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NPAFC Sockeye Scale Aging Test

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ABSTRACT

At the March 1997 NPAFC research planning meeting in Vancouver, B.C., the Working Group on Stock Identification and Growth discussed the need to test inter-laboratory variation in scale age and growth data. In this document, sockeye salmon scale age determinations by experts at nine laboratories in Canada, Japan, Russia, and the United States are compared. The results indicate that ocean age determinations are consistent among laboratories. However, there was substantial variation among the laboratories in freshwater age determinations. The results suggest that there may be need for international review and standardization of methods and criteria used to interpret freshwater age and growth patterns on salmon scales.

INTRODUCTION

At the March 1997 NPAFC Research Planning and Coordinating Meeting in Vancouver, B.C., the Working Group on Stock Identification and Growth discussed the need to test inter-laboratory variation in salmon scale age and growth data (NPAFC 1997). Consistency in interpretation of scale patterns is essential for accurate results in both stock identification and growth studies. In most cases, the true ages of salmon in scale samples are not known. When the stock or river of origin of a fish is known, however, scale experts often apply stock-specific criteria in interpreting age and growth patterns on salmon scales. Even when stock is known, there may be disagreements among experts on the interpretation of scale growth patterns (e.g., Kovalev 1995). In this document, sockeye salmon scale age determinations by experts at nine laboratories in Canada, Japan, Russia, and the United States are compared.

METHODS

The test sample was composed of acetate impressions of scales from adult sockeye salmon returning to five different rivers in Kamchatka, Russia (Icha, Vorovskaya, Krutogorova, Bolshaya, and Kamchatka rivers) in June and July, 1995-96. Duplicate sets of acetate impressions of the test sample (2 scales per fish, 30 fish per card, and 8 cards) were sent to a contact person in each laboratory. Participants were told that the samples were from "maturing sockeye caught in rivers in June and July," but river names and locations were not provided. The acetate card number, fish number, length, weight, and sex of each fish were listed on data sheets. To standardize age designation, participants were asked to enter the number of freshwater annuli and the number of ocean annuli for each fish in separate columns on the data sheets (or on an electronic data sheet provided on computer diskette). Each laboratory was instructed to provide their best determination of the age of each fish, either from age determinations by a single scale expert or by concurrence of a group of experts in each laboratory.

The results provided by each laboratory were compiled into a single database for analysis. The database is archived at the Fisheries Research Institute (FRI), School of Fisheries, University of Washington, and is available from K. Myers on request. Only those fish that were assigned both a freshwater and an ocean age by all nine participating laboratories were included in the analysis. The results for freshwater and ocean age determinations were analyzed separately. The results among laboratories were compared graphically by calculating percentages of each age group in the total sample. The true ages of the fish in the test sample were not known, but individual chi-square tests were used to compare age determinations by

each laboratory to the original age determinations made prior to the test by the Kamchatka Research Institute of Fisheries and Oceanography.

RESULTS AND DISCUSSION

The initial test sample size was 240 fish, but only 90 fish (37.5% of the total) were assigned both a freshwater and an ocean age by all nine laboratories (Appendix Table 1). The Vladivostok and Anchorage laboratories did not age the entire test sample, which reduced the initial sample size by about 50%. The other laboratories aged the entire test sample, but did not always assign a freshwater age or an ocean age or both to every fish because of other difficulties in interpretation (e.g., scale regeneration, mixed fish, wrong species, etc.). The Sapporo laboratory provided two complete sets of age determinations by two different scale experts, and only one of these was used in the analysis.

In general, the results indicate a high degree of consistency in ocean age determinations by the nine laboratories, but there was substantial variation in freshwater age determinations (Fig. 1). One laboratory supervisor noted: "We found the sample difficult to interpret. The freshwater patterns were especially challenging. Most times, we are aware of which stocks/rivers our sockeye samples are from. In many cases, we do apply individual stock freshwater growth criteria to samples." Another laboratory supervisor noted: "It was very difficult for us to decide the age of sockeye salmon, especially . . . the freshwater and last ocean age on the outer edge of the scale. Because we do not know the life history . . . such as size of smolt at seaward migration and run timing of adults at entrance to the river." The results suggest that there may be a need for international review and standardization of methods and criteria used to interpret freshwater age and growth patterns on salmon scales.

ACKNOWLEDGMENTS

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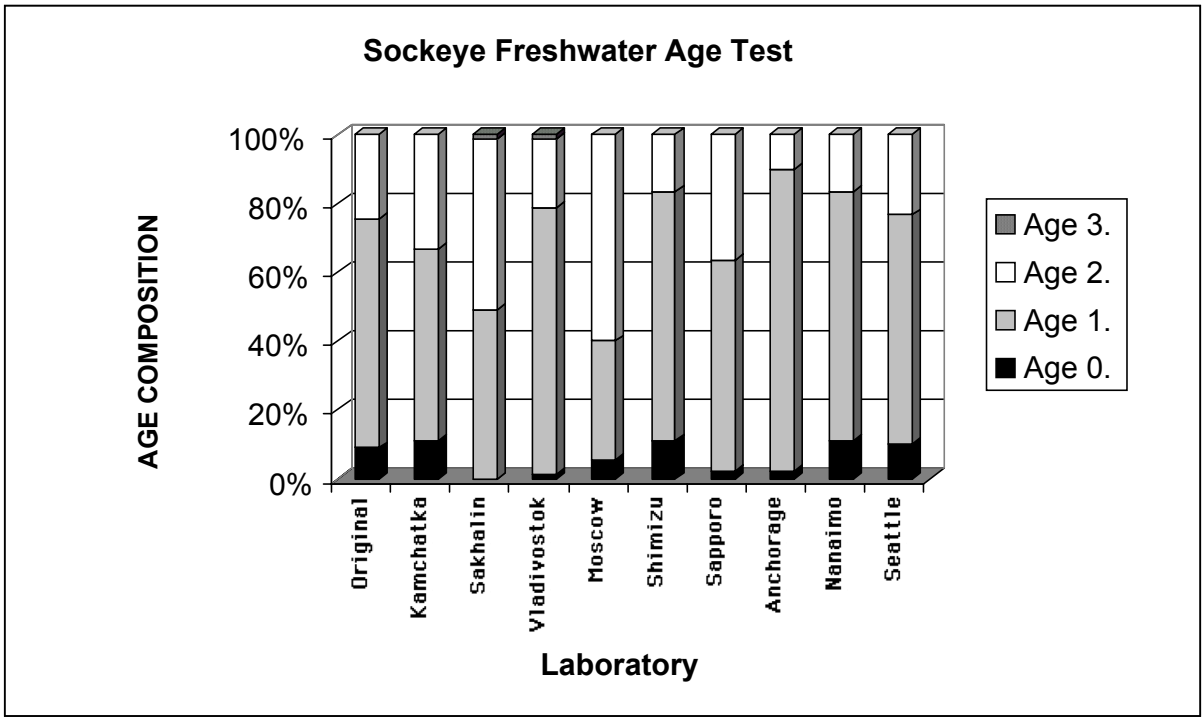

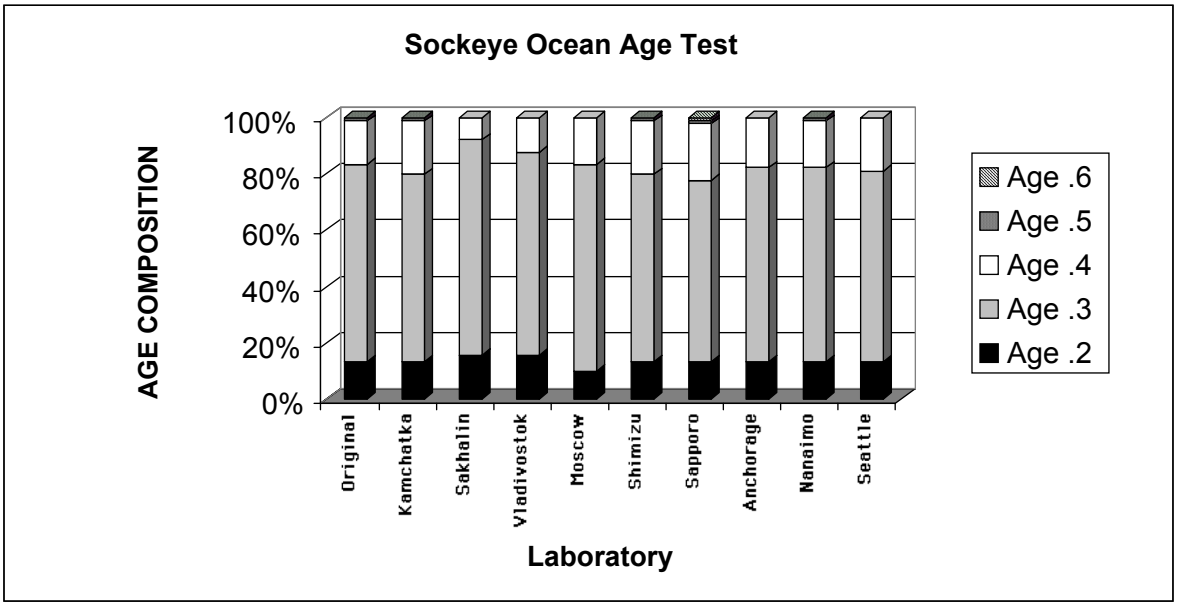

Fig. 1. Results of the NPAFC sockeye salmon scale age test comparing freshwater and ocean age determinations among nine laboratories. The original samples (n = 90 fish) were from adult salmon returning to Kamchatka in June and July 1995. Comparisons with original age determinations by Kamchatka experts (chi square, $\alpha = .01$) showed no statistically significant differences in ocean ages, and significant differences in freshwater age determinations by the Sakhalin ($p = .0002$), Vladivostok ($p = .0547$), Moscow ($p = .0001$), Sapporo ($p = .0494$), and Anchorage ($p = .003$) laboratories.

Appendix Table 1. Final data set used in NPAFC sockeye scale aging test. FW = number of freshwater annuli, OCN = number of ocean annuli.

Fish	Test Sample								Kamchatka		Sakhalin		Vladivostok		Moscow		Shimizu		Sapporo		Anchorage		Nanaimo		Seattle	
No.	River	Year	Card no.	Fish no.	Length	Weight	Sex	FW OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN
1	Icha	95	1	1	68.0	3.8m	1	3	1	3	1	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3
2	Icha	95	1	2	71.0	4.3m	2	3	1	3	1	3	1	3	2	3	1	3	2	3	1	3	2	3	1	3
3	Icha	95	1	3	66.0	3.5f	0	3	0	3	1	3	1	3	1	4	0	3	1	3	1	3	0	3	1	3
4	Icha	95	1	4	67.0	3.7m	1	3	1	3	2	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3
5	Icha	95	1	5	63.0	3.2f	1	3	0	3	2	3	1	3	0	3	0	3	1	3	1	3	0	3	0	3
6	Icha	95	1	6	66.0	3.8m	1	3	1	3	1	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3
7	Icha	95	1	8	69.0	3.8f	0	3	0	3	1	3	1	3	0	3	0	3	0	3	1	3	0	3	0	3
8	Icha	95	1	9	62.0	3.0f	0	3	0	3	2	3	1	3	1	3	0	3	0	3	1	3	0	3	0	3
9	Icha	95	1	10	70.0	4.1m	2	3	2	3	2	3	1	3	2	3	2	3	2	3	1	3	2	3	2	3
10	Icha	95	1	12	68.0	3.6f	0	3	0	3	1	3	1	3	1	3	0	3	1	3	1	3	0	3	0	3
11	Icha	95	1	13	69.0	4.0m	1	3	1	3	1	3	1	3	1	3	1	3	2	3	1	3	1	3	1	3
12	Icha	95	1	15	64.0	3.3f	0	3	0	3	1	3	1	3	1	3	0	3	1	3	1	3	0	3	0	3
13	Icha	95	1	16	69.0	3.8f	2	3	2	3	2	3	1	3	2	3	1	3	2	3	1	3	1	3	2	3
14	Icha	95	1	17	72.0	4.3m	1	3	1	3	2	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3
15	Icha	95	1	19	67.0	3.7m	0	3	0	3	2	3	1	3	1	3	0	3	1	3	1	3	0	3	0	3
16	Icha	95	1	20	63.0	3.2f	1	3	1	3	2	3	2	3	2	3	1	3	2	3	1	3	1	3	1	3
17	Icha	95	1	22	74.0	4.4m	2	3	2	3	2	3	1	3	2	3	2	3	2	3	1	3	2	3	2	3
18	Icha	95	1	23	67.0	3.4m	1	3	1	3	2	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3
19	Icha	95	1	24	67.0	3.5f	0	3	0	3	2	3	1	3	1	3	0	3	1	3	0	3	0	3	0	3
20	Icha	95	1	25	70.0	4.0m	2	3	2	4	2	3	1	3	2	3	1	3	2	3	1	3	2	3	2	3
21	Icha	95	1	26	73.0	4.4m	1	3	1	3	2	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3
22	Icha	95	1	27	62.0	3.1f	0	3	0	3	1	3	1	3	1	3	0	3	1	3	0	3	0	3	0	3
23	Icha	95	1	28	69.0	3.4f	2	3	2	3	2	3	1	3	2	3	2	3	2	3	1	3	1	3	2	3
24	Icha	95	1	29	67.0	3.5m	1	3	2	3	1	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3
25	Icha	95	1	30	74.0	4.4m	2	3	2	4	2	3	1	3	2	3	1	3	2	3	1	3	2	3	2	3
26	Vorovskaya	95	2	2	57.0	3.2m	1	3	0	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
27	Vorovskaya	95	2	3	64.0	4.1m	1	4	1	4	2	3	1	4	1	4	1	4	2	4	1	4	1	4	1	4
28	Vorovskaya	95	2	5	62.0	3.6f	1	4	1	4	2	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
29	Vorovskaya	95	2	8	61.0	3.2m	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
30	Vorovskaya	95	2	9	66.0	4.4m	1	4	2	4	2	4	1	4	1	3	1	4	2	4	1	4	1	4	1	4
31	Vorovskaya	95	2	12	58.5	2.9f	1	3	1	3	1	3	1	3	0	3	1	3	1	3	1	3	1	3	1	3
32	Vorovskaya	95	2	13	56.0	2.6m	1	2	2	2	2	2	1	2	2	2	1	2	2	2	1	2	1	2	2	2
33	Vorovskaya	95	2	15	56.0	2.7f	1	3	1	3	1	3	1	3	0	3	1	3	1	3	1	3	1	3	1	3
34	Vorovskaya	95	2	16	57.0	2.9f	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
35	Vorovskaya	95	2	17	58.5	3.2m	1	2	1	2	1	2	1	2	2	2	1	2	1	2	1	2	1	2	1	2
36	Vorovskaya	95	2	18	63.5	4.0m	1	3	1	3	1	3	2	3	2	3	1	3	1	3	1	3	1	3	1	3
37	Vorovskaya	95	2	19	63.0	3.7m	1	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3

Fish	Test Sample								Kamchatka		Sakhalin		Vladivostok		Moscow		Shimizu		Sapporo		Anchorage		Nanaimo		Seattle	
No.	River	Year	Card no.	Fish no.	Length	Weight	Sex	FW OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN
38	Vorovskaya	95	2	22	58.5	3.0f	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
39	Vorovskaya	95	2	23	46.5	1.3m	1	2	1	2	1	2	1	2	0	2	1	2	1	2	1	2	1	2	1	2
40	Vorovskaya	95	2	27	60.0	3.1f	1	4	1	4	1	3	2	4	1	4	1	4	1	4	1	4	1	4	1	4
41	Vorovskaya	95	2	28	59.0	2.7f	1	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
42	Vorovskaya	95	2	29	65.0	4.0m	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
43	Vorovskaya	95	2	30	59.0	3.2m	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
44	Krutogorova	95	3	1	67.0	3.4f	1	4	1	4	1	3	1	3	1	3	1	4	1	4	1	4	1	4	1	4
45	Krutogorova	95	3	2	63.0	2.9f	1	3	1	3	1	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
46	Krutogorova	95	3	3	62.0	2.7f	1	3	1	3	1	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
47	Krutogorova	95	3	4	72.0	3.9m	1	3	1	3	1	3	1	3	2	3	1	4	1	4	1	3	1	3	1	4
48	Krutogorova	95	3	5	61.0	2.6m	1	2	1	2	1	2	1	2	2	2	1	2	1	2	1	2	1	2	1	2
49	Krutogorova	95	3	6	64.0	3.0f	1	4	1	4	1	4	1	3	1	4	1	4	1	4	1	4	1	4	1	4
50	Krutogorova	95	3	7	73.0	4.0m	1	3	1	3	1	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
51	Krutogorova	95	3	12	61.0	2.5f	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
52	Krutogorova	95	3	14	61.0	2.5f	1	3	1	3	1	2	1	3	2	3	1	3	1	3	1	3	1	3	2	3
53	Krutogorova	95	3	16	54.0	1.7m	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
54	Krutogorova	95	3	17	66.0	3.4f	2	3	2	3	2	3	2	3	2	3	1	3	2	3	1	3	1	3	1	3
55	Krutogorova	95	3	18	65.0	2.7f	2	4	2	4	2	3	2	3	2	4	1	4	2	4	1	4	1	4	2	4
56	Krutogorova	95	3	19	63.0	2.6f	2	4	2	4	2	3	2	4	2	4	1	4	2	4	1	4	1	4	2	4
57	Bolshaya	95	4	1	64.0	3.2f	1	5	1	5	1	3	1	4	1	4	1	5	1	5	1	4	1	5	1	4
58	Bolshaya	95	4	2	62.0	2.8f	1	3	2	3	2	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3
59	Bolshaya	95	4	5	67.0	3.3f	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
60	Bolshaya	95	4	6	67.0	3.4m	1	3	2	3	2	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
61	Bolshaya	95	4	7	64.0	3.3f	1	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
62	Bolshaya	95	4	8	67.0	3.4m	1	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
63	Bolshaya	95	4	9	64.0	3.0f	1	3	1	3	2	3	0	3	1	3	0	3	1	3	1	3	0	3	0	3
64	Bolshaya	95	4	10	64.0	2.9f	2	3	1	3	2	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3
65	Bolshaya	95	4	11	50.0	1.3m	1	2	2	2	1	2	1	2	2	2	1	2	1	2	1	2	0	2	1	2
66	Bolshaya	95	4	13	64.0	2.9f	1	4	1	4	1	3	1	4	1	4	1	4	1	6	1	4	1	4	1	4
67	Bolshaya	95	4	15	62.0	2.8f	1	3	1	3	1	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
68	Bolshaya	95	4	16	64.0	2.8f	1	3	2	3	2	2	1	3	2	3	2	3	1	4	1	3	1	3	2	3
69	Bolshaya	95	4	17	59.0	2.3f	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
70	Bolshaya	95	4	19	60.0	2.4f	1	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
71	Bolshaya	95	4	20	70.0	3.9m	1	3	2	3	2	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
72	Bolshaya	95	4	22	55.0	1.8m	1	2	1	2	1	2	1	2	2	2	1	2	1	2	1	2	1	2	1	2
73	Bolshaya	95	4	23	63.0	2.9f	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
74	Bolshaya	95	4	25	61.0	2.5f	1	3	1	3	2	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
75	Bolshaya	95	4	26	66.0	2.8m	1	3	2	3	1	3	1	3	2	3	1	3	1	3	1	3	1	3	1	3
76	Bolshaya	95	4	27	61.0	2.4f	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3

Fish	Test Sample								Kamchatka		Sakhalin		Vladivostok		Moscow		Shimizu		Sapporo		Anchorage		Nanaimo		Seattle	
No.	River	Year	Card no.	Fish no.	Length	Weight	Sex	FW OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN	FW	OCN
77	Bolshaya	95	4	30	61.0	2.8f	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
78	Kamchatka	95	5	1	61.0	2.5m	2	3	2	3	2	3	2	3	2	3	2	3	2	4	2	3	2	3	2	3
79	Kamchatka	95	5	3	50.5	1.4m	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
80	Kamchatka	95	5	4	44.0	0.9m	1	2	1	2	2	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
81	Kamchatka	95	5	5	53.0	1.7m	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3
82	Kamchatka	95	5	6	44.0	1.1m	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	2	2	2
83	Kamchatka	95	5	7	61.0	2.8f	1	3	2	4	2	3	2	3	2	4	1	4	2	4	1	4	1	4	1	3
84	Kamchatka	95	5	8	60.0	2.4f	1	4	1	4	1	3	3	3	2	3	1	4	1	4	1	4	1	4	1	4
85	Kamchatka	95	5	9	64.5	3.0m	2	3	2	3	3	3	2	3	2	3	2	4	1	4	2	3	2	3	2	3
86	Kamchatka	95	5	10	63.0	3.1m	2	3	2	3	2	3	2	3	2	3	2	3	1	3	2	3	2	3	2	3
87	Kamchatka	95	5	16	50.5	1.3m	2	3	2	3	2	3	2	2	1	4	2	3	2	3	2	3	2	3	1	4
88	Kamchatka	95	5	17	46.0	1.1m	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1	2	2	2	2	3
89	Kamchatka	95	5	18	57.0	1.9f	2	3	2	3	1	3	2	3	2	3	2	3	2	3	2	3	2	3	2	2
90	Kamchatka	95	5	20	53.0	1.7m	2	3	2	3	2	3	2	2	2	3	2	3	1	3	2	3	2	3	2	3