SUMMER CHUM SALMON CONSERVATION INITIATIVE

An Implementation Plan To Recover Summer Chum Salmon in the Hood Canal and Strait of Juan de Fuca Region

Supplemental Report No. 5

Interim Summer Chum Salmon Recovery Goals

Point No Point Treaty Tribes
Washington Department of Fish and Wildlife

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INTRODUCTION

The Washington Department of Fish and Wildlife and Point No Point Treaty Tribes, with the assistance of National Marine Fisheries Service and U.S. Fish and Wildlife Service, completed the Summer Chum Salmon Conservation Initiative (SCSCI) in April 2000 (WDFW and PNPTT 2000). This initiative is intended to provide the basis for protection and recovery of Hood Canal and Strait of Juan de Fuca summer chum salmon. It addresses specific management strategies and actions applicable to artificial production, harvest and habitat. The initiative also describes performance standards measured by abundance (run size), productivity, spawning escapement and management actions that would lead to recovery of the summer chum salmon. However, it does not describe specific recovery goals. This paper addresses that task.

The recovery goals apply to abundance, escapement, productivity and diversity of the natural origin, summer chum. Because the information upon which the goals are based is expected to improve over time, the goals are currently characterized as interim and will be revised as more information becomes available. Interim recovery goals for individual summer chum stocks and for the Hood Canal Evolutionarily Significant Unit (ESU) are addressed in this paper. The following sections include brief discussions of the need for recovery goals, the background for interim recovery goal development and the approach used, followed by a description of the interim recovery goals and their derivation.

NEED FOR INTERIM RECOVERY GOALS

Stock-specific recovery goals are needed to provide tangible targets against which the success of recovery efforts can be measured. Specific, attainable goals can motivate recovery efforts and help justify the time, sacrifices and costs incurred when implementing problematic and difficult actions involving habitat restoration, the regulation of land use, and the management of fisheries and hatchery programs. The goals presented here, regarding abundance, escapement, productivity and diversity, are specific to the Hood Canal and Strait of Juan de Fuca summer chum stocks and reflect upon the watersheds and estuaries that support them. Habitat-related recovery measures can thus be associated with the stock-specific goals. Current provisions for managing harvest and artificial production address specific stocks and point toward recovery (see Part 3 of SCSCI and the annual reports [WDFW and PNPT 2001, 2003]). An ESU-wide recovery goal accounts for the composite of summer chum stocks in addressing conditions for recovery. The goals set standards by which progress toward and attainment of recovery can be measured.

BACKGROUND

The interim recovery goals presented here are fully supportive of and consistent with the overall goal for summer chum stated in the SCSCI:

> *To protect, restore and enhance the productivity, production and diversity of Hood Canal summer chum salmon and their ecosystems to provide surplus production sufficient to allow future directed and incidental harvests of summer chum salmon.*

Summer chum salmon production is usually measured as recruits (number of adult returns prior to fisheries interceptions) and spawning escapement (number of adults that escape fisheries). The number of fish surviving to recruits is dependent on habitat (including climatological conditions) in the stream, estuary and ocean environments, and predation and competition by and with other species. The spawning escapement levels of a given stream are limited primarily by the number of fish surviving to adulthood and by fisheries interceptions.

Productivity is a measure of survival, expressed here as recruits per spawner. It is an estimate of the natural survival of adults originating from spawners of a given brood year.

Recruits, escapement and recruits per spawner are interrelated. The spawning escapement of a given brood year produces progeny that mature and return as adults, primarily at three and four years of age. If the ages of the adult returns are known, it is possible to separate annual returns by their originating brood years and thus accumulate total adult returns from a given brood year's escapement. In this manner, recruits per spawner is determined.

Unfortunately, historical age data are currently inadequate to reconstruct summer chum adult returns (see section 1.4.5 of SCSCI) that would allow us to specify total recruits resulting from individual historical brood years. Thus we cannot estimate recruits per spawner from historical data. We can, however, estimate annual recruits (described herein as abundance) and annual spawning escapement and use these values to estimate production of summer chum salmon. Recently, efforts to collect age data have increased and in the future we expect we to be able to estimate recruits, escapement and recruits per spawner for individual brood years.

Diversity is reflected in the number of life history pathways of a population, in its biological characteristics and genetic traits, in the population's spatial distribution, and in the number and distribution of all populations across the landscape. Generally, with more and larger populations, and with greater spatial distribution, the species would be expected to be more diverse. Diversity reduces the risk of catastrophic impact, short-term environmental effects, and long-term effects of climatic cycles or regime shifts on individual populations and the species as a whole. It also enhances a population's ability to take advantage of a wider range of habitats. Diversity can be fostered by maintaining and restoring good quality habitat across a wide range of environments, and by effectively managing artificial production and fish harvest.

The Hood Canal summer chum interim recovery goals presented in this paper address the above-described parameters of annual abundance and spawning escapement, productivity, and diversity. The National Marine Fisheries Service (NMFS) has identified four parameters to be used in evaluating salmonid populations and that are the basis for its general guidelines identifying viable salmonid populations (McElhany et al. 2000). The NMFS parameters are abundance, productivity, diversity and population spatial structure; essentially the same parameters we are using here. However, we address the NMFS' general description of abundance in terms of annual recruits (abundance) and spawning escapement. We also include spatial population distribution as a component of diversity rather than as a separate parameter.

The Puget Sound Technical Recovery Team (TRT), organized under the auspices of NMFS to address recovery planning of listed salmon species for the Puget Sound area, has adopted the aforementioned NMFS parameters as a basis for development of recovery goals (NMFS 2000). The TRT has coordinated with Washington Department of Fish and Wildlife and the Treaty Tribes in developing interim recovery goals for another regional threatened species, Puget Sound Chinook. As the TRT considers recovery goals for Hood Canal Summer Chum, we anticipate a similar coordinated effort that will take into account the interim recovery goals presented here.

The above-described SCSCI goal statement includes the provision for future directed and incidental harvests of summer chum salmon. The interim recovery goals addressed here, when realized, are also expected to provide, on average, sufficient surplus abundance for harvest. In order to rebuild and maintain summer chum populations to levels that meet the SCSCI goal (and the interim recovery goals), habitat conditions must be restored and protected, and fisheries harvest must be managed effectively. Furthermore, an integrated approach (that also incorporates proper use of artificial production) is necessary if summer chum recovery is to be realized (see also section 3.6 of SCSCI). The specific recovery goals, consistent with the SCSCI goal statement, provide measurable targets for the managers in their pursuit of summer chum salmon recovery.

Approach to Interim Recovery Goal Development

Ideally, recovery goals should be developed based on knowledge and assessment of the habitat and of how the habitat affects potential production, productivity and diversity of the stocks. Currently no such assessment exists that is adequate to tie the habitat directly to recovery goals. Studies should be undertaken in the future to develop quantitative relationships between habitat conditions and summer chum salmon performance within the watersheds and estuaries that then could provide knowledge for improving the recovery goals. But for now, an alternative approach based on available historic population data is used to derive interim recovery goals. This approach is limited by the time span and quality of the available data (see section 1.4 of the SCSCI). However, it provides reference to individual stocks and relates to their status before the recent summer chum salmon declines (for discussion of declines, see section 1.5 of SCSCI).

Available population data for all years and across most stocks, extend back to 1974 and while these data include years before the recent summer chum population declines, they likely do not represent the full production potential of summer chum that existed before many of the impacts on habitat from human actions occurred, beginning in the late nineteenth century (see section 3.4 and Appendix 3.6 of SCSCI). Accordingly, the interim, population-based recovery goals presented here likely do not reflect historic production potential and perhaps not even the full production potential that is practically feasible through current, effective habitat and fisheries management actions. However, these goals do point to recovery, at least at population levels that existed before recent population declines, and they can be modified when new information and assessments become available.

The Co-managers are currently reintroducing summer chum salmon to the Big Beef, Chimacum, and Tahuya watersheds. We consider these reintroductions initially to be range extensions of the donor stocks that reduce the stocks' risk of extinction. Eventually, through local adaptation, new stocks may become established in the reintroduced watersheds. While these reintroduction programs are expected to contribute to increasing the abundance and diversity of summer chum, they are experimental programs and their success is uncertain. If and when reintroduced populations become self-sustaining, we will consider what role they play in recovering summer chum and whether to establish independent recovery goals for them.

Available age data are inadequate to allow us to reconstruct historical recruitments by brood year (section 1.4.5 of SCSCI). Our use of the population data is therefore limited to estimates of spawning escapements and catches that allow us to reconstruct annual run sizes (See Appendix 1.3 of SCSCI for description of run reconstruction methodology).

Of the available population data sets, the annual estimates of spawning escapement are the most representative of the individual stocks, because the fish are clearly in their home streams and no stock composition assumptions are required. However, spawning escapement by itself is not a measurement of stock abundance (unless there is no harvest) or productivity, but rather is simply the numbers of fish left over after fishery removals. Because of this, spawning escapements of exploited populations are not representative of overall abundance. For this reason, the co-managers have decided not to base recovery standards on historical summer chum spawning escapement levels that occurred prior to population declines. Rather, our definition of the interim recovery goals initially focuses on the historical stock-specific runsizes (or abundances that include spawning escapement and harvest) because they better represent pre-decline stock performance.

The interim recovery goals apply only to natural-origin-recruits in their native watersheds. Our approach is to develop integrated recovery goals for each stock and for the ESU as a whole that take into account abundance, productivity and spawning escapement. In brief, we first approximate an abundance threshold for each stock by calculating the arithmetic mean of annual natural-origin-recruit run sizes prior to population decline. We then derive a threshold for recruits per spawner and use it to calculate a spawning escapement threshold; i.e., by dividing the abundance threshold by the recruits per spawner threshold. All three thresholds are used in developing recovery criteria that together constitute an interim recovery goal.

We cannot over emphasize the inter-related nature of abundance, spawning escapement and productivity in the present application. Recovery criteria of all three must be addressed together because, as described briefly above and in more detail below, the parameters have been derived under a set of assumptions that link them together.

Diversity within and between stocks incorporates differences in geographic distribution, morphology, behavior, physiology and other characteristics that are controlled by genetics and habitat. Diversity can be difficult to define specifically and quantitatively by stock. However, conceptually, there is an understanding of risks associated with reduced diversity and of actions that can be taken to decrease risk of its loss. Provisions to decrease risk have been incorporated in the SCSCI. The interim recovery goals for diversity emphasize the need to reestablish stocks, to rebuild stocks and to protect and restore habitat.

The following section provides detailed descriptions of how the interim recovery goals are derived.

DESCRIPTION OF THE INTERIM RECOVERY GOALS

The development of interim recovery goals for abundance, spawning escapement and productivity is described in a progression beginning first with the abundance and spawning escapement thresholds, second, the productivity threshold and, last, the specific recovery criteria. For each stock, the recovery criteria address abundance, spawning escapement and productivity together as a single goal. A recovery goal based on similar criteria but applicable to the ESU as a whole is also described. Finally, interim recovery goals for diversity are described separately.

Abundance and Spawning Escapement Recovery Thresholds

The estimation of abundance and spawning escapement recovery thresholds are based on estimates of run sizes prior to population declines. An analysis has been performed to determine a statistically derived breakpoint between periods of initial high and later low abundance for each stock.

The analysis, described in Appendix A, is based on a progressive comparison of mean abundances for expanding groups of years over time. It estimates a statistically derived breakpoint between periods of high and subsequent low abundance for each stock. The span of years prior to population decline is thus determined for each stock beginning with the year 1974 (the escapement and harvest data before 1974 are judged to be of limited utility; see section 1.4 of SCSCI). The one exception is the Union stock that shows no evidence of population decline since 1974 and thus has not been subjected to the analysis; the time span for the Union stock is set at the period from 1974 through 2000. The time spans prior to decline determined for each stock are as follows:

Stock	Time Span before Population Decline
Quilcene	1974-1978
Dosewallips	1974-1980
Duckabush	1974-1980
Hamma Hamma	1974-1979
Lilliwaup	1974-1978
Union	1974-2000
Salmon/Snow	1974-1989
Jimmycomelately	1974-1989

A straightforward approach is used to estimate the interim natural-origin-recruit abundance and escapement recovery thresholds. First, an abundance threshold for each stock is calculated as the arithmetic mean of abundances within the above noted span of years. Then a spawning escapement threshold is estimated by dividing the abundance threshold by a recruit per spawner ratio of 1.6. The choice of this recruit per spawner value is described in the following subsection addressing the interim threshold for productivity. See Appendix A for details regarding determination of the abundance and spawning escapement thresholds. The thresholds are as follows:

Abundance and Escapement Recovery Thresholds (Values rounded to nearest 10)		
Hood Canal Stocks	**Abundance**	**Escapement**
Quilcene	4,570	2,860
Dosewallips	3,080	1,930
Duckabush	3,290	2,060
Hamma Hamma	6,060	3,790
Lilliwaup	3,130	1,960
Union	550	340
Strait of Juan de Fuca Stocks		
Salmon/Snow	1,560	970
Jimmycomelately	520	330

A question arose as to whether years with high values should be eliminated (as outliers) when determining the breakpoint year of decline, as well as the pre-decline average abundance and escapement threshold values of the stocks. This was a difficult issue to resolve but in the end, it was decided to not eliminate any years with high values. However, because of the difficulty in making the decision for two of the stocks, Quilcene and Lilliwaup, and because keeping or eliminating the high value years for these two stocks made a large difference in their threshold levels, the Co-managers agreed to an assessment of the productivity and capacity of the Quilcene and Lilliwaup watersheds and estuaries to be completed in time for reevaluation of their interim recovery goals, as part of the five-year summer chum plan review in 2005 (the five-year review is specified in section 3.6 of the Summer Chum Salmon Conservation Initiative). See Appendix A for additional details regarding the question of data outliers.

The SCSCI provides an assessment of extinction risk for each stock (section 1.7.4 of SCSCI). The criteria of that assessment, when applied to the above listed spawning escapement thresholds, indicate that the threshold population levels for all but the Union and Jimmycomelately stocks are at low risk of extinction. Appendix B shows that the escapement recovery thresholds of the Union and Jimmycomelately stocks meet the criteria for moderate extinction risk. The applicable criteria, in the case of these two stocks, are based on population size; that is, the small size of these populations is the reason for the moderate risk of extinction designation. However, while smaller populations generally are considered at greater risk, small population size may be a natural and even acceptable characteristic of the stock (see discussion in Appendix B). In any case, the spawning escapement thresholds are based on population data prior to any recent population decline and their use for setting the interim escapement recovery criteria provides a fairly conservative approach that may be modified whenever new information and assessments become available.

Productivity Recovery Threshold

To sustain a salmon population, the average ratio of return spawners to brood spawners must at least equal 1.0 (McElhaney et al. 2000). This "spawner to spawner" ratio differs from the "recruits per spawner" ratio in that recruits include, in addition to number of spawners, any fishery-related mortalities that may occur. The performance standards described in the SCSCI, and under the Base Conservation Regime, require a minimum five-year mean productivity, or recruits per spawner value, of 1.2 (section 3.6, page 334). This productivity standard was set above 1.0 to accommodate the low-level incidental fishery mortality (up to 16.7 % exploitation rate) that may occur even under the strict harvest controls of the Base Conservation Regime.

For the present purpose of addressing recovery, the Co-managers have selected a productivity threshold of 1.6 recruits per spawner. This threshold is within a reasonable range of observed values (see below). When achieved it would accommodate lifting some restrictions on the harvest of salmon species commingled with summer chum salmon (e.g., when average surplus recruitment of summer chum would be 37.5%) while ensuring sustainability; in this sense, the threshold is consistent with the harvest provision of the SCSCI overall summer chum goal (see page 1).

As previously indicated, the lack of age data prevents proper assessment of the historical recruits per spawner by brood for Hood Canal summer chum. However, average ratios of historical abundance to spawning escapement suggest that the threshold of 1.6 recruits per spawner is not unrealistic. For example, summing historical summer chum abundance and escapement estimates over all stocks within Hood Canal and dividing the total abundance by total escapement yields the values: 1.63 for the years 1974 –1978 (before the general population declines in Hood Canal) and 1.74 for the years 1974-1994 (prior to any summer chum returns from supplementation).

The range of recruits per spawner reported for other chum salmon populations also implies that the productivity threshold of 1.6 is within a reasonable range. Bakkala (1970) describes natural chum salmon returns per spawner in central and southeastern Alaska averaging approximately 1.4 to 4.0 and reports averages from 1.2 to 1.8 for Johnstone Strait in British Columbia (no designation of run timing for these populations). Myers et al. (1999) evaluated the recruit per spawner relationship of seven chum salmon populations[1] using the Ricker model, log transformed and incorporated into a linear mixed model. A mean log α value of 1.31 was estimated that translates to a α value of 3.7; that is, 3.7 recruits per spawner assuming no density dependence. This is an approximation of recruits per spawner at the origin of the Ricker curve and indicates that recruits per spawner of a recovered population, more likely to be found on the curve where density dependence effects exist (for example, near the point of maximum sustainable yield), would be at a lower value. Finally, reconstruction of Hood Canal natural fall chum runs by brood year, beginning 1968, shows a range of recruits per spawner from 1.0 to 12.3 (excluding one outlier) with an average of 5.0 (PNPTC and WDFW 2001). These natural fall chum runs have remained strong over the years (however, it should be noted that because of the presence of a large hatchery fall chum production program in Hood Canal, the recruits per spawner estimates may have been inflated by the assignment of an undefined portion of the large hatchery returns to the natural recruitment estimate when the runs were reconstructed). Given the above observations, the productivity threshold of 1.6 recruits per spawner for Hood Canal/Strait of Juan de Fuca summer chum appears to be within a reasonable range.

Interim Recovery Goals' Criteria for Abundance, Spawning Escapement and Productivity

Recovery goals are defined for the individual stocks and the ESU. In each case, there is one recovery goal that links abundance, escapement and productivity together under a set of criteria that must be met for the recovery goal to be achieved. All references to mean values are to arithmetic means.

Individual Stocks

For each stock, all of the following criteria must be met:

1) The mean natural origin abundance and mean natural origin spawning escapement of each stock shall meet or exceed the above-described abundance and spawning escapement thresholds, over a period of the most recent 12 years.
2) The natural origin abundance and natural origin spawning escapement of each stock shall be lower than the stock's respective critical thresholds (or, where applicable, minimum escapement flag)[2] in no more than 2 of the most recent 8 years and, additionally, in no more than 1 of the most recent 4 years.
3) Natural recruits per spawner shall average at least 1.6 over the 8 most recent brood years for which estimates exist and no more than 2 of the 8 years shall fall below 1.2 recruits per spawner.

The ESU

No less than the extant 6 Hood Canal natural stocks and 2 Strait natural stocks must meet all the individual stock recovery criteria. The corollary to this criterion is that, on average, the ESU-wide abundance must meet or exceed the sum of all these individual stock thresholds and the

[1] Six populations were from Canada, one from Alaska (Myers et al. 1995).

[2] Critical abundance and escapement thresholds have been defined for all management units in the SCSCI that except for the mainstem Hood Canal management unit are currently equivalent to individual stocks. Minimum escapement flags have been described for individual stocks of the mainstem Hood Canal management unit (see Appendix 1.5 of SCSCI for description of the critical thresholds, minimum escapement flags and their derivation).

ESU-wide spawning escapement must meet or exceed the sum of all these individual stock escapement thresholds; also, on average, the ESU-wide productivity must meet or exceed 1.6 recruits per spawner.

Appendix C describes the current status of the summer chum salmon stocks relative to the above first "Individual Stocks" criterion (i.e., the criterion applicable to minimum mean abundance and escapement over a 12-year period). The appendix shows that this criterion is not currently being met by any stock except Union. The Union stock, while meeting this first criterion, does not however meet the other two "Individual Stocks" criteria. In fact, it is not yet possible for it to meet the productivity (third) criterion because that criterion requires a minimum 8 years of recruits per spawner estimates averaging at least 1.6, and age data that would allow such estimates to be made have only recently begun to be collected. All stocks are presently constrained by the time requirements of the productivity criterion.

DIVERSITY INTERIM RECOVERY GOALS

Diversity of summer chum salmon is controlled by genetics and habitat, and is manifested by variations in geographic distribution, behavior, morphology and other characteristics. It is reflected in the number and distribution of stocks, and in the expression of multiple life history pathways accommodated by habitat condition. We believe that diversity has decreased owing to the loss and reduced quality of habitat (section 3.4 of SCSCI). It has also been diminished by the recent population declines of summer chum salmon, primarily through the extinction of stocks (see section 1.7.2 of SCSCI) but also potentially by the reduced size of populations. Population size reduction, from historical levels, may have resulted in a decreased distribution within watersheds and nearshore areas, and this reduction in the range of habitats used may have also decreased the currently available life history pathways. The risk of losing genetic diversity also increases with smaller population sizes. (See McElhany et al. 2000 for more in-depth discussion of diversity.)

The SCSCI includes provisions intended to protect and restore diversity of the summer chum salmon. These provisions include programs to reintroduce summer chum salmon into watersheds where the stocks have become extinct and to supplement critically low populations. Criteria and procedures for selecting and operating reintroduction and supplementation projects have been identified and are being implemented (Section 3.2 of SCSCI). These criteria and procedures are intended to minimize the risks of reducing diversity within and between stocks. A qualitative assessment of summer chum salmon habitat has also been completed in the watersheds and nearshore areas, and recommendations have been made for restoring watershed functions and increasing habitat complexity; that is, to improve habitat conditions supportive of population diversity (section 3.4 of SCSCI). Finally, the Co-managers have developed a Base Conservation Regime to control harvest and help rebuild the summer chum salmon populations and their diversity (Section 3.5 of SCSCI).

In addition to the above ESU-wide interim recovery goal provision that all currently extant stocks meet individual stock recovery criteria, the Co-managers have agreed upon the following goals to protect and increase population diversity of the summer chum salmon:

1) Support planning and implementation of effective habitat protection and recovery actions by the agencies and local governments who have the jurisdiction (see section 3.4.6 of SCSCI).
2) Rebuild by natural or artificial (i.e., supplementation) means, under the guidelines, criteria and provisions of the SCSCI, the existing summer chum salmon stocks to meet their abundance and escapement recovery goals.

3) Reestablish by natural or artificial (i.e., recolonization or reintroduction) means and under the guidelines, criteria and provisions of the SCSCI, the majority of the identified extinct summer chum salmon stocks, where feasible.

MONITORING AND EVALUATION

The use of recovery goals requires monitoring and evaluation. Annual catches and escapements need to be monitored to show progress toward and ultimately attainment of the abundance and escapement recovery goals. Adipose fin-clips and otolith marks of summer chum salmon should be sampled to distinguish natural origin recruits of selected stocks. Monitoring should also include genetic sampling to track any changes in genetic diversity of populations over time. Monitoring also measures success and failure of supplementation and reintroduction programs, and the effects of those programs on diversity.

Provisions for monitoring and evaluation required to implement summer chum salmon recovery and to address recovery goals are included in the SCSCI. Most of the specified monitoring and assessment actions described in the SCSCI relate directly or indirectly to accomplishing and measuring progress toward the recovery goals. These actions are summarized in Table 4.6 of the SCSCI (pages 367 to 371) and include reference to sections of the SCSCI where the specific actions are described in more detail. However, in addition to those actions, there should be studies to quantitatively evaluate habitat conditions relative to summer chum populations in the watersheds and estuaries. Such studies should provide the basis for assessment and possible revision of the current interim recovery goals. The Co-managers are making progress in carrying out the recommended monitoring provisions of the SCSCI as described in follow-up reports. Monitoring activities in 1999 and 2000 are described in the 2000 annual report (WDFW and PNPT Tribes 2001) and are updated in the annual report for 2001 and 2002 returns (WDFW and PNPT Tribes 2003).

As mentioned previously, in response to questions that arose about use of outlier data to estimate the abundance and spawning escapement thresholds for recovery (see page 5 and Appendix A), the Co-managers have agreed to assess the productivity and capacity of the Quilcene and Lilliwaup watersheds and estuaries. This assessment is to be completed in time for reevaluation of the interim recovery goals of the Quilcene and Lilliwaup stocks, as part of the five-year summer chum plan review in 2005 (the five-year review is specified in section 3.6 of the Summer Chum Salmon Conservation Initiative).

SUMMARY OF INTERIM RECOVERY GOALS

The interim natural-origin-recruit recovery goals for abundance, escapement, productivity and diversity are listed in the following table. These recovery goals are based on currently available limited information with the expectation that they may be revised as additional information is generated. However, given the available information, the Co-managers believe that these interim recovery goals provide effective initial targets to use in managing for recovery and that by meeting the goals, the risk of extinction will be reduced and the stocks will become more resilient while moving toward healthy abundance levels.

Parameters	Interim Recovery Goals
Abundance, Spawning Escapement and Productivity	**<u>Individual Stocks</u>** For each stock, all of the following criteria must be met: 1) The mean natural origin abundance and mean natural origin spawning escapement of each stock shall meet or exceed the below-listed abundance and escapement thresholds, over a period of the most recent 12 years. 2) The natural origin abundance and natural origin spawning escapement of each stock must be lower than the respective stock's critical thresholds (or, where applicable, minimum escapement flag)[1] in no more than 2 of the most recent 8 years and, additionally, in no more than 1 of the most recent 4 years. 3) Natural recruits per spawner shall average at least 1.6 over the 8 most recent brood years for which estimates exist and no more than 2 of the 8 years shall fall below 1.2 recruits per spawner. **<u>The ESU</u>** No less than the extant 6 Hood Canal natural stocks and 2 Strait natural stocks must meet all the individual stock recovery criteria. The corollary to this criterion is that, on average, the ESU-wide abundance must meet or exceed the sum of the individual stock thresholds and the ESU-wide escapement must meet or exceed the sum of individual stock escapement thresholds; also, on average, the ESU-wide productivity must meet or exceed 1.6 recruits per spawner. **<u>Hood Canal Stock Thresholds</u>** Quilcene Abundance: 4,570 Escapement: 2,860 Dosewallips Abundance: 3,080 Escapement: 1,930 Duckabush Abundance: 3,290 Escapement: 2,060 Hamma Hamma Abundance: 6,060 Escapement: 3,790 Lilliwaup Abundance: 3,310 Escapement: 1,960 Union Abundance: 550 Escapement: 340 **<u>Strait Stock Thresholds:</u>** Salmon/Snow Abundance: 1,560 Escapement: 970 Jimmycomelately Abundance: 520 Escapement: 330
Diversity	In addition to the above ESU-wide interim recovery goal provision that all currently extant stocks meet individual stock recovery criteria, the Co-managers have agreed upon the following goals to protect and increase population diversity of the summer chum salmon: 1) Support planning and implementation of effective habitat protection and recovery actions by the agencies and local governments who have the jurisdiction. 2) Rebuild by natural or artificial means, (under the guidelines of the SCSCI) the existing summer chum salmon stocks to meet their abundance and escapement recovery goals. 3) Reestablish by natural or artificial (i.e., reintroduction) means (under the guidelines of the SCSCI) the selected extinct summer chum salmon stocks, where feasible.

[1] Critical abundance and escapement thresholds have been defined for all management units in the SCSCI that except for the mainstem Hood Canal management unit are currently equivalent to individual stocks. Minimum escapement flags have been described for individual stocks of the mainstem Hood Canal management unit (see Appendix 1.5 of SCSCI for description of the critical thresholds, minimum escapement flags and their derivation).

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APPENDIX A

DERIVATION OF INTERIM ABUNDANCE AND ESCAPEMENT RECOVERY THRESHOLDS OF THE HOOD CANAL AND STRAIT OF JUAN DE FUCA SUMMER CHUM SALMON STOCKS

Abundance (run size) and escapement thresholds are the basis for describing interim recovery goals for the summer chum salmon natural-origin-recruits of Hood Canal and Strait of Juan de Fuca. Available historical adult population data for the periods before the recent declines of the summer chum salmon provide the means for estimating these thresholds. Following is a description of the approach used to estimate the thresholds from these data.

BACKGROUND

The escapement database was previously reviewed and revised back to 1968 as part of the effort to develop the Summer Chum Salmon Conservation Initiative (see Supplemental Report No. 1 – Haymes 2000). An updated reconstruction of runsizes for the same period was also undertaken as part of the SCSCI planning. However, it was determined that the escapement and harvest data before 1974 and across all management units was of limited utility (section 1.4.6.1 of SCSCI). Therefore, the run reconstruction provided in the SCSCI was limited to the years following 1973 (Appendix A - Figures 1 and 2, Appendix A - Table 1). The present analysis is similarly restricted by not including data from years prior to 1974. Also, data from years following 1994 were not included in the analysis to avoid the influence of returns from supplementation (artificial production) projects, several of which began in 1992 and had initial adult returns (three-year-olds) in 1995. In fact, the year, 1994, also was not included to make an even number of twenty years for the symmetrical forward and backward analysis described below.

Within the SCSCI, runs were reconstructed for management units. Management units define areas of origin at the smallest level practical for relatively reliable run reconstruction and management of fisheries harvest. In all cases but one, these management units currently correspond to single stocks. The exception is the Mainstem Hood Canal Management Unit that includes four stocks, Dosewallips, Duckabush, Hamma Hamma and Lilliwaup. For the present purpose, it is assumed that the exploitation rate on each of these stocks is the same as for the Mainstem Management Unit, which allows runs to be reconstructed for the individual stocks. While this approach has enabled stock-specific run reconstruction, it includes the risk of inaccurately allocating the total Mainstem Management Unit run among the four stocks since individual stock returns may not be randomly mixed within the inshore fisheries, as this analysis assumed.

The present purpose is to develop abundance and escapement thresholds for individual stocks based on estimates of run sizes prior to the population declines. The first task is to determine when the population declines occurred. Assessment by regions show general declines of abundance and escapement occurring after 1978 and 1988 in Hood Canal and Strait of Juan de Fuca, respectively (Section 1.5 of SCSCI). However, these are approximated regional values that do not necessarily reflect when declines occurred for the individual stocks. The following analysis is used to estimate a statistically derived breakpoint between higher and lower abundance periods for each stock.

ANALYSIS TO DETERMINE BREAKPOINTS BY STOCK

Consideration of Outliers The first concern is with data outliers, that is, with data observations that are highly unusual either because of environmental circumstances for the specific stock and return year, or that may be reflecting a problem with the abundance estimate for the year. Assessment of outliers requires balanced judgment of apparent unusual data points since wide variations from the more usual data points may be part of a normal abundance distribution pattern that, with limited data, is difficult to perceive.

Box-and-whiskers plots of the abundance data for each stock, from 1974 through 1993 (20 years) have been used to initially display and help identify potential outliers (Appendix A - Figure 3). Each box-and-whiskers plot shows the median (dark horizontal line in the box) and the central 50% of the data (enclosed in the box). Each plot also shows the lowest and highest run sizes (indicated by the endpoints of the box whiskers) that are less than 3.0 box lengths from the edge of the box. Hoaglin et al. (1983) suggest that values more than three 3.0 box lengths from the edge of the box may be considered outliers; we, therefore use that criterion to identify high values as outlier candidates that are shown as asterisks in Appendix A - Figure 3. We recognize that by including in the Appendix A – Figure 3 display, the years following population declines, the lower values of those years will tend to magnify the appearance of potential outliers. However, because of the limited data before the declines, in Hood Canal especially, and to help focus on prospective outliers, we have used this approach here to help address the outlier question.

All stocks except Dosewallips, Duckabush and Salmon/Snow have at least one potential outlier as defined by the above criterion. The most distant potential outliers are shown for Quilcene, Lilliwaup and Union having values at approximately 6, 13 and 6 box lengths from the edge of their boxes, respectively. Three Hamma Hamma potential outliers are an approximate 4 box lengths from the edge of their box. The remaining potential outliers (Lilliwaup and Jimmycomelately) are just over 3 box lengths from the edge of their boxes.

The existence of so many potential outliers is likely due to the limited number of years of data, especially prior to population declines, and to the naturally variable nature of the summer chum populations. Recognizing this situation, members of the recovery goals technical workgroup agreed not to identify as outliers the indicated high values for Hamma Hamma, and Jimmycomelately, or the secondary high value for Lilliwaup. The workgroup has also agreed that the high Union value (year 1986) should be treated as an outlier and removed from its dataset. This outlier occurs in a 20-year data series in which there is no major decline in values.

However, we found it extremely difficult to reach consensus on whether or not the higher values observed for Quilcene and Lilliwaup (both in year 1976) should be treated as outliers. Our dilemma is due in part to both stocks having relatively few years (five) within the 20-year data series that occur before the major decline (see below). Briefly, the opposing points of view are summarized as follows: 1) The two high values should not be eliminated as outliers because they are part of a recurring pattern of high values that exist with Hood Canal summer chum and to eliminate the high values would ignore this natural occurrence. 2) The high values should be considered outliers because they are such extreme values in comparison to values of other years, and therefore should be eliminated on a statistical basis because of the extreme weight they exert on such a short dataset. The opposing views and arguments were more involved and complicated than presented here. However, in the end, the matter was resolved by agreement that the high values of Quilcene and Lilliwaup would not be treated as outliers, and therefore not eliminated from the process of determining the recovery thresholds, recognizing that this decision had been reached with difficulty. Additionally, it was agreed that the Co-managers commit to an assessment of the productivity and capacity of the Quilcene and Lilliwaup watersheds and estuaries to be completed in time for reconsideration of the outlier question as part of the five-year summer chum plan review in 2005 (the five-year review is specified in section 3.6 of the SCSCI).

Identifying Periods Prior To Population Decline, Forward Process The basic premise behind the forward methodology is that there was a period of abundance early in the time series that reflected relatively "good" conditions and abundances that can be realized during these "good" conditions. The problem is to objectively define the length of this period of "good" conditions.

Methodology: A sequential process was used to identify periods of equal length (in years) of consecutive years whose difference in mean abundances was maximized. The process used was:

1. Calculate the mean abundance for the 3-year period 1974-1976 and the mean abundance for the following 3-year period (1977-1979). Calculate the difference in mean abundances.
2. Lengthen the period used to calculate the means by one year and repeat the process; e.g., the next series would calculate the mean abundance for the 4-year period 1974-1977 and the mean abundance for the following 4-year period (1978-1981). Calculate the difference in mean abundances.
3. This process was repeated up to 10-year periods that encompassed the entire time series.
4. The period before decline was determined to be the period where the difference in mean abundance was greatest.

Results: The results of the Forward Process are summarized in Appendix A - Table 2.

Identifying Periods Prior to Population Decline, Backward Process The basic premise behind the backward methodology is similar to the Forward Process but instead of trying to identify the period of "good" conditions, we are now trying to identify the period of "poor" conditions present during the latter years of the time series. The use of this method is necessary if the decline breakpoint is suspected of having occurred more than 9 years after 1974, as in the case of the Strait of Juan de Fuca populations. We assume that at least the last several years in the time series (1992-1994) reflect "poor" conditions. By default, the comparative period immediately prior to the period of "poor" conditions has "good" conditions".

Methodology: A sequential process was used to identify periods of equal length (in years) of consecutive years whose difference in mean abundances was maximized. The process used was:

1. Calculate the mean abundance for the 3-year period 1991-1993 and the mean abundance for the preceding 3-year period (1988-1990). Calculate the difference in mean abundances.
2. Lengthen the period used to calculate the means by one year and repeat the process; e.g., the next series would calculate the mean abundance for the 4-year period 1990-1993 and the mean abundance for the preceding 4-year period (1986-1989). Calculate the difference in mean abundances.
3. This process was repeated up to 10-year periods that encompassed the entire time series.
4. The period before decline was determined to be the period where the difference in mean abundance was greatest.

Results: The results of the Backward Process are summarized in Appendix A - Table 3.

Selection of Breakpoints Appendix A - Table 4 summarizes the results. Results of the two methods may also be compared for each stock in Appendix A – Figures 4 through 10. For all stocks except two, the forward method identifies a greater maximum difference between the "good" and "poor" periods than the backward method. The exceptions, Salmon/Snow and Jimmycomelately in the Strait of Juan de Fuca, show greater maximum differences with the backward method. We therefore have adopted the breakpoints indicated by the forward method for the Hood Canal stocks and the breakpoints of the backward method for the Strait of Juan de Fuca stocks.

The breakpoint is defined as the last year of the "good" period of maximum difference for each stock. The resulting ranges of breakpoints for the stocks correspond approximately with the regional assessment (Section 1.5 of SCSCI) that showed general declines of abundance and escapement occurring after 1978 in Hood Canal and after 1988 in the Strait of Juan de Fuca. Note that the Union stock has not been included in the above analysis because it does not show a decline over the period of record (Appendix A - Figure 1).

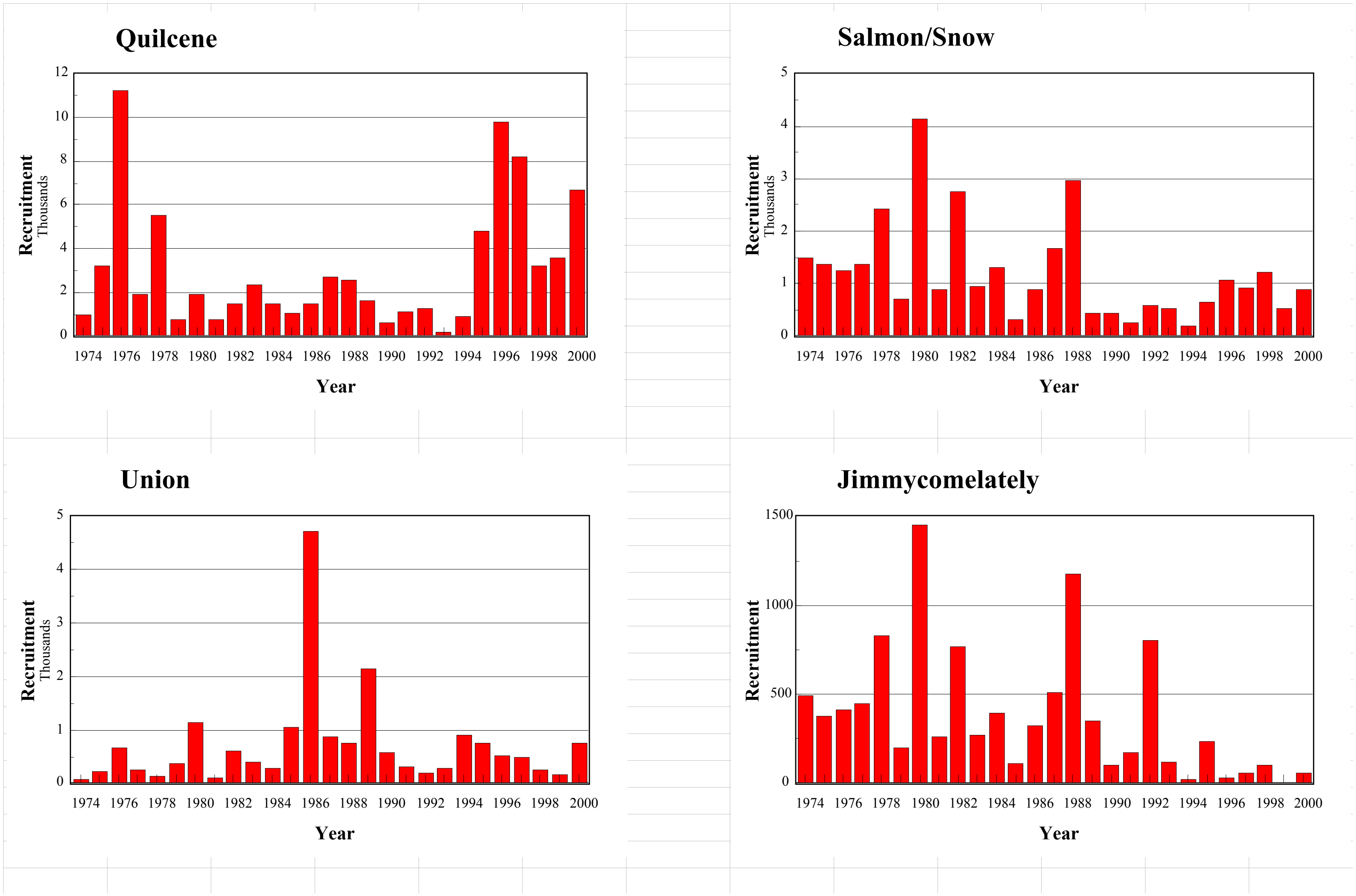
DETERMINATION OF ABUNDANCE AND SPAWNING ESCAPEMENT THRESHOLDS

The abundance threshold of each stock is simply the average abundance of the pre-decline years. The spawning escapement threshold is calculated by dividing the abundance threshold by the assumed recruit per spawner ratio of 1.6. This ratio corresponds to the productivity minimum threshold described in the body of the report. Appendix A - Table 5 describes the pre-decline mean abundance (abundance threshold), the standard error of that mean and the calculated spawning escapement threshold for each stock and the two regions. Because there was no decline of the Union population, the abundance threshold is calculated as the average abundance for the period, 1974 – 2000, excluding the outlier year, 1986. Note that, for this 1974 – 2000 time period, there were no supplementation returns to the Union River and thus no influence of adult returns from such a project on the Union River population.

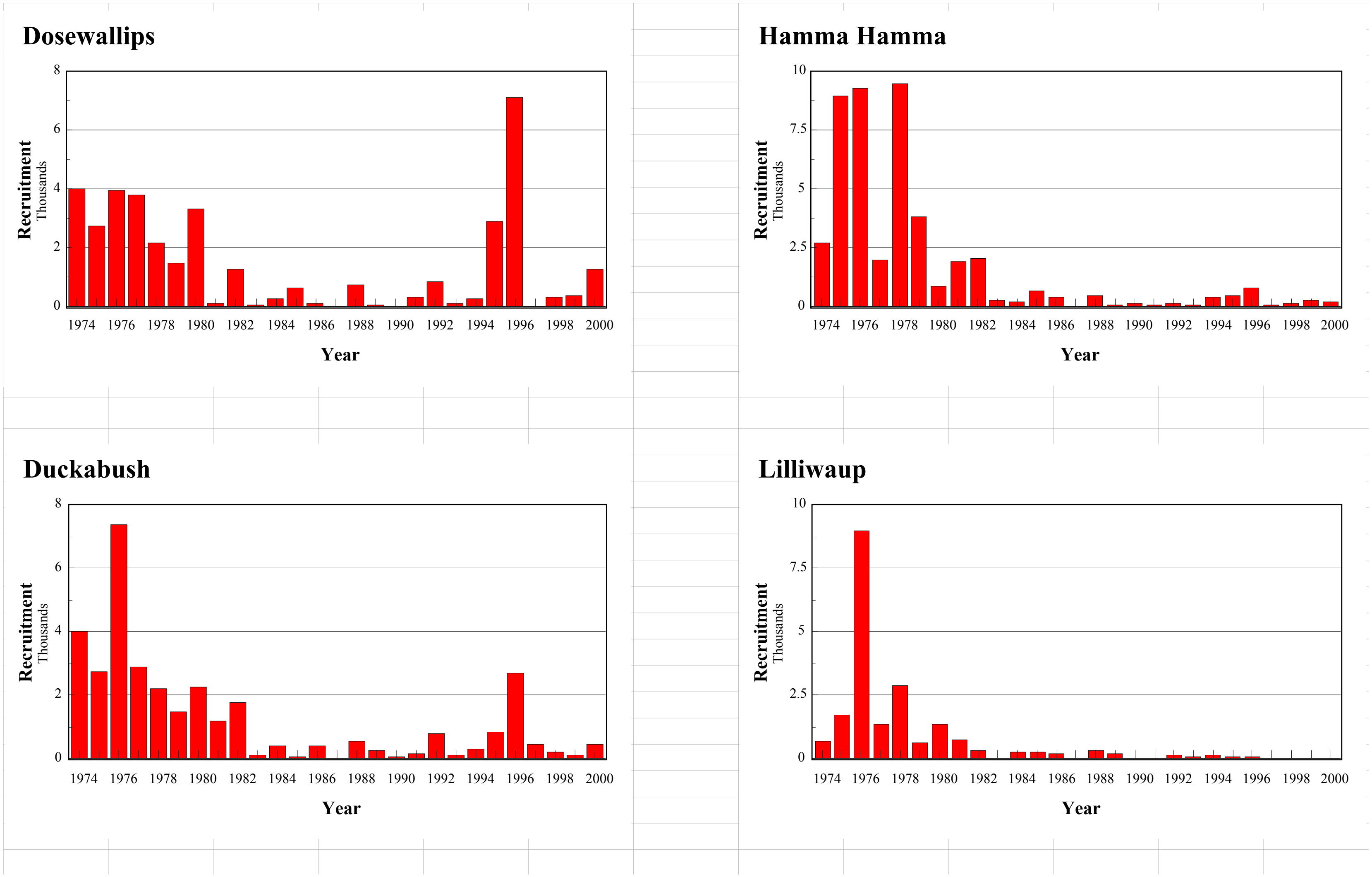
REFERENCES

Haymes, J. 2000. Revised Estimates of Escapement for Hood Canal and Strait of Juan de Fuca Natural Spawning Summer Chum Salmon Populations. Supplemental Report No. 1 to Summer Chum Salmon Conservation Initiative. 294 p.

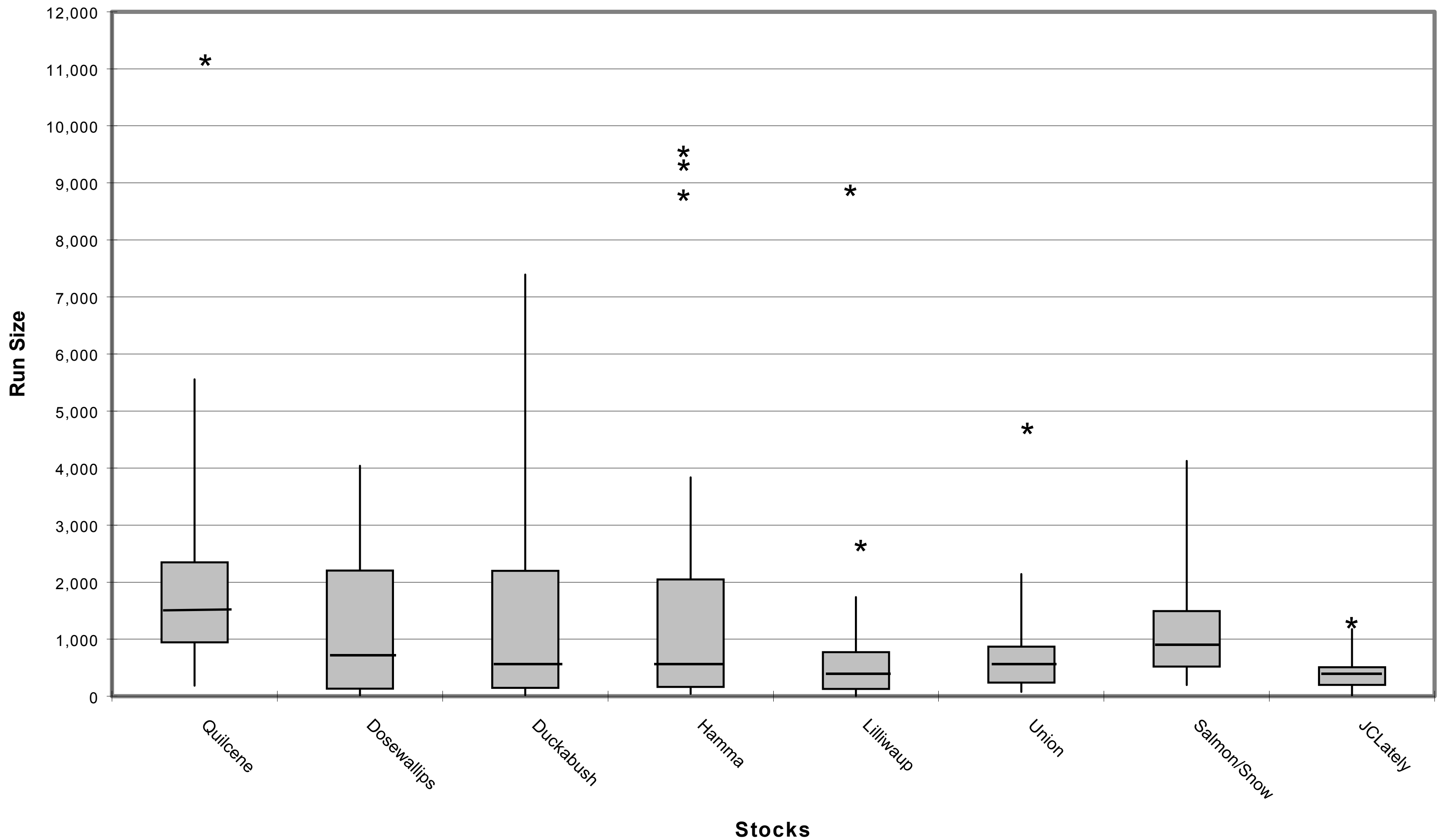
Hoaglin, D. C., F. Mosteller, and J. W. Tukey (editors). 1983. Understanding Robust and Exploratory Data Analysis. John Wiley and Sons, New York.



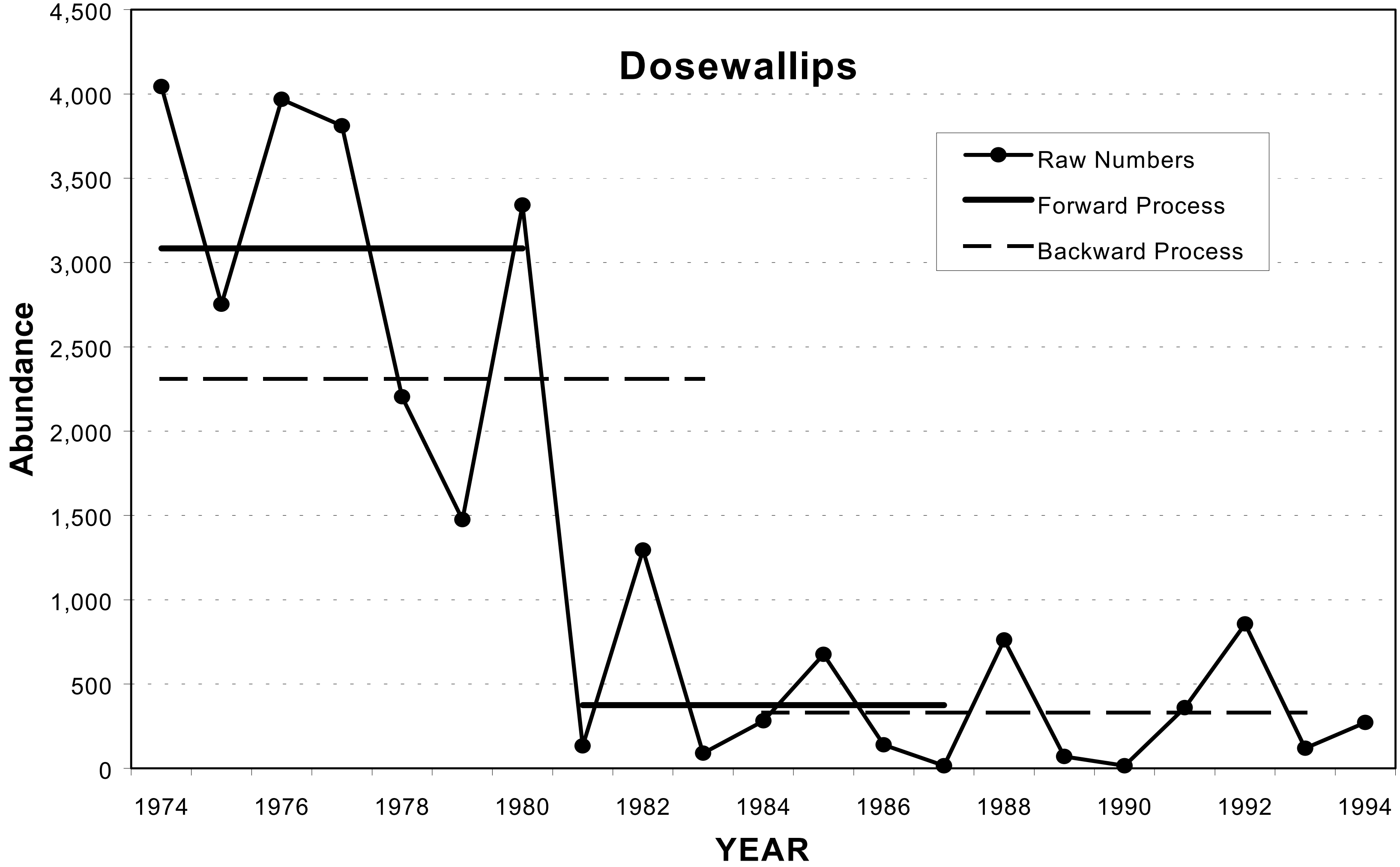
Appendix A – Figure 1. Historical abundances of Quilcene, Union, Salmon/Snow and Jimmycomelately summer chum salmon stocks, 1974 – 2000.



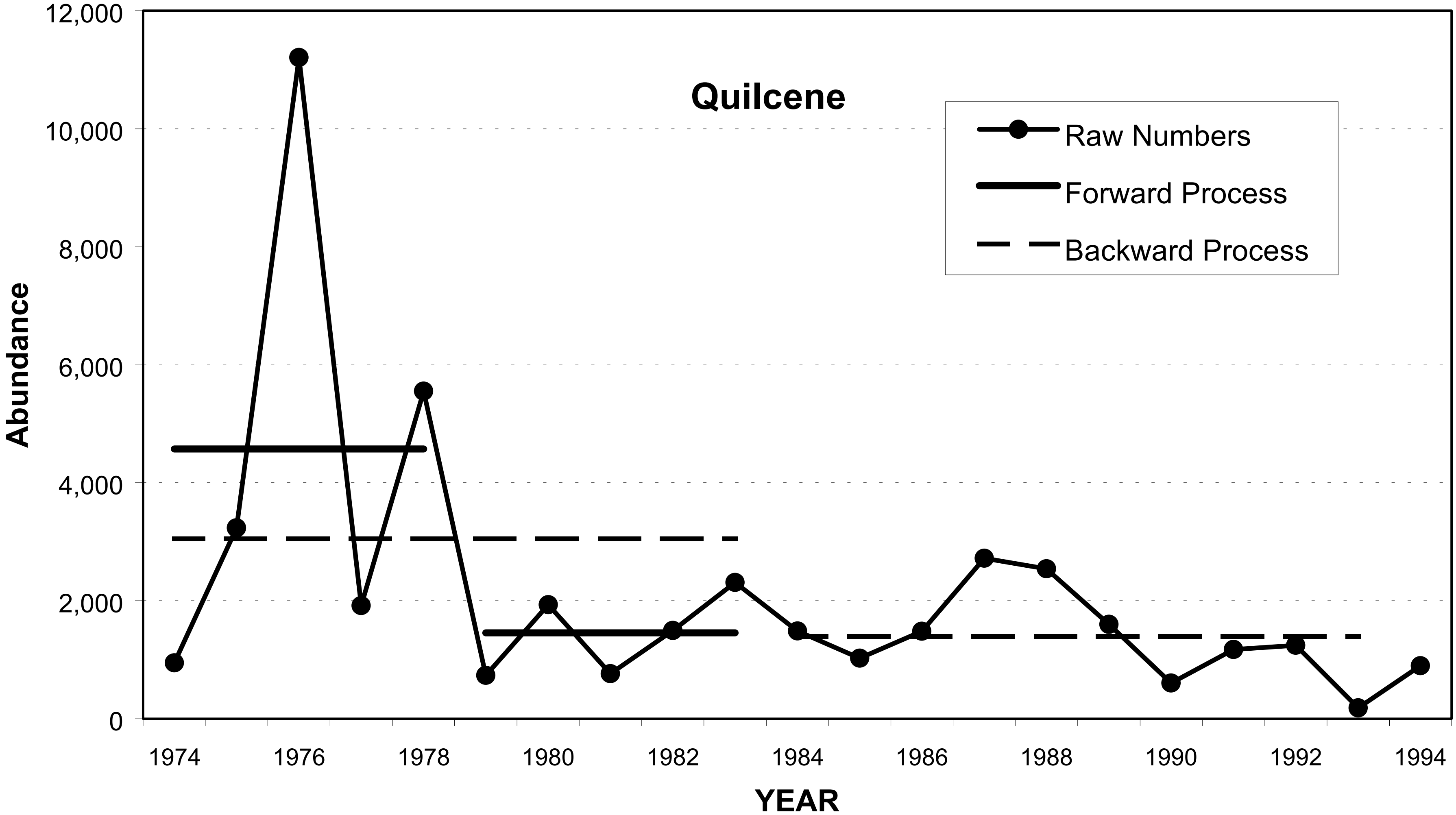
Appendix A – Figure 2. Historical abundances of Dosewallips, Duckabush, Hamma Hamma and Lilliwaup summer chum salmon stocks, 1974 – 2000.



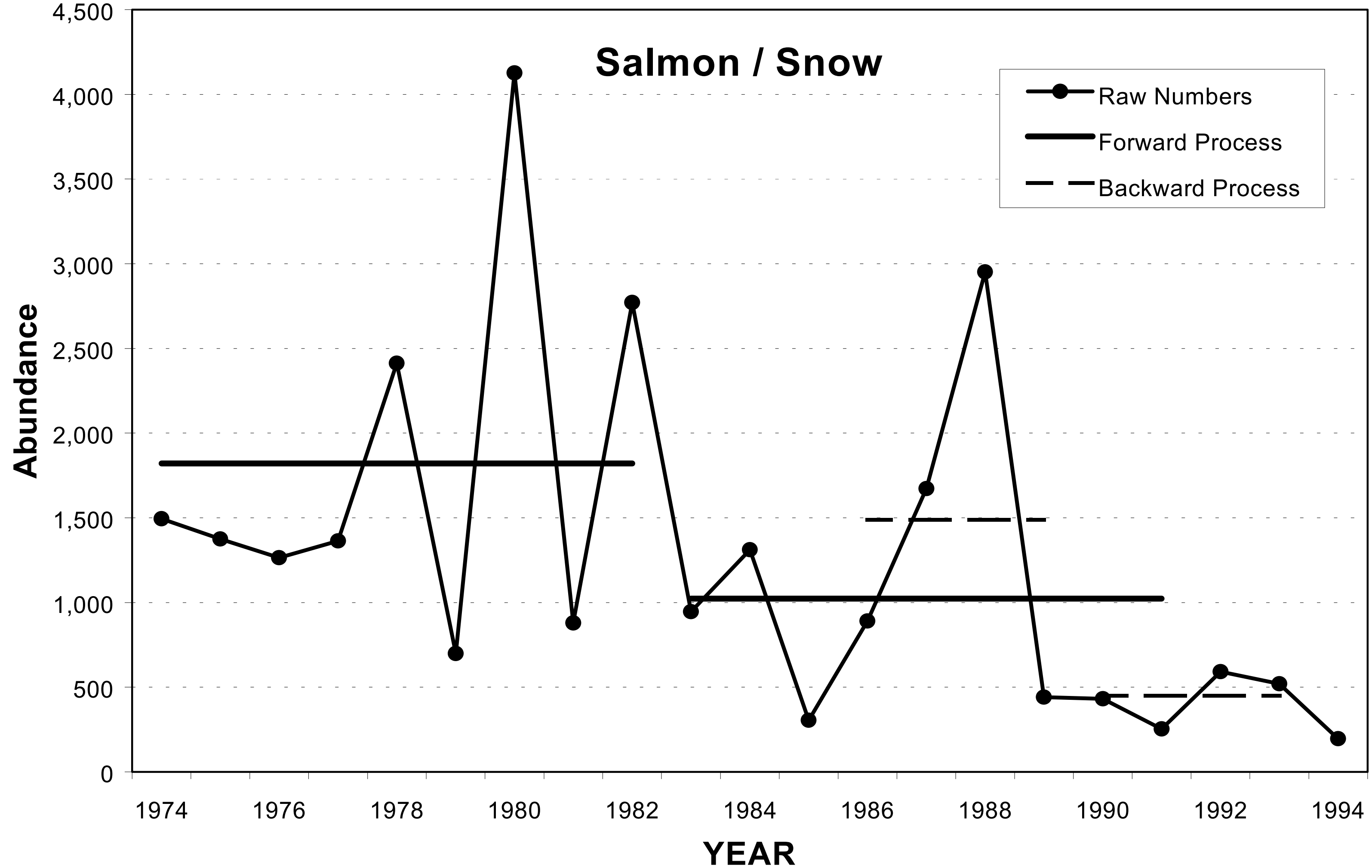
Appendix A - Figure 3. Box-and-whiskers plots of Hood Canal-Strait of Juan de Fuca summer chum abundance data (1974-1993) by stock.



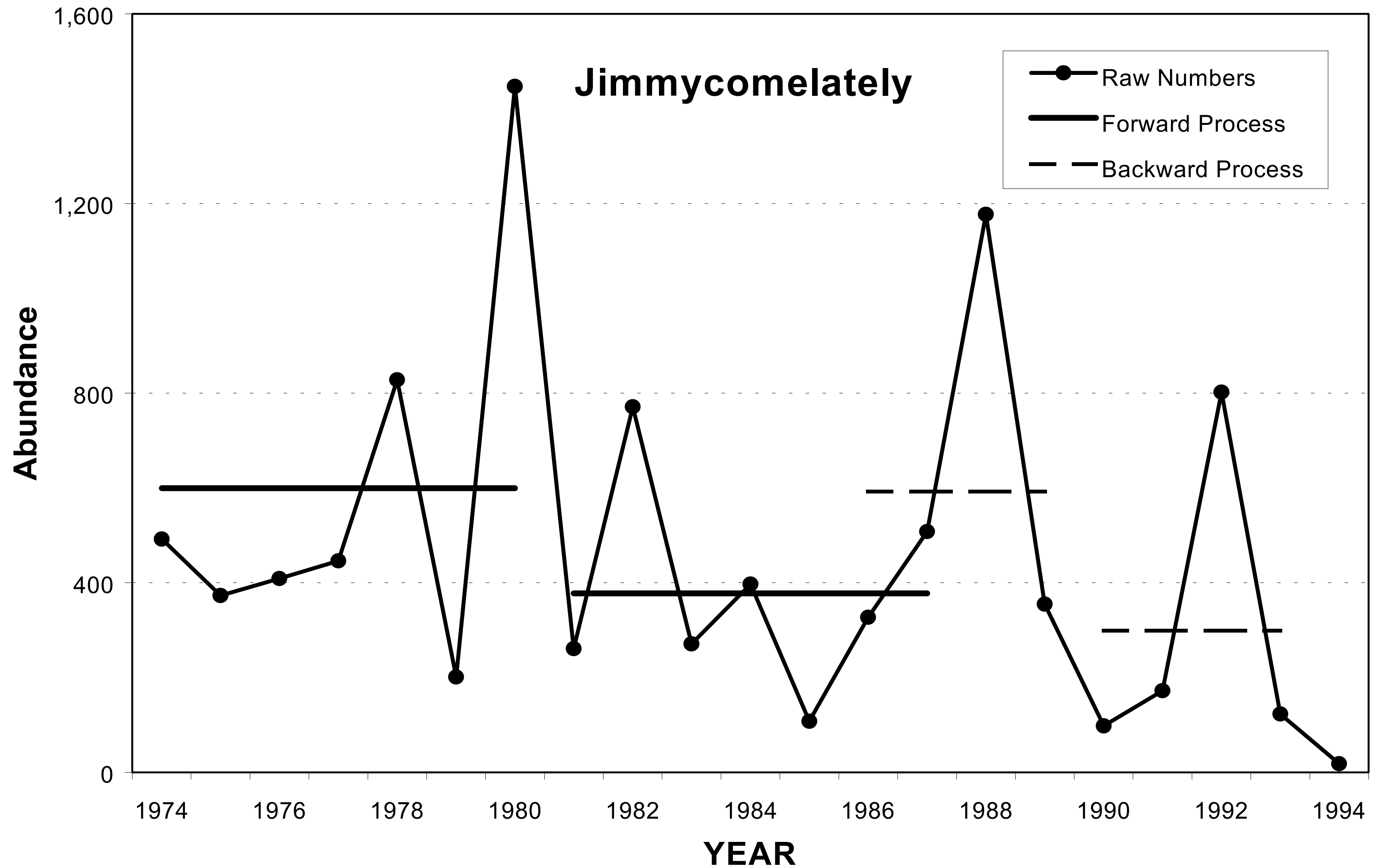
Appendix A – Figure 4. Dosewallips summer chum stock - comparison of mean abundances for "good" and "poor" periods at the maximum difference in mean abundance using the forward and backward methods. See explanation in text



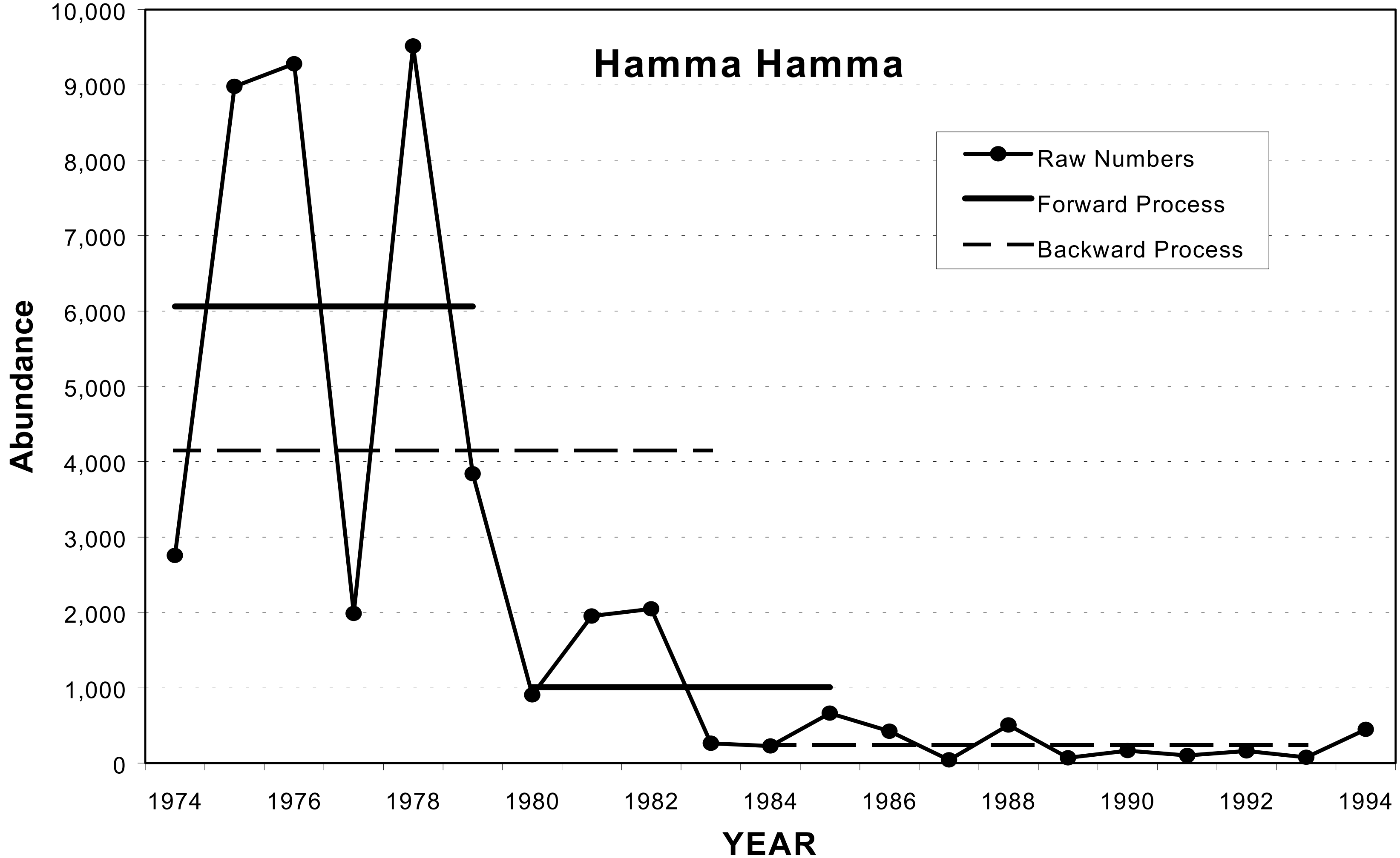
Appendix A – Figure 5. Quilcene summer chum stock (including outlier year, 1976) - comparison of mean abundances for "good" and "poor" periods at the maximum difference in mean abundance using the forward and backward methods. See explanation in text



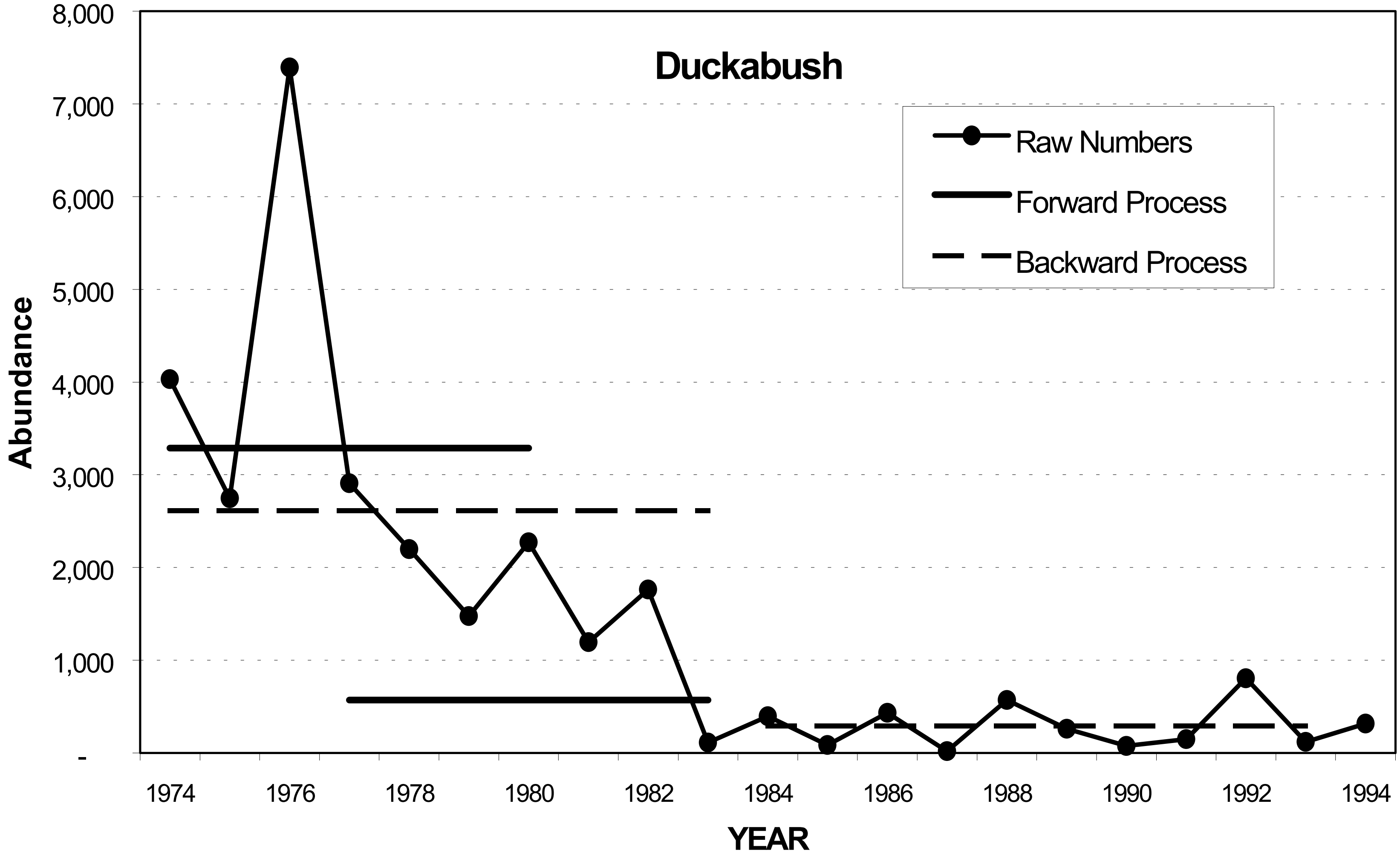
Appendix A – Figure 6. Salmon/Snow summer chum stock - comparison of mean abundances for "good" and "poor" periods at the maximum difference in mean abundance using the forward and backward methods. See explanation in text



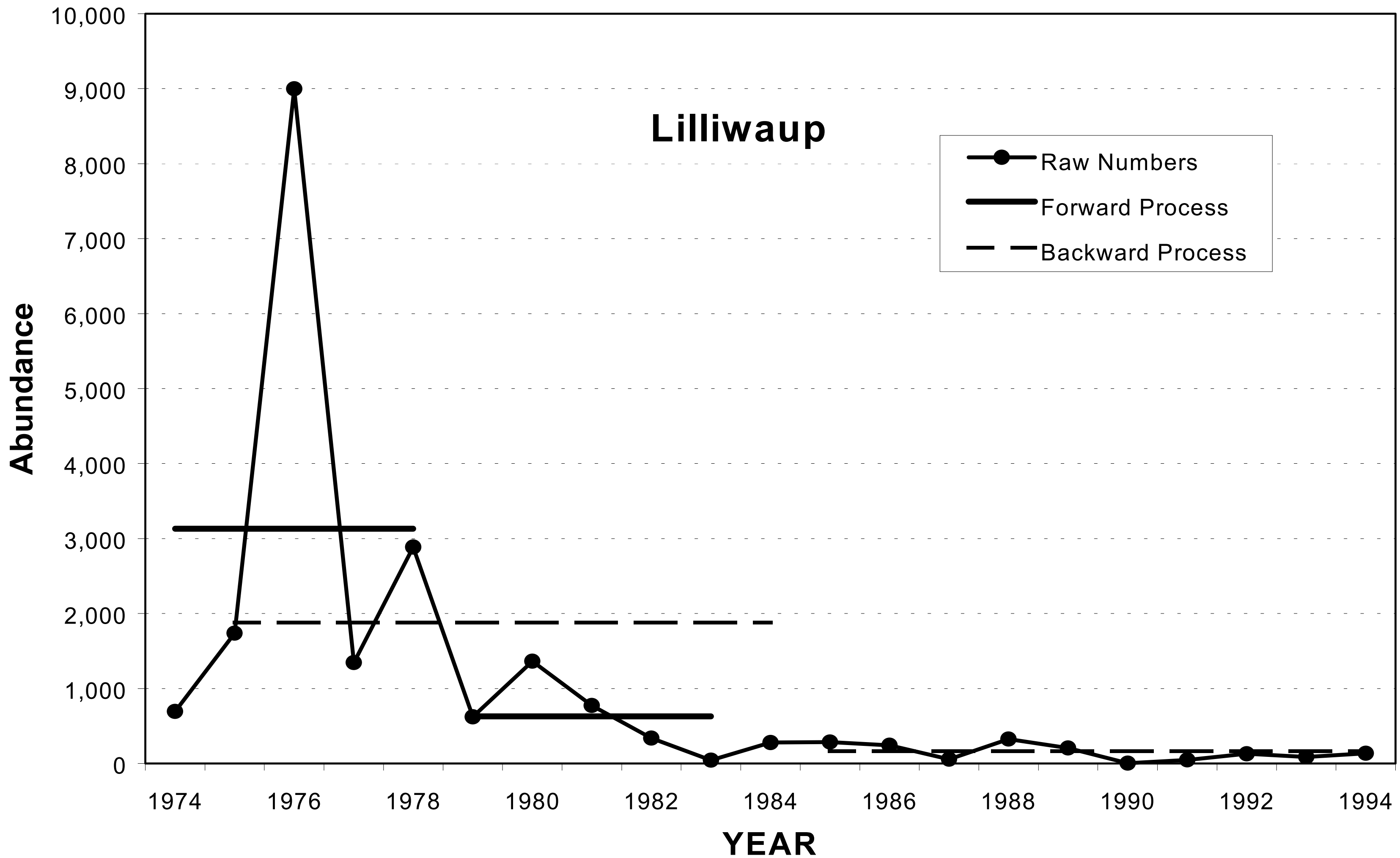
Appendix A – Figure 7. Jimmycomelately summer chum stock - comparison of mean abundances for "good" and "poor" periods at the maximum difference in mean abundance using the forward and backward methods. See explanation in text



Appendix A – Figure 8. Hamma Hamma summer chum stock - comparison of mean abundances for "good" and "poor" periods at the maximum difference in mean abundance using the forward and backward methods. See explanation in text



Appendix A – Figure 9. Duckabush summer chum stock (including outlier year, 1976) - comparison of mean abundances for "good" and "poor" periods at the maximum difference in mean abundance using the forward and backward methods. See explanation in text



Appendix A – Figure 10. Lilliwaup summer chum stock - comparison of mean abundances for "good" and "poor" periods at the maximum difference in mean abundance using the forward and backward methods. See explanation in text.

Appendix A – Table 1. Summer chum salmon abundance (run size) estimates by stock, 1974 –2002.

Year	Quilcene	Dosewallips	Duckabush	Hamma	Lilliwaup	Union	Salmon/Snow	JC Lately
1974	944	4,043	4,030	2,755	693	77	1,494	492
1975	3,235	2,752	2,746	8,979	1,737	214	1,374	373
1976	11,206	3,968	7,394	9,279	8,998	663	1,264	409
1977	1,918	3,811	2,908	1,986	1,345	242	1,364	446
1978	5,555	2,203	2,199	9,517	2,886	139	2,413	828
1979	734	1,475	1,476	3,839	622	370	699	201
1980	1,932	3,341	2,272	904	1,362	1,147	4,127	1,447
1981	761	133	1,174	1,952	772	108	878	261
1982	1,494	1,295	1,762	2,045	336	612	2,769	771
1983	2,351	89	112	265	42	396	946	271
1984	1,486	281	397	226	279	290	1,311	397
1985	1,025	674	86	660	286	1,038	303	108
1986	1,483	139	431	422	242	4,728	890	327
1987	2,722	15	19	42	56	870	1,673	508
1988	2,540	761	572	506	325	744	2,952	1,177
1989	1,599	70	261	70	205	2,142	441	355
1990	623	15	76	164	4	565	430	98
1991	1,174	360	147	102	45	313	253	172
1992	1,237	856	807	161	129	183	591	802
1993	183	118	118	78	87	283	520	123
1994	896	272	318	447	134	891	196	18
1995	4,830	2,939	870	502	83	760	647	234
1996	9,801	7,148	2,715	793	78	506	1,075	31
1997	8,199	48	487	107	32	493	923	62
1998	3,201	351	236	133	25	255	1,215	102
1999	3,554	381	100	277	14	173	532	7
2000	6,704	1,279	471	232	22	755	879	55
2001	7,595	1,007	958	1,248	94	1,516	2,811	262
2002	6,044	1,660	541	2,375	875	890	6,070	42

Appendix A – Table 2. Use of forward method to identify breakpoint between high and low abundance years. Numbers in bold show where the maximum difference in mean abundance occurs.

	Last yr. of first or "good" period (1974 to:	1976	1977	1978	1979	1980	1981	1982	1983
	# of Years in Series:	3	4	5	6	7	8	9	10
	Mean abund. for "good" period:	3,588	3,644	3,355	3,042	**3,085**	2,716	2,558	2,311
	Mean abund, for subsequent period:	2,496	1,788	1,267	969	**375**	416	267	329
Dosewallips	Difference:	-1,091	-1,856	-2,089	-2,073	**-2,710**	-2,300	-2,291	-1,982
	Mean abund. for "good" period:	5,128	4,326	**4,572**	3,932	3,646	3,286	3,087	3,013
	Mean abund, for subsequent period:	2,736	2,246	**1,454**	1,508	1,617	1,838	1,667	1,407
Quilcene	Difference:	-2,393	-2,080	**-3,117**	-2,424	-2,029	-1,448	-1,420	-1,606
	Mean abund. for "good" period:	1,377	1,374	1,582	1,435	1,819	1,702	**1,820**	1,733
	Mean abund, for subsequent period:	1,492	2,029	1,884	1,722	1,253	1,411	**1,022**	936
Salmon/Snow	Difference:	115	655	302	288	-566	-291	**-798**	-796
	Mean abund. for "good" period:	425	430	510	458	**599**	557	581	550
	Mean abund, for subsequent period:	492	684	590	543	**378**	489	379	407
Jimmycomelately	Difference:	67	254	81	84	**-222**	-68	-202	-143
	Mean abund. for "good" period:	7,004	5,750	6,503	**6,059**	5,323	4,901	4,584	4,152
	Mean abund, for subsequent period:	5,114	4,053	1,801	**1,009**	802	530	273	243
Hamma Hamma	Difference:	-1,890	-1,697	-4,702	**-5,051**	-4,521	-4,372	-4,311	-3,909
	Mean abund. for "good" period:	4,723	4,270	3,855	3,459	**3,289**	3,025	2,885	2,607
	Mean abund, for subsequent period:	2,194	1,780	1,359	967	**569**	455	233	291
Duckabush	Difference:	-2,529	-2,489	-2,496	-2,492	**-2,721**	-2,570	-2,651	-2,316
	Mean abund. for "good" period:	3,809	3,193	**3,132**	2,714	2,520	2,302	2,083	1,879
	Mean abund, for subsequent period:	1,618	1,411	**627**	513	288	221	165	166
Lilliwaup	Difference:	-2,192	-1,783	**-2,505**	-2,201	-2,233	-2,081	-1,919	-1,714

Appendix A – Table 3. Use of backward method to identify breakpoint between high and low abundance years. Numbers in bold show where the maximum difference in mean abundance occurs.

	Last yr. of "good" period (1st year in series to:	1990	1989	1988	1987	1986	1985	1984	1983
	# of Years in Series:	3	4	5	6	7	8	9	10
	Mean abund. for "good" period:	282	246	374	416	850	1,186	1,844	**2,311**
	Mean abund, for subsequent period:	445	337	284	363	314	292	334	**329**
Dosewallips	Difference:	163	91	-90	-52	-537	-895	-1,510	**-1,982**
	Mean abund. for "good" period:	1,587	2,086	1,851	1,760	1,505	1,917	**3,049**	3,013
	Mean abund, for subsequent period:	865	804	963	1,226	1,440	1,445	**1,398**	1,407
Quilcene	Difference:	-723	-1,282	-888	-534	-65	-472	**-1,650**	-1,606
	Mean abund. for "good" period:	1,274	**1,489**	1,426	1,315	1,603	1,681	1,752	1,733
	Mean abund, for subsequent period:	455	**449**	447	865	980	969	895	936
Salmon/Snow	Difference:	-820	**-1,041**	-979	-451	-623	-712	-858	-796
	Mean abund. for "good" period:	543	**592**	503	397	512	536	559	550
	Mean abund, for subsequent period:	366	**299**	310	455	462	445	408	407
Jimmycomelately	Difference:	-178	**-293**	-193	58	-50	-90	-151	-143
	Mean abund. for "good" period:	247	260	371	610	925	2,426	3,335	**4,152**
	Mean abund, for subsequent period:	114	126	115	180	160	193	245	**243**
Hamma Hamma	Difference:	-133	-134	-256	-430	-764	-2,233	-3,090	**-3,909**
	Mean abund. for "good" period:	303	321	301	468	891	1,185	2,188	**2,607**
	Mean abund, for subsequent period:	357	287	282	330	286	304	280	**291**
Duckabush	Difference:	54	-34	-19	-138	-605	-881	-1,909	**-2,316**
	Mean abund. for "good" period:	178	207	238	207	474	823	1,849	**1,879**
	Mean abund, for subsequent period:	87	66	94	133	122	137	153	**166**
Lilliwaup	Difference:	-91	-141	-144	-74	-353	-687	-1,696	**-1,714**

Appendix A – Table 4. Summary of results using forward and backward methods.

	FORWARD METHOD		BACKWARD METHOD	
Stock	"Good" Period	Maximum Mean Population Diff. Between Periods	"Good" Period	Maximum Mean Population Diff. Between Periods
Dosewallips	1974-1980	2,710	1974-1983	1,982
Quilcene	1974-1978	3,117	1974-1984	1,650
Salmon/Snow	1974-1982	798	1986-1989	1,041
Jimmycomelately	1974-1980	222	1986-1989	293
Hamma Hamma	1974-1979	5,051	1974-1983	3,909
Duckabush	1974-1980	2,721	1974-1983	2,316
Lilliwaup	1974-1978	2,505	1974-1983	1,714

Appendix A – Table 5. Mean abundance and standard error of the mean for each stock prior to population declines. Also shown is the spawning escapement projection based on mean abundance of each stock.

	Quilcene	Dosewallips	Duckabush	Hamma	Lilliwaup	Union	Salmon/Snow	JCLately
Time Span Prior to Decline*	1974-1978	1974-1980	1974-1980	1974-1979	1974-1978	1974-2000	1974-1989	1974-1989
Mean Abundance**	4,571	3,085	3,289	6,059	3,132	548	1,556	523
Std. Error of Mean	1,830	371	746	1,452	1,509	176	257	91
Projected Escapement***	2,857	1,928	2,056	3,787	1,957	342	973	327

* Time spans begin with 1974 but end prior to population decline as described in text.

** The mean abundance and escapement estimates for Union do not include the outlier year 1986. Mean abundance estimates for Quilcene and Lilliwaup are qualified pending future review of outliers in the respective datasets. See "Consideration of Outliers" on page 14.

*** Each mean abundance is divided by the recruit per spawner ratio of 1.6 to arrive at the escapement value. See "Determination of Abundance and Spawning Escapement Thresholds" on page 16.

APPENDIX B

RELATIONSHIP OF ESCAPEMENT RECOVERY THRESHOLDS TO POPULATION EXTINCTION RISK CRITERIA

The thresholds for escapement of the Union and Jimmycomelately stocks are equivalent to levels of escapement that indicate a moderate risk of extinction using the methodology described in section 1.7.4 of the SCSCI (following the methods of Allendorf et al. 1997). The threshold values of the other summer chum stocks exceed the extinction risk criteria, indicating low risk. The following estimates of total escapement population size per generation (N) and effective population size (N_e) have been calculated as shown using the escapement threshold values for the Union and Jimmycomelately stocks (note that the value 3.6 represents the estimated length of a generation for summer chum salmon and the value 0.2 represents the assumed ratio of the effective population to the total population of summer chum salmon; see section 1.7.4 of SCSCI).

Union:	Total population per generation = 340 x 3.6 = 1,224
	Effective population size = 340 x 3.6 x 0.2 = 245
Jimmycomelately:	Tot. population per generation = 330 x 3.6 = 1,188
	Effective population size = 330 x 3.6 x 0.2 = 238

The methodology of the SCSCI specifies that a population is at moderate risk of extinction if the total escapement population per generation is less than 2,500 or if the effective population size is less than 500. So, by this assessment, the average annual escapement at the threshold level of the Union and Jimmycomelately stocks would indicate moderate risk of extinction. However, the applicable assessment criteria, based on population size, were established to protect against potential genetic and demographic risks, on theoretical grounds. It is possible for a summer chum salmon population, of average size less than the population criteria, to exist naturally and historically as a function of the amount and quality of habitat in its watershed. Risks associated with the small population size would still exist but, under the circumstances, may be understood and even accepted. However, acceptance should be tempered by (1) our current lack of knowledge regarding the quantitative relationship of habitats to summer chum population sizes and (2) considering the potential that population declines, associated with historical Euro-American impacts on habitat, may have occurred before the period of record.

The escapement thresholds for all the summer chum stocks, including Union and Jimmycomelately, are based on available population data prior to any recent population declines as described in the Background section of Appendix A. While two of the recovery escapement thresholds fall within the category of moderate risk of extinction as described above, the interim recovery goals upon which the thresholds are based, point to recovery, at least at population levels that existed before any recent declines, and they can be modified as new information and assessments become available.

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APPENDIX C

CURRENT STATUS OF HOOD CANAL AND STRAIT OF JUAN DE FUCA SUMMER CHUM SALMON STOCKS RELATIVE TO THE ABUNDANCE/SPAWNING ESCAPEMENT THRESHOLD CRITERION

One criterion for recovery is that a summer chum stock must, over a minimum of twelve years, have both a mean abundance and a mean spawning escapement of natural-origin recruits that meet or exceed defined abundance and spawning escapement thresholds (the population must also meet other recovery criteria as described in the main body of the report). The question then arises as to how the current status of the stocks' abundance and spawning escapement would compare to the respective recovery thresholds. To answer the question, the following table has been prepared; it describes the recent twelve-year period (1991-2002) of mean abundance and mean escapement by stock in comparison to the stock's abundance and escapement thresholds.

Stock	91-02 Mean Abundance	Abundance Threshold	91-02 Mean Escapement	Escapement Threshold
Hood Canal				
Quilcene[1]	4,452	4,570	3,892	2,860
Dosewallips	1,368	3,080	1,301	1,930
Duckabush	647	3,290	608	2,060
Hamma Hamma[1]	538	6,060	513	3,790
Lilliwaup[1]	135	3,130	126	1,960
Union	585	550	538	340
Strait				
Salmon/Snow[1]	1,307	1,560	1,271	970
Jimmycomelately[1]	159	520	137	330

[1] Mean abundance and escapement likely include both hatchery and natural origin recruits.

The table shows that except for the Quilcene, Union and Salmon/Snow stocks, no stock has a twelve-year mean abundance or mean escapement that exceeds its respective thresholds. The mean escapements of Quilcene and Salmon/Snow exceed their respective thresholds while the mean abundances are below their thresholds. Both the Union's mean abundance and mean escapement exceed their thresholds and thus Union meets the abundance/escapement recovery criterion. It is apparent that, with the exceptions of Quilcene, Union and Salmon Snow, no other stock is close to either its abundance or escapement thresholds.

The abundance and escapement estimates, used to calculate the means for the asterisked stocks in the above table, likely include summer chum returns from supplementation as well as natural production. The Quilcene, Lilliwaup and Salmon/Snow stocks, with supplementation programs beginning in 1992, would be expected to have had supplementation returns for eight of the twelve years on which the calculated means are based (assuming the first returning adults are three-yearold fish). Hamma Hamma would have had supplementation returns in three of the twelve years (program began in 1997) and Jimmycomelately in one of the twelve years (program started in 1999). It is reasonable to assume, given the large increase in summer chum returns that began in 1995 (the first year of supplementation returns) for Quilcene and Salmon/Snow, that these two stocks exceed the escapement threshold because of the supplementation contributions (and, in fact, mark-recovery data indicate a large proportion of the returns are supplementation-origin fish – see WDFW and PNPTT 2001, 2003).

Marking programs have been initiated for all supplemented fish (including the more recent supplementation and reintroduction projects in the Union, Chimacum and Big Beef watersheds) that will allow separation of returns by natural and hatchery origin. This information will be required to separate natural origin recruits for review of abundances and escapements relative to the thresholds as specified by the aforementioned recovery goal criterion. In the mean time, the above table indicates that, even including the contribution of supplementation programs to adult returns, the recovery goal abundance and escapement criterion (that requires both the abundance and escapement thresholds be exceeded by the 12-year means) is not currently being met by any stock except Union.

References

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