Regional Information Report 5J12-22

Western Alaska Salmon Stock Identification Program Technical Document 15: Chum Salmon Reporting Group Evaluations using Simulated Fishery Mixtures

by

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Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

REGIONAL INFORMATION REPORT 5J12-22

WESTERN ALASKA SALMON STOCK IDENTIFICATION PROGRAM TECHNICAL DOCUMENT 15: CHUM SALMON REPORTING GROUP EVALUATIONS USING SIMULATED FISHERY MIXTURES

by
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ABSTRACT

Uncertainty about the magnitude, frequency, location, and timing of the nonlocal harvest of sockeye and chum salmon in Western Alaska fisheries was the impetus for the Western Alaska Salmon Stock Identification Program (WASSIP). The project was designed to use genetic data in mixed stock analysis to reduce this uncertainty. Reporting groups refer to the groups of populations to which fishery mixtures were allocated during mixed stock analyses. At a joint meeting of the Advisory Panel (AP) and Technical Committee, Gene Conservation Laboratory (GCL) presented results evaluating reporting groups for the chum salmon baseline which indicated a low level of resolution in the Coastal Western Alaska (CWAK) area. The GCL recommended pooling the 4 groups of CWAK into a single aggregate for stock composition estimates. The AP requested additional evidence that pooling was necessary, prompting the GCL to run several fishery-based proof tests of hypothetical mixtures of chum salmon covering a range of possible real-life scenarios in fisheries around Western Alaska. The GCL worked closely with an *ad hoc* committee composed of AP members who developed 5 hypothetical mixtures for use in the simulations. In every simulated fishery-based proof test, the stock composition estimates for CWAK as a single reporting group were more precise and had smaller 90% credibility indices than for the subdivided reporting groups of CWAK. These fishery-based proof tests provided insight into the magnitude of errors and magnitude and direction of biases resulting from the division of CWAK into 4 reporting groups. The results showed that the combined CWAK estimate was relatively precise and only slightly biased. Based on these results the committee agreed unanimously to recommend the pooling of CWAK stocks for the purposes of estimating mixture samples in WASSIP.

Key words: Western Alaska Salmon Stock Identification Program, WASSIP, chum salmon, mixed stock analysis, reporting groups

INTRODUCTION

During the joint Advisory Panel (AP)/Technical Committee (TC) meeting held in Anchorage on September 21 and 22, 2011, the Gene Conservation Laboratory (GCL) presented results of tests evaluating reporting groups for the chum salmon baseline. The GCL followed the AP recommendations from the joint AP/TC meeting on March 17, 2011 and developed a flow chart for testing the viability of reporting groups. The viability of reporting groups was tested using 100% proof tests described in Dann et al. (2012). The results from these tests indicated that the addition of new single nucleotide polymorphisms (SNPs) and populations to the baseline did not provide the expected or desired level of resolution for the coastal western Alaska (CWAK) area.

At the September meeting, the AP requested tests using mixtures with compositions more similar to proportions that might be observed in an actual fishery (fishery-based proof tests) to inform decisions about determining appropriate reporting groups for CWAK populations. The fisheries-based proof tests would be more analogous to mixtures associated with the Western Alaska Salmon Stock Identification Program (WASSIP) than the 100% proof tests used to test reporting groups. In particular, they would 1) contain fish originating from more than one reporting group, 2) contain 400 fish (200 fish were used in the 100% proof tests), and 3) have a prior more similar to the prior likely to be used for WASSIP mixtures (the 100% proof tests used a uniform prior giving equal weight to each regional reporting group). Fishery-based proof tests would provide a better picture of the magnitude and direction of biases and errors in potential fishery samples when using Norton Sound, Yukon Coastal[1], Kuskokwim River, and Bristol Bay as separate reporting groups or as a single CWAK reporting group.

An *ad hoc* committee was assembled composed of AP members Art Nelson, Pat Martin, Doug Eggers and Denby Lloyd and chaired by Michael Link. The committee was tasked with

[1] Technical Document 15 had inconsistent names for this reporting group including "lower Yukon River" and "Lower Yukon." All references to this reporting group have been changed to "Yukon Coastal" in this document.

developing 6 fishery-based mixture compositions for the fishery-based proof testing by the Alaska Department of Fish and Game (ADF&G), reviewing the results and providing recommendations to the AP and TC. The timeframe for this exercise was short due to the time constraints of the project. The committee provided the mixture compositions to GCL by September 30 and the conclusion of this work was scheduled for October 15.

NOTE

Results were provided to the *ad hoc* committee for review as they became available, which produced 3 original documents between the dates of September 29 and October 16, here combined into a single report:

1) WASSIP Technical Document 15: Chum Reporting Group Evaluation, sent to the *ad hoc* committee on Sept 29, 2011
2) Addendum 1 to WASSIP Technical Document 15, presented the results of the first fishery-based proof test , hereafter referred to as "A1", sent to the *ad hoc* committee on October 10, 2011; and
3) Addendum 2 to WASSIP Technical Document 15, which presented results of the first 3 sets of simulations, and a re-run of the first simulation with errors corrected, hereafter referred to as "A2."

All original text, tables and figures from the original 3 documents are reproduced in this report. Minor changes were required to merge them into a single report such as the renumbering of tables and figures.

PRIOR CHOICE FOR FISHERY-BASED PROOF TESTS

In order to provide fishery-based proof tests that are useful for interpreting bias and error in stock composition estimates associated with WASSIP, it is important that the analysis methods follow, as closely as possible, those proposed for WASSIP mixtures. The priors that we anticipated using to analyze WASSIP mixtures used information from strata within each fishery (Appendix C in Jasper et al. 2012; sent to the TC September 26, 2011). Since we did not have this information for this exercise, we used a surrogate for these priors based on estimates of stock composition for the same mixtures derived from the maximum likelihood-based method implemented in SPAM version 3.7b (Debevec et al. 2000).

The other prior options considered were to use the regional reporting group uniform prior or to use the known stock composition; both options are problematic. The regional reporting group uniform prior would likely inflate biases compared to estimates using the methods anticipated for WASSIP mixtures because no fishery-based information would be incorporated in the prior. This is especially pronounced for reporting groups that are genetically less distinct, such as the potential reporting groups within CWAK, where the effects would be more pessimistic. On the other hand, using the known stock composition as the prior would likely produce less bias than we might expect from the methods anticipated for WASSIP mixtures. The effect would be more optimistic for reporting groups that are genetically less distinct, such as the CWAK reporting groups.

KUSKOKWIM RIVER REPORTING GROUP

During the September meeting, the AP requested that the upper Kuskokwim River populations be moved into the CWAK reporting group rather than being included in the upper Yukon/Kuskokwim reporting group. For these fishery-based proof tests, the upper Kuskokwim River populations were added to the lower Kuskokwim River reporting group and this new reporting group was referred to as the "Kuskokwim River" reporting group. The upper Yukon River reporting group was maintained separately.

METHODS

DEVELOPING MIXTURE COMPOSITIONS

The committee developed 6 fishery-based stock compositions for proof testing. These fishery compositions covered a wide range of stock compositions for evaluating the magnitude and direction of biases and the magnitude of error for reporting groups present from high to low proportions within fisheries. Final stock compositions for proof tests were provided to the GCL by September 30.

TESTING MIXTURE COMPOSITIONS

A set of 400 fish was randomly selected and removed from the baseline in exact proportion to the mixture compositions provided by the committee. The process was repeated 5 times for each set of fishery-based mixture compositions. SPAM was used to produce stock composition estimates for each set of selected fish. These estimates served as priors for the BAYES analyses. BAYES was performed as described in Dann et al. (2012), except that we used the SPAM results as the prior, with a prior weight of 1 fish. Estimates and 90% credibility intervals were determined from the posterior distribution formed from 3 chains with different starting conditions. Each chain was 40,000 iterations with only the last 20,000 used in the posterior distribution.

For any mixtures that contained Kuskokwim River, fish from only the coastal populations were selected for the mixtures. This was done to avoid over-optimistic simulation results that could be an artifact of the genetic divergence between upper Kuskokwim River fish and other coastal western Alaska fish. Upper Kuskokwim River fish are represented by a few small populations and these fish are unlikely to be in any WASSIP mixture in appreciable numbers (Gilk et al. 2009). If we included fish in mixtures in proportion to the number of populations represented in the baseline, the proof tests could appear inappropriately optimistic in estimating Kuskokwim River components.

REPORTING MIXTURE COMPOSITIONS AND PERFORMANCE OF REPORTING GROUPS

Results were tabulated for 2 sets of reporting groups: 1) the 9 reporting groups that passed the 90% correct allocation tests using the 100% proof tests (CWAK as a single reporting group), and 2) the 12 reporting groups where the CWAK reporting group was subdivided into Norton Sound,

Yukon Coastal, Kuskokwim River, and Bristol Bay reporting groups (Table 1). Tabulation of results included a table of 2 related measures[2]:

1) absolute deviations (range: 0 to 1) from known proportions,

$$\left(D_{s,g}^{(i)} = \left|\hat{p}_{s,g}^{(i)} - p_{s,g}\right|\right);$$

2) relative percent deviations (range: 0% to infinity%) from known proportion,

$$\left(\theta_{s,g}^{(i)} = \frac{D_{s,g}^{(i)}}{p_{s,g}} * 100\right);$$

Where p is the known proportion and $\hat{p}$ is the estimate. These measures were provided for each reporting group, g, for each fishery mixture, s, and for each repetition i ($i = 1,2,\ldots,n;\ n = 5$). Results were provided to the committee for review as they became available so that the committee could determine if a recommendation could be made to the AP/TC before all the fishery-based proof tests were completed. The results from the initial set of proportions (A1) are reported below.

RESULTS (A1)

DEVELOPING MIXTURE COMPOSITIONS

The committee provided the first fishery-based stock compositions for testing consisting of the proportions shown as *Actual* in Table 2. An additional 5 fishery-based stock compositions were provided later for testing. Here we present the results from this first fishery-based proof test (A1).

TESTING MIXTURE COMPOSITIONS

SPAM results that served as priors for the BAYES analyses are reported in Table 2.

REPORTING MIXTURE COMPOSITIONS AND PERFORMANCE OF REPORTING GROUPS

BAYES stock composition estimates and 90% credibility intervals along with absolute deviations and relative percent deviations for each of the 5 replicates are presented for both the 9 and 12 reporting group sets (Table 3). Stock compositions and 90% credibility intervals are also presented graphically in Figures 1 and 2. Root mean square error and relative root mean square error across repetitions for each reporting group for each mixture are reported in Table 4.

DISCUSSION (A1)

Stock composition estimates for the 9 reporting groups (CWAK as a single reporting group) were more precise and had smaller 90% CI than for the reporting groups of the subdivided CWAK (Norton Sound, Yukon Coastal, Kuskokwim River, and Bristol Bay reporting groups) (Table 3 and Figures 1 and 2). The estimates for the 9 reporting groups were within 0.03 of the

[2] The Technical Document 15 version sent out for review provided methods for estimating root mean square error and relative root mean square error. However, these estimates were not provided in the results because they were not available when the document was distributed. Therefore these methods are excluded from this final version.

actual in every case and averaged 0.01, whereas for the 4 reporting groups within CWAK, the deviations from the actual were as high as 0.14, and averaged 0.05. Credibility interval widths averaged 0.04 for the 9 reporting groups and 0.16 for the 12 reporting groups.

The CIs seem to be appropriate for both the highly identifiable 9 reporting groups and the 4 less-identifiable CWAK reporting groups. The actual (correct) proportion was included within the 90% CI 89% of the time for the 9 reporting groups, and 85% of the time for the 4 CWAK reporting groups. This indicates that the wider CI's for the CWAK reporting groups are appropriately wide.

A well-known statistical property is that variance of a proportional estimate is greater when the proportion approaches 0.5. This means that as actual proportions reach 0.5, the width of the CI increases. Conversely, proportions near 0 and 1 should have narrower CIs. In addition, because CIs are bounded by 0 and 1, they are necessarily truncated. However, this alone does not explain the broader 90% CI's for the Norton Sound, Yukon Coastal, Kuskokwim and Bristol Bay reporting groups (Figure 2). If this phenomenon were the primary reason for the inflated CI's, the Asia and CWAK reporting groups would have also had broad 90% CI's (Figure 1). The Asia reporting group had a proportion closer to 0.5 than any of the individual CWAK reporting groups, but the 90% CI width for this reporting group averaged half the width of the 4 reporting groups within CWAK (Figures 1 and 2). The same pattern was evident for the CWAK reporting group even though this reporting group was represented by 0.56 of the mixture—the proportion closest to 0.5. A more likely hypothesis to explain these wider CI within the CWAK group is a lack of genetic distinctiveness among these reporting groups.

Genetic distinctiveness also can explain the inclusion of 0 in the 90% CI of Norton Sound, but not Northwestern, and East of Kodiak reporting groups, which all had 5% actual contributions in the fishery-based proof test mixture. East of Kodiak and Northwestern both met the 90% correct allocation criterion in 100% proof tests, whereas Norton Sound did not. The imprecision of the Norton Sound measurement makes it difficult to distinguish the presence of this stock within mixtures.

A few biases were observed in these fishery-based proof tests. The largest average biases were seen in the CWAK reporting groups with upward biases in the Yukon Coastal reporting group (4 of 5 replicates with average of 0.05) and downward biases for the Bristol Bay (4 of 5 replicates with average of –0.02). In addition, 2 reporting groups had large relative negative biases (Kotzebue and Northern District Alaska Peninsula; both with averages of –0.01) and, for the Kotzebue reporting group, the estimate was not included in the 90% CI in 4 of the 5 replicates.

As pointed out during the September joint AP/TC meeting, determining the acceptable level of precision requires weighing the benefits of adding more reporting groups with the risks of providing less precise and more biased estimates. This one test provides insights into the magnitude of errors and magnitude and direction of biases resulting from the division of CWAK into 4 reporting groups. The 4 CWAK reporting groups that did not meet the standard 90% correct-allocation metric had 90% CI ranges that were 4 times as wide and average deviations from the actual stock composition that were 5 times higher than for reporting groups that met the metric. Finally, the largest biases were among the 4 CWAK reporting groups and they were 2 to 5 times larger than the biases observed for the reporting groups that met the metric.

QUESTIONS FOR THE TECHNICAL COMMITTEE (A1)

1) Is this method to investigate the possibility of separating the CWAK reporting group into 4 separate groups reasonable and acceptable for the purposes of WASSIP?
2) Are there better ways to determine whether this is possible?
3) Do you recommend other ways of comparing the error and bias from the 9 reporting groups we believe to be acceptably identifiable to the error and bias of the 12 groups described above?

TECHNICAL COMMITTEE RESPONSE

Excerpt of an e-mail message sent from Dr. Robin Waples to Bill Templin with cc to AP and TC on 10/4/2011 with subsequent affirmation by Dr. Bruce Weir

The proposed approach seems reasonable. I don't have any other suggestions for metrics to calculate; bias and MSE cover it pretty well. In my opinion, adding analyses like these with realistic mixture composition should provide a much more well rounded view of performance under realistic conditions. The 90% proof test criterion has proven useful as a standard for evaluating performance, but there is nothing magic about the 90% figure, nor are 100% simulations very realistic. After reviewing results of these simulations, the AP should have a better sense regarding whether the project can deliver the desired level of precision in particular areas.

Clarification:
When you say "A set of 400 fish will be randomly selected and removed from the baseline in proportion to the mixture compositions provided by the committee," are you saying that the mixture fractions will exactly correspond to those specified by the committee, or that this will be the expectation with random variation? I expect the latter is what is meant, and I think that is consistent with what has been done in other evaluations. It should be recognized, however, that this stochasticity means that the true mixture fractions will not always be as stipulated, so precision will probably be underestimated to some degree. For example, if the matrix stipulates 5% of stock A in the mix but by chance a mixture only includes 4%, an estimate that was exactly 4% would be judged to be in error by 1% (absolute) or 20% (relative). I don't believe this issue should affect bias but it would affect MSE.

RESULTS (A2)

DEVELOPING MIXTURE COMPOSITIONS

The *ad hoc* committee modified the stock proportions in the hypothetical fishery mixture labeled *S. Pen June (B*), created 5 additional fishery-based stock compositions for proof testing, and provided a priority order, which were sent out by the chairman, Michael Link, in an email to all committee members on October 10, 2011 (Table 4[3]). These fishery compositions covered a wide range of stock compositions for evaluating the magnitude and direction of biases and the magnitude of error for reporting groups present from high to low proportions within fisheries. The GCL analyzed proof tests based on these proportions following the priority order. Results

[3] The table and figure numbers have been changed from the numbers in the original appendices to accommodate incorporation of information from 2 appendices into a single document.

for the *S. Pen June (B) as run* were released on October 10, 2011. After these results were released, and during the analysis of the next mixtures, an error was discovered relating to the baseline used for each iteration, so the *S Pen June (B) as run* was reanalyzed with the error corrected. Here we present results from the corrected *S. Pen June (B) as run*, and the next 2 hypothetical fishery mixtures: *Bristol Bay* and *Kusko Bay*.

TESTING MIXTURE COMPOSITIONS

SPAM results that served as priors for the BAYES analyses are reported for each analysis (Tables 5–7).

REPORTING MIXTURE COMPOSITIONS AND PERFORMANCE OF REPORTING GROUPS

BAYES stock composition estimates and 90% credibility intervals along with absolute deviations and relative percent deviations for each of the 5 replicates are presented for both the 9 and 12 reporting-group sets (Tables 5–7). Stock compositions and 90% credibility intervals are also presented graphically in Figures 3–8.

DISCUSSION (A2)

ERROR IN PREVIOUSLY REPORTED RESULTS

The error detected in the original analysis of the hypothetical fishery mixture *S. Pen June (B) as run* and released in A1[4], resulted in some changes to the point estimates and CI's, especially for the Bristol Bay and Northern District reporting groups (Table 5 and Figures 3 and 4). Deviations from the *Actual* proportions were much higher and more biased in the reanalysis for the Bristol Bay and the Northern District reporting groups than reported in A1. These changes are consistent with expectations based on the error made during the original analysis where the baseline used for the mixture analysis included the individuals used in the mixture (not a true proof test). Since the mixture was made up of a large portion of Bristol Bay fish (26%) and because some Bristol Bay populations are genetically similar to some Northern District populations, the depopulation of the baseline in the new analysis reduced the ability of the model to allocate Bristol Bay fish correctly. However, the overall patterns of wider CI and high divergence from the actual proportions for the CWAK reporting groups relative to the reporting groups that met the 90% correct allocation in 100% proof tests remain similar.

COMPARISON OF THE 9 AND 12 REPORTING GROUP SETS

In all 3 fishery-based proof tests, the stock composition estimates for the 9 reporting groups (CWAK as a single reporting group) were more precise and had smaller 90% CI than for the reporting groups of the subdivided CWAK (Norton Sound, Yukon Coastal, Kuskokwim River, and Bristol Bay reporting groups) (Tables 5–7; Figures 3–8). In the *Bristol Bay* and the *Kusko Bay* proof tests, these differences among 2 groups were more exaggerated (Tables 6 and 7; Figures 5–7) than for the *South Pen June (B) as run* proof test (Table 5, Figures 3 and 4). The estimates for the 9 reporting groups were within 0.07 of the actual in every case and averaged 0.01, whereas for the 4 reporting groups within CWAK, the deviations were as high as 0.38 from

[4] A1 was referred to as "Addendum 1" in the original report.

the actual, and averaged 0.11. Credibility interval widths averaged 0.04 for the 9 reporting groups and 0.21 for 12 reporting groups.

Despite the much higher CI widths of the 4 less-identifiable CWAK reporting groups, they still appear to underestimating the true widths, whereas the widths of CIs for the highly identifiable 9 reporting groups appear appropriate. For the 9 reporting groups, the actual (correct) proportion was included within the 90% CI 94% of the time. In contrast, for the 4 CWAK reporting groups, the actual proportion was included in the 90% CI only 68% of the time. This indicates that the wider CI's for the CWAK reporting groups are still underestimating of the true 90% CI widths. This discrepancy may be due to the lack of genetic variation among these 4 reporting groups which leads to large biases in the point estimates.

As described in the A1 sections (above), the large 90% CI for estimates of the 4 CWAK reporting groups in each of the 3 fishery-based proof tests are not explained by statistics alone. A more likely hypothesis to explain these wider CI within the CWAK group is a lack of genetic distinctiveness among these reporting groups.

Consistent and relatively large biases were observed for some reporting groups in these fishery-based proof tests. The largest average biases were seen in the CWAK reporting groups with consistent downward biases for Bristol Bay (11 of 15 replicates, average 13%) and upward biases in Norton Sound (12 of 15 replicates; average 6%). The other CWAK reporting groups had biases within each fishery-based proof test, but these biases changed in magnitude and direction across the proof tests (Figures 4, 6 and 8). For example, the Kuskokwim reporting group was biased upward in the *Bristol Bay* mixture (5 of 5 replicates; average 14%) and downwardly biased in the *Kusko Bay* mixture (5 of 5 replicates, average 21%). Among the reporting groups that met the 90% correct assignment in the 100% proof tests, the highest average bias was 1% and the highest average bias within a fishery-based proof test was 2%. One bias that was consistent with the mixture that contained a large proportion of Bristol Bay fish and smaller proportion of Northern District fish was an upward bias for the estimated proportion of Northern District fish (*South Pen June (B)* and *Bristol Bay* mixtures; Figures 4 and 6). These results might be expected due to the genetic similarity between some Bristol Bay and Northern District populations.

Comparing the relative percent deviations between the 4 CWAK reporting groups and the remaining reporting groups is confounded because this measure is affected by both the absolute deviation and the *Actual* composition estimate. Small absolute deviations on a small *Actual* composition estimate can lead to a large relative percent deviation (i.e. a 2% deviation with an actual composition of 2% is a 100% relative deviation; whereas a 2% deviation with an actual composition of 50% is a 4% relative deviation). Since most of the *Actual* estimates for the reporting groups that met the 90% correct allocations in the 100% proof tests were small and the *Actual* estimates for the 4 CWAK reporting groups were large, testing the effects of the 2 types of reporting groups (4 CWAK vs. the 9 identifiable reporting groups) on the model performance is confounded by differences in *Actual* estimates between the 2 types of reporting groups.

As pointed out during the September joint AP/TC meeting, determining the acceptable level of precision requires weighing the benefits of adding more reporting groups with the risks of providing less precise and more biased estimates. These fishery-based proof tests provide insights into the magnitude of errors and magnitude and direction of biases resulting from the division of CWAK into 4 reporting groups. These can be summarized in 4 main observations:

1. The 4 CWAK reporting groups that did not meet the standard 90% correct-allocation metric had 90% CI ranges that were 5.25 times as wide as the reporting groups that did meet the metric.
2. These much wider confidence intervals appear to be biased low for these 4 reporting groups, with the correct proportion being contained within the 90% CI in only 68% of estimates across replicates and sets. This can be compared with the 94% rate for the other reporting groups.
3. Average deviations from the actual stock composition were 11 times higher for the 4 CWAK reporting groups than for the reporting groups that met the metric.
4. The largest biases were among the 4 CWAK reporting groups and they averaged 30 times larger than the biases observed for the reporting groups that met the metric.

QUESTIONS FOR THE AD HOC COMMITTEE (A2)

1) Do these results provide the information needed for the committee to make a recommendation on the definition of reporting groups to the WASSIP AP?

2) If not, will addition of the fourth fishery-based proof test based on expected Norton Sound proportions provide the information required to make this decision?

3) If so, what is the committee's recommendation on the definition of reporting groups for mixed stock analysis of chum salmon in WASSIP?

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ADVISORY PANEL COMMENTS

Report by *ad hoc* committee to the WASSIP AP, resolving the approach to CWAK chum reporting groups, presented in the form of the memorandum below on October 18, 2011.

MEMORANDUM

To: Advisory Panel (AP), Western Alaska Salmon Stock Identification Program (WASSIP)

cc. Technical Committee (TC) to WASSIP

From: Michael Link, Art Nelson, Pat Martin, Denby Lloyd, and Doug Eggers (*Ad hoc* Committee)

Re: The ***Ad hoc* committee of the AP** was asked to work with the Gene Conservation Lab to characterize and quantify the effects of misallocation errors associated with not pooling the coastal Western Alaska (CWAK) chum salmon stocks for WASSIP.

Date: October 18, 2011

Issue: At the September 21-22 joint meeting of the AP and TC of WASSIP, the Gene Conservation Laboratory (GCL) presented results of tests evaluating 11 reporting groups from the chum salmon baseline. These "100%proof tests" measured how well mixtures of fish drawn from single reporting groups allocate "to themselves". Results showed that 4 groups from coastal western Alaska did not perform well. Specifically, these groups shared sufficiently similar genetic allele frequencies that accurately estimating their contribution to mixed-stock fishery samples had the potential to be problematic. For example, in some circumstances, reporting groups might be underestimated in a fishery, and other reporting groups could be overestimated. However, proof tests alone cannot estimate the bias associated with estimates drawn from a mixture of stocks. Furthermore, the 100% proof tests showed that pooling these 4 groups into a single aggregate coastal Western Alaska (CWAK) reporting group, performed (as a single group) to the threshold typically used for defining reporting groups in WASSIP (>90% allocation threshold in a 100% proof test). CWAK was composed of the following groups: Norton Sound, Yukon Coastal, Kuskokwim, and Bristol Bay.

Methods: Given that the initial focus or goal of WASSIP was to apportion harvests down to the level of these 4 potentially problematic groups, the AP sought additional assurance or evidence that pooling the CWAK stocks was absolutely necessary. In particular, the AP asked what might the effects be in terms of bias and precision in stock composition estimates from a given fishery from not pooling these 4 groups. To do this, the GCL agreed to run several fishery-based proof tests of hypothetical mixtures of chum salmon that covered a range of possible real-life scenarios in fisheries around Western Alaska. An *ad hoc* committee was assigned to develop 6 hypothetical mixtures (Table 1 in Addendum 2 of Tech Doc 15[5]). In contrast to the proof test, these fishery-based proof tests would assess how well fish are assigned to their own group or others in the presence of fish from many other stocks. The 100% proof test only examines that ability from a collection of fish from its own baseline(s). Mixtures were composed of fish drawn (without replacement) from the baselines for each of the reporting groups. Mixture analyses were conducted on the hypothetical mixtures with baselines that did not contain the fish used in the mixture. The analysis methods are outlined in detail in each of the documents cited at the end of this memo.[6]

Results/Discussion: Given the tight timeline, the GCL worked quickly to begin analysis of these mixtures to evaluate the performance of estimating the composition of 3 hypothetical fishery

[5] Table 4 in this report.

[6] All 3 technical documents cited are now combined into this single report.

mixtures. These mixtures were modeled based on the *ad hoc* committee's professional judgment as to expected compositions in fisheries in the South Peninsula in June, Bristol Bay, and Kuskokwim Bay (i.e., hypothetical mixtures). Actual or precise proportions from these fisheries were not needed to characterize the accuracy and precision of estimates of the individual CWAK groups or the aggregate CWAK reporting group. For each fishery-based proof test, five random mixtures were developed and composition estimates and confidence intervals were developed by reporting group. Addendum 2 to Tech Doc 15[7] provides the results in tabular and graphic form from these three sets of fishery-based proof tests. Figures 1 through 6[8] in the tech document portray how well a pooled CWAK performed across a good range of underlying "true" compositions (Fig. 1, 3, and 5[9]). The paired figures (i.e., 2, 4, and 6[10]) in Addendum 2 of Tech Doc 15 show clearly how much less precise and biased estimates of the individual reporting groups from within CWAK were. For example, Figure 5[11] shows how the average estimated Bristol Bay composition was almost half the true percentage, and the credibility intervals did not even encompass the actual percentage, which was 78%. Figure 3 shows that the combined CWAK estimate is relatively precise and only slightly biased.

Committee Process: Communication among those on the *ad hoc* committee and the GCL staff was excellent over the three weeks. The ad hoc committee members talked one-on-one among themselves and with GCL personnel. In addition to phone and in-person discussions, the committee members exchanged several emails to develop the fishery-based proof mixtures, to discuss the incoming results, and discuss the need to run additional fishery-based proof test mixtures. On October 17, a teleconference was convened to review and discuss the results presented in Tech Doc 15 and its addendums.

Conclusion: The *ad hoc* committee agreed unanimously that the results provided by these analyses and presented in Tech Doc 15 and its addendums are sufficient to conclude that CWAK stocks should remain pooled for the purposes of estimating mixture samples in WASSIP. Furthermore, any attempts to estimate the contribution of any one stock within the CWAK reporting group would lead to imprecise and biased estimates, the problems from which would be further amplified when applying these composition estimates to estimate of harvests (numbers of fish) in WASSIP fisheries.

Literature Cited[12]

C. Habicht, W. D. Templin, N. Decovich, J. Jasper. Technical Document 15 (WASSIP): Chum salmon reporting group evaluations using simulated fishery mixtures. Sent to the *ad hoc* committee on Sept 29, 2011.

C. Habicht, W. D. Templin, N. Decovich, J. Jasper. Addendum 1 to Technical Document 15: Chum salmon reporting group evaluations using 2 simulated fishery mixtures". Send to the *ad hoc* committee on: October 10, 2011.

C. Habicht, W. D. Templin, N. Decovich, J. Jasper. Addendum 2 to Technical Document 15: Chum salmon reporting group evaluations using simulated fishery mixtures. Sent to the *ad hoc* committee on October 16, 2011

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[7] Sections labeled "A2" in this report.
[8] See Figures 3–8 of this report.
[9] See Figures 3, 5, and 7 of this report.
[10] See Figures 4, 6, and 8 in this report.
[11] See Figure 6 of this report.
[12] All now included in this single report.

TABLES

Table 1.–Populations associated with the 9 reporting groups that met the 90% correct allocation criteria based on 100% proof tests and the 12 reporting groups where coastal western Alaska (CWAK) is divided into 4 reporting groups. Mixture sets of 400 individual fish will be randomly selected and removed from the baseline in proportion to the mixture compositions provided by the committee. These mixtures will be analyzed using both the 9 and 12 reporting groups to examine bias and error of the 2 sets of reporting groups.

Reporting groups		Population	N
9	12		
Asia		Namdae River	90
		Gakko River - early	78
		Abashiri River	80
		Sasauchi River	77
		Yurappu River - early	80
		Yurappu River - late	80
		Teshio River	78
		Shinzunai River	80
		Tokachi River	78
		Kushiro River	79
		Nishibetsu River	80
		Shari River	75
		Tokoro River	69
		Tokushibetsu River	80
		Naiba	98
		Tym River	53
		Bolshaya River	59
		Paratunka River	94
		Amur River - summer run	88
		Bistraya River	66
		Hairusova River	85
		Ozerki Hatchery	93
		Pymta	147
		Penzhina	43
		Kol River	123
		Vorovskaya	101
		Kamchatka River	50
		Palana River	90
		Magadan	77
		Ossora	87
		Ola River - Hatchery	78
		Oklan River	75
		Kanchalan	77

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Table 1. Page 2 of 7.

Reporting groups		Population	N
9	12		
Asia		Udarnitza River	43
Kotzebue Sound		Inmachuk River	91
		Kiana River	95
		Kobuk - Salmon River (Mile 4)	99
		Noatak River - above hatchery	47
		Selby Slough	90
		Agiapuk River	94
CWAK	Norton Sound	Eldorado River	89
		Nome River	94
		Pilgrim River	75
		Snake River	90
		Solomon River	62
		Fish River	92
		Kwiniuk River	94
		Niukluk River	93
		Tubutulik River	93
		Shaktoolik River	94
		Pikmiktalik River	95
		Koyuk River	43
		Unalakleet	188
		Ungalik River	144
	Yukon Coastal	Black River	93
		Andreafsky River - East Fork	94
		Chulinak	92
		Beaver Creek - Anvik	110
		Yellow River - Anvik	80
		Innoko River	85
		Kaltag River	92
		Nulato River	189
		Gisasa River	95
		Melozitna River	91
		South Fork Koyukuk R. - Early	90
		Henshaw Creek - early	94
		Huslia River, Koyukuk	95
		Tozitna River	92
	Kuskokwim River	Mekoryuk River	104
		Kwethluk River	143

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Table 1. Page 3 of 7.

Reporting groups		Population	N
9	12		
	Kuskokwim River	Tuluksak River Weir	92
		Kisaralik River	93
		Aniak River	92
		Salmon River	95
		Holokuk River	103
		Kogrukluk River weir	95
		Kasigluk River - (Set G)	55
		George River	95
		Stony River - Early	95
		Stony River - Late	55
		Necons River	95
		Tatlawiksuk River weir	95
		Nunsatuk River - (Set A)	92
		Takotna River	94
		Kanektok River weir	94
		Goodnews River - North Fork	43
		Big River	94
		South Fork Kuskokwim - fall	95
		Windy Fork Kuskokwim	93
	Bristol Bay	Osviak River	88
		Sunshine Creek	47
		Iowithla River	95
		Snake River	48
		Upper Nushagak	97
		Stuyahok River	86
		Klutuspak Creek	70
		Alagnak River	92
		Whale Mountain Creek	189
		Pumice Creek	95
		Wandering Creek	50
Upper Yukon River		Henshaw Creek - late	60
		South Fork Koyukuk R.- Late	92
		Jim River	92
		Tanana River Mainstem	95
		Toklat River	95
		Kantishna River	94
		Chena River	77

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Table 1. Page 4 of 7.

Reporting groups		Population	N
9	12		
Upper Yukon River		Salcha River	83
		Delta River - Fairbanks	149
		Bluff Cabin	99
		Big Salt River	70
		Chandalar River	92
		Sheenjek River	93
		Black River	95
		Old Crow - Porcupine River	92
		Fishing Branch	90
		Kluane River	114
		Pelly River	84
		Minto Slough	91
		Tatchun Creek	92
		Big Creek - Canadian Mainstem	100
		Teslin River	92
Northern District		Wiggly Creek - Cinder	177
		Meshik River	78
		Plenty Bear Creek	138
		Meshik Braided	94
		Ilnik River - "Three Hills River"	49
		North of Cape Seniavin	96
		Right Head Moller Bay	189
		Lawrence Valley Creek	190
		Coal Valley	94
		Deer Valley	91
		Sapsuk River, Nelson Lagoon	144
Northwest District		Moffet Creek (Cold Bay)	95
		Joshua Green	186
		Frosty Creek	190
		Alligator Hole	183
		Traders Cove (AK. Peninsula)	76
		St. Catherine Cove	171
		Peterson Lagoon	181
South Peninsula		Little John Lagoon	80
		Sandy Cove	186
		Little John Lagoon	92
		Russell Creek	185

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Table 1. Page 5 of 7.

Reporting groups		Population	N
9	12		
South Peninsula		Delta Creek (Cold Bay)	95
		Belkovski River	87
		Volcano Bay (Cold Bay)	189
		Ruby's Lagoon (Cold Bay)	92
		Canoe Bay	186
		Zachary Bay	76
		Foster Creek - Balboa Bay	182
		Coleman Creek	95
		Chichagof Bay	180
		Stepovak Bay - Big River	143
		Stepovak River	189
Chignik/ Kodiak (includes K. Island)		Ivanoff River	181
		Portage Creek	190
		Kujulik - North Fork	93
		North Fork Creek, Kujulik Bay	71
		North Fork Creek, Aniakchak R.	94
		Main Creek	174
		Northeast Creek	94
		Ocean Bay	78
		Nakililock River	95
		Chiginagak Bay River	159
		Kialagvik Creek (Wide Bay)	177
		Pass Creek - Wide Bay	94
		Dry Bay River	71
		Bear Bay Creek	187
		Alagogshak River	94
		Big River	95
		Big River (Hallo Bay)	92
		Karluk Lagoon	83
		Sturgeon River	109
		Big Sukhoi	189
		Deadman River	95
		Sitkinak Island	93
		NE Portage - Alitak	94
		Barling Bay Creek	92
		West Kiliuda Creek	87
		Dog Bay	95

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Table 1. Page 6 of 7.

Reporting groups		Population	N
9	12		
Chignik/ Kodiak (includes K. Island)		Coxcomb Creek	89
		Gull Cape Creek	92
		Gull Cape Lagoon	94
		Eagle Harbor	94
		Rough Creek	77
		American River	95
		Russian River	185
		Kizhuyak River	174
		Uganik River	175
		Spiridon River - Upper	89
		Zachar River	66
		Kitoi Hatchery	194
East of Kodiak		McNeil River Lagoon	108
		Chunilna River	83
		Susitna River (Slough 11)	94
		Talkeetna River	50
		Little Susitna River weir	95
		Willow Creek	89
		Carmen Lake	67
		Williwaw Creek	67
		Siwash	97
		Wally Noerenberg Hatchery	189
		DIPAC Hatchery	94
		Dry Bay Creek	94
		Ford Arm Lake - fall	95
		Hidden Falls Hatchery	95
		Long Bay	94
		Medvejie Hatchery	95
		Nakwasina River	93
		Ralph's Creek	95
		Sanborn Creek	94
		Saook Bay	94
		Sawmill Creek - Berners Bay	95
		Taku River - fall	93
		West Crawfish	92
		Wells Bridge	46
		Disappearance Creek - fall run	181
		Fish Creek - Hyder	83

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Table 1. Page 7 of 7.

Reporting groups		Population	N
9	12		
East of Kodiak		Fish Creek - early	49
		Fish Creek - late	49
		Karta River	56
		Lagoon Creek - fall run	78
		Nakat Inlet - summer	95
		North Arm Creek	94
		Carroll River	85
		Neets Bay - fall	95
		Neets Bay - summer	95
		Traitors Cove Creek	91
		Sample Creek	74
		Kitwanga River	74
		Elwha River	93
		Nisqually River Hatchery	94

Table 2.–SPAM estimates from 5 replicate samples for the first fishery-based proof test. These estimates were used as priors for the BAYES analysis of the same replicate samples. The 5 replicate samples consisted of different sets of individuals drawn from the baseline in the same reporting group proportions (Actual). These fish were removed from the baseline and used as mixtures.

		Replicates				
Reporting group	Actual	1	2	3	4	5
Asia	0.250	0.251	0.250	0.246	0.245	0.246
Kotzebue	0.020	0.014	0.016	0.017	0.018	0.033
Norton	0.050	0.045	0.076	0.092	0.059	0.075
Yukon Coastal	0.100	0.140	0.124	0.106	0.115	0.106
Kuskokwim	0.150	0.118	0.144	0.155	0.191	0.142
Bristol Bay	0.260	0.254	0.200	0.192	0.199	0.211
Upper Yukon	0.020	0.027	0.024	0.026	0.021	0.032
Northern District	0.020	0.018	0.033	0.023	0.008	0.034
Northwestern District	0.060	0.057	0.059	0.059	0.061	0.051
South Peninsula	0.010	0.019	0.010	0.010	0.010	0.007
Chignik/Kodiak	0.010	0.013	0.016	0.022	0.018	0.011
East of Kodiak	0.050	0.043	0.049	0.053	0.055	0.051

Table 3.–BAYES estimates for 5 replicate samples for a single fishery-based proof test. Estimate (mean), standard deviation (sd), lower (CI 5) and upper (CI 95) 90% credibility interval values, absolute deviation from the known (ABS dev; proportion) and relative absolute deviation from the known (Rel ABS dev; percent) for each estimate are provided. Estimates for coastal western Alaska (CWAK) are shown both for a single reporting group and that proportion divided among the 4 reporting groups.

Replicate 1

Reporting group	mean	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.258	0.023	0.222	0.296	0.008	3.2
Kotzebue	0.001	0.004	0.000	0.008	0.019	94.5
CWAK	0.591	0.027	0.546	0.636	0.031	5.6
Norton [a]	*0.006*	*0.017*	*0.000*	*0.040*	*0.044*	*88.1*
Yukon Coastal [a]	*0.237*	*0.052*	*0.152*	*0.322*	*0.137*	*136.8*
Kuskokwim [a]	*0.051*	*0.046*	*0.004*	*0.139*	*0.099*	*65.8*
Bristol Bay [a]	*0.297*	*0.048*	*0.217*	*0.374*	*0.037*	*14.3*
Upper Yukon	0.015	0.011	0.000	0.035	0.005	25.7
Northern District	0.005	0.011	0.000	0.032	0.015	74.8
Northwestern District	0.064	0.015	0.041	0.090	0.004	7.5
South Peninsula	0.020	0.012	0.000	0.042	0.010	104.2
Chignik/Kodiak	0.001	0.005	0.000	0.011	0.009	86.0
East of Kodiak	0.044	0.011	0.027	0.063	0.006	12.7

Replicate 2

Reporting group	mean	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.249	0.022	0.213	0.286	0.001	0.4
Kotzebue	0.006	0.004	0.001	0.013	0.014	72.4
CWAK	0.575	0.028	0.528	0.620	0.015	2.6
Norton [a]	*0.062*	*0.047*	*0.000*	*0.143*	*0.012*	*24.1*
Yukon Coastal [a]	*0.119*	*0.057*	*0.037*	*0.222*	*0.019*	*19.0*
Kuskokwim [a]	*0.189*	*0.060*	*0.091*	*0.288*	*0.039*	*26.0*
Bristol Bay [a]	*0.204*	*0.042*	*0.141*	*0.278*	*0.056*	*21.3*
Upper Yukon	0.025	0.013	0.004	0.046	0.005	22.5
Northern District	0.011	0.011	0.000	0.034	0.009	43.1
Northwestern District	0.064	0.014	0.042	0.088	0.004	6.3
South Peninsula	0.020	0.012	0.000	0.040	0.010	98.3
Chignik/Kodiak	0.005	0.012	0.000	0.038	0.005	51.7
East of Kodiak	0.046	0.012	0.029	0.067	0.004	7.1

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Table 3. Page 2 of 3.

Replicate 3

Reporting group	mean	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.243	0.022	0.207	0.280	0.007	2.7
Kotzebue	0.009	0.005	0.002	0.019	0.011	56.7
CWAK	0.581	0.028	0.535	0.627	0.021	3.8
Norton [a]	*0.069*	*0.052*	*0.000*	*0.159*	*0.019*	*37.2*
Yukon Coastal [a]	*0.085*	*0.045*	*0.002*	*0.160*	*0.015*	*14.6*
Kuskokwim [a]	*0.203*	*0.059*	*0.113*	*0.305*	*0.053*	*35.3*
Bristol Bay [a]	*0.224*	*0.046*	*0.149*	*0.302*	*0.036*	*13.7*
Upper Yukon	0.020	0.012	0.004	0.042	0.000	1.9
Northern District	0.003	0.007	0.000	0.019	0.017	83.2
Northwestern District	0.065	0.013	0.044	0.088	0.005	8.2
South Peninsula	0.002	0.005	0.000	0.011	0.008	79.0
Chignik/Kodiak	0.033	0.012	0.015	0.053	0.023	225.9
East of Kodiak	0.043	0.011	0.026	0.063	0.007	13.3

Replicate 4

Reporting group	mean	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.246	0.022	0.210	0.282	0.004	1.8
Kotzebue	0.004	0.007	0.000	0.018	0.016	80.0
CWAK	0.592	0.026	0.549	0.634	0.032	5.8
Norton [a]	*0.021*	*0.037*	*0.000*	*0.105*	*0.029*	*58.9*
Yukon Coastal [a]	*0.148*	*0.067*	*0.039*	*0.261*	*0.048*	*47.8*
Kuskokwim [a]	*0.233*	*0.072*	*0.116*	*0.353*	*0.083*	*55.1*
Bristol Bay [a]	*0.191*	*0.041*	*0.132*	*0.264*	*0.069*	*26.4*
Upper Yukon	0.016	0.007	0.006	0.030	0.004	18.3
Northern District	0.001	0.003	0.000	0.004	0.019	96.2
Northwestern District	0.064	0.014	0.043	0.088	0.004	6.7
South Peninsula	0.013	0.013	0.000	0.035	0.003	25.3
Chignik/Kodiak	0.008	0.011	0.000	0.030	0.002	18.6
East of Kodiak	0.056	0.013	0.037	0.078	0.006	12.8

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Table 3. Page 3 of 3.

Replicate 5

Reporting group	mean	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.250	0.022	0.214	0.287	0.000	0.0
Kotzebue	0.025	0.012	0.008	0.047	0.005	25.8
CWAK	0.564	0.030	0.514	0.611	0.004	0.7
Norton [a]	*0.062*	*0.042*	*0.000*	*0.133*	*0.012*	*23.1*
Yukon Coastal [a]	*0.157*	*0.057*	*0.067*	*0.254*	*0.057*	*57.1*
Kuskokwim [a]	*0.085*	*0.069*	*0.004*	*0.215*	*0.065*	*43.0*
Bristol Bay [a]	*0.260*	*0.053*	*0.180*	*0.355*	*0.000*	*0.1*
Upper Yukon	0.023	0.010	0.008	0.042	0.003	14.9
Northern District	0.015	0.014	0.001	0.042	0.005	26.2
Northwestern District	0.059	0.015	0.037	0.084	0.001	1.0
South Peninsula	0.010	0.007	0.000	0.022	0.000	4.9
Chignik/Kodiak	0.003	0.004	0.000	0.011	0.007	66.2
East of Kodiak	0.051	0.012	0.033	0.072	0.001	2.2

[a] The numbers in italics for these 4 reporting groups are the subset numbers of the total CWAK number, and therefore should not be summed with the nonitalicized numbers.

Table 4.–Six hypothetical mixtures, and their priority, provided by the *ad hoc* committee on October 10, 2011 to be used in proof tests to examine the performance of a divided coastal Western Alaska (CWAK) group for chum salmon for WASSIP. *S. Pen June (B) as run* proportions were provided by the Advisory Panel (AP) at the conclusion of the September 21-22 joint AP/Technical Committee meeting for the Gene Conservation Laboratory to start proof testing. The *Modified* numbers were provided after this mixture was analyzed and therefore not used.

	Composition of Hypothetical Mixtures (%)						
	S. Pen June (B)						
Reporting Group	As run	Modified	Bristol Bay	Kusko Bay	Norton Sound	S. Pen June (A)	S. Pen Post June
Asia	25	30		2	3	30	15
Kotzebue	2	2		2	5	2	1
CWAK	56	51	93	86	92	51	4
Norton [a]	*5*	*5*		*7*	*76*	*0*	*1*
Yukon Coastal [a]	*10*	*10*	*5*	*20*	*15*	*25*	*1*
Kuskokwim [a]	*15*	*15*	*10*	*55*	*1*	*10*	*1*
Bristol Bay [a]	*26*	*21*	*78*	*4*		*16*	*1*
Upper Yukon	2	2	2	5		2	
Northern District	2	2	5	2		2	5
Northwestern District	6	6		2		6	10
South Peninsula	1	1		1		1	45
Chignik/Kodiak	1	1				1	5
East of Kodiak	5	5				5	15
Priority/order	1	1	2	3	4	5	6

[a] The numbers in italics for these 4 reporting groups are the subset numbers of the total CWAK number, and therefore should not be summed with the nonitalicized numbers.

Table 5.–SPAM and BAYES estimates from 5 replicate samples for the *South Pen June (B) as run* fishery-based proof test. The 5 replicate samples consisted of different sets of individuals drawn from the baseline in the same reporting group proportions (Actual). These fish were removed from the baseline and used as mixtures. SPAM estimates were used as priors for the BAYES analysis. BAYES estimate (BAYES), standard deviation (sd), lower (CI 5) and upper (CI 95) 90% credibility interval values, absolute deviation from the known (ABS dev; proportion) and relative absolute deviation from the known (Rel ABS dev; percent) for each estimate are provided. Estimates for coastal western Alaska (CWAK) are shown both for a single reporting group and that proportion divided among the 4 reporting groups that make up CWAK.

Replicate 1

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.25	0.25	0.26	0.02	0.22	0.30	0.01	3.31
Kotzebue	0.02	0.01	0.00	0.00	0.00	0.00	0.02	98.6
CWAK	0.56	0.56	0.59	0.03	0.53	0.64	0.03	4.59
Norton [a]	*0.05*	*0.05*	*0.02*	*0.04*	*0.00*	*0.11*	*0.03*	*59.0*
Yukon Coastal [a]	*0.10*	*0.14*	*0.25*	*0.06*	*0.16*	*0.34*	*0.15*	*150.0*
Kuskokwim [a]	*0.15*	*0.12*	*0.14*	*0.06*	*0.01*	*0.24*	*0.01*	*9.10*
Bristol Bay [a]	*0.26*	*0.25*	*0.18*	*0.05*	*0.10*	*0.27*	*0.08*	*31.0*
Upper Yukon	0.02	0.03	0.01	0.01	0.00	0.03	0.01	49.4
Northern District	0.02	0.02	0.02	0.02	0.00	0.07	0.00	3.40
Northwestern District	0.06	0.06	0.06	0.02	0.04	0.09	0.00	1.25
South Peninsula	0.01	0.02	0.02	0.01	0.00	0.05	0.01	105.0
Chignik/Kodiak	0.01	0.01	0.00	0.01	0.00	0.02	0.01	68.8
East of Kodiak	0.05	0.04	0.04	0.01	0.03	0.06	0.01	13.1

Replicate 2

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.25	0.25	0.25	0.02	0.21	0.29	0.00	0.88
Kotzebue	0.02	0.02	0.01	0.00	0.00	0.01	0.01	73.6
CWAK	0.56	0.54	0.55	0.04	0.48	0.61	0.01	2.64
Norton [a]	*0.05*	*0.08*	*0.11*	*0.05*	*0.02*	*0.20*	*0.06*	*112.0*
Yukon Coastal [a]	*0.10*	*0.12*	*0.14*	*0.07*	*0.04*	*0.28*	*0.04*	*44.0*
Kuskokwim [a]	*0.15*	*0.14*	*0.18*	*0.07*	*0.04*	*0.30*	*0.03*	*21.0*
Bristol Bay [a]	*0.26*	*0.20*	*0.11*	*0.04*	*0.05*	*0.19*	*0.15*	*56.0*
Upper Yukon	0.02	0.02	0.03	0.01	0.01	0.05	0.01	26.5
Northern District	0.02	0.03	0.04	0.03	0.00	0.09	0.02	95.7
Northwestern District	0.06	0.06	0.06	0.01	0.04	0.09	0.00	2.52
South Peninsula	0.01	0.01	0.01	0.01	0.00	0.04	0.00	36.1
Chignik/Kodiak	0.01	0.02	0.01	0.02	0.00	0.05	0.00	45.5
East of Kodiak	0.05	0.05	0.05	0.01	0.03	0.07	0.00	4.82

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Table 5. Page 2 of 3.

Replicate 3

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.25	0.25	0.24	0.02	0.21	0.28	0.01	2.62
Kotzebue	0.02	0.02	0.01	0.00	0.00	0.02	0.01	58.7
CWAK	0.56	0.55	0.53	0.04	0.48	0.60	0.03	4.57
Norton [a]	*0.05*	*0.09*	*0.13*	*0.05*	*0.05*	*0.22*	*0.08*	*166.0*
Yukon Coastal [a]	*0.10*	*0.11*	*0.08*	*0.05*	*0.00*	*0.17*	*0.02*	*22.0*
Kuskokwim [a]	*0.15*	*0.16*	*0.22*	*0.06*	*0.13*	*0.32*	*0.07*	*47.0*
Bristol Bay [a]	*0.26*	*0.19*	*0.10*	*0.06*	*0.02*	*0.20*	*0.16*	*61.0*
Upper Yukon	0.02	0.03	0.02	0.01	0.01	0.04	0.00	15.6
Northern District	0.02	0.02	0.05	0.03	0.00	0.09	0.03	130.0
Northwestern District	0.06	0.06	0.06	0.01	0.04	0.09	0.00	6.52
South Peninsula	0.01	0.01	0.00	0.00	0.00	0.01	0.01	84.8
Chignik/Kodiak	0.01	0.02	0.04	0.01	0.02	0.06	0.03	258.0
East of Kodiak	0.05	0.05	0.04	0.01	0.03	0.06	0.01	12.9

Replicate 4

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.25	0.25	0.25	0.02	0.21	0.28	0.00	1.87
Kotzebue	0.02	0.02	0.00	0.00	0.00	0.01	0.02	95.0
CWAK	0.56	0.56	0.59	0.03	0.55	0.63	0.03	5.66
Norton [a]	*0.05*	*0.06*	*0.10*	*0.05*	*0.00*	*0.18*	*0.05*	*99.0*
Yukon Coastal [a]	*0.10*	*0.12*	*0.11*	*0.06*	*0.01*	*0.22*	*0.01*	*15.0*
Kuskokwim [a]	*0.15*	*0.19*	*0.25*	*0.06*	*0.15*	*0.35*	*0.10*	*66.0*
Bristol Bay [a]	*0.26*	*0.20*	*0.13*	*0.03*	*0.09*	*0.18*	*0.13*	*50.0*
Upper Yukon	0.02	0.02	0.02	0.01	0.01	0.03	0.00	14.7
Northern District	0.02	0.01	0.00	0.01	0.00	0.02	0.02	85.9
Northwestern District	0.06	0.06	0.06	0.01	0.04	0.09	0.00	7.62
South Peninsula	0.01	0.01	0.01	0.01	0.00	0.03	0.00	4.25
Chignik/Kodiak	0.01	0.02	0.01	0.01	0.00	0.03	0.00	20.5
East of Kodiak	0.05	0.06	0.06	0.01	0.04	0.08	0.01	11.8

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Table 5. Page 3 of 3.

Replicate 5

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.25	0.25	0.25	0.02	0.21	0.28	0.00	1.14
Kotzebue	0.02	0.03	0.02	0.01	0.01	0.05	0.00	22.5
CWAK	0.56	0.53	0.54	0.03	0.49	0.59	0.02	3.90
Norton [a]	*0.05*	*0.08*	*0.05*	*0.05*	*0.00*	*0.13*	*0.00*	*2.20*
Yukon Coastal [a]	*0.10*	*0.11*	*0.14*	*0.05*	*0.05*	*0.24*	*0.04*	*39.0*
Kuskokwim [a]	*0.15*	*0.14*	*0.21*	*0.09*	*0.06*	*0.34*	*0.06*	*38.0*
Bristol Bay [a]	*0.26*	*0.21*	*0.14*	*0.04*	*0.08*	*0.22*	*0.12*	*45.0*
Upper Yukon	0.02	0.03	0.02	0.01	0.01	0.04	0.00	10.9
Northern District	0.02	0.03	0.04	0.02	0.01	0.07	0.02	114
Northwestern District	0.06	0.05	0.06	0.02	0.03	0.08	0.00	3.35
South Peninsula	0.01	0.01	0.01	0.01	0.00	0.02	0.00	25.5
Chignik/Kodiak	0.01	0.01	0.00	0.00	0.00	0.01	0.01	61.6
East of Kodiak	0.05	0.05	0.06	0.01	0.04	0.08	0.01	11.88

[a] The numbers in italics for these 4 reporting groups are the subset numbers of the total CWAK number, and therefore should not be summed with the nonitalicized numbers.

Table 6.–SPAM and BAYES estimates from 5 replicate samples for the *Bristol Bay* fishery-based proof test. The 5 replicate samples consisted of different sets of individuals drawn from the baseline in the same reporting group proportions (Actual). These fish were removed from the baseline and used as mixtures. SPAM estimates were used as priors for the BAYES analysis. BAYES estimate (BAYES), standard deviation (sd), lower (CI 5) and upper (CI 95) 90% credibility interval values, absolute deviation from the known (ABS dev; proportion) and relative absolute deviation from the known (Rel ABS dev; percent; na if Actual = 0) for each estimate are provided. Estimates for coastal western Alaska (CWAK) are shown both for a single reporting group and that proportion divided among the 4 reporting groups that make up CWAK.

Replicate 1

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na
Kotzebue	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na
CWAK	0.93	0.80	0.88	0.03	0.82	0.92	0.05	5.6
Norton [a]	*0.00*	*0.13*	*0.21*	*0.08*	*0.07*	*0.33*	*0.21*	*na*
Yukon Coastal [a]	*0.05*	*0.11*	*0.02*	*0.03*	*0.00*	*0.08*	*0.03*	*68.3*
Kuskokwim [a]	*0.10*	*0.23*	*0.23*	*0.09*	*0.09*	*0.40*	*0.13*	*131.3*
Bristol Bay [a]	*0.78*	*0.33*	*0.42*	*0.06*	*0.31*	*0.52*	*0.36*	*46.2*
Upper Yukon	0.02	0.03	0.02	0.01	0.01	0.03	0.00	5.8
Northern District	0.05	0.12	0.10	0.03	0.06	0.15	0.05	104.2
Northwestern District	0.00	0.01	0.00	0.00	0.00	0.01	0.00	na
South Peninsula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
Chignik/Kodiak	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na
East of Kodiak	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na

Replicate 2

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.00	0.02	0.00	0.00	0.00	0.00	0.00	na
Kotzebue	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na
CWAK	0.93	0.80	0.94	0.03	0.87	0.98	0.01	0.8
Norton [a]	*0.00*	*0.09*	*0.02*	*0.02*	*0.00*	*0.07*	*0.02*	*na*
Yukon Coastal [a]	*0.05*	*0.09*	*0.22*	*0.06*	*0.13*	*0.32*	*0.17*	*342.0*
Kuskokwim [a]	*0.10*	*0.19*	*0.15*	*0.08*	*0.00*	*0.27*	*0.05*	*48.1*
Bristol Bay [a]	*0.78*	*0.43*	*0.55*	*0.07*	*0.44*	*0.66*	*0.23*	*29.2*
Upper Yukon	0.02	0.03	0.02	0.01	0.01	0.04	0.00	9.0
Northern District	0.05	0.08	0.04	0.03	0.01	0.11	0.01	11.4
Northwestern District	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na
South Peninsula	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na
Chignik/Kodiak	0.00	0.02	0.00	0.00	0.00	0.00	0.00	na
East of Kodiak	0.00	0.02	0.00	0.00	0.00	0.00	0.00	na

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Table 6. Page 2 of 3.

Replicate 3

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
Kotzebue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
CWAK	0.93	0.85	0.86	0.05	0.79	0.94	0.07	7.5
Norton [a]	*0.00*	*0.07*	*0.04*	*0.04*	*0.00*	*0.11*	*0.04*	*na*
Yukon Coastal [a]	*0.05*	*0.08*	*0.05*	*0.07*	*0.00*	*0.20*	*0.00*	*9.7*
Kuskokwim [a]	*0.10*	*0.18*	*0.28*	*0.09*	*0.13*	*0.41*	*0.18*	*180.7*
Bristol Bay [a]	*0.78*	*0.53*	*0.49*	*0.07*	*0.37*	*0.61*	*0.29*	*37.3*
Upper Yukon	0.02	0.03	0.02	0.01	0.01	0.04	0.00	17.5
Northern District	0.05	0.10	0.12	0.04	0.04	0.19	0.07	131.6
Northwestern District	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
South Peninsula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
Chignik/Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
East of Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na

Replicate 4

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
Kotzebue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
CWAK	0.93	0.88	0.94	0.02	0.90	0.96	0.01	*1.0*
Norton [a]	*0.00*	*0.07*	*0.07*	*0.05*	*0.00*	*0.16*	*0.07*	*na*
Yukon Coastal [a]	*0.05*	*0.06*	*0.02*	*0.03*	*0.00*	*0.10*	*0.03*	*69.0*
Kuskokwim [a]	*0.10*	*0.18*	*0.33*	*0.07*	*0.22*	*0.43*	*0.23*	*226.1*
Bristol Bay [a]	*0.78*	*0.57*	*0.52*	*0.05*	*0.45*	*0.61*	*0.26*	*32.8*
Upper Yukon	0.02	0.03	0.02	0.01	0.01	0.03	0.00	5.4
Northern District	0.05	0.08	0.04	0.02	0.02	0.07	0.01	16.6
Northwestern District	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
South Peninsula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
Chignik/Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
East of Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na

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Table 6. Page 3 of 3.

Replicate 5

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na
Kotzebue	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na
CWAK	0.93	0.85	0.92	0.04	0.83	0.97	0.01	0.8
Norton [a]	*0.00*	*0.10*	*0.06*	*0.05*	*0.00*	*0.15*	*0.06*	*na*
Yukon Coastal [a]	*0.05*	*0.10*	*0.11*	*0.07*	*0.00*	*0.23*	*0.06*	*125.9*
Kuskokwim [a]	*0.10*	*0.19*	*0.20*	*0.09*	*0.07*	*0.36*	*0.10*	*103.5*
Bristol Bay [a]	*0.78*	*0.46*	*0.55*	*0.08*	*0.41*	*0.67*	*0.23*	*29.4*
Upper Yukon	0.02	0.03	0.02	0.01	0.01	0.04	0.00	2.6
Northern District	0.05	0.08	0.06	0.04	0.02	0.15	0.01	13.4
Northwestern District	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
South Peninsula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
Chignik/Kodiak	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na
East of Kodiak	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na

[a] The numbers in italics for these 4 reporting groups are the subset numbers of the total CWAK number, and therefore should not be summed with the nonitalicized numbers.

Table 7.–SPAM and BAYES estimates from 5 replicate samples for the *Kusko Bay* fishery-based proof test. The 5 replicate samples consisted of different sets of individuals drawn from the baseline in the same reporting group proportions (Actual). These fish were removed from the baseline and used as mixtures. SPAM estimates were used as priors for the BAYES analysis. BAYES estimate (BAYES), standard deviation (sd), lower (CI 5) and upper (CI 95) 90% credibility interval values, absolute deviation from the known (ABS dev; proportion) and relative absolute deviation from the known (Rel ABS dev; percent; na if Actual = 0) for each estimate are provided. Estimates for coastal western Alaska (CWAK) are shown both for a single reporting group and that proportion divided among the 4 reporting groups that make up CWAK.

Replicate 1

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.02	0.03	0.02	0.01	0.01	0.04	0.00	8.7
Kotzebue	0.02	0.03	0.02	0.01	0.00	0.05	0.00	19.5
CWAK	0.86	0.79	0.84	0.03	0.79	0.88	0.02	2.8
Norton [a]	*0.07*	*0.16*	*0.05*	*0.05*	*0.00*	*0.15*	*0.02*	*25.7*
Yukon Coastal [a]	*0.20*	*0.22*	*0.26*	*0.08*	*0.13*	*0.39*	*0.06*	*28.8*
Kuskokwim [a]	*0.55*	*0.34*	*0.47*	*0.09*	*0.31*	*0.62*	*0.08*	*15.0*
Bristol Bay [a]	*0.04*	*0.08*	*0.06*	*0.06*	*0.00*	*0.16*	*0.02*	*46.9*
Upper Yukon	0.05	0.07	0.06	0.02	0.03	0.09	0.01	23.1
Northern District	0.02	0.03	0.03	0.01	0.00	0.05	0.01	27.1
Northwestern District	0.02	0.02	0.02	0.01	0.00	0.04	0.00	5.9
South Peninsula	0.01	0.01	0.01	0.01	0.00	0.02	0.00	43.9
Chignik/Kodiak	0.00	0.02	0.01	0.01	0.00	0.02	0.01	na
East of Kodiak	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na

Replicate 2

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.02	0.03	0.02	0.01	0.01	0.04	0.00	11.8
Kotzebue	0.02	0.02	0.01	0.01	0.00	0.02	0.01	65.8
CWAK	0.86	0.84	0.88	0.02	0.85	0.91	0.02	2.6
Norton [a]	*0.07*	*0.13*	*0.10*	*0.04*	*0.03*	*0.17*	*0.03*	*36.6*
Yukon Coastal [a]	*0.20*	*0.23*	*0.29*	*0.08*	*0.16*	*0.42*	*0.09*	*46.5*
Kuskokwim [a]	*0.55*	*0.37*	*0.47*	*0.08*	*0.33*	*0.61*	*0.08*	*15.1*
Bristol Bay [a]	*0.04*	*0.10*	*0.03*	*0.03*	*0.00*	*0.10*	*0.01*	*34.0*
Upper Yukon	0.05	0.05	0.04	0.01	0.02	0.07	0.01	19.7
Northern District	0.02	0.02	0.02	0.01	0.00	0.04	0.00	20.3
Northwestern District	0.02	0.02	0.03	0.01	0.01	0.05	0.01	34.0
South Peninsula	0.01	0.01	0.00	0.00	0.00	0.01	0.01	63.2
Chignik/Kodiak	0.00	0.01	0.00	0.00	0.00	0.01	0.00	na
East of Kodiak	0.00	0.01	0.00	0.00	0.00	0.00	0.00	na

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Table 7. Page 2 of 3.

Replicate 3

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.02	0.02	0.02	0.01	0.01	0.03	0.00	11.0
Kotzebue	0.02	0.02	0.01	0.01	0.00	0.02	0.01	66.1
CWAK	0.86	0.84	0.89	0.02	0.85	0.92	0.03	3.1
Norton [a]	*0.07*	*0.15*	*0.24*	*0.07*	*0.11*	*0.36*	*0.17*	*243.3*
Yukon Coastal [a]	*0.20*	*0.28*	*0.44*	*0.09*	*0.29*	*0.58*	*0.24*	*117.6*
Kuskokwim [a]	*0.55*	*0.31*	*0.17*	*0.08*	*0.05*	*0.31*	*0.38*	*68.8*
Bristol Bay [a]	*0.04*	*0.10*	*0.04*	*0.03*	*0.01*	*0.10*	*0.00*	*0.1*
Upper Yukon	0.05	0.06	0.05	0.01	0.03	0.07	0.00	3.9
Northern District	0.02	0.02	0.00	0.01	0.00	0.01	0.02	92.2
Northwestern District	0.02	0.02	0.03	0.01	0.02	0.05	0.01	53.0
South Peninsula	0.01	0.01	0.00	0.00	0.00	0.01	0.01	88.2
Chignik/Kodiak	0.00	0.01	0.01	0.01	0.00	0.02	0.01	na
East of Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na

Replicate 4

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.02	0.02	0.02	0.01	0.01	0.03	0.00	3.5
Kotzebue	0.02	0.01	0.00	0.00	0.00	0.00	0.02	99.2
CWAK	0.86	0.85	0.86	0.02	0.82	0.90	0.00	0.4
Norton [a]	*0.07*	*0.15*	*0.19*	*0.08*	*0.04*	*0.31*	*0.12*	*165.7*
Yukon Coastal [a]	*0.20*	*0.24*	*0.30*	*0.09*	*0.16*	*0.45*	*0.10*	*51.1*
Kuskokwim [a]	*0.55*	*0.36*	*0.31*	*0.12*	*0.11*	*0.51*	*0.24*	*43.4*
Bristol Bay [a]	*0.04*	*0.11*	*0.06*	*0.06*	*0.00*	*0.17*	*0.02*	*60.0*
Upper Yukon	0.05	0.07	0.07	0.02	0.04	0.10	0.02	38.1
Northern District	0.02	0.02	0.02	0.01	0.00	0.04	0.00	12.5
Northwestern District	0.02	0.01	0.01	0.01	0.00	0.02	0.01	55.1
South Peninsula	0.01	0.01	0.02	0.01	0.00	0.04	0.01	83.7
Chignik/Kodiak	0.00	0.01	0.00	0.01	0.00	0.01	0.00	na
East of Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na

-continued-

Table 7. Page 3 of 3.

Replicate 5

Reporting group	Actual	SPAM	BAYES	sd	CI 5	CI 95	ABS dev	Rel ABS dev
Asia	0.02	0.02	0.02	0.01	0.01	0.03	0.00	1.1
Kotzebue	0.02	0.01	0.01	0.00	0.00	0.01	0.01	70.3
CWAK	0.86	0.87	0.89	0.02	0.85	0.92	0.03	3.6
Norton [a]	*0.07*	*0.16*	*0.13*	*0.07*	*0.02*	*0.26*	*0.06*	*92.6*
Yukon Coastal [a]	*0.20*	*0.22*	*0.38*	*0.10*	*0.21*	*0.53*	*0.18*	*88.6*
Kuskokwim [a]	*0.55*	*0.34*	*0.29*	*0.09*	*0.16*	*0.45*	*0.26*	*47.3*
Bristol Bay [a]	*0.04*	*0.15*	*0.09*	*0.05*	*0.00*	*0.18*	*0.05*	*124.1*
Upper Yukon	0.05	0.06	0.05	0.02	0.02	0.08	0.00	5.9
Northern District	0.02	0.01	0.00	0.01	0.00	0.01	0.02	90.3
Northwestern District	0.02	0.02	0.03	0.01	0.01	0.05	0.01	42.1
South Peninsula	0.01	0.01	0.01	0.01	0.00	0.02	0.00	49.8
Chignik/Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na
East of Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	na

[a] The numbers in italics for these 4 reporting groups are the subset numbers of the total CWAK number, and therefore should not be summed with the nonitalicized numbers.

FIGURES

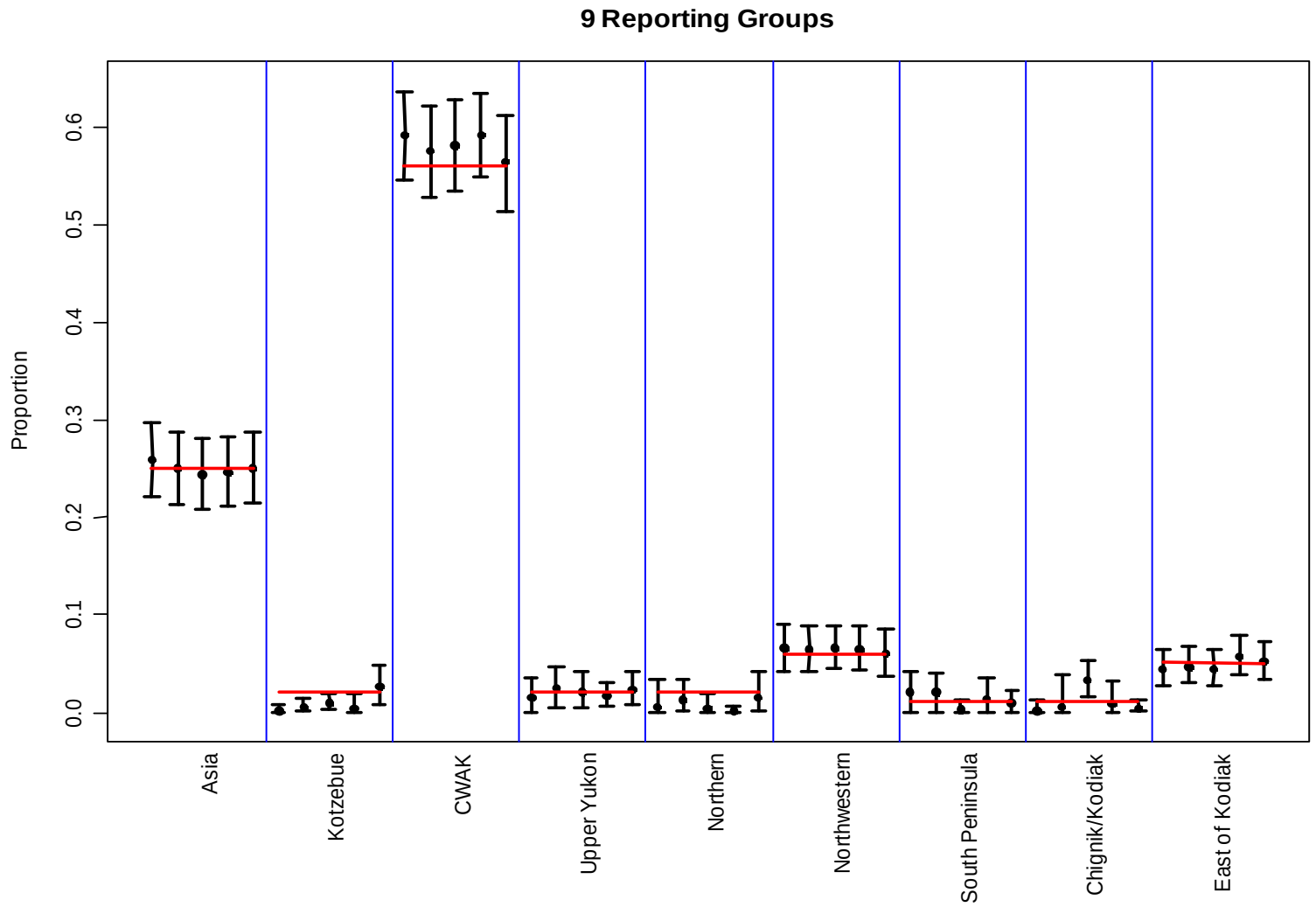

Figure 1.– BAYES estimates for 5 replicate samples for a fishery-based proof test for 9 reporting groups where Coastal Western Alaska (CWAK) is a single reporting group. The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot) and 90% credibility interval (vertical line) are provided.

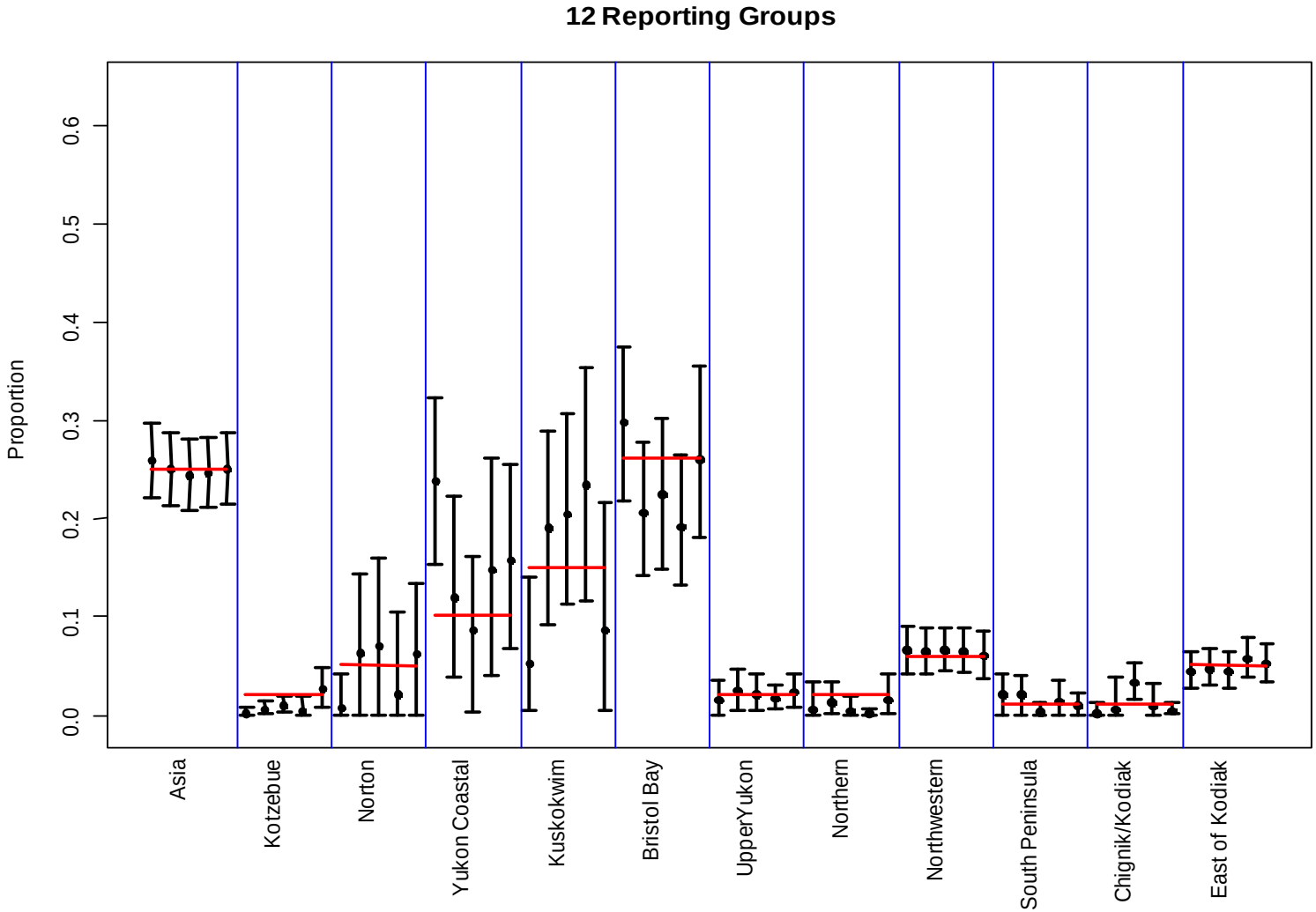

Figure 2.– BAYES estimates for 5 replicate samples for a fishery-based proof test for 12 reporting groups where Coastal Western Alaska (CWAK) divided into 4 reporting groups (Norton, Yukon Coastal, Kuskokwim, Bristol Bay). The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot) and 90% credibility interval (vertical line) are provided.

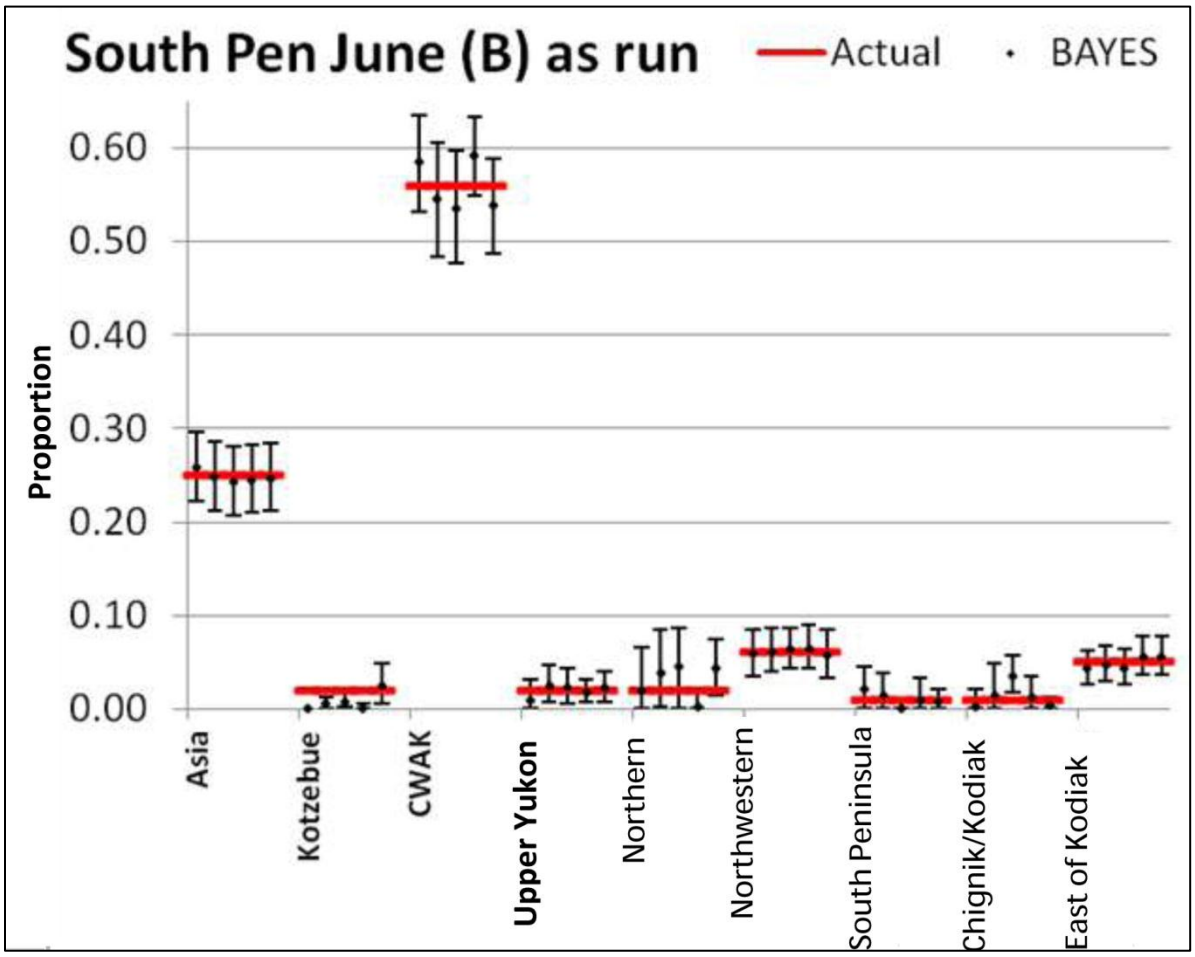

Figure 3.– BAYES estimates for 5 replicate samples for the fishery-based proof test *South Pen June (b) as run* (see Table 4) for 9 reporting groups where Coastal Western Alaska (CWAK) is a single reporting group. The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot) and 90% credibility interval (vertical line) are provided.

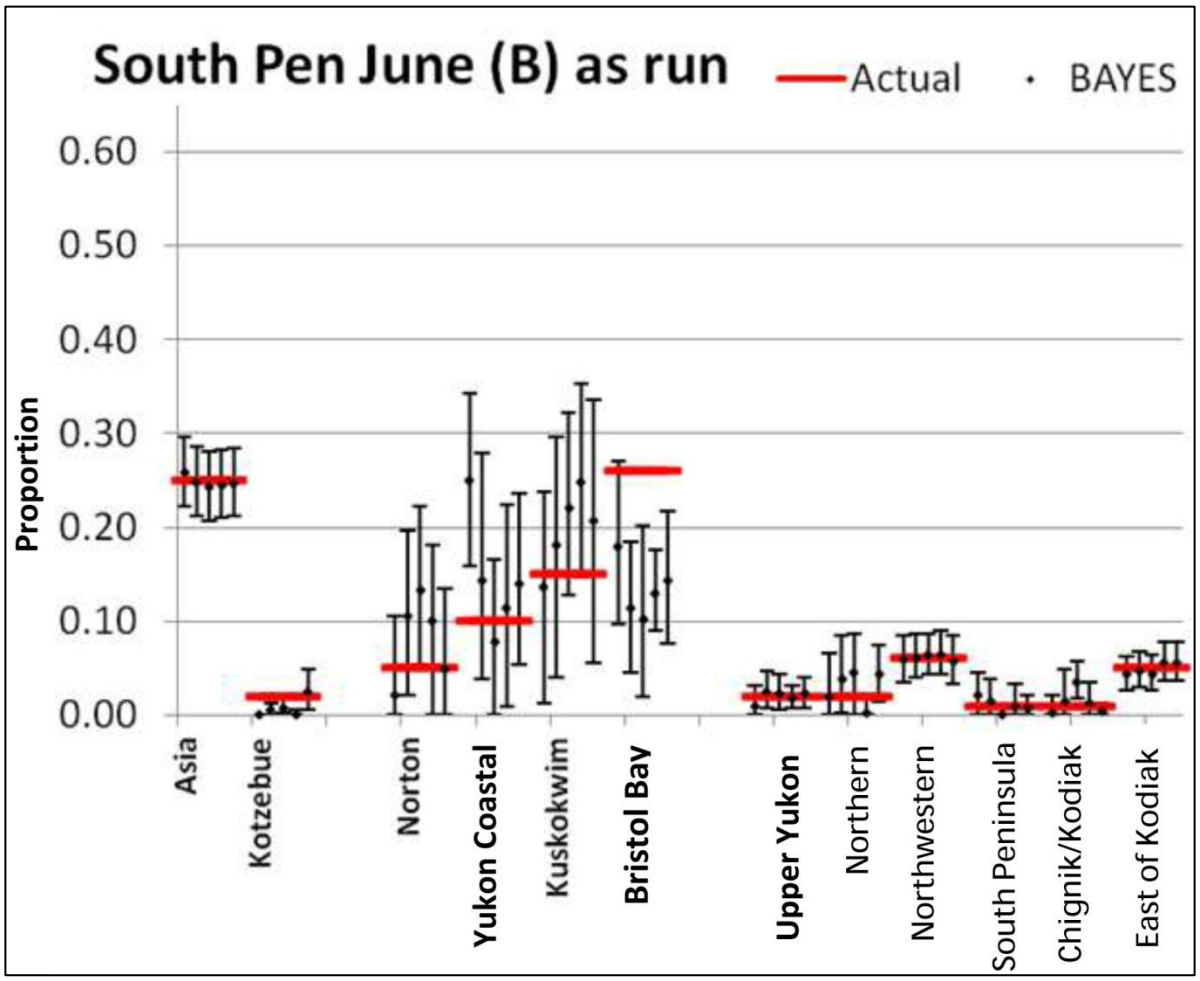

Figure 4.–BAYES estimates for 5 replicate samples for a fishery-based proof test *South Pen June (b) as run* (see Table 4) for 12 reporting groups where Coastal Western Alaska (CWAK) divided into 4 reporting groups (Norton, Yukon Coastal, Kuskokwim, Bristol Bay). The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot) and 90% credibility interval (vertical line) are provided.

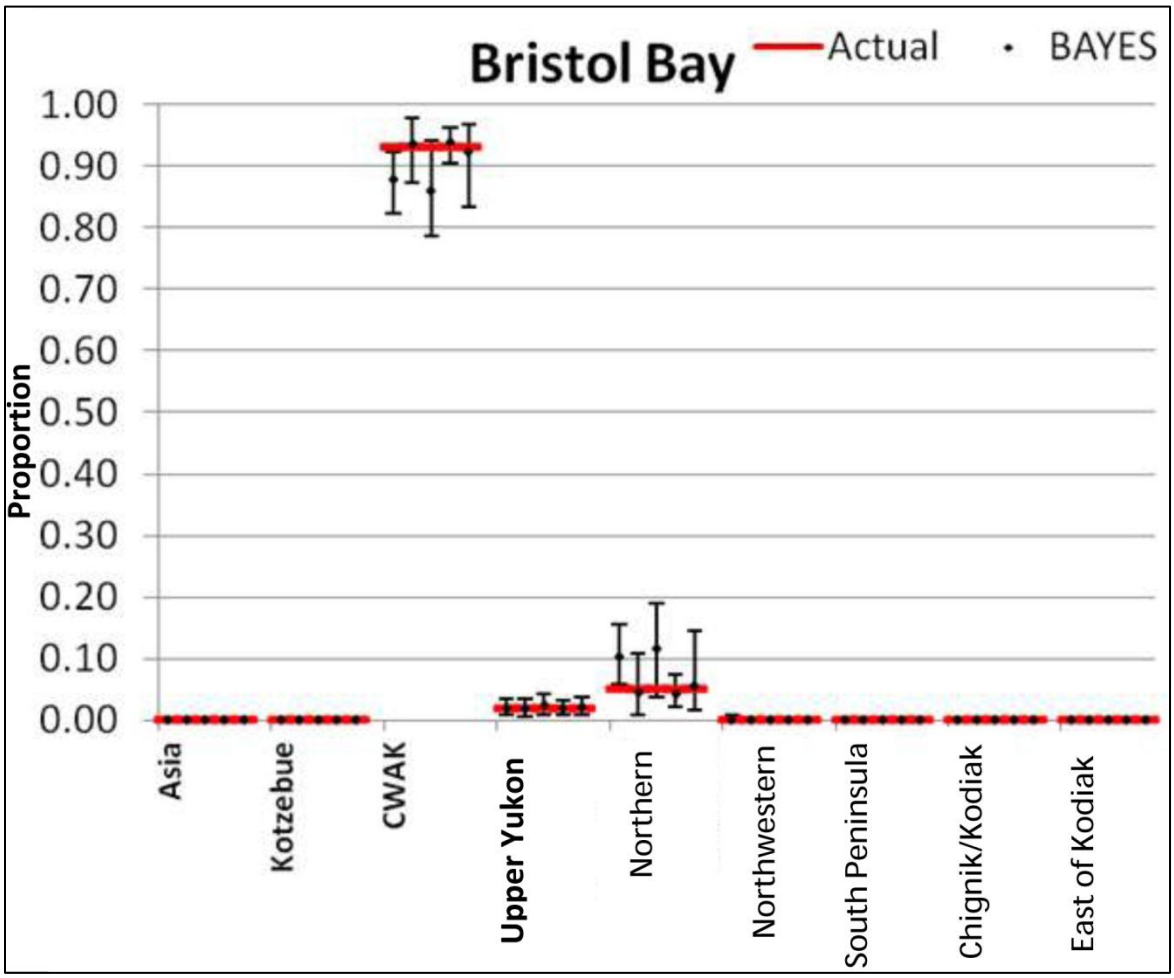

Figure 5.– BAYES estimates for 5 replicate samples for the fishery-based proof test *Bristol Bay* (see Table 4) for 9 reporting groups where Coastal Western Alaska (CWAK) is a single reporting group. The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot) and 90% credibility interval (vertical line) are provided.

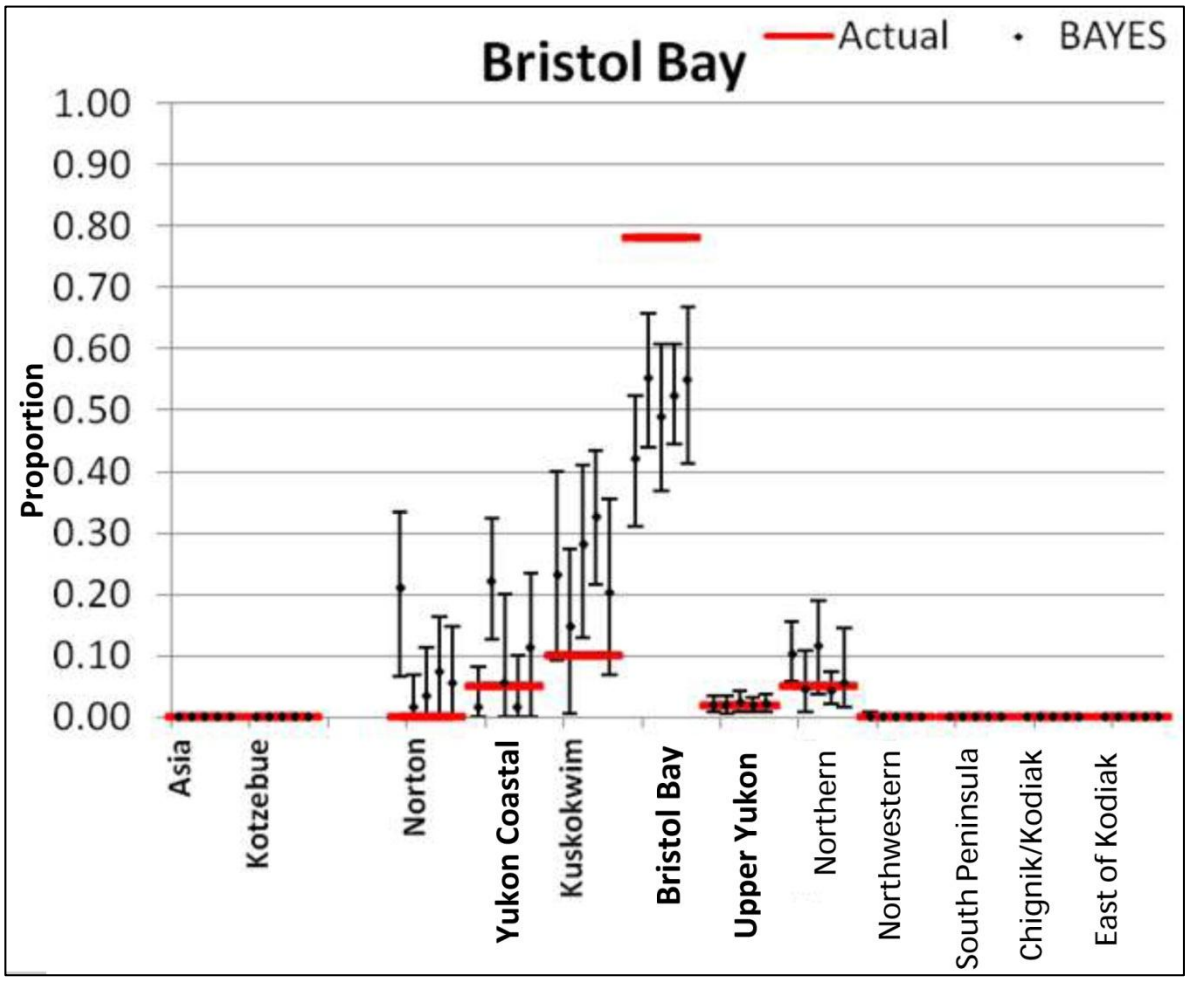

Figure 6.–BAYES estimates for 5 replicate samples for a fishery-based proof test *Bristol Bay* (see Table 4) for 12 reporting groups where Coastal Western Alaska (CWAK) divided into 4 reporting groups (Norton, Yukon Coastal, Kuskokwim, Bristol Bay). The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot) and 90% credibility interval (vertical line) are provided.

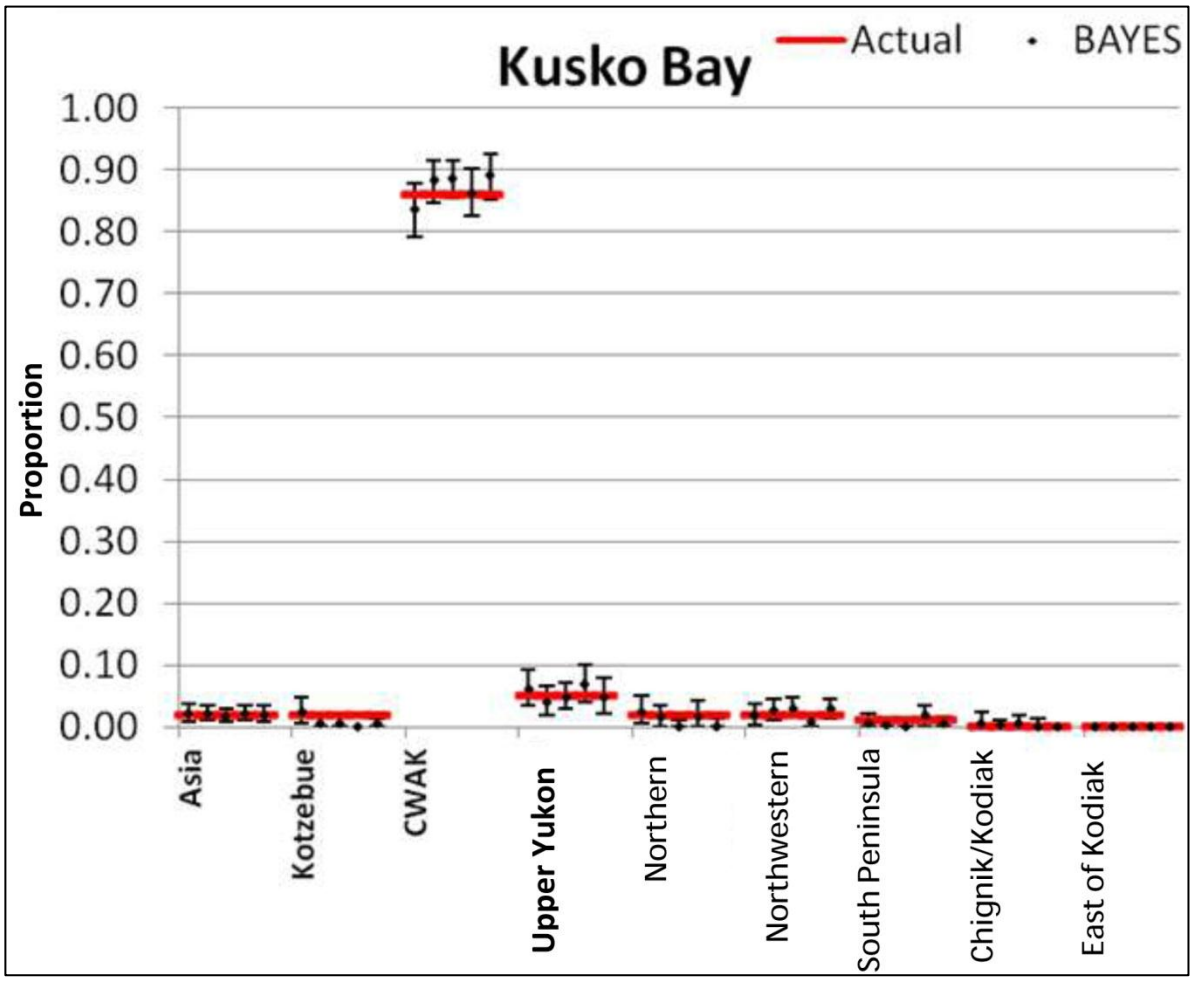

Figure 7.– BAYES estimates for 5 replicate samples for the fishery-based proof test *Kusko Bay* (see Table 4) for 9 reporting groups where Coastal Western Alaska (CWAK) is a single reporting group. The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot) and 90% credibility interval (vertical line) are provided.

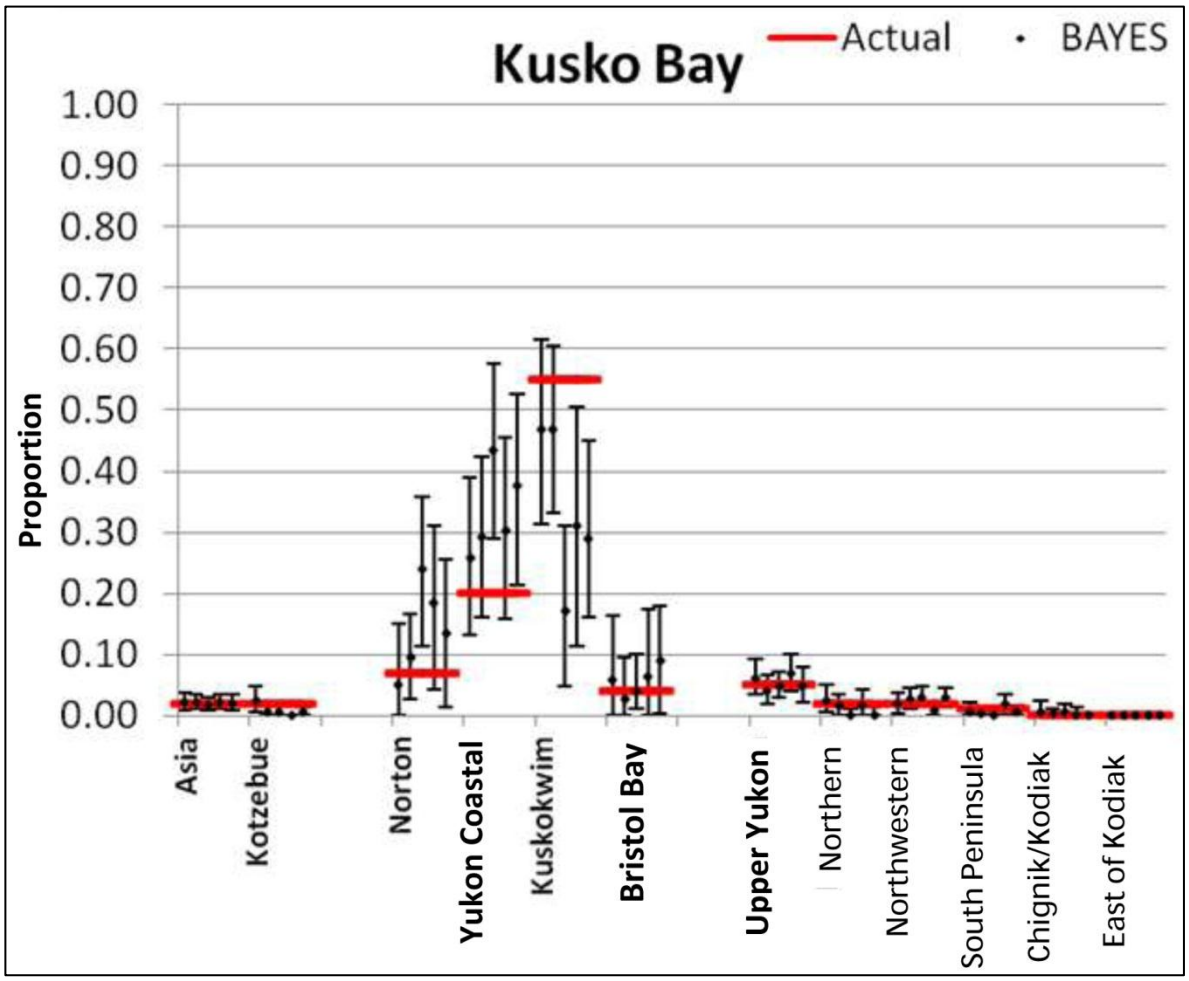

Figure 8.– BAYES estimates for 5 replicate samples for a fishery-based proof test *Kusko Bay* (see Table 4) for 12 reporting groups where Coastal Western Alaska (CWAK) divided into 4 reporting groups (Norton, Yukon Coastal, Kuskokwim, Bristol Bay). The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot) and 90% credibility interval (vertical line) are provided.