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PACIFIC SALMON COMMISSION
JOINT CHUM TECHNICAL COMMITTEE REPORT

REPORT TCCHUM (88)-2

PROGRESS REPORT ON GENETIC STOCK IDENTIFICATION OF CHUM SALMON IN SOUTHERN BRITISH COLUMBIA AND WASHINGTON

February 14, 1988

EXECUTIVE SUMMARY

The Pacific Salmon Commission has assigned the Chum Technical Committee the task of developing estimates of the stock composition of catches of chum salmon in intercepting fisheries in southern British Columbia and Washington. The progress that the Chum Technical Committee has made on this assignment is summarized below.

- A review program has been initiated to evaluate the differences in the statistical techniques used by Canada and Washington.

- The sampling programs conducted in 1986 were evaluated. Sampling programs for the west coast Vancouver Island troll fishery and the United States San Juan Islands net fishery were determined to not be adequate to estimate the stock composition of the catch in these fisheries.

- The Washington baseline data base has been enhanced with the addition of several stocks and resampling of all major stocks.

- An interim joint baseline data base was developed. The committee could not agree that the joint baseline produced estimates with an acceptable level of bias.

- A series of recommendations were made regarding the steps needed to arrive at joint estimates of the stock composition of the catch.

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INTRODUCTION

In November of 1986, the Pacific Salmon Commission first assigned the Chum Technical Committee the task of estimating the stock composition of catches of chum salmon in intercepting fisheries in southern British Columbia and Washington. The Commission identified the following components of that task:

1) Attempt to develop agreed-upon criteria and methods for the application of currently available genetic stock identification (GSI) data to catch data;

2) Evaluate and develop recommendations for standardization of GSI sampling, processing, and analysis methods;

3) Apply the above methodology to catch data for the fisheries for which adequate GSI data are available.

Progress on this assignment was initially reported by the Chum Technical Committee in a report issued in February of 1987 (TCCHUM 8702). Included in that report were a number of recommendations regarding the steps necessary to complete the assignment from the Commission. The recommendations of greatest priority were subsequently identified as:

1) Review and evaluate the alternative statistical methods to estimate stock composition from GSI data.

2) Evaluate the sampling design of commercial and test fisheries;

3) Enhance the Washington baseline and develop a joint Canada/United States (U.S.) baseline;

This report summarizes progress made by the Chum Technical Committee on each of these recommendations, problem areas encountered, work remaining to be completed, and recommendations for additional work.

Although some progress has been made on several components of the task assigned by the Commission, we are not able to provide mutually acceptable estimates of catch contributions at this time.

PROGRESS ON ASSIGNED TASKS

The progress to date on the assigned tasks is summarized below.

1) Different models are used in Washington and Canada to estimate stock composition from GSI data. Representatives from the CDFO (Canadian Department of Fisheries and Oceans) and the WDF (Washington Department of Fisheries) have undertaken the task of determining the consistency of the point and variance estimates produced by these models.

2) The review of the 1986 fishery sampling programs indicated that obtaining representative samples from large, dispersed fisheries is a difficult task. In particular, samples from the U.S. San Juan Islands commercial net fishery and the WCVI troll fishery in 1986 did not provide data which could be used to estimate the stock composition of the catch of those fisheries. Additional attention must be given to developing effective means to sample the catch from all fisheries.

   The following table summarizes the adequacy of sampling programs in 1986.

	Adequate	Not Adequate	Unresolved
BRITISH COLUMBIA			
Johnstone Strait (Areas 12,13)			X
Qualicum (Area 14)	X		
Nitinat (Area 21)	X		
WCVI Troll (Areas 111,127)		X	
WASHINGTON			
Western Juan de Fuca (4B,5,6C)	X		
San Juan Islands (Areas 7,7A)		X	

3) The Washington baseline data set has been enhanced. All major stocks in Washington were sampled in 1985 or 1986. Screening of loci revealed many new polymorphic loci which may improve the accuracy and precision of the stock composition estimates.

4) Different baseline data were previously used in Canada and Washington to estimate stock composition. Differences previously identified (see TCCHUM 8702) included the stocks represented in the baseline, the degree of stock aggregation, and the time period when the data were collected. Recognizing that this might produce inconsistent results, the Chum Technical Committee recommended that a joint baseline be developed. An interim baseline was developed in January of 1988. Subsequent review has identified problems which preclude the immediate use of this baseline to estimate the stock composition.

PROBLEMS ENCOUNTERED WITH THE JOINT BASELINE DATA BASE

The baseline data are used to characterize the genetic attributes of the chum salmon stocks expected to be harvested by a fishery. Accurate estimates of stock composition require baseline data which accurately characterize each stock in the fishery.

The suitability of the joint baseline data base was assessed using biological criteria (stock size, run timing, migration rates, genetic traits) and simulation analyses. The committee concluded that:

1) The biological criteria previously developed were not satisfactory;

2) The committee could not agree that the baseline produced estimates with an acceptable level of bias;

3) The GSI methods currently available are unlikely to accurately and precisely estimate the contribution of stocks present in small proportions.

Criteria were established to create an interim baseline which was consistent with known characteristics of the stocks. Stocks were aggregated and in some cases deleted from the baseline based on stock size, run timing, migration routes, and genetic characteristics. Problems occurred in instances when a stock from one area was genetically similar to a stock or stocks from a second area. For example, the Goldstream River stock (near Victoria) was very similar to stocks in Washington and dissimilar to neighboring Vancouver Island stocks. The Goldstream stock was deleted from the baseline with the belief that this would reduce the misallocation of fish between Vancouver Island and Washington stocks. In this and other cases (i.e., elimination of the Stave River stock from the Fraser River baseline), the committee is uncertain at this time if the criteria were correctly applied and if the deletion of the stocks reduced the misallocation of fish.

Bias occurs when fish are consistently allocated to the incorrect stock. This is most likely to occur when two or more stocks are genetically similar. The joint baseline was constructed with the objective of minimizing the misallocation of stocks between Washington and British Columbia, thus reducing the bias of the estimates.

The bias inherent in the joint baseline was assessed with several analyses. In the first analysis, the baseline was used to estimate the stock composition of a sample taken from the Fraser River at Albion (approximately 40 miles from the mouth of the Fraser River). Based on the location from which the sample was taken, it is believed that all of the fish originated from the

Fraser River. The stock composition of the Albion sample, as estimated using the CDFO baseline and the interim joint baseline, is presented below:

	Percent Stock Composition		
	Fraser	South Coast	Washington
CDFO Baseline	95	3	2
Joint Baseline	80	14	6

A number of simulation studies were utilized to assess bias with known mixtures of stocks. A "fishery sample" was constructed from the baseline data by selecting the desired number of fish from each stock. The stock composition of this sample was then estimated using current statistical procedures. Results from the estimation process were then compared with the known proportions to determine the bias present.

In the first set of simulations, a data set was constructed which contained no fish from Washington. The relative proportions among the Canadian stocks were varied in an attempt to define the possible range of the bias. The estimated Washington proportion in these simulations ranged from 1 to 9 percent. The conclusion from this simulation was that in a fishery where no Washington fish are present, the estimated contribution of Washington stocks could be from 1 to 9 percent.

In the second set of simulations, a small component of north Puget Sound fish was added to the "sample". These simulations indicated that the contribution of the north Puget Sound stocks would not be identified. Thus, the Washington proportion of the catch could be underestimated if north Puget Sound stocks contribute more than the background bias.

The CDFO baseline and the interim baseline were compared using samples from an actual mixed stock fishery. Results from this comparison are presented below:

	Percent Stock Composition					
	--- Fraser ---		- South Coast -		--- Wash. ---	
Week	CDFO	Joint	CDFO	Joint	CDFO	Joint
1	37.6	26.5	62.2	69.3	0.2	4.3
2	36.9	26.6	60.2	66.4	2.9	7.1

The electrophoretic methods currently available are unlikely to accurately and precisely estimate the contribution of stocks which are present in small quantities. This creates problems when estimates are desired of the catch of relatively small contributors, particularly in large fisheries. The current methods are most useful when attempting to estimate the contribution of relatively large stock groups.

In conclusion, the Chum Technical Committee wishes to respectfully note that we have beaten the data to death and still not extracted a confession.

RECOMMENDATIONS

Based on the discussions and work completed at this time, the Chum Technical Committee recommends that the following steps be taken to develop joint estimates of the stock composition of chum salmon catches, as requested by the Commission.

1) **Evaluate the effects that the utilization of genotypic versus allelic frequencies have upon the stock compositions estimates.**

Different methods are used in Canada and Washington to record the genetic characteristics of each stock. Canada uses genotypic frequencies to characterize the stocks, whereas the United States uses allelic frequencies. Although genotypic and allelic frequencies are very closely related to each other, it has not been demonstrated that both forms of the genetic information will produce the same results when applied to the same sample.

2) **Evaluate the effects that the alternative estimation procedures have upon the stock composition estimates.**

Different computer models are used by Canada and Washington to estimate stock compositions. Although the models are different, the same statistical technique is used in both models. However, it remains to be demonstrated that no significant differences exist between the stock composition and variance estimates provided by the two models.

3) **Compare the consistency of the laboratory procedures used in Washington and Canada by analyzing in each laboratory a set of identical samples.**

The genetic characteristics of each stock are the basic information used to estimate stock composition. This genetic information is derived from the starch gels through electrophoresis. Laboratories in both countries use electrophoretic analyses, but it has not been demonstrated that identical results will be obtained by each laboratory if the same samples are analyzed.

4) **The sampling programs should be modified to adequately sample the west coast Vancouver Island troll fishery and the U.S. San Juan Islands net fishery if stock composition estimates are desired for these fisheries.**

Adequate sampling of fisheries require that a representative sample of sufficient size be taken. Two fisheries were identified as having inadequate sampling for estimation of interceptions: the west coast of Vancouver Island troll fishery and the U.S. San Juan Islands net fishery. Significant costs may be associated with the implementation of improved sampling programs.

5) **Develop a baseline data set that will produce the most accurate estimates of stock composition.**

The objective in choosing a baseline data set is to provide the most accurate estimates possible, i.e., to minimize bias in the estimated stock compositions. More analysis is required to decide upon a baseline data set that will minimize bias in estimated stock compositions. Simulation analysis should be used to examine the bias present in the estimates of stock composition from each potential baseline data set.

6) **Evaluate the changes in accuracy and precision of estimated stock compositions which could be obtained by increasing the number of genetic markers used and/or increasing the number of fish comprising each sample from each time/area stratum.**

Accuracy and precision of estimated stock compositions, and thus estimates of interceptions, are dependent upon the number of fish sampled and the number and quality of genetic markers used to identify fish from different regions. If the accuracy and precision of estimates derived from a common database incorporating seven genetic markers (loci) and 150-200 fish comprising each sample are inadequate, two courses are possible. One is to increase the number of genetic markers used to distinguish among fish from different regions. The second is to increase the number of fish sampled from each time/area stratum. Both techniques would be expected to increase the accuracy and precision of the estimates. The effect of increasing the number of genetic markers used and the number of fish sampled should be investigated using computer simulations.

7) **Investigate techniques other than electrophoretic analysis for stock identification and determine their utility for providing highly accurate and precise estimates of chum salmon stock composition.**

Electrophoretic analysis is currently the only technique that is used to estimate the stock compositions of catches of chum salmon. Improvements can be made in the procedures used to estimate stock composition as noted in recommendations four through six. Despite these improvements, it may be found that electrophoretic analysis can not provide sufficiently accurate and precise estimates of chum stock composition. This may be particularly true if precise and accurate estimates are required for stocks which are relatively small contributors to the catch. Techniques other than electrophoretic analysis may be useful in this regard.