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MEMORANDUM FOR: F/NW - William Stelle
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THRU: F/NWC - Usha Varanasi

FROM: F/NWC-3 - Michael H. Schiewe

SUBJECT: Conclusions regarding the updated status of the Columbia River Chum Salmon ESU and Hood Canal Summer-Run Chum Salmon ESU

The Biological Review Team (BRT) for the west coast chum salmon status review met in Seattle on 4-5 November 1998 to discuss new information received regarding status of two evolutionarily significant units (ESUs) that earlier this year were proposed for listing under the Endangered Species Act (ESA). The BRT concluded that both the Columbia River ESU and the Hood Canal Summer-Run Chum Salmon ESU remain at risk of becoming endangered in the foreseeable future if present conditions continue. Time did not allow the BRT to review the ESA status of those chum salmon ESUs previously determined to be not at risk.

Attached is the BRT report "Status Review Update for Chum Salmon from Hood Canal Summer-Run and Lower Columbia River ESUs." This report presents BRT conclusions concerning ESU delineation and risk assessment for chum salmon in these ESUs. This report also summarizes comments on the 1997 status review and new scientific information received, for all ESUs and populations of chum salmon in Washington, Oregon, and California from co-managers, peer-reviewers, and others.

Please contact either Dr. Robin Waples or myself if you have any questions about this report.

cc: F/PR - Hilda Diaz-Saltero
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Attachment

Status Review Update for Chum Salmon from Hood Canal Summer-Run and Columbia River ESUs

Prepared by the
West Coast Chum Salmon Biological Review Team[1]

12 February 1999

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1 The biological review team (BRT) for this updated status review included Stewart Grant, Jeffrey Hard, Robert Iwamoto, Orlay Johnson, Robert Kope, Conrad Mahnken, Michael Schiewe, William Waknitz, Robin Waples, and John Williams, from the NWFSC, and Jack Helle from the NMFS Auke Bay Laboratory.

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INTRODUCTION

On March 10, 1998, the National Marine Fisheries Service (NMFS) published a federal register notice describing four evolutionarily significant units (ESUs) within the range of west coast chum salmon from the states of Washington, Oregon, and California (NMFS 1998). The notice included a proposed rule to list two ESUs as threatened under the U.S. Endangered Species Act (ESA) (Table 1). This proposal was largely based upon the status review conducted by the west coast chum salmon Biological Review Team (BRT) convened by NMFS (Johnson et al. 1997), but also included consideration of conservation measures not addressed by the BRT.

The BRT was reconvened on 4-5 November 1998 to discuss comments and new data received in response to the proposed rule and to determine if the new information warranted any modification of the conclusions of the original BRT. This report summarizes this new information and the final BRT conclusions on the following ESUs: Hood Canal Summer-Run ESU and the Columbia River ESU. Updated information for other chum salmon ESUs and populations is included for comparison only. No effort was made to obtain complete updated information for populations not proposed for listing.

BACKGROUND INFORMATION

In March 1994, NMFS received a petition seeking protection under the ESA for chum salmon (*Oncorhynchus keta*). At about the same time, NMFS received several other petitions for other populations of Pacific salmon in Washington, Oregon, Idaho, and California. In response to these petitions and to more general concerns for the status of Pacific salmon throughout the region, NMFS (1994) initiated ESA status reviews for all species of anadromous salmonids in the Pacific Northwest. The results of the status review for chum salmon were published in Johnson et al. (1997). Subsequent to the status review, NMFS (1998) proposed listing chum salmon in the Hood Canal Summer-Run ESU and the Columbia River ESU as threatened species under the ESA. This status review update considers new information for those two populations received since the original status review, and considers technical comments received regarding the status review and listing proposal.

The ESA allows listing of "distinct population segments" of vertebrates as well as named species and subspecies. The policy of NMFS on this issue for anadromous Pacific salmonids is that a population will be considered "distinct" for purposes of the ESA if it represents an evolutionarily significant unit (ESU) of the species as a whole. To be considered an ESU, a population or group of populations must 1) be substantially reproductively isolated from other populations, and 2) contribute substantially to the ecological or genetic diversity of the biological

species.

Once an ESU is identified, a variety of factors related to population status are considered in determining the degree of extinction risk it faces (Johnson et al. 1997). The BRT has been asked to evaluate available scientific information for each ESU and to determine whether 1) it is presently in danger of extinction throughout all or a significant portion of its range or 2) it is likely to become endangered in the foreseeable future throughout all or a significant portion of its range. Following this evaluation by the BRT, other factors (e.g., adequacy of existing conservation measures) are considered by NMFS before deciding whether conditions warrant listing an ESU under the Endangered Species Act.

The conclusions from the original status review (Johnson et al. 1997) are briefly presented below.

Summary of Previous Conclusions

After considering available information on genetics, phylogeny, and life history, and environmental features that may affect chum salmon, the BRT identified 4 ESUs of the species in California, Oregon, Washington, and southern British Columbia. The BRT reviewed population abundance data and other risk factors for these ESUs and concluded that two (Hood Canal Summer-Run ESU and Columbia River ESU) were likely to become endangered in the foreseeable future, and that the remaining ESUs (Puget Sound ESU and Pacific Coast ESU) were not presently in significant danger of becoming extinct or endangered, although there were substantial conservation concerns for at least some populations in both of these ESUs. Specific conclusions for the Hood Canal Summer-Run ESU and Columbia River ESU follow.

Hood Canal Summer-Run Chum Salmon ESU

In 1994, petitioners identified 12 streams in Hood Canal as recently supporting spawning populations of summer chum salmon[2]. At the time of the petition, summer chum salmon runs in 5 of these streams may already have been extinct, and those in 6 of the remaining 7 showed strong downward trends. Similarly, summer chum salmon in Discovery and Sequim Bays were also at low levels of abundance. A variety of threats to the continued existence of these populations were identified, including degradation of spawning habitat, low river flows, possible competition among hatchery fall chum salmon juveniles and naturally produced summer chum salmon juveniles in Hood Canal, and high levels of incidental harvest in salmon fisheries in Hood Canal and the Strait of Juan de

2 "Summer-Run Chum Salmon" and "Summer Chum Salmon" are used synonymously in the 1997 NOAA Technical Memorandum "Status Review of Chum Salmon from Washington, Oregon, and California and in this revised status review.

Fuca.

Spawner surveys in 1995 and 1996 revealed substantial increases in the number of summer chum salmon returning to some streams in Hood Canal and the Strait of Juan de Fuca. However, serious concerns remained (Johnson et al. 1997). First, the population increases in 1995 and 1996 were limited to streams on the western side of Hood Canal, especially the Quilcene River system, while streams on the southern and eastern sides of Hood Canal continued to have few or no returning spawners. Second, a hatchery program initiated in 1992 was at least partially responsible for adult returns to the Quilcene River system. Third, the strong returns to the west side streams were the result of a single, strong year class, while declines in most of these streams have been severe and have spanned two decades. Last, greatly reduced incidental harvest rates in recent years probably contributed to the increased abundance of summer chum salmon in this ESU. In Hood Canal, these reductions have been implemented because of greatly reduced abundance of the target species, coho salmon (*O. kisutch*), rather than concern for summer chum salmon. If coho salmon in the area rebound, and fishery management policies are not implemented to protect summer chum salmon, then these populations could again face high levels of incidental harvest. Also, a harvest of summer chum salmon in fisheries at the entrance to the Strait of Juan de Fuca is primarily incidental to targeted harvest of Fraser River sockeye salmon (*O. nerka).* When returns of Fraser River sockeye salmon are strong in this area, the impact of this incidental take may be an important risk to this ESU.

In conclusion, although the BRT agreed that the 1995-1996 data on summer chum salmon from the ESU provided a more encouraging picture than was the case in 1996, most members concluded that this ESU was still at significant risk of extinction. A major factor in this conclusion was that, in spite of strong returns to some streams, summer chum salmon were either extinct or at very low abundance in more than half of the streams in this ESU that historically supported summer-run populations. A minority of the BRT concluded that the more recent data indicated somewhat less risk of extinction, but that the ESU was still likely to become extinct in the foreseeable future. One member believed that the large returns to some streams indicated that this ESU as a whole was not a significant extinction risk.

Columbia River Chum Salmon ESU

This ESU historically supported commercial landings of hundreds of thousands of fall chum salmon, with landings of nearly half a million fish as recently as 1942. However, beginning in the mid-1950s, commercial catches declined drastically and commercial fishing was severely curtailed by the late 1960s. No targeted commercial or sport fisheries for chum salmon occur on the mainstem Columbia River. Sport angling was closed on the Oregon side of the river in 1992 and an angling closure was adopted for the Grays River in Washington in 1994. Chum salmon are incidentally harvested in the Columbia River during the late-

period coho gill net fishery. The annual average catch from 1983 to 1993 was about 1,100 chum, but less than 42 fish were caught commercially in 1994.

Historically, chum salmon also spawned in many Columbia River tributaries. Currently, the Washington Department of Fish and Wildlife (WDFW) recognizes and monitors only three natural populations in the lower river basin, one in the Grays River and two in small streams, Hardy and Hamilton creeks just below Bonneville Dam. All of these populations have been influenced by hatchery programs and fish transfers, including a hatchery on the Chinook River near the mouth of the Columbia River, that had a return of 3,000 fish in 1993. Substantial habitat loss in the Columbia River, its tributaries, and estuary presumably was an important factor in the decline and also represents a significant continuing risk for this ESU. Taking all of these factors into consideration, all members of the BRT agreed that the ESU is at some risk of extinction. However, because population trends in recent years indicate that the monitored populations may be stable, about half of the BRT members concluded that the imminent short-term extinction risk was low, while the remaining BRT members concluded that this ESU was at significant risk of extinction.

West Coast Chum Salmon Proposed Rule

On 10 March 1998, NMFS published a proposed rule to list the Hood Canal Summer-Run Chum Salmon ESU and the Columbia River Chum Salmon ESU as threatened species under the ESA (NMFS 1998). The proposed rule followed the findings of the BRT with regard to ESU boundaries and risk assessment.

TECHNICAL COMMENTS

Comments on the status review (Johnson et al. 1997) and proposed rule (NMFS 1998) were received from a variety of federal, state, and tribal agencies; environmental organizations; consulting firms; and private individuals (Table 2). In addition, peer review comments were solicited by the NMFS and received from several scientists with expertise in chum salmon biology.

In general, all federal, state, and tribal responses supported the BRT's findings on ESU boundaries and risk designations. In regards to the ESU boundaries, one respondent presented data to support extending the boundary of the Hood Canal Summer-Run Chum Salmon ESU approximately 10 miles westward along the Strait of Juan de Fuca to include early-returning chum salmon in the Dungeness River. Another commenter pointed out that the geographical area encompassed by the Hood Canal Summer-Run ESU contains many rivers that have never supported summer chum salmon populations and the authors suggested these rivers should not be included in the ESU.

Few comments were received on the risk analysis of the Columbia River ESU.

On peer reviewer stated that he concurred with the BRT that this ESU is threatened (due to small population size with limited buffering capacity) but he was not compelled to believe that the ESU faces a high short term risk of extinction. Another commenter questioned the adequacy of available quantitative data, but concluded that they were "unsure" how to interpret the conclusions on abundance that the BRT had reached. They also suggested that NMFS has not provided valid scientific evidence that abundances are below present carrying capacity and contended that the relative stability of Columbia River chum salmon stocks since the mid-1950s does not indicate a danger of extinction in the foreseeable future.

Comments on the risk analysis of the Hood Canal Summer-Run ESU all supported the analysis conducted by the BRT, although commenters pointed out some specific concerns. Among these concerns were:

1) Numbers of returning adults to Union R. were depressed in 1996, but the decrease was not statistically significant, and may have no biological significance.

2) In estimating strength of Hood Canal summer chum salmon runs, the BRT should use the number of returning adults compared to the number of parents creating those adults. Estimates of these ratios (spawner-to-spawner) suggest a trend toward increasing populations over the last eight years in those Hood Canal runs that still exist.

3) Fishery co-managers have greatly reduced harvest impacts on summer chum salmon by limiting fisheries on other co-mingled species (even when these species have been plentiful (e.g., coho salmon) and this should be taken into account in risk analyses.

Comments by environmental organizations, independent scientists, and consultants were generally supportive of the BRT decisions in regard to ESU boundaries and risk analyses. Two commenters suggested that more data should be collected on chum salmon from the Oregon coast and southern Puget Sound, because they believed this data would demonstrate that these fish are at greater risk than presently believed.

One commenter suggested the BRT did not present sufficiently strong scientific evidence to support the identification of multiple ESUs in the Pacific Northwest. This commenter believed that all the ESUs identified by the BRT are likely segments of a general north-south cline of chum salmon and not distinct ESUs. Further, this commenter believed NMFS has not shown with statistical data that any chum salmon ESUs are at high risk of extinction. They also noted that the BRT failed to fully investigate and evaluate the impact of adverse marine conditions and climate change on chum salmon abundance.

Comments solicited from peer reviewers with specific expertise on chum salmon biology were also supportive of the BRT's findings. With regard to ESU boundaries, one commenter supported separation of the LCR from coastal regions based upon a combination of the genetic data developed by the BRT and data from other species. However, he pointed out that only two genetic samples from the

Columbia River were evaluated by the BRT, and that this was inadequate to support an accurate description of the ESU.

Another peer reviewer emphasized that the observations by WDFW biologists, reported in the NMFS status review, that chum salmon do not actively select spawning sites with upwelling ground water certainly does not appear to hold true for the Columbia River chum salmon populations. He reports that the three populations of chum salmon monitored by WDFW in the Columbia River spawn in upwellings and seeps (two in spring fed systems and one in seeps and springs, all with upwellings).

This commenter also noted that there is a population of chum salmon of undetermined size spawning below Bonneville Dam between Hamilton and Ives Islands in the Columbia River and that a few chum salmon are documented to migrate above Bonneville Dam to an unknown stream or streams.

DISCUSSION OF ESU DETERMINATIONS

New Information

Information related to ESU determinations focused primarily on the Hood Canal Summer-Run Chum Salmon ESU. No new information was available on the Lower Columbia Rive ESU.

Information regarding ESU determination was provided by WDFW (J. Ames, pers. commun., September and December, 1998) on observations of early returning chum salmon to the Dungeness River, located to the immediate west of the proposed boundary of the Hood Canal Summer-Run Chum Salmon ESU. The state agency and tribal comanagers are collecting this information as part of a state initiated recovery planning process, that will result in an updated inventory of regional summer chum salmon stocks and their status. Observations of summer chum salmon in the Dungeness River are being evaluated by the co-managers as possible evidence of the occurrence of a self-sustaining stock. The following is a brief review of the extant summer chum salmon spawner data provided by WDFW for the Dungeness River.

The Nature of the Survey Data

The observations of summer chum salmon in the Dungeness River have all been made incidentally while conducting directed spawner surveys for chinook or pink salmon. Although all chum salmon observed on these surveys are counted, the timing and locations of surveys conducted for other species may not adequately cover the temporal and spacial distribution of summer chum salmon.

Before 1986, spawning ground counts in the mainstem Dungeness River were conducted primarily for pink salmon (odd years only) below the Woodcock Road

bridge at river mile (RM) 3.3, with occasional surveys up to the Highway 101 bridge at RM 6.4. Directed chinook salmon surveys were sporadic, and were mainly conducted to fill in on even numbered years, when no pink salmon surveys were occurring. Pink and chinook salmon passing upstream of RM 10.5 were counted at the WDFW Salmon Hatchery weir. In 1981 the permanent weir at the Salmon Hatchery was removed, and over a period of several years spawner survey effort was expanded in the system to make up for the loss of counts from the weir, and to provide a consistent approach to escapement estimation. In 1986, a survey program with emphasis on chinook salmon resulted in greatly expanded survey effort in the Dungeness River.

Survey conditions in the lower Dungeness River are often poor, with limited visibility in pools throughout the season, a condition that is often exacerbated by high snow melt flows in August. When stream flows are elevated by fall rains (typically mid-October to mid-November), the opportunity to conduct accurate spawner counts ranges from extremely poor to impossible.

Early Returning Chum Salmon Observations

The observations of chum salmon in the mainstem Dungeness River during spawner surveys are presented in Tables 4 and 5. Table 4 documents all chum counts for the mainstem, including observations of fall chum from November through January. Table 5 presents only chum salmon counts made in the river during the months of September and October, presumably the time period that summer chum would be present. No chum salmon were observed in 1997; however, there was only very limited survey effort after the month of September.

The first recorded observations of chum salmon in the Dungeness River (Table 4) occurred in December 1952, but no early-returning chum salmon were reported until 1971. The lack of summer-run chum salmon counts prior to 1971 maybe a function of low survey effort; less than a dozen surveys were conducted in the mainstem Dungeness River before 1971. The highest counts occurred in the 1970s, with two counts exceeding 60 fish per mile, and four additional counts ranged between 20 and 49 spawners per mile. Since these instantaneous counts represent only a fraction of the total escapements, it is reasonable to assume that a modest summer chum salmon population existed in the river.

Counts made in the 1980s and 1990s show lower densities of summer chum salmon spawners, mirroring the declines seen in other Hood Canal/Strait of Juan de Fuca river systems. For 1995 and 1996 the highest annual counts were 8.2 fish per mile on October 4, 1995, and 2.1 fish per mile on October 14, 1996.

Caveats

The count data presented in Table 4 and 5 are subject to a number of limitations regarding their applicability for considering the status of summer chum salmon in the Dungeness River. The following discussion highlights some of the

limitations on the uses of raw spawner count data.

The data shown in Tables 4 and 5 have been edited to show just the surveys where chum salmon were observed. Since 1981, surveys for chinook salmon have resulted in hundreds of stream reach counts where no chum salmon were seen. There are also numerous pink salmon surveys in which no chum or chinook salmon were seen. Even with this intensive survey effort, however, there are still temporal and spacial gaps in survey coverage (e.g. a lack of October surveys in 1997). To fully understand the nature of the summer chum counts in the Dungeness River, the survey data in its entirety should be examined (see Big Eagle & Associates and LGL Ltd. 1995).

Another caution in interpreting the count data in Table 5 is that these are partial, instantaneous counts that do not represent total escapements. Given the visibility problems and incomplete nature of the counts, the spawners represented in Table 5 are an unknown fraction of the total population.

A final caveat is that even though summer chum salmon spawn in September and October, any counts that are predominantly composed of live fish in late October should be viewed with some skepticism (e.g., 60 live and 0 dead on 10/25/94). There is a distinct possibility that counts made late in October are fall-run chum salmon arriving on the spawning grounds.

SUMMARY AND CONCLUSIONS OF ESU DETERMINATIONS

In the 4 November 1998 meeting, the Biological Review Team discussed the comments and new information received since the proposed rule and reevaluated the decisions of the original BRT regarding ESU determinations. The only significant information received pertained to inclusion of early returning chum salmon from the Dungeness River in the Hood Canal Summer-Run ESU. During the original BRT meetings in 1994 for the coastwide status review of chum salmon, the BRT considered including the Dungeness River early returning fish in the Hood Canal Summer-Run ESU, but at that time, the only data available on summer-run fish in the river were anecdotal.

The new data provided by WDFW, and summarized in the previous section, clearly showed that in almost every year since extensive salmon surveys were begun in 1971, early-returning chum salmon were observed in the mainstem Dungeness River. Further, because the data are all incidental counts collected during pink or chinook salmon spawning surveys, the actual numbers of early-returning summer chum salmon might be significantly greater. Also, the Dungeness River is geographically and environmentally similar to rivers in the Summer-Run ESU. The Dungeness River drains from Olympic Mountains like other rivers in the ESU, the mouth of the Dungeness River is less than 10 km from the western boundary of the Hood Canal Summer-Run ESU, and its tributaries intermingle with tributaries of Sequim Bay, which is within the ESU. Based this information, the BRT concluded

the Hood Canal Summer-Run ESU should be extended westward to include summer-run chum salmon in the Dungeness River.

DISCUSSION OF EXTINCTION RISK FACTORS

New information

Columbia River ESU

Little new information bearing on the risk assessment for this ESU was provided for the BRT's consideration. WDFW (R. Woodard, pers. commun, October 1998) provided historical escapement data from 6 streams in the lower Columbia River basin (Hardy Cr., West Fort Grays R., Gorley Cr., Crazy Johnson Cr., Grays R., and Fossil Cr.) dating from the late 1940s to 1993 (Figure 2).

Hood Canal Summer-Run Chum Salmon ESU

WDFW (J. Ames, pers. commun., November 1998) provided updated final 1997 and preliminary 1998 spawning escapement for summer chum salmon in Hood Canal and Strait of Juan de Fuca tributaries (Figure 3). Spawning escapement to the ESU in 1997 was estimated to be 10,013 fish and estimated in 1998 to be 5,290 fish. Of these totals, 8,734 spawners in 1997 and 3,959 spawners in 1998 returned to streams with supplementation programs. As shown in Figure 3, these spawning escapements in 1997 and 1998 represent 46% and 25%, respectively, of the recent high escapement of 21,594 fish in 1996.

The Western Washington Treaty Tribes and WDFW have revised the run reconstruction of Hood Canal summer chum salmon. The revision has been comprehensive and thorough, including recalculation of escapement from historic survey data using consistent methods, an earlier cutoff date for distinguishing summer run from fall run chum salmon in catches, and incorporation of summer chum salmon catches in Canadian Area 20 fisheries (N. Lampsakis, PNPTC, pers. commun., November 1998). These changes in the run reconstruction database have resulted in a substantial improvement in the quality of data available for summer chum salmon and are described in more detail below.

When a summer chum salmon database was initially put together for run reconstruction, escapement values were supplied using a variety of methods. In some cases, in the years from 1968 to 1973, these estimates were based on average values or a proportional relationship to escapement in another stream. State and tribal biologists examined the original raw stream survey data and applied consistent methods to obtain the best possible escapement estimates for all streams with chum salmon populations in Hood Canal (Figure 3). The revisions result in mostly minor changes in escapement estimates for individual streams, with little change in the overall pattern of historic spawning escapements (Figure 4).

The cutoff date for discriminating between summer chum and fall chum salmon was also changed on the basis of an analysis of the distribution of run timings and the temporal distribution of catches of chum salmon in coho salmon fisheries. The analysis concluded that substantial numbers of fall chum salmon had been classified as summer chum.

Canadian fisheries in Area 20 (Northern Strait of Juan de Fuca) have had variable impacts on Hood Canal summer chum salmon (Figure 5). Area 20 fisheries generally target Fraser River sockeye salmon, and the impact that they have on summer chum salmon depends on the intensity of sockeye salmon fisheries in the Strait of Juan de Fuca. In recent years a high proportion of Fraser River sockeye salmon has migrated through the Strait of Georgia rather than the Strait of Juan de Fuca with a consequent reduction in the intensity of Area 20 fisheries. If a higher proportion of Fraser River sockeye salmon migrates through the Strait of Juan de Fuca in the future, the intensity of Area 20 fisheries may increase. With implementation of conservation measures taken to reduce harvest impacts on summer chum salmon within Hood Canal, Canadian fisheries have accounted for the majority of fishery impacts within this ESU in recent years.

SUMMARY AND CONCLUSIONS OF RISK ASSESSMENTS

Evaluation Methods

To tie the various risk considerations into an overall assessment of extinction risk for each ESU, the Biological Review Team (BRT) members scored risks in a number of categories using a matrix form, then drew conclusions regarding overall risk to the ESU on the basis of the score matrix. The general risk categories evaluated were abundance; trends, productivity, and variability in abundance; genetic integrity; and "other risks." The summary of overall risk to an ESU uses categories that correspond to definitions in the Endangered Species Act: in danger of extinction, likely to become endangered in the foreseeable future, or neither. (Note, however, that these do not correspond to recommendations for a particular listing action because they are based only on past and present biological condition of the populations and do not contain a complete evaluation of conservation measures as required under the ESA.) The risk summaries do not reflect a simple average of the risk factors for individual categories, but rather a judgement of overall risk based on likely interactions among, and cumulative effects of factors. A single factor with a "high risk" score may be sufficient to result in an overall conclusion of "in danger of extinction," but such an overall determination could result from a combination of several factors with low or moderate risk scores. Risk scores for the three main risk categories are summarized in Table 6.

The BRT used two methods to characterize the uncertainty underlying their risk evaluations. One way the BRT captured the levels of uncertainty associated

with the overall risk assessments was for each member to attach a certainty score (1=low, 5=high) to their overall risk evaluation for each ESU. For example, a BRT member who felt strongly that an ESU was likely to become endangered in the foreseeable future (or not currently at significant risk) would vote for that category of risk and assign a certainty score of 4 or 5; if that member was less sure about the level of risk, a lower certainty score would be given to the risk vote.

The second method for characterizing uncertainty was one fashioned after an approach used by the Forest Ecosystem Management Assessment Team (FEMAT 1993), whereby each BRT member was given 10 total "likelihood" points to distribute in any way among the three risk categories. For example, complete confidence that an ESU should be in one risk category would be represented by most or all of the 10 points allocated to that category. Alternatively, if a BRT member was undecided about whether the ESU was likely to become endangered but felt the ESU was at some risk, they could allocate the same or nearly the same number of points into each of the "likely to become endangered" and "not likely to become endangered" categories. This assessment process follows well documented, peer-reviewed methods for making probabilistic judgements (references in FEMAT 1993 pp. IV-40-45). The BRT interpreted these scores similarly to the way they were used in the FEMAT process: ". . . the likelihoods are not probabilities in the classical notion of frequencies. They represented degrees of belief [in risk evaluations], expressed in a probability scale that could be mathematically aggregated and compared across [ESUs]" (FEMAT 1993 p. IV-44).

Conclusions of Risk Analysis

The outcomes of the two methods for evaluating uncertainty in risk evaluations were generally consistent; the bulk of likelihood points for an ESU were allocated to the same risk category in which the majority of BRT members placed the ESU, and the number of likelihood points assigned to other categories reflected the certainty scores BRT members associated with their conclusions. The BRT felt that clear presentation of the scientific and personal uncertainty underlying risk assessments could allow BRT members and managers to better understand the issues and make informed listing decisions. The certainty scores for these ESUs were moderate (most being in the range 2-4), reflecting some uncertainty regarding the conservation status of these ESUs (Table 6). Similarly, in applying the likelihood method, most BRT members put the majority of points in a single category, but some weight was given to alternative conclusions.

Hood Canal Summer-Run Chum Salmon ESU

The majority of BRT members concluded that the Hood Canal summer chum salmon ESU is likely to become endangered in the foreseeable future if present conditions persist. The rest of the BRT concluded that the ESU was already in

danger of extinction if present conditions persist. The certainty underlying these conclusion was moderately high with relative consistency among BRT members: certainty scores ranged from 3-4, with an average of 3.3, on a 5-point scale. While BRT members were relatively certain that Hood Canal summer chum salmon are at risk, they were less certain about the degree of risk. A majority of BRT members placed a majority of likelihood in the "likely to become endangered" category, a minority placed a majority of the likelihood in the "in danger of extinction" category. However, several BRT members also placed some weight in the "not presently at risk" category.

Perceived risks focused on low current abundance relative to historic abundance and the loss of several of the historically smaller populations on the Kitsap Peninsula (Table 6). Declining trends and low productivity were also identified as risk factors. Less concern was expressed regarding genetic risks to the ESU. Other concerns included the increasing urbanization of the Kitsap Peninsula, recent increases in pinniped populations in Hood Canal, and the fact that recent increases in spawning escapement have been associated primarily with hatchery supplementation programs. Concerns were mitigated to some extent by recent reforms in hatchery practices for fall chum salmon and measures taken by the state and tribes to reduce harvest impacts on summer chum salmon.

Columbia River ESU

The majority of the BRT concluded that the Columbia River chum salmon ESU is likely to become endangered in the foreseeable future if present conditions continue. A minority concluded that this ESU is presently in danger of extinction. The uncertainty underlying this conclusion was moderate: certainty scores ranged from 2-5, with an average of 3.6, on a 5-point scale, and most BRT members placed a majority of likelihood in the "likely to become endangered" category, but most BRT members also placed some likelihood in other categories (Table 6).

The BRT had several concerns about the overall health of this ESU, focusing on dramatic declines in abundance from historic levels and apparently comparable contractions in the distribution of chum salmon within the ESU. Of comparable concern was the low productivity of the extant populations, as evidenced by flat trend lines in the face of low population sizes and little identifiable mortality inflicted by passage problems or harvest. More uncertainty was evident regarding genetic integrity, with small effective populations and hatchery programs using out-of-ESU broodstocks identified as risk factors. Other risk factors identified included potential increases in predation from pinniped and Caspian tern populations, and uncertainty about current run size and distribution. The BRT noted that chum salmon populations have benefitted from reductions in Columbia River gillnet fisheries aimed at protecting listed upriver chinook salmon populations.

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Myers, J. M.., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

National Marine Fisheries Service (NMFS). 1998. Endangered and threatened species: Proposed threatened status and designated critical habitat for Hood Canal summer-run chum salmon and Columbia River chum salmon. Federal Register [Docket 980219043-8043-01, No. 011498B. 10 March 1998] 63(46):11774-11795.NMFS 1998

Personal Communications

J. Ames, Washington Department of Fish and Wildlife, P.O. Box 43151, Olympia, Washington 98504. Pers. commun., September, November, and December 1998.

N. Lampsakis, Fisheries Office, Point No Point Treaty Council, 7999 N.E. Salish Lane, Kingston, Washington 98346. Pers. commun, November 1998

R. Woodard, Washington Department of Fish and Wildlife, 2108 Grand Blvd., Vancouver, Washington 98661. Pers. commun., October 1998.

Table 1. Chum salmon evolutionarily significant units (ESUs) and their status as proposed by the National Marine Fisheries Service (NMFS 1998).

Status	ESUs
Proposed Threatened	
	Hood Canal Summer-Run Chum Salmon
	Columbia River
Not proposed for listing	
	Puget Sound ESU
	Pacific Coast ESU

Table 2. Organizations and individuals providing comments on the west coast chum salmon status review (Johnson et al. 1997) and proposed rule (NMFS 1998).

Category	Person/Organization/Date Received
Peer Reviewers	(1) Terry Beacham, Canada's Department of Fisheries and Oceans (received July 10, 1998). (2) Travis Coley, USFWS, (received August 4, 1998) (3) A.J. Gharrett, Juneau Center, School of Fisheries and Ocean Sciences, (received August 4, 1998). (4) Stevan Phelps, WDFW, (received August 3, 1998).
General Public	(1) Jim Myron, Oregon Trout (received April 22, 1998). (2) Bruce Crawford, Washington Department of Fish and Wildlife & Randy Harder, Point No Point Treaty Council (received May 29, 1998). (3) Charles Burley, Northwest Forest Resource Council (received June 30, 1998). Note that comments are extracted from a report to NFRC submitted by John Palmisano Biological Consultants and V.W. Kaczynski, (4) Ted Mahr, legal counsel for Save Allison Springs (received July 2, 1998). (5) Lou La-Sle-Wit (Lonnie) Selam Sr., Chairman, Yakama Nation Tribal Council (received July 9, 1998).
Comangers	California Department of Fish and Game Oregon Department of Fish and Wildlife Point No Point Treaty Counsil U.S. Fish and Wildlife Service U.S. Department of Argriculture, Forest Service Washington Department of Fish and Wildlife Western Washington Treaty Indian Tribes

Table 3. Summary of new population abundance and distribution information for chum salmon received by the NMFS from Washington Departmetn of Fish and Wildlife Service (WDFW) and Point No Point Treaty Council (PNPTC).

ESU	Type of Information	Source
Columbia River ESU		
	Historical adult escapement data	R. Woodard, WDFW, pers. commun., October 1998
Hood Canal Summer-Run Chum Salmon ESU		
	Updated adult escapement data	PNPTC/WDFW 1998
	Revised run reconstruction analysis	PNPTC/WDFW 1998

Table 4. Dungeness R. chum salmon observations (WDFW spawning ground database, November 1998). All fish were incidentally observed in the mainstem Dungeness R. during spawning surveys for chinook or pink salmon.

YR	MO	DAY	Lower RM	Upper RM	Survey Length	Live	Dead	Live + Dead	Fish per mile	Type survey
52	12	08	0.0	0.0	0.0	14	0	14	0.0	spot
52	12	08	3.1	3.3	0.2	78	23	101	505.0	supplemental
52	12	08	9.2	10.5	1.3	29	7	36	27.7	supplemental
71	09	24	0.0	1.2	1.2	21	0	21	17.5	supplemental
71	10	01	0.0	1.2	1.2	18	6	24	20.0	supplemental
71	10	01	1.2	2.2	1.0	6	0	6	6.0	supplemental
71	10	09	0.0	1.2	1.2	6	4	10	8.3	supplemental
72	09	19	0.0	1.2	1.2	24	0	24	20.0	supplemental
72	09	27	0.0	1.2	1.2	43	2	45	37.5	supplemental
72	10	13	0.0	1.2	1.2	51	32	83	69.1	supplemental
73	09	26	0.0	2.0	2.0	20	2	22	11.0	supplemental
73	10	03	0.0	2.0	2.0	3	3	6	3.0	supplemental
74	09	17	0.0	1.2	1.2	15	0	15	12.5	supplemental
74	10	03	0.0	1.2	1.2	5	0	5	4.2	supplemental
74	10	21	0.0	1.2	1.2	4	4	8	6.7	supplemental
75	09	24	0.0	0.9	0.9	21	23	44	48.9	supplemental
75	09	25	0.0	4.3	4.3	20	4	24	5.6	supplemental
76	09	22	0.0	3.2	3.2	189	10	199	62.2	supplemental
76	09	22	3.2	6.5	3.3	0	0	0	0.0	supplemental
77	09	26	0.0	6.5	6.5	14	0	14	2.2	supplemental
77	10	07	0.1	6.5	6.4	28	3	31	4.8	supplemental
79	09	17	0.0	3.1	3.1	39	10	49	0.0	supplemental
79	10	12	0.0	6.4	6.4	60	61	121	0.0	supplemental
81	11	13	0.0	9.0	9.0	4	0	4	0.4	supplemental
81	11	16	7.0	9.0	2.0	5	0	5	2.5	supplemental
81	11	23	3.0	5.0	2.0	8	0	8	4.0	supplemental
81	12	01	8.0	10.5	2.5	8	0	8	3.2	supplemental
83	09	30	0.0	0.9	0.9	0	2	2	0.0	index
83	10	05	0.9	3.3	2.4	0	1	1	0.0	index
83	11	23	4.0	0.0	0.0	1	1	2	0.0	spot
83	11	23	5.7	6.5	0.8	3	1	4	0.0	index
83	11	23	7.2	9.4	2.2	2	0	2	0.0	index
83	11	30	5.7	6.5	0.8	5	0	5	0.0	index
83	11	30	6.5	10.7	4.2	15	0	15	0.0	index
83	12	07	3.3	4.0	0.7	1	2	3	0.0	index
83	12	07	4.0	5.7	1.7	0	1	1	0.0	index
83	12	07	5.7	6.5	0.8	4	3	7	0.0	index
83	12	07	6.5	10.7	4.2	6	5	11	0.0	index
83	12	14	1.5	2.5	1.0	1	21	22	0.0	supplemental
83	12	14	3.3	4.0	0.7	0	2	2	0.0	index
83	12	14	5.7	6.5	0.8	0	5	5	0.0	index
83	12	14	6.5	10.7	4.2	0	6	6	0.0	index
83	12	21	6.5	10.7	4.2	0	1	1	0.0	index
83	12	28	0.9	3.3	2.4	0	14	14	0.0	index
83	12	28	5.7	6.5	0.8	0	1	1	0.0	index
84	01	11	1.5	2.5	1.0	1	11	12	12.0	supplemental
84	01	18	1.5	2.5	1.0	0	11	11	11.0	supplemental
84	01	18	5.7	6.5	0.8	0	3	3	0.0	index
84	01	18	6.7	7.0	0.3	0	0	0	0.0	index
84	01	18	7.0	8.0	1.0	0	0	0	0.0	index
84	01	18	8.5	9.0	0.5	0	0	0	0.0	index
84	01	18	9.0	10.4	1.4	0	0	0	0.0	index
84	01	25	1.5	2.5	1.0	0	4	4	0.0	index
84	02	01	0.0	0.9	0.9	0	0	0	0.0	index
84	02	01	0.9	3.3	2.4	0	0	0	0.0	index
84	02	01	3.3	4.0	0.7	0	1	1	0.0	index
84	02	01	4.0	5.7	1.6	0	2	2	0.0	index

Table 4 (Continued).

YR	MO	DAY	Lower RM	Upper RM	Survey Length	Live	Dead	Live + Dead	Fish per mile	Type survey
84	02	01	5.7	6.5	0.8	0	0	0	0.0	index
84	02	01	6.7	7.0	0.3	0	0	0	0.0	index
84	02	01	7.0	8.0	1.0	0	0	0	0.0	index
84	02	01	8.5	9.0	0.5	0	0	0	0.0	index
84	10	03	0.0	0.9	0.9	5	2	7	0.0	index
84	10	03	0.9	3.3	2.4	0	2	2	0.0	index
84	12	05	0.0	0.3	0.3	0	0	0	0.0	index
85	09	23	0.8	6.4	5.6	4	1	5	0.0	supplemental
85	09	23	6.4	10.4	4.1	2	0	2	0.0	supplemental
85	10	15	0.1	4.0	3.9	0	3	3	0.8	supplemental
87	09	30	0.0	0.9	0.9	0	1	1	0.0	supplemental
87	10	19	0.9	1.9	1.0	0	1	1	0.0	supplemental
88	09	09	0.0	0.9	0.9	13	0	13	0.0	supplemental
88	09	15	0.6	1.1	0.5	4	0	4	0.0	supplemental
88	09	19	0.9	3.3	2.4	3	0	3	0.0	supplemental
88	10	10	0.9	3.3	2.4	12	3	15	0.0	supplemental
88	10	10	4.0	6.4	2.4	1	0	1	0.0	supplemental
89	10	06	0.0	3.3	3.3	0	1	1	0.0	supplemental
89	10	13	0.0	6.4	6.4	0	2	2	0.0	supplemental
90	10	08	0.0	3.3	3.3	1	0	1	0.0	index
90	10	18	0.0	3.3	3.3	2	0	2	0.0	index
91	09	24	0.0	3.2	3.2	2	0	2	0.0	supplemental
92	10	01	0.0	3.3	3.3	3	0	3	0.0	supplemental
92	10	09	0.0	3.3	3.3	4	1	5	0.0	supplemental
92	10	15	0.0	3.3	3.3	7	5	12	0.0	supplemental
92	10	21	0.3	3.3	3.0	30	4	34	11.3	supplemental
92	10	22	0.0	3.3	3.3	7	3	10	0.0	supplemental
93	09	29	0.0	1.7	1.7	0	0	0	0.0	supplemental
93	10	07	0.0	3.2	3.2	0	0	0	0.0	supplemental
93	10	14	0.0	3.2	3.2	3	0	3	0.0	supplemental
93	10	14	0.0	3.3	3.3	3	0	3	0.0	supplemental
93	11	02	0.0	1.9	1.9	22	0	22	0.0	index
93	11	02	1.9	4.0	2.1	31	1	32	0.0	index
94	09	16	0.0	3.3	3.3	2	0	2	0.0	index
94	09	29	0.0	3.3	3.3	1	0	1	0.0	supplemental
94	10	06	0.0	3.3	3.3	1	0	1	0.0	supplemental
94	10	25	0.0	4.0	4.0	60	0	60	0.0	supplemental
95	08	22	0.0	3.3	3.3	2	0	2	0.0	index
95	08	28	0.0	3.3	3.3	6	0	6	0.0	index
95	09	11	0.0	3.3	3.3	2	0	2	0.0	index
95	09	13	0.0	3.3	3.3	2	0	2	0.0	index
95	09	13	9.2	10.8	1.6	1	0	1	0.0	index
95	09	22	0.0	3.3	3.3	1	0	1	0.0	supplemental
95	09	26	0.0	0.5	0.5	9	2	11	0.0	supplemental
95	10	04	0.0	3.3	3.3	16	11	27	0.0	supplemental
95	10	13	0.0	1.9	1.9	0	1	1	0.0	index
95	10	16	4.5	4.6	0.1	2	0	2	0.0	spot
96	09	20	0.0	3.3	3.3	1	0	1	0.0	index
96	09	24	3.3	6.4	3.1	1	0	1	0.0	supplemental
96	09	27	0.0	3.3	3.3	1	0	1	0.0	index
96	10	01	0.0	3.3	3.3	1	2	3	0.0	index
96	10	14	0.0	3.3	3.3	6	1	7	0.0	index

Table 5. Dungeness R. chum salmon observations before November 1 (WDFW spawning ground database, November 1998). All fish were incidentally observed in the mainstem Dungeness R. during spawning surveys for chinook or pink salmon.

Year	Month	Day	Lower RM	Upper RM	Survey Length	Live	Dead	Live + Dead	Fish per mile	Type survey
71	09	24	0.0	1.2	1.2	21	0	21	17.5	supplemental
71	10	01	0.0	1.2	1.2	18	6	24	20.0	supplemental
71	10	01	1.2	2.2	1.0	6	0	6	6.0	supplemental
71	10	09	0.0	1.2	1.2	6	4	10	8.3	supplemental
72	09	19	0.0	1.2	1.2	24	0	24	20.0	supplemental
72	09	27	0.0	1.2	1.2	43	2	45	37.5	supplemental
72	10	13	0.0	1.2	1.2	51	32	83	69.1	supplemental
73	09	26	0.0	2.0	2.0	20	2	22	11.0	supplemental
73	10	03	0.0	2.0	2.0	3	3	6	3.0	supplemental
74	09	17	0.0	1.2	1.2	15	0	15	12.5	supplemental
74	10	03	0.0	1.2	1.2	5	0	5	4.2	supplemental
74	10	21	0.0	1.2	1.2	4	4	8	6.7	supplemental
75	09	24	0.0	0.9	0.9	21	23	44	48.9	supplemental
75	09	25	0.0	4.3	4.3	20	4	24	5.6	supplemental
76	09	22	0.0	3.2	3.2	189	10	199	62.2	supplemental
76	09	22	3.2	6.5	3.3	0	0	0	0.0	supplemental
77	09	26	0.0	6.5	6.5	14	0	14	2.2	supplemental
77	10	07	0.1	6.5	6.4	28	3	31	4.8	supplemental
79	09	17	0.0	3.1	3.1	39	10	49	0.0	supplemental
79	10	12	0.0	6.4	6.4	60	61	121	0.0	supplemental
83	09	30	0.0	0.9	0.9	0	2	2	0.0	index
83	10	05	0.9	3.3	2.4	0	1	1	0.0	index
84	10	03	0.0	0.9	0.9	5	2	7	0.0	index
84	10	03	0.9	3.3	2.4	0	2	2	0.0	index
85	09	23	0.8	6.4	5.6	4	1	5	0.0	supplemental
85	09	23	6.4	10.4	4.1	2	0	2	0.0	supplemental
85	10	15	0.1	4.0	3.9	0	3	3	0.8	supplemental
87	09	30	0.0	0.9	0.9	0	1	1	0.0	supplemental
87	10	19	0.9	1.9	1.0	0	1	1	0.0	supplemental
88	09	09	0.0	0.9	0.9	13	0	13	0.0	supplemental
88	09	15	0.6	1.1	0.5	4	0	4	0.0	supplemental
88	09	19	0.9	3.3	2.4	3	0	3	0.0	supplemental
88	10	10	0.9	3.3	2.4	12	3	15	0.0	supplemental
88	10	10	4.0	6.4	2.4	1	0	1	0.0	supplemental
89	10	06	0.0	3.3	3.3	0	1	1	0.0	supplemental
89	10	13	0.0	6.4	6.4	0	2	2	0.0	supplemental
90	10	08	0.0	3.3	3.3	1	0	1	0.0	index
90	10	18	0.0	3.3	3.3	2	0	2	0.0	index
91	09	24	0.0	3.2	3.2	2	0	2	0.0	supplemental
92	10	01	0.0	3.3	3.3	3	0	3	0.0	supplemental
92	10	09	0.0	3.3	3.3	4	1	5	0.0	supplemental
92	10	15	0.0	3.3	3.3	7	5	12	0.0	supplemental
92	10	21	0.3	3.3	3.0	30	4	34	11.3	supplemental
92	10	22	0.0	3.3	3.3	7	3	10	0.0	supplemental
93	09	29	0.0	1.7	1.7	0	0	0	0.0	supplemental
93	10	07	0.0	3.2	3.2	0	0	0	0.0	supplemental
93	10	14	0.0	3.2	3.2	3	0	3	0.0	supplemental

Table 5 (Continued).

Year	Month	Day	Lower RM	Upper RM	Survey Length	Live	Dead	Live + Dead	Fish per mile	Type survey
93	10	14	0.0	3.3	3.3	3	0	3	0.0	supplemental
94	09	16	0.0	3.3	3.3	2	0	2	0.0	index
94	09	29	0.0	3.3	3.3	1	0	1	0.0	supplemental
94	10	06	0.0	3.3	3.3	1	0	1	0.0	supplemental
94	10	25	0.0	4.0	4.0	60	0	60	0.0	supplemental
95	08	22	0.0	3.3	3.3	2	0	2	0.0	index
95	08	28	0.0	3.3	3.3	6	0	6	0.0	index
95	09	11	0.0	3.3	3.3	2	0	2	0.0	index
95	09	13	0.0	3.3	3.3	2	0	2	0.0	index
95	09	13	9.2	10.8	1.6	1	0	1	0.0	index
95	09	22	0.0	3.3	3.3	1	0	1	0.0	supplemental
95	09	26	0.0	0.5	0.5	9	2	11	0.0	supplemental
95	10	04	0.0	3.3	3.3	16	11	27	0.0	supplemental
95	10	13	0.0	1.9	1.9	0	1	1	0.0	index
95	10	16	4.5	4.6	0.1	2	0	2	0.0	spot
96	09	20	0.0	3.3	3.3	1	0	1	0.0	index
96	09	24	3.3	6.4	3.1	1	0	1	0.0	supplemental
96	09	27	0.0	3.3	3.3	1	0	1	0.0	index
96	10	01	0.0	3.3	3.3	1	2	3	0.0	index
96	10	14	0.0	3.3	3.3	6	1	7	0.0	index

Table 6. Summary of BRT conclusions for extinction risk categories. The five-point scale used, with 1 representing lowest risk and 5 representing highest risk, is described in Myers et al. (1998, Appendix E).

	Risk Category					
	low				high	
	1	2	3	4	5	aver-age
Hood Canal summer chum salmon						
Abundance/Distribution			1	6	2	4.1
Trends/Productivity			3	6		3.7
Genetic Integrity	3	6				1.7
Columbia River chum salmon						
Abundance/Distribution			4	5		3.6
Trends/Productivity		1	5	3		3.2
Genetic Integrity	2	4	2	1		2.2

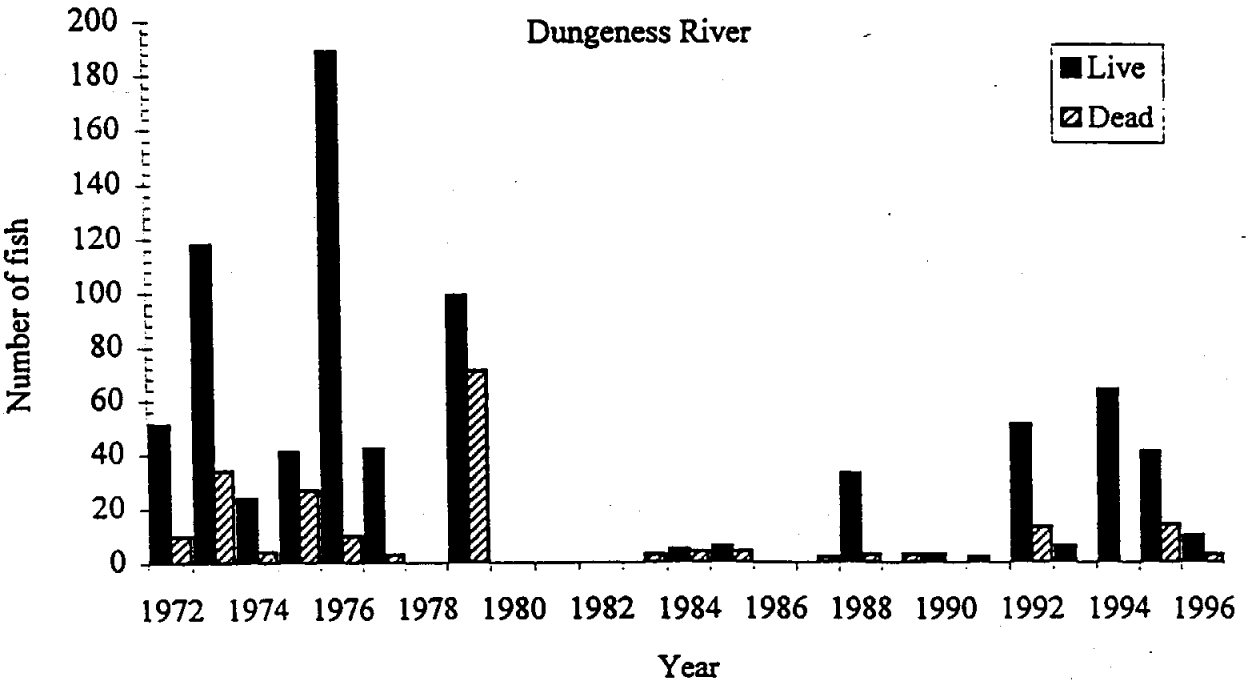

Figure 1. Counts of living and dead chum salmon incidentally observed in the Dungeness River during spawning surveys for other species (PNPTC /WDFW 1998).

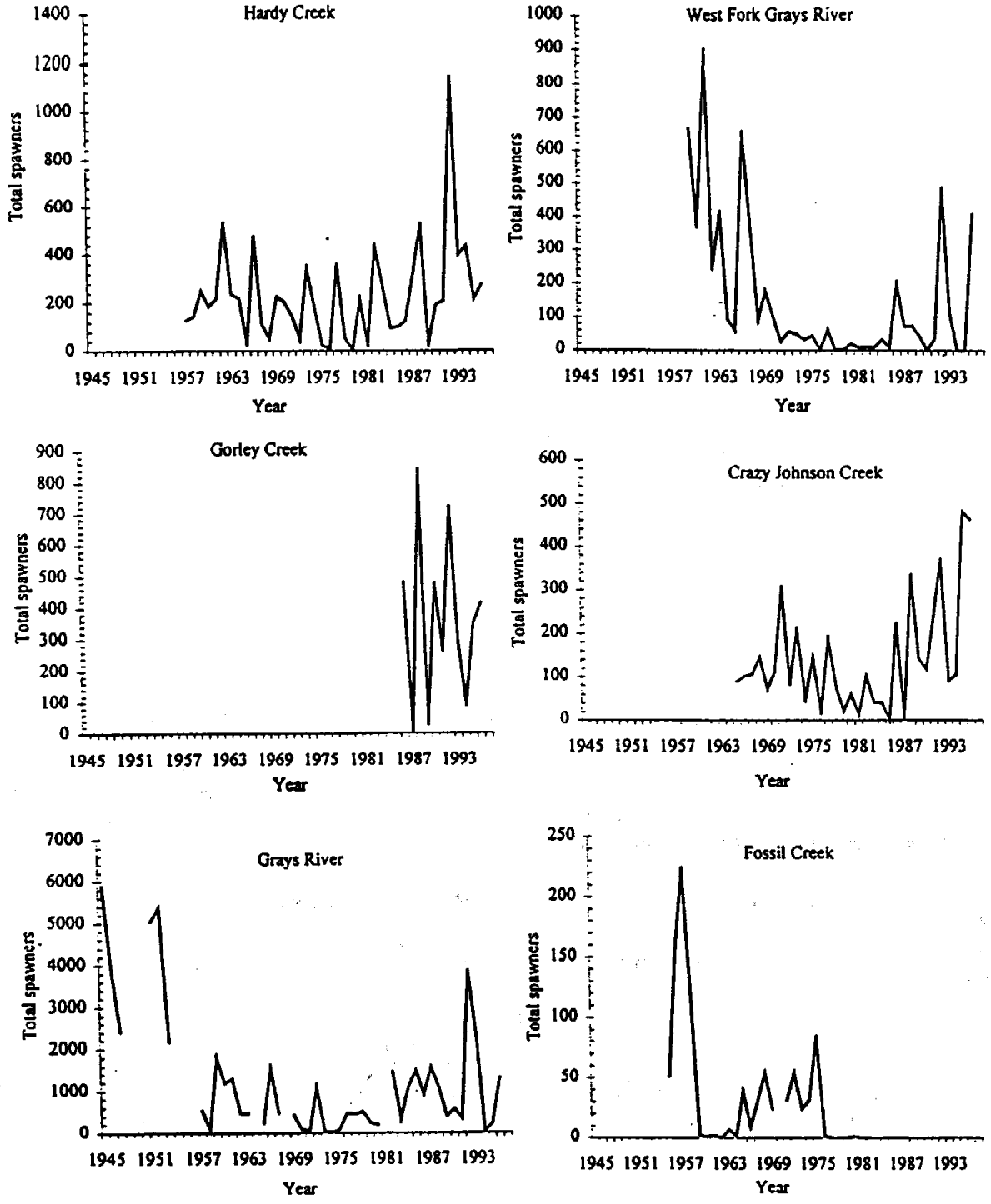

Figure 2. Chum salmon escapement counts (1945-1993) from 6 streams in the lower Columbia River basin (R. Woodard, WDFW, pers. commn., October 1998).

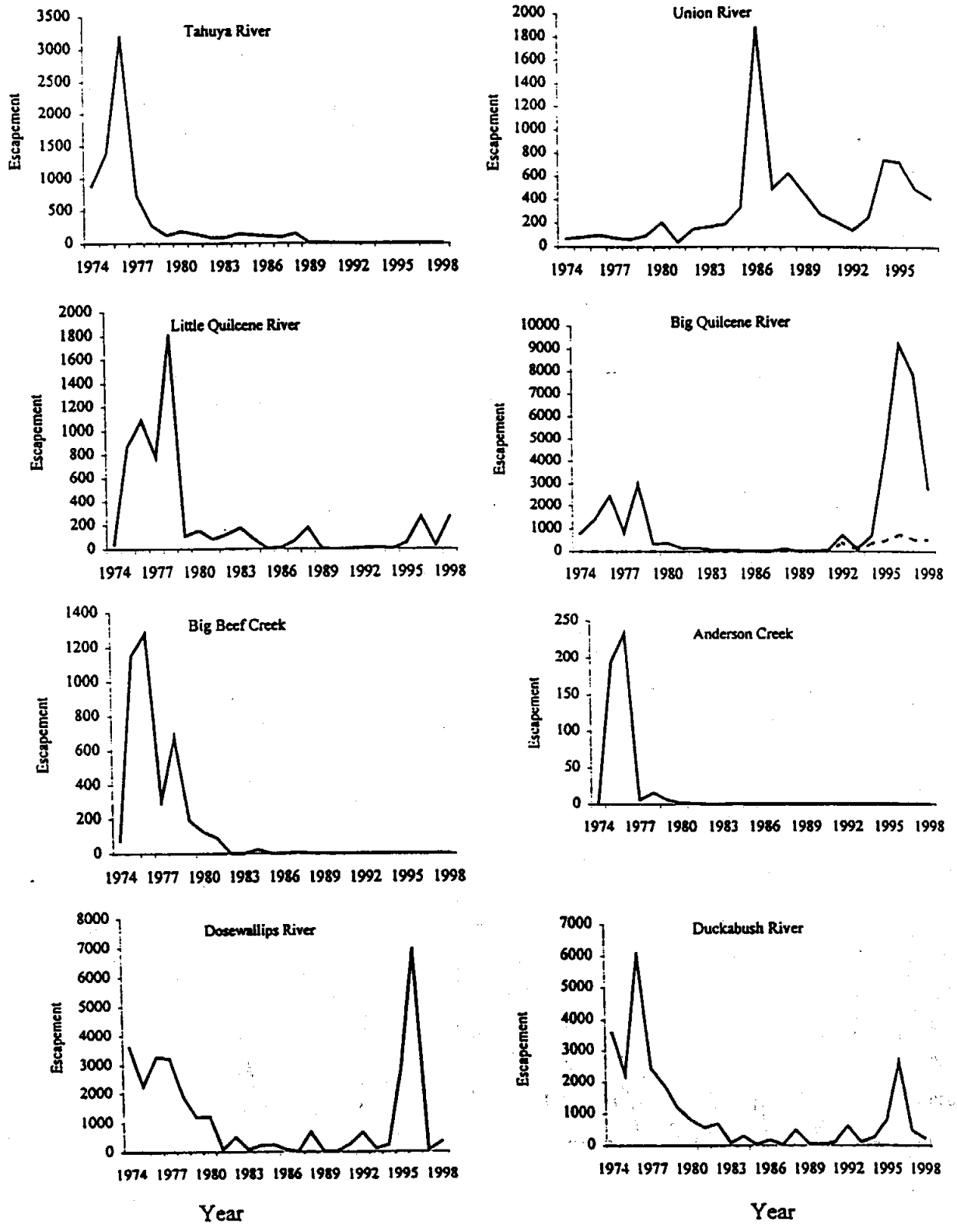

Figure 3. Revised escapement of summer-run chum salmon to streams in the Hood Canal Summer-Run Chum Salmon ESU (PNPTC/WDFW 1998).

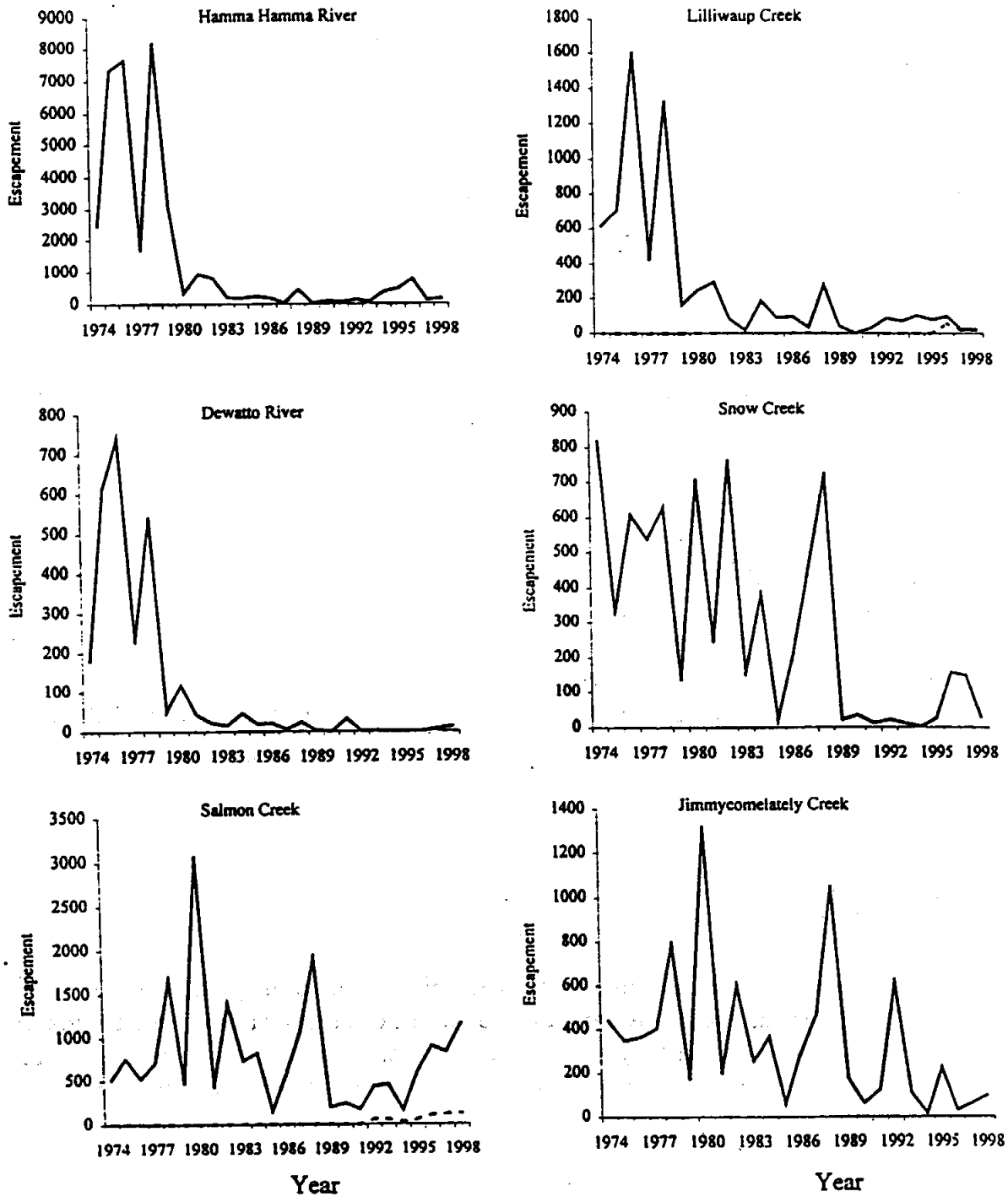

Figure 3. (Continued).

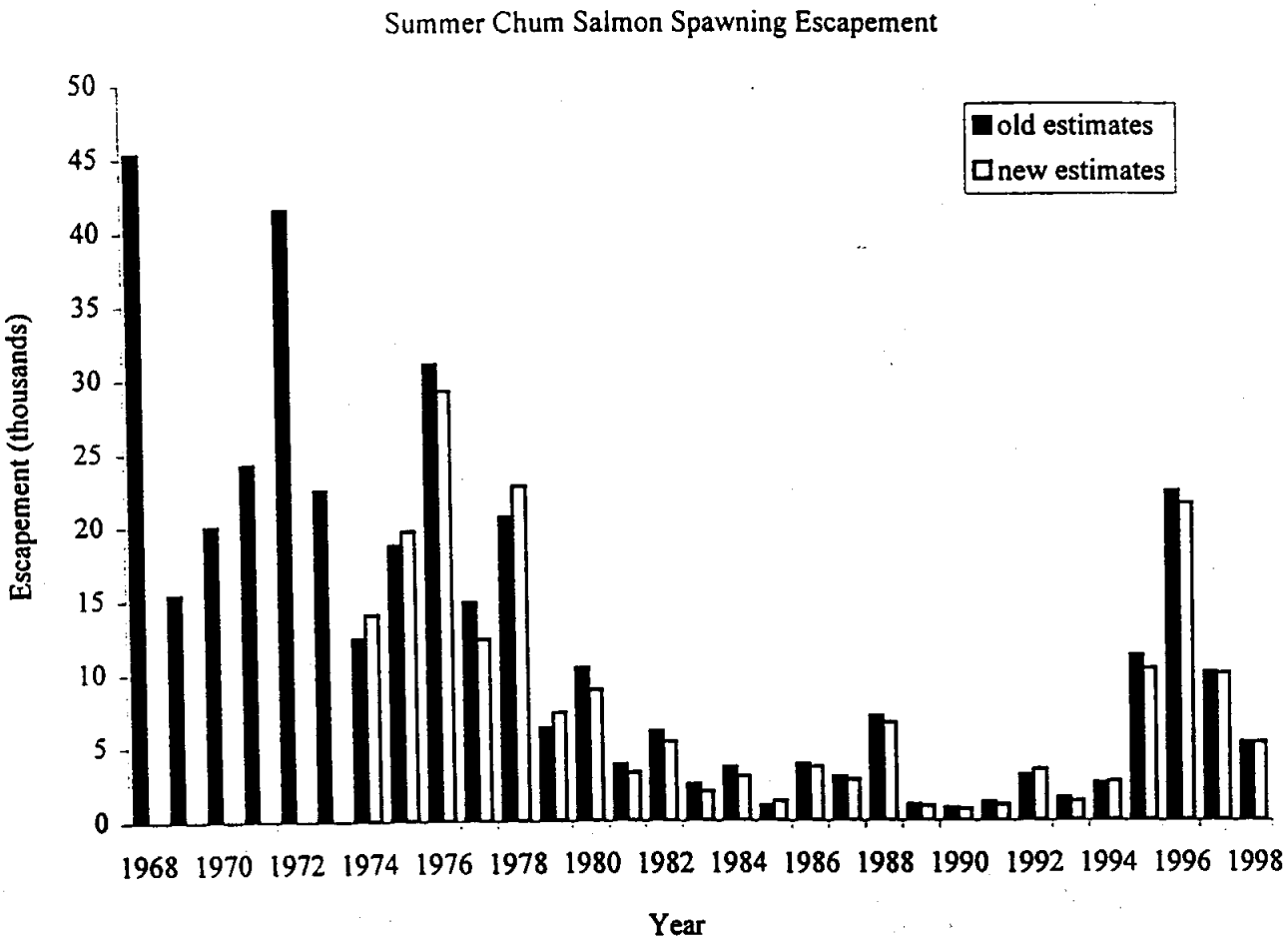

Figure 4. Comparisons of differences between old and new methods used to calculate spawning escapement of summer chum salmon to streams in the Hood Canal summer-run ESU. The older method is based on average values or a proportional relationship to escapement in another stream. State and tribal biologists examined the original raw stream survey data and applied consistent methods to obtain the second, newer set of values (N. Lampsakis, PNPTC, pers. commun., November 1998).

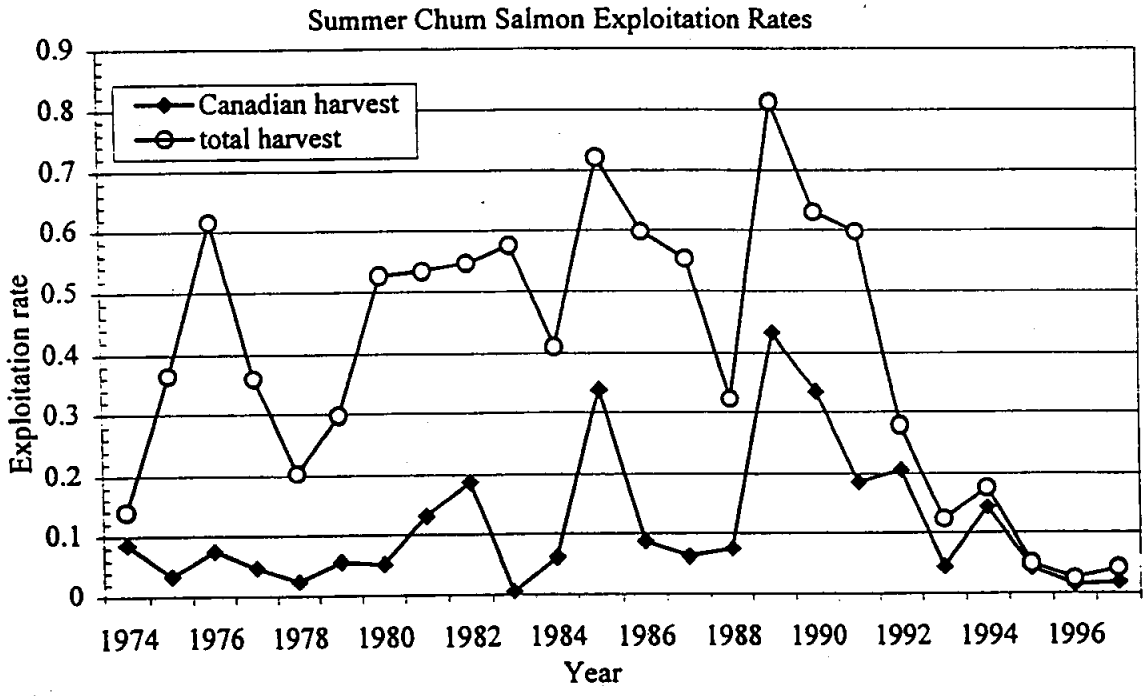

Figure 5. Comparision of Canadian harvest and total harvest rate for summer-run chum salmon from 1947 to 1997 (N. Lampsakis, NNPTC, pers. commun., November 1998.)