stock composition among years. However, numbers of tagged fish recovered from releases of some fisheries and half-month periods were too small to reliably assess stock composition. Information concerning the number of recoveries and precision of stock-composition estimates for each fishery and time stratum is provided so that the reader will be warned of unreliable estimates.

Tagged fish were also stratified into areas of release. Areas of release correspond to the interceptive fisheries of concern; their definitions are provided in Tables 1, 2, 3 and Figs. 2-7. The area definitions are straightforward, but some explanation of the subdivisions of Canada's Dixon Entrance is provided.

During the course of the studies, Canada developed areal statistical systems for increasing resolution, primarily within the open water of Dixon Entrance. At the beginning of the studies in 1982, open water of Dixon Entrance was treated as a single statistical area; it was divided into nine areas in 1984 (Fig. 5), and redefined into seven areas in 1985 (Fig. 6). Areas with few tagged-fish releases were aggregated into larger units (Table 3; Figs. 5, 6) with greater total numbers of releases.

Catches were stratified by weeks and fishing areas. The boundary fishing areas included ADF&G statistical areas 101 through 108 in Southeast Alaska and areas 1, 3X, 3Y, 3Z, 4, 5, and 6 in northern British Columbia. Within the British Columbia portion of the boundary area, area stratification was no finer, but in Alaska, fishing areas were further subdivided because of higher area resolution of the Alaskan statistical system.

Fishing areas outside this border region were generally monitored only incidentally to other management activities by agencies of either country. However, Canada began monitoring the Johnstone Strait fishery at Vancouver Island for tagged sockeye salmon in 1983 after tagged fish unexpectedly appeared in catches.

Numbers of fish examined for tags from catches were available by statistical week, gear, and fishing area, and also by ADF&G statistical subarea for Alaskan fisheries. The total numbers of tagged fish in Alaskan catches (by half-month period and area of release, and week and area of recovery) were estimated by expanding numbers of tagged fish recovered in the weekly catch samples to account for unexamined catches.

Statistical records from Canadian fisheries were less refined than those from Alaskan fisheries, and records were inadequate to determine with certainty the size of weekly catch from which samples were obtained (Gazey et al. 1983; English et al. 1984). However, the season catch by gear and fishing area was available. Therefore, the total numbers of tagged fish in Canadian catches (by half-month period and area of release, and week and area of recovery) were estimated by expanding numbers of tagged fish recovered in the weekly catch samples by each gear in the recovery area for an estimate of the part not examined. The estimate of the part of the weekly catches not examined was the season portion of the catch by the gear in the recovery area that was unexamined.

Total numbers of tagged fish that were part of the escapements to spawning stocks of either country (from releases of a half-month period and area) were estimated by expanding numbers of tagged fish recovered at weirs or during foot surveys on streams to account for portions of the escapements not examined for tags. Various methods were used to estimate the percentages of the escapements examined (or the complementary percentages unexamined) for tagged fish. We describe these methods under the individual experiments.

Estimates of stock composition in the fishing areas during a release period were computed from the basic equation system for tag recoveries (Equation 1). We substituted estimates for unknown quantities of the equations before solving for the stock proportions (p-variables). Estimated numbers of tagged fish from release areas, which were subsequently caught

in intervening fishing areas, were substituted for the corresponding unknown values in the equations. Similarly, estimated numbers of tagged fish which escaped to major individual stocks or regional groups of stocks were substituted for the corresponding unknown values in the equations. We then solved the equation system for the percentages from major individual stocks or regional groups of stocks in the fisheries; the solutions were our point estimates of stock composition in each fishery and period.

The bootstrap approach (Efron and Tibshirani 1986) was used to evaluate potential error in the point estimate of stock composition due to subsampling catches and escapements for tagged fish. This procedure consisted of drawing samples with replacement and equivalent size from actual samples. These bootstrap samples were used to estimate numbers of tagged fish in escapements and catches, just as the actual samples were used in computing the original point estimates. Bootstrap values for numbers in escapements and catches were substituted into Equation (1), which was solved for the stock percentages when possible.

Resampling of samples, estimation of numbers of tags in catches and escapements, and recomputation of stock percentages were repeated 100 times for each experiment. By this procedure, we determined empirically the variation in estimates of the stock percentages in the fisheries, which was induced by subsampling escapements and catches. We used the standard errors of the bootstrap estimates of stock percentages as a measure of their precision. A rule of thumb regarding the precision of a reported estimate of a stock percentage in a fishery is as follows: in 95 of 100 imagined repetitions of the samplings of catches and escapements for tags during the tagging experiments, the unknown actual stock percentage in the fishery would be within two standard errors of the reported estimate. Therefore, a small standard error for a reported stock percentage indicates the estimate was not subject to much variation due to subsampling catches and escapements. Contrariwise, if the standard error was large, then the reported estimate of the stock percentage may have been poorly determined because of subsampling errors.

In some cases, stock percentages could not be recomputed from the bootstrap samples because Equation (1) became singular. Equation (1) became singular if no recovery occurred in the bootstrap samples from releases in one or more fisheries. If such singular cases were rare among the 100 repetitions, they were simply omitted from our evaluations of precision; that is, the empirical distributions were based on corresponding reduced numbers of bootstrap estimates of stock percentages. When singular cases became frequent, the fisheries causing the singular problem were omitted from the evaluation. This practice led to mildly optimistic estimates

of precision by understating the variation in stock composition estimates induced by subsampling.

In addition to the bootstrap results regarding precision, observed numbers of tag recoveries in escapements and catches are reported; these recoveries are classified by half-month period and area of release. If tag recoveries were few, especially in escapements, the estimates of stock composition from that release were viewed skeptically. In a few cases, bootstrap evaluation of possible error in stock-composition estimates did not reflect the obvious uncertainty due to few recoveries; therefore, numbers of recoveries were considered when judging reliability of estimates.

Furthermore, the bootstrap evaluation of variation in stock-composition estimates due to subsampling catches and escapements did not include errors incurred from estimating escapements of salmon in spawning systems without weirs. Neither did the evaluation account for possible bias in estimates of tagged fish in escapements from possible differences between in-river recovery rates of primary- and secondary-tagged fish. To evaluate such errors and differences, estimation of stock composition was repeated for ranges of possible escapements and recovery rates. To compare these analyses, catch-weighted averages were computed of half-month estimates of Alaskan and Canadian percentages for a fishery using percentage of the season catch in each period as the weight for the corresponding half-month stock percentage. Such catch-weighted averages are inherently important because they represent the stock composition of the catch for the entire season in the fishery. If no reliable estimate of stock composition was available in a fishery during a half-month period, the unreliable estimate available was combined with a reliable estimate of an adjacent period, or the estimate from the adjacent period was simply substituted for the period that lacked an estimate altogether. Specifically, for a period with an unreliable stock-composition estimate, a weighted average of the estimate and the estimate from an adjacent period was computed; numbers of tagged fish recovered in the periods were used as the weights. Only if 75% or more of the catch for the season in a fishery was covered by reasonably reliable estimates of stock composition was a catch-weighted average computed. The 75% criterion was chosen to limit the reported catch-weighted averages to those least distorted from the underlying season stock composition because of missing estimates of stock composition within the season.

SOCKEYE SALMON TAGGING EXPERIMENTS OF 1982 AND 1983

Primary Tagging in the Fisheries

A total of 40,455 sockeye salmon were tagged in 16 general areas during 1982 (Table 4). Numbers tagged varied substantially among areas; fewer than 100 fish were tagged in Cordova Bay and Dixon Entrance, but other areas had well over 1,000 tagged fish. In 1983, the tagging program was reduced (Table 4). Total number of tagged fish released during 1983 was 21,293--about one-half the number of the previous year. Tagged sockeye salmon were released in 13 areas--with more than 1,000 released in 8 of the areas.

Fishery Recoveries

Estimates of total numbers of primary-tagged fish subsequently caught in intervening fisheries in Alaska and Canada are provided by area and period of release for either year (Tables 5 and 6); these estimates were obtained by summing estimates over statistical areas in Alaska or Canada. The vast majority of tagged fish released in British Columbia waters and caught in intervening fisheries were recovered in Canadian fisheries. Canadian fisheries also recovered substantial portions of tagged fish caught from Alaskan releases. The broad implication of these recoveries is clear: given that significant fisheries and sockeye salmon catches occurred in both Alaska and Canada, most tagged sockeye salmon were migrating toward Canadian waters. However, catches of tagged fish alone are not sufficient to estimate stock composition in fisheries.' The number of tagged fish escaping to the spawning grounds in Alaska and Canada must also be considered.

Terminal Recoveries

Corresponding estimates of total numbers of tagged fish in escapements were obtained by expanding numbers of tagged fish recovered at weirs and from riverine fisheries to account for unexamined fish or incomplete recovery of tagged fish entering rivers with weirs. Expansions for Alaskan escapement were based on numbers of sockeye salmon examined for tags at weirs and on estimates of total numbers escaping to southern Southeast Alaska (Pella et al. 1988). These numbers (weir counts and estimates) are provided for Alaskan fishing districts (Table 7).

Weirs on the Skeena River system at Babine Lake and the Nass River system at Meziadin Lake were used to recover tagged fish in both years. The weirs accounted for most of the primary-tag recoveries in both the Skeena River (92% in 1982

and 94% in 1983) and Nass River (98% in 1982 and 99% in 1983). The weirs also accounted for most of the secondary-tag recoveries in the Skeena (96% in 1982 and 99% in 1983) and Nass Rivers (94% in 1982 and 99% in 1983). Foot surveys of spawning grounds in the two river systems accounted for the additional recoveries.

Based on the results of secondary tagging, many primary-tagged sockeye salmon entering the Skeena and Nass Rivers were not recovered at the weirs or by the spawning surveys. The estimated percentage of secondary-tagged sockeye salmon recovered ranged from only 17% to 61% (Table 8). Tagged fish may have died, shed their tags, been caught in unsampled native food fisheries, been undetected during foot surveys, or migrated to unsurveyed spawning grounds. Although some tagged fish avoided capture at the weirs, this was not an important cause for the shortfall in recoveries.

In 1983, Canada released secondary-tagged sockeye salmon at three locations along the Skeena River (English et al. 1984). Recovery rate at the Babine weir ranged from 22% for estuary releases, to 2% for a midway location, and 7% for the uppermost site about 140 km upriver. Corresponding recovery rates from these tagging locations when foot-survey recoveries were included with the weir recoveries were 25, 2, and 7%.

Secondary tagging within the Nass River in 1983 also resulted in only a combined 6% recovery rate for the Meziadin Lake weir and foot-survey recoveries. The recovery rate at the Meziadin Lake weir from releases in the nearby ocean fishery (area 32) was greater than that from releases within the Nass River. The outcome of secondary tagging in the Nass River was similar to that in the Skeena River; that is, recovery rate at the Babine Lake weir of tagged sockeye salmon released in the estuary of the Skeena River was also considerably greater than that of tagged fish released within the river.

Observed recovery rate during 1983 was inconsistent with the initial supposition that both primary- and secondary-tagged fish would be recovered at similar rates. Clearly, recovery rates of primary-tagged fish entering the Skeena and Nass Rivers are not well known.

We adopted interim estimates of recovery rates proposed by LGL Limited analysts (Gazey et al. 1983; English et al. 1984) (Table 8) for our initial analyses. In 1983, the observed recovery rate for salmon tagged in the estuary of the Skeena River was 25%, which was slightly higher than the 1982 recovery rate based on in-river tagging (17%). The recovery rate for the Nass River in 1983 (61%) was simply the midpoint of a range of possible values considered extreme by LGL Limited analysts, which was higher than the 1982 rate (43%) based on in-river tagging.

Numbers of primary-tagged salmon recovered at the weirs and during foot surveys of spawning grounds in the Skeena and Nass Rivers were expanded to estimate initial numbers entering the rivers; the expansions were based on recovery rates of secondary-tagged sockeye salmon (Table 8). This procedure for estimating numbers of primary-tagged entrants follows closely that used earlier by LGL Limited analysts (Gazey et al. 1983; English et al. 1984).

In addition to examining major escapements of the Skeena and Nass River systems, Canada extended their coverage in 1983 to include the Stikine River, Johnstone Strait, and several smaller sockeye salmon systems. A secondary-tagging program was conducted by Canada on the Stikine River in 1983 to estimate the number of primary-tagged fish returning to this system; the Canadian commercial fishery in the Stikine River was the recovery mechanism for tagged fish, analogous to the weirs on the Skeena and Nass Rivers. In 1983, a total of 862 sockeye salmon were tagged in the river below the U.S.-Canadian border on the U.S. side, and 187 (22%) of these tagged fish were recovered in the fishery. Numbers of primary-tagged fish in the catches were expanded correspondingly to estimate total numbers in the river.

Johnstone Strait represented a fishery located between Vancouver Island and the British Columbia mainland rather than a spawning ground. Unexpectedly, this Canadian fishery, far south of the boundary area, caught primary-tagged sockeye salmon released in 1983 (English et al. 1984). Evidence of their origin was limited, but the Fraser River--a major sockeye salmon system which enters the Pacific Ocean south of the fishery--was the logical primary source. Four 1983 tags occurred within the escapement to the Pitt River, which enters the Fraser River about 48 km above its mouth. Eleven live, tagged sockeye salmon were observed during index counting of escapement at the Hell's Gate fishway 200 km above the mouth of the Fraser River by Pacific Salmon Commission personnel, but subsequent foot surveys of the Fraser River system above Hell's Gate produced only a single tag--from the stream bottom of the Seymour River. A single tag, volunteered from the sport fishery of Lake Washington, showed sockeye salmon from Washington State were also probably at Johnstone Strait; however, the Washington State contribution was probably small. Estimated total return of sockeye salmon to the Fraser River was more than 10-fold that of sockeye salmon from Washington State in 1983.

⁵Dr. James Woodey, Chief Biologist, Fishery Management, Pacific Salmon Commission, No. 600, 1155 Robson St., Vancouver, B.C. V6E-1B9, Canada, pers. commun., 28 October 1991.

Although the Johnstone Strait fishery was not sampled by personnel of the tagging program until 20 August, fishermen volunteered recoveries as early as 12 July. After 20 August, volunteer recoveries from fishermen comprised about 42% of the tagged fish in catches (as estimated from program sampling). Recoveries volunteered by fishermen before program sampling were assumed to equal 42% of the primary-tagged fish of these catches. Therefore, the analysis included the entire return through Johnstone Strait of the presumed Fraser River-origin tagged sockeye salmon.

Weirs were installed on Devon, Bonilla, and Eden Lakes--coastal systems supporting minor (compared to the Skeena, Nass, and Stikine Rivers) Canadian sockeye salmon populations. Losses of tags in the short rivers leading to these lakes were assumed negligible, so numbers of tags recovered at these weirs were treated as the total escapement of tagged fish.

Estimates of total numbers of tagged fish escaping to spawning areas in Alaska and Canada are provided by period and general area of release for each year (Tables 9 and 10). During both years, the vast majority of sockeye salmon tagged throughout the season in Canadian fisheries escaped to Canadian river systems. Also, more tagged sockeye salmon released during the season from several Alaskan fishing areas (e.g., Noyes Island, Dall Island, and Tree Point) escaped to Canadian than to Alaskan spawning areas; but the disparity in recovery rates was not as great as for spawning-area recoveries of releases from Canadian fishing areas. Furthermore, at times more tags from releases of some Alaskan fisheries were recovered in Alaskan escapements than in Canadian escapements (e.g., Lower Clarence Strait and Revillagigedo Channel in the first period of 1982, Middle and Upper Clarence Straits and Revillagigedo Channel in the second period of 1982, Upper Clarence Strait throughout 1983, and Sumner Strait from the second period of 1983 onward).

Numbers of tagged sockeye salmon released at most locations in either year exceeded the combined estimates of recoveries in catches and escapements to Alaska and Canada, often by wide margins (Table 11). The overall recovery rate of total releases from Alaska or Canada accounted for by estimates of tagged fish in catches and escapements was consistent with findings of secondary tagging in saltwater estuaries in Alaska. Ancillary experiments during secondary-tagging studies in Alaska included release of tagged sockeye salmon captured purse seining by hand adjacent to the mouths of several outlet streams with weirs to count them (Pella et al. 1988). Counts at the nearby weirs and recoveries from all weirs, foot surveys, and commercial and subsistence fisheries of Southeast Alaska could not account for roughly 40% of these secondary-tagged fish. Tagged fish may have shed their tags or died from the effects of tagging (Pella et al. 1988). However,

shedding of a substantial percentage of tags was improbable because the fish had less than 1 km to migrate to the weir on the way to their spawning grounds. More likely, tagged fish died from tagging stress, either directly or indirectly due to their increased vulnerability to predation.

Similarly, primary-tagged sockeye salmon released in Alaska and Canada, which were not accounted for in catch or escapement, may have died from tagging stress or predation, shed their tags, been caught in native food fisheries, or migrated from the region to unmonitored spawning grounds. Such overall loss of tags from Alaskan tag releases was 50% in 1982 and 39% in 1983 (loss = 100% minus recovery rate from last pair of columns of Table 11). Corresponding estimates of overall loss for Canadian releases in those years were 13% and 43%. Only the loss from Canadian releases of 1982 (13%) was inconsistent with a conjecture, based on the experience of secondary tagging in Alaska, that around 40% of primary-tagged fish may have died from tagging stress. However, recovery rate varied substantially among release locations, and was far greater than 60% (conjectured survival rate from tagging stress) for many locations in either year.

Estimated percentage of tagged fish in catches and escapements from two Canadian release locations (areas 3Y and 4) was 101-105% in 1982. Generally, recovery rates in catches or escapements from Canadian release locations during 1982 were high compared to Alaskan releases of both years, or Canadian releases of 1983. Recovery rates among Alaskan locations in either year were comparatively high for Lower Clarence Strait, Revillagigedo Channel, and Tree Point.

Possibly the apparently high recovery rates of fish tagged in Canadian release locations and nearby Alaskan locations in Lower Clarence Strait, Revillagigedo Channel, and Tree Point were caused partly by overestimates of tagged fish in Canadian escapements to the Nass and Skeena Rivers--the destinations of most fish released from these tagging locations. Estimated numbers of primary-tagged fish in escapements to the Nass and Skeena River systems depended inversely on estimates of recovery rates of these fish after they entered the rivers. If the recovery rate of primary-tagged entrants was underestimated, primary-tagged fish escaping to these systems was overestimated. If this were the case, then estimated numbers of primary-tagged fish accounted for by catches and escapements (Table 11) could exceed 100%. As mentioned earlier, interim estimates of recovery rates of primary-tagged entrants to these rivers proposed by LGL Limited analysts (Gazey et al. 1983; English et al. 1984) were used (notwithstanding our questions of their accuracy) to compute estimates of numbers of primary-tagged fish in Canadian escapements. The discussion below (see Sensitivity Analysis,

p. 24) explains why recovery rates of primary-tagged entrants to the Canadian systems may have been underestimated.

Furthermore, numbers of tag recoveries in some Canadian catches possibly were over- or underestimated because proportions of the catches sampled in the various Canadian fisheries varied during the season. Such variation could not be accounted for when actual recoveries were expanded to estimate total recoveries. (For Canadian fishing areas, the weekly proportions of catches examined for tags were not available, so the proportions sampled for the entire season were used to expand actual tag recoveries to total tag recoveries.) The expansions were applied to tagged fish recovered in Canadian catches from both Canadian and Alaskan release locations, possibly accounting for the high recovery rate from releases of some Alaskan locations.

The observed variation among release locations in percentage of tags accounted for by catches and escapements is not satisfactorily explained by uniform mortality rates from tagging stress, overestimation of tagged fish in Canadian escapements, or errors in estimates of tagged fish caught in Canadian fisheries. Most fish released at Noyes Island, Dall Island, and Langara Island were destined for the Skeena and Nass Rivers and many were caught in Canadian fisheries, yet recovery rates from these locations remained comparatively low both years. Recovery rates also remained comparatively low for other release locations--such as Sumner Strait, Upper Clarence Strait, Middle Clarence Strait, and Union Bay--less dominated by Nass and Skeena River stocks. Whatever causes may underlie the variation in recovery rate among the release locations, the apparent effect varied among locations and between years of tagging.

Stock-Composition Estimates

Estimates of total recoveries in catches and escapements by location and period of release were used to compute stock composition in fisheries (Tables 12, 13) by the algorithm described earlier. Skeena and Nass River stocks were abundant throughout much of the region during the entire season; Nass River stocks returned earlier than Skeena River stocks (Fig. 8). Southern stocks passing through Johnstone Strait in 1983 were in the boundary area mainly from mid-July to the end of tagging (Fig. 8). Along the outer-coast fisheries, abundance of the southern stocks peaked during August, constituting an estimated 58% and 30% of sockeye salmon at Langara Island and Noyes Island, respectively. The main Alaskan stocks in the fishing areas originated in ADF&G statistical areas 101 and 102.

Generally, greater changes occurred in stock composition estimates from Alaskan releases than Canadian releases after tags recovered in intervening fisheries were allocated to stocks (Tables 12, 13); that is, percentages of Alaskan or Canadian fish in combined escapements (last pair of columns) from Alaskan releases often changed substantially (next to last pair of columns) after caught tagged fish were allocated. As expected, estimates in the percentages of tagged Canadian sockeye salmon in Alaskan fisheries increased substantially after the allocation of caught tags because tagged fish released in Alaskan fisheries and destined for Canadian spawning grounds were exploited in intervening Alaskan and intense Canadian fisheries, but releases destined for Alaskan systems were exploited mainly in Alaskan fisheries.

Alaskan and Canadian percentages of Alaskan-origin sockeye salmon in the fisheries were summarized using Alaskan percentages; corresponding Canadian percentages can be obtained by subtraction from 100% (Tables 14, 15). Variation of stock-composition estimates due to subsampling catches and escapements, but not including variation from escapement estimates, was evaluated by the bootstrap approach (Tables 14, 15). Standard errors of most estimates of stock percentages appeared reasonably small (<55%), but several were greater. Because credibility of estimates of stock percentages depends partly on numbers of tagged fish recovered in escapements or catches, these were also summarized (Tables 16, 17). As expected, estimates of stock percentages were quite unreliable (as indicated by bootstrap standard errors) when total tags recovered in catches and escapements was small.

Estimates of stock proportions for both years are summarized by omitting release time and area strata for which fewer than 10 total tag recoveries were obtained in sampling catches and escapements (Table 18); hence, the remaining estimates generally had reasonably low standard errors based on bootstrap results.

Discussion

Two generalities concerning Alaskan and Canadian percentages in the fisheries were evident by inspection of the results of our analysis (Table 18). First, the percentage of Alaskan-origin sockeye salmon in Alaskan fisheries is greater than in Canadian fisheries; hence, the percentage of Canadian fish in Canadian fisheries is greater than in Alaskan fisheries. Second, the percentage of Canadian sockeye salmon in Alaskan fisheries tends to be much greater than the percentage of Alaskan sockeye salmon in Canadian fisheries.

Catch-weighted averages, of half-month stock-composition estimates for each fishery provided estimates of season stock

composition (Table 19). Most sockeye salmon in Alaskan catches were of Canadian origin (except in Sumner Strait), whereas only a small percentage of Canadian catches were of Alaskan origin. Contribution rates from Alaskan stocks to Canadian fisheries were greater in 1982 than in 1983, and contribution rates of Canadian stocks to Alaskan fisheries were greater in 1983 than in 1982 for two of the three fisheries where comparison was possible.

Sensitivity Analysis

Outcomes of the analyses should be considered with circumspection. Stock-composition estimates depended heavily on estimates of tagged fish escaping to either country. Estimates of tagged fish escaping to Alaska depended directly on the estimate of total Alaskan escapement. Specifically, an estimate of larger escapement to Alaska would result in an estimate of more tagged fish escaping to Alaska; conversely, an estimate of smaller escapement to Alaska would result in an estimate of fewer tagged fish escaping to Alaska. The estimates of total escapements of sockeye salmon to southern Southeast Alaska for 1982 and 1983 were 354,000 (90% confidence interval 254,000-466,000) and 324,000 (90% confidence interval 216,000-458,000), respectively (Pella et al. 1988). Imprecise estimates of Alaskan escapements in 1982 and 1983 possibly caused large errors in estimates of escaping tagged fish.

Estimates of tagged fish escaping to Canadian spawning grounds depended inversely on estimates of recovery rates of terminal entrants to the Nass, Skeena, and Stikine Rivers. Such estimates were the percentages of secondary-tagged sockeye salmon recovered at weirs and spawning grounds of the Nass and Skeena River systems or in the commercial fishery of the Stikine River. Estimates of lower recovery rates in the Canadian systems would result in estimates of more primary-tagged fish escaping to Canada. Conversely, estimates of higher recovery rates in Canadian systems would result in estimates of fewer primary-tagged fish escaping to Canada.

Estimates of recovery rates of primary-tagged sockeye salmon entering Canadian rivers (Table 8) were too low if recovery rates of secondary-tagged sockeye salmon were less than those of the primary-tagged sockeye salmon. The recovery rate of secondary-tagged fish could have been substantially less than of primary-tagged terminal entrants to the rivers if fish died from tagging stress (similar in magnitude to that inferred from estuarine secondary-tagging studies in Alaska) within a few days after tagging. That is, primary-tagged entrants had already survived tagging stress during the time of ocean migration to the river entrance, but the secondary-tagged fish could have experienced losses due to it, reducing

the percentage of secondary-tagged sockeye salmon recovered at weirs and spawning grounds.

In 1982, secondary taggings conducted within the Nass and Skeena Rivers were used to estimate the recovery rate of primary-tagged sockeye salmon (Table 8). However, the estimates of recovery rate of primary-tagged sockeye salmon in the rivers during 1983 were based on either recovery rate of estuary releases on the Skeena River or fishery releases from area 32 near the Nass River entrance. Evidence presented earlier from secondary tagging of sockeye salmon in estuaries in Alaska indicated that possibly 40% of estuary-tagged fish died of tagging stress. Similarly, sockeye salmon released in ocean fishing areas may also suffer substantial mortality, for recoveries in catches and escapements constitute but a portion of total Alaskan or Canadian primary-tagged releases (Table 11). Yet recovery rates at the weirs of the Skeena River estuary and area 32 releases during 1983 were larger than from secondary taggings within the rivers themselves.

Further evidence for substantial mortality -from tagging stress of returning adult sockeye salmon released in coastal fishing areas comes from a 1949 tagging experiment at Kodiak Island (Bevan 1962). Sockeye salmon were tagged from trap catches, a seemingly less stressful mode of capture than the purse seine, gill-net, and troll gear used in the present studies. Fishermen reported only 32% of the tagged fish, even though the tagging program emphasized recovery of tags from the fishery. Bevan (1962) must have considered recovery of tags from the fishery to be nearly complete because his model of the results does not include the possibility of unreported tag recoveries. Another 25% of the releases were observed passing the Karluk weir, the stock considered to be the major contributor to the fishery from which the tagged fish were released. Escapements of other stocks may have accounted for another 1% if tags recovered in foot surveys of these escapements constituted the same percentage of their total tagged fish as did the tags recovered in foot surveys of the Karluk River. If these catch and escapement recoveries are expanded for the estimated 11% shedding loss provided by Bevan (1962), the total tagged fish accounted for by catches, escapements, and shedding equals only 66% of the releases. In other words, 34% were missing.

Bevan (1962) modeled these losses as a continuous process during the return through the fishery rather than as an abrupt mortality shortly after tagging. However, his view was based on the outcome of an experiment which would not have detected a large initial mortality from stress if it were not increased by additional handling of fish being tagged. In addition to mortality from tagging stress, the Kodiak experiment also demonstrated that the behavior of tagged fish is initially

affected; recovery rates in the fishery were depressed for two days after tagged groups were released.

In summary regarding the recovery rates of primary-tagged sockeye salmon entrants to the Nass and Skeena Rivers, we judged that values obtained from secondary-tagging experiments upstream within the rivers were questionable because of the contradictory outcomes of 1983. In view of the probable mortality of some of these fish from tagging stress shortly after release, we also questioned whether values obtained from estuarine or nearby fisheries provided valid estimates of such recovery rates.

The uncertainty in actual recovery rates of primary-tagged sockeye salmon in the major rivers of Canada demands further analysis. To evaluate the effects of potential errors in estimates of tagged fish escaping to Canadian or Alaskan spawning grounds on the outcomes of the analyses, the analyses were repeated using several combinations of estimates of Alaskan escapements and recovery rates in the Skeena, Nass, and Stikine River systems. Three estimates of Alaskan escapements were used: the point estimate and the lower and upper bounds of the 90% confidence interval of each year (Table 7). Two estimates of recovery rates of primary-tagged fish in the Canadian rivers were used, equivalent to 0% and 40% mortality of secondary-tagged fish. A 40% tagging mortality reduced estimates of numbers of terminal entrants to the Nass, Skeena, and Stikine River systems to 60% of the values computed using 0% mortality.

Evaluations of the effects of errors in estimates of tagged fish escaping to Alaska and Canada on stock-composition estimates were computed for five combinations of estimates of Alaskan escapement and Canadian secondary-tagging mortality (Tables 20, 21). Almost certainly, the extremes of possible errors were included.

As expected, estimates of larger Alaskan escapement reduced estimates of percentages of Canadian-origin sockeye salmon in the fisheries, and a 40% secondary-tagging mortality further reduced the percentages (Tables 20, 21). On the other hand, estimates of smaller Alaskan escapement increased estimates of percentages of Canadian-origin sockeye salmon in the fisheries, and a 0% Canadian tagging mortality further increased percentages. Estimates of season stock composition in the fisheries changed most between the combination of the upper 90% bound on Alaskan escapement and 40% Canadian secondary-tagging mortality and the combination of the lower 90% bound on Alaskan escapement and 0% Canadian secondary-tagging mortality (compare lines 3 and 4 of Tables 20 and 21).

Regardless of the combination of Alaskan escapement and Canadian secondary-tagging mortality, the 1982-season stock composition in Alaskan fisheries changed by 15 percentage

points or less, depending on the fishery; for 1983, the changes were 8 percentage points or less at Noyes Island, Dall Island, Lower Clarence Strait, and Tree Point (Table 20). Greatest changes (percentage points are indicated in parentheses below) occurred when contributions of Alaskan and Canadian stocks were nearly equal, such as Upper Clarence Strait (10) and Revillagigedo Channel (15) during 1982, or Upper Clarence Strait (19) and Sumner Strait (25) during 1983. Corresponding changes in Canadian fisheries were at most 6 percentage points in both 1982 and 1983 (Table 21).

Concern that errors in estimating tagged fish escaping to spawning systems of Alaska or Canada could seriously distort estimates of stock composition and interceptions was largely allayed for all Canadian fishing areas and the important Alaskan fishing areas at Noyes Island, Dall Island, and Tree Point. However, the effect on stock-composition estimates of such extreme errors in estimating numbers of tags escaping to spawning areas of either country was greater for some remaining Alaskan fishing areas. Nonetheless, most sockeye salmon in Alaskan fisheries were estimated to originate from Canadian stocks, regardless of the extremes of errors examined.

The ranges of reported estimates of season stock composition (Tables 20, 21) understate the uncertainty in actual season stock composition. Point estimates summarized possible effects of errors in estimated numbers of tagged fish escaping to Canada and Alaska. However, uncertainty in actual stock composition included variation due to subsampling catches and escapements; such variation was generally not large (e.g., see standard errors of season stock-composition estimates in Table 19), and would be superimposed on the reported point estimates (Tables 20, 21). Finally, the uncertainty in actual season stock composition due to the tagged fish unaccounted for by catches and escapements remains unmeasured.

PINK SALMON TAGGING EXPERIMENT OF 1982, 1984, AND 1985

Primary Tagging in the Fisheries

Large numbers of pink salmon were tagged in the boundary waters of the United States and Canada during 1982, 1984, and 1985 (Table 22). In 1982, more than 151,000 pink salmon were tagged in 9 Alaskan and 7 Canadian fishing areas. Even-year stocks were tagged again in 1984, but only slightly more than 82,000 fish were tagged in 5 Alaskan and 6 Canadian fishing areas. Odd-year stocks were first tagged in 1985; more than 125,000 fish were tagged in 10 Alaskan and 8 Canadian fishing areas.

Fishery Recoveries

Numbers of primary-tagged pink salmon subsequently recovered in intervening fisheries from each general area and period of release were expanded to account for the unexamined portion of catches to estimate total recoveries. Estimates of total tagged pink salmon caught in Alaska and Canada were obtained by summing estimates of total tag recoveries over fisheries within each country (Tables 23, 24, 25).

Generally, Alaskan catches of pink salmon tagged in Alaskan waters (other than at Tree Point) greatly exceeded Canadian catches. On the other hand, relative numbers of Canadian releases caught in Alaska and Canada depended more on the year, time, and place of release.

Terminal Recoveries

Estimates of tagged pink salmon in escapements from each general release area and period were computed from tagged fish recovered at weirs (in a few Canadian rivers) or from the numbers of tagged carcasses observed during foot surveys of streams (in both Alaska and Canada). Actual tag recoveries were expanded to account for unexamined fish or tagged fish which entered the rivers but did not arrive at the Canadian weirs.

Total tagged fish escaping to Alaskan systems were estimated from numbers of pink salmon carcasses counted and examined for tags during stream surveys, numbers of tags recovered from the carcasses, and estimates of total escapements to southern Southeast Alaska. In 1982, a total of 569 foot surveys were made on 375 Alaskan streams. In 1984 the total was 475 surveys on 316 streams, and in 1985 the total was 588 surveys on 388 streams. Survey counts of carcasses and estimated escapements were classified by ADF&G statistical areas for each tagging year (Table 26). Observed numbers of

carcasses with tags were divided by the proportions of total escapements examined during the surveys to estimate tagged fish in the escapements. Proportions of escapements examined were computed from the cumulative counts of carcasses examined and corresponding escapements in groups of ADF&G statistical areas listed (Table 26).

Expansions to estimate numbers of tagged pink salmon returning to British Columbia spawning systems depended on the system and were based on either 1) numbers of carcasses examined for tags combined with escapement estimates, as was done for Alaska, or 2) results of secondary-tagging experiments. Escapement estimates were based on counts made from foot surveys, which were expanded to account for escapement not seen. Numbers of carcasses examined for tags and escapement estimates were classified by tagging year and fishing area (Table 27). No escapement estimates were available for 1982 when only stocks of the Skeena, Kwinamass, and Khutzeymateen Rivers (where secondary-tagging studies were conducted) were included in the analysis.

Secondary tagging of pink salmon was conducted on the Skeena and Kwinamass Rivers during each tagging year, but only during 1982 on the Khutzeymateen River. The percentage of secondary-tag releases in these rivers subsequently recovered at weirs or during surveys was generally low and no more than 14%. The recovery rate varied among years by slightly more than twofold for the Skeena and Kwinamass Rivers (Table 28). Such variation could occur as amount-or effectiveness of recovery effort changed; for example, effectiveness of recovery effort could vary with water levels of the rivers. Recovery rate in the Kwinamass River was consistently greater than in the Skeena River. Differences among rivers in recovery rate was expected because the portions of escapements accessible to survey probably differed.

Recovery rate of secondary-tagged fish was assumed to equal the rate of primary-tagged fish in the rivers. Before computing their recovery rate, numbers of secondary-tagged fish released were reduced by numbers estimated to have strayed. The number of primary-tagged fish 'observed in these rivers was expanded to account for those unobserved by dividing by the recovery rate of secondary-tagged fish.

Estimates of total tagged fish escaping to Alaskan and Canadian spawning streams were summarized for each tagging year by area and period of release (Tables 29, 30, 31). These estimates were obtained by summing estimated tagged fish in the various escapements of Alaska or Canada. Generally, numbers of primary-tagged pink salmon escaping to Alaskan spawning streams from nearly all Alaskan release areas throughout the season were vastly greater than numbers escaping to Canada. Relative numbers of Canadian releases escaping to Alaska and Canada were more dependent on time and place of

release than were Alaskan releases. For the first two release periods, the combined number of Canadian releases escaping to Alaska roughly equaled or exceeded the number escaping to Canada; however, in the last two periods, Canadian releases escaping to Canada greatly exceeded those to Alaska. Clearly, fish from Alaskan stocks predominated in most Alaskan fisheries throughout the season and were more abundant in Canadian fisheries earlier than later in the season.

Estimates of total number of recoveries of tagged pink salmon in catches and escapements were plausible (Tables 32, 33, 34) in the sense that the numbers released at any location in any tagging year exceeded the numbers estimated in catches and escapements. Overall percentages of Alaskan or Canadian releases subsequently observed in catches and escapements were similar each year. However, in 1982, estimated overall recovery rate was 39%; this value is considerably lower than that of 1984 (52%) or 1985 (59%).

The type of tags used may have affected the recovery rate of tagged salmon in catches and escapements. Petersen disk tags were used in 1982, but spaghetti tags were used in 1984 and 1985. Possibly more pink salmon died from the use of Petersen tags. Substantial percentages (61%, 48%, and 41% in 1982, 1984, and 1985, respectively) of primary-tagged pink salmon were not accounted for in either catches or escapements. Presumably the tagged pink salmon died from tagging stress or predation, shed their tags, or migrated to areas not completely covered by tag-recovery sampling.

Stock-Composition Estimates

Estimates of tagged pink salmon in catches and escapements were used to estimate stock composition in fisheries by the algorithm described earlier. Estimates of percentages contributed by regional stock groups were summarized by release year, area, and time of season (Tables 35, 36, 37; Fig. 9). Generally, fish from Alaskan stocks were abundant throughout the season over much of the boundary area in all years. The more significant contributors were Alaskan stocks of ADF&G statistical area 101, especially early in the season. Stocks from ADF&G statistical areas 102, 103, and 104 appeared in substantial numbers during the latter half of the season, especially in Alaskan fisheries (excluding Tree Point), and in Canadian fisheries of area 1. Canadian area 3 and Skeena River stocks were significant contributors to Canadian fishing areas and, at times, to Tree Point, Revillagigedo Channel, Noyes Island, and Dall Island. Pink salmon from stocks south of the Skeena River (Canadian areas 5 through 14) were detected in 1984 and 1985. In 1984, tag recoveries in catches and escapements occurred as far south as Canada area 6. In 1985, escapement recoveries were made farther south in central

British Columbia, and catch recoveries were made even farther south in Johnstone Strait and the western coast of Vancouver Island. Increase in geographic range of recoveries from 1982 to the later years coincided with increased coverage of escapements by the sampling program (recall that in 1982, coverage of Canadian escapements was limited to the Skeena, Khutzeymateen, and Kwinamass Rivers).

Percentages of Alaskan pink salmon in fisheries were summarized (Tables 38, 39, 40). Precision of stock-composition estimates, excluding variation from escapement estimates, was evaluated using the bootstrap technique. Standard errors of most stock-composition estimates appeared reasonably small (15%), but some were subject to large variation from subsampling catches and escapements for tags. Numbers of tagged fish recovered in catches and escapements affect the accuracy of stock-composition estimates, and therefore were summarized (Tables 41, 42, 43). As expected, stock-composition estimates were quite unreliable (as indicated by bootstrap methods) when total tags recovered in catches and escapements was small. Therefore, we summarized what we considered the reasonably reliable estimates of stock composition for the 3 years of tagging by omitting time and area strata for which fewer than 10 total tags were recovered in sampling catches and escapements (Table 44).

Discussion

Several generalities on stock distribution of pink salmon were evident from the estimated percentages of Alaskan-origin pink salmon in international boundary fisheries (Table 44). First, the percentage of pink salmon of Alaskan origin caught in Alaskan fisheries generally remained, high (>75%) throughout the season in all tagging years. The main exceptions were at Tree Point and Revillagigedo Channel, where the percentage from Alaska was sometimes lower. Second, percentage of Alaskan-origin pink salmon in Canadian fisheries varied more among areas and years of tagging than in Alaska. The percentage of Alaskan-origin pink salmon was generally greatest in Canadian areas adjacent to Alaska (Dixon Entrance, Langara Island, and areas 3X, 3Y, and 3Z). Finally, the percentage of Alaskan pink salmon in Canadian fishing areas in 1984 and 1985 was generally highest early in the season and declined later. In 1982, the percentage of Alaskan pink salmon in the Canadian fishing areas was also high early in the season, generally declined through the third release period, and then recovered in the last release period.

Catch-weighted averages of stock-composition estimates were computed across release periods to approximate season stock composition of the interceptive fisheries (Table 45). Resulting averages were reasonably precise because imprecise

estimates of stock composition usually corresponded to release periods with small catches. The percentage of season catches in Alaska from Canadian stocks was low (<12%) in all years and fisheries except Tree Point. On the other hand, the percentage of season catches in Canadian areas consisting of Alaskan-origin stocks was variable among areas and years, and ranged to near 50% and higher for areas adjacent to Alaska, including Dixon Entrance and area 3.

Sensitivity Analysis

All stock-composition estimates should be treated with circumspection because their values were determined mostly from estimated numbers of tagged fish escaping to either Alaskan or Canadian spawning systems. Estimates of tagged fish in escapements depended, in turn, on estimates of escapements; the accuracy of escapement estimates to each country was unknown. However, included with the best estimates of escapements provided by analysts of LGL Limited and ADF&G were lower and upper bounds within which the true escapements probably occurred (Tables 26 and 27). We considered the estimates of escapements as expert opinions, and the bounds were the only measures of their accuracy.

Canada utilized secondary tagging to estimate numbers of escaping primary-tagged pink salmon in several major river systems (Table 28). Recovery rate of secondary-tagged pink salmon was used to expand recoveries of primary-tagged fish to estimate numbers of primary-tagged entrants to the rivers. Similar to the sockeye salmon experiments, if secondary-tagged pink salmon suffered losses not experienced by primary-tagged fish after the latter entered the rivers, numbers of primary-tagged pink salmon entering these rivers would be overestimated. Such bias could affect stock-composition estimates, causing Canadian-origin pink salmon to be overestimated.

Results of behavioral experiments on pink salmon (Helle 1966) at Olsen Creek, Alaska, were consistent with our postulated tagging mortality. On 10 dates between 29 July and 3 September 1961, Helle captured five maturing pink salmon of each sex in Olsen Creek within tidal influence of Olsen Bay. The fish were tagged with Petersen disk tags without the use of an anesthetic (anesthetic was not used for primary or secondary tagging during the present study) and released several miles away in seawater at Port Gravina, a major body of salt water which contains Olsen Bay. Also on each date, a control group of fish was captured, tagged, but released at the capture location rather than being moved. Olsen Creek was surveyed by foot daily for the tagged fish, and 12 nearby salmon streams within Port Gravina were surveyed by foot weekly. The totals of tagged fish which could be accounted for from the foot surveys were 54 and 58 of the 100 released

from the displaced and nondisplaced groups, respectively. In other words, 46% and 42% of the displaced and nondisplaced groups, respectively, were not found even though the likely places to which they might have strayed were monitored.

To evaluate effects of possible errors in estimates of escaping tagged fish, stock-contribution estimates were recomputed under several combinations of estimates of escapements and mortality of secondary-tagged pink salmon for the Skeena, Kwinamass, and Khutzeymateen Rivers. The three escapement estimates used for Alaska and Canada in each tagging year were the lower and upper bounds and the best point estimates (Tables 26, 27). Two choices of mortality rate of secondary-tagged fish in the Canadian rivers were 0% and 40%. Assuming a 40% mortality rate of secondary-tagged fish reduced estimates of tagged fish escaping to the Skeena, Kwinamass, and Khutzeymateen systems to 60% of the estimates computed assuming 0% mortality. Five combinations of estimates of Alaskan escapements and Canadian secondary-tagging mortality rates were examined for 1982. (Recall that Canadian escapements to systems other than those in the secondary-tagging program of 1982 were not available.) Four combinations of Alaskan and Canadian escapements and Canadian secondary-tagging mortality rates were examined for 1984 and 1985. Presumably, the extremes of possible errors in estimated tagged fish escaping to Alaska and Canada were included.

Regardless of the combination of estimates or tagging year, the season stock-composition estimates changed by only a few percentage points in Alaskan fisheries other than Tree Point and Revillagigedo Channel (Table 46). Some fisheries in Canada were affected more: changes in seasonal stock-composition estimates ranged up to 21 percentage points (Table 47). Concern that potential errors in escapement estimates or mortality rates of secondary-tagged fish could seriously mislead us was allayed for most fisheries.

The ranges of reported estimates of seasonal stock composition (Tables 46, 47) understate the uncertainty in actual season stock composition. Point estimates were used to summarize possible effects of errors in estimated tagged fish escaping to Canada and Alaska. However, uncertainty in actual stock composition also included variation due to subsampling catches and escapements; such variation was generally not large (e.g., see standard errors of season stock-composition estimates in Table 45), and would be superimposed on the reported point estimates (Tables 46, 47).

DISCUSSION AND SUMMARY

Major tagging experiments on adult sockeye and pink salmon were conducted in southern Southeast Alaska and northern British Columbia between 1982 and 1985. Sockeye salmon were tagged in coastal ocean fisheries during 1982 and 1983; pink salmon were tagged during 1982, 1984, and 1985. The immediate purpose of the experiments was to assess interceptions of fish originating in Canada or the United States by fishermen of the other nation. In addition, the studies provided information on timing and migration routes of major salmon stocks which could be used in management of the fisheries.

Primary Tagging

Returning adult salmon were captured and tagged in the international boundary-area fisheries of Southeast Alaska and northern British Columbia. Adults were primary tagged in Southeast Alaska fishing areas at Noyes Island, Dall Island, Cordova Bay, Sumner Strait, Clarence Strait, and Tree Point, as well as in northern British Columbia at Dixon Entrance and Hecate Strait, including near Langara Island, Dundas Island, Tracy Bay, Boston Rocks, Stephens Island, Porcher Island, Birnie Island, Maskelyne Island, Portland Inlet, and Canada areas 5 and 6. Total tagged sockeye salmon released from Alaskan fisheries were 9,050 and 9,156 in 1982 and 1983, respectively; corresponding numbers released from Canadian fisheries were 31,405 and 12,137. Totals of tagged pink salmon released from Alaskan fisheries were 83,487, 30,502, and 68,811 in 1982, 1984, and 1985, respectively; corresponding numbers released from Canadian fisheries were 67,854, 51,631, and 56,801.

Fishery Recoveries

Portions of catches in boundary-area fisheries were examined for tagged fish. Time and place of release were identified for tagged fish recovered during catch sampling. Total numbers of tagged fish occurring in catches of each fishery from half-month interval releases of each fishery were estimated by expanding numbers of tagged fish recovered in catch samples to account for tagged fish in portions of catches not examined for tags.

Terminal Recoveries

Portions of spawning escapements of both countries were also examined for tagged fish, and time and place of release were identified from recovered tags. Total numbers of tagged fish arriving at various streams or regional stream groupings from half-month interval releases of each fishery were estimated by expanding the numbers of tagged fish recovered in the samples to account for fish which were not examined for tags, died, or shed their tags. Several methods were used to expand recoveries from escapements.

Sockeye salmon

Based on early migration studies and general knowledge of sockeye salmon stocks of the region, the main Alaskan stocks contributing to boundary-area fisheries were presumed to originate from southern Southeast Alaska (ADF&G statistical areas 101 through 108). Weirs were built on some larger Alaskan lake systems for nearly complete counting of escapements and recovery of tagged fish. Additional tagged sockeye salmon in escapements to systems without weirs were estimated by two steps. First, fish escaping to systems without weirs were estimated from secondary Petersen tagging experiments adjusted for mortality of tagged fish and from foot-survey counts expanded for unseen fish. Second, the tagged fish among these escapements were estimated, assuming that escapements at weirs represented a random sample of tagged and untagged fish in escapements to all systems with or without weirs. The two-step process was applied to regional stock groups. Ranges of possible total escapements to Alaskan spawning grounds were broad because only a sample of 12 of the 48 known stocks in nonweired systems could be included in the first step in either year. Total escapement to southern Southeast Alaska in 1982 was estimated as 354,000 (90% confidence interval 254,000-477,000); in 1983 the estimate was 324,000 (90% confidence interval 216,000-458,000). Therefore, approximately 48% (90% confidence interval 36%-67%) and 39% (90% confidence interval 27%-58%) of the estimated total escapements of 1982 and 1983, respectively, were examined for tags at Alaskan weirs.

In Canada, the main stocks of sockeye salmon were considered in 1982 to be limited to the Nass and Skeena Rivers. Canada used weirs and foot surveys on the Nass and Skeena Rivers to recover tagged sockeye salmon. Meziadin Lake weir in the Nass River system and the Babine Lake weir in the Skeena River system were believed to cover most sockeye salmon escapements to each system, although nonweired spawning tributaries existed in either system. In 1983, Canada extended sampling coverage of its escapements. A commercial Canadian

fishery on the Stikine River was used to recover tagged sockeye salmon. Canada also built weirs on several minor systems in the boundary area. In addition, in 1983, substantial numbers of southward-migrating tagged sockeye salmon were caught as far south as Johnstone Strait. Canada sampled catches in Johnstone Strait for tagged fish to estimate total tagged fish in catches. Most southward-migrating fish probably originated in the Fraser River, although other stocks occur as far south as the Columbia River. Escapement to the Fraser River equaled nearly 1 million fish and total return was estimated as slightly more than 5 million fish in 1983 (Pacific Salmon Commission 1988). The main sockeye populations from Washington State were from the Cedar River in the Lake Washington system and Lake Wenatchee on the Columbia River; their combined escapements in 1983 were over 300,000 fish, and their total returns were about 380,000 fish.

Estimation of tagged sockeye salmon entering the large Nass, Skeena, and Stikine River systems posed special difficulty because of incomplete recovery of tagged fish entering the rivers. Some tagged fish probably migrated to spawning grounds without weirs and were not seen during foot surveys; others may have shed their tags, been caught in unsampled native food fisheries on the rivers, or died from other causes. In the Stikine River, recoveries obtained from the Canadian commercial fishery obviously did not include all tagged entrants. Therefore, counts of tagged fish caught in the Stikine River fishery or recovered at weirs and during foot surveys of spawning grounds of the Nass and Skeena Rivers, represented only a portion of the initial entrants to each river. Canada attempted to estimate the total tagged entrants based on numbers of tagged fish recovered by estimating the percentage of entrants which were recovered. To estimate recovery rate, fish were captured, tagged, and released at the estuary or locations within the rivers throughout migration. The recovery rate of such secondary-tagged fish was used to estimate the recovery rate of the primary-tagged entrants to the rivers.

However, outcomes of secondary-tagging experiments on sockeye salmon in the Skeena and Nass Rivers in 1983 were inconsistent. Recovery rate of releases upriver was lower than releases in the estuary or nearby ocean fisheries. If fish tagged in the rivers were representative of ocean-tagged entrants, the recovery rate of upriver releases should have been no less than that of releases in estuaries or in nearby ocean fisheries.

⁶Kurt Fresh, Washington Department of Fisheries, 115 General Administration Building, Olympia, WA 98504, pers. commun.

LGL Limited analysts provided estimates of recovery rate of primary-tagged sockeye salmon entering the Nass and Skeena Rivers (Gazey et al. 1983; English et al. 1984). The recovery rate during 1982 was based on taggings upstream within each river. The recovery rate during 1983 for the Skeena River was based solely on estuary tagging because of the contradictory lower recovery rate of upriver tagging. The recovery rate used for the Nass River for 1983 was the midpoint of a postulated range of extreme values determined partially on the nearby ocean fishery tagging, and partially on a proposed maximum. The outcome of the taggings for the Skeena and Nass Rivers in 1983 discredited upstream tagging for estimating the recovery rate of primary-tagged entrants. The recovery rate based on estuary or ocean tagging near the river entrances appeared more plausible. However, estuary or ocean tagging also probably induced mortality of sockeye salmon such that their recovery rates were not representative of primary-tagged entrants.

Substantial percentages (roughly 40%) of secondary-tagged Alaskan sockeye salmon released in estuaries during 1982 and 1983 probably died from short-term tagging stress (Pella et al. 1988). Further, we estimated that 34% of returning adult sockeye salmon tagged and released in coastal fishing areas at Kodiak Island during 1949 (Bevan 1962) were not present in catches or escapements in which they should have occurred had they survived.

Finally, the outcome of the present tagging experiments confirmed a substantial loss of primary-tagged fish from the ocean releases. Cause of the losses was not determined, but presumably included mortality, tag shedding, and migration to unsampled fisheries and spawning escapements. Initially, estimates of recovery rate provided by LGL Limited analysts were used to compute primary-tagged fish in escapements to these rivers. Later, estimates of primary-tagged sockeye salmon in all escapements and catches were combined to estimate the total accounted for by the experiments. Only 50% and 61% of the tagged fish released from Alaskan fisheries subsequently occurred in catches and escapements in 1982 and 1983, respectively. Corresponding recovery rates for releases from Canadian fisheries were 87% and 57%. Viewed in the complementary sense, 50% and 39% of primary Alaskan releases were not found in escapements or catches of 1982 and 1983, respectively; 13% and 43% were corresponding values for Canadian releases. Recovery rates from releases in individual fisheries varied considerably among the fisheries in both years.

In summary, we judged that the recovery rates obtained from secondary-tagging experiments within the Nass and Skeena Rivers are questionable in view of the contradictory outcomes of 1983. We also questioned whether values obtained from tagging in the estuary or nearby fisheries provided valid

estimates of such recovery rates in view of the probable losses from these tagged releases before they entered the rivers. Therefore, although we initially used LGL Limited analysts' estimates of recovery rates within the rivers for our assessment; alternative values were tried to evaluate effects on estimates of stock composition in the fisheries.

Pink salmon

Both Canada and Alaska had many more pink than sockeye salmon stocks. Not only were the numbers of stocks greater, but the total number of pink salmon returning to the boundary area was manyfold that of sockeye salmon during the tagging years. Pink salmon catches in boundary-area fisheries were 13, 23, and 33 million fish in 1982, 1984, and 1985 compared to corresponding sockeye salmon catches of 3, 2, and 4 million fish.

The difficulty in determining numbers of primary-tagged pink salmon in escapements was vastly increased when compared to sockeye salmon. The use of weirs to cover significant portions of escapements to either country was impractical; pink salmon spawning streams are far more numerous than sockeye salmon spawning systems, and the large physical size of many streams with large numbers of fish limited use of weirs.

Similar to sockeye salmon, the only Alaskan pink salmon stocks contributing to boundary-area fisheries were presumed those of ADFCG statistical areas 101 through 108. Pink salmon in Alaskan escapements were estimated by the ADF&G biologists from counts made during regular aerial surveys of spawning streams. These estimates and bounds, which probably contained the actual values, were available for regions within Southeast Alaska. We evaluated neither the accuracy of these escapement estimates nor validity of the bounds but viewed both as expert opinions of the analysts.

Pink salmon tags in Alaska were recovered during surveys of spawning grounds. On the surveys, carcasses examined for tags were counted and any tags were recovered. Estimates of tagged pink salmon escaping to Alaskan spawning grounds from fishery releases tagged during half-month intervals were obtained by expanding numbers of tagged fish recovered in escapements to account for escaping pink salmon not examined during the surveys. These estimates of tagged fish in escapements were obtained for regions in Southeast Alaska.

Canadian pink salmon in boundary-area fisheries were initially thought to arise mainly from stocks of northern British Columbia, but southward-migrating odd-year stocks were detected beyond the geographical range of program sampling in the 1985 tagging experiment. Numbers of these southward-migrating

fish could not be determined and such stocks were omitted from our analysis.

Tagged pink salmon escaping to spawning grounds of northern and central British Columbia were estimated from 1) stream surveys and escapement estimates from foot-survey counts, following the procedure used for Alaska, or 2) secondary-tagging experiments in conjunction with recoveries from weirs or stream surveys. Secondary tagging of pink salmon was conducted on the Skeena and Kwinamass Rivers each tagging year but on the Khutzeymateen River only in 1982. Tagged fish recovered in Canadian escapements were identified to fishery and half-month period of release, as was done for Alaskan escapements. The number of primary-tagged fish recovered in any of these rivers was expanded to account for those unobserved.

The estimates of total tagged pink salmon in boundary-area catches and escapements from Alaskan releases were 42, 55, and 59% of the fish released in 1982, 1984, and 1985, respectively; corresponding values for Canadian releases were 34, 51, and 59%. As with sockeye salmon, substantial proportions of primary-tagged pink salmon were apparently missing. Possibly the number of recoveries in catches and especially escapements were underestimated but mortality from tagging stress, shedding of tags, and migration to unsampled fisheries and spawning grounds were probably largely responsible. Similar to sockeye salmon, mortality of secondary-tagged pink salmon may have been substantial. Results of a behavioral experiment on pink salmon (Helle 1966) at Olsen Creek, Alaska, were consistent with a possible mortality from tagging stress of 40% or more.

Stock-Composition Estimation Method

After computing estimates of tagged sockeye and pink salmon in catches in various fisheries and escapements, we calculated estimates of the stock composition in the release fisheries. Ideally, estimation of stock composition from primary tagging in interceptive fisheries would be based directly on relative numbers of tagged fish from any release belonging to each contributing stock. Although the recovery of tagged fish in escapements and some catches provided clear evidence of origins, more tagged fish were caught in other interceptive fisheries when compared with terminal fisheries. Therefore, origins of most caught tagged fish were unknown. Nonetheless, recoveries of tagged fish of unknown origin in the catches could not be ignored because the stock composition of survivors to escapements was altered by intervening fisheries. To correct stock-composition estimates based on relative numbers in escapements, tagged fish caught in interceptive fisheries were allocated to stocks and combined with tagged

fish in escapements. Although fish which lost their tags should also have been included in the correction, no estimate of their numbers was available. Estimates of the percentages of fish from stocks or regional groups of stocks in an interceptive fishing area were then computed as the percentages of total recoveries from the releases in that area, either in the escapements or allocated from the catches to the stocks or stock groups. Releases were grouped by fishery and half-month period of the season, and corresponding estimates of stock composition were determined for these strata.

The procedure by which we allocated recovered tags of catches to stocks was described by Gazey (1983). Any allocation was arbitrary to some extent, in that no basis exists by which the destinations of releases from a particular fishery, subsequently caught in an interceptive fishery, can be inferred from the taggings. The method of Gazey (1983) infers the stock destinations of the mix of tags originating from all release areas subsequently caught in an intervening fishery from the presumed-available stock composition in the intervening fishery. However, the stock composition of the component groups of tagged fish, coming from different release sites to the intervening fishery, almost surely varies among the groups, yet the method allocates the tagged fish of these groups caught by the intervening fishery as if they were the same. Numerical simulation studies demonstrated that the adopted procedure provided accurate estimates of stock composition if numbers tagged in fisheries were proportional to abundance. The tagging program was conducted with the intention, at least, to approximate such proportional tagging. However, we could not determine the degree to which this condition was satisfied.

Stock-Composition Estimates

Sockeye salmon

Most sockeye salmon in Alaskan and Canadian catches originated in Canada. The percentage of Alaskan-origin sockeye salmon in Alaskan fisheries was greater than in Canadian fisheries; only a small percentage of the catch in Canada was of Alaskan origin. Alaskan sockeye salmon stocks were relatively more abundant in 1982 than in 1983, compared to Canadian stocks of those years.

As expected, the Canadian Nass and Skeena River sockeye salmon stocks were major contributors to most fisheries of the boundary area. Although both stocks were present throughout the fishing seasons, the bulk of Nass River stocks tended to return earlier than that of the Skeena River stocks. The main Alaskan stocks originated in Southeast Alaska (ADF&G statistical areas 101 and 102). Stikine River sockeye salmon stocks

were significant contributors at times during 1983 in several fisheries, including Sumner Strait and Tree Point in Alaska, and at Langara Island in Canada. Finally, southward-migrating stocks, presumably mainly from the Fraser River, were found in significant percentages at times in 1983. The southward-migrating stocks appeared most abundant in outer coastal fisheries at Noyes Island in Alaska and Langara Island in Canada, as well as in Canadian fisheries at the southern portion of the study area.

Sensitivity analysis.-To evaluate the effects of possible errors in estimates of escaping tagged fish, stock-composition estimates were recomputed for several combinations of estimates of Alaskan escapements and mortality rates of secondary-tagged fish of the Nass, Skeena, and Stikine rivers. The three estimates of Alaskan escapements were the point estimate, and lower and upper bounds of the 90% confidence interval. Two choices of mortality rate of secondary-tagged fish in the Canadian rivers were 0% and 40%. Assuming 40% mortality reduced estimates of ocean-tagged fish escaping to the Nass, Skeena, and Stikine rivers to 60% of the values using 0% mortality. Five combinations of estimates of Alaskan escapement and Canadian tagging mortality were examined. The extremes of possible errors in estimates of tagged fish escaping were presumably included in the values used.

Regardless of the combination of estimates used, subsequent stock-composition estimates of season catches in Canada changed by 6 percentage points or less. Changes in some Alaskan fisheries were greater, as much as 25 percentage points. However, in 2 of 4 Alaskan fisheries of 1982 and 4 of 6 of 1983, changes were no greater than 10 percentage points. Concern that errors in Alaskan escapement estimates or mortality of secondary-tagged fish severely affect stock composition estimates was largely allayed for all Canadian fishing areas, as well as the important Alaskan fishing areas at Noyes Island, Dall Island, Lower Clarence Strait, and Tree Point.

Pink salmon

The catch of Alaskan-origin pink salmon in Alaskan fisheries generally remained greater than 75% throughout the season in all years of tagging. Only at Tree Point and Revillagigedo Channel did the percentage drop lower. Furthermore, the percentage of Alaskan pink salmon in Canadian fisheries was more variable among areas and years of tagging than in Alaska; as expected, the percentage of Alaskan pink salmon was generally greatest in Canadian areas adjoining Alaska.

Finally, the percentage of Alaskan pink salmon in Canadian fishing areas in 1984 and 1985 was generally greatest early in the season but declined later. In 1982, the percentage of Alaskan pink salmon in the Canadian fishing areas also was high early and generally declined until it rebounded near the end of the season.

Pink salmon stocks from Alaska, ADF&G statistical area 101, were abundant throughout most of the boundary area, especially early in the season for all years. Stocks from ADF&G statistical areas 102 and 103 appeared later and primarily in Alaskan fisheries or in Canadian fisheries of Dixon Entrance. Canada area 3 stocks and Skeena River stocks were significant contributors to Canadian fishing areas, as well as to Alaskan fishing areas bounding Dixon Entrance. Stocks south of the Skeena River were detected in 1984 and 1985. In 1984, no tags were recovered in catches or escapements south of Canada area 6. However, in 1985, tags were recovered in escapements as far south as central British Columbia and in catches around Vancouver Island. Increased geographical region of recovery of tagged fish may have resulted from increase in Canadian recovery efforts.

Sensitivity analysis.-To evaluate the effects of possible errors in estimates of escaping tagged fish, stock-composition estimates were recomputed for several combinations of estimates of escapements and mortality rates of secondary-tagged pink salmon of the Skeena, Khutzeymateen, and Kwinamass Rivers. The three estimates of escapements to Alaska and Canada were the upper and lower bounds and point estimates. Two choices of mortality rate of secondary-tagged fish in the Canadian rivers were 0% and 40%. Assuming 40% mortality of secondary-tagged fish reduced estimates of ocean-tagged fish escaping to the Skeena, Khutzeymateen, and Kwinamass Rivers to 60% of the values using 0% mortality. Five combinations of estimates of Alaskan escapements and Canadian secondary-tagging mortality rate were examined for 1982. (Canadian escapements to systems other than those in the secondary-tagging program were omitted for 1982.) Four combinations of Alaskan and Canadian escapement estimates and Canadian secondary-tagging mortality rate were examined for 1984 and 1985. The extremes of possible errors in estimates of tagged fish escaping were presumably included in the values used.

Regardless of the combination of estimates used, subsequent stock-composition estimates of season catches in Alaskan fisheries (other than Tree Point and Revillagigedo Channel) changed by only a few percentage points. In some Canadian fisheries, stock-composition estimates of season catches changed up to 21 percentage points. Concern that errors in escapement estimates or mortality of secondary-

tagged pink salmon severely affect subsequent stock-composition estimates was allayed for many fisheries.

Caveats and Qualifications

Information derived from the U.S.-Canada program of tagging adult salmon in fisheries for estimation of stock composition of catches was rife with difficulties. Stock origins of tagged fish released from interceptive fisheries could not be identified until they had migrated to terminal areas. Intervening fisheries caught many tagged fish before they could escape to terminal areas. Importantly, substantial numbers of tagged fish apparently died from tagging stress or shed their tags, and some may have migrated to unmonitored spawning grounds or been caught in unsampled fisheries. The numbers of tagged survivors released in a fishery, which escaped to the various terminal areas, were not representative of their original numbers at release. Correction of stock-composition estimates, based on relative numbers of tagged fish in escapements, for losses en route to the spawning grounds only accounted for tagged fish caught in intervening fisheries. Furthermore, this correction, which relied on the allocation of the tagged fish in catches to stocks of origin, was only expected to be successful if numbers of tagged fish released were in proportion to overall stock abundance in the fisheries. Tagging was directed to this goal, but degree of achievement was unknown. Therefore, in the tagging years, the stock-composition estimates presented must be considered susceptible to this source of bias. In years without tagging, estimation of stock composition in northern boundary-area fisheries presents even greater difficulty.

Stock composition in the northern boundary-area fisheries probably varies among years as magnitudes of stocks, ocean conditions, and the fisheries themselves change. Clearly, past or future stock contributions to northern boundary-area fisheries vary from their levels during the tagging studies as relative magnitudes of stocks change. As an example, the odd-year pink salmon stocks of the Skeena River appeared to have increased significantly in magnitude relative to Southeast Alaska stocks after the 1985 taggings.

Migration routes of stocks are probably affected by annual changes in oceanographic conditions of the region (Hamilton and Mysak 1986). Therefore, an El Nino event during 1982-83 (Wooster and Fluharty 1985) with associated warmer ocean temperatures along the western coast of Southeast Alaska and British Columbia in 1983, as compared to 1982, would have contributed to observed variations of stock composition of northern boundary-area fisheries during tagging years. El Nino events occur at irregular intervals roughly every 2-7 years, vary in strength, and presumably affect to varying

degrees the stock composition in northern boundary-area fisheries.

Finally, distribution of fishing effort and associated catch by time of season within fishing areas change because of decisions by fishermen and fishery managers.< Because salmon stocks have their own timings of passage through the fishing areas, the fishery changes could alter the stock composition of catches. Clearly, based on results of these experiments, assessing stock composition of catches in northern boundary-area fisheries in years without tagging will be subject to great uncertainty.

As a final caveat, we warn that the estimates of stock composition and interpretation of results are ours alone for use by the United States in negotiations with Canada regarding northern boundary-area fisheries; Canada has obtained similar analyses of the taggings from staff of LGL Limited. We used much of the methodology developed by LGL Limited in our analysis; generally, their estimates of stock composition in northern boundary-area fisheries from the taggings appear to agree reasonably well with our estimates when we assumed, as they did, that initial mortality of secondary-tagged fish from stress was negligible. Unique aspects of the analyses necessarily make identification of the source of any disagreements difficult. For example, partitioning of time of release differed (LGL Limited chose months and we chose half-month periods) because of individual judgments of best approach. In a few cases, area of release was partitioned differently by us because of interests within Alaska. Efforts are ongoing between Canada and the United States within the Pacific Salmon Commission to determine estimates of stock composition in northern boundary-area fisheries that are mutually agreeable to both countries.

ACKNOWLEDGMENTS

The scale of these tagging experiments required the cooperation of many fisheries management and research employees of Canada and the United States. We shall not attempt to identify the many individuals involved, but acknowledge those we knew were involved directly in the planning and direction of these studies.

The planning of these tagging experiments was begun by personnel of the Canada Department of Fisheries and Oceans and the Alaska Department of Fish and Game. Brian Riddell of the Pacific Biological Station at Nanaimo, B.C., and consultants of Environmental and Social Systems Analysts Ltd. of Vancouver, B.C., and LGL Limited of Sidney, B.C.,--including Karl English, Bill Gazey, and Mike Staley--developed and applied for Canada the basic estimation procedure we followed; they also recommended the numbers of tagged fish to be released in each experiment, based on simulation studies. Staff of LGL Limited also directed the tagging and recovery of both sockeye and pink salmon in Canada. Dave Cantillon, Gary Gunstrom, and Mel Seibel of the Alaska Department of Fish and Game initiated the planning of tagging and recovery in Alaska. Jack Bailey, Bill Heard, and Jack Helle of the National Marine Fisheries Service (NMFS) directed the planning and execution of the recovery effort for sockeye salmon in Alaska. Jim Olsen of the NMFS administered the program for the United States.

We received helpful reviews of an earlier version of the manuscript from Jim Blick and Mel Seibel (Alaska Department of Fish and Game), and Richard Carlson and Aven Andersen (NMFS).

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TABLES

Table 1. --Delineation of general areas of release in
Southeast Alaska in terms of the Alaska Department
of Fish and Game statistical system.'

| Release area | Areas and subareas |
|------------------------|---------------------------------------------|
| Noyes Island | 10430, 10435, 10440 |
| Dall Island | 10410, 10420 |
| Cordova Bay | 10311, 10325, 10328, 10330, 10340 |
| Lower Clarence Strait | 10125, 10129, 10210, 10220, 10240, 10250 |
| Middle Clarence Strait | 10270, 10280 |
| Union Bay | 10710 |
| Upper Clarence Strait | 10610, 10620, 10630 |
| Sumner Strait | 10641 |
| Revillagigedo Channel | 10123, 10130, 10141, 10153 |
| Tree Point | 10111 |

*The first three digits represent an ADF&G statistical area, and the last two digits represent a statistical subarea.

Table 2. --Delineation of general areas of release in British Columbia in terms of the Canada Department of Fisheries and Oceans statistical system.

| Release area | Areas and subareas |
|----------------|--------------------|
| Langara Island | 1-1 through 1-5 |
| 3x | 3.1 |
| 3Y | 3.2 through 3.6 |
| 3Z | 3.7 through 3.12 |
| 4 | 4.1 through 4.11 |
| 5 | 5.1 through 5.20 |
| 6 | 6.5 through 6.10 |

Table 3. --Delineation of areas of release in Canada's Dixon Entrance in terms of Canada Department of Fisheries and Oceans statistical system by year: 1984 and 1985.

| Release area | Areas and subareas | |
|--------------|--------------------|------------------------------|
| | 1984 | 1985 |
| Northwest | 1-10 | 101-4 |
| Northeast | 1-11,1-12 | 101-8 |
| South | 1-16,1-17,1-18 | 101-7 |
| Other | 1-13,1-14 1-15 | 101-5,101-6, 101-9,101-10 |

Table 4. --Number of tagged sockeye salmon released
in southern Southeast Alaska and north-
ern British Columbia, 1982 and 1983.

| Release location | 1982 | 1983 |
|------------------------|--------|--------|
| <u>Alaska</u> | | |
| Noyes Island | 2,813 | 3,047 |
| Dall Island | 1,442 | 1,039 |
| Cordova Bay | 29 | 0 |
| Lower Clarence Strait | 373 | 473 |
| Middle Clarence Strait | 386 | 0 |
| Union Bay | 114 | 0 |
| Upper Clarence Strait | 2,196 | 1,716 |
| Sumner Strait | 0 | 1,998 |
| Revillagigedo Channel | 617 | 134 |
| Tree Point | 1,080 | 749 |
| Alaska total | 9,050 | 9,156 |
| <u>Canada</u> | | |
| Langara Island | 7,909 | 4,314 |
| Dixon Entrance | 47 | 0 |
| 3x | 10,090 | 2,958 |
| 3Y | 5,920 | 1,308 |
| 3Z | 1,348 | 2,493 |
| 4 | 5,637 | 758 |
| 5 | 490 | 306 |
| Canada total | 31,405 | 12,137 |
| Totals | 40,455 | 21,293 |

Table 5. --Estimates of total numbers' of tagged sockeye salmon caught in Alaskan and Canadian fisheries by general area and period of release, 1982.

| Release location | Release period | | | | | | | |
|------------------------|----------------|--------|----------|--------|-----------|--------|----------|--------|
| | 15-30 Jun | | 1-15 Jul | | 16-31 Jul | | 1-15 Aug | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 150 | 177 | 86 | 166 | 43 | 151 | 52 | 15 |
| Dall Island | 55 | 122 | 0 | 6 | 0 | 0 | 0 | 9 |
| Cordova Bay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lower Clarence Strait | 16 | 17 | 10 | 31 | 0 | 0 | 10 | 4 |
| Middle Clarence Strait | 0 | 0 | 86 | 5 | 0 | 3 | 2 | 2 |
| Union Bay | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 |
| Upper Clarence Strait | 0 | 0 | 124 | 71 | 99 | 299 | 35 | 37 |
| Revillagigedo Channel | 13 | 89 | 8 | 10 | 36 | 69 | 8 | 0 |
| Tree Point | 40 | 127 | 11 | 152 | 11 | 167 | 13 | 13 |
| Alaska total | 274 | 532 | 325 | 441 | 189 | 701 | 120 | 80 |
| <u>Canada</u> | | | | | | | | |
| Langara Island | 234 | 1,395 | 139 | 670 | 5 | 428 | 0 | 0 |
| Dixon Entrance | 0 | 0 | 3 | 27 | 0 | 10 | 0 | 0 |
| 3x | 256 | 441 | 233 | 1,807 | 32 | 2,629 | 8 | 77 |
| 3Y | 55 | 3,155 | 84 | 533 | 10 | 338 | 0 | 18 |
| 3Z | 10 | 494 | 6 | 74 | 0 | 91 | 0 | 0 |
| 4 | 16 | 135 | 33 | 493 | 66 | 1,797 | 0 | 56 |
| 5 | 0 | 0 | 0 | 0 | 0 | 27 | 0 | 45 |
| Canada total | 571 | 5,620 | 498 | 3,604 | 113 | 5,320 | 8 | 196 |
| Totals | 845 | 6,152 | 823 | 4,045 | 302 | 6,021 | 128 | 276 |

*Numbers of actual tag recoveries expanded for subsampling of catches.

Table 6. --Estimates of total numbers* of tagged sockeye salmon caught in Alaskan and Canadian fisheries by general area and period of release, 1983.

| Release location | Release period | | | | | | | |
|-----------------------|----------------|--------|----------|--------|-----------|--------|----------|--------|
| | 15-30 Jun | | 1-15 Jul | | 16-31 Jul | | 1-15 Aug | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 47 | 2 | 91 | 147 | 375 | 142 | 71 | 74 |
| Dall Island | 29 | 23 | 7 | 5 | 70 | 106 | 22 | 94 |
| Lower Clarence Strait | 0 | 0 | 0 | 0 | 1 | 130 | 32 | 115 |
| Upper Clarence Strait | 27 | 0 | 39 | 117 | 87 | 72 | 42 | 1 |
| Sumner Strait | 121 | 12 | 122 | 33 | 26 | 35 | 91 | 13 |
| Revillagigedo Channel | 0 | 1 | 21 | 10 | 0 | 11 | 0 | 0 |
| Tree Point | 15 | 0 | 50 | 67 | 32 | 184 | 14 | 115 |
| Alaska total | 239 | 38 | 330 | 379 | 605 | 680 | 272 | 412 |
| <u>Canada</u> | | | | | | | | |
| Langara Island | 91 | 20 | 13 | 252 | 14 | 84 | 0 | 29 |
| 3x | 15 | 21 | 15 | 374 | 0 | 123 | 0 | 232 |
| 3Y | 15 | 10 | 14 | 60 | 5 | 49 | 7 | 309 |
| 3Z | 19 | 8 | 0 | 67 | 24 | 739 | 7 | 296 |
| 4 | 0 | 1 | 0 | 112 | 5 | 19 | 0 | 10 |
| 5 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 |
| Canada total | 140 | 60 | 42 | 876 | 48 | 1,014 | 14 | 876 |
| Totals | 379 | 98 | 372 | 1,255 | 653 | 1,694 | 286 | 1,288 |

*Numbers of actual tag recoveries expanded for subsampling of catches.

Table 7. --Southeast Alaskan sockeye salmon escapement and weir counts by fishing district, 1982 and 1983.

| Fishing district | Weir counts | | Escapement estimates' 11,000s of fish) | | | | | |
|------------------|-------------|---------|-------------------------------------------|------|------|------|------|------|
| | | | 1982 | | | 1983 | | |
| | 1982 | 1983 | Low | Best | High | Low | Best | High |
| 101 | 75,570 | 72,616 | 76 | 106 | 143 | 72 | 108 | 153 |
| 102 | 55,966 | 31,283 | 58 | 81 | 109 | 43 | 64 | 90 |
| 103 | 22,213 | 8,327 | 48 | 66 | 89 | 33 | 50 | 71 |
| 104-108 | 16,042 | 14,023 | 72 | 101 | 136 | 68 | 102 | 144 |
| Totals | 169,791 | 126,249 | 254 | 354 | 477 | 216 | 324 | 458 |

*Estimates of total escapement and its lower (Low) and upper (High) 90% confidence bounds are provided by Pella et al. (1988); corresponding values for fishing districts were obtained from unreported numerical results of Pella et al. (1988) by summing weir counts and estimates over systems within districts.

Table 8. --Numbers of sockeye salmon released in secondary tagging on the Skeena, Nass, and Stikine Rivers (adjusted for straying), numbers recovered at weirs or during foot-surveys of spawning grounds (Nass and Skeena Rivers) or in the commercial river fishery (Stikine River), and the recovery rate of tagged fish in each river, 1982 and 1983 (Source: Gazey et al. 1983; English et al. 1984).

| River system | 1982 | | | 1983' | | |
|--------------|---------------|------------------|-------------------|---------------|------------------|-------------------|
| | Number tagged | Number recovered | Recovery rate (%) | Number tagged | Number recovered | Recovery rate (%) |
| Skeena | 3,325 | 559 | 17 | 1,698 | 420 | 25 |
| Nass | 3,049 | 1,305 | 43 | 150 | 92 | 61 |
| Stikine | 0 | | | 862 | 187 | 22 |

*In 1983, results of tagging in the Skeena River estuary (area 4.12) were used for the Skeena River. Also in 1983, the value for number tagged on the Nass River was concocted by LGL Limited analysts to provide the reported value of recovery rate based on actual number recovered. The reported value of recovery rate for the Nass River was the midpoint between extremes determined by portion recovered from primary tagging in area 32 and other unspecified information (English et al. 1984).

Table 9.--Estimates of total numbers of tagged sockeye salmon escaping to Alaskan and Canadian spawning areas by period and general area of release, 1982.

| Release location | Release period | | | | | | | |
|------------------------|----------------|--------|-----------|--------|------------|--------|-------------|--------|
| | 15-30 June | | 1-15 July | | 16-31 July | | 1-15 August | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 80 | 303 | 14 | 20 | 0 | 170 | 0 | 12 |
| Dall Island | 49 | 60 | 5 | 0 | 0 | 0 | 0 | 53 |
| Cordova Bay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lower Clarence Strait | 46 | 14 | 17 | 23 | 0 | 0 | 3 | 0 |
| Middle Clarence Strait | 0 | 0 | 58 | 0 | 4 | 12 | 2 | 0 |
| Union Bay | 0 | 0 | 1 | 0 | 10 | 18 | 1 | 0 |
| Upper Clarence Strait | 0 | 0 | 88 | 2 | 46 | 133 | 23 | 98 |
| Revillagigedo Channel | 43 | 33 | 35 | 7 | 20 | 58 | 1 | 5 |
| Tree Point | 8 | 19 | 14 | 85 | 35 | 83 | 8 | 12 |
| Alaska total | 226 | 429 | 232 | 137 | 115 | 474 | 38 | 180 |
| <u>Canada</u> | | | | | | | | |
| Langara Island | 102 | 1,251 | 18 | 209 | 5 | 229 | 0 | 0 |
| Dixon Entrance | 0 | 0 | 6 | 2 | 0 | 0 | 0 | 0 |
| 3x | 68 | 379 | 58 | 770 | 11 | 2,192 | 0 | 454 |
| 3Y | 7 | 1,057 | 14 | 657 | 3 | 199 | 6 | 83 |
| 3Z | 1 | 44 | 0 | 95 | 4 | 122 | 0 | 0 |
| 4 | 12 | 1,405 | 0 | 299 | 22 | 1,037 | 0 | 305 |
| 5 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 311 |
| Canada total | 190 | 4,136 | 96 | 2,032 | 45 | 3,785 | 6 | 1,153 |
| Totals | 416 | 4,565 | 328 | 2,169 | 160 | 4,259 | 44 | 1,333 |

Table 10. --Estimates of total numbers of tagged sockeye salmon escaping to Alaskan and Canadian spawning areas by period and general area of release, 1983.

| Release location | Release period | | | | | | | |
|-----------------------|----------------|--------|-----------|--------|------------|--------|-------------|--------|
| | 15-30 June | | 1-15 July | | 16-31 July | | 1-15 August | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 14 | 73 | 53 | 138 | 18 | 436 | 8 | 117 |
| Dall Island | 9 | 148 | 4 | 6 | 7 | 154 | 0 | 27 |
| Lower Clarence Strait | 0 | 0 | 0 | 0 | 6 | 105 | 3 | 16 |
| Upper Clarence Strait | 41 | 3 | 167 | 33 | 84 | 23 | 15 | 8 |
| Sumner Strait | 102 | 131 | 120 | 53 | 99 | 49 | 64 | 4 |
| Revillagigedo Channel | 1 | 12 | 18 | 21 | 0 | 11 | 0 | 0 |
| Tree Point | 6 | 28 | 16 | 52 | 26 | 66 | 0 | 31 |
| Alaska total | 173 | 395 | 378 | 303 | 240 | 844 | 90 | 203 |
| <u>Canada</u> | | | | | | | | |
| Langara Island | 9 | 73 | 7 | 113 | 1 | 176 | 0 | 38 |
| 3x | 4 | 385 | 2 | 394 | 0 | 375 | 1 | 146 |
| 3Y | 5 | 269 | 7 | 220 | 0 | 53 | 0 | 110 |
| 3Z | 1 | 408 | 4 | 287 | 0 | 537 | 0 | 66 |
| 4 | 0 | 10 | 0 | 34 | 0 | 57 | 0 | 0 |
| 5 | 0 | 7 | 0 | 5 | 0 | 0 | 0 | 0 |
| Canada total | 19 | 1,152 | 20 | 1,053 | 0 | 1,198 | 1 | 360 |
| Totals | 192 | 1,547 | 398 | 1,356 | 241 | 2,042 | 91 | 563 |

Table 11. --Numbers of tagged sockeye salmon released, combined numbers estimated as caught or escaping, percentage of total estimated recoveries from catch and escapement, and recovery rate of tagged releases estimated as occurring in catch or escapement, by release fishery and year.

| Release fishery* | Number | | Total | | Percentage of recoveries | | | | Recovery | |
|------------------|----------|--------|------------|--------|--------------------------|------|------------|------|----------|------|
| | released | | recoveries | | Catch | | Escapement | | rate (%) | |
| | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 |
| <u>Alaska</u> | | | | | | | | | | |
| Noyes | 2,813 | 3,047 | 1,439 | 1,806 | 58 | 53 | 42 | 47 | 51 | 59 |
| Dall | 1,442 | 1,039 | 359 | 711 | 53 | 50 | 47 | 50 | 25 | 68 |
| Cordova | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Lclar | 373 | 473 | 191 | 432 | 46 | 68 | 54 | 32 | 51 | 91 |
| Mclar | 386 | 0 | 174 | 0 | 56 | 0 | 44 | 0 | 45 | |
| Union | 114 | 0 | 42 | 0 | 29 | 0 | 71 | 0 | 37 | |
| Uclar | 2,196 | 1,716 | 1,055 | 759 | 63 | 51 | 37 | 49 | 48 | 44 |
| Sumner | 0 | 1,998 | 0 | 1,075 | 0 | 42 | 0 | 58 | | 54 |
| Revla | 617 | 134 | 435 | 106 | 54 | 41 | 46 | 59 | 71 | 79 |
| Tree | 1,080 | 749 | 798 | 702 | 67 | 68 | 33 | 32 | 74 | 94 |
| Alaska tot. | 9,050 | 9,156 | 4,493 | 5,591 | 59 | 53 | 41 | 47 | 50 | 61 |
| <u>Canada</u> | | | | | | | | | | |
| L = % | 7,909 | 4,314 | 4,685 | 920 | 61 | 55 | 39 | 45 | 59 | 21 |
| Dixon | 47 | 0 | 48 | 0 | 83 | 0 | 17 | 0 | | - |
| 3x | 10,090 | 2,958 | 9,415 | 2,087 | 58 | 37 | 42 | 63 | 93 | 71 |
| 3Y | 5,920 | 1,308 | 6,219 | 1,133 | 67 | 41 | 33 | 59 | 105 | 87 |
| 3Z | 1,348 | 2,493 | 941 | 2,463 | 72 | 47 | 28 | 53 | 70 | 99 |
| 4 | 5,637 | 758 | 5,676 | 248 | 46 | 59 | 54 | 41 | 101 | 33 |
| 5 | 490 | 306 | 389 | 23 | 19 | 48 | 81 | 52 | 79 | 8 |
| Can. tot. | 31,405 | 12,137 | 27,373 | 6,874 | 58 | 45 | 42 | 55 | 87 | 57 |
| Totals | 40,455 | 21,293 | 31,866 | 12,465 | 58 | 48 | 42 | 52 | 79 | 59 |

*Noyes = Noyes Island; Dall = Dall Island; Cordova = Cordova Bay; Lclar = Lower Clarence Strait; Mclar = Middle Clarence Strait; Union = Union Bay; Uclar = Upper Clarence Strait; Sumner = Sumner Strait; Revla = Revillagigedo Channel; Tree = Tree Point; Lang - Langara Island; and Dixon - Dixon Entrance.

Table 12. --1982 stock-composition estimates (%) of sockeye salmon by area and period of release, totals for Alaska and Canada (%), and estimated numbers of tagged fish in 'Alaskan and Canadian escapements (%). Best estimates of escapements were used, and recovery rate of primary-tagged entrants to major rivers in Canada was assumed to equal that of secondary-tagged fish.

| Release area ^a | Alaska stocks | | | | Canada stocks | | Total | | Esc. | |
|-------------------------------------|---------------|-----|-----|-------|---------------|--------|-------|------|------|------|
| | 101 | 102 | 103 | other | Nass | Skeena | AX | Can. | AK | Can. |
| Release period 1: June | | | | | | | | | | |
| <u>Alaska</u> | | | | | | | | | | |
| Noyes | 7 | 4 | 3 | 1 | 37 | 48 | 15 | 85 | 21 | 79 |
| Dall | 15 | 3 | 5 | 1 | 34 | 44 | 23 | 78 | 45 | 55 |
| Lclar | 27 | 24 | 3 | 0 | 33 | 12 | 55 | 45 | 77 | 23 |
| Revla | 28 | 0 | 0 | 0 | 62 | 10 | 28 | 72 | 57 | 43 |
| Tree | 9 | 0 | 0 | 0 | 75 | 15 | 10 | 90 | 31 | 69 |
| <u>Canada</u> | | | | | | | | | | |
| Lang | 5 | 1 | 0 | 0 | 27 | 67 | 7 | 93 | 8 | 92 |
| 3x | 9 | 0 | 0 | 0 | 60 | 30 | 10 | 90 | 15 | 85 |
| 3Y | 4 | 1 | 0 | 0 | 86 | 10 | 4 | 96 | 1 | 99 |
| 3Z | 5 | 1 | 0 | 0 | 85 | 9 | 6 | 94 | 3 | 97 |
| 4 | 0 | 0 | 0 | 0 | 3 | 97 | 0 | 100 | 0 | 100 |
| Release period 2: early to mid-July | | | | | | | | | | |
| <u>Alaska</u> | | | | | | | | | | |
| Nowey | 10 | 7 | 3 | 2 | 21 | 57 | 22 | 78 | 41 | 59 |
| Dall | 14 | 34 | 0 | 0 | 31 | 20 | 48 | 52 | 100 | 0 |
| Uclar | 14 | 26 | 0 | 5 | 18 | 38 | 44 | 56 | 97 | 3 |
| Union ^b | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Mclar | 27 | 27 | 0 | 16 | 16 | 14 | 70 | 30 | 100 | 0 |
| Lclar | 21 | 6 | 0 | 1 | 16 | 56 | 28 | 72 | 43 | 57 |
| Revla | 52 | 2 | 0 | 10 | 24 | 12 | 64 | 36 | 83 | 17 |
| Tree | 8 | 0 | 0 | 0 | 35 | 56 | 9 | 91 | 14 | 86 |
| <u>Canada</u> | | | | | | | | | | |
| Dixon | 17 | 0 | 0 | 0 | 46 | 36 | 18 | 82 | 71 | 29 |
| Lang | 8 | 1 | 1 | 1 | 18 | 71 | 10 | 90 | 8 | 92 |
| 3x | 5 | 0 | 0 | 0 | 22 | 72 | 5 | 95 | 7 | 93 |
| 3Y | 4 | 0 | 0 | 1 | 58 | 37 | 5 | 95 | 2 | 98 |
| 3Z | 1 | 0 | 0 | 0 | 79 | 20 | 1 | 99 | 0 | 100 |
| 4 | 3 | 0 | 0 | 1 | 8 | 88 | 4 | 96 | 0 | 100 |

Table 12. --Continued.

| Release area' | Alaska stocks | | | | Canada stocks | | Total | | Esc. | |
|------------------------------------|---------------|-----|-----|-------|---------------|--------|-------|------|------|------|
| | 101 | 102 | 103 | other | Nass | Skeena | AK | Can. | AK | Can. |
| Release period 3: mid- to end July | | | | | | | | | | |
| <u>Alaska</u> | | | | | | | | | | |
| Noyes | 1 | 0 | 1 | 0 | 7 | 90 | 3 | 97 | 0 | 100 |
| Uclar | 3 | 3 | 1 | 5 | 8 | 80 | 12 | 88 | 26 | 74 |
| Union ^b | 4 | 8 | 0 | 14 | 3 | 72 | 26 | 74 | 36 | 64 |
| Mclar ^b | 0 | 0 | 0 | 22 | 1 | 77 | 22 | 78 | 26 | 74 |
| Revla | 14 | 0 | 1 | 0 | 22 | 64 | 15 | 85 | 25 | 75 |
| Tree | 12 | 0 | 1 | 1 | 20 | 66 | 14 | 86 | 30 | 70 |
| <u>Canada</u> | | | | | | | | | | |
| Dixon ^b | 1 | 0 | 1 | 0 | 4 | 93 | 3 | 97 | 0 | 100 |
| Lang | 1 | 0 | 1 | 0 | 8 | 89 | 3 | 97 | 2 | 98 |
| 3X | 1 | 0 | 1 | 0 | 7 | 91 | 2 | 98 | 1 | 99 |
| 3Y | 1 | 0 | 1 | 0 | 15 | 83 | 2 | 98 | 1 | 99 |
| 3Z | 2 | 0 | 0 | 0 | 35 | 62 | 3 | 97 | 3 | 97 |
| 4 ^b | 1 | 0 | 1 | 0 | 4 | 93 | 3 | 97 | 2 | 98 |
| 5 ^b | 1 | 0 | 1 | 0 | 5 | 93 | 2 | 98 | 0 | 100 |
| Release period 4: August | | | | | | | | | | |
| <u>Alaska</u> | | | | | | | | | | |
| Noyes | 4 | 0 | | 0 | 16 | 79 | 4 | 96 | 0 | 100 |
| Dall | 0 | 0 | | 0 | 8 | 92 | 0 | 100 | 0 | 100 |
| Uclar ^b | 3 | 17 | | 6 | 9 | 65 | 26 | 74 | 19 | 81 |
| Union ^b | 0 | 100 | | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Mclar ^b | 2 | 47 | | 0 | 5 | 46 | 49 | 51 | 100 | 0 |
| Lclar ^b | 11 | 25 | | 9 | 35 | 20 | 44 | 56 | 100 | 0 |
| Revla ^b | 23 | 0 | | 0 | 77 | 0 | 23 | 77 | 23 | 77 |
| Tree | 18 | 28 | | 0 | 25 | 29 | 46 | 54 | 42 | 58 |
| <u>Canada</u> | | | | | | | | | | |
| 3X | 0 | 0 | | 0 | 1 | 98 | 0 | 100 | 0 | 100 |
| 3Y | 5 | 0 | | 0 | 4 | 90 | 5 | 95 | 6 | 94 |
| 4 | 0 | 0 | | 0 | 0 | 100 | 0 | 100 | 0 | 100 |
| 5 | 0 | 0 | | 0 | 0 | 100 | 0 | 100 | 0 | 100 |

^aNoyes = Noyes Island; Dall = Dall Island; Union = Union Bay; Lclar = Lower Clarence Strait; Mclar = Middle Clarence Strait; Uclar = Upper Clarence Strait; Revla = Revillagigedo Channel; Tree = Tree Point; Lang = Langara Island; and Dixon = Dixon Entrance.

^bFewer than 10 tagged fish were recovered in catches and escapements from these releases of tagged fish, and the estimates of stock composition should be considered in light of this limited basis.

Table 13. --1983 stock-composition estimates (%) of sockeye salmon by area and period of release, totals for Alaska and Canada (%), and estimated numbers of tagged fish in Alaskan and Canadian escapements

Best estimates of escapements were used, and recovery rate of primary-tagged entrants to major rivers in Canada was assumed equal to that of secondary-tagged fish.

| Release area ^b | Alaska stocks | | | | Canada stocks | | | | Total | | Esc. | |
|---------------------------|---------------|-----|-----|------|---------------|------|------|-------|-------|------|------|------|
| | 101 | 102 | 103 | oth. | Nass | Skn. | oth. | Stik. | AK | Can. | AK | Can. |

Release period 1: June

Alaska

| | | | | | | | | | | | | |
|--------------------|----|----|---|---|----|----|---|----|----|----|----|----|
| Noyes | 5 | 7 | 5 | 0 | 59 | 19 | 1 | 4 | 17 | 83 | 16 | 84 |
| Dall | 3 | 4 | 0 | 0 | 73 | 16 | 0 | 4 | 7 | 93 | 6 | 94 |
| Sumnr | 8 | 30 | 0 | 4 | 22 | 0 | 1 | 34 | 43 | 57 | 44 | 56 |
| Uclar | 3 | 64 | 0 | 0 | 30 | 0 | 0 | 2 | 68 | 32 | 93 | 7 |
| Revla ^c | 11 | 0 | 0 | 0 | 89 | 1 | 0 | 0 | 11 | 89 | 11 | 89 |
| Tree | 18 | 0 | 0 | 0 | 69 | 0 | 0 | 14 | 18 | 82 | 18 | 82 |

Canada

| | | | | | | | | | | | | |
|----------------|----|---|---|---|----|----|----|---|----|-----|----|-----|
| Lang | 12 | 3 | 0 | 0 | 69 | 6 | 1 | 9 | 15 | 85 | 12 | 88 |
| 3X | 1 | 1 | 0 | 0 | 27 | 70 | 1 | 1 | 2 | 98 | 1 | 99 |
| 3Y | 2 | 1 | 0 | 0 | 91 | 3 | 1 | 2 | 3 | 97 | 2 | 98 |
| 3Z | 1 | 0 | 0 | 0 | 90 | 8 | 0 | 0 | 1 | 99 | 0 | 100 |
| 4 ^c | 0 | 0 | 0 | 0 | 50 | 0 | 50 | 0 | 0 | 100 | 0 | 100 |
| 5 ^c | 0 | 0 | 0 | 0 | 25 | 60 | 15 | 0 | 0 | 100 | 0 | 100 |

Release period 2: early to mid-July

Alaska

| | | | | | | | | | | | | |
|-------------------|----|----|---|----|----|----|---|----|----|----|----|----|
| Noyes | 6 | 4 | 5 | 4 | 38 | 39 | 4 | 0 | 18 | 82 | 28 | 72 |
| Dall ^c | 8 | 20 | 0 | 0 | 38 | 31 | 2 | 1 | 27 | 73 | 42 | 58 |
| Sumnr | 18 | 8 | 0 | 24 | 23 | 14 | 2 | 10 | 51 | 49 | 69 | 31 |
| Uclar | 43 | 9 | 0 | 0 | 27 | 14 | 3 | 4 | 51 | 49 | 84 | 16 |
| Revla | 30 | 0 | 0 | 0 | 45 | 22 | 2 | 1 | 30 | 70 | 46 | 54 |
| Tree | 15 | 1 | 0 | 0 | 56 | 22 | 3 | 3 | 15 | 85 | 24 | 76 |

Canada

| | | | | | | | | | | | | |
|------|---|---|---|---|----|----|----|---|---|-----|---|-----|
| Lang | 4 | 0 | 0 | 0 | 42 | 43 | 11 | 0 | 4 | 96 | 6 | 94 |
| 3X | 1 | 0 | 0 | 0 | 26 | 64 | 9 | 0 | 1 | 99 | 1 | 99 |
| 3Y | 3 | 0 | 0 | 0 | 84 | 10 | 3 | 0 | 3 | 97 | 3 | 97 |
| 3Z | 1 | 0 | 0 | 0 | 81 | 14 | 3 | 0 | 1 | 99 | 2 | 98 |
| 4 | 1 | 0 | 0 | 0 | 38 | 36 | 25 | 0 | 1 | 99 | 0 | 100 |
| 5 | 0 | 0 | 0 | 0 | 35 | 0 | 65 | 0 | 0 | 100 | 0 | 100 |

Table 13.--Continued.

| Release area ^b | Alaska stocks | | | | Canada stocks ^a | | | | Total | | Esc. | |
|------------------------------|---------------|-----|-----|------|----------------------------|------|------|-------|-------|------|------|------|
| | 101 | 102 | 103 | oth. | Nass | Skn. | oth. | Stik. | AK | Can. | AK | Can. |

Release period 3: mid- to end July

Alaska

| | | | | | | | | | | | | |
|--------------------|----|---|---|----|----|----|---|----|----|-----|----|-----|
| Noyes | 3 | 1 | 0 | 0 | 6 | 89 | 1 | 0 | 4 | 96 | 4 | 96 |
| Dall | 1 | 0 | 2 | 0 | 6 | 90 | 1 | 0 | 4 | 96 | 5 | 95 |
| Sumnr | 19 | 0 | 0 | 33 | 4 | 28 | 0 | 16 | 52 | 48 | 67 | 33 |
| Uclar | 29 | 3 | 0 | 3 | 4 | 59 | 0 | 2 | 35 | 65 | 79 | 21 |
| Lclar | 3 | 0 | 0 | 0 | 7 | 90 | 0 | 0 | 3 | 97 | 5 | 95 |
| Revla ^c | 0 | 0 | 0 | 0 | 33 | 67 | 0 | 0 | 0 | 100 | 0 | 100 |
| Tree | 8 | 1 | 0 | 0 | 13 | 77 | 0 | 0 | 10 | 90 | 29 | 71 |

Canada

| | | | | | | | | | | | | |
|------|---|---|---|---|---|----|---|---|---|-----|---|-----|
| Lang | 1 | 0 | 0 | 0 | 1 | 91 | 7 | 0 | 1 | 99 | 1 | 99 |
| 3X | 0 | 0 | 0 | 0 | 1 | 97 | 2 | 0 | 0 | 100 | 0 | 100 |
| 3Y | 1 | 0 | 0 | 0 | 7 | 92 | 0 | 0 | 1 | 99 | 0 | 100 |
| 3Z | 1 | 0 | 0 | 0 | 4 | 95 | 0 | 0 | 1 | 99 | 0 | 100 |
| 4 | 1 | 0 | 0 | 0 | 2 | 97 | 0 | 0 | 1 | 99 | 0 | 100 |

Release period 4: August

Alaska

| | | | | | | | | | | | | |
|-------|----|---|---|----|----|----|----|---|----|-----|----|-----|
| Noyes | 3 | 1 | 0 | 0 | 6 | 60 | 30 | 0 | 4 | 96 | 6 | 94 |
| Dall | 0 | 0 | 0 | 0 | 17 | 76 | 6 | 0 | 0 | 100 | 0 | 100 |
| Sumnr | 18 | 0 | 0 | 21 | 5 | 54 | 1 | 0 | 40 | 60 | 94 | 6 |
| Uclar | 23 | 3 | 0 | 0 | 8 | 65 | 0 | 0 | 27 | 73 | 66 | 34 |
| Lclar | 2 | 0 | 0 | 0 | 8 | 90 | 1 | 0 | 2 | 98 | 16 | 84 |
| Tree | 0 | 0 | 0 | 0 | 16 | 84 | 1 | 0 | 0 | 100 | 0 | 100 |

Canada

| | | | | | | | | | | | | |
|------|---|---|---|---|---|----|----|---|---|-----|---|-----|
| Lang | 0 | 0 | 0 | 0 | 2 | 39 | 58 | 0 | 0 | 100 | 0 | 100 |
| 3X | 0 | 0 | 0 | 0 | 4 | 95 | 0 | 0 | 0 | 100 | 1 | 99 |
| 3Y | 0 | 0 | 0 | 0 | 6 | 92 | 2 | 0 | 0 | 100 | 0 | 100 |
| 3Z | 0 | 0 | 0 | 0 | 7 | 92 | 1 | 0 | 0 | 100 | 0 | 100 |

^aNass - Nass River; Skn. = Skeena River; oth. - other; and Stik. - Stikine River.

^bNoyes - Noyes Island; Dall = Dall Island; Sumnr = Sumner Strait; Lclar = lower Clarence Strait; Uclar = Upper Clarence Strait; Revla - Revillagigedo Channel; Tree - Tree Point; and Lang - Langara Island.

^cFewer than 10 tagged fish were recovered in catches and escapements from these releases of tagged fish, and the estimates of stock composition should be considered in light of this limited basis.

Table 14. --Percentage of Alaskan-origin* sockeye salmon
(bootstrap standard error in parentheses) by
fishery and period of release, 1982. Dash means
no estimate could be made.

| Release fishery | June | Early to mid-July | Mid- to end July | August |
|------------------------|----------|----------------------|---------------------|-----------|
| <u>Alaska</u> | | | | |
| Noyes Island | 15 (1.8) | 22 (2.2) | 3 (0.4) | 5 (7.0) |
| Dall Island | 23 (2.9) | 48 (10.5) | - | 0 (0.0) |
| Lower Clarence Strait | 55 (5.6) | 28 (5.3) | - | 51 (17.1) |
| Middle Clarence Strait | - | 70 (4.0) | 22 (16.9) | 77 (19.0) |
| Union Bay | | 100 (0.0) | 26 (11.0) | 100 (0.0) |
| Upper Clarence Strait | - | 44 (2.9) | 12 (1.3) | 27 (5.8) |
| Revillagigedo Channel | 28 (3.2) | 64 (6.1) | 15 (3.3) | 23 (28.9) |
| Tree Point | 10 (3.1) | 9 (1.8) | 14 (2.4) | 58 (8.5) |
| <u>Canada</u> | | | | |
| Dixon Entrance | | 18 (5.8) | 3 (0.7) | - |
| langara Island | 7 (0.7) | 10 (1.1) | 3 (0.8) | |
| 3x | 10 (1.6) | 5 (0.7) | 2 (0.4) | 0 (0.5) |
| 3Y | 4 (1.9) | 5 (0.7) | 2 (0.6) | 6 (3.3) |
| 3Z | 6 (2.6) | 1 (0.2) | 3 (1.2) | |
| 4 | 0 (0.1) | 4 (0.7) | 3 (0-7). | 0 (0.0) |
| 5 | - | | 2 (0.6) | 0 (0.0) |

*Standard errors account for chance variation of recoveries from subsampling catches and escapements, but not for errors in escapement estimates for either Alaska or Canada.

Table 15. --Percentage of Alaskan-origin* sockeye salmon
(bootstrap standard error in parentheses) by
fishery and period of release, 1983. Dash means
no estimate could be made.

| Release fishery | June | Early to mid-July | Mid- to end July | August |
|-------------------------|-----------|----------------------|---------------------|----------|
| <u>Alaska</u> | | | | |
| Noyes Island | 17 (5.4) | 18 (3.9) | 4 (0.8) | 4 (1.3) |
| Dall Island | 7 (2.5) | 27 (11.3) | 4 (2.3) | 0 (0.0) |
| Lower Clarence Strait - | | | 3 (1.3) | 2 (1.3) |
| Upper Clarence Strait | 68 (6.6) | 51 (3.0) | 35 (3.4) | 27 (6.9) |
| Sumner Strait | 43 (4.8) | 51 (5.1) | 52 (7.1) | 40 (6.4) |
| Revillagigedo Channel | 11 (11.2) | 30 (6.3) | 0 (0.1) | - |
| Tree Point | 18 (10.0) | 15 (3.3) | 10 (2.0) | 0 (0.1) |
| <u>Canada</u> | | | | |
| Langara Island | 15 (5.1) | 4 (0.9) | 1 (0.6) | 0 (0.0) |
| 3x | 2 (0.8) | 1 (0.3) | 0 (0.1) | 0 (0.5) |
| 3Y | 3 (1.1) | 3 (1.2) | 1 (0.2) | 0 (0.1) |
| 3Z | 1 (0.5) | 1 (0.8) | 1 (0.2) | 0 (0.0) |
| 4 | 0 (0.0) | 1 (0.3) | 1 (0.2) | |
| 5 | 0 (0.0) | 0 (0.0) | | - |

*Standard errors account for chance variation of recoveries from subsampling catches and escapements, but not for errors in escapement estimates for either Alaska or Canada.

Table 16. --Number of tags recovered in catches and escapements of sockeye salmon by area and period of release in 1982.

| | <u>June</u> | | <u>Early to mid-July</u> | | <u>Mid- to end July</u> | | <u>August</u> | |
|------------------------|-------------|-------|--------------------------|-------|-------------------------|-------|---------------|-------|
| Release area | Esc. | Catch | Esc. | Catch | Esc. | Catch | Esc. | Catch |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 130 | 62 | 11 | 46 | 30 | 45 | 2 | 9 |
| Dall Island | 51 | 43 | 5 | 2 | 0 | 0 | 10 | 4 |
| Lower Clarence Strait | 44 | 7 | 18 | 10 | 0 | 0 | 3 | 2 |
| Middle Clarence Strait | 0 | 0 | 45 | 6 | 5 | 1 | 2 | 2 |
| Upper Clarence Strait | 0 | 0 | 83 | 30 | 62 | 89 | 33 | 14 |
| Cordova Bay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tree Point | 14 | 30 | 34 | 37 | 51 | 42 | 11 | 6 |
| Revillagigedo Channel | 45 | 19 | 28 | 5 | 31 | 20 | 3 | 1 |
| Union Bay | 0 | 0 | 1 | 0 | 11 | 4 | 1 | 0 |
| <u>Canada</u> | | | | | | | | |
| Dixon Entrance | 0 | 0 | 5 | 7 | 0 | 2 | 0 | 0 |
| Langara Island | 331 | 401 | 54 | 182 | 48 | 107 | 0 | 0 |
| 3x | 166 | 130 | 199 | 488 | 427 | 641 | 76 | 30 |
| 3Y | 445 | 586 | 255 | 143 | 51 | 84 | 19 | 4 |
| 3Z | 20 | 90 | 39 | 18 | 41 | 20 | 0 | 0 |
| 4 | 238 | 49 | 50 | 121 | 191 | 433 | 51 | 15 |
| 5 | 0 | 0 | 0 | 0 | 1 | 6 | 52 | 23 |

Table 17. --Number of tags recovered in catches and escapements of sockeye salmon by area and period of release in 1983.

| Release area | <u>June</u> | | <u>Early to mid-July</u> | | <u>Mid- to end July</u> | | <u>August</u> | |
|-----------------------|-------------|-------|--------------------------|-------|-------------------------|-------|---------------|-------|
| | Esc. | Catch | Esc. | Catch | Esc. | Catch | Esc. | Catch |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 41 | 8 | 65 | 36 | 128 | 78 | 31 | 25 |
| Dall Island | 83 | 7 | 4 | 3 | 44 | 28 | 12 | 17 |
| Lower Clarence Strait | 0 | 0 | 0 | 0 | 34 | 23 | 6 | 25 |
| Upper Clarence Strait | 22 | 4 | 117 | 30 | 58 | 22 | 12 | 10 |
| Tree Point | 19 | 2 | 36 | 19 | 44 | 38 | 13 | 21 |
| Revillagigedo Channel | 8 | 1 | 22 | 5 | 5 | 3 | 0 | 0 |
| Sumner Strait | 86 | 28 | 55 | 41 | 45 | 18 | 25 | 12 |
| <u>Canada</u> | | | | | | | | |
| Langara Island | 45 | 19 | 40 | 60 | 47 | 20 | 9 | 8 |
| 3x | 133 | 17 | 101 | 65 | 96 | 19 | 37 | 37 |
| 3Y | 162 | 6 | 136 | 14 | 15 | 9 | 28 | 50 |
| 3Z | 236 | 10 | 167 | 12 | 144 | 119 | 18 | 45 |
| 4 | 8 | 1 | 10 | 18 | 14 | 4 | 0 | 2 |
| 5 | 3 | 0 | 4 | 7 | 0 | 0 | 0 | 0 |

Table 18. --Percentages of Alaskan-origin sockeye salmon by area and period of release for which 10 or more tags were recovered in catch and escapement sampling, 1982 and 1983.

| Release area | <u>June</u> | | <u>Early to mid-July</u> | | <u>Mid- to end July</u> | | <u>August</u> | |
|------------------------|-------------|------|------------------------------|------|-----------------------------|------|---------------|------|
| | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 15 | 17 | 22 | 18 | 3 | 4 | 5 | 4 |
| Dall Island | 23 | 7 | - | - | - | 4 | 0 | 0 |
| Sumner Strait | | 43 | - | 51 | - | 52 | - | 40 |
| Upper Clarence Strait | - | 68 | 44 | 51 | 12 | 35 | 27 | 27 |
| Union Bay | | - | - | - | 26 | - | - | - |
| Middle Clarence Strait | - | - | 70 | - | - | - | - | - |
| Lower Clarence Strait | 55 | - | 28 | - | - | 3 | - | 2 |
| Revillagigedo Channel | 28 | - | 64 | 30 | 15 | - | - | - |
| Tree Point | 10 | 18 | 9 | 15 | 14 | 10 | 58 | 0 |
| <u>Canada</u> | | | | | | | | |
| Dixon Entrance | - | - | 18 | - | - | - | - | - |
| Langara Island | 7 | 15 | 10 | 4 | 3 | 1 | - | 0 |
| 3x | 10 | 2 | 5 | 1 | 2 | 0 | 0 | 0 |
| 3Y | 4 | 3 | 5 | 3 | 2 | 1 | 6 | 0 |
| 3Z | 6 | 1 | 1 | 1 | 3 | 1 | - | 0 |
| 4 | 0 | - | 4 | 1 | 3 | 1 | 0 | - |
| 5 | - | - | - | 0 | - | - | 0 | - |

Table 19.--Estimated season stock compositions based on catch-weighted averages" of half-month percentage of sockeye salmon in northern boundary fisheries bound for the other country, 1982 and 1983.

| Fishery | Percentage from other country | |
|------------------------|-------------------------------|------------|
| | 1982 | 1983 |
| <u>Alaska</u> | | |
| Noyes Island | 86.1 (2.4) | 93.7 (1.0) |
| Dall Island | ne ^c | 97.0 (1.1) |
| Lower Clarence Strait | ne | 97.3 (0.9) |
| Middle Clarence Strait | nc ^d | nt |
| Upper Clarence Strait | 63.9 (2.2) | 62.0 (2.4) |
| Sumner Strait | nt ^e | 51.1 (3.3) |
| Union Bay | ne | nt |
| Revillagigedo Channel | 67.2 (3.1) | ne |
| Tree Point | 84.1 (1.6) | 91.7 (1.5) |
| <u>Canada</u> | | |
| Langara Island | 5.2 (0.6) | 1.8 (0.5) |
| 3X | 3.0 (0.3) | 0.3 (0.1) |
| 3Y | 3.9 (0.5) | 0.7 (0.1) |
| 3Z | 3.3 (1.0) | 0.5 (0.1) |
| 4 | 2.7 (0.5) | ne |
| 5 | ne | ne |

*Catch-weighted averages were computed for a fishing area provided that the reasonably reliable half-month estimates of stock composition (those of release periods for which at least 10 tagged fish were recovered) covered at least 75% of the season catch in the area.

^bStandard errors in parentheses account for chance variation of recoveries from subsampling catches and escapements but not for errors in escapement estimates of either Alaska or Canada.

^cne - Less than 75% of the season catch occurred during the periods for which stock-composition estimates were reasonably reliable.

^dnc = No catches were made in this area.

^ent - No tagging occurred this year in this area.

Table 20. --Effects of different estimates of Alaskan escapements and Canadian secondary-tagging mortality on estimated season percentages of Canadian sockeye salmon in Alaskan fisheries, 1982 and 1983.

| Alaskan escapement (1,000s) | Canadian tagging mortality | Canadian percentage in fishery | | | | | |
|-----------------------------|----------------------------|--------------------------------|-----------------------|---------------------------------------|---------------|------------|----|
| 1982 | | | | | | | |
| | | Noyes Island | Upper Clarence Strait | Revilla-gigedo Channel | Tree Point | | |
| 354 | 0% | 86 | 64 | 67 | 84 | | |
| 477 | 0% | 84 | 61 | 62 | 81 | | |
| 477 | 40% | 80 | 57 | 57 | 76 | | |
| 254 | 0% | 88 | 67 | 72 | 87 | | |
| 254 | 40% | 84 | 64 | 68 | 83 | | |
| Range | | 8 | 10 | 15 | 11 | | |
| 1983 | | | | | | | |
| | | Noyes Island | Dall Island | <u>Clarence Strait</u> Lower Upper | Sumner Strait | Tree Point | |
| 324 | 0% | 94 | 97 | 97 | 62 | 51 | 92 |
| 458 | 0% | 92 | 92 | 96 | 54 | 42 | 89 |
| 458 | 40% | 90 | 90 | 95 | 52 | 36 | 86 |
| 216 | 0% | 96 | 98 | 98 | 71 | 61 | 94 |
| 216 | 40% | 94 | 95 | 98 | 69 | 55 | 92 |
| Range | | 6 | 8 | 3 | 19 | 25 | 8 |

Table 21. --Effects of different estimates of Alaskan escapements and Canadian secondary-tagging mortality on estimated season percentages of Alaskan sockeye salmon in Canadian fisheries, 1982 and 1983. Dash means no estimate could be made.

| Alaskan escapement (1,000s) | Canadian tagging mortality | Alaskan percentage in fishery | | | | |
|-----------------------------------|----------------------------------|-------------------------------|----|----|----|----------|
| | | Langara Island | 3X | 3Y | 3Z | 4 |
| 1982 | | | | | | |
| 354 | 0% | 5 | 3 | 4 | 3 | 3 |
| 477 | 0% | 6 | 4 | 5 | 4 | 3 |
| 477 | 40% | 10 | 7 | 8 | 7 | 7 |
| 254 | 0% | 4 | 2 | 3 | 3 | 2 |
| 254 | 40% | 7 | 4 | 6 | 5 | 4 |
| Range | | 6 | 5 | 5 | 4 | 5 |
| 1983 | | | | | | |
| 324 | 0% | 2 | 0 | 1 | 1 | - |
| 458 | 0% | 2 | 0 | 1 | 1 | |
| 458 | 40% | 4 | 1 | 2 | 1 | |
| 216 | 0% | 1 | 0 | 0 | 0 | - |
| 216 | 40% | 2 | 0 | 1 | 1 | - |
| Range | | 3 | 1 | 2 | 1 | - |

Table 22. --Number of tagged pink salmon released in southern Southeast Alaska and northern British Columbia, 1982, 1984, and 1985.

| Release Location | 1982 | 1984 | 1985 |
|---------------------------|---------|--------|---------|
| <u>Alaska</u> | | | |
| Noyes Island | 17,200 | 5,464 | 17,968 |
| Dall Island | 5,795 | 9,652 | 10,298 |
| Cordova Bay | 5,606 | 0 | 4,012 |
| Lower Clarence Strait | 12,713 | 6,375 | 7,573 |
| Middle Clarence Strait | 15,499 | 0 | 5,970 |
| Union Bay | 1,310 | 0 | 3,349 |
| Upper Clarence Strait | 6,960 | 0 | 7,152* |
| Revillagigedo Channel | 11,321 | 2,937 | 7,458 |
| Tree Point | 7,083 | 6,074 | 5,031 |
| Alaska total | 83,487 | 30,502 | 68,811 |
| <u>Canada</u> | | | |
| Langara Island | 3,465 | 0 | 5,603 |
| Dixon Entrance | 12,487 | 17,293 | 9,250 |
| Dundas Island (area 3X) | 12,749 | 12,195 | 8,439 |
| Tracy/Boston (area 3Y) | 17,624 | 6,490 | 7,241 |
| Portland Inlet (area 3Z) | 4,924 | 6,003 | 7,481 |
| Stephens/Percher (area 4) | 7,132 | 4,534 | 5,680 |
| Area 5 | 9,473 | 5,116 | 7,005 |
| Area 6 | 0 | 0 | 6,102 |
| Canada total | 67,854 | 51,631 | 56,801 |
| Totals | 151,341 | 82,133 | 125,612 |

*Composed of 6,108 releases from Upper Clarence Strait and 1,044 from Sumner Strait.

Table 23.--Estimates of total* tagged pink salmon caught in Alaskan and Canadian fisheries by general area and period of release in 1982.

| Release location | Release period | | | | | | | |
|------------------------|-----------------------|--------|-------------------|--------|--------------------|--------|----------------------|--------|
| | <u>1 June-15 July</u> | | <u>16-31 July</u> | | <u>1-15 August</u> | | <u>16 Aug-1 Sept</u> | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 37 | 40 | 299 | 45 | 1,238 | 51 | 1,706 | 191 |
| Dall Island | 56 | 4 | 0 | 0 | 740 | 87 | 509 | 7 |
| Cordova Bay | 0 | 0 | 0 | 0 | 884 | 2 | 737 | 18 |
| Lower Clarence Strait | 333 | 24 | 0 | 0 | 1,263 | 36 | 694 | 6 |
| Middle Clarence Strait | 256 | 6 | 392 | 27 | 3,017 | 17 | 395 | 5 |
| Union Bay | 0 | 0 | 65 | 2 | 15 | 2 | 0 | 0 |
| Upper Clarence Strait | 25 | 2 | 229 | 8 | 268 | 185 | 5 | 2 |
| Revillagigedo Channel | 1,312 | 110 | 782 | 99 | 103 | 51 | 633 | 31 |
| Tree Point | 552 | 12 | 166 | 181 | 216 | 325 | 309 | 109 |
| Alaska total | 2,571 | 198 | 1,933 | 362 | 7,744 | 756 | 4,988 | 369 |
| <u>Canada</u> | | | | | | | | |
| Langara Island | 579 | 220 | 136 | 106 | 158 | 3 | 0 | 0 |
| Dixon Entrance | 300 | 17 | 1,706 | 59 | 1,388 | 209 | 398 | 18 |
| 3x | 262 | 167 | 216 | 648 | 439 | 816 | 113 | 559 |
| 3Y | 49 | 123 | 112 | 232 | 256 | 577 | 620 | 1,465 |
| 3Z | 15 | 44 | 10 | 337 | 14 | 11 | 31 | 0 |
| 4 | 44 | 10 | 235 | 849 | 25 | 797 | 0 | 0 |
| 5 | 0 | 0 | 0 | 22 | 171 | 654 | 0 | 73 |
| Canada total | 1,249 | 581 | 2,415 | 2,253 | 2,451 | 3,067 | 1,162 | 2,115 |
| Totals | 3,820 | 779 | 4,348 | 2,615 | 10,195 | 3,823 | 6,150 | 2,484 |

*Numbers of actual tag recoveries expanded for subsampling of catches.

Table 24. --Estimates of total tagged pink salmon caught in Alaskan and Canadian fisheries by general area and period of release in 1984.

| Release location | Release period | | | | | | | |
|-----------------------------|-----------------------|--------|-------------------|--------|--------------------|--------|---------------------|--------|
| | <u>1 June-15 July</u> | | <u>16-31 July</u> | | <u>1-15 August</u> | | <u>16 Aug- Sept</u> | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 171 | 77 | 262 | 124 | 217 | 5 | 679 | 0 |
| Dall Island | 350 | 91 | 274 | 155 | 1,437 | 198 | 735 | 10 |
| Lower Clarence Strait | 4 | 0 | 187 | 27 | 1,148 | 28 | 103 | 0 |
| Revillagigedo Channel | 98 | 44 | 90 | 12 | 151 | 3 | 356 | 3 |
| Tree Point | 82 | 141 | 320 | 541 | 505 | 710 | 46 | 38 |
| Alaska total | 705 | 353 | 1,133 | 859 | 3,458 | 944 | 1,919 | 51 |
| <u>Canada</u> | | | | | | | | |
| Dixon Entrance ^b | | | | | | | | |
| 1-10 | 0 | 0 | 350 | 209 | 260 | 80 | 0 | 0 |
| 1-11,-12 | 262 | 92 | 390 | 148 | 1,265 | 44 | 318 | 10 |
| 1-13,-14,-15 | 0 | 0 | 53 | 18 | 75 | 22 | 0 | 0 |
| 1-16,-17,-18 | 5 | 24 | 27 | 57 | 186 | 240 | 38 | 30 |
| 3x | 34 | 212 | 179 | 761 | 514 | 1,609 | 97 | 846 |
| 3Y | 4 | 320 | 37 | 543 | 80 | 631 | 35 | 207 |
| 3Z | 7 | 1 6 5 | 13 | 591 | 66 | 710 | 26 | 252 |
| 4 | 13 | 48 | 67 | 485 | 159 | 504 | 0 | 46 |
| 5 | 35 | 141 | 29 | 450 | 8 | 570 | 17 | 184 |
| Canada total | 360 | 1,002 | 1,145 | 3,262 | 2,613 | 4,410 | 531 | 1,575 |
| Totals | 1,065 | 1,355 | 2,278 | 4,121 | 6,071 | 5,354 | 2,450 | 1,626 |

^aNumbers of actual tag recoveries expanded for subsampling of catches.

^bSee Figure 5 for reference.

Table 25.--Estimates of total* tagged pink salmon caught in Alaskan and Canadian fisheries by general area and period of release in 1985.

| Release location | Release period | | | | | | | |
|------------------------|-----------------------|--------|-------------------|--------|--------------------|--------|----------------------|--------|
| | <u>1 June-15 July</u> | | <u>16-31 July</u> | | <u>1-15 August</u> | | <u>16 Aug-1 Sept</u> | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 434 | 47 | 1,312 | 144 | 2,426 | 39 | 298 | 0 |
| Dall Island | 245 | 56 | 663 | 165 | 1,196 | 74 | 744 | 5 |
| Cordova Bay | 0 | 0 | 0 | 0 | 896 | 5 | 34 | 0 |
| Lower Clarence Strait | 50 | 4 | 211 | 4 | 989 | 54 | 129 | 0 |
| Middle Clarence Strait | 31 | 0 | 42 | 1 | 342 | 0 | 654 | 0 |
| Union Bay | 16 | 0 | 55 | 0 | 388 | 2 | 3 | 0 |
| Upper Clarence Strait | 0 | 0 | 54 | 0 | 241 | 0 | 198 | 0 |
| Revillagigedo Channel | 265 | 5 | 354 | 81 | 310 | 82 | 1,202 | 0 |
| Tree Point | 9 | 34 | 169 | 528 | 55 | 602 | 34 | 17 |
| Alaska total | 1,050 | 146 | 2,860 | 923 | 6,843 | 858 | 3,296 | 22 |
| <u>Canada</u> | | | | | | | | |
| Langara Island | 125 | 191 | 89 | 289 | 132 | 259 | 0 | 0 |
| Dixon Entrance | 81 | 66 | 386 | 338 | 253 | 433 | 53 | 15 |
| 3x | 0 | 4 | 3 | 392 | 130 | 898 | 153 | 39 |
| 3Y | 9 | 66 | 9 | 49 | 68 | 653 | 28 | 57 |
| 3Z | 6 | 25 | 7 | 346 | 22 | 663 | 6 | 27 |
| 4 | 3 | 5 | 0 | 422 | 16 | 594 | 0 | 2 |
| 5 | 0 | 16 | 31 | 726 | 16 | 575 | 4 | 0 |
| 6 | 6 | 38 | 0 | 2 3 6 | 0 | 571 | 0 | 148 |
| Canada total | 230 | 411 | 525 | 2,798 | 637 | 4,646 | 244 | 288 |
| Totals | 1,280 | 557 | 3,385 | 3,721 | 7,480 | 5,504 | 3,540 | 310 |

*Numbers of actual tag recoveries expanded for subsampling of catches.

Table 26. --Southeast Alaska pink salmon escapement estimates and numbers of carcasses examined for tags by ADF&G statistical areas, 1982, 1984, and 1985.

| Statistical areas | Escapement ^b (1,000s) | | | Number examined |
|----------------------|----------------------------------|--------|--------|----------------------|
| | Low | Best | High | |
| 1982 | | | | |
| 101 | 2,851 | 3,634 | 5,050 | 256,386 ^a |
| 102 | 925 | 1,198 | 1,700 | 138,418 ^a |
| 103 | 2,795 | 3,584 | 5,018 | 95,331 |
| 104-108 | 1,607 | 2,057 | 13,117 | 89,877 |
| Totals | 8,178 | 10,473 | 24,885 | 580,012 |
| 1984 | | | | |
| 101 | 3,568 | 5,352 | 6,422 | 323,044 |
| 102 | 892 | 1,338 | 1,606 | 73,884 |
| 103-104 | 3,270 | 4,905 | 5,886 | 53,341 |
| 105-108 | 1,220 | 1,830 | 2,196 | 76,668 |
| Totals | 8,950 | 13,425 | 16,110 | 526,937 |
| 1985 | | | | |
| 101 | 3,692 | 5,538 | 5,833 | 285,570 |
| 102 | 1,118 | 1,677 | 1,766 | 40,109 |
| 103-104 | 4,559 | 6,839 | 7,203 | 319,834 |
| 105-108 | 2,815 | 4,224 | 4,448 | 332,357 |
| Totals | 12,184 | 18,278 | 19,250 | 977,870 |

^aSample sizes were obtained from Gazey et al. (1983).

^bEscapement estimates were obtained from Appendix 13 of Hoffman et al. (1984) and M. Seibel, National Marine Fisheries Service, Alaska, (at ADF&G), P.O. Box 25526, Juneau, AK 99802-5526.

Table 27.--British Columbia pink salmon escapement estimates and numbers of carcasses examined for tags by fishing area, 1984 and 1985.

| Fishing area | Escapement (1,000s) | | | Number examined |
|-----------------|---------------------|-------|-------|--------------------|
| | Low ^B | Best | High | |
| 1984 | | | | |
| 1 ^b | 896 | 1,086 | 1,277 | 724,000 |
| 2 | 192 | 250 | 300 | 56,267 |
| 3 ^c | 256 | 330 | 450 | 32,528 |
| 5 | 160 | 200 | 300 | 5,050 |
| Totals | 1,504 | 1,886 | 2,327 | 817,845 |
| 1985 | | | | |
| 3 ^c | 150 | 225 | 270 | 17,754 |
| 5 | 175 | 263 | 315 | 24,749 |
| 6 | 1,062 | 1,593 | 1,912 | 106,578 |
| 7 | 329 | 494 | 592 | 39,464 |
| 8 | 2,300 | 2,500 | 2,700 | 284,405 |
| Totals | 4,016 | 5,075 | 5,789 | 472,950 |

*Low estimates were unexpanded foot-survey counts.

^bThe Yakoun River was the stock examined for tags; a weir missed an unknown portion of total escapement to the river during flooding.

^cKwinamass River was omitted from escapement estimates because estimates of primary-tag recoveries were obtained by secondary tagging.

Source: K. English and J. Taylor, LGL Limited, Environmental Research Associates, 9768 Second St., Sidney, B.C., VBL-4P8, Canada, pers. commun.

Table 28. --Numbers of pink salmon tagged in major Canadian rivers (adjusted for straying), numbers recovered in the rivers, and the recovery rate (%) by tagging year.

| River system | Number tagged | Number recovered | Recovery rate (%) |
|---------------|---------------|------------------|-------------------|
| 1982 | | | |
| Skeena | 2,262 | 119 | 5.3 |
| Kwinamass | 1,345 | 83 | 6.2 |
| Khutzeymateen | 131 | 5 | 3.8 |
| 1984 | | | |
| Skeena | 2,815 | 69 | 2.5 |
| Kwinamass | 1,477 | 196 | 13.3 |
| 1985 | | | |
| Skeena | 4,842 | 127 | 2.6 |
| Kwinamass | 3,288 | 453 | 13.8 |

Table 29.--Estimates of total numbers of tagged pink salmon escaping to Alaskan and Canadian spawning systems by general area and period of release, 1982.

| Release location | Release period | | | | | | | |
|------------------------|----------------|--------|------------|--------|-------------|--------|---------------|--------|
| | 1 June-15 July | | 16-31 July | | 1-15 August | | 16 Aug-1 Sept | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 0 | 0 | 114 | 0 | 223 | 16 | 1,739 | 130 |
| Dall Island | 23 | 0 | 0 | 0 | 446 | 57 | 357 | 0 |
| Cordova Bay | 0 | 0 | 0 | 0 | 234 | 19 | 553 | 0 |
| Lower Clarence Strait | 321 | 0 | 0 | 0 | 1,893 | 38 | 2,246 | 0 |
| Middle Clarence Strait | 512 | 0 | 770 | 19 | 1,872 | 0 | 1,986 | 0 |
| Union Bay | 24 | 0 | 62 | 0 | 276 | 0 | 0 | 0 |
| Upper Clarence Strait | 143 | 0 | 395 | 19 | 1,347 | 23 | 95 | 0 |
| Revillagigedo Channel | 747 | 19 | 650 | 17 | 14 | 17 | 264 | 0 |
| Tree Point | 23 | 0 | 236 | 67 | 57 | 68 | 193 | 35 |
| Alaska total | 1,793 | 19 | 2,227 | 122 | 6,362 | 238 | 7,433 | 165 |
| <u>Canada</u> | | | | | | | | |
| Langara Island | 111 | 35 | 32 | 16 | 0 | 0 | 0 | 0 |
| Dixon Entrance | 234 | 0 | 594 | 54 | 398 | 147 | 195 | 19 |
| 3x | 183 | 19 | 207 | 398 | 83 | 466 | 74 | 38 |
| 3Y | 37 | 33 | 99 | 375 | 179 | 342 | 499 | 785 |
| 3Z | 0 | 38 | 354 | 703 | 14 | 49 | 32 | 0 |
| 4 | 23 | 0 | 273 | 145 | 71 | 1,616 | 0 | 0 |
| 5 | 0 | 0 | 14 | 0 | 51 | 588 | 0 | 247 |
| Canada total | 588 | 125 | 1,573 | 1,691 | 796 | 3,208 | 800 | 1,089 |
| Totals - | 2,381 | 144 | 3,800 | 1,813 | 7,158 | 3,446 | 8,233 | 1,254 |

Table 30. --Estimates of total numbers of tagged pink salmon escaping to Alaskan and Canadian spawning systems by general area and period of release, 1984.

| Release location | Release period | | | | | | | |
|-----------------------|-----------------------|--------|-------------------|--------|--------------------|--------|----------------------|--------|
| | <u>1 June-15 July</u> | | <u>16-31 July</u> | | <u>1-15 August</u> | | <u>16 Aug-1 Sept</u> | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 139 | 0 | 398 | 41 | 415 | 0 | 211 | 0 |
| Dall Island | 343 | 0 | 377 | 78 | 1,381 | 140 | 509 | 91 |
| Lower Clarence Strait | 24 | 0 | 106 | 10 | 1,081 | 18 | 120 | 0 |
| Revillagigedo Channel | 412 | 0 | 198 | 0 | 115 | 0 | 82 | 0 |
| Tree Point | 132 | 0 | 362 | 8 | 199 | 353 | 0 | 61 |
| Alaska total | 1,050 | 0 | 1,441 | 137 | 3,191 | 511 | 922 | 152 |
| <u>Canada</u> | | | | | | | | |
| Dixon Entrance* | | | | | | | | |
| 1-10 | 0 | 0 | 186 | 23 | 109 | 92 | 0 | 0 |
| 1-11,-12 | 154 | 41 | 341 | 103 | 355 | 44 | 24 | 41 |
| 1-13,-14,-15 | 0 | 0 | 33 | 0 | 0 | 85 | 0 | 0 |
| 1-16,-17,-18 | 16 | 0 | 33 | 0 | 49 | 277 | 0 | 43 |
| 3x | 115 | 41 | 249 | 159 | 115 | 1,594 | 0 | 2,003 |
| 3Y | 165 | 23 | 165 | 127 | 395 | 227 | 16 | 401 |
| 3Z | 82 | 8 | 296 | 195 | 216 | 563 | 16 | 173 |
| 4 | 0 | 41 | 16 | 214 | 33 | 779 | 0 | 10 |
| 5 | 33 | 10 | 33 | 334 | 0 | 326 | 0 | 0 |
| Canada total | 565 | 164 | 1,352 | 1,155 | 1,272 | 3,987 | 56 | 2,671 |
| Totals | 1,615 | 164 | 2,793 | 1,292 | 4,463 | 4,498 | 978 | 2,823 |

*See Figure 5 for reference.

Table 31.--Estimates of total numbers of tagged pink salmon escaping to Alaskan and Canadian spawning systems by general area and period of release, 1985.

| Release location | Release period | | | | | | | |
|------------------------|-----------------------|--------|-------------------|--------|--------------------|--------|----------------------|--------|
| | <u>1 June-15 July</u> | | <u>16-31 July</u> | | <u>1-15 August</u> | | <u>16 Aug-1 Sept</u> | |
| | Alaska | Canada | Alaska | Canada | Alaska | Canada | Alaska | Canada |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 679 | 39 | 3,116 | 46 | 1,365 | 116 | 320 | 39 |
| Dall Island | 735 | 13 | 1,480 | 15 | 1,250 | 0 | 172 | 92 |
| Cordova Bay | 0 | 0 | 0 | 0 | 1,570 | 0 | 41 | 0 |
| Lower Clarence Strait | 361 | 0 | 1,099 | 0 | 1,830 | 92 | 189 | 0 |
| Middle Clarence Strait | 500 | 0 | 422 | 0 | 660 | 0 | 371 | 7 |
| Union Bay | 398 | 0 | 415 | 0 | 750 | 0 | 0 | 0 |
| Upper Clarence Strait | 0 | 0 | 1,350 | 0 | 1,026 | 0 | 254 | 0 |
| Revillagigedo Channel | 362 | 0 | 1,149 | 7 | 310 | 0 | 233 | 77 |
| Tree Point | 310 | 7 | 698 | 44 | 407 | 120 | 110 | 104 |
| Alaska total | 3,345 | 59 | 9,729 | 112 | 9,168 | 328 | 1,690 | 319 |
| <u>Canada</u> | | | | | | | | |
| Langara Island | 245 | 150 | 19 | 262 | 181 | 272 | 0 | 0 |
| Dixon Entrance | 103 | 15 | 974 | 78 | 161 | 551 | 0 | 30 |
| 3x | 19 | 0 | 175 | 218 | 187 | 1,524 | 58 | 1,774 |
| 3Y | 116 | 15 | 78 | 7 | 1,920 | 649 | 175 | 663 |
| 32 | 78 | 0 | 756 | 143 | 1,454 | 1,250 | 116 | 563 |
| 4 | 19 | 0 | 0 | 349 | 52 | 1,748 | 0 | 1,088 |
| 5 | 19 | 0 | 97 | 1,033 | 39 | 1,176 | 0 | 1,075 |
| 6 | 0 | 75 | 0 | 389 | 19 | 533 | 0 | 833 |
| Canada total | 599 | 255 | 2,099 | 2,479 | 4,013 | 7,703 | 349 | 6,026 |
| Totals | 3,944 | 314 | 11,828 | 2,591 | 13,181 | 8,031 | 2,039 | 6,345 |

Table 32.--Number of tagged pink salmon released, total number estimated as caught or escaping, percentage of estimated total recoveries from catch and escapement, and estimated recovery rate (%) in catch or escapement, by release fishery, 1982.

| Release fishery | Number released | Total recoveries | <u>Percentage of recoveries</u> | | Estimated recovery rate (%) |
|------------------------|-----------------|------------------|---------------------------------|------------|-----------------------------|
| | | | Catch | Escapement | |
| <u>Alaska</u> | | | | | |
| Noyes Island | 17,200 | 5,683 | 63 | 37 | 33 |
| Dall Island | 5,795 | 2,229 | 63 | 37 | 38 |
| Cordova Bay | 5,606 | 2,428 | 68 | 32 | 43 |
| Lower Clarence Strait | 12,713 | 6,882 | 35 | 65 | 54 |
| Middle Clarence Strait | 15,499 | 9,255 | 44 | 56 | 60 |
| Union Bay | 1,310 | 446 | 19 | 81 | 34 |
| Upper Clarence Strait | 6,960 | 2,704 | 27 | 73 | 39 |
| Revillagigedo Channel | 11,321 | 4,796 | 65 | 35 | 42 |
| Tree Point | 7,083 | 2,379 | 79 | 21 | 34 |
| Alaska total | 83,487 | 35,117 | 49 | 51 | 42 |
| <u>Canada</u> | | | | | |
| Langara Island | 3,465 | 1,396 | 86 | 14 | 40 |
| Dixon Entrance | 12,487 | 5,736 | 71 | 29 | 46 |
| 3x | 12,749 | 2,827 | 48 | 52 | 22 |
| 3Y | 17,624 | 5,783 | 59 | 41 | 33 |
| 3Z | 4,924 | 1,652 | 28 | 72 | 34 |
| 4 | 7,132 | 4,088 | 48 | 52 | 57 |
| 5 | 9,473 | 1,820 | 51 | 49 | 19 |
| Canada total | 67,854 | 23,302 | 58 | 42 | 34 |
| Totals | 151,341 | 58,419 | 53 | 47 | 39 |

Table 33. --Number of tagged pink salmon released, total number estimated as caught or escaping, percentage of estimated total recoveries from catch and escapement, and estimated recovery rate (%) in catch or escapement, by release fishery, 1984.

| Release fishery | Number released | Total recoveries | <u>Percentage of recoveries</u> | | Estimated recovery rate (%) |
|-----------------------|-----------------|------------------|---------------------------------|------------|-----------------------------|
| | | | Catch | Escapement | |
| <u>Alaska</u> | | | | | |
| Noyes Island | 5,464 | 2,739 | 56 | 44 | 50 |
| Dall Island | 9,652 | 6,169 | 53 | 47 | 64 |
| Lower Clarence Strait | 6,375 | 2,856 | 52 | 48 | 45 |
| Revillagigedo Channel | 2,937 | 1,564 | 48 | 52 | 53 |
| Tree Point | 6,074 | 3,498 | 68 | 32 | 58 |
| Alaska total | 30,502 | 16,826 | 56 | 44 | 55 |
| <u>Canada</u> | | | | | |
| Dixon Entrance | 17,293 | 6,252 | 67 | 33 | 36 |
| 3x | 12,195 | 8,528 | 50 | 50 | 70 |
| 3Y | 6,490 | 3,376 | 55 | 45 | 52 |
| 3Z | 6,003 | 3,379 | 54 | 46 | 56 |
| 4 | 4,534 | 2,415 | 55 | 45 | 53 |
| 5 | 5,116 | 2,170 | 66 | 34 | 42 |
| Canada total | 51,631 | 26,120 | 57 | 43 | 51 |
| Totals | 82,133 | 42,946 | 57 | 43 | 52 |

Table 34. --Number of tagged pink salmon released, total number estimated as caught or escaping, percentage of estimated total recoveries from catch and escapement, and estimated recovery rate (%) in catch or escapement, by release fishery, 1985.

| Release fishery | Number released | Total recoveries | <u>Percentage of recoveries</u> | | Estimated recovery rate (%) |
|------------------------|-----------------|------------------|---------------------------------|------------|-----------------------------|
| | | | Catch | Escapement | |
| <u>Alaska</u> | | | | | |
| Noyes Island | 17,968 | 10,420 | 45 | 55 | 58 |
| Dall Island | 10,298 | 6,905 | 46 | 54 | 67 |
| Cordova Bay | 4,012 | 2,546 | 37 | 63 | 63 |
| Lower Clarence Strait | 7,573 | 5,012 | 29 | 71 | 66 |
| Middle Clarence Strait | 5,970 | 3,030 | 35 | 65 | 51 |
| Union Bay | 3,349 | 2,027 | 23 | 77 | 61 |
| Upper Clarence Strait | 7,152 | 3,123 | 16 | 84 | 44 |
| Revillagigedo Channel | 7,458 | 4,437 | 52 | 48 | 60 |
| Tree Point | 5,031 | 3,248 | 45 | 55 | 65 |
| Alaska total | 68,811 | 40,748 | 39 | 61 | 59 |
| <u>Canada</u> | | | | | |
| Langara Island | 5,603 | 2,214 | 49 | 51 | 40 |
| Dixon Entrance | 9,250 | 3,537 | 46 | 54 | 38 |
| 3x | 8,439 | 5,574 | 29 | 71 | 66 |
| 3Y | 7,241 | 4,562 | 21 | 79 | 63 |
| 3Z | 7,481 | 5,462 | 20 | 80 | 73 |
| 4 | 5,680 | 4,298 | 24 | 76 | 76 |
| 5 | 7,005 | 4,807 | 28 | 72 | 69 |
| 6 | 6,102 | 2,848 | 35 | 65 | 47 |
| Canada total | 56,801 | 33,302 | 29 | 71 | 59 |
| T o t a l s | 125,612 | 74,050 | 35 | 65 | 59 |

Table 35.--1982 stock-composition estimates (%) of pink salmon by release area and period, totals for Alaska and Canada (%), and estimated numbers of tagged fish in Alaskan and Canadian escapements (%). Best estimates of escapements were used, and recovery rate of primary-tagged entrants in Canada was assumed equal to that of secondary-tagged fish. Dash indicates no recovery in escapement samples.

| Release area ^a | Alaska stocks | | | | Canada stocks | | | Total | Escapement recoveries | |
|----------------------------------|---------------|-----|-----|-------|---------------|--------|-----|-------|-----------------------|------|
| | 101 | 102 | 103 | other | 3 | Skeena | AK | Can. | AK | Can. |
| Release period 1: 1 June-15 July | | | | | | | | | | |
| Noyee ^b | 4 | 0 | 0 | 77 | 19 | 0 | 81 | 19 | | |
| Dall | 96 | 0 | 0 | 0 | 4 | 0 | 96 | 4 | 100 | 0 |
| Lclar | 91 | 0 | 0 | 6 | 3 | 0 | 97 | 3 | 100 | 0 |
| Mclar | 73 | 0 | 0 | 26 | 1 | 0 | 99 | 1 | 100 | 0 |
| Uclar | 50 | 0 | 0 | 49 | 1 | 0 | 99 | 1 | 100 | 0 |
| Tree | 92 | 0 | 0 | 0 | 7 | 0 | 93 | 7 | 100 | 0 |
| Revla | 90 | 0 | 0 | 3 | 7 | 0 | 93 | 7 | 94 | 6 |
| Union ^b | 50 | 0 | 0 | 50 | 0 | 0 | 100 | 0 | 100 | 0 |
| Dixon | 97 | 0 | 0 | 0 | 3 | 0 | 97 | 3 | 100 | 0 |
| Lang | 86 | 0 | 0 | 0 | 14 | 0 | 85 | 15 | 76 | 24 |
| 3x | 86 | 1 | 0 | 0 | 13 | 0 | 87 | 13 | 91 | 9 |
| | 48 | 0 | 0 | 0 | 52 | 0 | 48 | 52 | 30 | 70 |
| | 4 | 0 | 0 | 41 | 56 | 0 | 44 | 56 | 0 | 100 |
| 4 | 5 | 0 | 0 | 88 | 7 | 0 | 93 | 7 | 100 | 0 |
| Release period 2: 16-31 July | | | | | | | | | | |
| Noyes | 81 | 3 | 0 | 0 | 14 | 2 | 84 | 16 | 100 | 0 |
| Mclar | 72 | 1 | 0 | 21 | 3 | 3 | 94 | 6 | 98 | 2 |
| Uclar | 55 | 6 | 0 | 30 | 6 | 4 | 91 | 9 | 95 | 5 |
| Tree | 64 | 2 | 0 | 0 | 30 | 3 | 66 | 34 | 72 | 28 |
| Revla | 82 | 0 | 0 | 0 | 16 | 1 | 83 | 17 | 90 | 10 |
| Union ^b | 56 | 1 | 0 | 28 | 13 | 1 | 85 | 15 | 100 | 0 |
| Dixon | 64 | 5 | 2 | 14 | 12 | 3 | 84 | 16 | 92 | 8 |
| Lang | 65 | 4 | 0 | 0 | 26 | 5 | 69 | 31 | 66 | 34 |
| 3x | 49 | 1 | 0 | 0 | 34 | 16 | 49 | 51 | 33 | 67 |
| 3Y | 22 | 1 | 0 | 10 | 57 | 10 | 33 | 67 | 19 | 81 |
| 3Z | 28 | 0 | 0 | 4 | 66 | 2 | 33 | 67 | 29 | 71 |
| 4 | 53 | 3 | 0 | 8 | 21 | 14 | 64 | 36 | 65 | 35 |
| 5 ^b | 55 | 0 | 0 | 6 | 32 | 6 | 62 | 38 | 100 | 0 |

Table 35. --Continued.

| Release area' | Alaska stocks | | | | Canada stocks | | Total | | Escapement recoveries | |
|-----------------------------------------|---------------|-----|-----|-------|---------------|--------|-------|------|--------------------------|------|
| | 101 | 102 | 103 | other | 3 | Skeena | AK | Can. | AK | Can. |
| Release period 3: 1-15 August | | | | | | | | | | |
| Noyes | 24 | 13 | 18 | 21 | 17 | 6 | 77 | 23 | 93 | 7 |
| Dall | 33 | 12 | 15 | 14 | 18 | 9 | 73 | 27 | 89 | 11 |
| Lclar | 40 | 29 | 9 | 14 | 5 | 3 | 91 | 9 | 98 | 2 |
| Mclar | 50 | 23 | 5 | 17 | 3 | 2 | 94 | 6 | 100 | 0 |
| Uclar | 60 | 14 | 1 | 20 | 3 | 2 | 95 | 5 | 99 | 1 |
| Cordv | 6 | 23 | 28 | 35 | 4 | 4 | 91 | 9 | 92 | 8 |
| Tree | 30 | 2 | 1 | 4 | 52 | 12 | 36 | 64 | 46 | 54 |
| Revla | 29 | 4 | 1 | 8 | 51 | 7 | 42 | 58 | 45 | 55 |
| Union | 91 | 0 | 0 | 8 | 0 | 0 | 100 | 0 | 100 | 0 |
| Dixon | 41 | 15 | 5 | 7 | 17 | 15 | 67 | 33 | 73 | 27 |
| Lang | 12 | 18 | 21 | 28 | 16 | 6 | 78 | 22 | - | |
| 3x | 24 | 3 | 0 | 0 | 38 | 36 | 26 | 74 | 15 | 85 |
| 3Y | 29 | 1 | 0 | 0 | 54 | 15 | 30 | 70 | 30 | 70 |
| 32 | 24 | 1 | 0 | 2 | 71 | 3 | 27 | 73 | 23 | 77 |
| 4 | 7 | 0 | 0 | 1 | 11 | 80 | 8 | 92 | 4 | 96 |
| 5 | 12 | 2 | 1 | 4 | 25 | 56 | 19 | 81 | 8 | 92 |
| Release period 4: 16 August-1 September | | | | | | | | | | |
| Noyes | 33 | 21 | 36 | 4 | 1 | 5 | 94 | 6 | 93 | 7 |
| Dall | 59 | 11 | 29 | 0 | 1 | 2 | 98 | 2 | 100 | 0 |
| Lclar | 32 | 60 | 1 | 8 | 0 | 0 | 99 | 1 | 100 | 0 |
| Mclar | 59 | 23 | 0 | 18 | 0 | 0 | 100 | 0 | 100 | 0 |
| Uclar | 30 | 45 | 0 | 24 | 0 | 0 | 100 | 0 | 100 | 0 |
| Cordv | 30 | 36 | 28 | 5 | 0 | 1 | 98 | 2 | 100 | 0 |
| Tree | 83 | 5 | 0 | 0 | 5 | 7 | 87 | 13 | 84 | 16 |
| Revla | 90 | 5 | 0 | 1 | 1 | 2 | 96 | 4 | 100 | 0 |
| Dixon | 61 | 29 | 4 | 0 | 1 | 5 | 94 | 6 | 91 | 9 |
| 3x | 61 | 11 | 0 | 2 | 7 | 19 | 74 | 26 | 66 | 34 |
| 3Y | 51 | 11 | 1 | 0 | 18 | 19 | 63 | 37 | 38 | 62 |
| 3Z ^b | 28 | 56 | 0 | 15 | 0 | 0 | 100 | 0 | 100 | 0 |
| 5 | 6 | 2 | 0 | 1 | 1 | 90 | 9 | 91 | 0 | 100 |

^aNoyes - Noyes Island; Dall = Dall Island; Lclar - Lower Clarence Strait; Mclar = Middle Clarence Strait; Uclar - Upper Clarence Strait; Cordv - Cordova Bay; Tree = Tree Point; Revla - Revillagigedo Channel; Union - Union Bay; Dixon = Dixon Entrance; and Lang - Langara Island.

^bFewer than 10 tagged fish were recovered in catches and escapements from releases of tagged fish, and the estimates of stock composition should be considered in light of this limited basis.

Table 36.--1984 stock-composition estimates (%) of pink salmon by release area and period, totals for Alaska and Canada (%), and estimated numbers of tagged fish in Alaskan and Canadian escapements (%). Best estimates of escapements were used, and recovery rates of-primary-tagged entrants to the Skeena and Kwinamass Rivers were assumed equal to that of secondary-tagged fish. Dash indicates no recovery in escapement samples.

| Release area ^a | Alaska stocks | | | | Canada stocks | | | | Total | | Esc. recov. | |
|----------------------------------|---------------|-----|-------|-------|---------------|----|--------|-----|-------|------|-------------|------|
| | 101 | 102 | 103&4 | other | 1 | 3 | Skeena | 5-6 | AK | Can. | AK | Can. |
| Release period 1: 1 June-15 July | | | | | | | | | | | | |
| Noyes | 78 | 0 | 0 | 19 | 0 | 2 | 1 | 0 | 97 | 3 | 100 | 0 |
| Dall | 66 | 0 | 0 | 32 | 0 | 1 | 1 | 0 | 98 | 2 | 100 | 0 |
| Tree | 92 | 0 | 0 | 3 | 0 | 3 | 2 | 0 | 95 | 5 | 100 | 0 |
| Revla ^b | 98 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 99 | 1 | 100 | 0 |
| Lclar ^b | 14 | 0 | 0 | 85 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| 1B | 53 | 0 | 0 | 36 | 0 | 1 | 10 | 0 | 88 | 12 | 79 | 21 |
| 1D | 80 | 0 | 0 | 5 | 0 | 4 | 11 | 0 | 86 | 14 | 100 | 0 |
| 3X | 83 | 0 | 0 | 0 | 0 | 4 | 12 | 0 | 84 | 16 | 74 | 26 |
| 3Y | 89 | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 89 | 11 | 88 | 12 |
| 3Z | 90 | 0 | 0 | 0 | 0 | 8 | 2 | 0 | 91 | 10 | 92 | 8 |
| 4 | 54 | 0 | 0 | 0 | 0 | 4 | 42 | 0 | 54 | 46 | 0 | 100 |
| 5 | 84 | 0 | 0 | 2 | 0 | 9 | 4 | 0 | 86 | 14 | 76 | 24 |
| Release period 2: 16-31 July | | | | | | | | | | | | |
| Noyes | 51 | 3 | 25 | 7 | 0 | 4 | 9 | 0 | 86 | 14 | 91 | 9 |
| Dall | 47 | 7 | 23 | 4 | 0 | 9 | 9 | 0 | 82 | 18 | 83 | 17 |
| Tree | 80 | 0 | 0 | 0 | 0 | 11 | 9 | 0 | 80 | 20 | 98 | 2 |
| Revla | 95 | 0 | 0 | 1 | 0 | 2 | 2 | 0 | 97 | 3 | 100 | 0 |
| Lclar | 78 | 0 | 1 | 10 | 0 | 7 | 3 | 0 | 89 | 11 | 91 | 9 |
| 1A | 70 | 8 | 1 | 2 | 0 | 10 | 9 | 0 | 81 | 19 | 89 | 11 |
| 1B | 58 | 15 | 0 | 7 | 0 | 7 | 9 | 4 | 80 | 20 | 77 | 23 |
| 1C | 88 | 0 | 0 | 2 | 0 | 5 | 5 | 0 | 90 | 10 | 100 | 0 |
| 1D | 74 | 0 | 0 | 0 | 0 | 8 | 17 | 0 | 74 | 26 | 100 | 0 |
| 3x | 60 | 2 | 0 | 0 | 0 | 14 | 20 | 3 | 62 | 38 | 61 | 39 |
| 3Y | 60 | 0 | 0 | 0 | 0 | 24 | 16 | 0 | 60 | 40 | 57 | 43 |
| 3Z | 60 | 0 | 0 | 0 | 0 | 22 | 17 | 0 | 60 | 40 | 60 | 40 |
| 4 | 42 | 0 | 0 | 0 | 0 | 12 | 45 | 0 | 42 | 58 | 7 | 93 |
| 5 | 29 | 0 | 0 | 0 | 0 | 8 | 63 | 0 | 29 | 71 | 9 | 91 |

Table 36. --Continued.

| Release area ^a | Alaska stocks | | | | Canada stocks | | | | Total | | Esc. recov. | |
|-----------------------------------------|---------------|-----|-------|-------|---------------|----|--------|-----|-------|------|----------------|------|
| | 101 | 102 | 103&4 | other | 1 | 3 | Skeena | 5-6 | AK | Can. | AK | Can. |
| Release period 3: 1-15 August | | | | | | | | | | | | |
| Noyes | 5 | 12 | 22 | 60 | 0 | 1 | 1 | 0 | 99 | 1 | 100 | 0 |
| Dall | 23 | 20 | 41 | 6 | 0 | 3 | 7 | 0 | 89 | 11 | 91 | 9 |
| Tree | 45 | 5 | 1 | 0 | 0 | 21 | 28 | 0 | 51 | 49 | 36 | 64 |
| Revla | 89 | 8 | 1 | 0 | 0 | 1 | 1 | 0 | 98 | 2 | 100 | 0 |
| Lclar | 30 | 58 | 8 | 1 | 0 | 2 | 1 | 0 | 97 | 3 | 98 | 2 |
| 1A | 35 | 26 | 4 | 6 | 0 | 8 | 20 | 0 | 71 | 29 | 54 | 46 |
| 1B | 40 | 37 | 12 | 3 | 0 | 2 | 5 | 0 | 92 | 8 | 89 | 11 |
| 1C | 24 | 14 | 3 | 1 | 2 | 3 | 53 | 0 | 42 | 58 | 0 | 100 |
| 1D | 23 | 11 | 2 | 1 | 7 | 9 | 47 | 0 | 36 | 64 | 15 | 85 |
| 3X | 26 | 2 | 0 | 0 | 0 | 16 | 52 | 3 | 28 | 72 | 7 | 93 |
| 3Y | 51 | 2 | 0 | 0 | 0 | 35 | 12 | 0 | 53 | 47 | 64 | 36 |
| 3Z | 30 | 3 | 0 | 0 | 0 | 43 | 24 | 0 | 33 | 67 | 28 | 72 |
| 4 | 18 | 2 | 0 | 0 | 0 | 6 | 73 | 0 | 20 | 80 | 4 | 96 |
| 5 | 10 | 1 | 0 | 0 | 0 | 6 | 82 | 0 | 11 | 89 | 0 | 100 |
| Release period 4: 16 August-1 September | | | | | | | | | | | | |
| Noyes | 1 | 5 | 43 | 49 | 0 | 0 | 1 | 1 | 98 | 2 | 100 | 0 |
| Dall | 6 | 18 | 47 | 19 | 0 | 2 | 5 | 4 | 90 | 10 | 85 | 15 |
| Tree | 6 | 15 | 1 | 10 | 0 | 28 | 40 | 0 | 32 | 68 | 0 | 100 |
| Revla | 62 | 8 | 0 | 6 | 0 | 10 | 14 | 0 | 76 | 24 | 100 | 0 |
| Lclar | 0 | 57 | 3 | 40 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| 1B | 3 | 38 | 3 | 36 | 0 | 2 | 17 | 0 | 81 | 19 | 37 | 63 |
| 1D | 7 | 15 | 3 | 12 | 2 | 9 | 52 | 0 | 37 | 63 | 0 | 100 |
| 3X | 3 | 1 | 0 | 1 | 0 | 53 | 41 | 0 | 5 | 95 | 0 | 100 |
| 3Y | 7 | 2 | 0 | 1 | 0 | 59 | 31 | 0 | 10 | 90 | 4 | 96 |
| 3Z | 10 | 2 | 0 | 2 | 0 | 49 | 38 | 0 | 14 | 86 | 9 | 91 |
| 4 | 12 | 6 | 1 | 5 | 0 | 52 | 25 | 0 | 23 | 77 | 0 | 100 |
| 5 | 31 | 5 | 0 | 4 | 0 | 37 | 22 | 0 | 40 | 60 | - | - |

^aNoyes = Noyes Island; Dall = Dall Island; Tree = Tree Point; Revla = Revillagigedo Channel; Lclar = Lower Clarence Strait; 1A = 1-10; 1B = 1-11, 1-12; 1C = 1-13, 1-14, 1-15; 1D = 1-16, 1-17, 1-18.

^bFewer than 10 tagged fish were recovered in catches and escapements from releases of tagged fish, and the estimates of stock composition should be considered in light of this limited basis.

Table 37.--1985 stock-composition estimates (%) of pink salmon by release area and period, totals for Alaska and Canada (%), and estimated numbers of tagged fish in Alaskan and Canadian escapements (%). Best estimates of escapements were used, and recovery rates of primary-tagged entrants to the Skeena and Kwinamass Rivers were assumed equal to that of secondary-tagged fish.

| Release area ^a | Alaska stocks | | | | Canada stocks | | | Total | | Esc. recov. | |
|----------------------------------|---------------|-----|-------|-------|---------------|--------|------|-------|------|-------------|------|
| | 101 | 102 | 103&4 | other | 3 | Skeena | 5-14 | AK | Can. | AK | Can. |
| Release period 1: 1 June-15 July | | | | | | | | | | | |
| Noyes | 62 | 1 | 5 | 27 | 0 | 5 | 0 | 95 | 5 | 95 | 5 |
| Dall | 85 | 1 | 0 | 12 | 0 | 0 | 2 | 98 | 2 | 98 | 2 |
| Tree | 98 | 0 | 0 | 0 | 2 | 0 | 0 | 98 | 2 | 98 | 2 |
| Revla | 95 | 0 | 0 | 4 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Lclar | 72 | 21 | 0 | 7 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Mclar | 48 | 0 | 0 | 52 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Union | 60 | 0 | 0 | 40 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| 101-4 | 59 | 4 | 0 | 18 | 0 | 0 | 18 | 81 | 19 | 46 | 54 |
| 101-7 | 91 | 2 | 0 | 1 | 0 | 0 | 5 | 95 | 5 | 100 | 0 |
| Lang | 62 | 1 | 0 | 9 | 0 | 12 | 16 | 72 | 28 | 62 | 38 |
| 3X | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| | 91 | 0 | 0 | 0 | 8 | 0 | 0 | 92 | 8 | 89 | 11 |
| | 99 | 0 | 0 | 0 | 1 | 0 | 0 | 99 | 1 | 100 | 0 |
| 4 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| 5 ^b | 99 | 0 | 0 | 0 | 1 | 0 | 0 | 99 | 1 | 100 | 0 |
| 6 | 33 | 0 | 0 | 0 | 0 | 0 | 67 | 33 | 67 | 0 | 100 |
| Release period 2: 16-31 July | | | | | | | | | | | |
| Noyes | 42 | 1 | 21 | 33 | 1 | 2 | 0 | 97 | 3 | 99 | 1 |
| Dall | 65 | 8 | 12 | 11 | 1 | 1 | 1 | 96 | 4 | 99 | 1 |
| Tree | 89 | 0 | 0 | 0 | 9 | 1 | 0 | 90 | 11 | 94 | 6 |
| Revla | 93 | 3 | 2 | 0 | 2 | 0 | 0 | 98 | 2 | 99 | 1 |
| Lclar | 60 | 22 | 9 | 9 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Mclar | 38 | 0 | 0 | 62 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Uclar | 15 | 0 | 0 | 85 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Union | 25 | 0 | 0 | 74 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| 101-4 | 74 | 9 | 7 | 6 | 1 | 1 | 1 | 97 | 3 | 100 | 0 |
| 101-7 | 43 | 0 | 1 | 9 | 7 | 26 | 14 | 54 | 46 | 46 | 54 |
| Lang | 20 | 1 | 1 | 1 | 2 | 15 | 60 | 23 | 77 | 7 | 93 |
| 3x | 54 | 0 | 0 | 0 | 14 | 31 | 1 | 54 | 46 | 44 | 56 |
| 3Y | 88 | 0 | 0 | 0 | 11 | 1 | 0 | 89 | 11 | 91 | 9 |
| 3Z | 83 | 0 | 0 | 0 | 16 | 1 | 0 | 84 | 16 | 84 | 16 |
| 4 | 13 | 0 | 0 | 0 | 2 | 84 | 1 | 13 | 87 | 0 | 100 |
| 5 | 17 | 0 | 0 | 0 | 3 | 74 | 6 | 17 | 83 | 9 | 91 |
| 6 | 8 | 0 | 0 | 0 | 1 | 6 | 85 | 8 | 92 | 0 | 100 |

Table 37. --Continued.

| Release area ^a | Alaska stocks | | | | Canada stocks | | | Total | | ESC. recov. | |
|-----------------------------------------|---------------|-----|-------|-------|---------------|--------|------|-------|------|----------------|------|
| | 101 | 102 | 103&4 | other | 3 | Skeena | 5-14 | AK | Can. | AK | Can. |
| Release period 3: 1-15 August | | | | | | | | | | | |
| Noyes | 11 | 10 | 57 | 13 | 0 | 8 | 0 | 92 | 8 | 92 | 8 |
| Dall | 22 | 20 | 49 | 6 | 1 | 2 | 1 | 96 | 4 | 100 | 0 |
| Cordv | 4 | 11 | 81 | 2 | 0 | 1 | 0 | 98 | 2 | 100 | 0 |
| Tree | 66 | 1 | 0 | 0 | 21 | 11 | 1 | 67 | 33 | 77 | 23 |
| Revla | 86 | 4 | 0 | 0 | 6 | 3 | 0 | 90 | 10 | 100 | 0 |
| Lclar | 17 | 69 | 4 | 4 | 2 | 5 | 0 | 94 | 6 | 95 | 5 |
| Mclar | 12 | 28 | 5 | 54 | 0 | 0 | 0 | 99 | 1 | 100 | 0 |
| Uclar | 0 | 25 | 1 | 74 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Union ^b | 40 | 13 | 1 | 45 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| 101-4 ^b | 61 | 31 | 2 | 2 | 2 | 3 | 0 | 95 | 5 | 100 | 0 |
| 101-7 | 22 | 3 | 3 | 3 | 4 | 44 | 22 | 30 | 70 | 20 | 80 |
| Lang | 30 | 3 | 9 | 1 | 4 | 29 | 24 | 43 | 57 | 40 | 60 |
| 3X | 18 | 1 | 0 | 1 | 5 | 62 | 14 | 19 | 81 | 11 | 89 |
| 3Y | 70 | 0 | 0 | 0 | 20 | 9 | 1 | 71 | 29 | 75 | 25 |
| 3Z | 53 | 0 | 0 | 0 | 34 | 11 | 1 | 54 | 46 | 54 | 46 |
| 4 | 6 | 0 | 0 | 1 | 2 | 88 | 3 | 7 | 93 | 3 | 97 |
| 5 | 6 | 0 | 0 | 0 | 1 | 84 | 8 | 7 | 93 | 3 | 97 |
| 6 | 5 | 0 | 0 | 0 | 1 | 3 | 91 | 5 | 95 | 4 | 96 |
| Release period 4: 16 August-1 September | | | | | | | | | | | |
| Noyes | 5 | 10 | 61 | 15 | 0 | 8 | 0 | 92 | 8 | 89 | 11 |
| Dall | 11 | 30 | 37 | 9 | 0 | 12 | 2 | 87 | 13 | 65 | 35 |
| Cordv ^b | 29 | 34 | 37 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Tree | 44 | 2 | 0 | 5 | 24 | 18 | 5 | 52 | 48 | 51 | 49 |
| Revla | 51 | 25 | 5 | 1 | 1 | 16 | 0 | 83 | 17 | 75 | 25 |
| Lclar | 0 | 89 | 11 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| Mclar | 7 | 52 | 3 | 36 | 1 | 0 | 0 | 99 | 1 | 98 | 2 |
| Uclar | 1 | 16 | 1 | 81 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| 101-7 | 12 | 30 | 4 | 0 | 0 | 16 | 38 | 46 | 54 | 0 | 100 |
| 3X | 6 | 2 | 0 | 0 | 7 | 73 | 11 | 9 | 91 | 3 | 97 |
| 3Y | 21 | 0 | 0 | 0 | 49 | 24 | 6 | 22 | 78 | 21 | 79 |
| 3Z | 17 | 0 | 0 | 0 | 42 | 34 | 6 | 18 | 82 | 17 | 83 |
| 4 | 0 | 0 | 0 | 0 | 0 | 96 | 4 | 0 | 100 | 0 | 100 |
| 5 | 0 | 0 | 0 | 0 | 0 | 79 | 21 | 0 | 100 | 0 | 100 |
| 6 | 0 | 0 | 0 | 0 | 0 | 9 | 91 | 0 | 100 | 0 | 100 |

^aNoyes - Noyes Island; Dall - Dall Island; Tree - Tree Point; Revla - Revillagigedo Channel; Lclar - Lower Clarence Strait; Mclar - Middle Clarence Strait; Uclar - Upper Clarence Strait; Union - Union Bay; Cordv - Cordova Bay; and Lang - Langara Island.

^bFewer than 10 tagged fish were recovered in catches and escapements from releases of tagged fish, and the estimates of stock composition should be considered in light of this limited basis.

Table 38.--Estimated percentage of Alaskan-origin* pink salmon (bootstrap standard error in parentheses) by fishery and period of release, 1982. Dash indicates no estimate could be made.

| Release fishery | Late June to mid-July | Mid- to late July | Early to mid-August | Mid-Aug to early Sep |
|------------------------|-----------------------|-------------------|---------------------|----------------------|
| <u>Alaska</u> | | | | |
| Noyes Island | 81 (4.5) | 84 (4.2) | 77 (2.8) | 94 (1.5) |
| Dall Island | 96 (1.5) | | 73 (4.7) | 98 (0.5) |
| Cordova Bay | | | 91 (2.3) | 98 (0.3) |
| Lower Clarence Strait | 97 (1.3) | | 91 (1.7) | 99 (0.1) |
| Middle Clarence Strait | 99 (0.3) | 94 (1.9) | 94 (1.1) | 100 (0.0) |
| Union Bay | 100 (0.0) | 85 (6.2) | 100 (0.1) | - |
| Upper Clarence Strait | 99 (0.6) | 91 (4.2) | 95 (1.3) | 100 (0.3) |
| Revillagigedo Channel | 93 (3.9) | 83 (6.7) | 42 (12.8) | 96 (1.0) |
| Tree Point | 93 (0.3) | 66 (8.0) | 36 (8.6) | 87 (3.7) |
| <u>Canada</u> | | | | |
| Dixon Entrance | | | | |
| Overall | 97 (1.3) | 84 (3.6) | 67 (3.4) | 94 (3.0) |
| Langara Island | 85 (2.6) | 69 (6.2) | 78 (3.9) | |
| 3x | 87 (3.8) | 49 (4.9) | 26 (6.4) | 74 (6.7) |
| 3Y | 48 (13.9) | 33 (6.0) | 30 (7.3) | 63 (4.0) |
| 3Z | 44 (16.1) | 33 (6.1) | 27 (19.1) | 100 (0.0) |
| 4 | 93 (3.8) | 64 (6.6) | 8 (2.3) | - |
| 5 | | 62 (19.0) | 19 (4.4) | 9 (3.1) |

*Standard errors account for chance variation in numbers of recoveries from subsampling catches and escapements but not for errors in escapement estimates of Alaska or Canada.

Table 39. --Estimated percentage of Alaskan-origin' pink salmon (bootstrap standard error in parentheses) by fishery and period of release, 1984. Dash indicates no estimate could be made.

| Release fishery | Late June to mid-July | Mid- to late July | Early to mid-August | Mid-Aug to early Sep |
|-----------------------------|-----------------------|-------------------|---------------------|----------------------|
| <u>Alaska</u> | | | | |
| Noyes Island | 97 (1.8) | 86 (5.4) | 99 (0.5) | 98 (1.5) |
| Dall Island | 98 (1.0) | 82 (5.7) | 89 (2.6) | 90 (4.7) |
| Lower Clarence Strait | 100 (0.6) | 89 (4.0) | 97 (1.0) | 100 (0.2) |
| Revillagigedo Channel | 99 (0.9) | 97 (1.2) | 98 (0.8) | 76 (8.3) |
| Tree Point | 95 (3.2) | 80 (3.2) | 51 (4.0) | 32 (10.8) |
| <u>Canada</u> | | | | |
| Dixon Entrance ^b | | | | |
| 1-10 | | 81 (3.0) | 71 (7.7) | |
| 1-11,-12 | 88 (7.5) | 80 (5.2) | 92 (2.4) | 81 (8.6) |
| 1-16,-17,-18 | 86 (8.5) | 74 (6.7) | 36 (5.4) | 37 (18.2) |
| 3x | 84 (8.5) | 62 (5.3) | 28 (3.1) | 5 (1.0) |
| 3Y | 89 (5.6) | 60 (7.4) | 53 (4.4) | 10 (3.4) |
| 3Z | 91 (8.3) | 60 (7.7) | 33 (5.2) | 14 (6.0) |
| 4 | 54 (23.0) | 42 (9.0) | 20 (3.4) | 23 (5.6) |
| 5 | 86 (6.3) | 29 (7.4) | 11 (3.5) | 40 (4.6) |

'Standard errors account for chance variation in numbers of recoveries from subsampling catches and escapements but not for errors in escapement estimates of Alaska or Canada.

^bSee Figure 5 for reference.

Table 40. --Estimated percentage of Alaskan-origin' pink salmon (bootstrap standard error in parentheses) by fishery and period of release, 1985. Dash indicates no estimate could be made.

| Release fishery | Late June to mid-July | Mid- to late July | Early to mid-August | Mid-Aug to early Sep |
|-----------------------------|-----------------------|-------------------|---------------------|----------------------|
| <u>Alaska</u> | | | | |
| Noyes Island | 95 (4.0) | 97 (1.0) | 92 (3.4) | 92 (7.4) |
| Dall Island | 98 (1.3) | 96 (0.8) | 96 (0.6) | 87 (5.9) |
| Cordova Bay | | | 98 (0.4) | 100 (0.0) |
| Lower Clarence Strait | 100 (0.0) | 100 (0.0) | 94 (2.0) | 100 (0.0) |
| Middle Clarence Strait | 100 (0.0) | 100 (0.0) | 99 (0.2) | 99 (1.2) |
| Union Bay | 100 (0.0) | 100 (0.0) | 100 (0.1) | - |
| Upper Clarence Strait | - | 100 (0.0) | 100 (0.0) | 100 (0.2) |
| Revillagigedo Channel | 100 (0.1) | 98 (0.7) | 90 (1.6) | 83 (9.1) |
| Tree Point | 98 (2.0) | 90 (1.6) | 67 (4.0) | 52 (12.5) |
| <u>Canada</u> | | | | |
| Dixon Entrance ^b | | | | |
| 101-4 | 81 (12.3) | 97 (0.5) | 95 (2.1) | - |
| 101-7 | 95 (1.9) | 54 (12.6) | 30 (4.3) | 46 (11.6) |
| Langara Island | 72 (7.4) | 23 (3.4) | 43 (5.6) | - |
| 3x | 100 (0.3) | 54 (6.8) | 19 (2.5) | 9 (2.2) |
| 3Y | 92 (6.3) | 89 (6.9) | 71 (3.0) | 22 (6.2) |
| 32 | 99 (5.9) | 84 (4.0) | 54 (3.6) | 18 (6.1) |
| 4 | 100 (0.3) | 13 (4.5) | 7 (1.6) | 0 (0.0) |
| 5 | 99 (1.4) | 17 (3.3) | 7 (1.8) | 0 (0.1) |
| 6 | 33 (14.6) | 8 (1.2) | 5 (3.4) | 0 (0.0) |

^aStandard errors account for chance variation in numbers of recoveries from subsampling catches and escapements but not for errors in escapement estimates of Alaska or Canada.

^bSee Figure 6 for reference.

Table 41. --Numbers of tags recovered in escapements and catches of pink salmon by area and period of release in 1982.

| Release area | <u>Late June to</u> <u>mid-July</u> | | <u>Mid- to</u> <u>late July</u> | | <u>Early to</u> <u>mid-August</u> | | <u>Mid-Aug to</u> <u>early Sept</u> | |
|------------------------|----------------------------------------|-------|------------------------------------|-------|--------------------------------------|-------|----------------------------------------|-------|
| | Esc. | Catch | Esc. | Catch | Esc. | Catch | Esc. | Catch |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 0 | 9 | 6 | 28 | 14 | 78 | 84 | 297 |
| Dall Island | 1 | 6 | 0 | 0 | 27 | 109 | 17 | 26 |
| Cordova Bay | 0 | 0 | 0 | 0 | 8 | 6 | 32 | 68 |
| Upper Clarence Strait | 12 | 3 | 29 | 10 | 86 | 68 | 8 | 3 |
| Union Bay | 2 | 0 | 5 | 4 | 13 | 9 | 0 | 0 |
| Middle Clarence Strait | 30 | 11 | 42 | 27 | 119 | 140 | 128 | 77 |
| Lower Clarence Strait | 15 | 18 | 0 | 0 | 135 | 126 | 204 | 97 |
| Revillagigedo Channel | 42 | 83 | 40 | 73 | 3 | 37 | 19 | 55 |
| Tree Point | 1 | 9 | 21 | 84 | 8 | 194 | 15 | 72 |
| <u>Canada</u> | | | | | | | | |
| Dixon Entrance | 11 | 28 | 40 | 92 | 35 | 156 | 12 | 61 |
| Langara Island | 11 | 67 | 3 | 40 | 0 | 8 | 0 | 0 |
| 3x | 13 | 58 | 41 | 186 | 33 | 449 | 8 | 271 |
| 3Y | 7 | 26 | 41 | 81 | 39 | 261 | 81 | 540 |
| 3Z | 8 | 10 | 95 | 95 | 4 | 7 | 4 | 5 |
| 4 | 1 | 7 | 26 | 171 | 94 | 235 | 0 | 0 |
| 5 | 0 | 0 | 1 | 6 | 43 | 225 | 13 | 25 |

Table 42. --Numbers of tags recovered in escapements and catches of pink salmon by area and period of release in 1984.

| Release area | Late June to <u>mid-July</u> | | Mid- to <u>late July</u> | | Early to <u>mid-August</u> | | Mid-Aug to <u>early Sept</u> | |
|-----------------------|---------------------------------|-------|-----------------------------|-------|-------------------------------|-------|---------------------------------|-------|
| | Esc. | Catch | Esc. | Catch | Esc. | Catch | Esc. | Catch |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 8 | 71 | 15 | 130 | 15 | 77 | 6 | 118 |
| Dall Island | 19 | 118 | 19 | 142 | 40 | 494 | 11 | 173 |
| Tree Point | 8 | 68 | 23 | 286 | 31 | 400 | 3 | 20 |
| Revillagigedo Channel | 25 | 38 | 12 | 33 | 7 | 43 | 5 | 84 |
| Lower Clarence Strait | 1 | 1 | 7 | 66 | 59 | 365 | 6 | 28 |
| <u>Canada</u> | | | | | | | | |
| Dixon Entrance* | | | | | | | | |
| 1-10 | 0 | 0 | 14 | 185 | 9 | 115 | 0 | 0 |
| 1-11,-12 | 9 | 96 | 24 | 181 | 20 | 395 | 2 | 85 |
| 1-13,-14,-15 | 0 | 0 | 2 | 20 | 5 | 33 | 0 | 0 |
| 1-16,-17,-18 | 1 | 10 | 2 | 27 | 37 | 158 | 3 | 16 |
| 3x | 8 | 78 | 23 | 318 | 71 | 729 | 131 | 298 |
| 3Y | 13 | 105 | 21 | 194 | 52 | 232 | 33 | 75 |
| 3Z | 6 | 55 | 34 | 203 | 68 | 255 | 13 | 90 |
| 4 | 1 | 20 | 7 | 183 | 22 | 227 | 1 | 15 |
| 5 | 3 | 55 | 11 | 166 | 8 | 207 | 0 | 73 |

*See Figure 5 for reference.

Table 43. --Numbers of tags recovered in escapements and catches of pink salmon by area and period of release in 1985.

| Release area | Late June to <u>mid-July</u> | | Mid- to <u>late July</u> | | Early to <u>mid-August</u> | | Mid-Aug to <u>early Sept</u> | |
|------------------------|---------------------------------|-------|-----------------------------|-------|-------------------------------|-------|---------------------------------|-------|
| | Esc. | Catch | Esc. | Catch | Esc. | Catch | Esc. | Catch |
| <u>Alaska</u> | | | | | | | | |
| Noyes Island | 42 | 106 | 190 | 355 | 72 | 459 | 18 | 51 |
| Dall Island | 42 | 96 | 78 | 241 | 59 | 286 | 11 | 141 |
| Cordova Bay | 0 | 0 | 0 | 0 | 72 | 156 | 2 | 7 |
| Tree Point | 17 | 21 | 42 | 339 | 31 | 327 | 14 | 19 |
| Revillagigedo Channel | 19 | 88 | 59 | 158 | 16 | 141 | 14 | 374 |
| Lower Clarence Strait | 17 | 17 | 52 | 63 | 58 | 268 | 5 | 30 |
| Middle Clarence Strait | 33 | 8 | 29 | 13 | 40 | 83 | 20 | 134 |
| Upper Clarence Strait | 0 | 0 | 101 | 15 | 67 | 56 | 20 | 44 |
| Union Bay | 25 | 5 | 30 | 17 | 46 | 100 | 0 | 1 |
| <u>Canada</u> | | | | | | | | |
| Dixon Entrance* | | | | | | | | |
| 101-4 | 2 | 20 | 40 | 98 | 1 | 7 | 0 | 0 |
| 101-7 | 1 | 13 | 6 | 31 | 31 | 244 | 2 | 22 |
| 101-N | 0 | 0 | 2 | 19 | 0 | 0 | 0 | 0 |
| 101-5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 |
| 101-6 | 4 | 11 | 2 | 17 | 0 | 7 | 0 | 0 |
| 101-8 | 0 | 0 | 2 | 7 | 0 | 0 | 0 | 0 |
| 101-g | 0 | 5 | 2 | 77 | 0 | 0 | 0 | 0 |
| 101-10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Langara Island | 21 | 114 | 20 | 142 | 22 | 163 | 0 | 0 |
| 3x | 1 | 2 | 21 | 192 | 62 | 433 | 68 | 65 |
| 3Y | 8 | 36 | 5 | 30 | 158 | 369 | 62 | 37 |
| 3Z | 4 | 15 | 58 | 195 | 206 | 357 | 52 | 15 |
| 4 | 1 | 3 | 9 | 145 | 51 | 221 | 31 | 2 |
| 5 | 1 | 6 | 38 | 276 | 37 | 203 | 43 | 1 |
| 6 | 5 | 17 | 26 | 105 | 37 | 266 | 53 | 70 |

*See Figure 6 for reference.

Table 44. --Estimated percentages of Alaskan-origin pink salmon by fishery and period of release for which 10 or more tags were recovered in catch and escapement sampling in 1982, 1984, and 1985.

| Release Area* | Late June to mid-July | | | Mid- to late July | | | Early to mid-August | | | Mid-Aug to early Sept | | |
|----------------|-----------------------|------|------|-------------------|------|------|---------------------|------|------|-----------------------|------|------|
| | 1982 | 1984 | 1985 | 1982 | 1984 | 1985 | 1982 | 1984 | 1985 | 1982 | 1984 | 1985 |
| <u>Alaska</u> | | | | | | | | | | | | |
| Noyes Island - | 97 | 95 | | 84 | 86 | 97 | 77 | 99 | 92 | 94 | 98 | 92 |
| Dall Island - | 98 | 98 | | - | 82 | 96 | 73 | 89 | 96 | 98 | 90 | 87 |
| Cordova Bay - | - | - | - | - | - | - | 91 | - | 98 | 98 | - | - |
| Lclar | 97 | - | 100 | - | 89 | 100 | 91 | 97 | 94 | 100 | 100 | 100 |
| Mclar | 99 | - | 100 | 94 | - | 100 | 94 | - | 99 | 100 | - | 99 |
| Union Bay | - | - | 100 | - | - | 100 | 100 | - | 100 | - | - | - |
| Uclar | 99 | - | - | 91 | - | 100 | 95 | - | 100 | 100 | - | 100 |
| Revla | 93 | 99 | 100 | 83 | 97 | 98 | 42 | 98 | 90 | 96 | 76 | 83 |
| Tree | 93 | 95 | 98 | 66 | 80 | 90 | 36 | 51 | 67 | 87 | 32 | 52 |
| <u>Canada</u> | | | | | | | | | | | | |
| Dixon Entrance | | | | | | | | | | | | |
| Northwest | - | - | 81 | - | 81 | 97 | - | 71 | - | - | - | - |
| Northeast | - | 88 | - | - | 80 | - | - | 92 | - | - | 81 | - |
| South | - | 86 | 95 | - | 74 | 54 | - | 36 | 30 | - | 37 | 46 |
| Overall | 97 | - | - | 84 | - | - | 67 | - | - | 94 | - | - |
| Langara Is. | 85 | - | 72 | 69 | - | 23 | - | - | 43 | - | - | - |
| 3X | 87 | 84 | - | 49 | 62 | 54 | 26 | 28 | 19 | 74 | 5 | 9 |
| 3Y | 48 | 89 | 92 | 33 | 60 | 89 | 30 | 53 | 71 | 63 | 10 | 22 |
| 3Z | 44 | 91 | 99 | 33 | 60 | 84 | 27 | 33 | 54 | - | 14 | 18 |
| 4 | - | 54 | - | 64 | 42 | 13 | 8 | 20 | 7 | - | 23 | 0 |
| 5 | - | 86 | - | - | 29 | 17 | 19 | 11 | 7 | 9 | 40 | 0 |
| 6 | - | - | 33 | - | - | 8 | - | - | 5 | - | - | 0 |

*Lclar = Lower Clarence Strait; Mclar = Middle Clarence Strait; Uclar = Upper Clarence Strait; Revla = Revillagigedo Channel; and Tree = Tree Point.

Table 45. --Estimated season stock compositions based on catch-weighted averages of half-monthly percentages of pink salmon in northern boundary fisheries bound for the other country, 1982, 1984, and 1985.

| Fishery | Percentage from other country | | |
|------------------------|-------------------------------|-----------------|------------------------|
| | 1982 | 1984 | 1985 |
| <u>Alaska</u> | | | |
| Noyes Island | 7.2 (1.4) | 2.0 (1.0) | 8.2 (4.0) |
| Dall Island | 5.9 (0.7) | 10.8 (2.6) | 8.1 _d (2.5) |
| Cordova Bay | 1.6 (0.3) | nt ^c | |
| Lower Clarence Strait | 2.0 (0.3) | 2.1 (0.5) | 1.4 (0.4) |
| Middle Clarence Strait | nc ^e | nt | 1.5 (1.2) |
| Union Bay | | nt | |
| Upper Clarence Strait | 3.9 (1.3) | nt | 0.2 (0.1) |
| Revillagigedo Channel | 8.3 (1.3) | 6.2 (1.6) | 12.1 (4.0) |
| Tree Point | 22.2 (3.1) | 42.5 (3.6) | 33.4 (4.7) |
| <u>Canada</u> | | | |
| Dixon Entrance | | | |
| North ^f | ni ^g | ni | 88.2 (6.8) |
| South ^f | | ni | 55.5 (4.2) |
| Langara Island | 75.0 (3.2) | nt | 36.8 (3.2) |
| 3x | 56.5 (4.0) | 35.9 (2.6) | 26.6 (2.3) |
| 3Y | 55.1 (3.3) | 49.5 (4.1) | 59.6 (2.6) |
| 3Z | | 45.1 (4.4) | 45.9 (2.9) |
| 4 | 37.5 (3.2) | 30.7 (4.4) | 6.5 (1.1) |
| 5 | ne | 28.8 (3.1) | 6.4 (1.0) |
| 6 | nt | nt | 2.3 (1.1) |

^aCatch-weighted averages were computed for a fishing area provided reasonably reliable half-month estimates of stock composition (those of release periods for which at least 10 tagged fish were recovered) covered at least 75% of the season catch in the area.

^bStandard errors in parentheses account for chance variation in numbers of recoveries from subsampling catches and escapements but not for errors in escapement estimates of Alaskan or Canadian stocks.

^cnt - No tagging occurred in this year and area.

^dne - Less than 75% of the season catch occurred during the periods for which stock-composition estimates were reasonably reliable.

^enc - No catch was made in this area.

^fNorth includes 101-3, 101-4, 101-5, 101-8, and 101-9; South includes 101-6, 101-7, and 101-10. Proportions from tagging in 101-4 were used to represent North catches, and those from tagging in 101-7 were used for South catches.

^gni - Insufficient information on catches by time and area are currently available to compute an annual value.

Table 46. --Effects of different estimates of Alaskan and Canadian escapements" and Canadian secondary-tagging mortality on estimated percentages of Canadian pink salmon in Alaskan fisheries, 1982, 1984, and 1985.

| Escapement (millions) | | Canadian tagging mortality | Canadian percentage in fishery | | | | | | |
|--------------------------|-----------------|----------------------------------|--------------------------------|----------------|-----------------------------------------|----------------------------------------|----|-------------------------------|---------------|
| AK | Can. | | | | | | | | |
| 1982 | | | | | | | | | |
| | | | Noyes Island | Dall Island | Cordova Bay | Clarence <u>Strait</u> Low up | | Revilla- gigedo Channel | Tree Point |
| 10.5 | na ^b | 0% | 7 | 6 | 2 | 2 | 4 | 8 | 22 |
| 24.9 | na | 0% | 5 | 3 | 1 | 1 | 1 | 7 | 19 |
| 24.9 | na | 40% | 3 | 2 | 1 | 1 | 1 | 5 | 13 |
| 8.2 | na | 0% | 7 | 5 | 2 | 2 | 5 | 9 | 22 |
| 8.2 | na | 40% | 5 | 4 | 1 | 2 | 3 | 7 | 16 |
| Range | | | 4 | 4 | 1 | 1 | 4 | 4 | 9 |
| 1984 | | | | | | | | | |
| | | | Noyes Island | Dall Island | Clarence Strait | Lower Revilla- gigedo Channel | | Tree Point | |
| 13.4 | 1.9 | 0% | 2 | 11 | 2 | | 6 | 43 | |
| 16.1 | 1.5 | 0% | 2 | 9 | 2 | | 6 | 40 | |
| 9.0 | 2.3 | 0% | 4 | 14 | 3 | | 10 | 47 | |
| 16.1 | 1.5 | 40% | 1 | 7 | 1 | | 5 | 34 | |
| Range | | | 3 | 7 | 2 | | 5 | 13 | |
| 1985 | | | | | | | | | |
| | | | Noyes Island | Dall Island | Clarence <u>Strait</u> Low Mid Up | | | Revilla- gigedo Channel | Tree Point |
| 18.3 | 5.1 | 0% | 8 | 8 | 12 | | 0 | 12 | 33 |
| 19.3 | 4.0 | 0% | 8 | 7 | 1 | 1 | 0 | 11 | 31 |
| 12.2 | 5.8 | 0% | 11 | 9 | 2 | 2 | 0 | 16 | 43 |
| 19.3 | 4.0 | 40% | 5 | 5 | 1 | 1 | 1 | 8 | 24 |
| Range | | | 6 | 4 | 1 | 1 | 1 | 8 | 9 |

'Point estimates and bounds for total escapements appear in this table, but corresponding values for regional stock groups (Tables 26, 27) were used in the computations.

^bna - data not available.

Table 47.--Effects of different estimates of Alaskan and Canadian escapements' and Canadian secondary-tagging mortality on estimated percentages of Alaskan pink salmon in Canadian fisheries, 1982, 1984, and 1985.

| Escapement (millions) | | Canadian tagging mortality | Alaskan percentage in fishery | | | | | | | | |
|--------------------------|-----------------|----------------------------------|-------------------------------|-------|---------|----|----|----|----|----|---|
| AK | Can. | | | | | | | | | | |
| 1982 | | | | | | | | | | | |
| | | | Langara Island | 3X | 3Y | 4 | | | | | |
| 10.5 | na ^b | 0% | 75 | 57 | 55 | 38 | | | | | |
| 24.9 | na | 0% | 79 | 61 | 59 | 44 | | | | | |
| 24.9 | na | 40% | 86 | 71 | 71 | 53 | | | | | |
| 8.2 | na | 0% | 73 | 56 | 55 | 37 | | | | | |
| 8.2 | na | 40% | 81 | 67 | 68 | 46 | | | | | |
| Range | | | 13 | 15 | 16 | 16 | | | | | |
| 1984 | | | | | | | | | | | |
| | | | 3X | 3Y | 3Z | 4 | 5 | | | | |
| 13.4 | 1.9 | 0% | 36 | 50 | 45 | 31 | 29 | | | | |
| 16.1 | 1.5 | 0% | 39 | 54 | 49 | 33 | 31 | | | | |
| 9.0 | 2.3 | 0% | 31 | 40 | 37 | 26 | 26 | | | | |
| 16.1 | 1.5 | 40% | 45 | 61 | 58 | 42 | 36 | | | | |
| Range | | | 14 | 21 | 21 | 16 | 10 | | | | |
| 1985 | | | | | | | | | | | |
| | | | <u>Dixon Entrance</u> | | Langara | | | | | | |
| | | | North | South | Island | 3X | 3Y | 3Z | 4 | 5 | 6 |
| 18.3 | 5.1 | 0% | 88 | 56 | 37 | 27 | 60 | 46 | 7 | 6 | 2 |
| 19.3 | 4.0 | 0% | 91 | 58 | 41 | 28 | 62 | 48 | 7 | 7 | 4 |
| 12.2 | 5.8 | 0% | 85 | 51 | 30 | 22 | 51 | 37 | 6 | 5 | 2 |
| 19.3 | 4.0 | 40% | 92 | 64 | 46 | 37 | 68 | 57 | 11 | 11 | 4 |
| Range | | | 7 | 13 | 16 | 15 | 17 | 20 | 5 | 6 | 2 |

'Point estimates and bounds for total escapements appear in this table, but corresponding values for regional stock groups (Tables 26, 27) were used in the computations.

^bna - data not available.

FIGURES

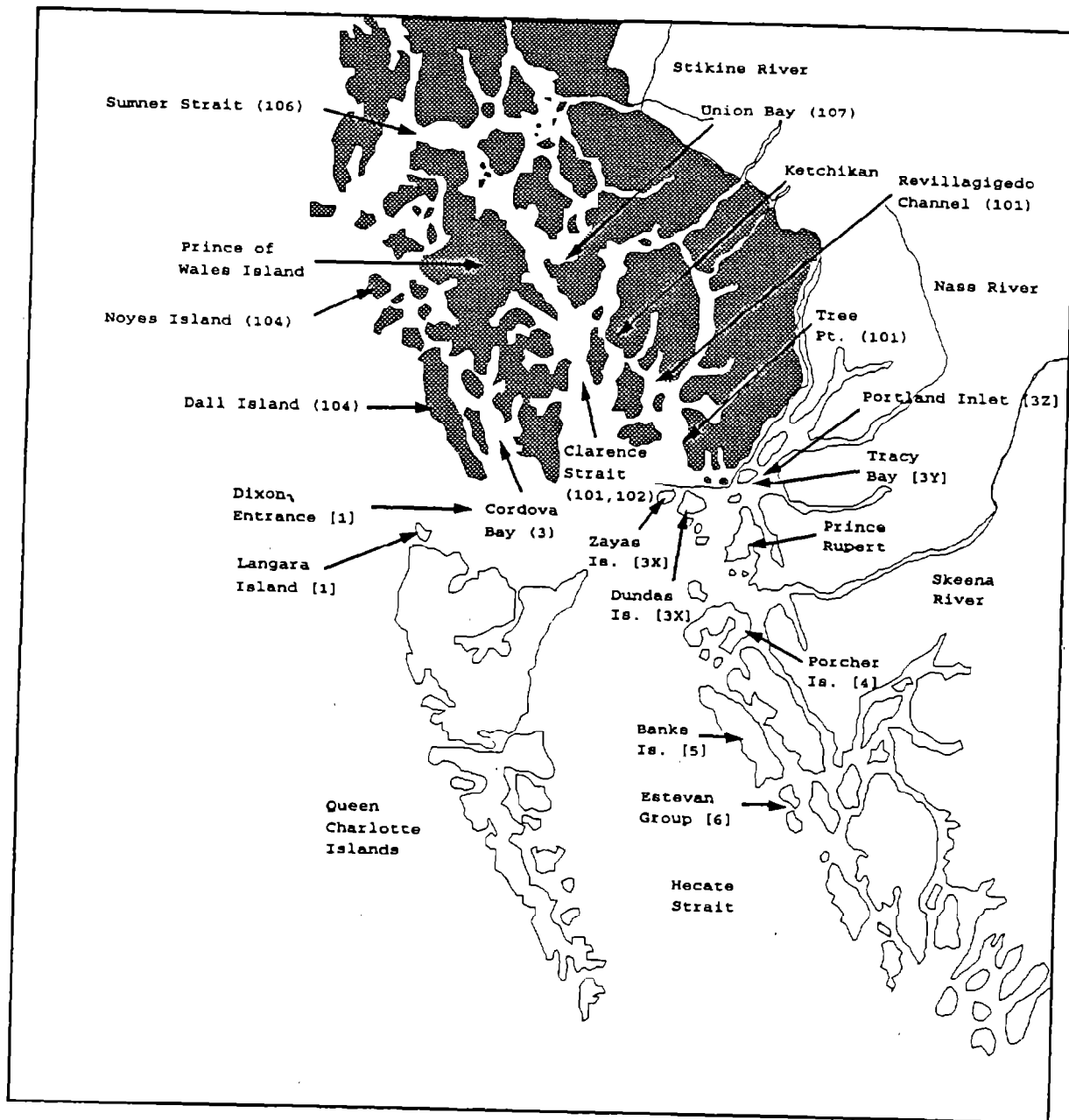


Figure 1.--International boundary area of southern Southeast Alaska and northern British Columbia, place names and associated area codes to help identify where returning adult salmon were tagged, 1982-85.

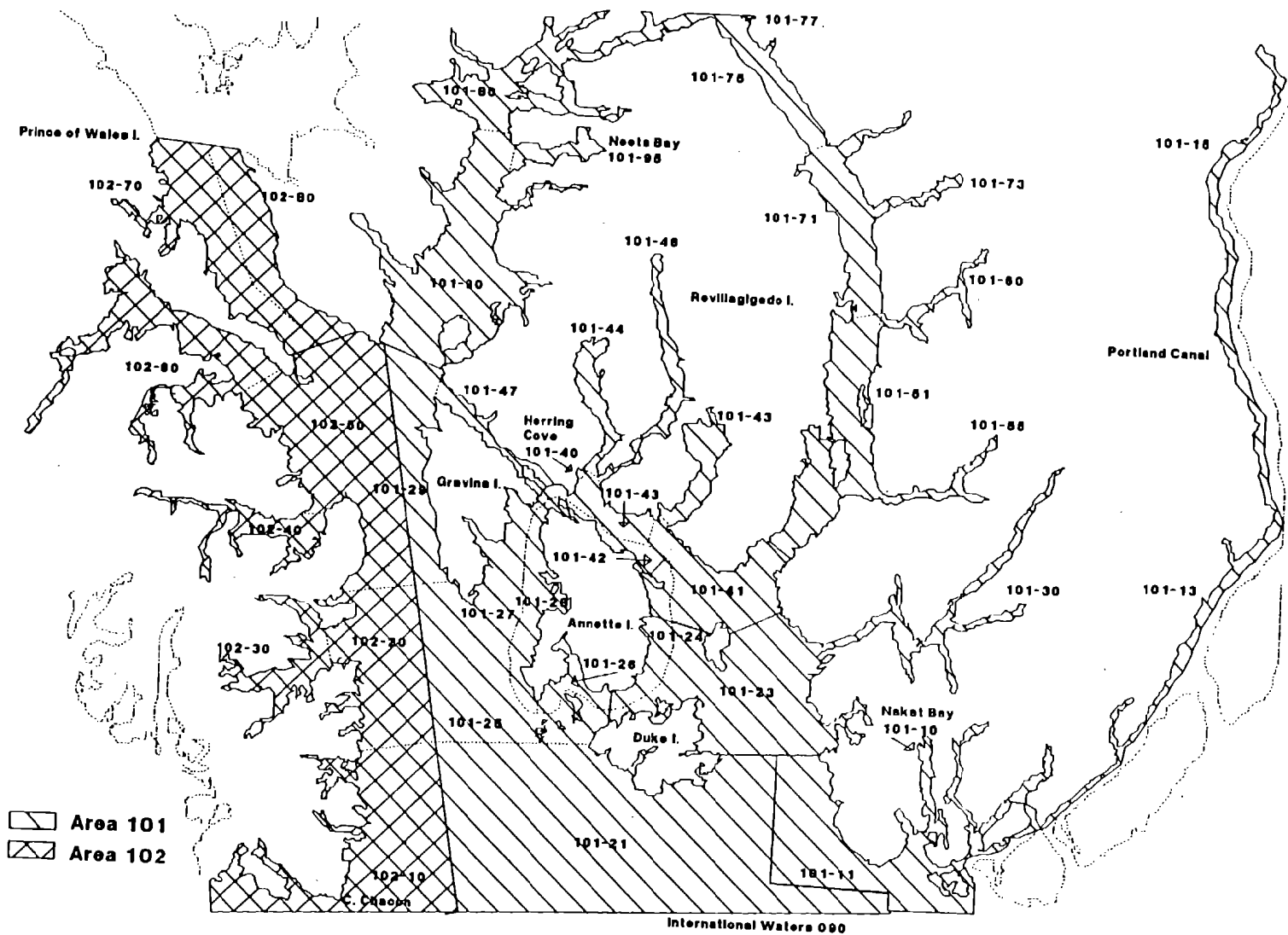


Figure 2.--ADF&G Southeast Alaska statistical areas 101 and 102.

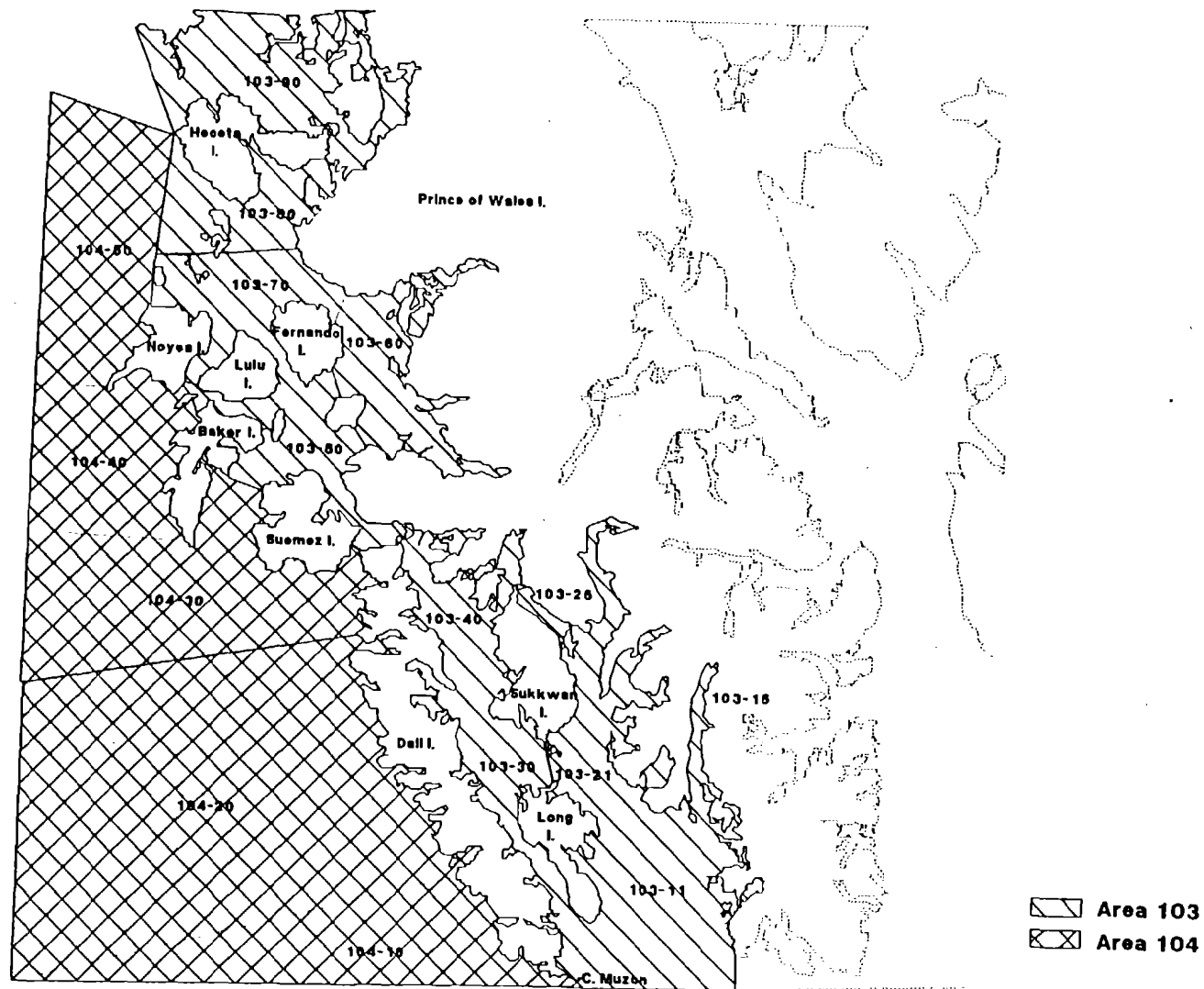


Figure 3.--ADF&G Southeast Alaska statistical areas 103 and 104.

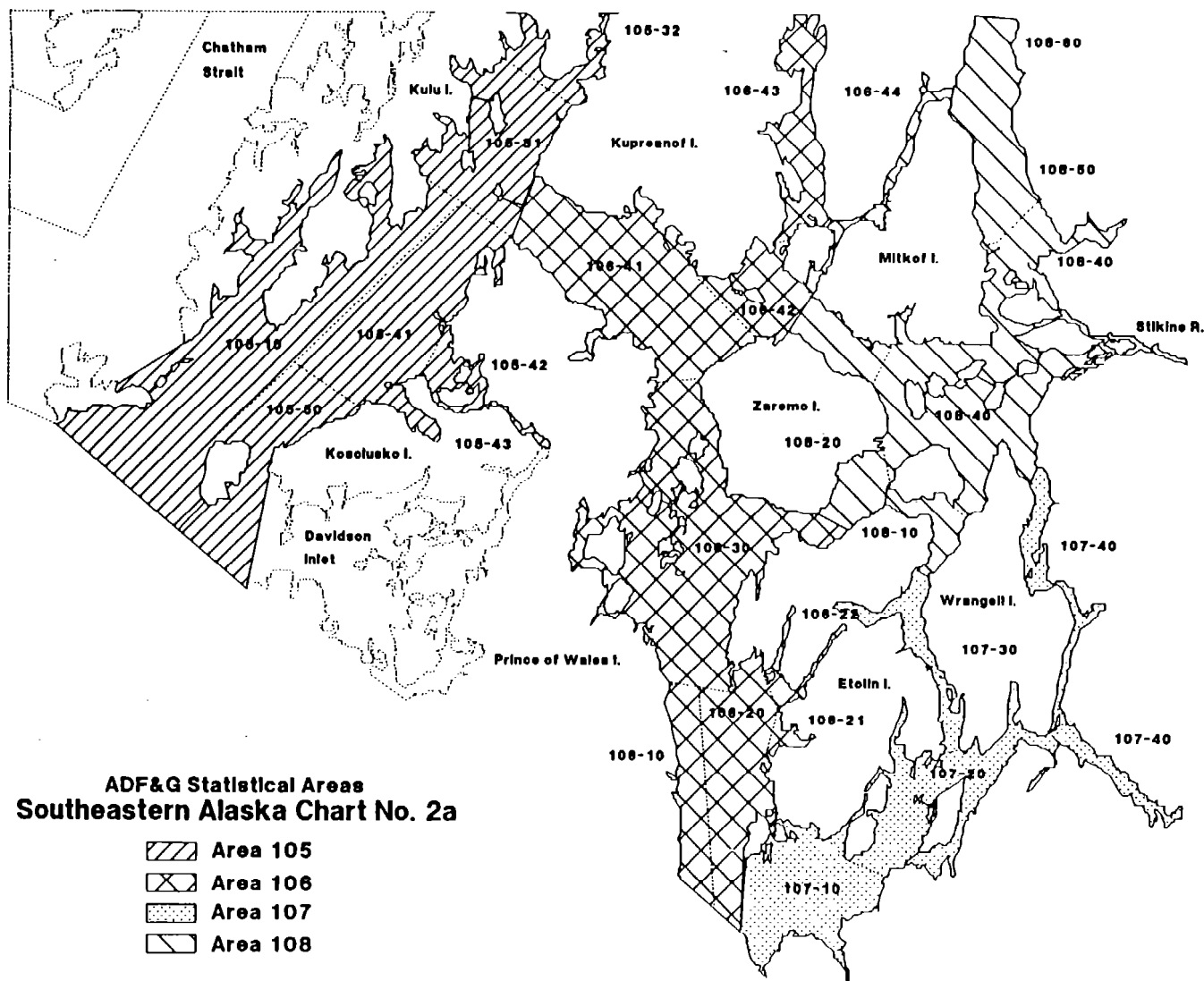


Figure 4. --ADF&G Southeast Alaska statistical areas 105-108.

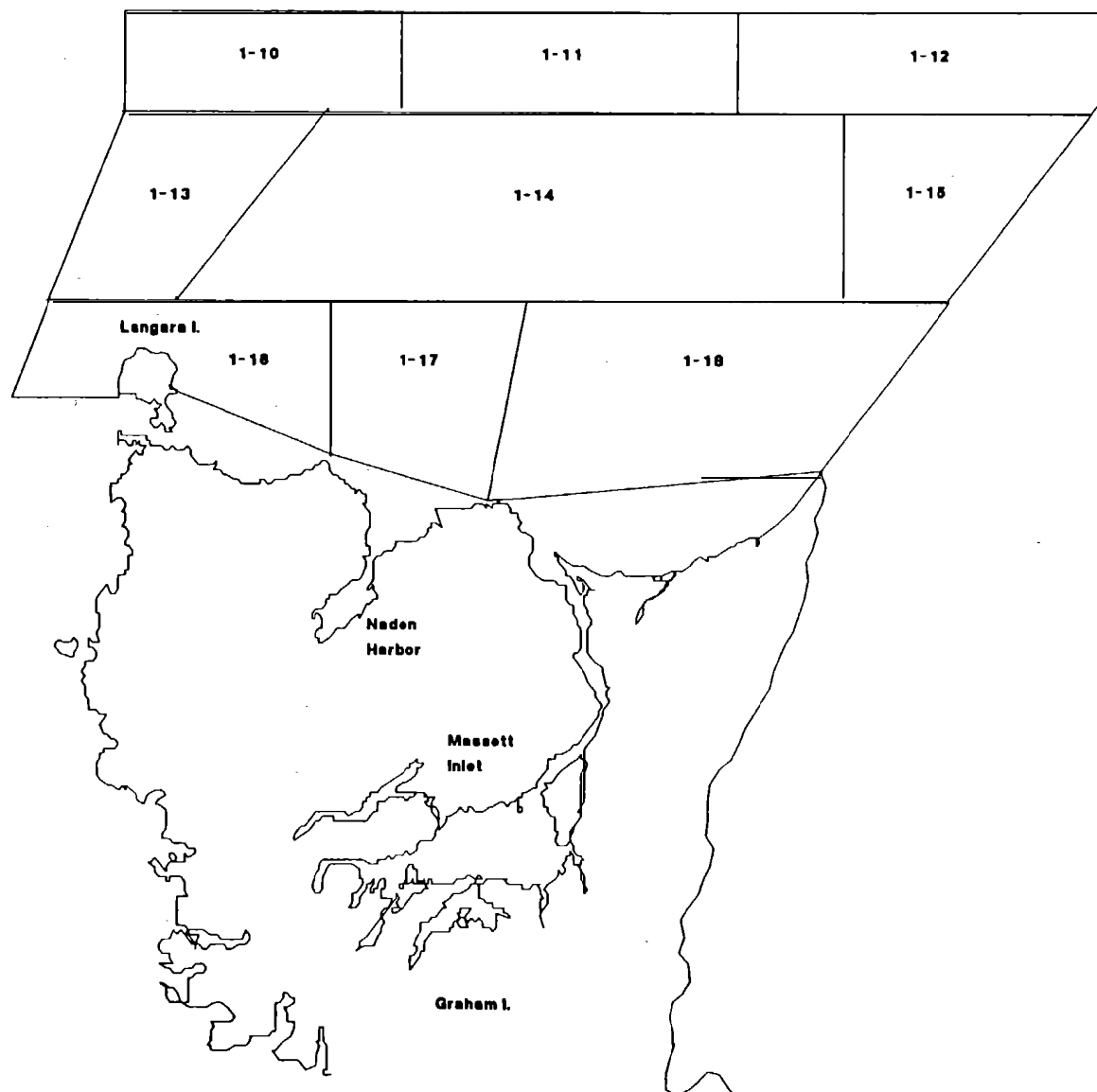


Figure 5.--British Columbia subareas 1-10 through 1-18 of area 1 in Dixon Entrance, 1984.

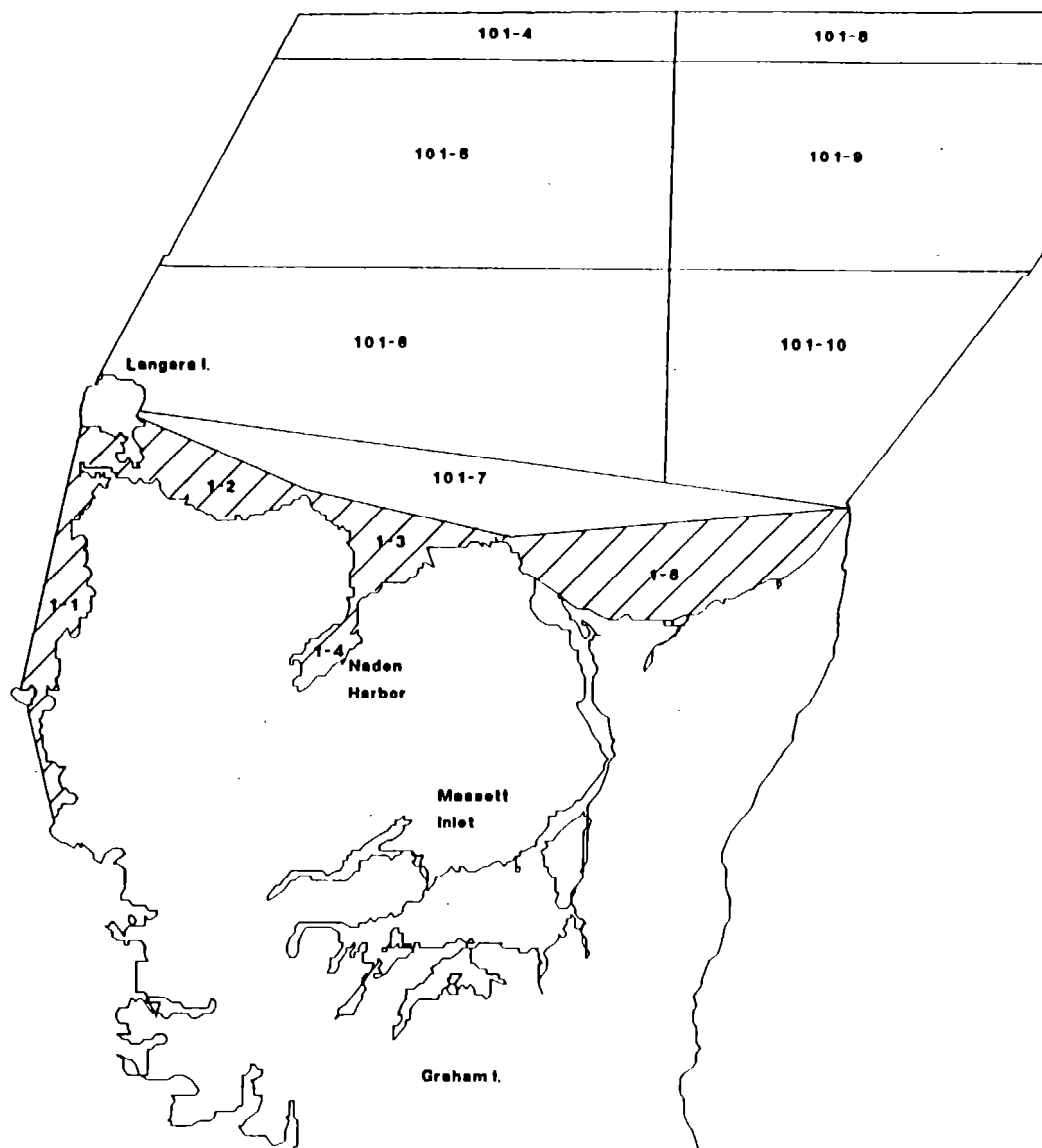


Figure 6.--British Columbia subareas 1-1 through 1-5 (Langara Island) and 101-4 through 101-10 of area 1 in Dixon Entrance, 1985.

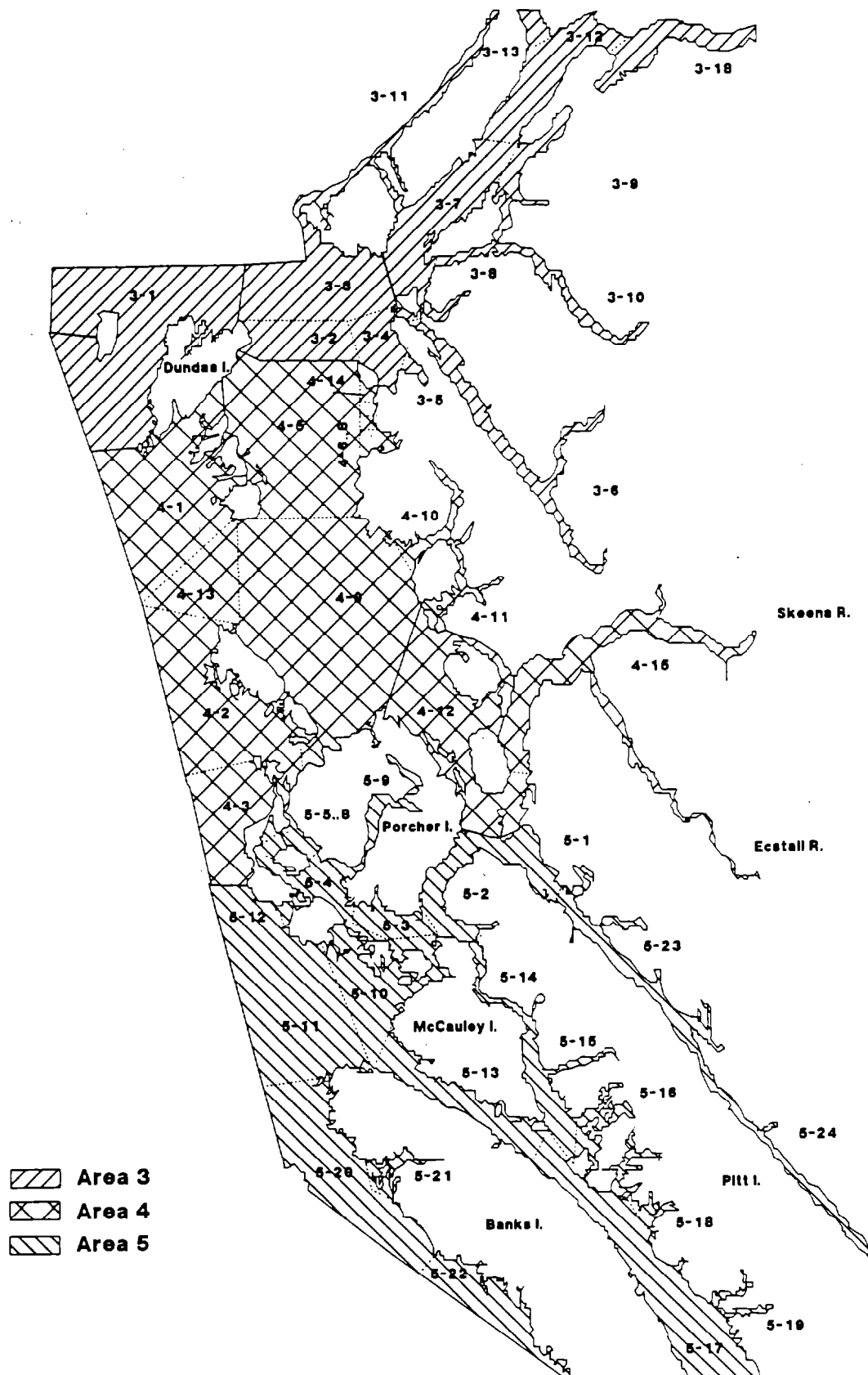


Figure 7. --British Columbia areas 3 through 5.

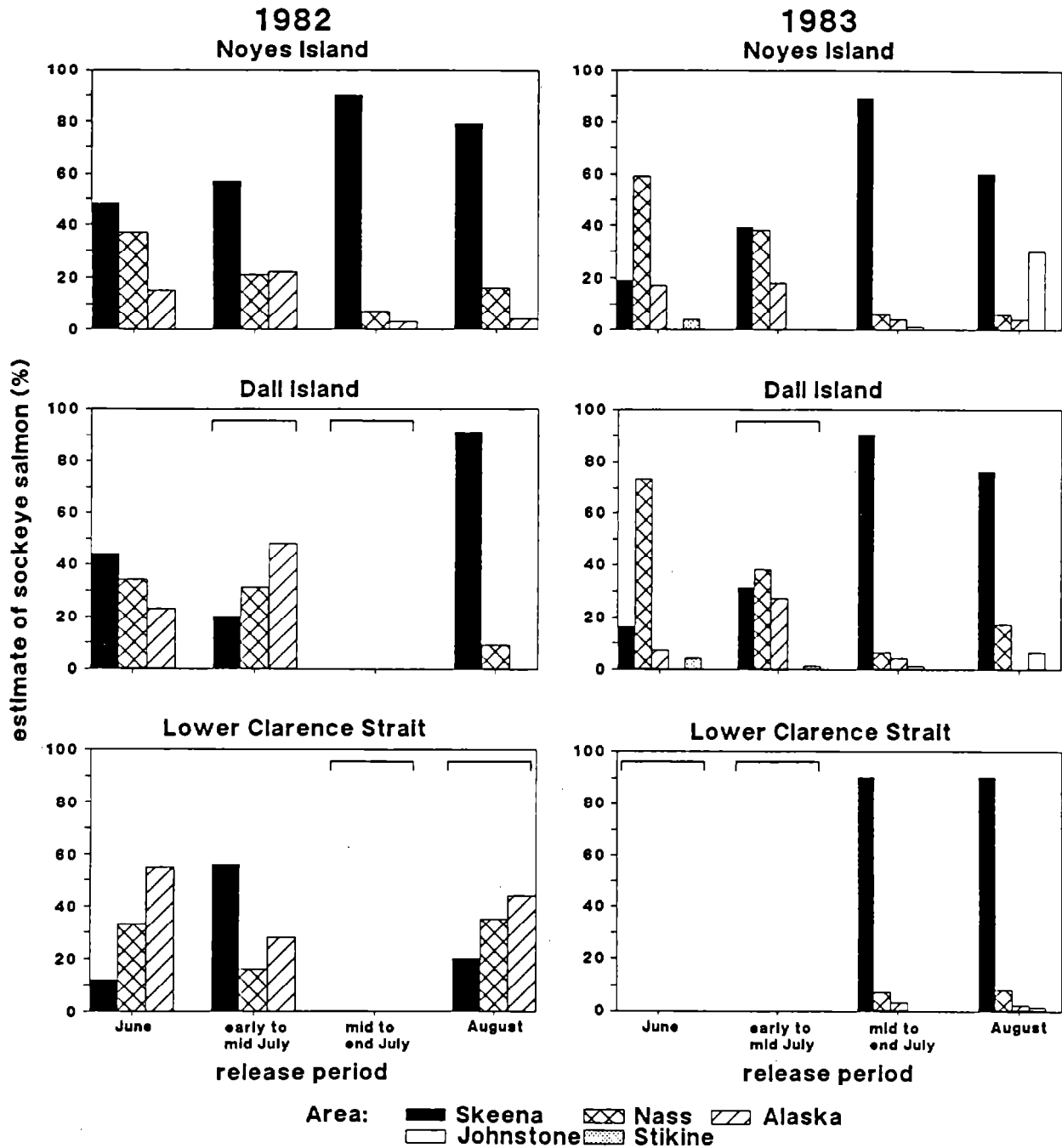


Figure 8.--1982 and 1983 stock-composition estimates (%) of sockeye salmon by area and period of release. Best estimates of escapements were used; and primary-tagged entrants in Canada were assumed to experience the same loss rates in rivers as secondary-tagged fish. Blanks indicate no recoveries were made; a bar indicates the stock-composition estimates are based on fewer than 10 tag recoveries from releases in this fishery and period.

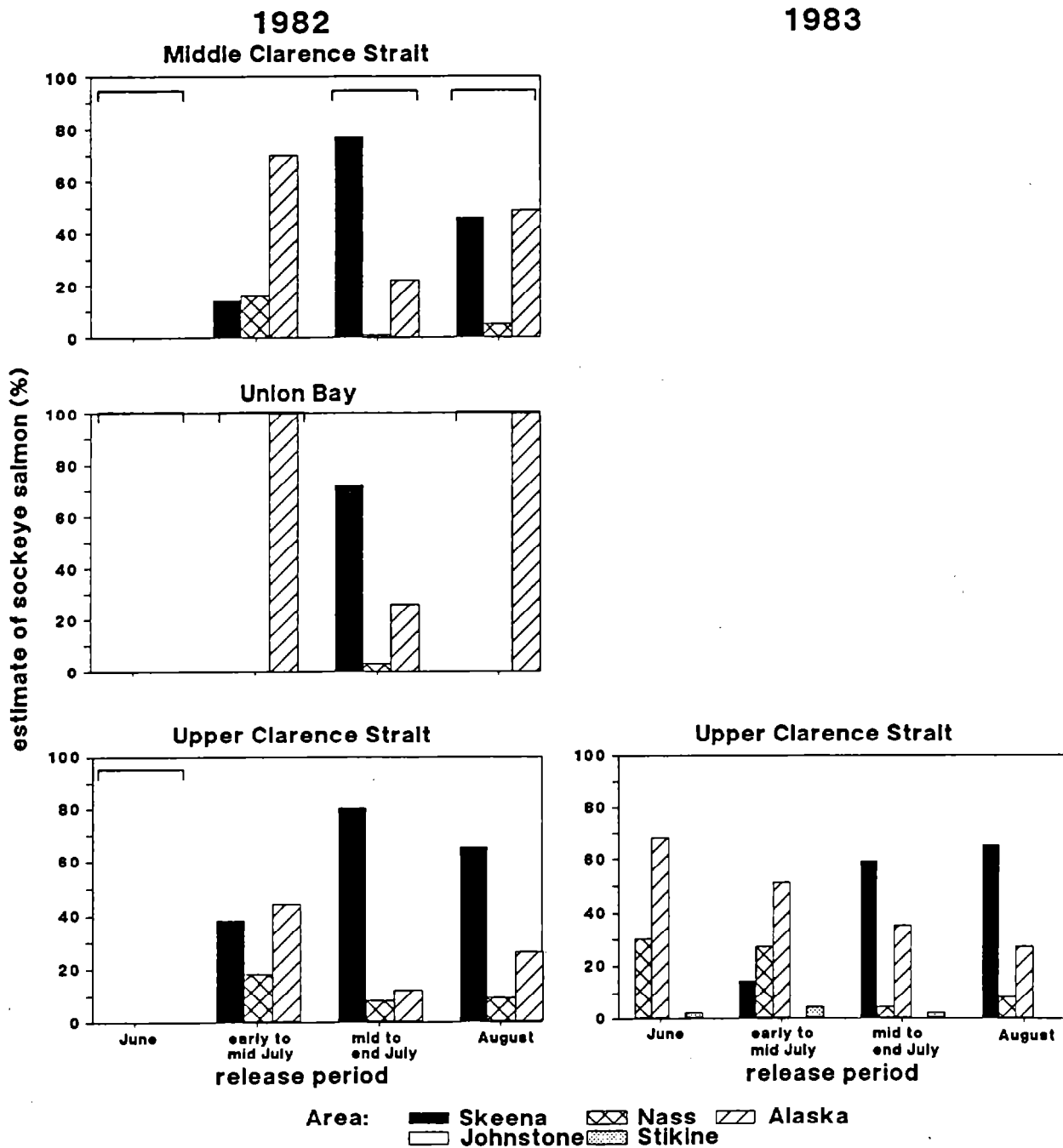


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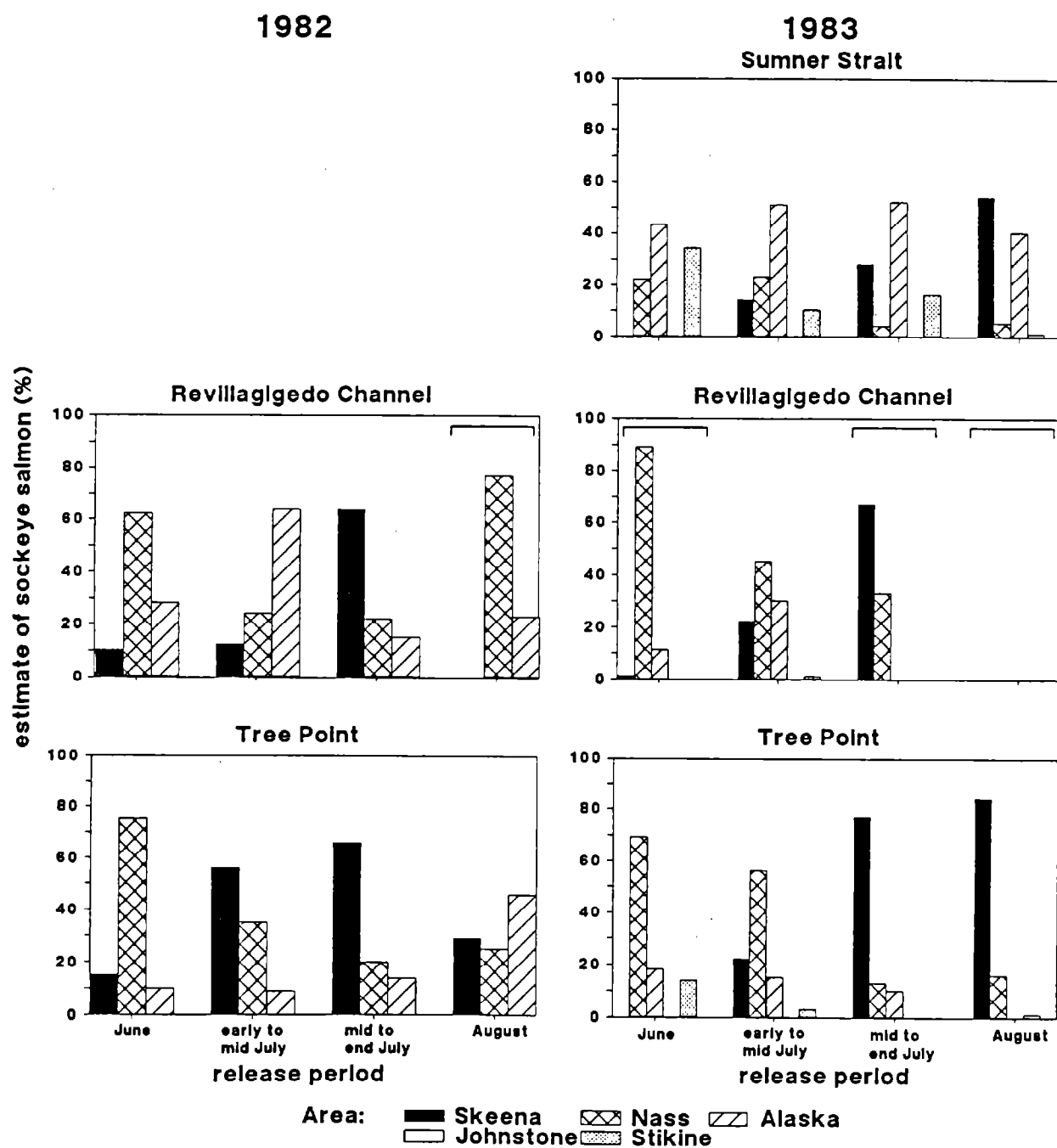


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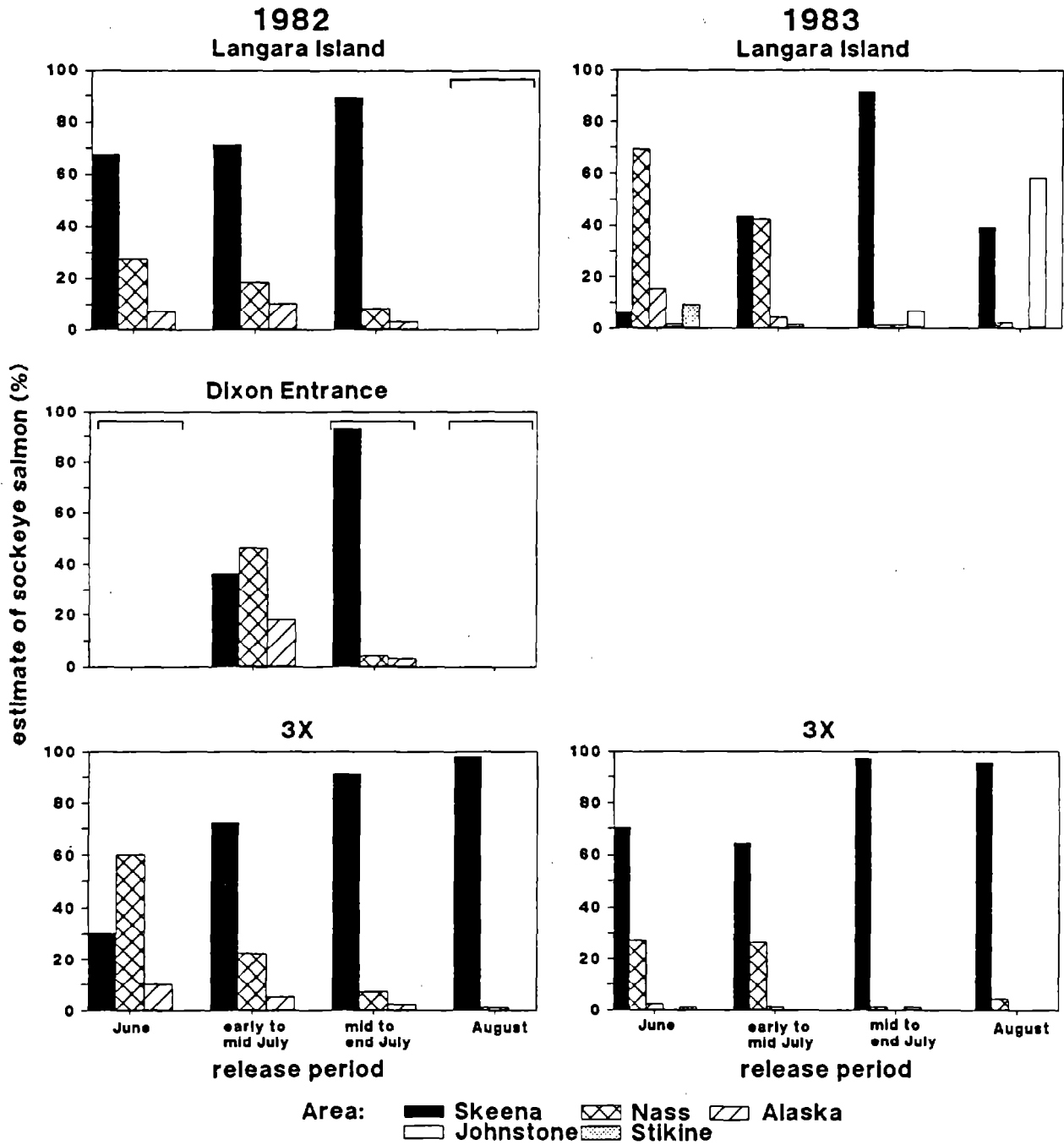


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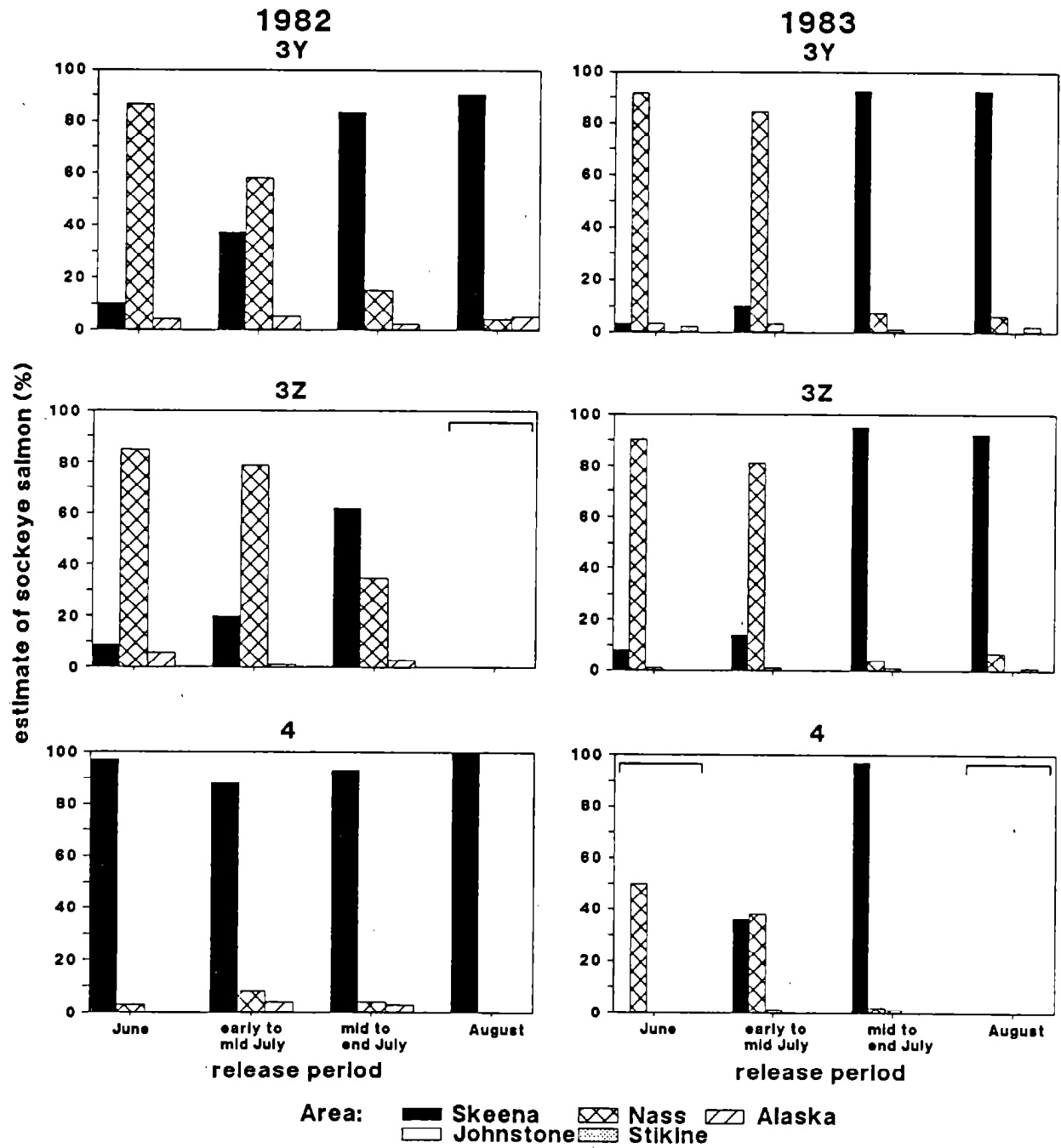


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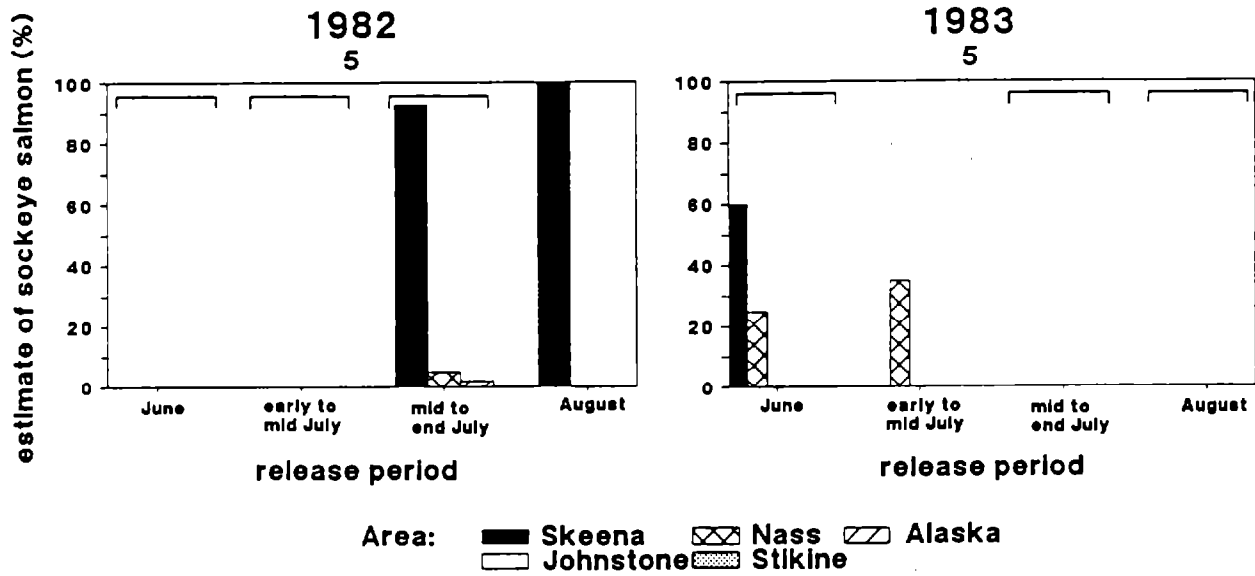


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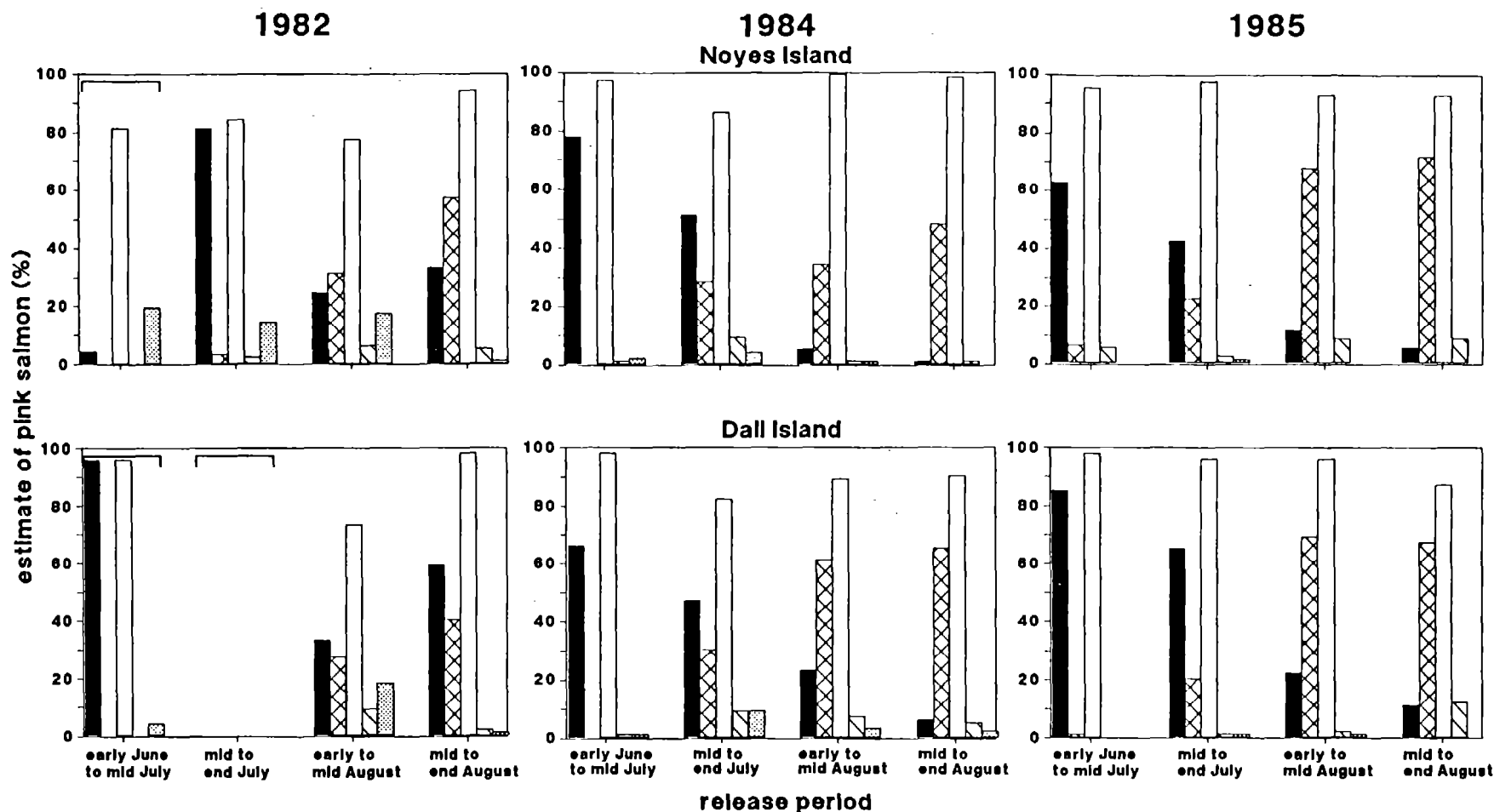


Figure 9.--1982, 1984, and 1985 stock-composition estimates (%) of pink salmon by release area and period. Best estimates of escapements were used, and primary-tagged entrants to Canadian streams with secondary tagging were assumed to experience the same recovery rates as secondary-tagged fish. Blanks indicate no recoveries were made; a bar indicates stock-composition estimates are based on fewer than 10 tag recoveries from releases in this fishery and period.

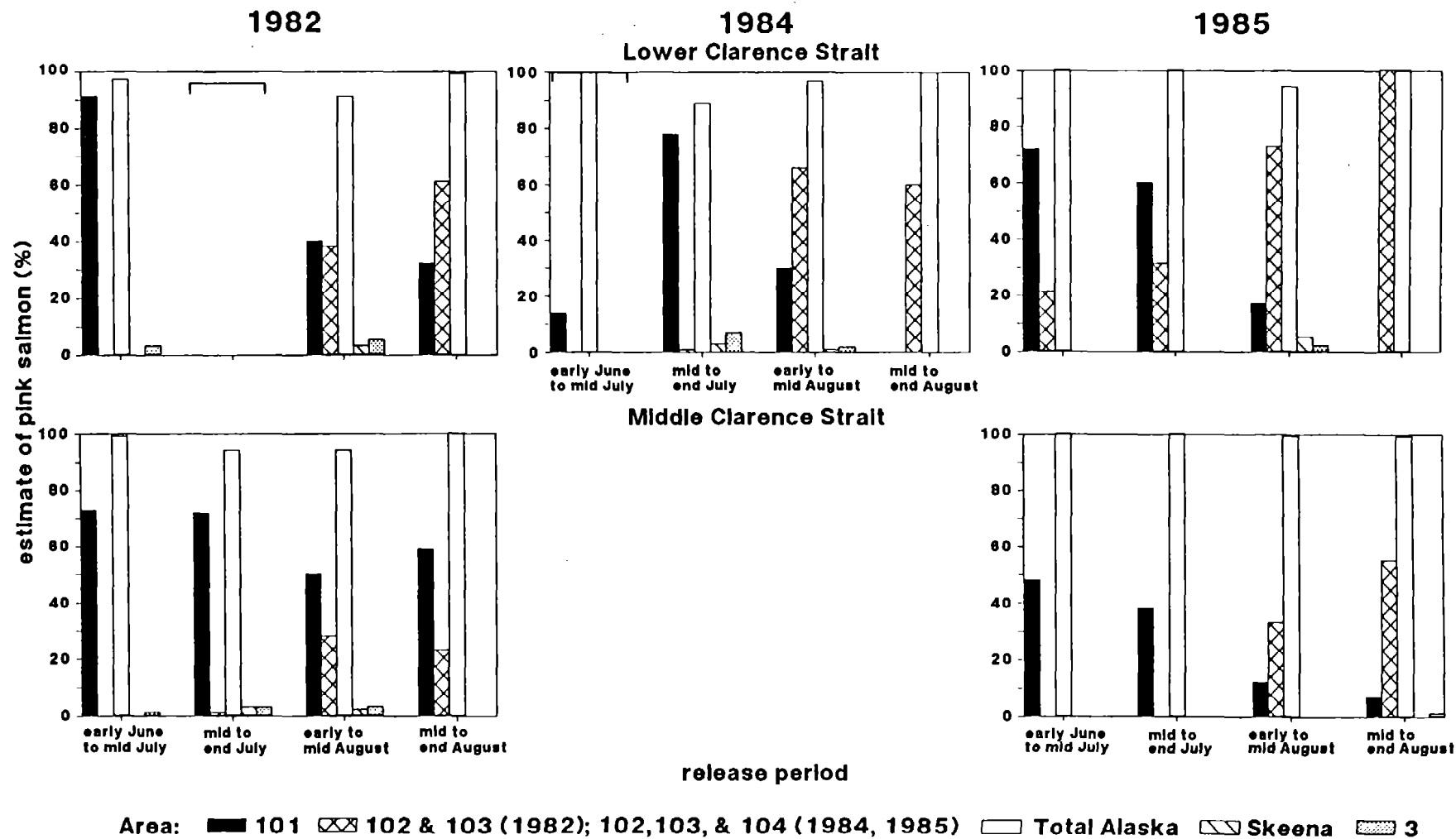


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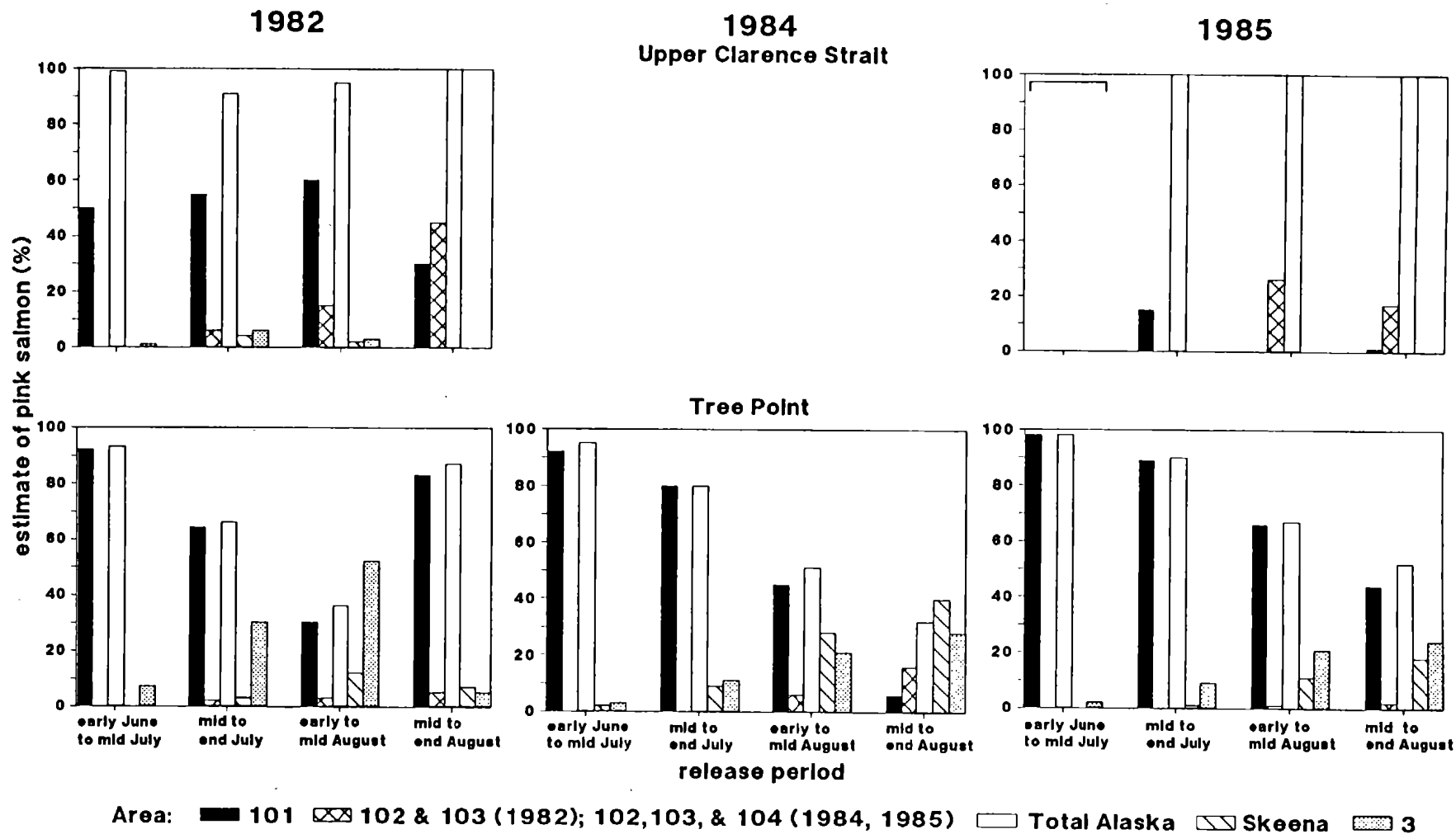
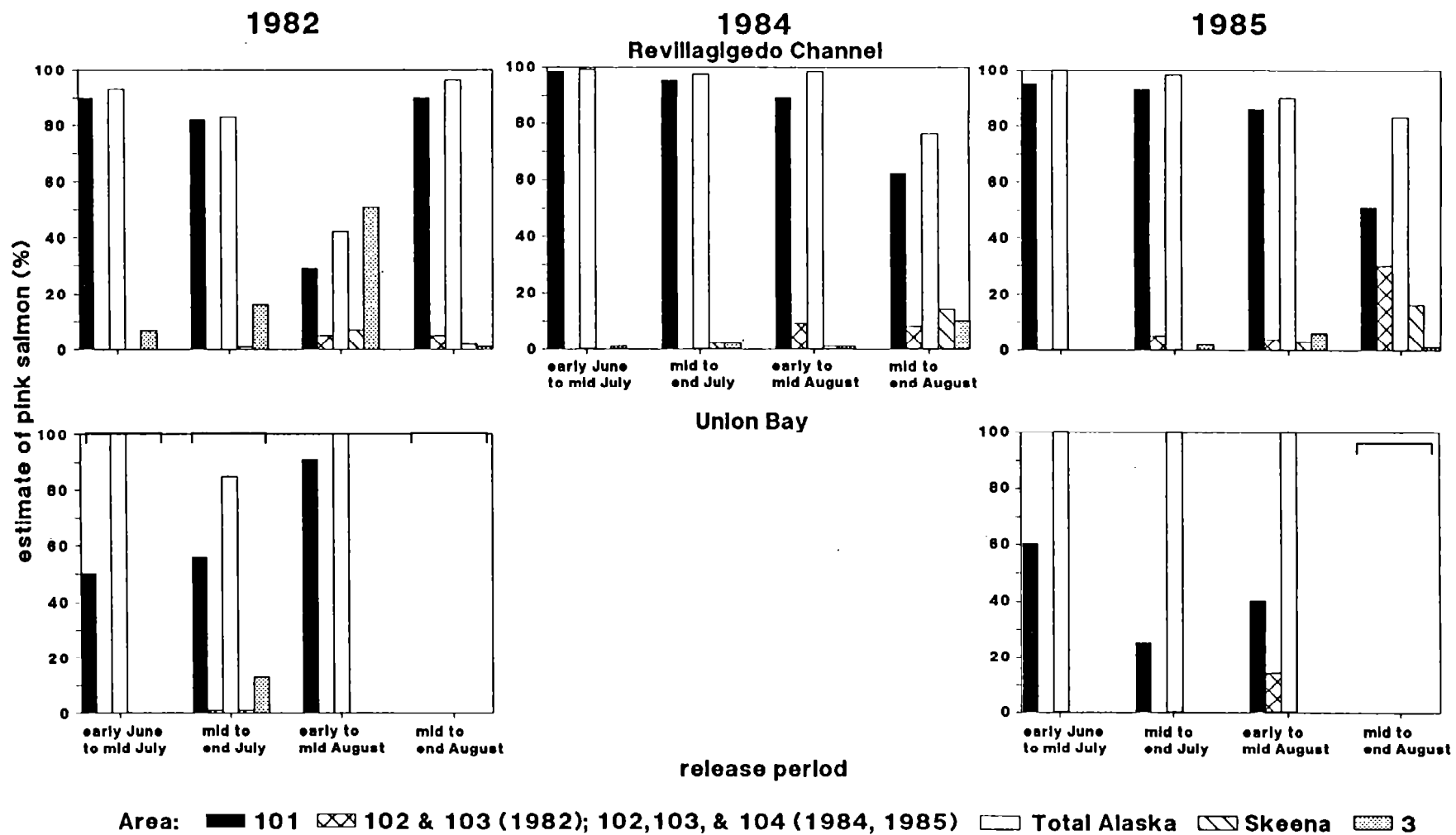


Figure 9.--Continued.



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Figure 9. --Continued.

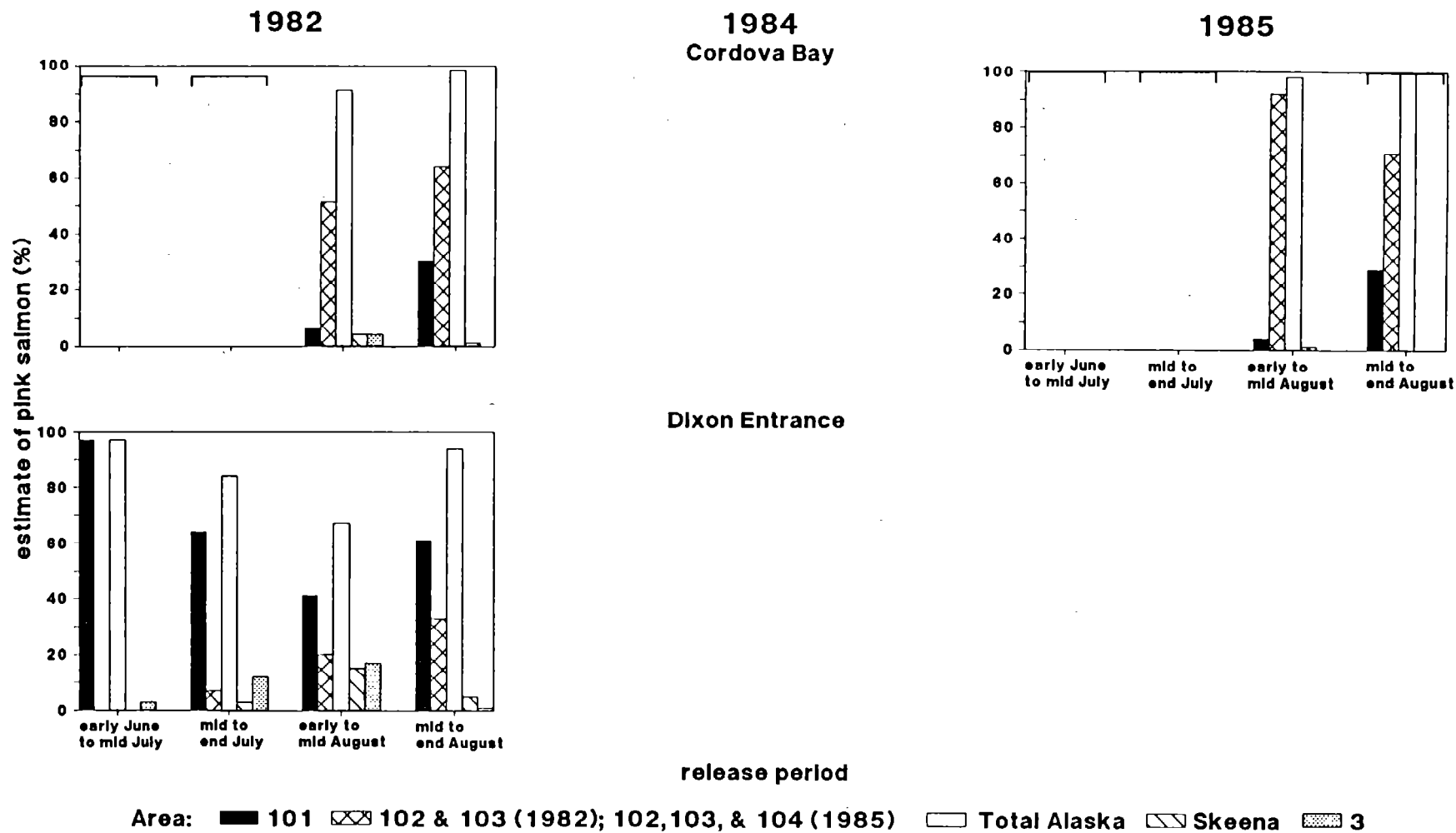


Figure 9. --Continued.

estimate of pink salmon (%)

1982

1984
101-4

1985

101-7

release period

Area: ■ 101 ▨ 102 & 103 (1982); 102,103, & 104 (1984, 1985) □ Total Alaska ▩ Skeena ▤ 3

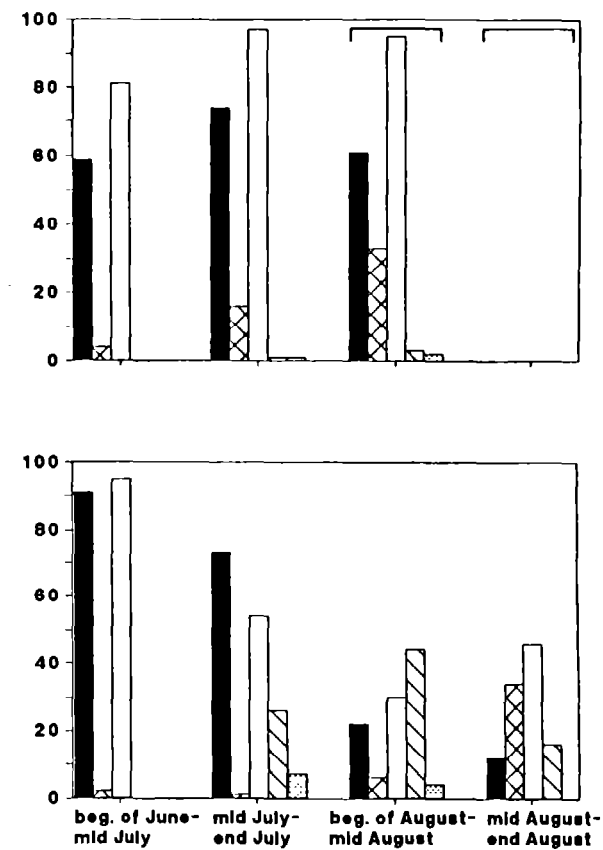


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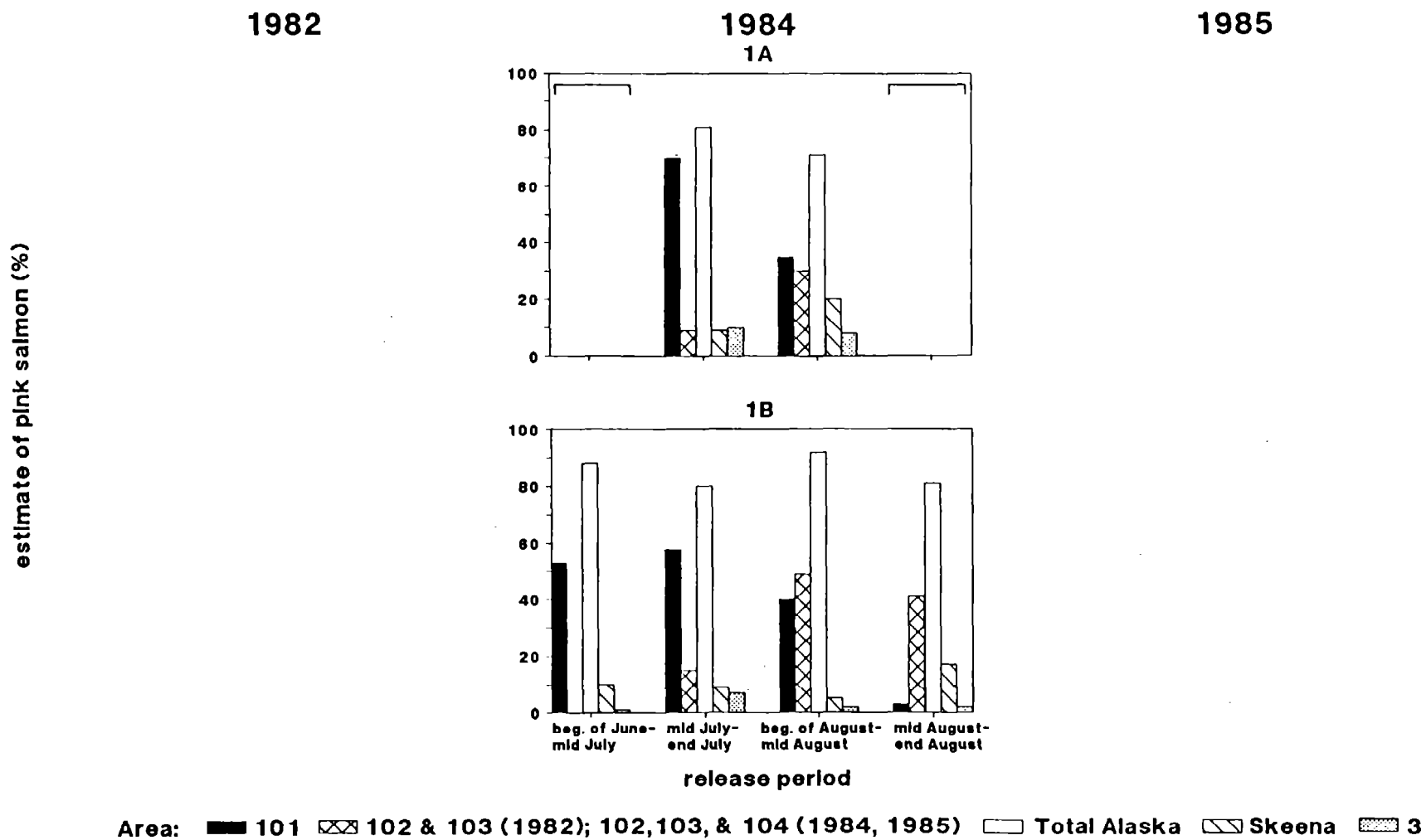


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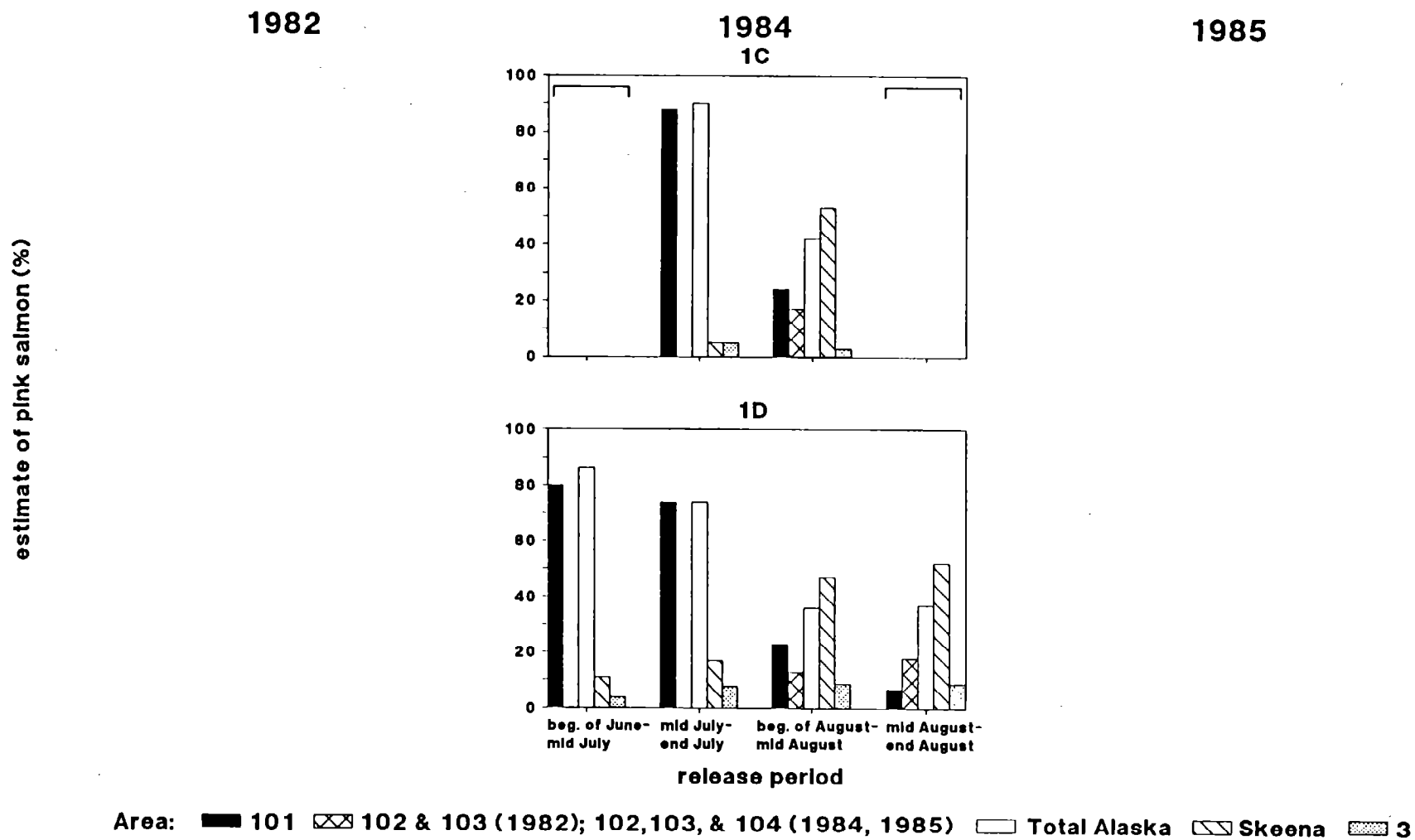


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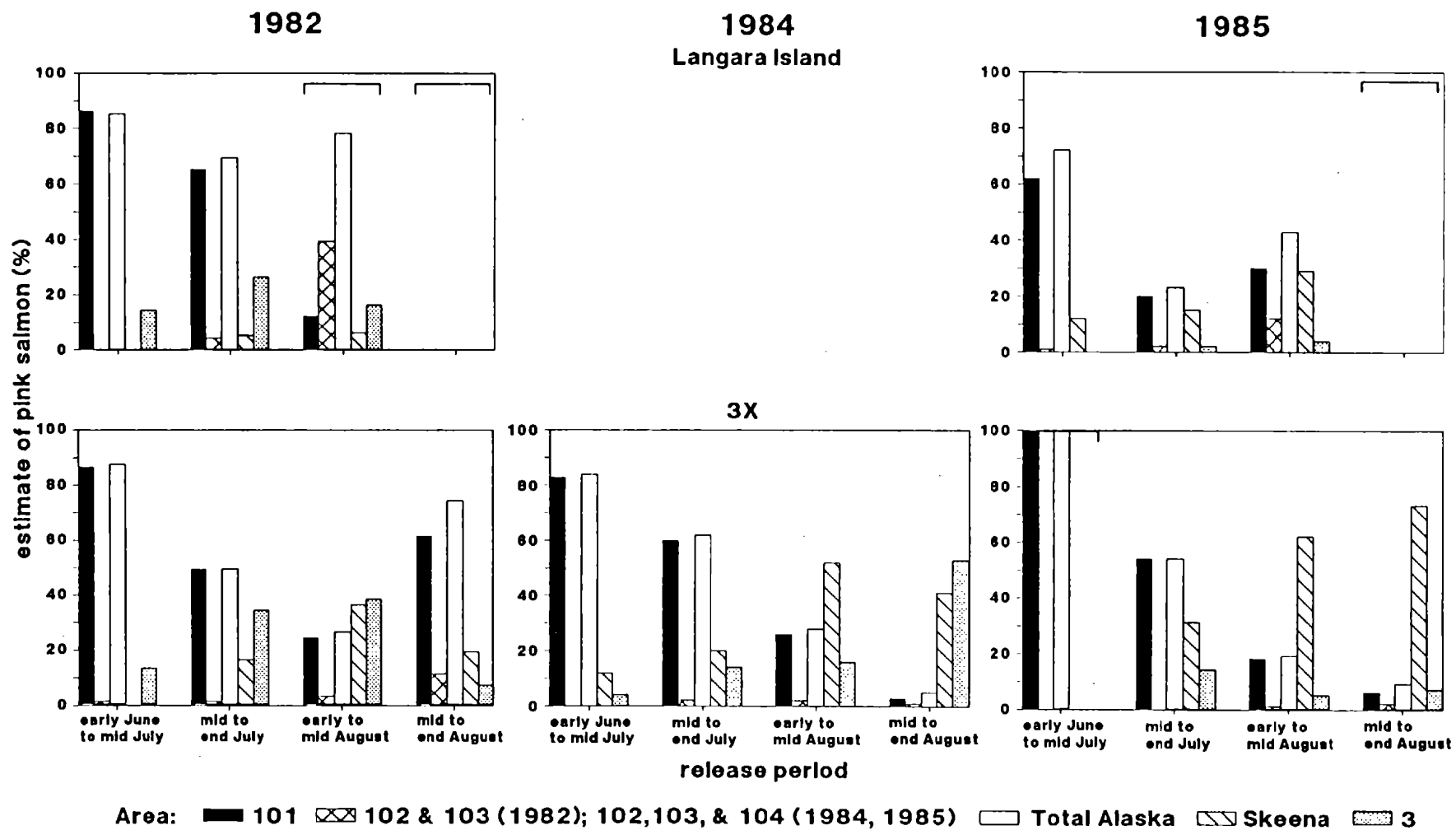


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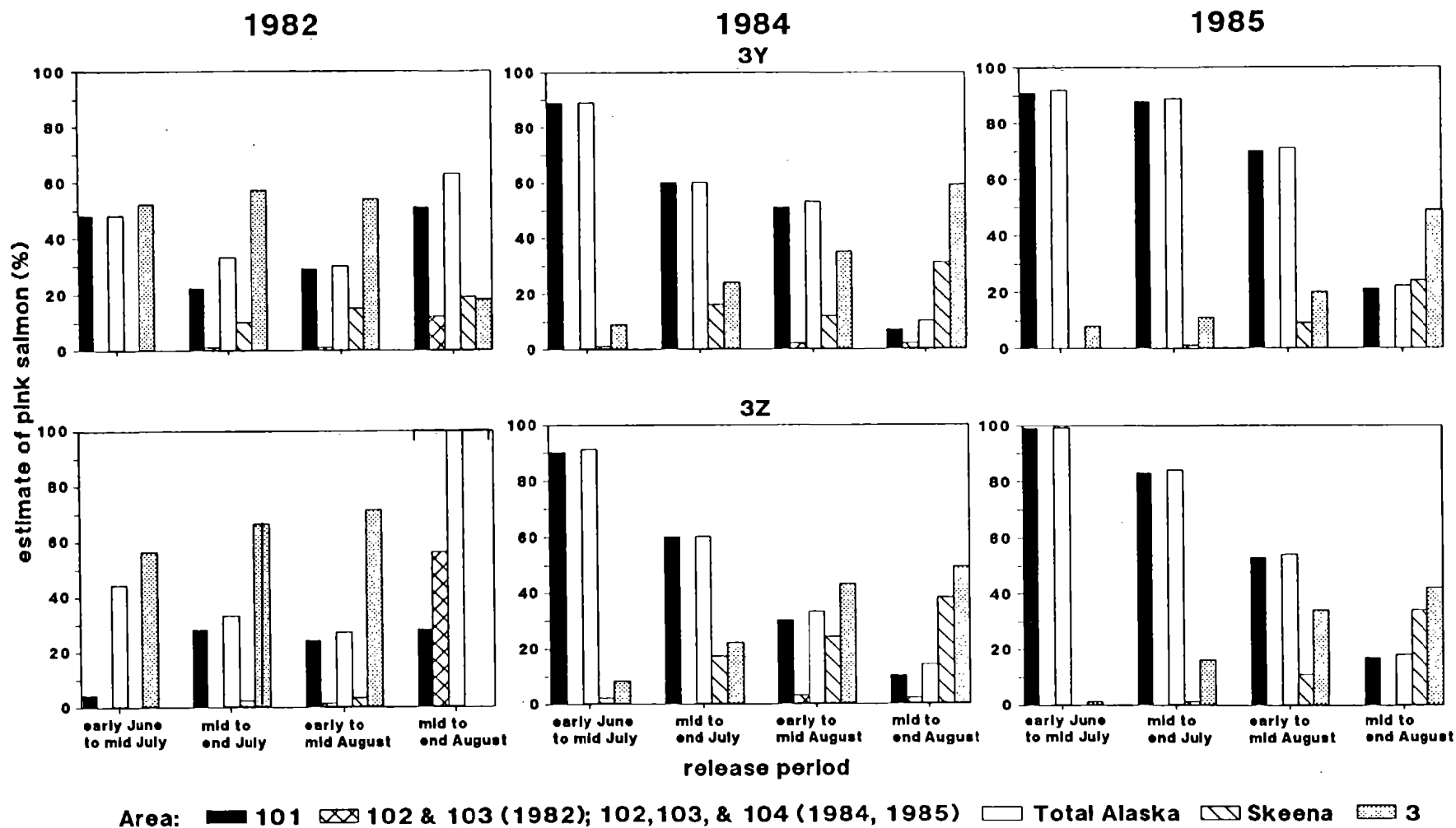


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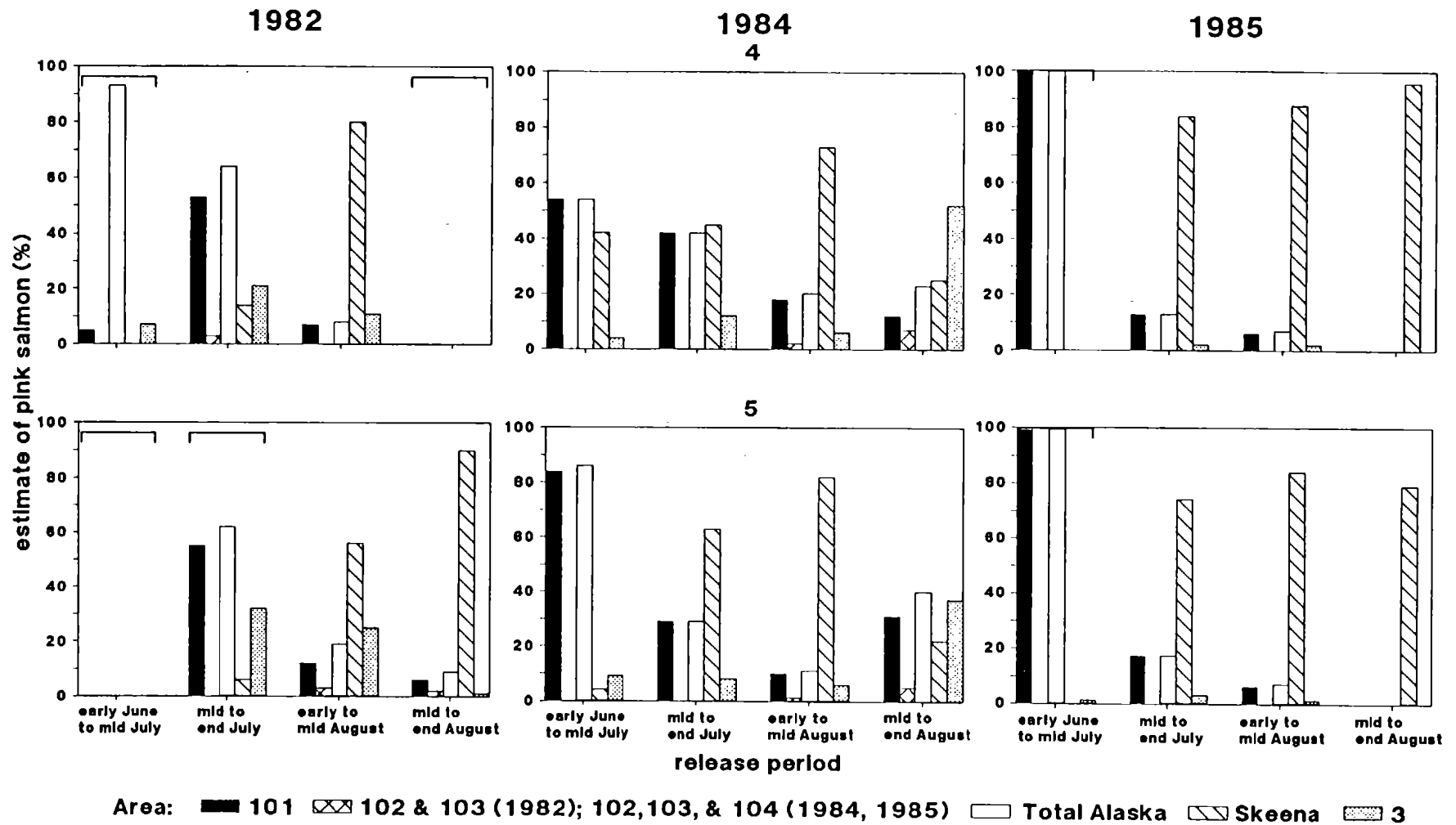


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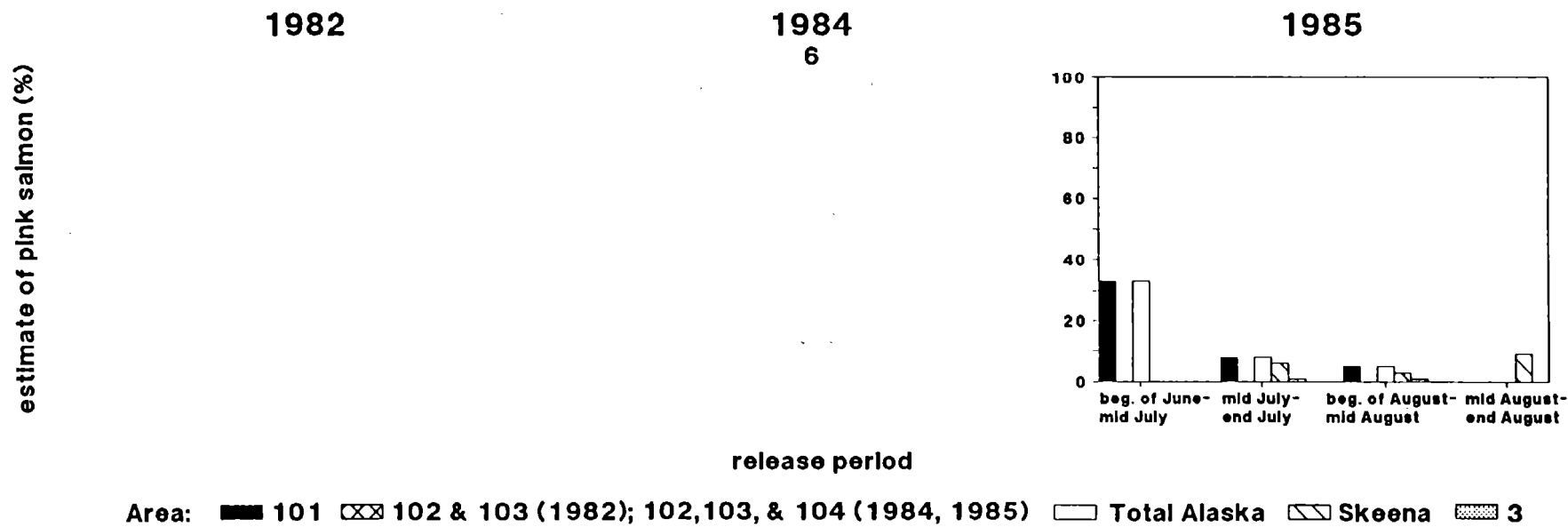


Figure 9.--Continued.

GLOSSARY

[*Italicized* words in a definition are also defined in this glossary.]

- Bootstrap--A computer-intensive method used to evaluate the variation in stock-composition estimates caused by subsampling catches and escapements for tag recovery. The measure of variation used in the present study was the *standard error of the estimates*. Good descriptions of this general statistical method can be found in Efron and Tibshirani (1986, 1991).
- Catch or fishery recoveries--Primary- and secondary-tagged salmon recovered during *tagging-program sampling* of catches of *intervening fisheries*.
- Confidence interval--A numerical statement consisting of a lower and upper bound for describing the precision with which an unknown quantity (such as *escapement* or the proportion of a catch comprising fish from a particular stock) has been determined. Were it possible to repeatedly replace and draw anew the randomly sampled observations used to compute the *point estimate* of the unknown quantity, a 90% confidence interval would include the unknown quantity in 90% of the drawings.
- Escapement--The maturing adult salmon which survive to return to spawning systems.
- Escapement recoveries--Tagged salmon recovered at weirs, in riverine fisheries, or during spawning-ground surveys as part of the *tagging-program sampling*.
- Expand--The total number of tagged fish (T) among a group of N tagged and untagged fish can be estimated by counting the number of tagged fish recovered (r) in a random subsample of size n . The proportion of fish in the subsample which are tagged, p , equals r/n , and this proportion estimates the unknown proportion of tagged fish among the N fish, P , equal to T/N . The estimate of T is obtained as $T = Np = (N/n).r$; that is, the number of tagged fish recovered in the subsample is multiplied by a number greater than one (N/n), or expanded to account for the unexamined fish.
- Intervening fishery--A fishery along the migration route of *primary-tagged* salmon as they proceed toward the spawning grounds of their river of origin. The fishery from which the tagged fish were released was considered one of the *intervening fisheries*.
- Petersen tagging experiments--The number of fish (N) in a lake or on a spawning ground can be estimated by tagging a known number of fish (M) which then mix with the untagged members of the population. Subsequently, a sample of C

fish is obtained from the mixture and the number with tags (R) is determined. If the tagged and untagged fish are thoroughly mixed at the time the sample is obtained, the expected proportion of tagged fish in the sample (R/C) will equal the proportion in the lake (M/N). An estimate of the number of fish in the lake is obtained by equating the two proportions and solving for the unknown number in the lake. The estimate is $N=MC/R$.

Point estimate--The particular estimate of an unknown quantity obtained from observed information, in contradistinction to an interval estimate (e.g., 90% confidence interval) for the same unknown quantity.

Primary tagging--Salmon were caught and tagged in the coastal ocean fishing areas of southern Southeast Alaska and northern British Columbia.

Secondary tagging--Salmon were caught and tagged in *terminal areas* in salt water near the outlet streams or rivers to their spawning grounds, or were caught and tagged within the rivers themselves.

Standard error of an estimate--The average of squared deviations of the estimate of an unknown quantity about its average value from repeated samplings. The standard error of an estimate usually must itself be estimated. An approximate 95% confidence interval for the unknown quantity is provided by the estimate of the quantity plus or minus 2 times the estimate of standard error of the estimate. The *bootstrap* was used in the present report to estimate the standard error of the estimate.

Tagging-program sampling--Known or estimated portions of commercial catches of salmon and escapements to *terminal areas* were subsampled for tag recovery in order to estimate total numbers of tagged fish present. Such sampling was conducted by government agencies or their contracted representatives.

Terminal area--The ocean area and adjacent fresh waters (outlet stream or river and spawning grounds) within which the origin of the salmon is presumed known.

Terminal-area entrants--Salmon which have passed through the commercial fisheries and enter the *terminal areas* leading to their spawning ground.

Volunteer tag recovery--Any tag recovered by sampling other than the *tagging-program sampling*. Number of fish examined for tags (among which the tag was found) was not available. For example, fishermen recovered tags from fish in their catches but numbers of fish examined were unreported.