

## Origin of Immature Chum Salmon Collected in the Eastern Bering Sea and Aleutian Islands during the F/V *Northwest Explorer* BASIS Survey, Fall 2002

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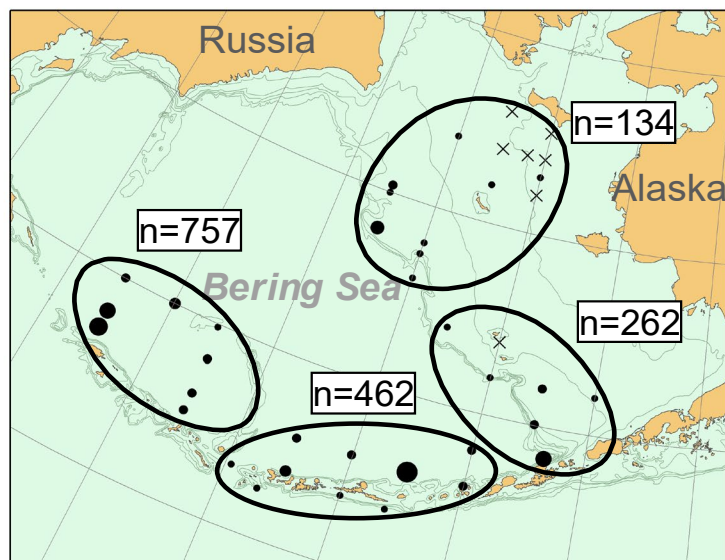
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Immature chum salmon were collected by the F/V *Northwest Explorer* between September 5 and October 8, during the 2002 BASIS survey across the eastern Bering Sea shelf and Aleutian Islands (for details, see Murphy et al. 2003). Approximately 1,600 fish were aged, checked for the presence of hatchery thermal marks, and genotyped for allozyme loci. Scale aging and otolith mark identification were done by the Alaska Department of Fish and Game's Mark, Tag, and Age Laboratory in Juneau, Alaska. Otoliths with thermal marks were compared with voucher specimens to verify hatchery of origin. Heart, liver, and muscle tissues were extracted and then analyzed with protein electrophoresis to identify genotypes for the 20 allozyme loci in the chum salmon coastwide genetic baseline (Kondzela et al. 2002). Genetic data were pooled into one of four geographic areas—western Aleutian Islands, eastern Aleutian Islands, southeastern Bering Sea shelf, and northeastern Bering Sea shelf. In the eastern and western Aleutian Islands, the catches were large enough to further stratify the data by ocean age. Regional origin estimates were made for each mixture collection using a conditional maximum likelihood method (Pella and Masuda model in SPAM v. 3.7, ADF&G 2001) and the full 356-population genetic baseline. The 95% non-symmetric confidence intervals were determined from 1000 bootstrap estimates in which the baseline and mixture were re-sampled.

Catches of immature chum salmon were much higher north of the Aleutian Island chain than from the Bering Sea shelf (Fig. 1). The predominant ocean age was 0.2 (65%)—a trait shared across all four areas—followed by ocean age 0.1, 0.3, and 0.4 (23%, 11%, and < 1%, respectively). Otolith marks were recovered from 17 immature hatchery chum salmon: seven marks from Alaskan hatcheries, four marks from Japanese hatcheries, two marks from Russian hatcheries, and four marks with multiple origins (Table 1). The four marks with multiple origins are the result of North American and Russian hatcheries releasing identically marked fish. These marks have a high probability of originating from North America due to the relatively small number of Russian marks released.

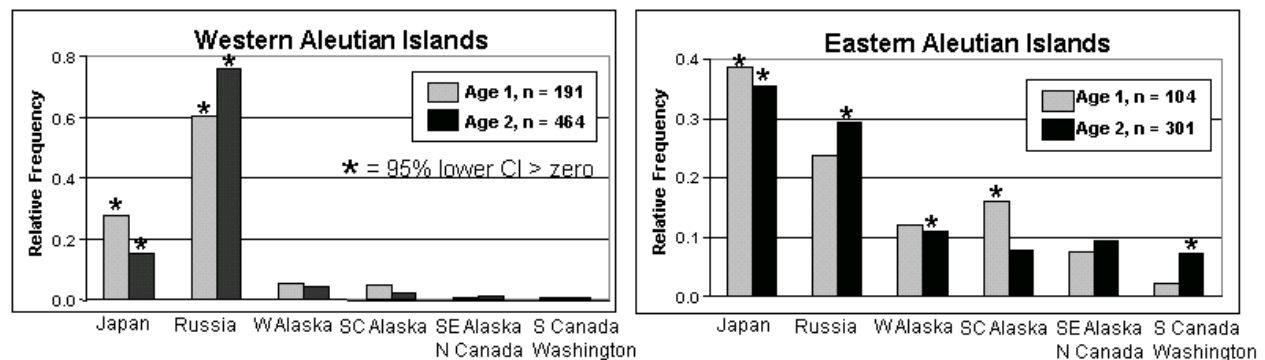
The majority of immature chum salmon in each mixture were of Asian origin (Table 2). Russian fish were the most abundant fraction in the western Aleutian Islands and the southeast Bering Sea shelf, whereas the component from Japan was greatest on the northeast Bering Sea shelf. More than 50% of the total catch of immature chum salmon were of Russian origin; more than 25% were from Japan, and each North American region contributed 5% or less. Small, but statistically significant estimates from southern North American populations were restricted to the eastern Aleutian Islands and southeastern Bering Sea shelf. Western and southcentral Alaska populations were detected at low levels in the eastern Aleutian Islands.

**Fig. 1.** Catches of immature chum salmon during the fall 2002 F/V *Northwest Explorer* BASIS survey grouped into the four geographic areas for which regional estimates of origin were made. Circle size is proportional to catch.



Within each of the Aleutian Island areas, ocean-age 0.1 and 0.2 fish shared similar stock estimates (Fig. 2). For example, in the eastern Aleutian Islands, the largest component for both ages was from Japan, with the next largest component from Russia. However, in the western Aleutian Islands, the largest component for both ages was from Russia, with a much smaller contribution for both ages from Japan and very small fractions from North American regions.

**Fig. 2.** Regional estimates of origin for ocean-age 0.1 and 0.2 immature chum salmon from the western and eastern Aleutian Island areas. W Alaska = western Alaska and fall Yukon; SC Alaska = Alaska Peninsula, Cook Inlet, Kodiak Island, and Prince William Sound; N Canada = northern British Columbia; S Canada = southern British Columbia.



**Table 1.** Otolith-marked hatchery fish recovered during the fall 2002 survey by the *F/V Northwest Explorer*. Length is fork length in mm; weight is body weight in g; release number is the number of marked fishes released from the hatchery.

Country and Stock	Catch Location	Catch Date	Length	Weight	Age	Release Number	Mark
<i>Japan</i>							
Chitose 1999	55.00 N, 175.04 E	15 Sep	516	1569	0.2	4,914,000	2,6nH
Ichani 1999	52.99 N, 172.52 W	9 Sep	440	952	0.2	3,503,000	2,8nH
Ichani 1999	52.99 N, 172.52 W	9 Sep	430	1166	0.2	3,503,000	2,8nH
Ichani 1999	54.17 N, 166.80 W	22 Sep	463	1120	0.2	3,503,000	2,8nH
<i>Russia</i>							
Bereznykovsky 1999	51.86 N, 172.99 W	20 Sep	425	967	0.2	22,546,100	4H
Ola 2000	60.19 N, 177.51 W	30 Sep	372	620	0.1	2,370,000	6H
<i>United States</i>							
Hidden Falls 1998	56.01 N, 167.50 W	23 Sep	561	2362	0.3	48,905,343	3,3H
Hidden Falls 1998	58.99 N, 177.49 W	30 Sep	567	2262	0.3	48,905,343	3,3H
Hidden Falls 1999	54.17 N, 166.80 W	22 Sep	461	1139	0.2	38,689,735	3,3H
Macaulay 1998	56.01 N, 164.99 W	6 Oct	590	2630	0.3	11,355,272	6H
Macaulay 2000 (Limestone)	53.00 N, 170.00 W	8 Sep	357	470	0.1	15,144,122	5H5
Medvejie 2000	53.50 N, 172.51 E	17 Sep	378	616	0.1	13,174,000	4,3H
Wally Noerenberg 2000	53.00 N, 170.00 W	8 Sep	393	652	0.1	57,712,566	5,2H
<i>Multiple Origin</i>							
Hidden Falls 2000 (Takatz)	53.00 N, 170.00 W	8 Sep	384	618	0.1	41,925,974	4H
Bereznykovsky 2000						240,900	4H
Hidden Falls 2000 (Takatz)	60.19 N, 177.51 W	30 Sep	353	570	0.1	41,925,974	4H
Bereznykovsky 2000						240,900	4H
Macaulay 1999	54.17 N, 166.80 W	22 Sep	483	1418	0.2	44,496,455	6H
Yana 1999						39,100	6H
Macaulay 1999	54.17 N, 166.80 W	22 Sep	512	1611	0.2	44,496,455	6H
Yana 1999						39,100	6H

**Table 2.** Regional estimates of immature chum salmon caught in the eastern Bering Sea and Aleutian Islands during the 2002 fall survey by the F/V *Northwest Explorer*. Below each estimate is the 95% non-symmetric bootstrap confidence interval; estimates significantly greater than zero are in bold font.

Mixture sample	n	Regional Allocation					
		Japan	Russia	Western Alaska Fall Yukon	Southcentral Alaska	SE Alaska N. British Columbia	S. British Columbia Washington
<i>Western Aleutian Is.</i>							
Ocean age 0.1	192	<b>0.27</b> (0.17-0.39)	<b>0.60</b> (0.50-0.78)	0.05 (0-0.10)	0.05 (0-0.10)	0.01 (0-0.02)	0.01 (0-0.02)
Ocean age 0.2	464	<b>0.15</b> (0.05-0.20)	<b>0.76</b> (0.75-0.96)	0.04 (0-0.06)	0.02 (0-0.05)	0.01 (0-0.02)	0.01 (0-0.02)
Total	747	<b>0.18</b> (0.10-0.23)	<b>0.74</b> (0.72-0.89)	0.04 (0-0.06)	0.03 (0-0.05)	0.01 (0-0.01)	0.01 (0-0.02)
<i>Eastern Aleutian Is.</i>							
Ocean age 0.1	104	<b>0.39</b> (0.25-0.57)	0.24 (0-0.37)	0.12 (0-0.24)	0.16 (0-0.31)	0.07 (0-0.15)	0.02 (0-0.04)
Ocean age 0.2	300	<b>0.36</b> (0.26-0.45)	<b>0.29</b> (0.21-0.44)	<b>0.11</b> (0.02-0.18)	0.08 (0-0.24)	<b>0.09</b> (0.01-0.16)	<b>0.07</b> (0.003-0.11)
Total	457	<b>0.36</b> (0.28-0.45)	<b>0.32</b> (0.24-0.46)	<b>0.09</b> (0.01-0.14)	<b>0.09</b> (0.004-0.15)	<b>0.09</b> (0.003-0.14)	<b>0.05</b> (0.003-0.08)
<i>Southeast Bering shelf</i>							
	262	<b>0.20</b> (0.12-0.29)	<b>0.45</b> (0.36-0.62)	0.02 (0-0.04)	0.06 (0-0.13)	<b>0.14</b> (0.03-0.23)	<b>0.13</b> (0.03-0.19)
<i>Northeast Bering shelf</i>							
	131	<b>0.57</b> (0.44-0.73)	<b>0.28</b> (0.12-0.44)	0.08 (0-0.15)	0.02 (0-0.03)	0.04 (0-0.07)	0.02 (0-0.04)
Total catch (% total catch)	1597	423 (27%)	851 (53%)	85 (5%)	86 (5%)	86 (5%)	66 (4%)

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