On Peculiarities of the Palana River Sockeye *(Oncorhynchus nerka)* Abundance (North-West Kamchatka)

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In the basin of the Palana River, which flows into the Sea of Okhotsk at 59°06'N a large stock of sockeye *(Oncorhynchus nerka)* occurs. This stock is the third or fourth largest of this species in Asia. Reproduction and growth of this stock as juveniles occurs almost entirely in the Palana Lake basin prior to migration to the sea. While migrating to the Pacific Ocean sockeye smolts make a long migration along the Western Kamchatka coast southward and bypassing the southern extremity of Kamchatka peninsula (50°52'N). Mature fishes then make the reverse migration.

As shown in Table 1, sockeye smolt migration from Palana Lake to the sea occurs at ages 1–4 years of age. In Table 2, one can see the age structure of mature fishes from the commercial catches in 1994–2001.

As shown in Fig. 1, the abundance of the sockeye reveals a stable two year cycle of abundance (violated in 1983–1984 only): in 1979, 1981, 1985, 1987, 1989, 1993, 1995, 1997, 1999 and 2001 peaks of abundance are observed, and in1978, 1980, 1982, 1986, 1988, 1990, 1992, 1994, 1996, 1998 and 2000 – decreases of abundance. We suppose that this cyclic recurrence is connected with the pink salmon fluctuations, which, as is well known, has a two-year life cycle.

Table 1. Body Length of Smolts of Sockeye Migrating From the Palana Lake in 1995–2000.

Age	Body length, mm			Body weight, g			Number of fishes (%)
	Limits	Average	Error	Limits	Average	Error	
				1995			
1+	50-62	57.15	1,07	0.80-2.40	1,74	0,12	13(10.2)
2+	71-107	89,35	0,64	3.60-11.80	6,67	0,15	113(88.3)
3+	87-100	93,5	6,5	6.20-9.40	7,8	1,6	2(1.5)
				1996			
1+	47-57	52,67	2,96	1.20-2	1,73	0,27	3(11.1)
2+	66-100	82,5	1,32	2.20-10.70	5,84	0,31	24(88.9)
3+	-	-	-	-	-	-	-
				1998			
1+	54-65	60,8	2,13	1.15-2.41	1,85	0,23	5(8.5)
2+	70-85	77,22	0,54	2.02-6.26	4,09	0,11	51(86.4)
3+	85-88	86,33	0,88	5.42-5.82	5,68	0,13	3(5.1)
				1999			
1+	56-79	67,63	3,16	1,51-4,64	3,14	0,42	8(9,9)
2+	78-101	87,89	0,71	4,63-11,34	6,62	0,16	64(79,0)
3+	83-100	92,89	1,91	5,32-9,25	7,64	0,45	9(11,1)
				2000			
1+	61-62	61.50	0.50	1.46-2.98	2.22	0.76	2(3.8)
2+	76-105	92.55	0.99	4.48-12.58	7.87	0.25	42(79.2)
3+	95-111	103.25	2.01	8.70-13.19	11.19	0.49	8(15.1)
4+	134	134.00	-	26.37	26.37	-	1(1.9)

Note. In 1997 the studies of dynamics sockeye smolt migration were not realized

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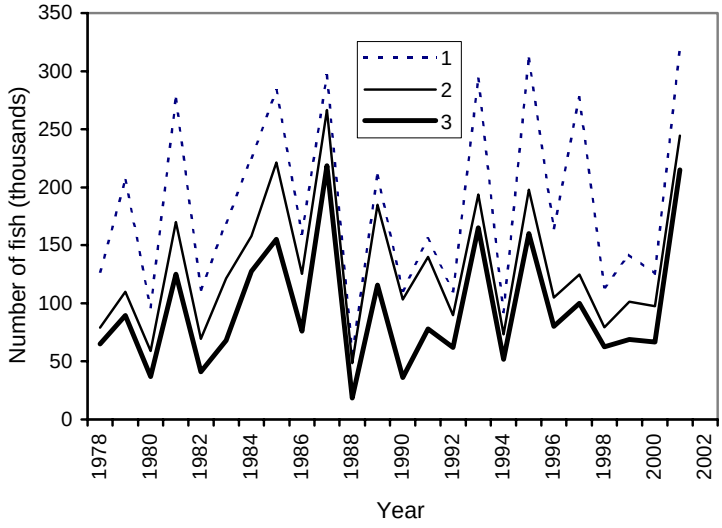
Table 2. Age Structure of the Palana River Mature Sockeye from the Commercial Catches in 1994–2001, %.

Year	1.2	1.3	1.4	2.2	2.3	2.4	3.2	3.3	3.4	Number of fishes
1990*	-	14.6	-	-	79.2	2.1	-	4.1	-	48
1994	0.7	18.4	-	10.9	54.8	2.0	1.0	12.2	-	294
1995	1.0	5.1	-	11.2	82.7	-	-	-	-	98
1996	-	9.7	-	50.0	40.3	-	-	-	-	72
1997	-	3.1	0.4	2.4	85.5	1.0	-	7.2	0.4	290
1998	8.4	9.4	0.7	26.2	50.7	1.0	1.8	1.8	-	286
1999	-	20.1	-	7.7	69.4	-	-	2.8	-	284
2000	-	9.4	-	-	86.4	1.1	-	3.1	-	287
2001	-	1.8	-	9.7	82.1	3.6	2.1	0.7	-	279

Note. The fist figure – duration of the fresh water life period, the second one – duration of the marine life period. * - fish caught at the Palana Lakespawning grounds.

Fig. 1. The Palana River sockeye abundance in 1978–2001: at the stock mature part (SMP) the ocean prior to the driftnet catch (1), at the approach to the river estuary (2) and the escapement into Palana Lake (3), in thousands of fish.



The researches recommend (Bugayev 2001) to consider the abundance dynamics of the Asian stocks of sockeye by periods of growth in the ocean: 1 – before 1984 inclusive, when the abundance of the dominant generations of the Western and North-Eastern Kamchatka pink salmon fluctuated in one phase, and 2 – starting in 1985, when a shift of the dominant generations of the Western Kamchatka pink salmon abundance from odd years to even ones occurred. As a result a high pink salmon abundance (dominant generations) was observed at Western and North-Eastern Kamchatka in different years unlike the previous period. Considering this, we have divided all the available data about the Palana River sockeye in generations of 1972–1981 and 1982–1999.

The average abundance of the Western Kamchatka pink salmon approaches to the coast in even years 1978–1984 (1986–2000) was made up of 36.9 (67.5) millions of fish, and in odd years 1977–1983 (1985–2001) – 80.6 (2.1) millions of fish. Starting in 1985 and up till present there has been a shift of abundant (dominant) generations from the odd years to even ones along with the change in pink salmon on this coast (Bugayev 2001). But this shift of pink salmon abundance has not considerably influenced the Palana River sockeye abundance.

Using the "STATISTICA" program we have calculated the coefficients of the multiple regression – R between the Palana River sockeye SMP and environmental factors and fish abundance by the forward stepwise method of inclusion at the generations of 1982–1995. In this work we have made a transform of all the initial indicators into natural logarithms as recommended by Borovikov and Borovikov (1998). Considering that for the Palana River sockeye the age at maturity for calculations was taken as 2.3, the abundance of SMP in this case is at the same time the abundance of generations (ZRPAL). This equation of the multiple regression looks like this:

LnZRPAL = 19.5504 + 0.0407*LnPINE-2 + 0.7758*LnSPKU – 0.4383*LnPINE-3 – 3.3311*LnLSMKU + 0.2658*LnPINW-0 + 0.1737*LnPINW-2 – 0.6267*LnOZZR + 0.2468*LnSPPAL + 0.0613*LnPINE-1; R = 0.997, P < 0.001, n = 14.

As it is seen from the equation of the multiple regression in our case the Palana River sockeye SMP is influenced by the following factors:

PINE-2 - the inshore run of mature North-East Kamchatka pink salmon (after driftnet harvesting) during the second year of marine life of sockeye salmon of the Palana River, which returned at the studied year (SY), millions of fish;

SPKU - the abundance of the parent escapement of sockeye of all the age groups spawned in the Kuril Lake at the year of spawning of the studied generation of the Palana River sockeye, which returned at the studied year (SY), in thousands of fish;

PINE-3 - the inshore run of mature North-Eastern Kamchatka pink salmon (after driftnet harvesting) during the third year of marine life of the Palana River sockeye, which returned at the SY, millions of fish;

LSMKU - the body length of the Kuril Lake sockeye smolts at the age 2+, from which the return of mature sockeye happens at the SY, mm;

PINW-0 - the inshore run of mature Western Kamchatka pink salmon (after driftnet harvesting) one year prior to ocean migration of sockeye smolts of the Palana River (from Palana Lake) at the age 2+, which returned at the SY, millions of fish;

PINW-2 - the inshore run of mature Western Kamchatka pink salmon (after driftnet harvesting) during the second year of the Palana River sockeye, which returned at the SY, millions of fish;

OZZR - the SMP of the Ozernaya River sockeye at ocean prior to the beginning of the driftnet harvesting at the SY, in thousands of fish;

SPPAL - the abundance of the parent escapement of sockeye of all the age groups spawned in the Palana Lake at the year of spawning of the studied generation of sockeye, which returned at SY, in thousands of fish;

PINE-1 - the inshore run of mature of the North-East Kamchatka mature pink salmon (after driftnet harvesting) during the first year of marine life of the Palana River sockeye, which returned at SY, millions of fish.

The analysis of the dynamics of the Palana River sockeye generations' abundance of 1972–1981 is now of historical and scientific interest only, and will not be of practical use until the abundance of the Western and North-Eastern Kamchatka pink salmon dominating generations does not fluctuate in phase again.

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