Western Alaska Salmon Stock Identification Program **Technical Document**:[1] 15

Version: Addendum 1

Title: Addendum 1 to Technical Document 15 "Chum salmon reporting group evaluations using simulated fishery mixtures"

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Introduction

During the joint Advisory Panel (AP)/Technical Committee (TC) meeting held in Anchorage on September 21 and 22, 2011, Gene Conservation Laboratory (GCL) presented results of tests evaluating reporting groups for the chum salmon baseline. 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 Technical Document (TD) 5, "*Status of the SNP baseline for sockeye salmon*." The results from these tests indicated that the addition of new 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 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 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).

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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, lower Yukon River, Kuskokwim River, and Bristol Bay as separate reporting groups or as a single CWAK reporting group.

An ad-hoc committee was assembled, chaired by Michael Link and including Art Nelson, Pat Martin, Doug Eggers and Denby Lloyd. The committee was tasked with developing 6 fishery-based mixture compositions for the fishery-based proof testing by ADFG, reviewing the results and providing recommendations to the AP and TC. The timeframe for this exercise is short due to the time constraints of the project. The committee will provide the mixture compositions to GCL by September 30 and the conclusion of this work is scheduled for October 15.

Prior choice for proof 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 anticipate using to analyze WASSIP mixtures will use information from strata within each fishery (addendum to TD 13, "*Selection of a Prior for Mixed Stock Analysis*"; sent to the TC September 26, 2011). Since we do not have this information for this exercise, we will use 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 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 will be added to the lower Kuskokwim River reporting group and this new reporting group will be referred to as the "Kuskokwim River" reporting group. The upper Yukon River reporting group will be maintained separately.

Methods

Developing mixture compositions

The committee will develop 6 fishery-based stock compositions for proof testing. These fishery compositions will cover 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 will be 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 TD 5, 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 two 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 as subdivided into Norton Sound, lower Yukon River, Kuskokwim River, and Bristol Bay reporting groups (Table 1). Tabulation of results included a table of four related measures:

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

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

3) root mean square error (range 0 to 1)

$$\left(rMSR_g = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\hat{p}_{s,g}^{(i)} - p_{s,g}\right)^2}\right), \text{ and;}$$

4) relative root mean square error (range 0 to infinity)

$$\left(rMSR_g' = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\hat{p}_{s,g}^{(i)} - p_{s,g}\right)^2 / \hat{p}_{s,g}^{(i)}}\right).$$

The first two measures were provided for each reporting group, g, for each fishery mixture, s, and for each repetition i $(i = 1,2, \ldots, n;\ n = 5)$, whereas the second set of measures are summaries across repetitions for each reporting group for each mixture. Results were provided to the committee for review as they became available so that the committee can determine if a recommendation can be made to the AP/TC before all the fishery-based proof tests are completed. The results from the initial set of proportions are reported here.

Results

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 will be provided for testing. Here we present the results from this first fishery-based proof test.

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

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, lower Yukon River, Kuskokwim River, and Bristol Bay reporting groups) (Table 3 and Figures 1 and 2). The estimates for the 9 reporting were within 0.03 of the actual in every case and averaged 0.01, whereas for the 4 reporting groups within CWAK, the deviations were as high as 0.14 from the actual, and averaged 0.05. Credibility interval widths averaged 0.04 and 0.16 for the 9 and 12 reporting groups, respectively.

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 for the 9 reporting groups and the 4 CWAK reporting groups 89% and 85% of the time, respectively. 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, Lower Yukon, 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, but not NWPenn, and EastKodiak reporting groups, which all had 5% actual contributions in the fishery-based proof test mixture. EastKodiak and NWPenn both met the 90% correct allocation criterion in 100% proof tests, whereas Norton did not. The imprecision of the Norton 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 River 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, two reporting groups had large relative negative biases (Koztebue 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.

Literature Cited

Debevec, E. M., R. B. Gates, M. Masuda, J. Pella, J. Reynolds, and L. W. Seeb. 2000. SPAM (version 3.2): Statistics Program for Analyzing Mixtures. Journal of Heredity 91: 509–510.

Gilk, S.E., D.B. Molyneaux, T. Hamazaki, J.A. Pawluk and W.D. Templin. 2009. Biological and genetic characteristics of fall and summer chum salmon in the Kuskokwim River, Alaska. Pages 161-179 *in* Krueger, C.C. and C.E. Zimmerman, editors. Pacific Salmon: ecology and management of western Alaska's populations. American Fisheries Society Symposium 70, Bethesda, MD.

Questions for the ad-hoc committee

1) Do these results provide the information needed for the committee to recommend reporting groups to the WASSIP AP?
2) If not, will additional tests of other fishery-based mixtures provide the information required to make this decision?
3) If so, has the committee agreed on proportions for up to 5 additional hypothetical mixtures that would be valuable for these tests?

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 two sets of reporting groups. Reporting group names in parentheses are used in result tables and figures.

Reporting groups		Population	N
“9”	“12”		
Asia		Namdae River	90
(Asia)		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

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		Kanchalan	77
		Udarnitza River	43
Kotzebue Sound		Inmachuk River	91
(Kotzebue)		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
(CWAK)	(Norton)	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
	Coastal Yukon River	Black River	93
	(Yukon Coastal)	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
	(Kuskokwim)	Kwethluk River	143
		Tuluksak River Weir	92

Table 1. (Page 3 of 6).

	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
(BristolBay)	Sunshine Creek	47
	Iowithla River	95
	Snake River	48
	Upper Nushagak	97
	Stuyahok River	86
	Klutuspak Creek	70
	Alagnek River	92
	Whale Mountain Creek	189
	Pumice Creek	95
	Wandering Creek	50
Upper Yukon River	Henshaw Creek - late	60
(UpperYukon)	South Fork Koyukuk R.- Late	92
	Jim River	92
	Tanana River Mainstem	95
	Toklat River	95
	Kantishna River	94
	Chena River	77
	Salcha River	83
	Delta River - Fairbanks	149
	Bluff Cabin	99
	Big Salt River	70

Table 1. (Page 4 of 6).

	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 Peninsula (NorthPenn)	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 Peninsula (NWPenn)	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 (SouthPenn)	Little John Lagoon	80
	Sandy Cove	186
	Little John Lagoon	92
	Russell Creek	185
	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

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	Coleman Creek	95
	Chichagof Bay	180
	Stepovak Bay - Big River	143
	Stepovak River	189
Chignik/Kodiak (includes K. Island)	Ivanoff River	181
(ChignikKod)	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
	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

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East of Kodiak (EastKodiak)	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
	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
YukonCoastal	0.100	0.140	0.124	0.106	0.115	0.106
Kusko	0.150	0.118	0.144	0.155	0.191	0.142
BristolBay	0.260	0.254	0.200	0.192	0.199	0.211
UpperYukon	0.020	0.027	0.024	0.026	0.021	0.032
NorthPenn	0.020	0.018	0.033	0.023	0.008	0.034
NWPenn	0.060	0.057	0.059	0.059	0.061	0.051
SouthPenn	0.010	0.019	0.010	0.010	0.010	0.007
ChignikKod	0.010	0.013	0.016	0.022	0.018	0.011
EastKodiak	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 (italics) that make up CWAK.

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	*0.006*	*0.017*	*0.000*	*0.040*	*0.044*	*88.1*
YukonCoastal	*0.237*	*0.052*	*0.152*	*0.322*	*0.137*	*136.8*
Kuskokwim	*0.051*	*0.046*	*0.004*	*0.139*	*0.099*	*65.8*
BristolBay	*0.297*	*0.048*	*0.217*	*0.374*	*0.037*	*14.3*
UpperYukon	0.015	0.011	0.000	0.035	0.005	25.7
NorthPenn	0.005	0.011	0.000	0.032	0.015	74.8
NWPenn	0.064	0.015	0.041	0.090	0.004	7.5
SouthPenn	0.020	0.012	0.000	0.042	0.010	104.2
ChignikKod	0.001	0.005	0.000	0.011	0.009	86.0
EastKodiak	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	*0.062*	*0.047*	*0.000*	*0.143*	*0.012*	*24.1*
YukonCoastal	*0.119*	*0.057*	*0.037*	*0.222*	*0.019*	*19.0*
Kuskokwim	*0.189*	*0.060*	*0.091*	*0.288*	*0.039*	*26.0*
BristolBay	*0.204*	*0.042*	*0.141*	*0.278*	*0.056*	*21.3*
UpperYukon	0.025	0.013	0.004	0.046	0.005	22.5
NorthPenn	0.011	0.011	0.000	0.034	0.009	43.1
NWPenn	0.064	0.014	0.042	0.088	0.004	6.3
SouthPenn	0.020	0.012	0.000	0.040	0.010	98.3
ChignikKod	0.005	0.012	0.000	0.038	0.005	51.7
EastKodiak	0.046	0.012	0.029	0.067	0.004	7.1

Replicate 3 Table 3 (continued)

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	*0.069*	*0.052*	*0.000*	*0.159*	*0.019*	*37.2*
YukonCoastal	*0.085*	*0.045*	*0.002*	*0.160*	*0.015*	*14.6*
Kuskokwim	*0.203*	*0.059*	*0.113*	*0.305*	*0.053*	*35.3*
BristolBay	*0.224*	*0.046*	*0.149*	*0.302*	*0.036*	*13.7*
UpperYukon	0.020	0.012	0.004	0.042	0.000	1.9
NorthPenn	0.003	0.007	0.000	0.019	0.017	83.2
NWPenn	0.065	0.013	0.044	0.088	0.005	8.2
SouthPenn	0.002	0.005	0.000	0.011	0.008	79.0
ChignikKod	0.033	0.012	0.015	0.053	0.023	225.9
EastKodiak	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	*0.021*	*0.037*	*0.000*	*0.105*	*0.029*	*58.9*
YukonCoastal	*0.148*	*0.067*	*0.039*	*0.261*	*0.048*	*47.8*
Kuskokwim	*0.233*	*0.072*	*0.116*	*0.353*	*0.083*	*55.1*
BristolBay	*0.191*	*0.041*	*0.132*	*0.264*	*0.069*	*26.4*
UpperYukon	0.016	0.007	0.006	0.030	0.004	18.3
NorthPenn	0.001	0.003	0.000	0.004	0.019	96.2
NWPenn	0.064	0.014	0.043	0.088	0.004	6.7
SouthPenn	0.013	0.013	0.000	0.035	0.003	25.3
ChignikKod	0.008	0.011	0.000	0.030	0.002	18.6
EastKodiak	0.056	0.013	0.037	0.078	0.006	12.8

Replicate 5 Table 3 (continued)

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	*0.062*	*0.042*	*0.000*	*0.133*	*0.012*	*23.1*
YukonCoastal	*0.157*	*0.057*	*0.067*	*0.254*	*0.057*	*57.1*
Kuskokwim	*0.085*	*0.069*	*0.004*	*0.215*	*0.065*	*43.0*
BristolBay	*0.260*	*0.053*	*0.180*	*0.355*	*0.000*	*0.1*
UpperYukon	0.023	0.010	0.008	0.042	0.003	14.9
NorthPenn	0.015	0.014	0.001	0.042	0.005	26.2
NWPenn	0.059	0.015	0.037	0.084	0.001	1.0
SouthPenn	0.010	0.007	0.000	0.022	0.000	4.9
ChignikKod	0.003	0.004	0.000	0.011	0.007	66.2
EastKodiak	0.051	0.012	0.033	0.072	0.001	2.2

Figures

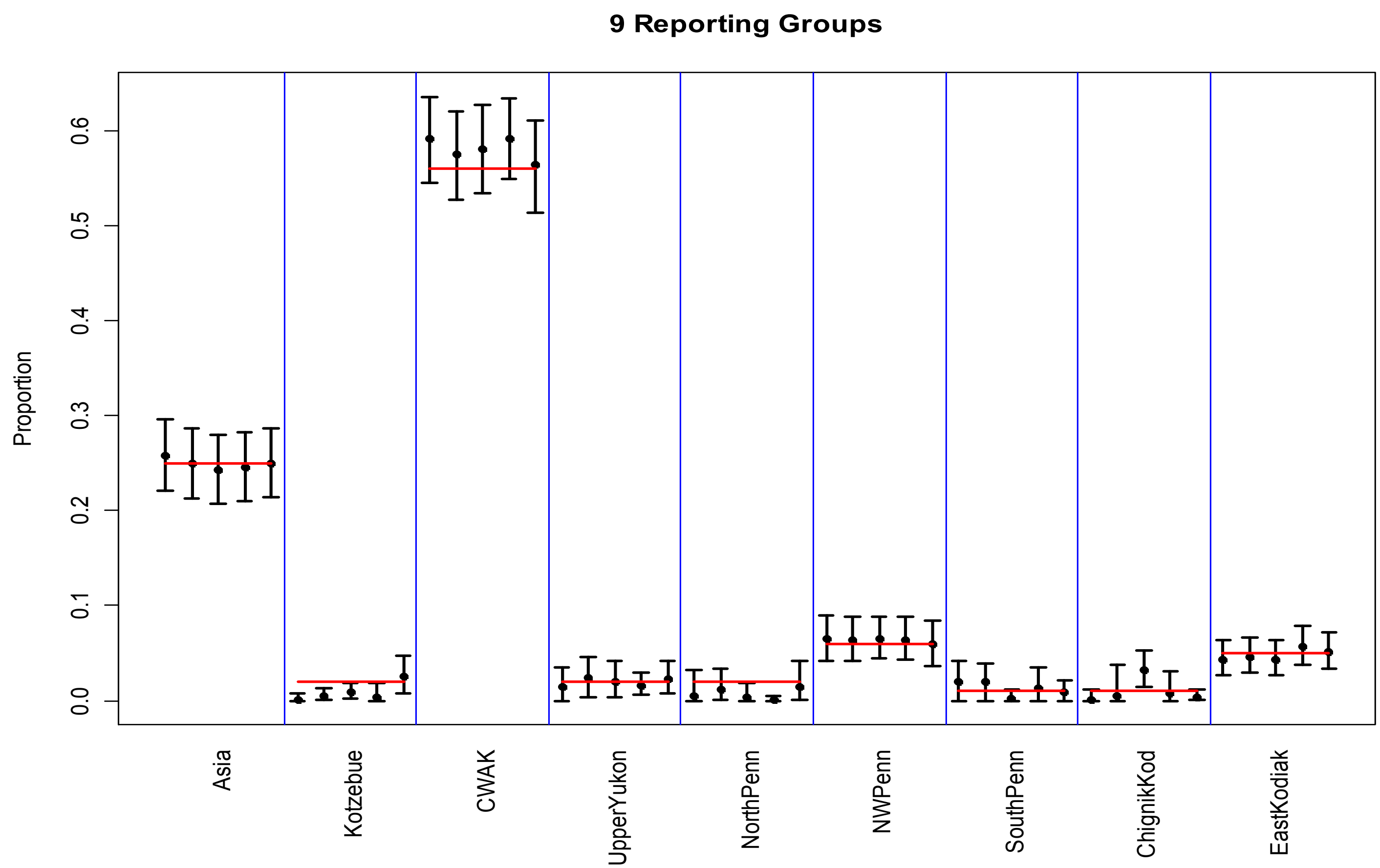

Figure 1. BAYES estimates for 5 replicate samples for a fishery-based proof test for 9 reporting groups where coastal western Alaska (CWAK) is a single reporting group. The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot)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

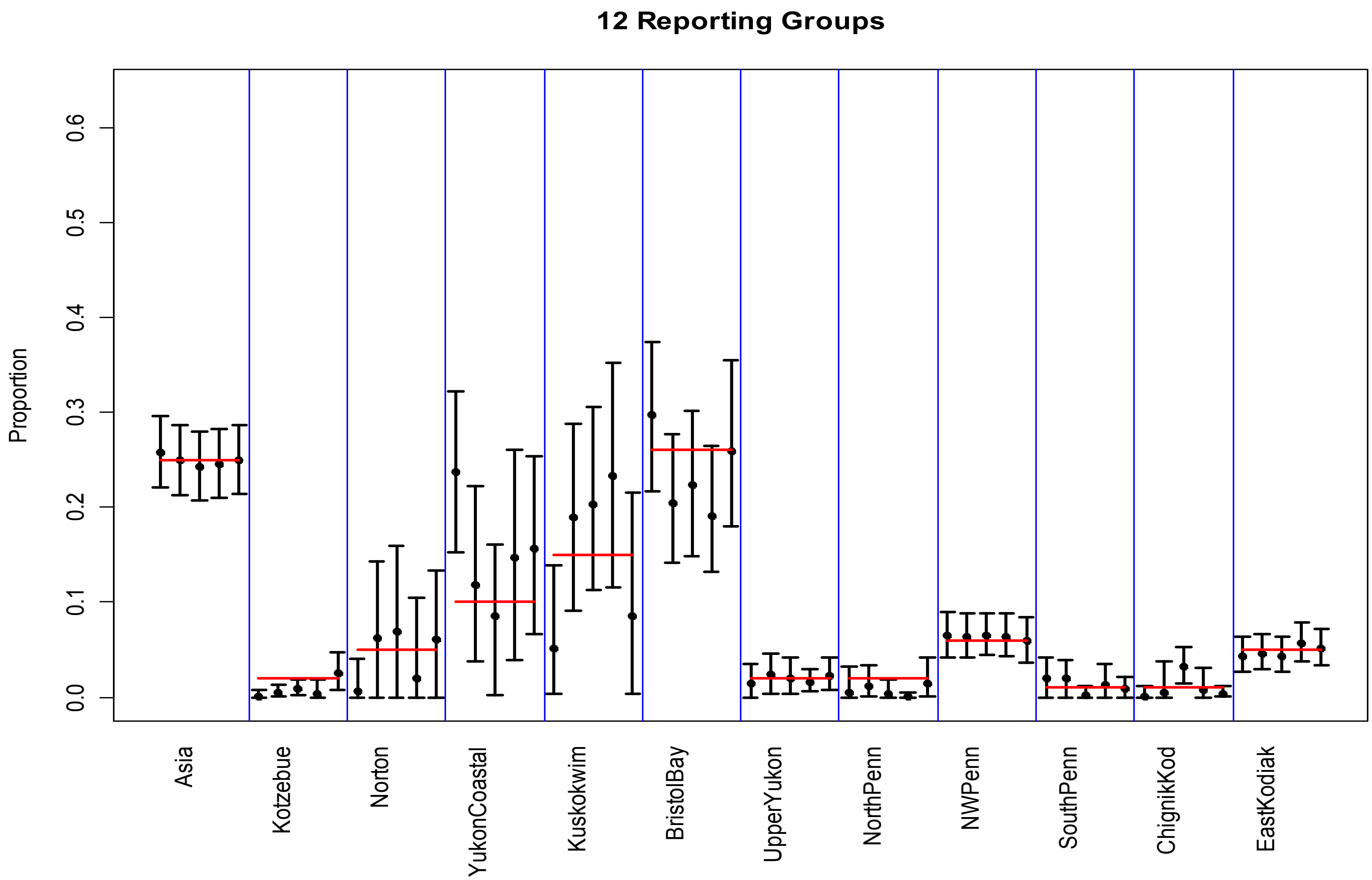

Figure 2. BAYES estimates for 5 replicate samples for a fishery-based proof test for 12 reporting groups where coastal western Alaska (CWAK) divided into 4 reporting groups (Norton, YukonCoastal, Kukokwim, BristolBay). The actual stock composition of the replicate samples is shown as a red horizontal line. For each replicate sample, the estimate (dot) and lower and upper 90% credibility interval (vertical line) are provided.